Department of Transportation

Metro Manila Subway Project (MMSP) Phase 1

Environmental Performance Report and Management Plan

Volume 1 Main Report

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LIST OF TECHNICAL NOMENCLATURE

Abbreviation	Definition
AFC	Automatic Fare Collection
AG	Automatic Gate
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATV	Acoustic Televiewer
AUV	Asian Utility Vehicle
BCDA	Bases Conversion and Development Authority
BOD	Biological Oxygen Demand
CAVITEX	Manila Cavite Expressway
CBD	Central Business District
CCC	Climate Change Commission
CENRO	City Environment and Natural Resources Office
CIA	Clark International Airport
CLUP	Comprehensive Land Use Plan
cm/sec^2	Centimeters per second squared
COD	Chemical Oxygen Demand
COP21	Conference of the Parties
dBA	Decibels A Weighted
DED	Detailed Engineering Design
DEM	Global Digital Elevation Model
DENR	Department of Environment and Natural Resources
DJF	Amihan season- December, January and February
DOTr	Department of Transportation
DO	Dissolved Oxygen
DOH	Department of Health
DAO	DENR Administrative Order
DDR/CCA	Disaster Risk Reduction and Climate Change Adaption
DepEd	Department of Education
DND	Department of National Defense
DOLE	Department of Occupation Labor and Employment
DP	Discharge Permit
DPWH	Department of Public Works and Highways
DSHA	Deterministic Seismic Hazard Assessment
DTI	Department of Trade and Industry
E/E	Entrance/Exit
ECA	Environmentally Critical Area
ECC	Environmental Compliance Certificate

Abbreviation	Definition
ECP	Environmentally Critical Project
EGF	Environmental Guarantee Fund
EGGAR	Engineering Geological and Geohazard Assessment Report
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EIS 2017	Environmental Impact Statement for Metro Manila Subway Project (MMSP)(Phase 1)
EMB	Environmental Management Bureau
EMMoP	Environmental Management and Monitoring Plan
ERA	Environmental Risk Assessment
FSPCC	Framework Strategy and Program on Climate Change
GHG	Greenhouse Gas
GMMA	Greater Metro Manila Area
GTHF	Grievance Handling Task Force
GWP	Global Warming Potential
ha	hectare
HWID	Hazardous Waste Generator's ID
IEC	Information, Education, Communication
IPCC	Intergovernmental Panel on Climate Change
ITS	North Integrated Transport Terminal
JICA	Japan International Cooperation Authority
JJA	Habagat season - June, July and August
km	Kilometers
kW	Kilowatt
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority
LOS	Level of Service
LPPCHEA	Las Piñas–Parañaque Critical Habitat and Ecotourism Area
LRT	Light Rail Transit
LULUCF	Land Use, Land Use Change and Forestry
m	meters
M	Magnitude
m^3	Cubic meter
MAM	Summer season – March, April and May
masl	Meters above sea level
mbgl	Meters below ground level
MCE	Maximum Credible Earthquake
MDFG	Millennium Development Goals Fund

Abbreviation	Definition
MGB	Mines and Geosciences Bureau
MLD	Million Liters per day
MMDA	Metro Manila Development Authority
MMICP	Metro Manila Interchange Project
MMSP	Metro Manila Subway Project
MMT	Multi-Partite Monitoring Team
MRT	Mass Rapid Transit
MVA	Megavolt-Amperes
NAAQGV	National Ambient Air Quality Guideline Value
NAAQS	National Ambient Air Quality Standards
NATM	New Austrian Tunneling Method
NAIA	Ninoy Aquino International Airport
NAMRIA	National Mapping and Resource Information Authority
NCR	National Capital Region
NEHRP	US National Earthquake Hazard Reduction Program
NGO	Non-Government Organization
NLEX	North Luzon Expressway
NPCC	National Pollution Control Commission
NSCR	North-South Commuter Railway
NSRP	North-South Railway Project
NWRB	National Water Regulatory Board
OCC	Operations Control Center
OCS	Overhead Catenary System
OTV	Optical Televiewer
P2P	Point to Point Bus
PAR	Philippine Area of Responsibility
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAGASA – CADS	Philippine Atmospheric, Geophysical and Astronomical Services Administration – Climatology and Agrometeorology
PEIS	PHIVOLCS Earthquake Intensity Scale
PEM	Philippine Earthquake Model
PFZ	Philippine Fault Zone
PGA	Peak Ground Acceleration
pH	Power of Hydrogen
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PMB	Philippines Mobile Belt
PNP	Philippine National Police

Abbreviation	Definition
PNR	Philippine National Railway
PPE	Personal Protection Equipment
PSD	Platform Screen Door
PSHA	Probabilistic Seismic Hazard Assessment
PSInSAR	Analysis of Persistent Scatterer Interferometric Synthetic Aperture Radar
PUJ	Public Utility Jeepney
PUV	Public Utility Vehicle
RAP	Resettlement Action Plan
RIMT	Resettlement Implementation Action Team
ROW	Right-of-Way
SCADA	Supervisory Control and Data Acquisition System
SCTEX	Subic Clark Tarlac Expressway
SDP	Social Development Plan
SLEX	South Luzon Expressway
SMDP	Barangay San Martin de Porres
SON	Transition from SW to NE monsoon season – September, October and November
SRES	Special Report on Emission Scenarios
TBM	Tunnel Boring Machine
TESDA	Technical Education and Skills Development Authority
TMP	Traffic Management Plan
TOD	Traffic Oriented Development
TSP	Total Suspended Particles
TSS	Total Suspended Solids
TVM	Ticket Vending Machine
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UPAO	City Urban Poor Affairs Office
UP NOAH	National Operational Assessment of Hazards of the University of the Philippines
USGS	United States Geological Survey
VFS	Valley Fault System
WHO	World Health Organization

EXECUTIVE SUMMARY

Project Fact Sheet

About the Project

The Department of Transportation (DOTr) in partnership with the Japan International Cooperation Agency (JICA) is proposing to construct the Metro Manila Subway Project (MMSP). This railway project is part of the Build Build Build Program of the current Philippine administration. This project has a total alignment length of 36 km running from its proposed depot Valenzuela City and to the proposed NAIA Terminal 3 Station and the interoperability area between the proposed FTI station and the Bicutan PNR Station. The project was given its Environmental Compliance Certificate (ECC) last October of 2017, **Annex ES.1-1**. However, due to a fault line discovered near the Cayetano Station, the alignment was shifted away from the fault line and thus was required to amend its ECC.

Including the additional components, the MMSP covers the following key components:

- Sixteen (16) subway stations including their corresponding;
  - Construction yards; and
  - Shield machine bases
- Underground sections in-between the stations;
- Valenzuela Depot;
- Interoperability area between FTI Station and Bicutan PNR Station; and
- Interconnections such as walkways, public utility vehicle (PUV) bays, etc.

The additional keycomponents:

- Three (3) new subwaystations;
  - Lawton East, Lawton West and NAIA Terminal 3 Stations
- The underground tunnels in-between the new stations; and
- The interoperability area between FTI Station and Bicutan PNR Station.

Name of the Project

Metro Manila Subway Project (MMSP) Phase 1

Project Proponent

Department of Transportation (DOTr)

Project Locations

Valenzuela City

- Barangay Ugong

Makati City

- Barangay East Rembo

Taguig City

- Barangay Fort Bonifacio
- Barangay Western Bicutan

Quezon City

- Barangay Talipapa
- Barangay Tandang Sora
- Barangay Bagong Pagasa
- Brgy. Project 6
- Barangay Pinyahan
- Barangay Bagumbuhay
- Barangay Blueridge A
- Barangay St. Ignatius

Pasig City

- Barangay Ugong
- Barangay San Antonio
- Barangay Oranbo
- Barangay Kapitolyo

Pasay City

- Barangay 183

Parañaque City

- Barangay San Martin de Porres
- Barangay Mervile

- Barangay Bayanihan
- Barangay White Plains
- Barangay Santo Cristo
- Barangay Tandang Sora
- Barangay Malaya
- Barangay Sikatuna Village
- Barangay East Kamias
- Barangay Quirino 2A
- Barangay Quirino 3A
- Barangay Milagrosa
- Barangay Project 6

Nature of the Project

Railway Project with Depot

Total Alignment Length

36 km

Previous ECC

ECC CO 1709-0017 (Issued: 25 October 2017)

Project Components

Retained Old Alignment Components

- Valenzuela Depot
- Quirino Highway Station
  - Underground Tunnel Between Quirino Highway Station and Tandang Sora Station
- Tandang Sora Station
  - Underground Tunnel Between Tandang Sora Station and North Avenue Station
- North Avenue Station
  - Underground Tunnel Between North Avenue Station and Quezon Avenue Station
- Quezon Avenue Station
  - Underground Tunnel Between Quezon Avenue Station and East Avenue Station
- East Avenue Station
  - Underground Tunnel Between East Avenue Station and Anonas Station
- Anonas Station
  - Underground Tunnel Between Anonas Station and Katipunan Station

New Alignment Components

- Kalayaan Station
  - Underground Tunnel Between Kalayaan Station and Bonifacio Global City Station
- Bonifacio Global City Station
  - Includes the construction yards and shield machine bases for the aforementioned stations and underground tunnels
  - Underground Tunnel Between Bonifacio Global City Station and Lawton East Station
- Lawton East Station
  - Underground Tunnel Between Lawton East Station and Lawton West Station
- Lawton West Station
  - Underground Tunnel Between Lawton West Station and FTI Station
  - Underground Tunnel Between Lawton West Station and NAIA Terminal 3 Station
- NAIA Terminal 3 Station (Two Alignment Options for this Station)

- Katipunan Station
  - Underground Tunnel Between Katipunan Station and Ortigas North Station
- Ortigas North Station
  - Underground Tunnel Between Ortigas North Station and Ortigas South Station
- Ortigas South Station
  - Underground Tunnel Between Ortigas South Station and Kalayaan Station
- FTI Station
  - Alignment Between FTI Station and Bicutan PNR Station for interoperability with the North South Commuter Railway (NSCR) Project
- Includes the construction yards and shield machine bases for the aforementioned stations and underground tunnels

Indicative Project Cost

PhP 356,964.17 Million

Proponent Address

Sergio Osmeña Road, Clark Freeport, Mabalabat, Pampanga

Proponent Representative

Atty. Arthur P. Tugade, DOTr Secretary

Proponent Contact Details

(632) 790-8300

EIA Process Documentation

Process Brief

The ECC amendment and the EIA process undergone for the MMSP was conducted in accordance with Philippine EIA legislation:

- Presidential Decree 1586 (PD 1586)
- DENR Administrative Order No. 15 Series of 2017 (DAO 2017-15)
- DENR Administrative Order No. 30 Series of 2003 (DAO 2003-30)
- DENR Administrative Order No. 09 Series of 2001 (DAO 2001-09)
- EMB Memorandum Circular No. 005 Series of 2014 (EMB MC 2014-005)
- EMB Memorandum Circular No. 002 Series of 2010 (EMB MC 2010-002)

Based on the project screening guideline in EMB MC 2014-005, the proposed project is an Environmentally Critical Project that is located in a non-Environmentally Critical Area. The amendment of the ECC of the MMSP will require the conduct of an Environmental Performance Report and Management Plan (EPRMP) and its submission to Environmental Management Bureau – Central Office (EMB-CO).

EIA Preparer

AECOM Philippines Inc.

Study Team Composition

Role/Specialization	Name	EIA Preparer Registration No.
Project Director/EIA Specialist/Peer Reviewer	Kathleen Anne Cruz	IPCO-164
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Environmental Risk Assessment Specialist	Richard Andal	IPCO-158

EIA Study Schedule

EIA Schedule 2017

Activity	Schedule	Venue / Area
Field studies		
Site survey	January to July 2017	Entire MMSP alignment
Landscape survey	May 5, 2017	Depot site in Brgy. Ugong, Valenzuela
Flora survey	April 28, July 5-18	Depot site in Brgy. Ugong, Valenzuela and all proposed stations
Ground vibration measurements	March 27 – May 4, 2017	MMSP alignment locations
Surface water quality sampling	March 1, 2017	All rivers along the MMSP alignment
Ambient air quality sampling	Dry season (March 27 – May 3, 2017) Wet season (July 10 – 27, 2017)	MMSP alignment locations
Noise measurements	March 27 – May 3, 2017 and July 10 – 27, 2017	MMSP alignment locations
Historical/Cultural heritage	May 18, 2017	BGC, Taguig City
Consultation[1]		
IEC meetings with LGUs for pre-scoping activity to introduce MMSP	December 6, 2016 – March 18, 2017	Quezon City, Caloocan City, Valenzuela City, Taguig City, Makati City, Pasig City and Parañaque City
Stakeholders' consultation	March 9 – April 17, 2017	Makati City, Taguig City, Pasig City, Quezon City,

[1] Full details included in Annex ES.1-1

meetings for environmental consideration and public scoping		Parañaque City and Valenzuela City
Public consultation for RAP	May 15 – 24, 2017	San Antonio, Blue Ridge, Bagumbuhay, Pinyahan, St. Ignatius, Talipapa, Tandang Sora
	April 18 – May 2, 2017	Quezon City, Makati City, Parañaque City, Pasig City, Taguig City, Valenzuela City
	June 5 – July 21, 2017	Bagumbuhay, Bayanihan, Blueridge, Kapitolyo, Merville, Oranbo, San Antonio, St Ignatius, Ugong, Bagong, Pinyahan, West Rembo, Quezon City, Makati City, Parañaque City, Pasig City, Taguig City, Valenzuela City
Public Hearings		
Public hearing – Pasig City, Makati City, Taguig City and Parañaque City	Sept 5, 2017	10th Flr. Kalayaan Hall, SM Aura Office Tower, Taguig City
Public hearing – Quezon City	Sept 6, 2017	3rd Flr., EPWMD Conference Room, Quezon City Hall
Public hearing – Valenzuela City	Sept 7, 2017	Roliing Hills Resort, Brgy. Ugong, Valenzuela City
ECC Granted	October 25, 2017	DENR- EMB Central Office

EIA Schedule 2019

Activity	Schedule	Venue / Area
Consultation		
IEC activities – Stakeholder consultation meetings	October 8 – 9, 2018	Training Room, Action Center, Brgy. Dalandanan, Valenzuela City
IEC activities – social preparation and scoping activities	May 16 – June 3, 2019	City Planning of Taguig, City Planning and Engineering of Pasay, Pasay Barangay 183, City Planning of Parañaque, Taguig Barangays (Bicutan and Fort Bonifacio) and Parañaque Barangays (San Martin De Porres)
Perception surveys	May 30 and June 4, 2019	Pasay City, Taguig City and Parañaque City
Public Scoping	July 1, 2019	Covered courts of United Hills Village, corner of Atis St. and Narra St, Parañaque
Technical Scoping	July 17, 2019	EMB Central Office
Field studies		
Ambient air quality and noise sampling	June 20-23, 2019	NAIA Terminal 3, Sitio Fort Bonifacio Health Center and Dr Arcadio Santos National High School
Wildlife surveys	June 29 – 30 and July 6 – 7, 2019	Bonifacio Global City, Lawton West and East and FTI
Perception surveys	May 30-31 and June 3, 2019	Barangay 183, Villamor (Pasay City), Barangay Fort Bonifacio (Taguig City) and Barangay San Martin de Porres (SMDP) (Parañaque City)

Vegetation surveys	June 18 – 20 and July 21, 2019	Bonifacio Global City, Lawton West and East and FTI
Traffic surveys	July 5 and July 8, 2019	NAIA Terminal 3 and FTI
Vibration surveys	July 4 – 7, 2019	Shrine of St. Therese of the Child Jesus, American Manila Cemetery and Administration building of United Hill Village
Technical Scoping	July 16, 2019	DENR – EMB Central Office
Submission of EPRMP to DENR for Procedural Screening	July 26, 2019	DENR – EMB Central Office
Public Hearing		
Public Hearing	September 3, 2019	TESDA, Taguig City
ECC completion	September 30, 2019	DENR – EMB Central Office

Study Area

This EPRMP will assess the environmental impacts and mitigations of the project throughout its 36 km alignment. However, particular focus will be given to the new shifted alignment. The succeeding presents a summary of the project components and the new components resulting from the shifting of the alignment.

As a whole, the alignment MMSP covers the following key components:

- Sixteen (16) subway stations including their corresponding;
    - Construction yards; and
    - Shield machine bases
- Underground sections in-between the stations;
- Valenzuela Depot;
- Interoperability area between FTI Station and Bicutan PNR Station; and
- Interconnections such as walkways, public utility vehicle (PUV) bays, etc.

EIA Methodology

The methodologies employed for the EIA are in accordance with the study guidelines stated in the EMB MC 2014-15, DAO 2017-15 and the requirements set forth by the EIA Review Committee during the Technical Scoping Meeting for the ECC application process.

Module	Methodology	Source of Information / Data
Land Use and Classification	Review and analysis of secondary data on land use of the proposed project area	• Comprehensive Land Use Plans
	Georeferenced, digitized, generate and overlaid on Project Development using Geographic Information System and ground truthing. Extract lad cover data using GIS	• Open Source Satellite imageries (Google Earth, Open Street Map)
Geology, Geomorphology and Geomorphology	Assessment of geohazard susceptibility using secondary data, slope gradient analysis via ArcMap (v.10) software and historical earthquake records	• Academic studies and reports from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) • Geological Hazard Maps released by PHIVOLCS, Mines and Geoscience Bureau (GMB) and National Operational Assessment of Hazards of the University of the Philippines.
	Review of historical geology of the project area	• National Mapping Resource Information Administration (NAMRIA) base maps

Pedology	Review and analysis of secondary data on soil types of the proposed project area	• Environmental Impact Statement (EIS) for Metro Manila Subway Project (MMSP; Phase 1) • Carating, R., Galanta, R., & Bacatio, C. (2014). *The Soils of the Philippines*. (A. Hartemink, Ed.) Madison, Wisconsin, USA: Springer. • BSWM. (2019, July). *Soil types of the Philippines.* (B. o. Management, Producer) Retrieved from Geoportal Philippines: http://www.geoportal.gov.ph/
Terrestrial Ecology	Review and analysis of secondary data on terrestrial ecology of the proposed project area Transect walk and walk-through survey Density, frequency and dominance calculation	• Environmental Impact Statement (EIS) for Metro Manila Subway Project (MMSP; Phase 1) • DENR Administrative Order No. 2017 – 11; Updated National List of Threatened Philippine Plants and Their Categories • Republic of the Philippines - Congress of the Philippines. Wildlife Act – Republic Act No. 9147 (2001). Metro Manila. • International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2019 • AECOM. 2018 Rapid Site Assessment of Filinvest City as Part of LEED Accreditation Process. • Bajarias, A. (2016). A Field Guide to Flight: Identifying Birds on Three School Grounds (pp. 1-142). Quezon City: Ateneo de Manila University Press. • Birds of the Philippines - Ayala Alabang Birds. Retrieved 25 July 2019, from https://www.tonjiandsylviasbirdlist.com/Birds-By-Location/Ayala-Alabang-Birds/ • Cuyegkeng, A., Favis, A., Gotangco, K., & Tan, M. (2014). Ateneo de Manila University Sustainability Report - July 2014. • de Guia, M. 2018 (unpublished). Bird Watching Observations near the northern perimeter fence of Forbes Park • The Convention on International Trade of Endangered Species of Flora and Fauna| CITES. (2019). Retrieved 25 July 2019, from https://www.cites.org/eng/disc/species.php • Vallejo, B., Aloya, A., Ong, P., Tamino, A., & Villasper, J. (2008). Spatial Patterns of Bird Diversity and Abundance in an Urban Tropical Landscape: The University of the Philippines (UP) Diliman Campus. Science Diliman, 20(1), 1-10.
Hydrology and Hydrogeology	Review of secondary hydrologic data	• Hydro-meteorological and hydrological monitoring data from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA); • Groundwater availability map from Mines and Geosciences Bureau (MGB); • Data from the NWRB; • Data from the MMSP EIS (2017); • Data from available Comprehensive Land Use Plans (CLUP) of cities that will be traversed by the MMSP; • NWRB permit grantees data and • Data from other published technical information.
Water Quality	Review of secondary water quality data	• Water quality monitoring data from DENR for Tullahan River, San Juan River, Paranaque River, and Maricaban Creek; • Water quality monitoring data from the Pasig River Rehabilitation Commission; • Data from the MMSP EIS (2017);

		• Data from available Comprehensive Land Use Plans (CLUP) of cities that will be traversed by the MMSP; and • Data from other published technical information.
	Water quality sampling and analysis using AS/NZS 5667.1:1998 and US EPA (2007) standards	• Completed as part of MMSP EIS (2017)
Aquatic Ecology	Review and analysis of secondary data on aquatic ecology of the proposed project area	• Modified Visual Stream Assessment Protocol: A Field Guide. Magbanua et al. (2013) • The use of a Stream Visual Assessment Protocol to determine ecosystem integrity in an urban watershed in Puerto Rico. de Jesús-Crespo, R., & Ramirez, A. (2011). • Australian river assessment system: AusRivAS physical assessment protocol. Parsons, et al. (2002)
	Visual stream habitat field survey	
Climate and Meteorology	Analysis of weather station data	• PAGASA Climate and Agrometeorological Data Section (2018) Normals and Extremes from NAIA Terminal 3 and Science Garden Synoptic Weather Stations
	Analysis of general climate	• Climate Classification of the Philippines first established by Coronas (Coronas, 1920) and slightly modified by PAGASA (Flores & Balagot, 1969; Kintanar, 1984) • Tropical Cyclone Frequency Map (The Manila Observatory)
	Wind analysis using Windrose PRO	PAGASA Climate and Agrometeorological Data Section (2018) 30-year Daily Wind Data from NAIA Terminal 3 and Science Garden Synoptic Weather Stations
	Analysis of Climate Change Projections in Metro Manila	• PAGASA Climate Change Projections (2011)
Greenhouse Gas Assessment	GHG Inventory Calculations	• Calculations based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the Principles of GHG Accounting and Reporting in the Greenhouse Gas Protocol, and ISO 14064:2006 Parts 1 and 2
	Comparison to Philippine and global emissions	• Computed GHG emissions were compared to the global and Philippine Emissions data from: o Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectors; Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change o Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change o Philippines. Second National Communication to the United Nations Framework Convention on Climate Change
Air Quality	Review of baseline ambient air quality	• Baseline ambient air data were reviewed and collected from the project's previous EIS conducted by Delta Tierra Consultants, Inc. (2017)
	Primary sample collection of TSP, PM_{10}, SO_2, and NO_2 for additional sites	• The additional ambient air quality sampling was performed with reference to the ambient air sampling protocols and analytical procedures specified in DAO 2000-81 (Implementing Rules and Regulations (IRR) of the Philippine Clean Air Act of 1999): o TSP – High volume, gravimetric; o PM_{10} – High volume with PM_{10} inlet, gravimetric o SO_2 – Gas Bubbler – Colorimetric Pararosaniline o NO_2 – Gas Bubbler – Griess-Saltzman

Noise	Review of baseline noise measurements	• Baseline noise data were reviewed and collected from the project's previous EIS conducted by Delta Tierra Consultants, Inc. (2017)
	Primary noise measurements for new sites	• Noise levels were measured using a sound level meter meeting the requirements of IEC 61672-1
Socio-economics and Demographics	Review of secondary socio-economic data	• Comprehensive Land Use Plans (CLUPs) of host municipalities / NCR Regional Development Plan • Socio-Economic Profiles • Official websites (e.g. host LGUs)
	Conduct of IEC, focus group discussions (FGDs) and key informant interviews (KIIs)	
	Conduct of social perception survey	
Environmental Risk Assessment	Determination of Level of Coverage	• Annex 2-7e DAO 2003-30
	Determination of Risk Levels	• Risk Matrix

EIA Summary

Summary of Baseline Characterization

The schedule of activities conducted for the EIA of the Project is presented below.

Baseline Information	Key Findings and Conclusions
Land Cover	The whole region of Metro Manila is classified under the Land Cover type of Built-up areas and Arable lands crops mainly cereals and sugar. Parts of the MMSP alignment traverse across the land classification of Arable lands (7.5%) while majority of the alignment falls under the Built-up zone classification (74%).
Land Use	The identified Land Use of the MMSP disturbance footprint are Residential (40%), Mixed Use (17%), and Commercial (16%). This is based from the consolidated Zoning Plans from the different cities which will be affected by the project.
Land Utilization	Upon visual inspection of the Google Earth images, it can be concluded based from this study that the MMSP Components (construction yard, underground station boxes, and the interconnection between stations) that the actual land use in the ground would mostly affect Commercial lands and Institutional zones, in general. The area of the proposed depot can be generalized as an Industrial zone. While, the FTI Station is within the Medium-density Residential zone.
Protected Area	The nearest declared Protected Areas (PAs) from the MMSP is the Ninoy Aquino Parks and Wildlife Center (NAPWC), which is around 740 meters southwest north-east away from MMSP, and the Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA) which is around 5.3 km south-west away from MMSP. The

	MMSP has no significant influence to both declared PAs.
Impact to the Land Use	The impact of the MMSP during pre-construction would be the displacement of the residents within the Residential zones especially in the construction the envisioned transportation hub in FTI Station. Also, rights-of-way of the villages (entrance and exit) along East Service Road would be a possible impact alongside with the potential vehicular traffic congestion during construction of the project. Furthermore, during the earl stage of the operation, the vehicular traffic would be displaced to the other roads/routes. The development of a Station within the vicinity of McKinley West Village (Lawton East Station) will be a threat to the amenities (e.g. solemnity and privacy of the place; and view value from the real estate properties) would eminent. Though, it is expected that land values would rise near the alignment of the project.
Topography	The MMSP alignment is located within the Central Plateau region of Metropolitan Manila, with elevations ranging from 6 – 54 masl and slope gradients of 0 – 8 %.
Hydrogeologic Setting	The MMSP alignment will cross at least 11 rivers and creeks, including major rivers like the Pasig River, San Juan River and the Tullahan River.
Geodynamic Setting	The MMSP alignment is located within a seismically active region of the Philippines affected by active subduction (Manila Trench), fault movement (West Valley Fault), and Recent volcanism (Taal Caldera, Mt. Pinatubo and Laguna Caldera).
Local Geology	The MMSP track will burrow through mostly Guadalupe Formation tuff underlain with up to 10 m residual soil along its alignment. The Vs30 model from PHIVOLCS shows that the East Avenue to Ortigas Stations has shear-wave velocities ranging from 760 – 1500 m/sec, indicating NHERP Site Class B (rock) condition. The rest of the alignment has Vs30 ranging from 360 – 760 m/s, indicating Class C (hard soil) condition.
Structures	The MMSP alignment has been designed to avoid the known trace of the West Valley Fault. The alignment is closest to this fault along the segment from Ugong Norte to Capitol Commons in Pasig, with distances of 150 – 700 m. Initial borehole scan results show presence of structural defects such as joints, fractures, shears, etc. in each surveyed hole, indicating that the foundation is layered and non-massive.
Seismic Hazards	The MMSP alignment may experience ground shaking of 0.371 – 0.662 g caused by a Magnitude 7.2 movement of the West Valley Fault. This is equivalent to PEIS Intensity VIII (i.e. Very Destructive) shaking. Other potential strong earthquake generators are the East Valley Fault, Laguna – Banahaw Fault, Philippine Fault Zone (Infanta Segment) and the undetermined source of the 1863 Manila earthquake. Probabilistic Seismic Hazard Assessment, as presented in the Philippine Earthquake Model by PHIVOLCS, show 0.35 – 0.5 g shaking along the MMSP alignment with a 10% probability of exceedance in 50 years (i.e. 500-year return period). 0.45 – 0.7 g shaking along the alignment is predicted to have 5% probability of exceedance in 50 years (i.e. 2,500-year return period). The MMSP alignment avoids the known trace of the West Valley Fault, so ground rupture resulting from its movement is unlikely along the track. However, unmapped buried splays of the fault may possibly be encountered while drilling. The MMSP alignment is founded on soil that is generally not susceptible to liquefaction. The exception is along the Pasig River crossing, which is highly susceptible to liquefaction. Most of the MMSP alignment lies within areas that are not susceptible to earthquake-induced landslide, except for segments between the Katipunan Avenue in Pasig and McKinley Parkway in Taguig.

	The MMSP alignment is not susceptible to tsunami due to its distance (3.8 km at the NAIA T3 Station and 1.9 km from the Bicutan Interconnection) and elevation (13 and 37 masl, respectively) from the coast.
Pedology	The soils along the Depot to Ortigas South Station belong to the Novaliches series, except for the Katipunan Station which is underlain with Marikina series soil. From the Kalayaan Station down to the NAIA T3 Station and Bicutan Interconnection, the soil cover belongs to the Guadalupe soil series. Both Novaliches and Guadalupe series soils are derived from Guadalupe Formation tuffs (Diliman Tuff member), while the Novaliches series soil developed from alluvial deposits within the Marikina Valley.
Mass Movements	The MMSP alignment is located in areas that are not generally susceptible to landslide. A higher susceptibility rating (i.e. Low) is given to significant portions of the proposed alignment within Quezon City, from Quirino Highway Station down to Katipunan Station. The proposed stations in Pasig—Ortigas North Station and Ortigas South Station, also are within an area of Low rainfall-induced landslide susceptibility. The southern segment, from Kalayaan Station to FTI Station are not susceptible to landslide. The Depot is the component of the MMSP most susceptible to subsidence, as shown in the PSInSAR map indicating local subsidence in that area due to extensive groundwater extraction.
Hydrological Hazards	The MMSP alignment is located on areas that have generally No to Low flooding susceptibility, except along portions that intersect rivers and creeks where flooding susceptibility can be Moderate to High. Almost the entire segment from Ortigas North Station down to NAIA T3 and Bicutan are located in areas that have Low susceptibility to flooding. The MMSP alignment is not susceptible to coastal hazards such as storm surge, tsunami and sea level rise resulting from climate change or coastal subsidence due to its distance (3.8 km at the NAIA T3 Station and 1.9 km from the Bicutan Interconnection) and elevation (13 and 37 masl, respectively) from the coast.
Volcanic Hazards	The MMSP alignment can be affected by strong ground shaking, resulting from explosive eruptions of Taal Volcano. Being largely underground, it is not susceptible to ashfall.
Land Cover and Terrestrial Vegetation Community Structure	Two unique land cover types were identified from the most recent land cover map from NAMRIA, which includes (1) built-up areas and (2) arable lands for crops. Based on the vegetation surveys (EIS 2017 and additional studies (2019), vegetation communities were mainly comprised of arborescent species interspersed in the remaining green spaces in the NCR.
Flora Species Inventory	**EIS (2017)** Recorded a total of 217 plant species belonging to 88 genera and 69 Families along the proposed 13 stations and train depot. Taxa richness were as follows: 86 species of trees, 43 species of herbs, 39 species of shrubs, 16 species of climbers, 13 species palms, 12 species of fodder grasses, 3 species of ferns, 2 species of erect bamboos, one (1) species of sedge, one (1) species of pandan, and one (1) species of orchid. **Additional Assessment (2019)** A total 98 morpho-species in 82 genera and 36 Families were recorded along the four (4) transects. Dominant families were Fabaceae (13 species), Moraceae (10 species), Arecaceae (6 species), and Myrtaceae (5 species). The most frequently occurring species were *Pterocarpus indicus* (Narra; 272 individuals), *Swietenia macrophylla* (Big leafed mahogany; 97 individuals), *Terminalia catappa* (Talisai; 77 individuals), *Albizia saman* (Akasya; 66 individuals), and *Delonix regia* (Fire tree; 35 individuals).
Endemicity and	**EIS (2017)**

Conservation Status of Plants	Of the 217 species, only three (3) species were Philippine endemic, namely *Ficus ulmifolia* (Is-is), *Artocarpus blancoi* (Antipolo), and *Caryota mitis* (Pugahang Sui). Sixty-three species (29%) were considered indigenous/native to the Philippines, with existing natural distributions extending beyond the region. The remaining 151 species (70%) are all introduced/exotic. A total of nine (9) species were categorized under IUCN 2019 and DAO 2017-11. Noteworthy among the list were *Adonida merrillii* (Manila palm), *Dypsis lutescens* (Butterfly palm), *Hyophorbe lagenicaulis* (Champagne palm), *Pterocarpus indicus* (Narra), *Vitex parviflora* (Molave), *Swietenia macrophylla* (Big leafed mahogany), *Artocarpus blancoi* (Antipolo), *Ficus ulmifolia* (Is-is), and *Nephelium lappaceum* (Rambutan). **Additional Assessment (2019)** Of the 98 morpho-species, only four (4) species were endemic to the Philippines. These include *Ficus balete* (Balete), *Ficus pseudopalma* (Niog-niogan) and *Ficus ulmifolia* (Is-is). The other endemic species is a Batanes- endemic gymnosperm called *Podocarpus costallis* (Arius). There were eight (8) species recorded that are classified as threatened under the updated national list of threatened Philippine plants and their categories (DAO 2017-11) and/or the IUCN Red list of threatened species (2019-1). These are *Podocarpus costalis* (Arius), *Pterocarpus indicus* (Narra), and *Ficus ulmifolia* (Is-is). *Podocarpus costalis* (Arius), an endemic species from Batanes is categorized as endangered under DAO 2017-11 and IUCN 2019-1. *Pterocarpus indicus* (Narra) is categorized as endangered in IUCN 2019-1 and
Density, Frequency and Dominance of Plants	vulnerable in DAO 2017-11. Lastly, *Ficus ulmiforlia* (Is-is), an endemic species recorded during opportunistic survey is categorized as vulnerable under IUCN 2019-1. Summary of the computed species diversity index values for EIS (2017) and the additional assessment (2019) are presented in the tables below: **EIS (2017) and Additional Assessment (2019)**

Station	Diversity Index (H)
Quirino Highway Station	2.57
Tandang Sora Station	1.23
North Avenue Station	2.33
Quezon Avenue Station	2.07
East Avenue Station	2.31
Katipunan Avenue Station	2.39
Ortigas North Station	2.21
Ortigas South Station	2.18
Kalayaan Avenue Station	0.89
Bonifacio Global City Station	0.00
FTI Station	2.57
Transect 1 (T1)	3.35
Transect 2 (T2)	0.97
Transect 3 (T3)	1.93
Transect 4 (T4)	2.17

Vulnerability to Climate	Expected sporadic increases in terms of ambient temperatures and extreme weather conditions (i.e., high

Change of Plants	precipitation events, strong typhoon-mediated winds, intense irradiance) in the coming decades could potentially impact the optimal growth rate, mortality rate, and survival rate of various tree species found within and near the surveyed areas.
Hydrology and Hydrogeology – Drainage system of the project	The entire MMSP project site is located within the Manila Bay Catchment Area, and straddles seven catchments that form part of the Pasig-Marikina-Laguna de Bay Basin. The Laguna de Bay Basin is one of the four major river basins of the Manila Bay Catchment Area. The seven catchments traversed by the MMSP alignment include the Tullahan River Catchment, San Juan River Catchment, Marikina River Catchment, Pasig River Catchment, Pateros River Catchment, Paranaque River Catchment, and Muntinlupa River Catchment. The alignment will cross at least 9 rivers/creeks, albeit underground, except for the Talipapa creek that will be directly crossed by the Quirino Highway Station.
Flooding	The MMSP alignment traverses areas along Metro Manila that have moderate to high flooding susceptibility. These areas include the Valenzuela Depot, Quirino Highway Station, Tandang Sora Station, Quezon Avenue Station, East Avenue Station, Katipunan Station, Anonas Station, Lawton East Station, Lawton West Station, and FTI Station.
Groundwater Environment	The area traversed by the MMSP consists of Class I (B) and Class I (C) aquifers. Class I (B) aquifers are fairly extensive and productive aquifers with moderate to high permeability while Class I (C) aquifers are considered local and less productive aquifers, with well yields mostly about 2 L/s but as high as 20 L/s in some sites. A total of 46 deep wells have been granted by the NWRB within a 1 km radius of the MMSP realignment site. As per the NWRB water listing, the static water level and drawdown of deepwells with available pumping test data located within the 1 km radius of the subway alignment ranged from 21.31 to 141.73 meters below ground level (mbgl) and 5.30 to 21.34 mbgl.
Water Users	Metro Manila's water supply is provided by the Manila Water Company, Inc. (MWCI), and Maynilad Water Services, Inc. (MWSI). Individual houses in Metro Manila not connected to MWCI's or MWSI's distribution system have their own wells or get their water from communal wells. A walkthrough survey of some of the host communities of the MMSP expansion site in Taguig City and Pasay City identified at least 20 perennial wells with approximate depths ranging from 9 to 20 m (based on information from well owners). These wells are used by residents for domestic purposes such as drinking (boiled prior to consumption), cooking, bathing, and cleaning.
Surface water quality	Tullahan River, San Juan River, Pasig River, and Maricaban Creek are currently heavily polluted and have poor water quality, with elevated concentrations of BOD, DO, phosphates, and fecal coliform that exceed the DAO 2016-08 Class C WQG
Groundwater quality	Water from the two groundwater deep wells sampled during the 2017 EIS meet the PNSDW except for fecal coliform levels in the Valenzuela City deepwell. Both deep wells are rarely used by the community and are used only as a back- up source of water supply (Delta Tierra Consultants, Inc., 2017).
Water quality - Existing sources of pollution	Sources of pollution that contribute to the degradation of Tullahan River, San Juan River, Pasig River, Maricaban Creek and Paranaque River include solid wastes from domestic, commercial, and industrial activities, and wastewater discharges from households, commercial/institutional establishments, and industries
Aquatic ecology	• Maricaban Creek

	Channel flow across the waterway is apparently low. Coupled with altered stream channel as a result of built-up concrete structures (i.e., perimeter walls, concrete ledges, bank reinforcements), having reduced channel flow entails less available microhabitat for resident aquatic biota. stream velocity and depth regime is somehow complex, as evidenced by the mixture of slow-deep and slow-shallow areas. Bank stability is good due to the observable bank strengthening components from both banks. Observed bank vegetative zone was relatively good. Notable riparian species include different varieties of figs (Ficus sp.) along the majority of the creek margin, which are important food sources for various insect and pollinator species thriving in the area. Sediment deposition was not common for the most part of the creek and canopy cover was variable. Overall, stream health in Maricaban Creek falls under the poor condition rating. • Don Galo Creek Low gradient stream courses through a highly residential area, with characteristic bank fortification structures along the entire surveyed stream channel. Channel flow was relatively good and comparatively higher in that the volume of water present in the channel reaches the majority of the stream cross-sectional area. Sparse vegetation communities were interspersed along the margins of the creek, as the bank vegetative zone width is reduced as a result of the construction of concrete-enriched stream banks. Canopy cover was relatively fair and could be attributable to the patchy distribution and dispersed orientation of the vegetation species in the immediate riparian buffer, whereas the vegetation zone width was low. Overall, the stream health in Don Galo Creek falls under the poor condition rating.
General Climate	• The project site is in an area classified as Type I based on the Modified Coronas' Classification. This climate type is characterized as having two pronounced seasons: dry from November to April and wet during the rest of the year. Maximum rain period is from June to September.
Monthly Rainfall	• The total monthly raindfall at the PAGASA synoptic weather station in NAIA Terminal 3 ranges from 4 mm (March) to 418.4 mm (August). The total annual rainfall amounts to 1,767.90 mm with an annual number of rainy days of 105 days or approximately 29% of the year. The rainfall in the PAGASA synoptic weather station in Science Garden were higher. The total rainfall ranges from 14.6 mm (February) to 504.2 mm (August) with a total annual rainfall of 2,574.30 mm. The annual number of rainy days is 151, corresponding to 41.4% of the year. • The highest daily rainfall recorded at the NAIA Terminal 3 was 472.4 mm on July 20, 1972. For the PAGASA Science Garden weather station. The highest daily rainfall was 455.0 mm on September 26, 2009 during Typhoon *Ondoy* (International name Ketsana)
Temperature	• At NAIA Terminal 3, the mean temperatures ranged from 26.1 °C (January) to 29.7 °C (May), with an annual average mean temperature of 27.8 °C. Although the temperature ranges (difference between maximum and minimum temperatures) are higher in Science Garden, the average annual mean temperature is similar (27.7 °C). The coldest month is January (25.7 °C) while May is the hottest (29.7 °C). In both weather stations, temperatures are usually higher the MAM period and lower during the DJF period. • The highest temperature recorded in NAIA Terminal 3 was 38.2 °C on May 18, 1969, while the coldest was 14.6°C on February 1, 1962. At the PAGASA Science Garden, the highest temperature was 38.5 °C on May 14, 1987, while the coldest was 14.9 °C on March 1, 1963
Relative Humidity	• The annual average relative humidity are 76% (NAIA Terminal 3) and 78% (Science Garden). August and

	September are the most humid months with average relative humidity of 76% and 79%, respectively, while the month of April is the least humid at 67% in both weather stations.
Wind	• Long-term wind data indicate that the average wind speeds in NAIA Terminal 3 and PAGASA Science Garden ranges from approximately 2.2 m/s to 3.2 m/s, and 1.9 m/s to 2.3 m/s, respectively. Based on the Beaufort Wind Force Scale, these wind speeds are classified as 'light breeze.' • Wind rose analysis of the 30-year daily wind data at the PAGASA synoptic weather station in NAIA Terminal 3 shows that the prevalent wind direction is to the west, east, and southeast directions. The wind directions are to the east and southeast directions during the months of October to April and starts to shift to the west in May, lasting until September. At the PAGASA synoptic weather station in Science Garden, the wind direction throughout the year is predominantly to the north. From October to April, the predominant wind direction is to the north, and shifts to the south and southwest directions from May to September. These characteristics are consistent with the two principal airstreams that dominate the Philippines: the Northeast Monsoon (*Amihan*) which prevails from October to April and the Southwest Monsoon (*Habagat*) which is prevalent from May to September. • Polynomial trend analysis shows that the average monthly wind speed in NAIA Terminal 3 based on the 1989 to 2018 dataset is highest during the MAM season and lowest in SON. In Science Garden, the windspeeds were highest during the JJA season and lowest during the DJF season.
Tropical Cyclone	• The project site is in an area traversed by 24 tropical cyclones in 12 years (two tropical cyclones per year)
Climate Change Projection for Rainfall	• The simulations indicate that for the medium-range emission scenario, rainfall is expected to decrease during the dry seasons (DJF and MAM) and increase during the wet seasons (JJA and SON) in both time-slices, making the dry season drier and the wet season wetter.
Climate Change Projection for Temperature	• The results of the simulation show that ambient mean temperatures have an increasing trend in 2020 and 2050 from the baseline. For the medium-range emission scenario, the temperature will range from 27.1 °C to 29.9 °C in 2020 and 29.3 to 30.9 °C 2050. In both 2020 and 2050 time slices, MAM is projected to be the warmest season every year.
Global Greenhouse Gas Profile	• Total anthropogenic GHG emissions have continued to increase over 1970 to 2010 with larger absolute decadal increases toward the end of this period. • CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% of the total GHG emission increase from 1970 to 2010, with a similar percentage contribution for the period 2000-2010. • About half of cumulative anthropogenic CO_2 emissions between 1750 and 2010 have occurred in the last 40 years. • Annual anthropogenic GHG emissions have increased by 10,000 million tonnes of CO_2-e between 2000 and 2010, with this increase directly coming from energy supply (47%), industry (30%), transport (11%), and buildings (3%) sectors. Accounting for indirect emissions raises the contributions of the buildings and industry sectors. • Globally, economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. The contribution of population growth between 2000 and 2010 remained roughly identical to the previous three decades, while the contribution of economic growth has risen sharply.

	• The IPCC Fifth Assessment Report (AR5) estimated that the worldwide anthropogenic greenhouse gas emissions totaled nearly 49 billion tonnes of CO_2-e in 2010.
Philippine Greenhouse Gas Profile	• An inventory of GHG emissions conducted in 2000 showed that the Philippines emitted approximately 21.767 million tonnes of CO_2 -e (including LULUCF[2]). • The Philippine GHG emissions in the year 2000 due to fuel consumption was estimated to be at 69.67 million tonnes of CO_2 –e (excluding LULUCF[6])
Particulate Pollutants	• The 24-hour ambient air quality monitoring along the MMSP's alignment ranges from 57.5 µg/NCM (Station A1) to 204.3 µg/NCM (Station A13) during the dry season, and 51 µg/NCM (Station A14) to 521 µg/NCM (Station A1). All ambient air quality monitoring stations are within their DAO 2000-81 NAAQGV (230 µg/NCM) except for Stations A1 (521 µg/NCM), A2 (248 µg/NCM) and A10 (265 µg/NCM). Based on Annex A of DAO 2000-81. The ambient air quality along the Project's alignment in terms of TSP is 'good' to 'acutely unhealthy.' • The 1-hour TSP in the three stations were 25 µg/NCM, 31 µg/NCM, and 32 µg/NCM, respectively. All monitoring stations are within the DAO 2000-81 NAAQS (300 µg/NCM). • PM_{10} concentrations ranged from 37.2 µg/NCM (Station A6) to 81.4 µg/NCM (Station A13) during the dry season and 25.2 µg/NCM (Station A14) to 209 µg/NCM (Station A1) during the wet season in the stations along the MMSP. All ambient air quality monitoring stations are within their DAO 2000-81 NAAQGV (150 µg/NCM) except for Stations A1 (209 µg/NCM), A2 (191 µg/NCM), and A12 (193 µg/NCM). Based on Annex A of the DAO 2000-81, the ambient air quality in the stations along the MMSP alignment in terms of PM_{10} is 'good' to 'unhealthy to sensitive groups.' • The 1-hour PM_{10} concentrations in Stations AN1, AN2, and AN3 where 19 µg/NCM, 21 µg/NCM, and 25 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (200 µg/NCM).
Gaseous Pollutants	• The 24-hour NO_2 concentrations in all monitoring stations ranged from 15.7 µg/NCM (Station A1) to 37.3 µg/NCM (Station A11) during the dry season and 4.5 µg/NCM (Station A3) to 86 µg/NCM (Station A10) during the wet season. All stations were within the DAO 2000-81 NAAQGV (150 µg/NCM). • The1-hour NO_2 concentrations in Stations AN1, AN2, and AN3 were 17 µg/NCM, 64 µg/NCM, and 20 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (260 µg/NCM). Annex A of DAO 2000-81 has no prescribed index for NO_2 concentrations below 1,220.5 µg/NCM. • The concentrations of 24-hour SO_2 ranged from below detection limit (<4 µg/NCM) (Stations A9 and A13) to 5.3 µg/NCM (Station A1) during the dry season and below detection limit (<4 µg/NCM) (Stations A2, A3, A4, A5, A7, A9, A11, AN1, and AN2) to 17.1 µg/NCM (Station A1) during the wet season. All stations are within the DAO 2000-81 NAAQGV (180 µg/NCM). Based on Annex A of the DAO 2000-81, the ambient air quality in the monitoring stations along the MMSP alignment is 'good.' • The 1-hour SO_2 concentrations were 16 µg/NCM, 20 µg/NCM, and 23 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (340 µg/NCM).
Lead and Ozone	• Lead (Pb) and Ozone (O_3) were monitored for the dry season in 2017 in Stations A1, A5, A6, A9, A11, and

2 Land Use, Land Use Change, and Forestry- is the subset of Agriculture, Forestry and Other Land Use (AFOLU) emissions and removals of GHGs related to direct human-induced land use, land-use change and forestry activities excluding agricultural emissions and removals

	A13. The concentrations of Pb and O_3 were undetected in all monitoring stations and below the DAO 2000-81 NAAQGV for Pb (1.5 µg/NCM) and O_3 (140 µg/NCM)
Existing Sources of Pollutants	• TSP and PM_{10} are generated when fossil fuel is consumed by vehicles. In addition, fugitive emissions of these particulate pollutants are released into the environment through wheel entrained dusts from roads. Dust kicked up by vehicles traveling on roads may make up 33% of air pollution. Road dust consists of deposits of vehicle exhausts and industrial exhausts, particles from tire and brake wear, dust from paved roads or potholes, and dust from construction sites. Road dust is a significant source contributing to the generation and release of particulate matter into the atmosphere. Control of road dust is a significant challenge in urban areas, and in other locations with high levels of vehicular traffic upon unsealed roads, such as mines and landfill dumps. • SO_2 and NO_2 are generated from the combustion of fossil fuel by vehicles.
Noise Levels	• For dry season, areas with relatively more residential areas have lower noise pollution levels compared with other stations. However, as some of these stations are situated near major roads, the application of correction factor showed that some of these stations exceeded their respective standards, except for a few residential and parking lot areas. For wet season, the survey sites generally had elevated noise levels except for some residential areas. Across seasons, some survey sites still exceeded the maximum tolerable noise standards, while only two (TriNoma and Brgy. Blue Ridge sites) among the common monitoring stations had significant changes.
Existing Sources of Noise	• Based on the land use categories and the results, noise associated with commercial, residential, and industrial activities can be considered as existing sources of noise pollution.
Wildlife species inventory	• A total of 213 species comprised of six (6) amphibians, 12 reptiles, 184 birds, and 11 mammals was recorded along the MMSP (original and revised) alignment, and nearby major greenspaces. • Recorded birds (184 species) represent approximately 37% of the known total for Luzon mainland (493 species).
Summary of range distribution	• Range distributions was dominated by native but non-endemics/ resident breeding non-endemics with 92 species or 43% of the total. • Other range distributions noted were: migratory birds with 67 species or 31% of the total, endemics with 29 species or 14% of the total, introductions with 19 species or 9% of the total, and migrants with resident breeding populations with six species or 3% of the total. • Endemics were relatively high despite the available habitat.
Conservation Status (Threatened, Near Threatened, and Least Concern)	• Majority of recorded wildlife are Least Concern with 182 species or 85% of the total based on IUCN 2019 and RA 9147/ CITES 2019. • At least 28 species or 13% of the total (composed of four reptiles and 24 birds) are included in various conservation listings based on IUCN 2019 and RA 9147/ CITES 2019. • Five (5) of these threatened species are introduced or not originally from the Philippines. • Three (3) species are Near Threatened based on IUCN 2019.
Hindrance to wildlife access, historical occurrences of pest	• The MMSP (original and revised) alignment and surrounding areas are highly urbanized and the original vegetation therein have long been removed and converted into development areas.

infestation, forest/grass fire, and/or similar incidences	• Wildlife access across the entire MMSP alignment is fragmented due to the absence of original vegetation and various development. Remaining wildlife habitats are limited within the 27 major greenspaces. • Major disturbances are growing human population, pollution, and conversion of natural habitats and remaining greenspaces to built-up areas.
Vulnerability to Climate Change	• As the NCR area is extra vulnerable to the effects of climate change due to high pollution levels, absence of good vegetation cover, and increased flooding incidents, these may add-up to the projected sporadic increases in terms of ambient temperatures and extreme weather conditions. Said conditions may potentially impact the already limited wildlife populations in the NCR and overall health of the few remaining greenspaces.
Vibration	•
Demographic Profile	In all three cities, about half the population is less than 27 years old with the largest population group in age 20 – 29; the lowest, 80 and over. There are about 40 – 45% young (0-14) and old (65 and over) people who are dependent on the working age population (15 – 64). Population growth rate ranges from 1.12% (Pasay, the lowest) to 4.32% (Taguig, the highest and almost four times the rate of Pasay).
Socio-Economic Profile	**Taguig City** • Highly Urbanized City • 53.67sqkm (5,367ha) land area; 8.66% of NCR • 28 barangays • First Class City: PHP5.56 Billion regular revenue (fiscal 2016) • Annual Population Growth Rate: 4.32% (2010-1015) **Barangay Fort Bonifacio** • 2.4sqkm (240ha); 4.47% of City Includes within its jurisdiction Fort Bonifacio (military camp), Bonifacio Global City (business, financial, and lifestyle district) **Pasay City** • Highly Urbanized City • 13.97sqkm (1,397ha) land area; 2.25% of NCR • 201 barangays • First Class City: PHP3.53 Billion regular revenue (fiscal 2016) • Annual Population Growth Rate: 1.12% (2010-2015) **Barangay 183** • 53 hectares; 3.79% of City Formerly part of military base (Philippine Airforce). Includes Newport City (lifestyle district), NAIA Terminal 3 **Pasay City** • Highly Urbanized City • 13.97sqkm (1,397ha) land area; 2.25% of NCR • 201 barangays • First Class City: PHP3.53 Billion regular revenue (fiscal 2016) • Annual Population Growth Rate: 1.12% (2010-2015)

	Barangay 183 • 53 hectares; 3.79% of City part of military base (Philippine Airforce). Includes Newport City (lifestyle district), NAIA Terminal 3
Public Health Services	Primary, secondary and tertiary health care and services are available in Taguig, Pasay and Paranaque. Primary health care is available in all barangays through the health centers of the municipal government. A world class and internationally accredited tertiary facility, St Luke's, is located in Bonifacio Global City, Taguig. Each city maintains a city-owned hospital.
Cultural Heritage	There are three cultural heritage sites near the project alignment; Bonifacio War Tunnel, the American War Memorial and Cemetery and the Nutrition Center of the Philippines (Interior Design). The closest to the alignment is the Nutrition Center of the Philippines at 25 meters.
Transport and Traffic	The existing transport systems near the project include road, railway, mass rapid transit, light rail transit, air transport, water transport and other modes of public transportation such as Public Utility Jeepneys, Asian Utility Vehicles and tricycles. Due to the road capacities and volume of traffic some nearby roads currently have a low level of service.
Perception of the Project	**Barangay 183** • The respondents constituted household members, property owners, tenants, and business owners. A total of 98 respondents were surveyed, 53 of which were female (54 %) and 45 were male (46 %). • Majority of the respondents (54 % or 52 individuals) in Barangay 183 answered that they do not have prior knowledge about the project, while 44 individuals (46 %) responded that they were aware about the project **Barangay Fort Bonifacio** • Targeted respondents were office workers near the direct impact areas, vendors, and residents. A total of 100 respondents were interviewed in the barangay, 58 of which were male (58 %) and 42 were female (42 %). • In general, respondents of the barangay were aware about the project (72 %), primarily sourcing the information from mass media (73 %). Others were aware of the project from the government and barangay officials (15 %), while others from relatives, neighbors, and friends (12 %). **San Martin de Porres** • The respondents were a diverse group of property owners, tenants, business owners and their employees. The survey was conducted upon the IEC to the Barangay Chairman and officials, as well as to the officials of the Homeowners' Association of the affected village. • Majority of the respondents from SMDP stated that they have prior knowledge about the project (76 %)

Key Impacts and Mitigation

The key impacts of the Project and proposed mitigation measures are presented below.

Project Phase	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention, Mitigation or Enhancement
Pre-construction, Construction, Operation, Closure	Land Use	*Change or inconsistency in land use and potential tenurial issues*	
		Some of the locations of the MMSP Station is within Residential zones, and most of the areas are within Commercial zones. Displacement of the residents within the Direct Impact Area of the station developments (transport hubs and station plazas) will be done.	• Doing the right practices with regards to the negotiations with the concerned parties pertaining to land acquisition will be done. Fair market value will be determined by providing a clear reference to the applicable legal instrument.
		Potential impact of the project to the other Subway Projects in Metro Manila (e.g. Makati Subway Project), such as intersection of the alignments.	The DOTr will continuously coordinate with the LGUs and other related government agencies (e.g. DPWH, MMDA) and secure the necessary permits, endorsements, and clearances required for the construction. • The depth of the underground activity of the project will closely coordinated with the authorities handling the other Subway Projects within Metro Manila.
		Land disputes	• Secure easement agreements with the owners of the properties in the vicinity to have safety net in response to tenurial issues over the development area for the project.
Construction, Operation,	Land	*Change in land values of areas near and within the alignment of the project*	
		The land values of the area within the vicinity of the station development is expected to increase.	• Limit/control the commercialization of the planned mixed-use developments within the planned Station Plazas to some of the stations
Pre-construction, Construction, Operation	Subsurface Conditions	*Change in sub-surface / underground conditions*	
		Tunneling will alter existing underground stress distributions	• Perform tunnel deformation analysis to determine how the hollowing of ground will affect underground stress regimes

Construction, Operation, Closure	Subsurface Conditions	Installation of buried facilities and introduces new material types to the ground which can react with the soil	• Use non-reactive materials for pipes and other buried components to ensure that soil contamination is prevented.
Pre-construction, Construction, Operation,	Subsurface Conditions	Solid wastes generated can be cause of pollution that would impact the quality of surrounding soil / ground	• Implement proper waste management and disposal system to prevent contamination of surrounding soil and water.
Pre-construction	Subsurface Conditions	Excavation and tunneling may accidentally hit buried facilities such as pipelines that could spill contaminants to the groundwater and soil.	• Perform due diligence and utilities survey. Adjust design to avoid utilities or coordinate with utility owner on how to transfer these to another location.
Construction, Operation,	Subsurface Conditions	Buried pipeline may leak water underground	• Use strong and durable materials for pipes to prevent leakage.
Pre-construction Construction, Operation	Geohazard Susceptibility	*Inducement of subsidence, liquefaction, landslides, mud / debris flows, flooding, etc.*	
		Tunneling will leave an underground void which will affect pore water pressure of overlying materials, leading to possible ground subsidence	• Perform tunnel deformation analysis to determine how the hollowing of ground will affect underground stress regimes • Install piezometers to monitor groundwater pressure around the tunnel, • Ensure that the tunnel is sufficiently supported and lined to prevent failure and ingress of groundwater.
Construction, Operation,	Geohazard Susceptibility	Leakage from pipes may saturate the ground, causing it to soften and subside.	• Use strong and durable materials for pipes to prevent leakage.
Pre-construction Construction, Operation	Geohazard Susceptibility	Continuous operation of heavy machinery produces vibration that may induce liquefaction.	• Perform liquefaction tests on segments found to have indications of liquefiable soil. • Use vibration dampers, if necessary.
Pre-construction Construction, Operation	Geohazard Susceptibility	*Inducement of flooding*	
		Excavation and tunneling sites may collect rainfall and groundwater, creating pools of water.	• Provide necessary drainage (e.g. pumps) in excavated components.
Pre-construction, Construction, Operation	Geohazard Susceptibility	Burst pipes can leak significant amounts of water to the surface, which could cause flooding.	• Use strong and durable materials for pipes to prevent leakage.
Pre-construction, Construction,	Soils	*Inducement of soil erosion*	
		Erosion of stockpiled excavated or burrowed soil due to exposure to rainfall and air can lead	• Regular hauling of excavated materials and storage in pads with appropriate soil

		to dust generation and increased siltation of water bodies.	protection facilities or management systems
Pre-Construction	Terrestrial Vegetation	*Vegetation removal and loss of habitat*	
		The Project will be constructed in a highly urbanized area, with interspersed green spaces supporting numerous diverse arborescent tree species. Approximately 63.23 ha of above ground land area will be cleared of vegetation prior to the subway construction.	• Clear delineation of the extent of vegetation removal on plans and on the ground prior to removal activities • Development and implementation of a pre-clearing plan prior to construction. The plan will contain detailed clearing and cutting protocols to reduce impacts to the surrounding areas. • Generation of a Biodiversity Management Plan (BMP) prior to the start of the development activities, as this document outlines the conservation objectives of the Project and will detail the perceived impacts in biodiversity • Securing both tree cutting and earth balling permits from the Department of Environment and Natural Resources (DENR). Replacement of cut trees will be in accordance with the DENR Memorandum Order (DMO) 2012-02. • Provision of offset sites for all areas that will be cleared. These designated areas will be approximately equivalent to the land area affected by the Project; and must be jointly identified by DOTr and DENR
Pre-Construction, Construction	Terrestrial Vegetation	*Vegetation removal as a threat to local existence of endemic and/or threatened plant*	
		Noted threatened species, including but not limited to, *Pterocarpus indicus* (Narra), *Adonidia merrillii* (Manila palm), *Diospyros discolour* (Kamagong), Vitex parviflora (Molvae), *Podocarpus costalis* (Arius within and in the immediate vicinity of the Project could be removed and displaced from their natural habitats.	• Securing earth balling permits from DENR prior to vegetation removal activities • Guided transplanting and earth balling activities with the supervision of an expert horticulturist / agriculturist to facilitate high survival rate of transplanted trees. • Appropriate maintenance activities will be conducted to ensure high survival rates of earth balled tree species

Pre-Construction, Construction	Terrestrial Vegetation	*Indirect effects*	
		Dust – the accumulation of dust on the leaf laminae could inhibit come major physiological processes of plants (i.e., photosynthesis, transpiration, respiration, phenology) and could even contribute to physical abrasion. Such may lead to decreased plant fitness and mortalities. **Increased weed infestation** – weeds prefer disturbed areas, which may be likely to occur in among the sites especially during construction phase.	• Implementation of regular water sprinkling, especially during the dry season along dusty areas to reduce the harmful effects of dust emissions. • Inclusion of weed control measure in the Biodiversity Management Plan (BMP) of the Project
Construction, Operation	Hydrology	*Change in drainage morphology / inducement of flooding / reduction in stream volumetric flow*	
		Ground disturbance during construction activities may temporarily disrupt natural drainage flow which may result to the development of new surface runoff paths	• All trench and foundation will be backfilled and ground restored to its original condition • Tunneling works using TBM are not anticipated to impact river/stream waterflows
Construction, Operation, Closure	Hydrology	*Inducement of flooding / reduction in stream volumetric flow*	
		Some sections of the MMSP alignment will traverse areas with moderate to high flooding susceptibility	• Temporary drainage and detention cum siltation ponds will be constructed in construction areas if necessary, to mitigate localized flooding. Temporary bund walls will also be provided as necessary • Stations will be provided with permanent bund walls along with water-sealed panels, tempered glass and waterproof iron doors, and drainage pumping stations • The Depot will be provided with a drainage system to collect surface runoff to designated outfalls • A Construction Waste Management Plan will be prepared for the project in order to appropriately handle and dispose excavated materials and demolition debris that may clog drainage systems and waterways

Construction	Hydrology	*Change in stream depth*	
		Temporary cofferdams will be required during the construction of the Quirino Highway Station, which will encroach on top of a Talipapa creek. Cofferdams constrict waterways and reduce flow area, which may cause a minimal increase in water surface level upstream of the construction area	• Construction activities along the waterway will be done during the drier months of the year or during low flows whenever practicable. Diversion channels that are designed to adequately convey design flows with minimum if any backwater effect will be used • Tunneling works are not anticipated to induce changes in stream depth given that the tunnel will be located about 16 m underground on average
Construction, Operation	Hydrology	*Depletion of water resources and water competition*	
		Fresh and potable water will be required during the construction and operation phase of the project which may strain existing water sources used by the community	• Considering that the proposed project will not be extracting water from existing surface waters crossed by the MMSP or construct new wells, potential water competition as a result of the project activities is unlikely • Potable water will be sourced from the local water utility providers.
Construction, Operation	Hydrology	*Groundwater drawdown*	
		Groundwater dewatering during the tunneling works could potentially induce groundwater drawdown	• Conduct detailed hydrogeological/ groundwater study in the detailed design stage. • Installation of monitoring wells for observation along the subway tunnel and monitor change of the surrounding groundwater levels • If water supply of people relying on groundwater along the alignment decreases, DOTr shall make arrangements to supply affected people with water. • DOTr will coordinate with NWRB regarding tunneling activities along the alignment and its potential effects on the water table • A Dewatering Permit may have to be secured from NWRB prior to tunneling activities.

Construction, Operation	Water quality	*Siltation and sedimentation of waterways*	
		Earth moving activities during the construction phase have the potential to increase turbidity and sedimentation in surface runoff which may eventually flow and discharge to nearby rivers and creeks	• Erosion and sediment control measures and spill prevention techniques including silt screens, drain channels, diversion dams, sumps and/or settling ponds will be provided in construction areas as necessary • Spoil and building material stockpiles will be provided with physical barriers and/or bunds to minimize silt-laden runoff • Surplus soil from tunneling will be used as backfill; remaining surplus soil after construction will be disposed appropriately in five identified sites within Metro Manila • Conduct of regular water quality monitoring
Construction, Operation	Water quality	*Contamination of groundwater as a result of tunneling activities*	
		Dewatering as part of borehole drilling and tunneling may potentially contaminate groundwater resources	• Dewatered groundwater from tunneling activities will meet DAO 2016-08 standards prior to disposal • Conduct of regular water quality monitoring
Construction, Operation	Water quality	*Contamination of waterways with hydrocarbons and project wastes*	
		Liquid and solid wastes generated by the project including lime slurry wastes that may be produced during the tunnel boring process may contaminate waterways if disposed improperly. Accidental spills of fuel and other hydrocarbon and chemical products may contaminate waterways.	• A Waste Management Program for the construction and operations phase will be developed and implemented for the MMSP. Contractors will also be required to submit a wastewater management plan. • Fuel storage facilities will be provided with adequate spillage protection
Pre-Construction, Construction,	Aquatic Ecology	*Sediment influx in waterways*	
		Delivery of sediments and other debris into the water column of the stream channel, originating from the activities during the pre-construction and construction phase.	• Designation of buffer zones approximately 5 m from each bank to dampen the rapid entry of sediments and organic debris • Development and implementation of a construction plan during earth moving actives which ensures that the potential delivery of sediments and other particulate matter into the stream channel is kept at minimum.

Construction, Operations	Climate	*Climate change impacts* The Project will be constructed in a highly urbanized area. The project's above ground disturbance footprint is 120 hectares in high density built-up areas and is not expected to significantly affect the local climate.	• Monitoring of any changes in local climate will still be performed, following the frequency of ambient air monitoring.
Pre-construction, Construction, Operations, Closure	Climate	Being in Metro Manila, the MMSP is vulnerable to sea level rise, increased intensity of storms, increased temperatures, and exposure to climate change-induced flooding and storm surge. Projected changes in temperature could potentially cause track expansion which can lead to train delays, and in the most extreme cases can lead to derailments Increase in ambient temperatures may require additional electricity usage for temperature regulation for MMSP. Electricity rationing and rotating blackouts may lead to challenges in subway operations and efficiency. Rising temperatures may increase the risk of heat-related illnesses and inhibit decision-making, increasing the likelihood of injuries, accidents, and fatalities and decreasing worker productivity Flooding may also affect employee safety on-site and on roads. Climate change induced flooding and storm surges could potentially flood subway tunnels, severely impacting mobility and economic activity	• Establishment of comprehensive management systems to address climate adaptation; • Preparation of risk-identification processes to include climate risk and opportunities; • Integration of climate-related risks and mitigation measures into business decisions throughout the project life; • Ensuring robust engineering design and construction standards for facilities; • Design of comprehensive management measures; • Integrate climate-compatible development into initiatives for sustainable local benefit from Project operations; and • Initiate cross-industry collaboration on regional adaptation strategies.
Construction, Operations	GHG	*Contributions in terms of GHG emissions* • Carbon dioxide (CO_2) accounts to the highest GHG emission share (9,352.79 tonnes of CO_2-e per year) among the three common GHGs associated with the combustion of	• consideration of fuel and equipment efficiency prior to construction and operation activities; • maximizing fuel efficiency through scheduling of vehicle and equipment

		fossil fuel during the construction phase. This is followed by nitrous oxide (N_2O) and methane (CH_4) with GHG emission shares of 20.07 tonnes of CO_2-e and 10.60 tonnes of CO_2-e per year, respectively. • Scope 1 emissions (direct GHG emissions) total 9,383.46 tonnes of CO_2-e per year due to the combustion of fossil fuel. Scope 2 emissions (indirect GHG emissions) total 14,497.89 tonnes of CO_2-e from the purchase of electricity. For the operations phase, the total annual GHG emissions are 109,021.00 tonnes of CO_2-e per year.	movement to minimize both idle time and distances travelled; • optimization of equipment and vehicle loadings through accurate monitoring and calculation of fuel and electricity requirements to reduce fuel weight and improve fuel efficiency; • regular maintenance of vehicles and construction equipment will be done to increase efficiency, reduce fuel and electricity use, and help reduce costs associated with equipment downtime; • close monitoring of equipment dispatches to eliminate unnecessary use and to increase efficiency of use; • Compensate the release of GHG during construction and operation by means of implementing carbon dioxide capture and sequestration through progressive rehabilitation (within or outside the project site). This will be undertaken as soon as areas for rehabilitation become available. Rehabilitation areas will at least be equivalent to the areas cleared of vegetation through the established National Greening Program, and/or the carbon sequestration program as discussed in **Section 2.1.4** of this EPRMP; and • Monitoring of carbon release by following the frequency of ambient air monitoring as discussed in **Section 2.3.3** of this EPRMP.
Construction	Air Quality	*Degradation of air quality*	
		Fugitive emissions generated from wheel entrained dusts, dusts generated from unpaved roads, storage and handling of construction material, and wind erosion from exposed surfaces and construction material stockpiles may increase the ground level concentration of dusts (TSP and PM_{10}) in the area.	• Fugitive dust from vehicular traffic and material handling activities will be controlled by management of vehicle speeds and application of regular water suppression to unpaved roads and stockpiles whenever visible dust is observed;

		The project is not expected to significantly affect the air quality during its operations phase.	• Trucks and vehicles that deliver construction material will be covered to prevent potential fugitive emissions of dust; • Regular ambient air quality monitoring will be performed in all monitoring stations as shown in Error! Reference source not found.; and • Workers will be provided with the appropriate personal protective equipment pursuant to BWC-DOLE Occupational Safety and Health Standards (Department of Labor and Employment, 1989) to protect them from disease associated with dusts.
Construction	Air Quality	Particulates and gaseous pollutants may be emitted through fossil fuel consumption of construction equipment which may increase the Ground Level Concentrations (GLCs) of the identified pollutants.	• Requiring sub-contractors to undergo and pass the government vehicle emission tests prior to contract award; • Exhaust fumes from vehicles, construction equipment, and other fuel burning equipment will be managed through the use of low sulphur fuel where possible; • Traffic management guidelines will be incorporated in worker's and subcontractor's induction seminar. Guidelines will include control in vehicle speed and spraying of road routes and work sites as well as transport routes near the host communities; • Fuel efficiency will be maximized through scheduling of vehicle and equipment movements in order to minimize both idle time and distances travelled; • Equipment and vehicle loadings will be optimized through accurate monitoring and calculation of fuel requirements in order to reduce fuel weight and improve fuel efficiency; • Vehicles and construction equipment will be regularly maintained in order to increase

			efficiency, reduce fuel use, and help reduce costs associated with equipment downtime; • Equipment dispatch will be monitored closely in order to eliminate unnecessary use and to increase efficiency of use; • Standard occupational health and safety practices will be implemented pursuant to BWC-DOLE Occupational Safety and Health Standards (Department of Labor and Employment, 1989); and • Regular ambient air quality monitoring will be performed in all monitoring stations as shown in Error! Reference source not found.
Construction	Ambient Noise	*Increase in ambient noise level*	
		Increase in noise level and ground vibration due to operations of construction machinery, which may cause disturbance to construction workers and nearby communities.	• Using equipment or machines that produce lesser noise, or considerations in using mufflers to minimize noise. • Strategic scheduling of activities per period within a day to minimize effects of noise on nearby residents/public areas. • Maintenance of equipment or machineries used during construction to minimize possible loud noises due to equipment damage. • Conducting a construction noise assessment during the preconstruction stage to determine the noise levels on the areas surrounding the construction site, and the predicted noise levels coming from equipment and machineries. • Construction of wall enclosures on areas that produce a lot of noise to minimize disturbance within the immediate area. • Continuous monitoring of ambient noise levels on the monitoring sites for impact mitigation purposes.
Construction	Noise	May cause hearing problems to workers who operate nearby machineries or equipment that produce extremely loud noise.	• Strictly implementation of Personal Protective Equipment (PPE), such as ear

			muffs and ear plugs, during work hours for the safety of the workers. • Taking note of equipment/machines that produce extremely loud noises (beyond tolerable levels – 85 decibels (Fink, 2017)) and keeping these areas off limits from workers for their safety. • Implementing permissible noise levels for construction workers as suggested by Department of Labor and Employment (DOLE).
Construction	Noise	May cause hearing problems to nearby residents who are a part of the vulnerable groups, and the public.	• Active response of LGU through necessary health programs for vulnerable groups, and massive public information for those areas that can produce noise level beyond tolerable limits of human ears.
Operations	Noise	May inadvertently cause mental stress to residents near the project location due to the noise from structures and ground vibration.	• Considerations in the design and operations of the subway to minimize vibration, such as noise barriers. • Continuous monitoring and survey for complaints from residents nearby the areas to assess the extent of the disturbance coming from the vibrations during operations.
Construction, operation	The People	*Displacement of setter/s / disturbance of properties*	
		Impacts on people displaced along the East Service Road	• Resettlement Action Plan development and implementation
Operation	The People	*Community safety and security*	
		The sheer amount and diversity of passengers using the Entrance / Exit Points suggest that some of them could intrude into the vicinities and areas beyond with no legitimate purpose and even engage in anti-social activities thereby posing a risk to legitimate residents and workers.	• Installation of security cameras at strategic places and instituting visible police presence. • Local residents and workers engaged to be more security and safety conscious • Development of quick response emergency teams drawn from office workers and residents
Construction, Operation	The People	*Change / conflict in land ownership*	
		Displacement of their constituents; break-up of communities; diminution of community amenities; transparency of information.	Transparency of Information; consider Use Value and Exchange Value orientation of stakeholders in engaging them

Construction, Operation	The People	*Impacts on cultural heritage*	
		Although the alignment passes near cultural heritage sites the construction and operation is not likely to impact these sites	• Assessment of "interior Design' aspects of the Nutrition Center of the Philippines • A photo-documentation of the entire 'interior design' will also be made to serve as a historical memory.
Construction	The People	*Traffic congestion during construction*	
		Because of the mobilization of heavy vehicles and equipment, construction activities, and staging of construction works, restriction on some roadways and sidewalks will be unavoidable. This will lead to increased traffic congestion and changes in traffic patterns during construction. Motorists, cyclists, and pedestrians might alter their trip routes to their inconvenience in order to avoid heavy traffic in the construction areas.	• Development and implementation of a Traffic Management Plan (TMP) • Rerouting/diverting traffic where possible • Use of construction methods to limit the disturbance to existing roadways during the construction of stations
Operation	The People	*Increase in roadside friction along road adjacent to stations*	
		Commuters are likely to wait, load and unload to and from other modes of road transport, impeding the flow of traffic.	• Conversion of the construction yard areas into facilities with sidewalks, taxi bays, loading and unloading stations or intermodal central terminal stations for interconnectivity with mass transit and public utility vehicles.

CHAPTER 1 PROJECT DESCRIPTION

The Metro Manila Subway Project, hereinafter referred to as "MMSP" or "project" is a subway project in Metro Manila stretching from its proposed depot in Valenzuela City to the cities of Pasay and Parañaque whose aim is to promote inclusive growth and improve the transportation within and beyond Metro Manila. The project secured its Environmental Compliance Certificate (ECC) with the control number ECC CO 1709-0017 for thirteen (13) underground stations and an initial alignment length of 28.3 km.

The project aims to amend its ECC to a revised total of sixteen (16) underground stations and a total length of 36 km which will traverse and connect seven (7) cities, more specifically the cities of Valenzuela, Quezon, Pasig, Makati, Taguig, Pasay and Parañaque. The project aims to service an estimated 973,000 passengers per day by year 2035. As a whole, the stations and project facilities that will be developed as part of the MMSP will include the following components:

- Sixteen (16) subway stations including their corresponding;
  - Construction yards; and
  - Shield machine bases
- Underground sections in-between the stations;
- Valenzuela Depot;
- Interoperability area between FTI Station and Bicutan Philippine National Railway (PNR) Station; and
- Interconnections such as walkways, public utility vehicle (PUV) bays, etc.

1.1 Project Location and Area

1.1.1 Project Alignment

The MMSP project site will be located within Metro Manila on the Island of Luzon as shown in **Figure 1.1-1**. The project will pass through seven (7) cities of Metro Manila namely through the cities of Valenzuela, Quezon, Pasig, Makati, Taguig, Pasay and Parañaque and will have a total length of 36km. DOTr is planning to establish a depot and possibly one station in Valenzuela City, while seven (7) of its stations to be located in Quezon City (**Figure 1.1-4**), two (2) of its stations to be located in Pasig City (**Figure 1.1-5**), four (4) of its station to be located in Taguig City, a station to be located in Pasay City and a station to be located in Parañaque City (**Figure 1.1-7**). The coordinates of the project site are presented in **Table 1.1-1.** The local government units hosting the MMSP alignment and its components are listed in **Table 1.1-3**.

The MMSP depot will be located in Barangay Ugong, Valenzuela City on approximately 30 ha parcel of land. The proposed location of the depot is shown in **Figure 1.1-1** and **Figure 1.1-3**.

In the alignment presented in the 2017 Environmental Impact Statement (EIS), there were originally thirteen stations. However, since a fault line was found near and parallel to the Cayetano Station, the original alignment from the Bonifacio Global City Station to the Cayetano station was shifted away from the fault line. As a result, two (2) new proposed stations were planned, the Lawton East Station and Lawton West Station located near Lawton Avenue in Barangay Fort Bonifacio, Taguig City. To increase the connectivity to the airport, the Ninoy Aquino International Airport (NAIA) Terminal 3 Station was included in the list of planned stations for the MMSP.

[1] As a result of several stakeholder engagement activities including the Public Hearing conducted on 2019 September 03, the location and layout of the FTI station and its adjacent components are being considered. The full utilisation of the road right of way of the Philippine National Railway (PNR) is also being considered.

The NAIA Terminal 3 Station is located in Barangay 183, Pasay City and has a connection to the Lawton West Station. The NAIA Terminal 3 Station has two alignment options where Option 1 places the proposed station along Resorts Drive alongside St. Therese Church while Option 2 places the proposed station along Andrew Ave directly behind St. Therese Church and in front of the gasoline station shown **Figure 1.1-1** and **Figure 1.1-25** as a solid red line and dashed blue line coming out of Lawton Avenue Station respectively. The Lawton West station then connects to the FTI Station which was part of the original list of planned stations in the 2017 EIS. However, the FTI station track will be extended to the Bicutan PNR Station to increase the interoperability with the North-South Commuter Railway (NSCR). The list of the changes to the original alignment presented in the 2017 EIS is presented in **Table 1.1-4**. The maps of the station locations per city can be found in **Figure 1.1-4** and **Figure 1.1-9**. The layouts of specific stations and the planned development with respect to surrounding buildings, structures and roadways are shown in **Figure 1.1-10** and **Figure 1.1-23**.

Table 1.1-1 Project Coordinates and Locations

Project Component	Longitude	Latitude	Description
Subway Stations			
Quirino Highway Station	121° 1' 42.528" E	14° 41' 22.022" N	South-east of an intersection of Mindanao Avenue and Quirino Highway near the HBC Corporate Center
Tandang Sora Station	121° 1' 55.931" E	14° 40' 30.697" N	South of the intersection of Mindanao Avenue and Tandang Sora Avenue. Near St. James College of Quezon City.
North Avenue Station	121° 2' 10.127" E	14° 39' 24.190" N	Within Veterans Memorial Golf Club of Mindanao Avenue East Side
Quezon Avenue Station	121° 2' 12.395" E	14° 38' 45.656" N	North of the intersection of EDSA and Quezon Avenue (underpass), inside the North Triangle, Vertis North Residential area development is in progress at north-east of the station.
East Avenue Station	121° 2' 58.209" E	14° 38' 14.020" N	East Avenue Station is planed near AFP Medical Center on V. Luna Avenue. West 240 meters from the entrance of the AFP Medical Center
Anonas Station	121° 3' 52.044" E	14° 37' 36.252" N	East of the intersection of South of the intersection of Anonas Road and Aurora Boulevard, between the Anonas LRT City Center and the World City Medical Center.
Katipunan Station	121° 4' 10.031" E	14° 36' 46.451" N	At the intersection of C5 Katipunan Road and Col. Boni Serrano Avenue. Near Camp Aguinaldo.
Ortigas North Station	121° 3' 50.873" E	14° 35' 12.083" N	North of the intersection of Ortigas Avenue and Meralco Avenue, north-east of Ortigas Center CBD.
Ortigas South Station	121° 3' 43.225" E	14° 34' 33.426" N	North of the intersection of Shaw Boulevard and Meralco Avenue, south-east of Ortigas Center CBD. East of the station Capital Commons (complex development of commercial ang high-rise residential buildings by Ortigas Corporation) is under construction. North of the station there is a parking area.
Kalayaan Station	121° 3' 21.363" E	14° 33' 29.066" N	South of the intersection of Kalayaan Avenue and 11th Avenue, north of Bonifacio Global City (BGC).

[1] As a result of several stakeholder engagement activities including the Public Hearing conducted on 2019 September 03, the location and layout of the FTI station and its adjacent components are being considered. The full utilisation of the road right of way of the Philippine National Railway (PNR) is also being considered.

Project Component	Longitude	Latitude	Description
Bonifacio Global City Station	121° 3' 17.128" E	14° 32' 56.068" N	North of the intersection of McKinley Parkway and 25th street south of BGC. West of the station is high-rise commercial and business district with High Street, a pedestrian mall located west of Serendra.
Lawton East Station	121° 2' 26.879" E	14° 32' 15.371" N	Chateau Rd. Lawton East Station was planned near the Chateau Road Terminal on the east side of Manila, near the American Memorial Cemetery.
Lawton West Station	121° 1' 38.097" E	14° 31' 50.899" N	Lawton West Station is located in the east of Manila Skyway, near the Philippine Marine Corps Grandstand. This station is planned as a station leading to NAIA Airport Terminal 3 and FTI station.
NAIA Terminal 3 Station	121° 0' 56.777" E	14° 31' 17.471" N	Two alignment options are being considered for this station which will be finalized during the detailed design stage of the project. One option is besides St. Therese Church and along Resorts Drive or along Andrews Street in Barangay 183, Pasay City.
FTI Station	121° 2' 17.826" E	14° 30' 7.238" N	South of the flyover crossing C5, South Luzon Expressway (SLEX) and Mega Manila Skyway.
Underground Tunnel			
Point 1	121° 1' 59.899" E	14° 30' 41.005" N	
Point 2	121° 1' 37.359" E	14° 31' 5.857" N	
Point 3	121° 1' 9.949" E	14° 31' 21.965" N	
Point 4	121° 1' 14.068" E	14° 31' 35.110" N	
Point 5	121° 1' 31.542" E	14° 31' 47.020" N	
Point 6	121° 2' 2.377" E	14° 32' 1.369" N	
Point 7	121° 2' 33.337" E	14° 32' 15.461" N	
Point 8	121° 2' 57.243" E	14° 32' 36.957" N	
Point 9	121° 3' 17.755" E	14° 32' 59.704" N	
Point 10	121° 3' 22.384" E	14° 33' 31.321" N	
Point 11	121° 3' 33.115" E	14° 34' 2.943" N	
Point 12	121° 3' 43.614" E	14° 34' 33.552" N	
Point 13	121° 3' 50.827" E	14° 35' 4.935" N	
Point 14	121° 4' 1.406" E	14° 35' 35.313" N	
Point 15	121° 4' 10.902" E	14° 36' 5.534" N	
Point 16	121° 4' 12.054" E	14° 36' 38.086" N	
Point 17	121° 4'4.340" E	14° 37' 10.497" N	
Point 18	121° 3' 49.522" E	14° 37' 39.692" N	
Point 19	121° 3' 26.570" E	14° 38' 3.982" N	
Point 20	121° 2' 55.296" E	14° 38' 15.096" N	
Point 21	121° 2' 26.704" E	14° 38' 31.243" N	

[1] As a result of several stakeholder engagement activities including the Public Hearing conducted on 2019 September 03, the location and layout of the FTI station and its adjacent components are being considered. The full utilisation of the road right of way of the Philippine National Railway (PNR) is also being considered.

Project Component	Longitude	Latitude	Description
Point 22	121° 2' 6.983" E	14° 38' 56.783" N	
Point 23	121° 2' 10.658" E	14° 39' 28.175" N	
Point 24	121° 2' 5.901" E	14° 39' 59.665" N	
Point 25	121° 1' 56.286" E	14° 40' 30.349" N	
Point 26	121° 1' 54.120" E	14° 41' 3.298" N	
Point 27	121° 1' 34.654" E	14° 41' 28.619" N	
Point 28	121° 1' 8.424" E	14° 41' 49.506" N	
Point 29	121° 0' 51.887" E	14° 42' 17.723" N	
Point 30	121° 0' 57.083" E	14° 42' 15.016" N	
Point 31	121° 1' 16.405" E	14° 41' 49.290" N	
Point 32	121° 2' 16.067" E	14° 30' 11.795" N	
Other Components			
Valenzuela Depot	121° 1' 7.203" E	14° 41' 54.858" N	Approx. 30ha parcel in Brgy, Ugong. Valenzuela City
Valenzuela Station	121° 1' 7.203" E	14° 41' 54.858" N	This proposed station will be located within the Depot area and will either be semi-underground or aboveground station. This may include a retaining wall, track, power and drainage lines. The decision to develop this station and its final layout will be confirmed after the detailed design.
PNR Bicutan Station (interoperability connection)	121° 2' 44.122" E	14° 29' 19.081" N	PNR Bicutan Station besides SLEX Bicutan Entrance corner General Santos Ave.

(Source: JICA Study Team)

1.1.2 Description of the Impact Areas

The alignment of the MMSP will be located mostly underground with structures aboveground for station entrances and exits, the depot and the track extension from FTI Station to the Bicutan PNR Station to increase interoperability with the NSCR. The project alignment will go through the several central business districts (CBDs) of Metro Manila namely, Quezon City, Ortigas Center and Bonifacio Global City. The proposed approximate 30ha depot location will be in Barangay Ugong, Valenzuela City. The depot will serve as the facility to maintain and service the trains.

The direct and indirect impact areas were delineated based on the guidelines laid out in Annex 2-2 of DAO 2003-30. Direct impact areas (DIAs) are generally areas where structures will be built during construction and the project operations will be conducted. Whereas indirect impact areas (IIAs) are areas immediately adjacent the coverage of the project facilities and project operations. The list of direct and indirect areas can be found in **Table 1.1-2**. The map showing the DIAs and IIAs along the MMSP alignment can be found in **Figure 1.1-2**.

[1] As a result of several stakeholder engagement activities including the Public Hearing conducted on 2019 September 03, the location and layout of the FTI station and its adjacent components are being considered. The full utilisation of the road right of way of the Philippine National Railway (PNR) is also being considered.

Table 1.1-2 Direct and Indirect Impact Areas

Area Classification	Area Coverage
Direct Impact Areas (DIA)	*In terms of biophysical impact:* • The ~30ha depot facility; • The 16 subway stations; • The construction yards and shield machine bases; • The interoperability area between FTI Station and Bicutan PNR Station; • The underground tunnel portion of the alignment in terms of noise and vibration;

[1] As a result of several stakeholder engagement activities including the Public Hearing conducted on 2019 September 03, the location and layout of the FTI station and its adjacent components are being considered. The full utilisation of the road right of way of the Philippine National Railway (PNR) is also being considered.

Area Classification	Area Coverage
	• 5 m from construction works for noise and vibration; • Tullahan River running along the east side of the proposed Depot • Talipapa Creek crossing the area reserved for the Quirino • Maricaban Creek about 150 m north of the proposed Lawton East Station • Maricaban Creek about 230 m north of the proposed Lawton West Station
	• In terms of socio-cultural impact: • Residents along the alignment affected by the resettlement; and • The direct beneficiaries of the project; 19 barangays and 7 cities hosting the MMSP alignment • Lawton East Station: immediate vicinity (at least 400 meters) from the Entrance / Exit (E/E) Points including the gated communities along Chateau Road and the office buildings and condominium communities adjacent, e.g., NAMRIA • Lawton West Station: immediate vicinities of a) the proposed Senate Building in Bonifacio Naval Station along Chino Roces Extension opposite the Nutrition Council of the Philippines Building where there will be E/E Points and b) the Nutrition Council Building • NAIA / Newport City: immediate vicinity (at least 400 meters) from the E / E Points at a) NAIA Terminal 3 and b) Resort Drive adjacent The Residential Resort • FTI Station to the PNR Bicutan Station: East Service Road from Cucumber Street to Marian Road 2 including 70 meters to the interior of this stretch to include United Hills Village 1 constituting an estimated area of four hectares to be acquired by the project proponent to initially serve as a construction yard and diversion road and later as an area for mixed development to accommodate waiting passengers. From a social perspective, this area will experience the most significant impact principally through displacement of residential, business and institutional establishments and their occupants.
Indirect Impact Areas (IIA)	*In terms of biophysical impact:* • The surface above the underground tunnel portion of the alignment in terms of noise and vibration
	In terms of socio-cultural impact: • Passengers that will be served by the MMSP; • Road network within and 1 km of the construction sites; and • Receiving communities that will host the resettled people

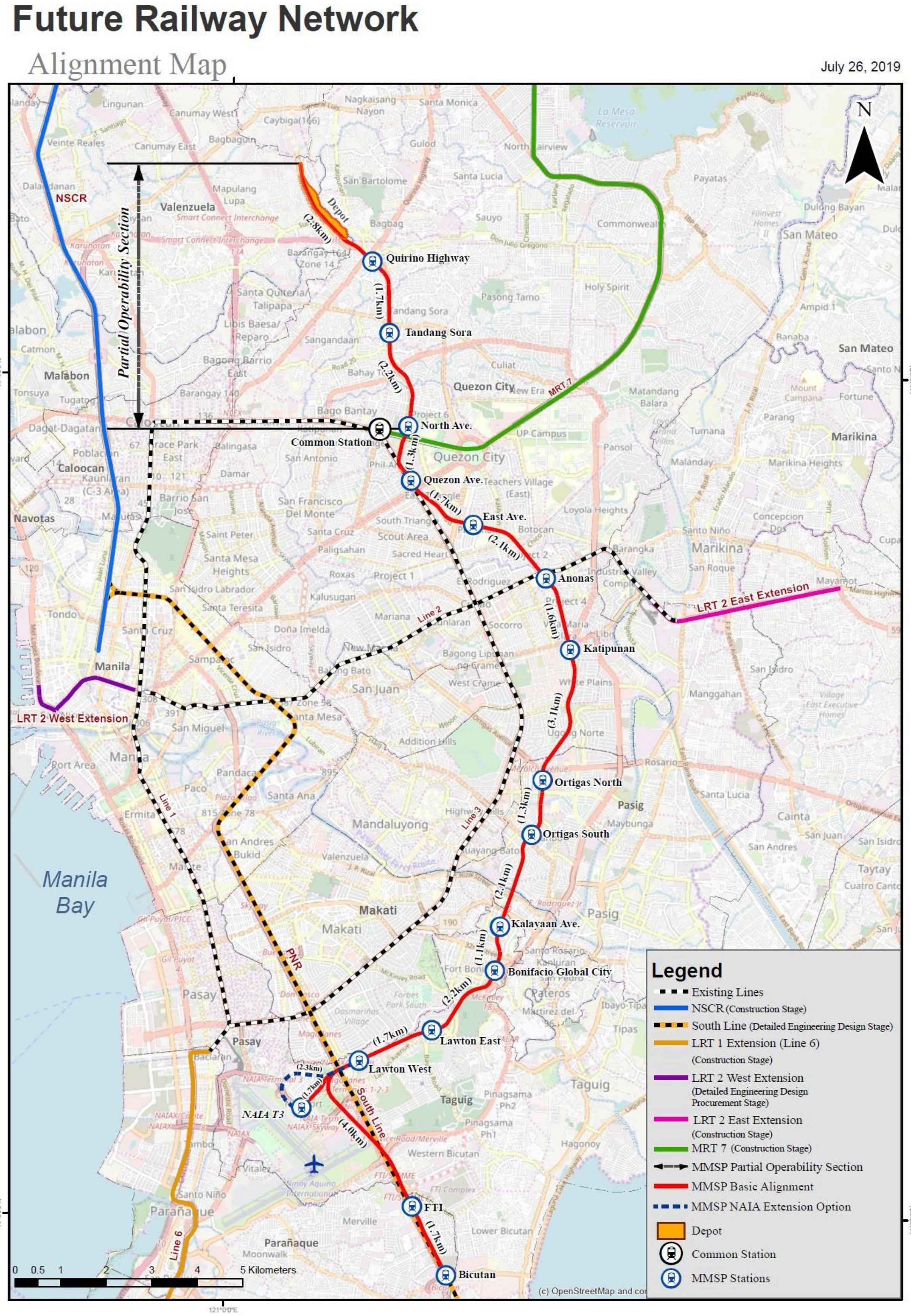


Figure 1.1-1 Project Location

Table 1.1-3 Local Government Units Hosting the MMSP

Project Components	Municipality	Barangay
Subway Stations		
Quirino Highway Station	Quezon City	Barangay Talipapa
Tandang Sora Station		Barangay Tandang Sora
North Avenue Station		Barangay Project 6
Quezon Avenue Station		Barangay Bagong Pagasa
East Avenue Station		Barangay Pinyahan
Anonas Station		Barangay Bagumbahay
Katipunan Station		Barangay Blueridge A Barangay St. Ignatius Barangay Bayanihan
Ortigas North Station	Pasig City	Barangay Ugong
Ortigas South Station		Barangay San Antonio Barangay Oranbo Barangay Kapitolyo
Kalayaan Station	Taguig CIty	Barangay Fort Bonifacio
Bonifacio Global City Station		Barangay Fort Bonifacio
Lawton East Station[a]		Barangay Fort Bonifacio
Lawton West Station[a]		Barangay Fort Bonifacio
NAIA Terminal 3 Station[a]	Pasay City	Barangay 183
FTI Station	Taguig City	Barangay Western Bicutan
	Parañaque City	Barangay San Martin de Porres Barangay Merville
Underground Tunnel Connections		
Alignment from Depot to Quirino Highway Station	Quezon City	Barangay Talipapa
Alignment from Quirino Highway Station to Tandang Sora Station		Barangay Tandang Sora
Alignment from Tandang Sora Station to North Ave. Station		Barangay Bahay Toro Barangay Santo Cristo Barangay Bagong Pagasa
Alignment from North Ave. Station to Quezon Ave. Station		Barangay Bagong Pagasa
Alignment from Quezon Ave. Station to East Ave. Station		Barangay Pinyahan
Alignment from East Ave. Station to Anonas Station		Barangay Malaya Barangay Sikatuna Village, Barangay East Kamias, Barangay Quirino 2A Barangay Quirino 3A
Alignment from Anonas Station to Katipunan Station		Barangay Bagumbuhay Barangay Milagrosa

Project Components	Municipality	Barangay
Alignment from Katipunan Station to Ortigas North Station		Barangay White Plains Barangay Ugong Norte
Alignment from Ortigas North Station to Ortigas South Station	Pasig City	Barangay Ugong Barangay Oranbo Barangay San Antonio
Alignment from Ortigas South Station to Kalayaan Ave. Station		Barangay Kapitolyo
	Makati City	Barangay East Rembo
Alignment from Kalayaan Ave. Station to Bonifacio Global City Station	Taguig City	Barangay Fort Bonifacio
Alignment from Bonifacio Global City Station to Lawton East Station[b]		Barangay Fort Bonifacio
Alignment from Lawton East Station to Lawton West Station[b]		Barangay Fort Bonifacio
Alignment from Lawton West Station to NAIA Terminal 3[b]		Barangay Fort Bonifacio
	Pasay City	Barangay 183
Alignment from Lawton West Station to FTI Station[b]	Taguig City	Barangay Fort Bonifacio Barangay Western Bicutan
	Parañaque City	Barangay San Martin de Porres
FTI Station to PNR Bicutan Station for interoperability with the North South Commuter Rail Project[c]		Barangay San Martin de Porres Barangay Merville
Other Components		
Valenzuela Depot	Valenzuela City	Barangay Ugong

Table 1.1-4 Changes to the Original Alignment as Presented in the 2017 EIA

Project Alignment	Placement	Old Project Location	Changes to the Alignment	New Project Location
Valenzuela Depot	Aboveground	Barangay Ugong, Valenzuela City	No Major Change	n/a
Valenzuela Station	Underground	Barangay Ugong, Valenzuela City	This development of this station is still under consideration and will not entail major changes as this will be within the depot station. One option also considered is that additional small track of land (not more than 1 hectare) adjacent to the depot area may be acquired.	n/a
Alignment from Depot to Quirino Highway Station	Underground	Barangay Talipapa, Quezon City	No Major Change	n/a
Quirino Highway Station	Underground with aboveground components	Barangay Talipapa, Quezon City	No Major Change	n/a
Alignment from Quirino Highway Station to Tandang Sora Station	Underground	Barangay Tandang Sora, Quezon City	No Change	n/a

Tandang Sora Station	Underground with aboveground components	Barangay Tandang Sora, Quezon City	No Change	n/a
Alignment from Tandang Sora Station to North Ave. Station	Underground	Barangay Bahay Toro, Quezon City Barangay Santo Cristo, Quezon City Barangay Bagong Pagasa, Quezon City	No Change	n/a

Project Alignment	Placement	Old Project Location	Changes to the Alignment	New Project Location
		Quezon City Barangay Bagong Pagasa, Quezon City		
North Ave. Station	Underground with aboveground components	Barangay Project 6, Quezon City	No Major Change	n/a
Alignment from North Ave. Station to Quezon Ave. Station	Underground	Barangay Bagong Pagasa, Quezon City	No Major Change	n/a
Quezon Ave. Station	Underground with aboveground components	Barangay Bagong Pagasa, Quezon City	No Major Change	n/a
Alignment from Quezon Ave. Station to East Ave. Station	Underground	Barangay Pinyahan, Quezon City	No Major Change	n/a
East Ave. Station	Underground with aboveground components	Barangay Pinyahan, Quezon City	No Major Change	n/a
Alignment from East Ave. Station to Anonas Station	Underground	Barangay Malaya, Quezon City Barangay Sikatuna Village, Quezon City Barangay East Kamias, Quezon City Barangay Quirino 2A, Quezon City Barangay Quirino 3A, Quezon City	No Major Change	n/a
Anonas Station	Underground with aboveground components	Barangay Bagumbuhay, Quezon City	No Major Change	n/a
Alignment from Anonas Station to Katipunan Station	Underground	Barangay Bagumbuhay, Quezon City Barangay Milagrosa, Quezon City	No Major Change	n/a
Katipunan Station	Underground with aboveground components	Barangay Blueridge A, Quezon City Barangay St. Ignatius, Quezon City Barangay Bayanihan, Quezon City	No Major Change	n/a

Project Alignment	Placement	Old Project Location	Changes to the Alignment	New Project Location
Alignment from Katipunan Station to Ortigas North Station	Underground	Barangay White Plains, Quezon City Barangay Ugong Norte, Quezon City	No Major Change	n/a
Ortigas North Station	Underground with aboveground components	Barangay Ugong, Pasig City	No Major Change	n/a
Alignment from Ortigas North Station to Ortigas South Station	Underground	Barangay Ugong, Pasig City Barangay Oranbo, Pasig City Barangay San Antonio, Pasig City	No Major Change	n/a
Ortigas South Station	Underground with aboveground components	Barangay Kapitolyo, Pasig City Barangay Oranbo, Pasig City Barangay San Antonio, Pasig City	No Major Change	n/a
Alignment from Ortigas South Station to Kalayaan Ave. Station	Underground	Barangay Kapitolyo, Pasig City Barangay Pineda, Pasig City Barangay East Rembo, Makati City	No Major Change	n/a
Kalayaan Ave. Station	Underground with aboveground components	Barangay Fort Bonifacio, Taguig City	No Major Change	n/a
Alignment from Kalayaan Ave. Station to Bonifacio Global City Station	Underground	Barangay Fort Bonifacio, Taguig City	No Major Change	n/a
Bonifacio Global City Station	Underground with aboveground components	Barangay Fort Bonifacio, Taguig City	No Major Change	n/a
Alignment from Bonifacio Global, City Station to Cayetano Boulevard Station	Underground	Barangay Fort Bonifacio, Taguig City Barangay Pembo, Makati City Barangay Rizal, Makati City Barangay Pinagsama,	This alignment was shifted toward a new proposed station at Lawton East due to a fault line discovered parallel to the Cayetano Station	This alignment was shifted toward a new proposed station at Lawton East due to a fault line discovered parallel to the Cayetano Station

Project Alignment	Placement	Old Project Location	Changes to the Alignment	New Project Location
		Taguig City Barangay Ususan, Taguig City		
Cayetano Boulevard Station	Underground with aboveground components	Barangay Pinagsama, Taguig City Barangay Ususan, Taguig City	A fault line was found parallel to the Cayetano Station. As a result, proposed new stations in Lawton East and Lawton West replaced the Cayetano Station in the alignment Additional NAIA Terminal 3 Station on Resorts Drive in Newport City in Barangay 183, Pasay City. Two alignment options are being considered for this station which will be finalized during the detailed design stage of the project.	<u>Lawton East Station</u> Barangay Fort Bonifacio, Taguig City <u>Lawton West Station</u> Barangay Fort Bonifacio, Taguig City <u>NAIA Terminal 3 Station</u> Barangay 183, Pasay City
Alignment from Cayetano Boulevard Station to FTI Station	Underground	Barangay Pinagsama, Taguig City Barangay Western Bicutan, Taguig City	The original alignment from Cayetano Boulevard to the FTI Station was shifted westward towards the locations of the Lawton East and Lawton West Stations. This is due to a fault line found parallel to the Cayetano Station Alignment from Lawton West Station to NAIA Terminal 3 Station	Alignment from Bonifacio Global City Station to Lawton East Station in Barangay Fort Bonifacio, Taguig City Alignment from Lawton East Station to Lawton West Station in Barangay Fort Bonifacio, Taguig City Alignment from Lawton West Station to NAIA Terminal 3 Station Barangay 183, Pasay City

Project Alignment	Placement	Old Project Location	Changes to the Alignment	New Project Location
FTI Station	Underground with aboveground components such as Service Track	Barangay San Martin de Porres, Parañaque City Barangay Merville, Parañaque City	No changes to the location of the proposed FTI station. However, the track will be extended from the proposed FTI station to the Bicutan PNR Station to increase the interoperability with the NSCR. Due to social considerations during the various stakeholder engagement activities with residents in Barangay San Marin de Porres, the development of this station is still under consideration, this includes: • Changing the layout of the station or merging it to adjacent components • Full utilization of the existing road right of way of the Philippine National Railway (PNR)	Underground with aboveground components such as Service Track

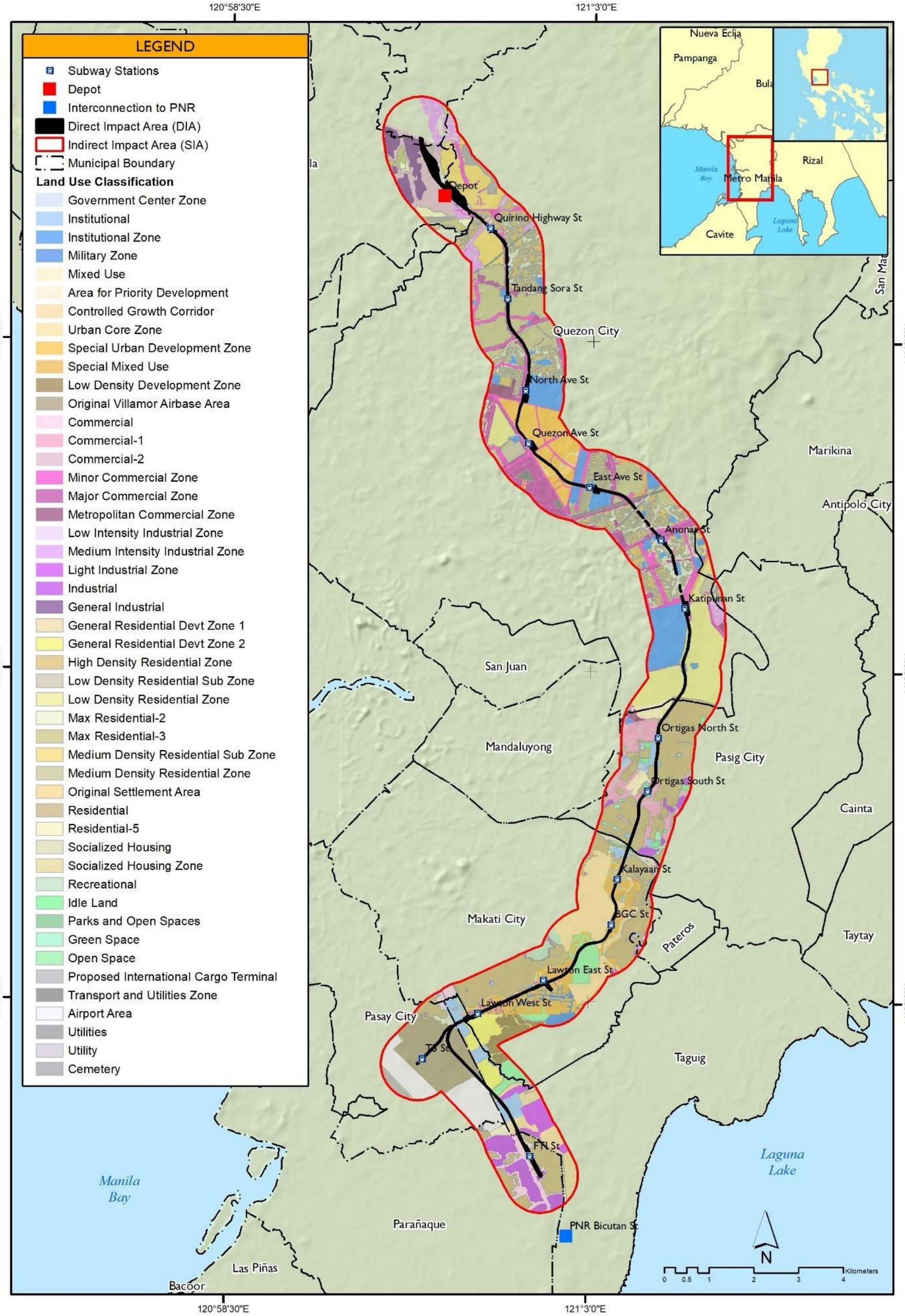


Figure 1.1-2 MMSP Direct and Indirect Impact Areas

Figure 1.1-3 Location of the Valenzuela Depot

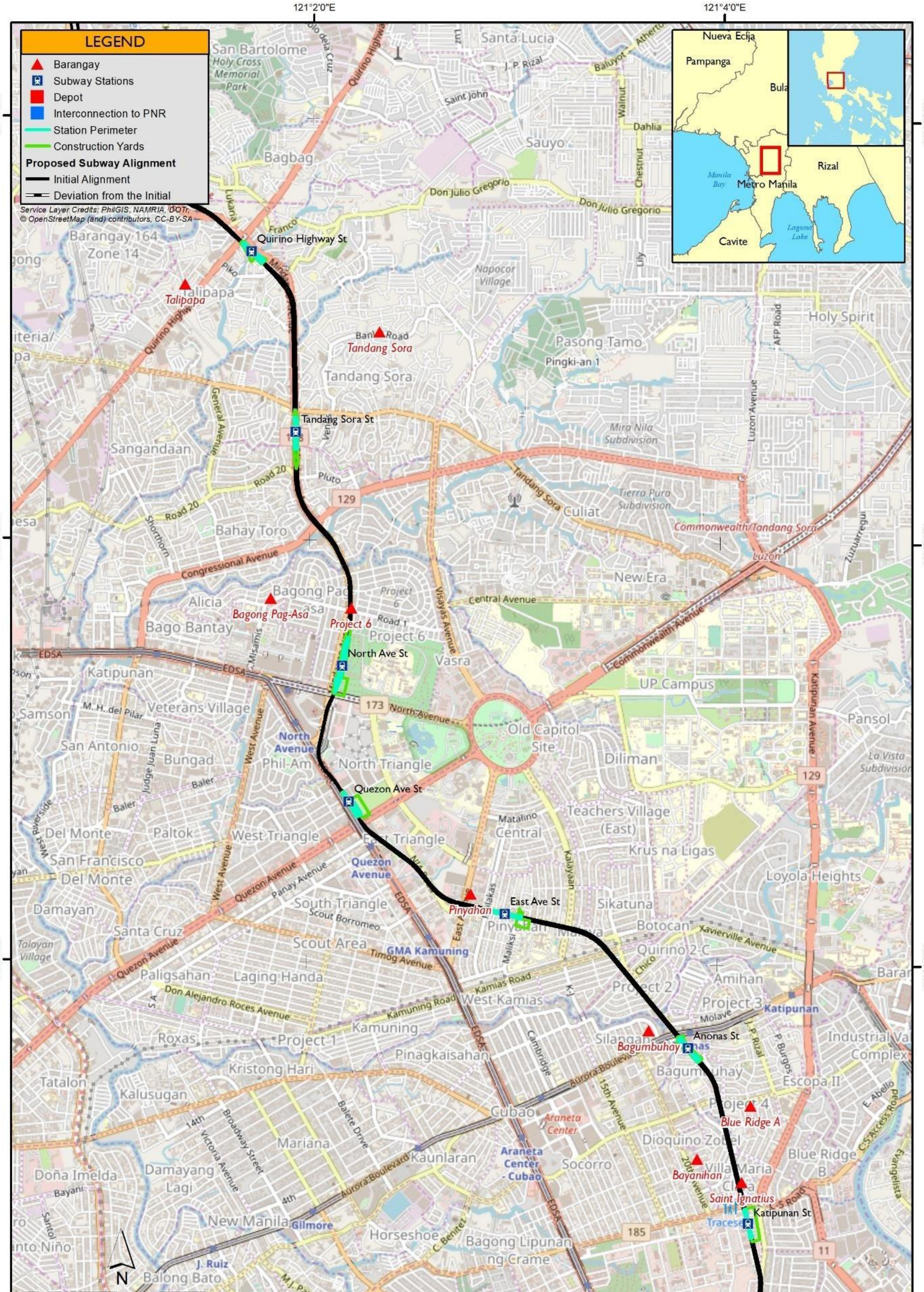


Figure 1.1-4 Locations of the Stations and Subway Alignment in Quezon City

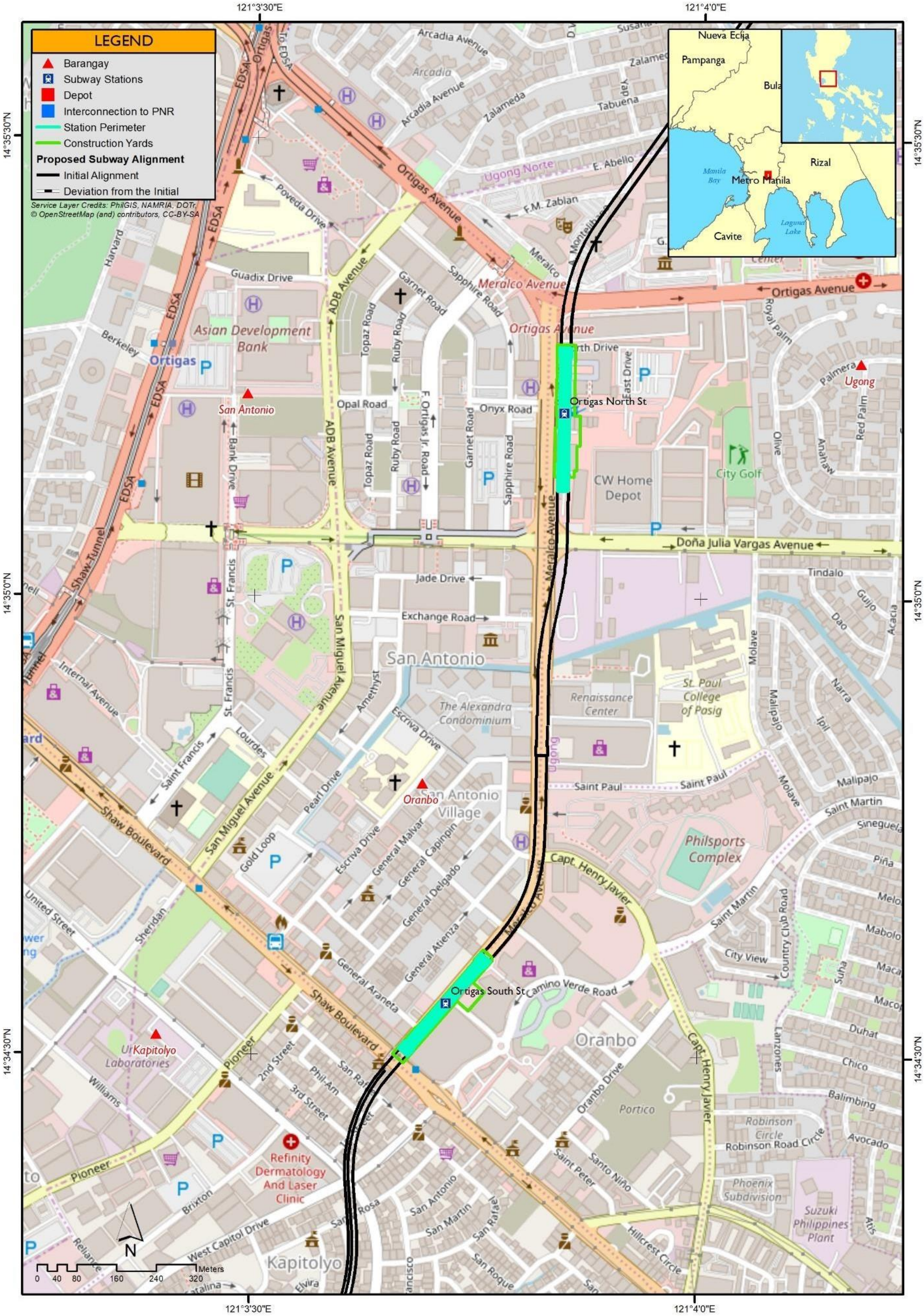


Figure 1.1-5 Locations of the Stations and Subway Alignment in Pasig City

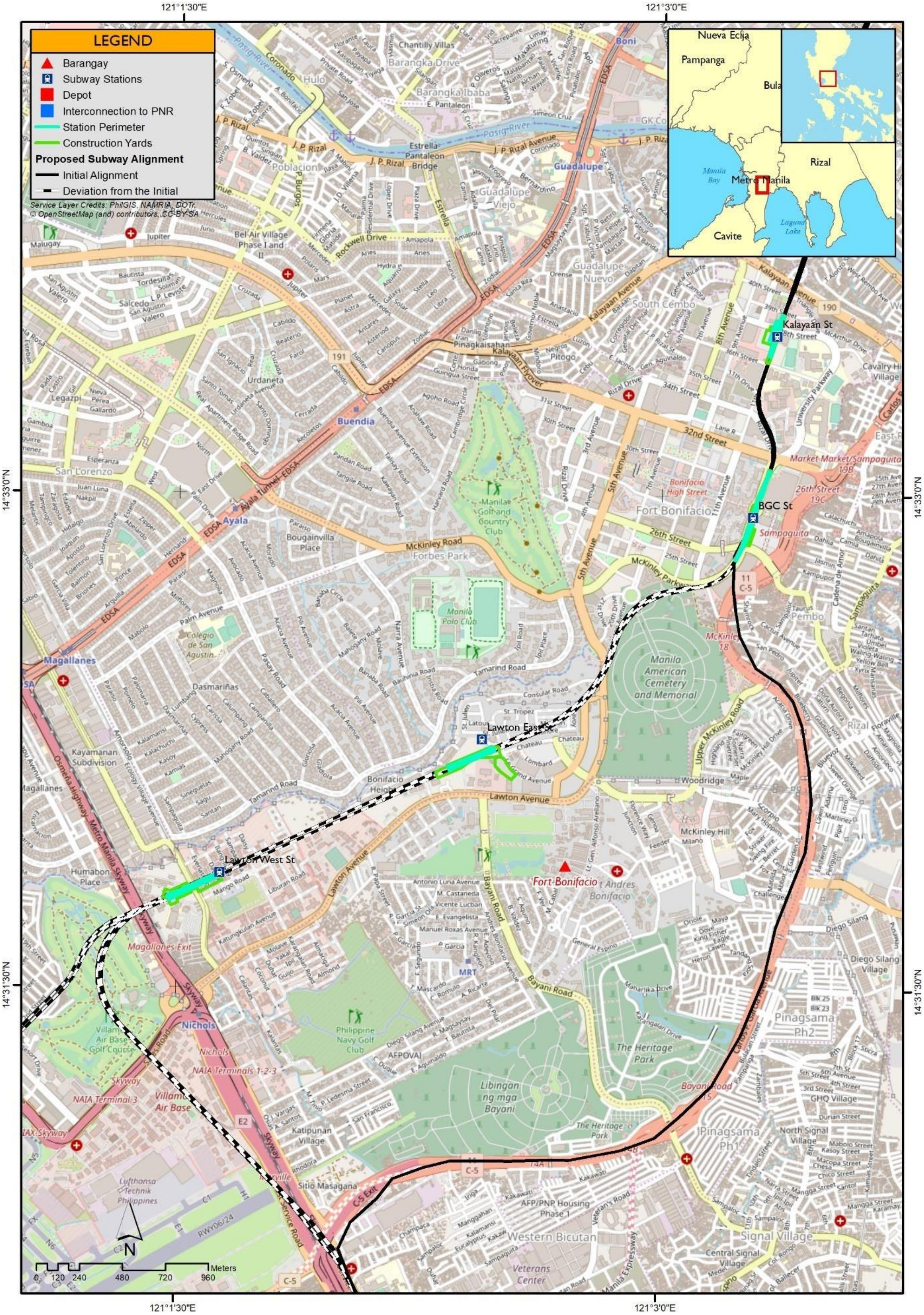


Figure 1.1-6 Locations of the Stations and Subway Alignment in Taguig City

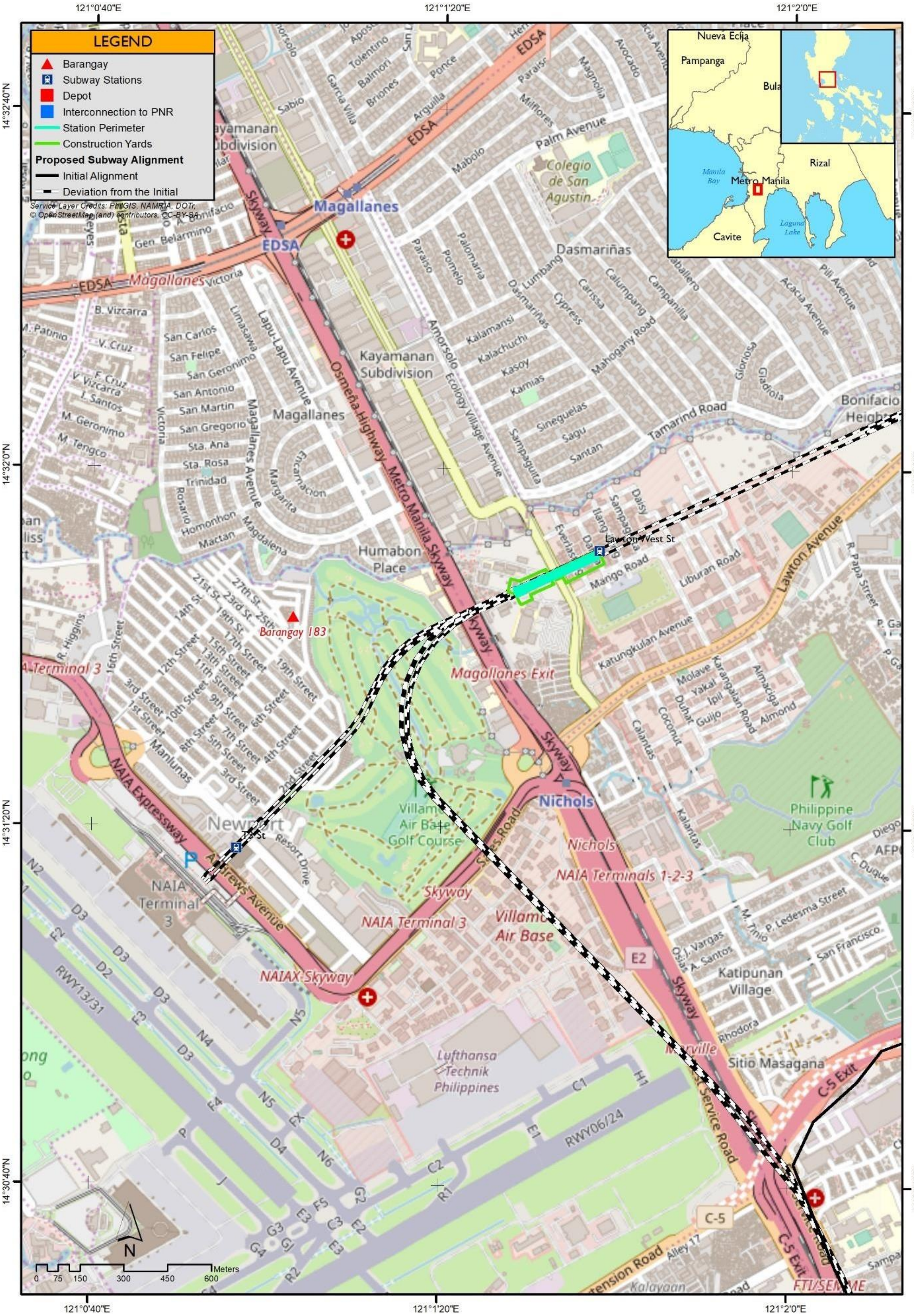


Figure 1.1-7 Locations of the Stations and Subway Alignment in Pasay City

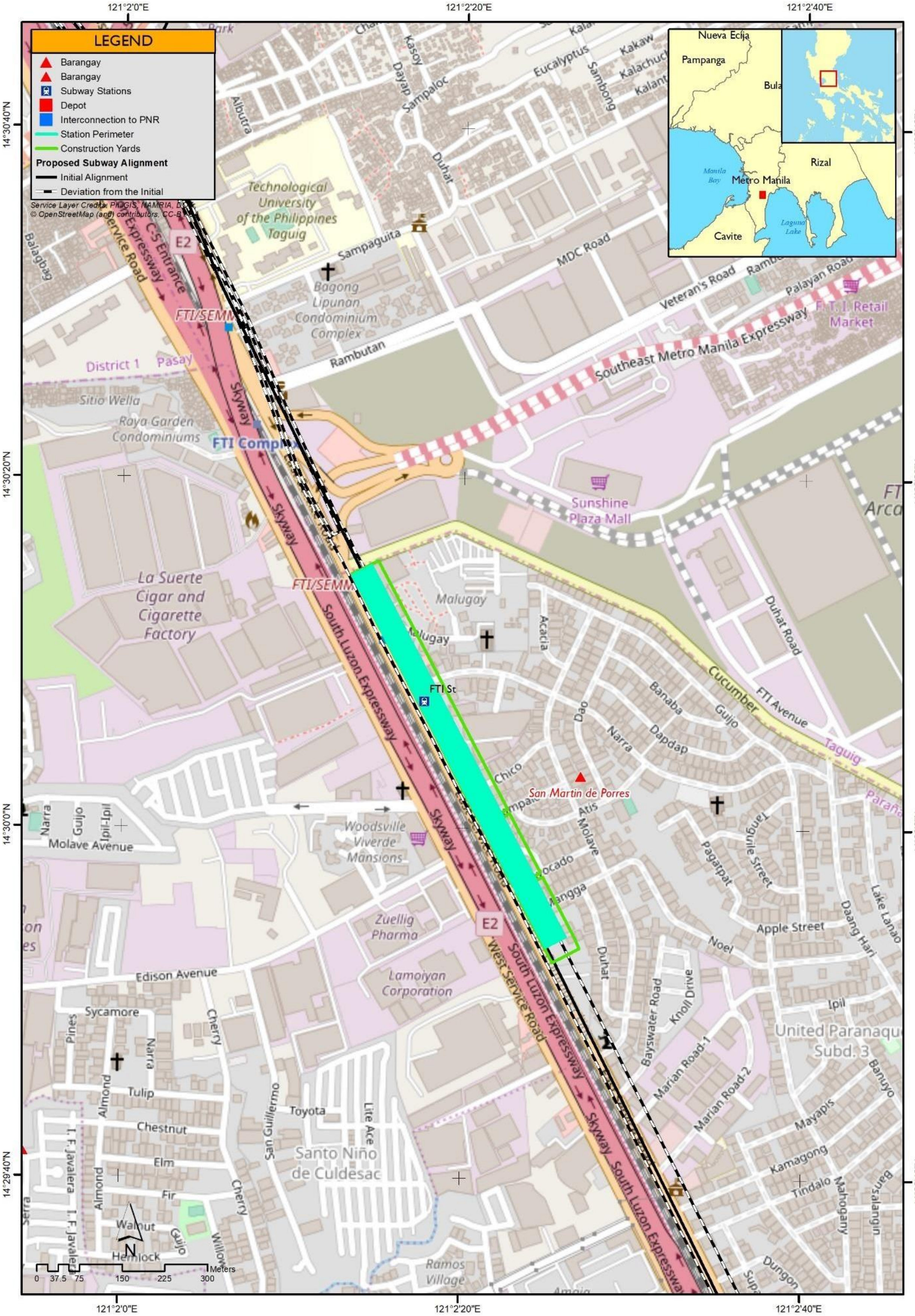


Figure 1.1-8 Locations of the Stations and Subway Alignment in Parañaque City

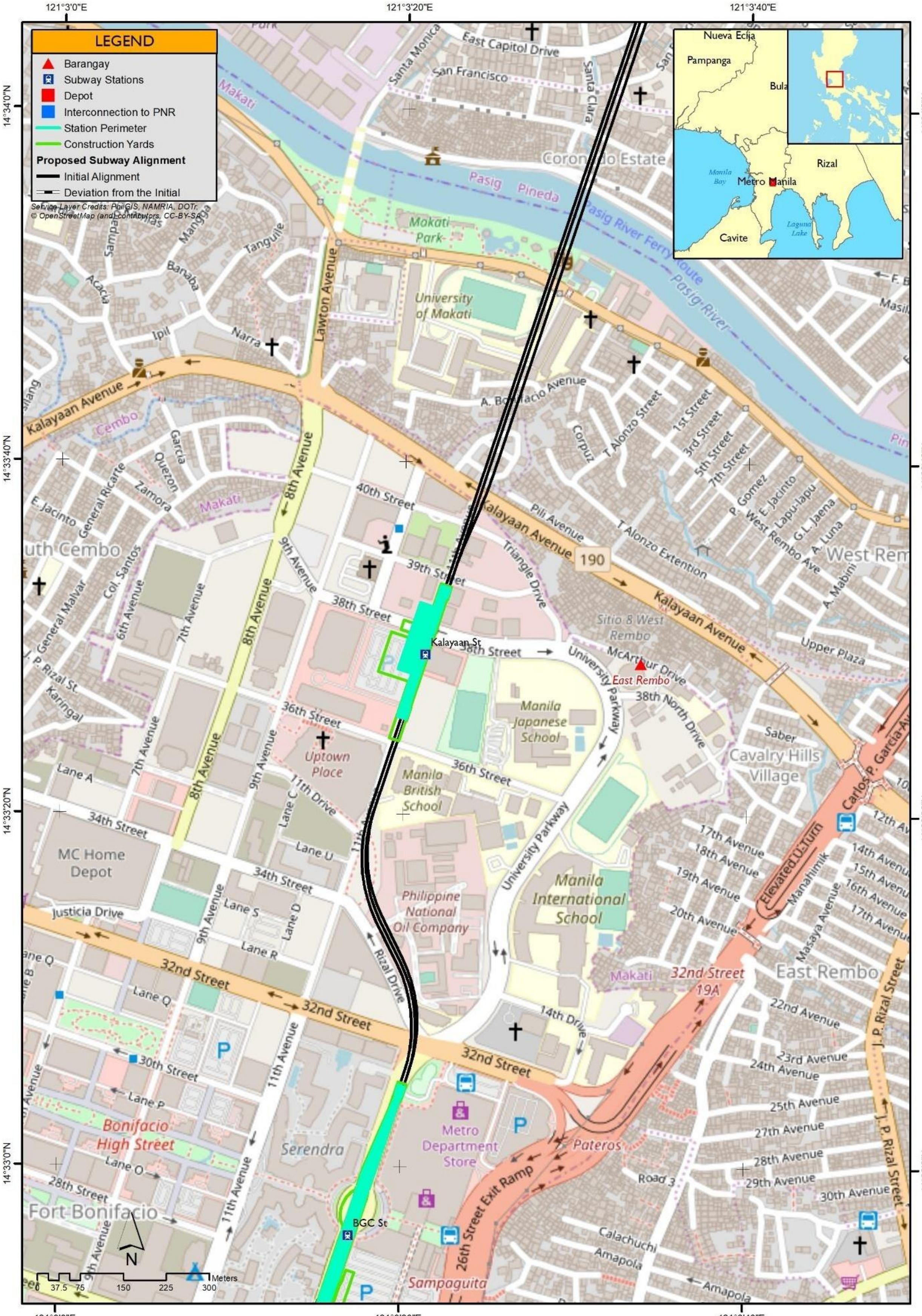


Figure 1.1-9 Locations of the Subway Alignment in Makati City

Figure 1.1-10 Planned Development of Quirino Highway Station (Source: JICA Study Team)

Figure 1.1-11 Planned Development of Tandang Sora Station (Source: JICA Study Team)

Figure 1.1-12 Planned Development of North Avenue Station (Source: JICA Study Team)

Figure 1.1-13 Planned Development of Quezon Avenue Station (Source: JICA Study Team)

East Avenue Station

Figure 1.1-14 Planned Development of East Avenue Station (Source: JICA Study Team)

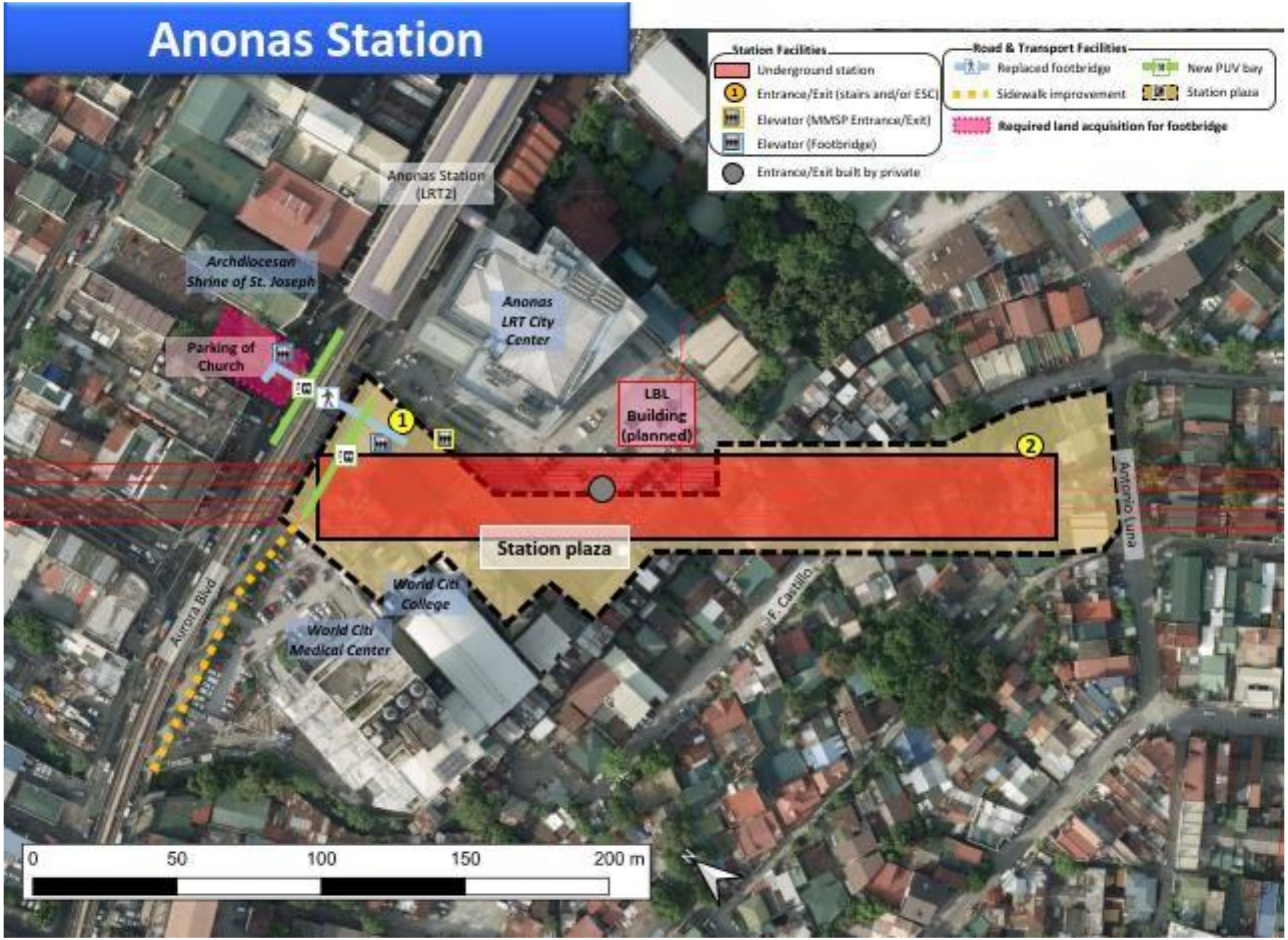


Figure 1.1-15 Planned Development of Anonas Station (Source: JICA Study Team)

Figure 1.1-16 Planned Development of Katipunan Station (Source: JICA Study Team)

Figure 1.1-17 Planned Development of Ortigas North Station (Source: JICA Study Team)

Figure 1.1-18 Planned Development of Ortigas South Station (Source: JICA Study Team)

Figure 1.1-19 Planned Development of Kalayaan Station (Source: JICA Study Team)

Figure 1.1-20 Planned Development of Bonifacio Global City Station (Source: JICA Study Team)

Figure 1.1-21 Planned Development of Lawton East Station (Source: JICA Study Team)

Figure 1.1-22 Planned Development of Lawton West Station (Source: JICA Study Team)

Figure 1.1-23 Planned Development of FTI Station (Source: JICA Study Team)

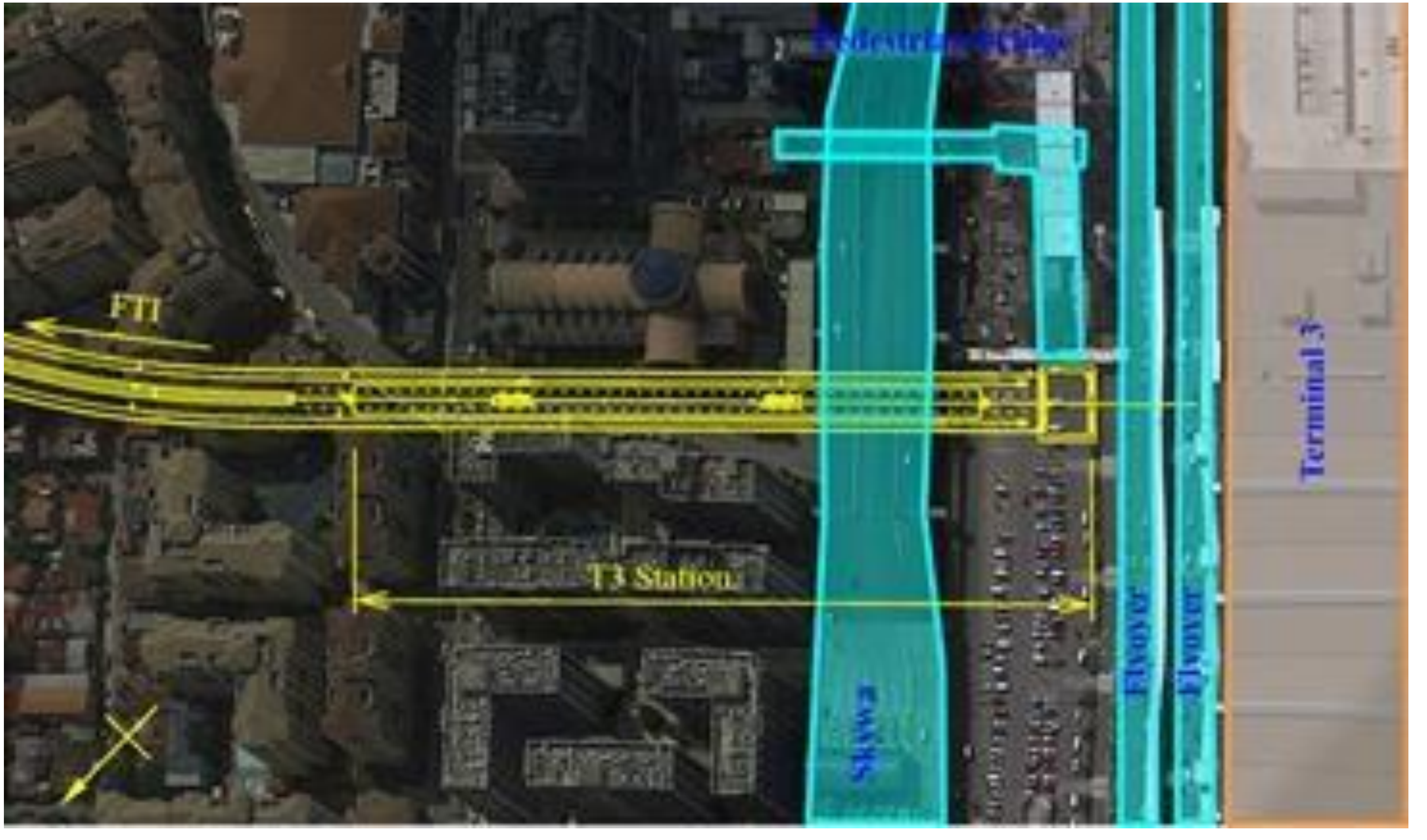


Figure 1.1-24 Development of NAIA Terminal 3 Station (Option 1)

Figure 1.1-25 Map Showing Options 1 & 2 for the NAIA Terminal 3 Station

1.2 Project Rationale

The total population has increased to 101 million as of 2015 and by 2020, the population is expected to grow to approximately 110 million. By 2030, it is expected that about 77% of the Philippine population will reside in urban areas (ADB, 2012). The National Capital Region (NCR) or Metro Manila is among the most populated regions of the Philippines which had a population of 12,877,253 in 2015 (PSA, 2015). Metro Manila houses 13% of the country's population with the economic activity of 38% of the gross domestic product (GDP).

The public transport services in Metro Manila are comprised road based public utility vehicles, taxis and mass transit systems. Despite the wide range of available modes of public conveyance, the public transport system in the Philippines is regarded as unsafe, unhealthy, unreliable and uncomfortable (Delgra III, 2018). Highly urbanized metropolitan centers such as Metro Manila which have inadequate public transport services can be cause discomfort and inconvenience to people living within the metropolitan. Increasing mass transit systems would reduce inconvenience to commuters who would normally opt to bear long hours of traffic via road-based commute. The present coverage of mass transport systems in Metro Manila is shown in **Figure 1.2-1**. The map showing the MMSP alignment with respect to the present mass transit systems coverage for Metro Manila is presented in **Figure 1.2-2**.

The Metro Manila area is highly urbanized and dense area which has a population density of 20,785 persons/km^2 (PSA, 2016). The MMSP is foreseen to connect to Bulacan in the north and Laguna to the south in its later phases which can reduce the population within the metropolitan by providing a fast, safe and reliable mass transit option thereby increasing the suitability of suburban areas as attractive places to reside.

The development of the MMSP will provide many benefits to Metro Manila such as:

- Creation of about 5,000 jobs during construction and about 1,400 jobs during operation;
- Serve as many as 973,000 passengers per day by 2035;
- Reduction of travel time between many points in Metro Manila;
- Increase royalties and taxes paid locally;
- Increase property values along the alignment;
- Increase in commercial activity along the alignment;
- Decongestion of traffic by reducing the number of vehicles on the road; and
- Reduction of air pollution through the reduction on the number of vehicles on the road.

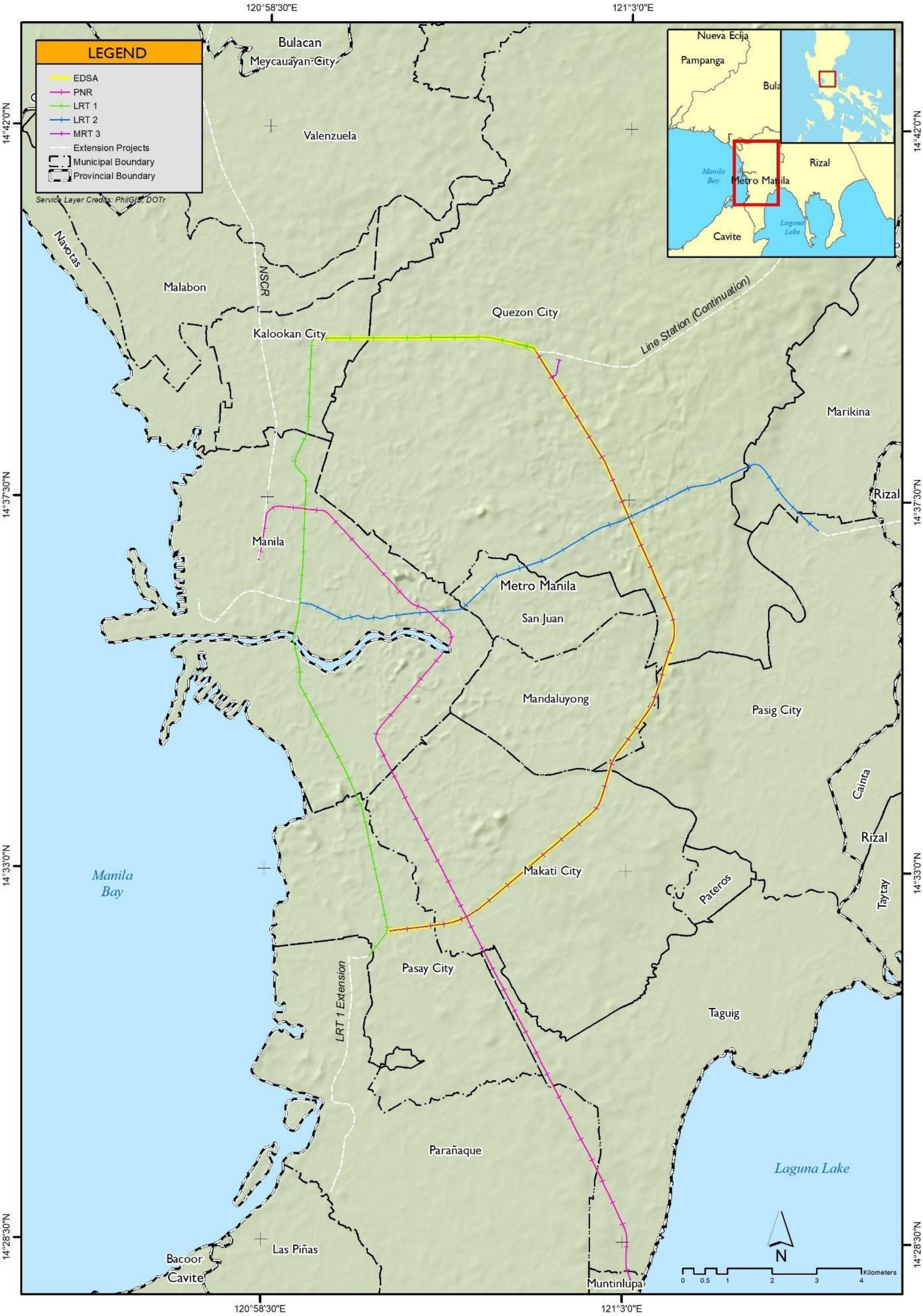


Figure 1.2-1 Present Coverage of Mass Transit Systems

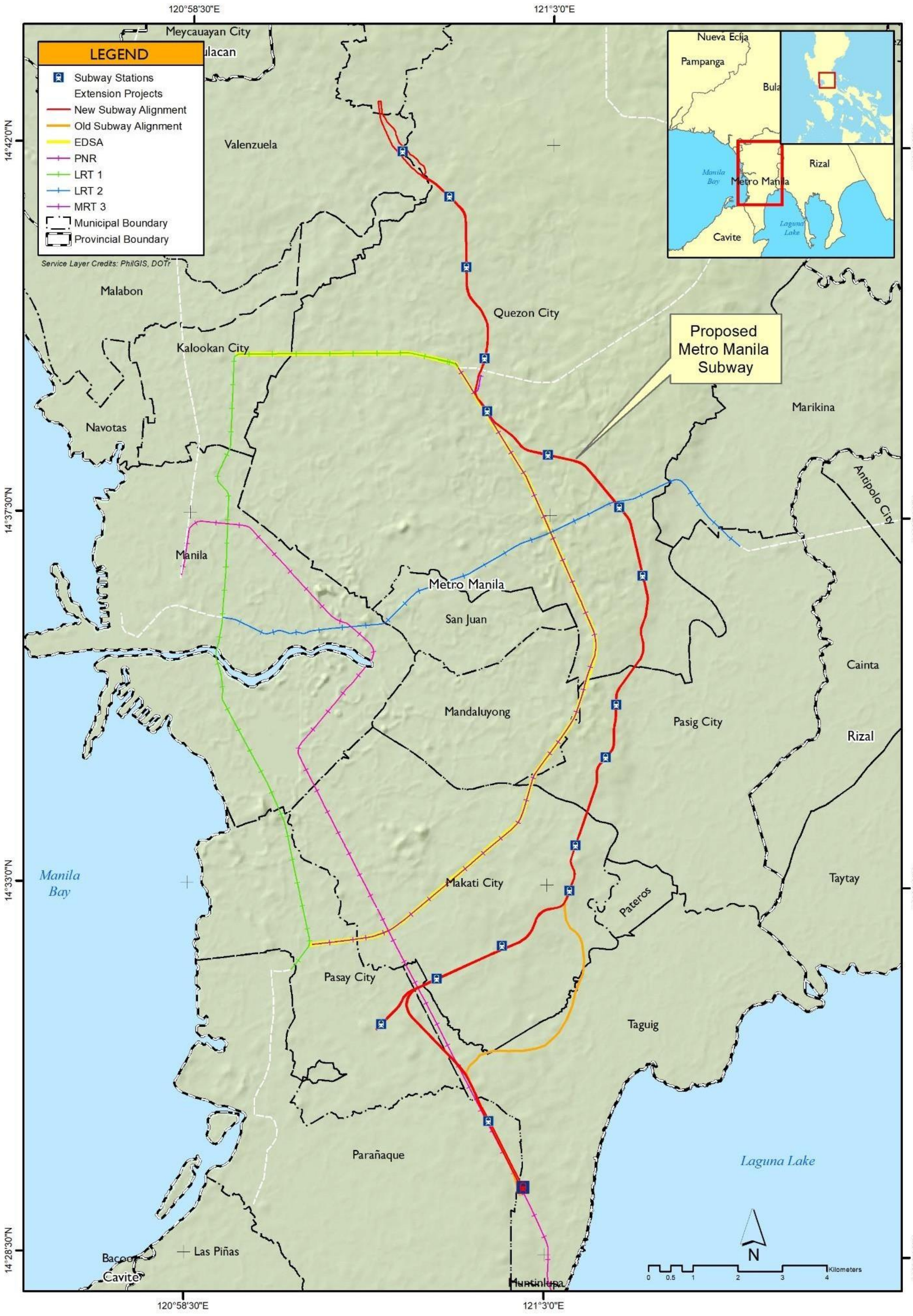


Figure 1.2-2 Project Alignment with Respect to other Mass Transit Systems in Metro Manila

1.3 Project Alternatives

Alternatives to the present alignment were considered as part of the development of the RPWSIP. The objective of the consideration of alternatives is to identify the most viable choices for the alignment minimizing the environmental and social impacts of the project while maximizing the benefits from the projects.

1.3.1 Zero Option

Public transport services in Metro Manila is presently insufficient to cater to its present population and to the population that commutes into and out the metropolitan. The Zero Option or the option of not pushing forward with the MMSP means that the worsening traffic situation will continue to hinder the development of Metro Manila. By extension, not pushing forward with the MMSP would further degrade the environment through worsening air pollution due to the traffic problem which would potentially remain unresolved. Thus, the Zero Option was not selected and the construction of the MMSP will be pursued to further develop Metro Manila.

1.3.2 Route Alternative Options for the Original Alignment

In the planning stage of the MMSP, three alternatives were considered as potential alternatives for a portion of the MMSP alignment between the proposed North Avenue Station and the proposed North Ortigas Station. Advantages and disadvantages between the alternatives were weighed using the criteria shown in **Table 1.3-1** and the assessment matrix shown in **Table 1.3-2**. **Figure 1.3-1** shows the three alignments options side by side.

After discussions with the Department of Transportation (DOTr), Department of Public Works and Highways (DPWH), Metropolitan Manila Development Authority (MMDA), Bases Conversion and Development Authority (BCDA) and the JICA Study Team, the 3rd option was evaluated to achieve the project's objectives and selected.

Table 1.3-1 Selection Criteria for the MMSP Portion between North Avenue and Ortigas North Stations

No.	Criteria	Suitability
V	Very Good or Desirable	Suitable or proper
G	Good or Desirable	Recommendable or acceptable
M	Middle	Recommendable or acceptable in case of no other options
B	Bad or Improper	Not recommendable or not acceptable

Source: 2017 EIS

Table 1.3-2 Project Alignment Alternatives for the MMSP Portion between North Avenue and Ortigas North Stations

Alternative	Option 1 (EDSA Route)	Option 2 (Greenhills Route)	Option 3 (Katipunan Route)
Route Characteristic	Route along the existing MRT 3 line and EDSA as main road	Route passing through many commercial and institutional areas and having a high development potential	Route passing through many commercial and residential areas and having a high development potential
Route Length (km)	22.7	23.7	23.6
Estimated project cost (Million PhP) (as of route selection)	208,753 (1.00)	210,639 (1.01)	218,307 (1.05)

Alternative	Option 1 (EDSA Route)				Option 2 (Greenhills Route)				Option 3 (Katipunan Route)			
Demand (in 2025) (passengers/day)	532				405				428			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ✓	B ☐
Fare Revenue (in 2025) (million PhP/km/day)	0.70				0.54				0.67			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐	V ☐	G ✓	M ☐	B ☐
Economic Loss due to traffic jams (million PhP/day) (without project: 3,512 million PhP/day)	3,490				3,470				3,466			
	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ✓	B ☐	V ☐	G ✓	M ☐	B ☐
No. of Stations connected to the Central Business District (CBD)	6				3				5			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐	V ☐	G ✓	M ☐	B ☐
Total CBD Areas along MMSP (ha)	810				660				680			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ✓	B ☐
Large Scale Intermodal (which connects 2 or more railways	3				1				2			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ✓	B ☐
Intermodal (which connects to another railway	2				2				1			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ✓	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐
Number of Stations with flood risk	0				2				0			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐	V ☐	G ✓	M ☐	B ☐
Number of Stations with earthquake risk (liquefaction)	0				0				0			
	V ☐	G ✓	M ☐	B ☐	V ☐	G ✓	M ☐	B ☐	V ☐	G ✓	M ☐	B ☐
Estimated required area (m^2)	19,000				46,000				54,000			
	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ☐	B ✓	V ☐	G ☐	M ☐	B ✓
Estimated Project Affected Persons (PAPs)	20				170				320			
	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ☐	B ✓	V ☐	G ☐	M ☐	B ✓
Estimated deemed PAPs	120				320				1,490			
	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ☐	B ✓	V ☐	G ☐	M ☐	B ✓
Residential Sections along MMSP (m)	990				2,541				2,168			
Noise and Vibration	Because the proposed alignment will pass through many residential areas, the impacts on local people will be more serious than Option-1				Because the proposed alignment will pass through many residential areas, the impacts on local people will be more serious than Option-1				Because the proposed alignment will pass through many residential areas, the impacts on local people will be more serious than Option-1			
	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ☐	B ✓	V ☐	G ☐	M ☐	B ✓

(Source: JICA Study Team)

Figure 1.3-1 Project Alignment Alternatives for the MMSP Portion between North Avenue and Ortigas North Stations (Source: JICA Study Team)

1.3.3 Depot Facility Siting

There were two site options that were considered for the depot during the planning stage. Namely, these two alternatives were located at Mindanao Avenue, Valenzuela City and General Luis, Caloocan City as shown in **Figure 1.3-2**. Using the criteria for selection shown in **Table 1.3-1**, it was decided that the best option was Option 2. The siting considerations for the depot location are tabulated in **Table 1.3-3**.

Table 1.3-3 Depot Siting Alternatives for the MMSP

Alternative	Option 1 (General Luis)	Option 2 (Mindanao Avenue)
Existing Land Use	Mixed-use of industrial and residential areas	Mixed-use of industrial, commercial and residential areas
Construction Cost, Depot Access Line (million	13,724	10,153

Alternative	Option 1 (General Luis)				Option 2 (Mindanao Avenue)			
PhP)	V ☐	G ☐	M ✓	B ☐	V ☐	G ✓	M ☐	B ☐
Land Acquisition Area (m²)	336,774				225,200			
	V ☐	G ☐	M ☐	B ✓	V ☐	G ☐	M ✓	B ☐
Land Acquisition Cost (million PhP)	6,735				5,104			
	V ☐	G ☐	M ☐	B ✓	V ☐	G ☐	M ✓	B ☐
Number of Affected Buildings	409 (residential development in progress)				576			
	V ☐	G ☐	M ☐	B ✓	1 ☐	2 ☐	3 ✓	4 ☐
Flood Risk	Risk of 0.5 m flood height expected at the southern part				Risk of maximum 0.5-1.5 m flood height expected			
	V ☐	G ☐	M ✓	B ☐	V ☐	G ☐	M ☐	B ✓
Others	• Road widening project for arterial road in progress going north to south • Arterial road is crossing the area which requires diversion of the road • Additional station is required				• Smart Connect Segment 8.2 (Expressway Project)			
	V ☐	G ☐	M ☐	B ✓	V ☐	G ☐	M ✓	B ☐

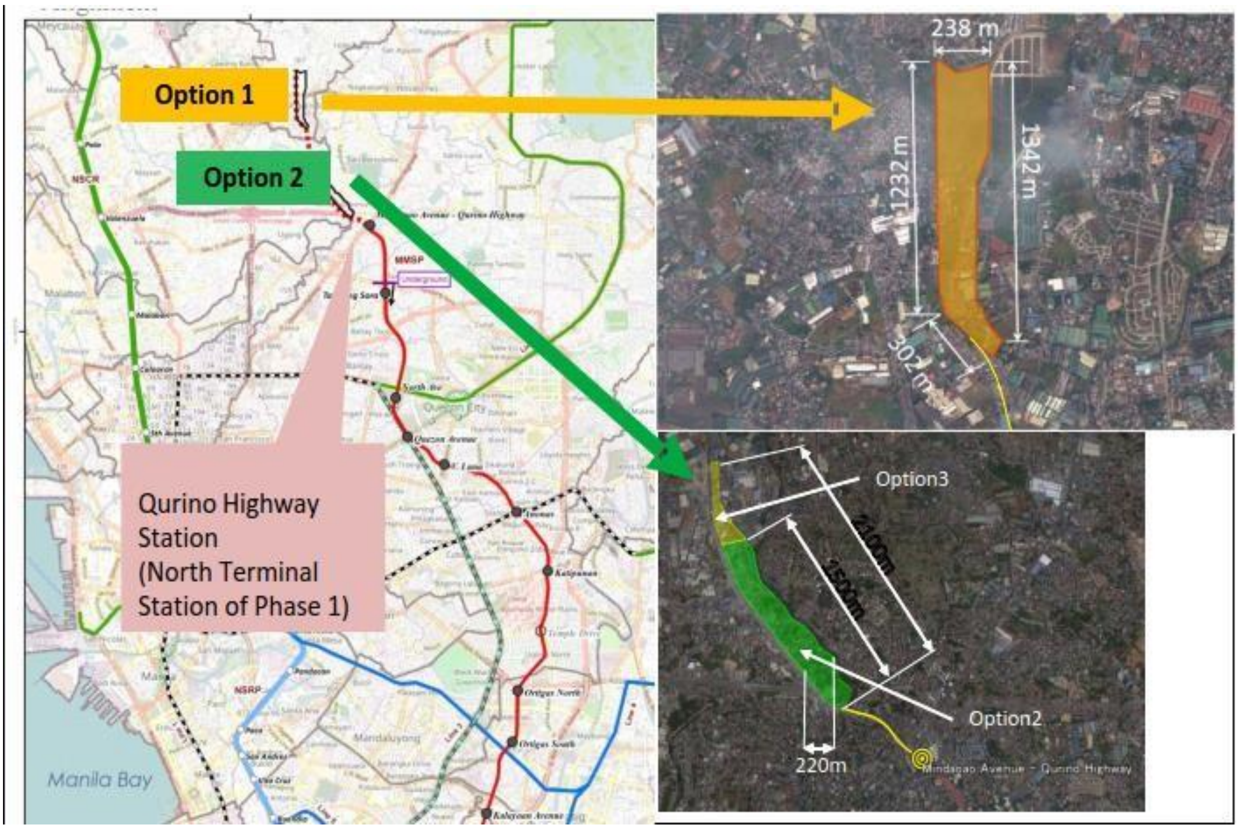


Figure 1.3-2 Siting Alternatives for the MMSP Depot (Source: JICA Study Team)

1.3.4 Options for the Alignment Shifted from the Cayetano Station

The option of keeping the alignment going through Cayetano Station in Taguig City was not desirable due to the fault line found running parallel to the station. The alternative route was selected where from Bonifacio Global City Station the alignment was shifter toward Lawton Avenue where two stations, Lawton East and Lawton West Stations, were established. The Lawton West station will connect to the FTI station and will also connect to another newly established station, NAIA Terminal 3 Station. The map of the new alignment can be found in **Figure 1.1-1**.

1.3.4.1 Cost-Benefit Analysis

(1) Difference between the Old and New Alignments

Figure 1.1-1 illustrates the difference between the old alignment and the new alignment. The alignment has changed starting from south of Bonifacio Global City Station. Previously, the MMSP will traverse Cayetano boulevard going to FTI and Bicutan. In the new alignment, the MMSP is proposed to pass through Lawton East and Lawton West, have a train station at NAIA Terminal 3, then connect to FTI and Bicutan.

(2) Economic Benefits of the Proposed Realignment

The new alignment south of Bonifacio Global City Station aims to provide a safer route, increase mobility by connecting to the international airport, and increase the connectivity of MMSP to other railway projects. Specifically, the economic benefits for the new sections are described as follows:

(3) Relocation of Cayetano Boulevard Station to Lawton East and Lawton West Stations

In the original alignment, one station is proposed to be located in Cayetano Boulevard in Taguig. Upon completion of the EIA, the proposed station was found located parallel to the West Valley Fault (WVF), which is approximately 23 meters west and 41 meters east of different segments of the alignment. As recommended by the DENR, the Cayetano Boulevard Station was removed, and the alignment shifted towards Lawton Avenue adjacent to the Manila American Cemetery and Memorial. The change also resulted in considering two stations parallel to Lawton Avenue, referred to as Lawton East and Lawton West station. Thus, the possibility of serious damaged caused by an earthquake is eliminated. The two new stations are expected to provide access to the Bonifacio Capitol District in which demand is expected to increase in the near future.

(4) Extension of the Project from Lawton West Station to NAIA Terminal 3 to Increase Connectivity and Mobility to and from the International Airport Terminals

As part of the original design, the MMSP is envisioned to connect to the NAIA Terminal 3. In view of this, Lawton West alignment will extend until Barangay 183 in Pasay. The MMSP station is proposed to connect with NAIA terminal 3, to be located either along Resorts Drive (perpendicular to NAIA 3 T3) which offers shorter thus fatser train travel or Andrews Avenue (parallel to NAIA T3) near the St. Therese Child of Jesus Church.

(5) Better Connectivity of MMSP to other Mass Transit Systems

To maximize efficiency of the intermodal transport system, the MMSP is proposed to connect to other railway networks in Metro Manila. The MMSP is being planned to be better connected to the Philippine National Railway (PNR) system, specifically to its FTI and Bicutan Stations. This PNR system is the same alignment for the planned upgrade into the North-South Commuter Railway Project (NSCR). The interconnection will improve convenience of passengers and is also expected to increase ridership demand.

(6) Improved Road Safety

Rail transport is safer than road transport. As such, more trip kilometers undertaken using rail transport means more economic benefit than when using road transport. Since the new alignment has a higher catchment area due to its longer distance and having more train stations, as well as improving the connectivity to other transport modes (i.e. rail and airport), the new alignment is expected to contribute higher economic benefits related to safety.

The project economic effects on accidents can be estimated using the following steps:

- Estimating the road accident rate per million vehicle-kilometers in the project catchment area, based on DPWH data for traffic accidents for 2012, estimates of the size of the vehicle fleet and estimates of the average annual distance travelled per vehicle, broken out separately for fatalities and injuries;
- Estimating the likely corresponding rail accident rates, based on the proposed technology and other characteristics of the operation. This study assumed rail fatality and accident rates will be approximately one-third those of road, based on reported experience in Europe with modernized systems;
- An estimate of the social cost per type of incident of PHP 5,250,000 per fatality and PHP750,000 for injuries was estimated, based on 2005 research into the socio-economic cost of road accidents. This was modified by applying the inflation rate from 2019 onwards. Based on the projected traffic volumes for the rail operations, the number of fatalities and injuries avoided over the course of the project is estimated;
- The saving to society is estimated by multiplying the cost per fatality/injury and the number of cases avoided.

(7) Decreased Road-Related Pollution

Rail transport produces less emissions than road transport. As such, more trip kilometers undertaken using rail transport means more economic benefit than when using road transport. Since the new alignment has a higher catchment area due to its longer distance and having more train stations, as well as improving the connectivity to other transport modes (i.e. rail and airport), the new alignment is expected to contribute higher economic benefits related to safety.

This analysis is restricted to the impact of the project on emissions of localized air pollutants and carbon dioxide. The steps taken were as follows:

- Estimates were made on the average emissions rates per litre for diesel locomotives, trucks, buses and passenger, based on literature review;
- Assumptions were made concerning the average fuel efficiency and the load factors for each transport alternative, leading to estimates of the emissions rates per unit of traffic;
- Based on the traffic forecasts and assumptions concerning diversion rates from road to rail, annual emissions of NOx and CO2 for both road and rail were estimated;

- Social cost per unit of pollutant emitted was estimated, based on values reported for the EU and converted to Philippine prices using purchasing power parity;
- The savings to society due to reductions in emissions as a result of the implementation of the project is obtained.

(8) Improved Travel Time

Rail transport is expected to be faster than road transport which is subject to road traffic. As such, more trip kilometers undertaken using rail transport means more economic benefit than when using road transport. Since the new alignment has a higher catchment area due to its longer distance and having more train stations, as well as improving the connectivity to other transport modes (i.e. rail and airport), the new alignment is expected to get more passenger demand which thereby gets more passenger kilometers. In addition, because of longer train distance of the proposed new alignment, there is even bigger time savings to use rail than using road transport from end-to-end of the alignment.

(9) Cost-Benefit Analysis

Economic Cost-Benefit analysis (CBA) of projects generates information on the benefits and costs of the project to society as a whole, as opposed to only the investors/operators of the project. When done on a national basis, as is the case herein, it generates the economic returns to the country as a whole, including the Government, the people and domestic investors/operators.

The key features of the CBA are as follows:

- To the extent possible, costs and benefits are expressed in monetary terms;
- Costs and benefit streams over the economic life of the project are expressed in present value terms by the use of discounting, using the social discount rate (SDR);
- External non-monetary effects (travel time savings, environmental cost) are included whenever possible, to the extent that they can be monetized;
- All benefits costs are subjected to inflation

For the purpose of this study, the CBA was compared between the old alignment and new alignment.
Please note that the economic CBA done for this study is high-level and preliminary for the purpose of EIA submission, upon the request of DENR. The estimates done for this study were made based on the high-level data and desktop information available at the time of this request. A more detailed CBA needs to be done for the later stages of project planning and development for better accuracy and precision, which will include more detailed survey and data gathering.

(10) Approach

Both financial cost and financial revenues were adjusted to translate to economic values. On the cost side, conversion factors were used to reflect the opportunity cost of resources used. On the benefit side, the effects of the project on transport cost and time savings as well as reduction of environmental costs were estimated. The streams of costs and benefits were then discounted using the social discount rate of 15% as currently mandated by NEDA.

Three metrics were used to evaluate the different scenarios:

- The Net Present Value (NPV) of the project
- The benefit cost ratio (B/C)
- The economic internal rate of return (EIRR)

The Net Present Value (NPV) is simply the discounted value of sum of the stream of costs and benefits, discounted over time. Projects with larger NPV are more valuable to society. It is hard to compare options since NPV generally grows with the size of the initial investment, i.e. there is no denominator which reflects the scale of the necessary investments. The NPV is also sensitive to the discount rate.

The Benefit Cost Ratio (B/C) resolves the issue of scalability. The B/C is the ratio of discounted total social benefits to discounted total social costs. Projects with higher B/C values indicate that for each unit of social cost, more benefits are generated than in other compared projects. Under this metric, projects of differing scale can be meaningfully compared, as the B/C appropriately reflects the “social return per social cost”. The key issue with the B/C is that the exact definition of benefits and costs, and how they are allocated, matters greatly. Moreover, the B/C is also sensitive to the discount rate.

Finally, the Economic Internal Rate of Return (EIRR) represents the social return on investment of the project. It also represents the discount rate at which the discounted total costs and benefits are equal (NPV = 0). It can be compared to a benchmark to evaluate the project performance from a social perspective. The EIRR, however, is insensitive to the discount rate and does not, however, provide much perspective on the timing of the costs and benefits. Also, for certain types of net benefit stream, e.g. if the net benefit stream is negative throughout, the EIRR formula will not yield a result.

(11) CBA Results

According to the JICA Study Team, the EIRR of the proposed project is 10.3%, which is higher than the social discount rate (10%) set by NEDA. This is a positive economic effect on the Philippine economy if this project includes the economic effects of the transit-oriented development (TOD). The Financial Internal Rate of Return (FIRR) value is 3.1%, while the current Philippine interest rate is Philippines Inter Bank Offered Rate (PHBOR) (7-8%) plus 2-3%. The indexes used for the CBA is shown in **Table 1.3-4** while the EIRR and FIRR are shown in **Table 1.3-5**.

Table 1.3-4 Calculation of Operation and Effect Index

Index	2025	2027	2030
Passenger transportation volume (person/kg)	3,531,915	5,129,957	7,527,020
Number of trips (round trip/day)	94	94	125
Occupancy Rate (%)	86.5	86.5	86.5
Vehicle km (km/day)	37,750.4	37,750.4	50,200.0

Index	2025	2027	2030
Days of vehicle maintenance plant days (day)	49	49	49
Time required for a specific section (hr)	There are suspensions: 42 min 20 sec There are no suspensions: 39 min 20 sec Rapid: 31 min 30 sec	There are suspensions: 42 min 20 sec There are no suspensions: 39 min 20 sec Rapid: 31 min 30 sec	There are suspensions: 42 min 20 sec There are no suspensions: 39 min 20 sec Rapid: 31 min 30 sec
Congestion Rate (%)	62.4	76.2	72.9
Load Factor (%)	33.4	48.5	53.5

(Source: JICA Study Team)

Table 1.3-5 Results of Economic and Financial Evaluations

	Evaluation	B/C	NPV (Million PhP)
EIRR	10.3	4.56	1,785.09
FIRR	3.1	1.94	612.58

(Source: JICA Study Team)

1.3.5 Options for the Alignment of the NAIA Terminal 3 Station

There are presently two alignment options being considered for the NAIA Terminal 3 Station as shown in **Figure 1.1-1** and **Figure 1.1-25**. The alignment of the station for Option 1 places the station along Resorts Drive alongside St. Therese Church. The alignment of the station for Option 2 places station along Andrews Avenue behind St. Therese Church and in front of a gasoline station. The final alignment will be decided during the detailed design stage of the project.

1.3.6 Tunneling and Excavation Methodology Alternatives

1.3.6.1 Station Sections

There were two tunneling methodologies considered for the construction of the underground structures for the stations along the MMSP alignment. In the Cut and Cover – Top Down Method the tunnel walls are constructed first then the roof which is supported by the tunnel walls. The surface is re-instated on top of the roof while the excavation is in progress underneath the roof. This continues from the top to the bottom from floor to floor until the station is constructed. In the Cut and Cover – Bottom Up Method, the retaining walls are installed first similar to the Top Down Method. The station is excavated while struts are placed in between the retaining walls to hold them in place. Once the bottom most floor is reached, the floors are built from the bottom up and once the top is reached the station is backfilled and the surface is reinstated.

It was determined that the best alternative for excavating and constructing the station section was the Top Down Method. The assessment of the tunneling method alternatives for station sections is shown in **Table 1.3-6**. An illustration of top down versus bottom up methods can be found in **Figure 1.3-3**.

Table 1.3-6 Tunneling Method Alternatives for the Station Sections of the MMSP Alignment

Alternative	Cut & Cover – Top Down Method		Cut & Cover – Bottom Up Method	
Utility Diversion	Almost all utilities need to be relocated but utility anchoring protection works are not required during excavation.	Good	Some utilities need to be relocated which can obstruct the retaining wall construction and temporary deck installation. Remaining utilities shall be protected by temporary anchorage method.	Good
Temporary Decking	Not Required	Very Good	Required. Temporary decking needs to be removed after work completion.	Poor
Temporary Strutting System	Not required. Retaining wall shall be supported by a permanent slab.	Very Good	Required. Temporary strutting needs to be removed during construction of permanent structure.	Poor
Material Movement	Materials need to be removed and installed from the temporary opening. Location of the temporary opening can be determined due to material movement plan.	Good	Openings can be made, if there are no obstructing utilities.	Very Good
Flood Control	Opening can be limited. So easy to control flooding.	Very Good	It is difficult to control flooding because of construction area is covered by temporary decking plate.	Bad
Construction Duration	Construction of utility diversion takes time. But many of temporary works can be omitted, which are utility protection, installation and removal of decking and strutting works.	Very Good	Many of temporary works are required, which includes utility protection, installation and removal of decking and strutting works. Overall total duration works would be longer	Poor
Total Cost	Many of activities can be omitted. Overall total cost could be lower.	Very Good	Most of the temporary works need to be done. Overall total cost could be higher.	Poor
Quality	Quality control during construction of permanent wall and Colum is required, but is manageable, using self-compaction concrete and non-shrink cement grouting works.	Very Good	Almost all of concrete casting can be done without any obstruction. Basically, quality can be controlled easily.	Very Good
Total Judgement	Very Good		Good	

(Source: JICA Study Team)

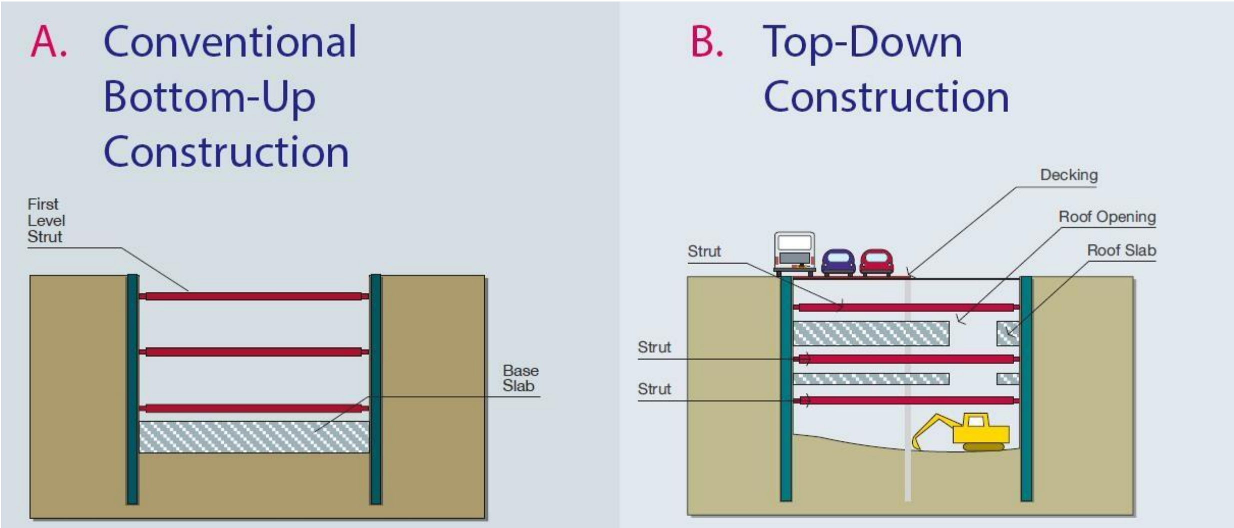


Figure 1.3-3 Illustration of Top-Down versus Bottom Up Methods of Cut and Cover (Source: www.railsystem.net)

1.3.6.2 Underground Sections in between Stations

Similar to the station sections, there were two tunneling methodologies considered for the construction of the underground structures in between the stations along the MMSP alignment.

Using the same selection criteria as shown in **Table 1.3-1**, it was determined that the best alternative for excavating for station section was the Non-Cut and Cover Method (Shield Tunneling and New Austrian Tunneling Method (NATM)). The assessment of the tunneling method alternatives for station sections is shown in **Table 1.3-7**.

Table 1.3-7 Tunneling Method Alternatives for the Sections in between Stations of the MMSP Alignment

Alternative	Option 1 (Cut and Cover Method)	Option 2 (Non-Cut and Cover Method – Shielded Tunneling and NATM)
General Description	• Generally utilized at shallow depth locations (15 m) because of the financial aspect, but is rarely utilized for tunneling in between stations because of traffic congestion due to works	• Possible to excavate inside the earth by a shielded tunneling machine regardless of conditions on the ground • Since traffic congestion due to works is the most objectionable factor for the Philippines, this method is desirable
	V ☐ G ☐ M ✓ B ☐	V ✓ G ☐ M ☐ B ☐
Cost	Comparatively inexpensive	More expensive than the Cut and Cover Method
	V ✓ G ☐ M ☐ B ☐	V ☐ G ✓ M ☐ B ☐
Construction Period	Overall period is shorter than Non-Cut and Cover Method because it's possible to conduct construction of civil works at the same time as the shielded tunnel construction between	Overall all period is longer than Cut an Cover Method because enlargement works are conducted after the completion of the shielded tunnel construction

Alternative	Option 1 (Cut and Cover Method)				Option 2 (Non-Cut and Cover Method – Shielded Tunneling and NATM)			
	stations							
	V ✓	G ☐	M ☐	B ☐	V ☐	G ☐	M ✓	B ☐
Social/Environment Friendliness	Temporary roads must be ensured in order to prevent negative impacts from the works on traffic which requires land acquisition of about 12 m.				There are a few influences on road traffic at the station sections and there are shafts, so they could influence road traffic and cause residence relocation as well			
	V ☐	G ☐	M ☐	B ☐	V ☐	G ☐	M ☐	B ☐

(Source: JICA Study Team)

1.4 Project Components

The project components, scales of the facilities and the specifications of the equipment are listed in **Table 1.4-1**.

Table 1.4-1 Project Components, Facility Scaling and Equipment Specifications

Particulars	Technical Parameter	Specifications		
Train Operation Plan	Maximum Speed	80 kph (underground sections)		
	Gauge	1,435 mm (standard gauge)		
	Length	Embankment	Elevated	Underground
		1.0 km	0.3 km	27.6 km
	Number of Stations	At Grade	Elevated	Underground
		-	-	16
	Traction Power Supply	Overhead Rigid Conductor System (Underground) Simple Catenary System (Depot)		
	Standard Passenger Capacity	Seated	Standing (7 passengers/m^2)	Total
	Lead Car	45	221	266
	Intermediate Car	54	231	285
	Capacity on a Train (8 car train)	Capacity per car	Number of cars	Capacity per train
	Lead Car	266	2	532
	Intermediate Car	285	6	1,170
	Total Passengers	-	8	2,242
	System Operational Specifications	Year		
		2020	2030	
	Traffic Demand (passengers per hour per direction, PPHPD)	12,800	19,900	

Particulars	Technical Parameter	Specifications	
	Train Composition (8 cars)	8	8
	Number of Operational Trains	9	12
	System Capacity (PPHPD)	20,178	26,904
	Travel Time	Travel Time	Scheduled Speed
	Express (Quirino Highway – FTI)	28 mins	~ 70 km/h
	Local (Quirino Highway – FTI)	36 mins	60 km/h
	Required Number of Trains	Year	
		2020	2030
	Train in Operation	16	20
	Reserved Train	4	4
	Train Composition	8 cars	8 cars
	Rolling Stock Procurement Plan	Year	
		2020	2030
	Number of Trains to Procure	152 Card (19 x 8 car train sets)	40 Card (5 x 8 car train sets)
Railway Alignment and Structure Plan	***Horizontal Curve Radius***		
	For Main Line	More than 160 m	
	For Stations	More than 400 m	
	For Turnout	More than 160 m (Main Line) More than 100 m (Depot)	
	Transition Curve Length	Maximum out of L1, L2, L3	
		L1=600C	
		L2=7.4CV	
		L3=6.7C_dV	
	Length between Transition Curves	More than 20 m	
	Maximum Gradient		
	For Main Line	35/1,000	
	For Stations	Level (0), 5/1,000 (absolute maximum) The underground section installs the gradient for a drainage	
	For Stabilizing Track	Level (0), 5/1,000 (absolute maximum) The underground section installs the gradient for a drainage	
	For Turnout	Level (0), 25/1,000 (absolute maximum) The underground section installs the gradient for a drainage	
	Vertical Curve	Radius 3,000 m (4,000 m where curve radius is less than 800 m) Vertical curve is required for more than 10/1,000 of gradient change	

Particulars	Technical Parameter	Specifications
	Width of Formation	
	Cut and cover tunnel and U-shaped retaining wall section	More than 2.8 m
	Shield Tunnel Section	The width which can arrange the evacuation passage width of 1 m or more.
	Depot	More than 3.0 m
	Other Sections	More than 3.15 m
	Distance Between Track Centers	More than 4.0 m (Main Line). More than 4.0 m (Station). More than 4.0 m (Stabilizing track)
	Width of Structural Gauge	3.4 m (underground), 3.8 m (others)
	Station Platform	
	Platform Length	210 m (for 10 cars train for future)
	Platform Width	10 m (Standard, island platform) 7.5 m (Standard, separate platform)
System Plan	***Train Formation***	
	*T_c: Trailer car with driver's cab	4M4T (T_c+M+M+T+T+M+M+T_c)
	*M: Motor car	
	*T: Trailer car	
	Major Dimension	
	Leading Car Length	20,470 mm
	Intermediate Car Length	19,500 mm
	Body Width	2,950 mm
	Passenger Capacity per Train	
	Number of Cars/Train Sets	8 cars
	Seat	414 passengers
	Standard (4 pax/m^2)	1,466 passengers
	Standing (7 pax/m^2) + Seat	2,242 passengers
	Weight per Train (tare)	254 T
	Body Materials	Aluminum Alloy
	Saloon Design	
	Door Ways	4 doorways each side of a car
	Door Type	Double sliding doors, Pocket Type, 1,300 mm width
	Special Facilities	
	Wheel Chair Space	Equipped

Particulars	Technical Parameter	Specifications
	Baggage Space	Not Equipped
	Cab Front End Door	Equipped
	Traffic Performance	
	Acceleration	0.92 m/s^2 (3.3km/h/s)
	Deceleration	Service: 1.17 m/s^2 (4.2 km/h/s) Emergency: 1.31 m/s^2 (4.7 km/h/s)
	Propulsion System	
	Power Collection System	DC 1,500 V Single-arm pantograph (1 unit per motor car) High Voltage Bus Line
	Control System	VVVF inverter with IGBT elements (Option: SiC) 1 set per motor car
	Traction Motor	High Performance Totally Enclosed Induction Motor Gear Ratio: 6.53 (98/15)
	Brake Control System	Electric command electro-pneumatic Regenerative brake Anti-Skid Device Equipped
	Bogies	Bogie with Bolster
	Air Conditioning Equipment	Roof top type (2 units per car)
	Auxiliary Power Supply Equipment	Static Inverter (SIV)
	Passenger Information System	Public address system via loudspeaker Emergency intercom Visual information system via 17" LCD screens
	Electrification System	DC 1500 V feeding system
	Signaling System	CBTC (Automatic Train Protection, Automatic Train Operation, Automatic Train Supervision), depot signalling (Shunting Signal, Track Circuit, Computer Based Interlocking)
	Telecommunication System	Multi-Service-Network, Telephone, Digital Radio, Closed-Circuit Television, Passenger Information System, Public Address System, Clock, Disaster Prevention System, Facility-SCADA
	Fare Collection System	Automatic Fare Collection System
	Track Work	
	Track Type	Main Line: Ballast-less track, solid track with resilient sleeper (Main Line: underground section), ballast track (embankment section and depot)
	Running Rail	Japanese standard 60 kg/m rail or its equivalent

Particulars	Technical Parameter	Specifications		
	Depot (Mindanao Avenue)	Year		
		2025	2045	
	Inspection Track for Daily and Monthly Inspection	2 trains	5 trains	
	Inspection Track after Overhaul and Semi Overhaul	1 train	1 train	
	Track for Occasional Repair	1 train	1 train	
	Assembling and Disassembling Track	2 train	2 train	
	Stabilizing Track	22	22	
	Washing Track (rolling stock washing plant)	1	1	
	Washing Track (manual washing)	1	2	
	Wheel Re-Profiling Track	1	1	
Operation Plan		Year		
		2025	2030	2035
	Number of Passengers (thousand passengers/day)	365	559	973
	Estimated PPHPD (passengers/hour/direction)	12,556	19,569	26,582

(Source: JICA Study Team)

1.4.1 Subway Stations

There are 16 subway stations planned for the MMSP. Seven (7) of the stations are to be located in Quezon City (**Figure 1.1-4**), two (2) of the stations are to be located in Pasig City (**Figure 1.1-5**), four (4) of the station are to be located in Taguig City, a station is to be located in Pasay City and another station is to be located in Parañaque City (**Figure 1.1-7**). The location of each of the station the corresponding coordinates of the project site are presented in **Table 1.1-1**. The location of all the stations with respect to each other and the map of Metro Manila is illustrated in **Figure 1.1-1**.

The facility areas of each station are different depending on the project number of passengers for each station. The areas of the stations' facilities are shown in **Table 1.6-1**.

The final design of each of the station has not yet been finalized as the MMSP moves from the conceptual stage to the detailed design station. The site development plans of some stations are available in **Annex 1.1-1**.

1.4.2 Depot Components and Facilities

The propose depot, to be located at Barangay Ugong, Valenzuela City, will serve as an area for inspection, maintenance and repair for the subway trains. The depot will also function as the command center for the operation of the subway trains, power management, crew facilities, signaling, communications and track maintenance.

The facilities of a typical depot and their individual function are listed in **Table 1.4-2**.

Table 1.4-2 Components of a Typical Depot and their Function

Facilities		Function
Tracks	Stabling track	Stabling cars
	Daily inspection track	Daily inspection
	Monthly inspection track	Periodic inspection
	Critical/general inspection Track	Inspection with car disassembling
	Departure/arrival track	Inspection at departure and arrival
	Car washing track	Machine washing and hand washing of cars
	Lead track	Shunting trains
	Test track	Test run
	Stabling track for maintenance vehicle	Stabling of maintenance and repair vehicle
Buildings/Facilities	Central management building	Central command office, depot command room, equipment room, office road, welfare facility
	Inspection and repair shed	For inspection with disassembling, repair facilities, workshop, warehouse, electric room
	Monthly inspection shed	Periodic inspection
	Daily inspection shed	Daily inspection
	Storage shed for maintenance vehicles	Stabling of maintenance and repair vehicle
	Power receiving and substation	Power supply for main line and depot
	Other buildings	Oil warehouse, emergency power generation room, storehouse, cleaning stand, footboard
Other Facilities	Depot Road	Access road to facilities and each track in depot
	Gate	Gate at the access entrance of depot
	Fence	Fence to prevent intrusion
	Greenbelt, Carpark	-
	Inspection and Repair Facilities	Facilities for inspection and repair of cars
	Drainage Treatment Facilities	Treatment facilities that meet the effluent standards of drainage from workshop and car washing
	Outside lighting facilities	Lighting for stabling track, washing track, and depot road
	Maintenance vehicle	Maintenance vehicle for maintenance and inspection of the main line facilities during night time

(Source: JICA Study Team)

1.4.3 Station Structure

1.4.3.1 Underground Station

The estimated space needed for the underground stations are shown as follows and as shown in **Figure 1.4-1**:

- Total required width for station: 27-32 m
- Width of an underground station: 17-22 m
- Escalator/Staircase: 2 meters for parallel installation of escalator and staircase with wall structure
- Sidewalk: 3 meters for wheelchairs passing at the narrowest part
- Typical width of underpass: 5-10 m, depending on the number of passengers
- Length of escalator/staircase: 13-18 m for 5-7.5 m gap
- Platform length: 41-210 m, defined by passenger volume and train length.

Estimated areas of all the stations can be found in **Table 1.6-1**. Since the project is in its conceptual stage and will be moving to the detailed design stage at a later date, not all stations have been fully designed yet.

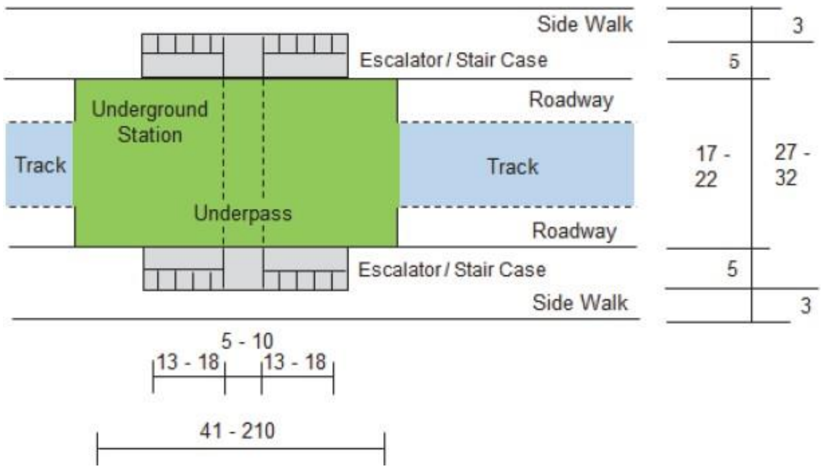


Figure 1.4-1 Typical Required Area for an Underground Station (Source: JICA Study Team)

1.5 Process / Technology

1.5.1 Construction Phase

1.5.1.1 Station Construction

During the construction of the subway stations, construction machines will be set up on the ground for the erection of the reinforce concrete diaphragm wall, installation of road decking, excavation and construction of the structure frame of the subway station. In order to prevent blockage of traffic flow, the following countermeasures are considered:

- A temporary diversion road will be constructed to secure the space for a construction yard by acquiring private land along the existing roadway, as much as possible, this way the present number of lanes can be provided, and traffic congestion is controlled.

- There must be a shield machine base in the vicinity of a station being constructed for the construction of the shielded tunnel. This shield machine base shall be placed in acquired private land instead of placing on the existing roads.
- If the land where the station is to be built is difficult to acquire for a temporary road because of tall buildings in private land, lane closures would have to be conducted to ensure work space.

The cut and cover method will be used to build box tunnel at the station section. Based on the common conditions observed at the proposed sites for the 16 stations, the use of diaphragm wall as retaining wall is recommended. Construction of the diaphragm wall involves excavating the ground with bentonite slurry or polymer slurry which is effective for ground stabilization. Rebar cages are placed at the excavated holes then concrete is poured to form the diaphragm wall. Top-down method of excavation will be applied. In this method, base slabs of the structure are constructed from top down in parallel with excavation. The structure works as a strut supporting retaining walls. The detailed step by step illustration the top down method can be found in **Figure 1.5-1**.

The number of storeys (below ground) and spans of the stations is listed in **Table 1.5-1**.

Table 1.5-1 Descriptive Design of Each MMSP Station

Station	Description/Design
Quirino Highway Station	4-storey and 2 spans with parallel type platform.
Tandang Sora Station	3-storey and 3 spans with island type platform.
North Avenue Station	It is designed 4-storey and 3 spans with island type (2 layer) platform. This station is end of partial opening section which train turns back. Therefore, this station needs a scissors rail tracks segment.
Quezon Avenue Station	It is designed 4-storey and 2 spans with parallel type (2 layer) platform.
East Avenue Station	It is designed 2-storey and 2 spans with island type platform. Because the road width is narrow and land acquisition is difficult, it is planned with using a method to construct a station by underground tunnel (NATM).
Anonas Station	It is designed 3-storey and 2 spans with island type platform.
Katipunan Station	It is designed 3-storey and 3 spans with island type platform.
Ortigas North Station	It is designed 5-storey and 3 spans with island type platform.
Ortigas South Station	It is designed 5-storey and 3 spans with island type platform.
Kalayaan Avenue Station	It is designed 5-storey and 3 spans with parallel type (2 layer) platform.
Bonifacio Global City Station	It is designed 4-storey and 2 spans with island type (2 layer) platform.
Lawton East Station	It is designed 3-storey and 3 spans with island type platform.
Lawton West Station	It is designed 4-storey and 3 spans with island type (2 layer) platform.
FTI Station	It is designed 2-storey and 4 spans with island type (2 layer) platform. The station design is not finalized yet.
NAIA Terminal 3 Station	No details yet on size and construction method

(Source: JICA Study Team)

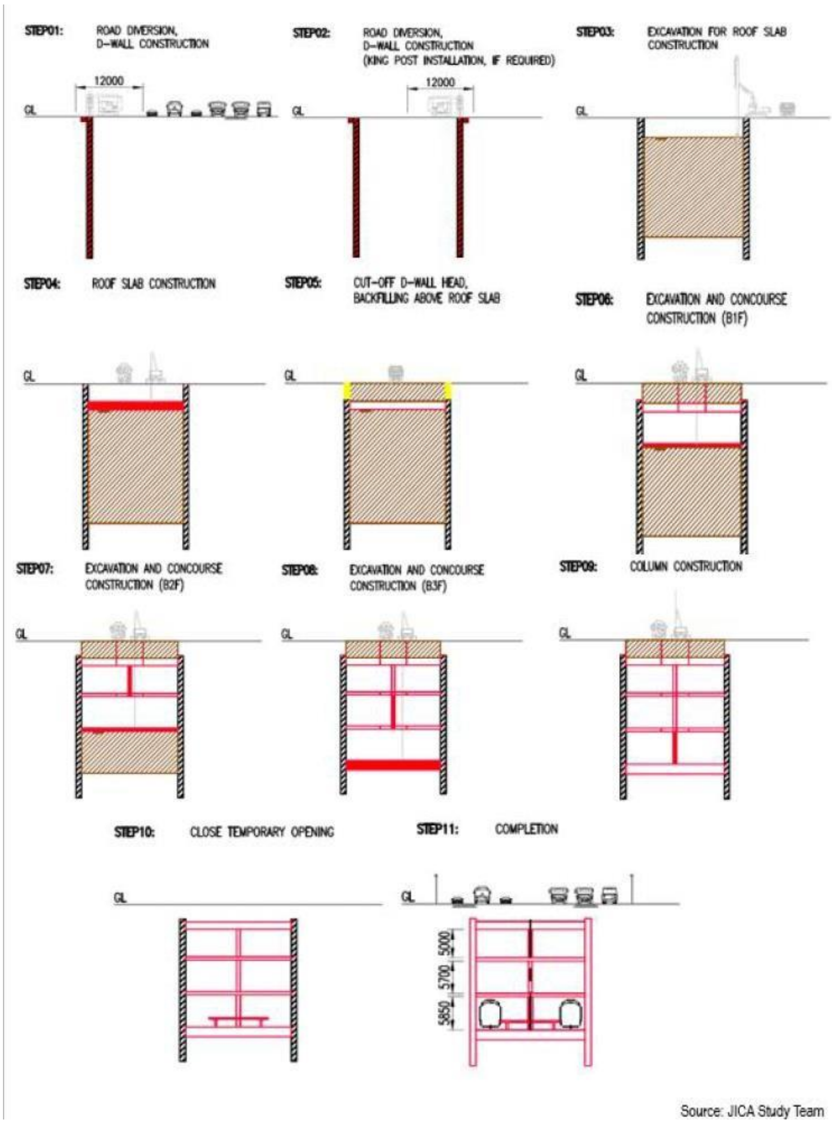


Figure 1.5-1 Step by Step Illustration of the Top Down Method (Source: JICA Study Team)

1.5.1.2 Tunneling in between Stations

As discussed in the project alternatives, the shielded tunneling method is selected as the construction method for the sections in between stations. However, if new information deems that NATM is a better choice for tunneling then the tunneling method will be changed accordingly. The tunnel will be located about 16 m underground on average.

A tunnel boring machine (TBM) will be used to tunnel the span of the alignment in between stations. The TBM can be broken down into three sections with three different functions. The TBM's front end is equipped with a cutting wheel which removes the soil in front thus creating a tunnel. The middle of the TBM places the tunnel ring or the support that keeps the tunnel from potential collapse. A tunnel ring is placed for every 1.5 – 2 meters the TBM advances. While behind the TBM, the displaced soil is removed via a system of slurry pumps or conveyors. The entry and exit points of the TBM are the cut and cover sections of the alignment where the subway stations are to be located.

The TBMs require a sizeable area for the base of operations which may feature the following elements: equipment storage, soil disposal pits, spaces for construction machinery and a slurry plant. Overall an area of 3,500 m^2 may be required for the base of operation.

The tunneling plan for the MMSP can be found in **Table 1.5-2**. In the tunneling plan, it is shown at which span the TBM tunneling method will be used and at which span the NATM tunneling method will be used. As mentioned earlier, the tunneling method for the station sections of the alignment will be cut and cover.

Table 1.5-2 MMSP Tunneling Plan

Structure/Component	Distance (m)		Standard	Platform
Depot: At Grade Structure	6,923.8	782.0		
Depot: U-Type		240.0		
Depot: Cut and Cover Box Culvert		125.6		
TBM Tunnel		1,274.4	Parallel x 2	
NATM Tunnel		234.0	Parallel x 2	
Quirino Highway Station		232.6	4-storey, 2 spans	Parallel
NATM Tunnel		115.7	Parallel x 2	
TBM Tunnel		1,340.0	Parallel x 2	
Tandang Sora Station		276.0	3-storey, 3 spans	Island
TBM Tunnel		1,026.0	Parallel x 2	
NATM Tunnel		104.0	Parallel x 2	
TBM Tunnel		641.5	Parallel x 2	
North Avenue Station		532.0	4-storey, 3 spans	Island x 2 Layer
TBM Tunnel	2,904.5	898.5	Parallel x 2	
Quezon Avenue Station		253.0	4-storey, 2 spans	Parallel x 2 Layer
TBM Tunnel		1,500.0	Parallel x 2	
East Avenue Station		253.0	2-storey, 2 spans	Island, NATM
TBM Tunnel	6,859.8	1,823.0	Parallel x 2	
Anonas Station		253.0	3-storey, 2 spans	Island
TBM Tunnel		1,398.0	Parallel x 2	
Katipunan Station		253.0	3-storey, 3 spans	Island
TBM Tunnel		2,826.3	Parallel x 2	
Ortigas North Station		306.5	5-storey, 3 spans	Island
NATM Tunnel	4,719.9	980.3	Parallel x 2	
Ortigas South Station		253.0	5-storey, 3 spans	Island
TBM Tunnel		1861.5	Parallel x 2	
Kalayaan Station		240.0	5-storey, 3 spans	Parallel x 2 Layer
TBM Tunnel		850.8	Parallel x 2	
Bonifacio Global City Station		534.3	4-storey, 2 spans	Island x 2 Layer
TBM Tunnel	8	1,999.8	Parallel x 2	

Structure/Component	Distance (m)	Standard	Platform
Lawton East Station	276.0	3-storey, 3 spans	Island
TBM Tunnel	1,439.5	Parallel x 2	
Lawton West Station	307.0	4-storey, 3 spans	Island x 2 Layer
TBM Tunnel	3,605.5	Parallel x 4	
FTI Station	450.0	2-storey, 4 spans	Island x 2 Layer

(Adapted from Source: JICA Study Team)

1.5.1.3 Depot Construction

The depot is to be located at a higher position than the current ground by embankment. It is necessary to prepare any retaining structures around the embankment in order to ensure as large a depot as possible within the limited site area. This is in view of cost and workability, the height of retaining structures and conditions of the foundation ground. The reinforced retaining wall is the wall with reinforced materials (steel plates, cloth, plastics, etc.) in backfill and its walls are constructed to stand at nearly right angles with respect to the ground. During depot construction, the depot construction area would be covered by embankment works for most of the construction period. Retaining wall construction would be conducted at the time in between embankment works.

A closer study will be commissioned to study the embankment structure at the detailed design stage of the project.

1.5.1.4 Water Management

The construction phase will employ around 5,000 workers and laborers. Using a per capita per day wa ter consumption of 250 L (Inocencio et al., 1999), it is estimated that the water consumption per day will be 1,250 m^3. The projected construction water use of the construction workers until 2025 is approximately 2.74 million m^3.

1.5.1.5 Power Requirements

The estimated power requirements based on the equipment to be used by the project including the TBM is 19,500 MW per year during the construction phase. **Annex 2.3-5** shows the computation of the power requirements for the construction phase.

1.5.1.6 General Description of Pollution Control Devices and Waste Management Systems

(1) Wastewater Management

Water is essential for any construction project as it is used during excavation, construction, cooling of machines, cleaning and septage. Wastewater resulting from these activities must be properly managed as well as properly treated prior to disposal. The management of wastewater and the effluents standard to be complied with was decreed under DENR Administrative Order No. 08 Series of 2016 (DAO 2016-08) or the Water Quality Guidelines and General Effluent Standards of 2016. Wastewater must be treated to meet DAO 2016-08 standards prior to discharge in to the environment.

The MMSP contractors will be required to submit wastewater management plan. The submission of the wastewater management plan will be a requirement for contract bidding before any construction activities begin to ensure that proper wastewater management is observed. Temporary sanitation facilities such as portable toilets for use of the construction workers.

The proponent will be required to secure its Discharge Permit (DP) from either the Environmental Management Bureau (EMB) or Laguna Lake Development Authority (LLDA) before it can legally discharge treated effluent.

1) Slurry Management

During the TBM tunneling process, slurry will be created as the TMB progressively excavates the tunnel. The slurry generated by the TBM is typically treated in a slurry treatment plant whose treatment process can be generally broken down into six steps (Transport for London, 2017). A diagram showing the plant in relation to the plant and the slurry circuit is shown in **Figure 1.5-2**.

- Separation of tunnel spoil from the slurry;
  - Material excavated by the TBM is separated from the slurry
- Dewatering;
  - Excess water is removed from the slurry material. The excess water is recycled back into the plant
- Preparation of fresh slurry;
  - Mixing of water and slurry materials such as bentonite. The fresh slurry is for make-up for losses to the cleaned slurry already in the slurry circuit.
- Storage of cleaned slurry;
  - Storage of cleaned and fresh slurry which are mixed in proportions to meet slurry properties needed at the tunnel face
- Slurry conditioning; and
  - This involves monitoring of the slurry properties and adjustment of properties to meet the requirements
- Water management
  - Water storage of fresh and filtrate water including facilities to adjust pH.

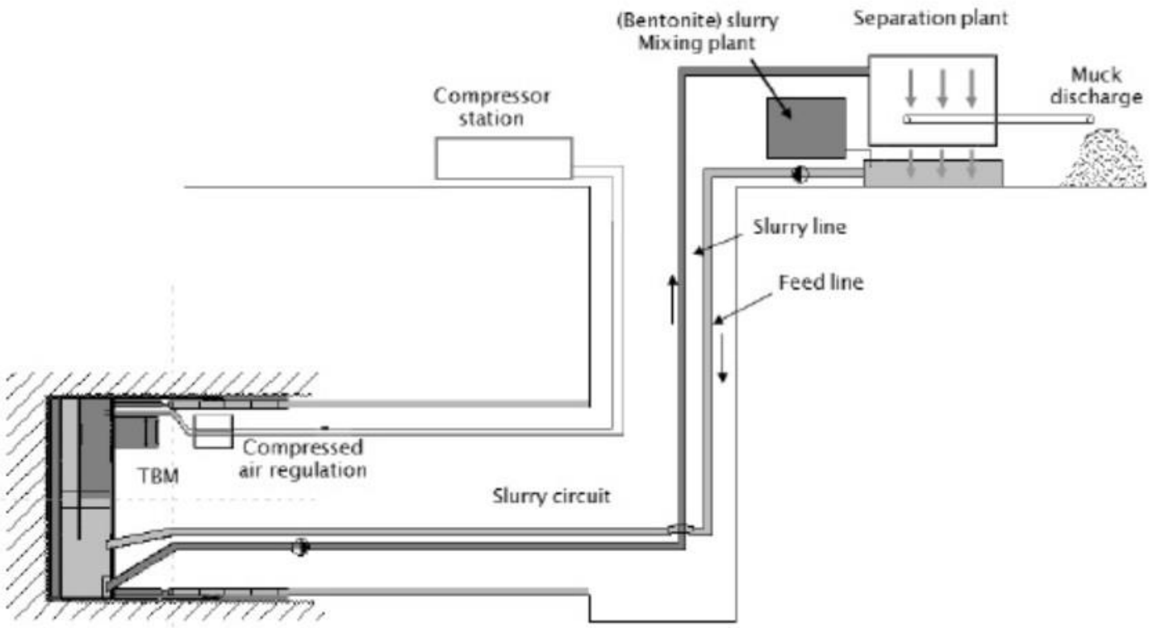


Figure 1.5-2 Diagram of a Slurry Circuit of a TBM (Duhme et al., 2015)

(2) Solid Waste Management

Non-Hazardous Waste / Construction Waste

In the Philippines, solid waste management is governed by Republic Act 9003 (RA 9003) and DENR Administrative Order No. 34 Series of 2001 (DAO 2001-34). In RA9003 and DAO 2001-34, the appropriate handling and disposal of non-hazardous wastes are laid out.

During construction, solid wastes will be generated by the construction workers and laborers constructing the MMSP. Solid wastes will typically include general refuse from the workers such as packaging materials and waste food. It was estimated that daily per capita generation of solid wastes by construction workers and laborers to be 1.21 kg*employee^{-1}*day^{-1} (EPD, 1999) Considering the maximum number of construction workers and laborers to be hired for the project who will be working on a daily basis (**Table 1.8-1**), it is estimated that during construction MMSP will be generating about 6 MT of solid wastes per day. Considering that the construction phase will last until 2025 (6 years), the estimated maximum amount of waste to be generated by the project is 13,300 MT of solid wastes. Quezon City generates about 2,150 MT of wastes per day which means that the MMSP project can be estimated to contribute 0.3% to the total solid waste generation of Quezon City per day.

Construction wastes are wastes expected to be generated in a typical construction or infrastructure project such as the MMSP. Construction wastes are typically composed of waste materials from the construction process such as packaging, scrap metal, scrap wood, waste concrete, etc. Construction wastes are generated 0.1 m^3/m^2 of gross floor area (HKPU, 1993). Considering the areas of the subway stations and depot, it was computed that approximately 14,000 MT of construction wastes will be generated during the construction phase.

The options for disposal non-hazardous solid wastes and construction wastes are shown in **Table 1.5-3**. As per RA 9003 encourages the segregation of wastes. As such, appropriate waste containers must be provided during the construction phase.

Table 1.5-3 Options for Disposal for Different Types Solid Wastes and Construction Wastes

Waste Material	Options for Disposal
Recyclable Plastics	Recycle
Cardboards and Papers	Reuse or Recycle
Metals	Recycle
Organic Material/Waste Food	Composting
Wood	Mulch and biomass
Concrete	Crushed into gravel and used as backfill, reclamation, etc.
Dirt, Rock, Sand	Backfill, landfill cover, reclamation, etc.
Inerts	Road base
Residuals	Landfill

Hazardous Wastes

The collection, treatment and disposal of hazardous wastes or wastes containing hazardous substances are considered separately from non-hazardous wastes and is governed under Republic Act 6969 (RA 6969) and DENR Administrative Order No. 22 Series of 2013 (DAO 2013-22). The responsibility of getting hazardous wastes collected, treated and disposed belongs to the proponent/contractor. Similarly, the proponent/contractor will also be registered as a hazardous waste generator with DENR which requires the proponent to secure its Hazardous Waste Generator's ID (HWID).

Lime slurry wastes, if any are produced during the tunnel boring process, is considered hazardous if it has a pH above 12.5. Alkali wastes such as lime slurry will be neutralized and treated prior to disposal.

Any hazardous wastes collected during the construction of the MMSP must be properly collected by a DENR accredited hauler, treated and disposed by a DENR accredited treater.

(3) Spoils/Surplus Soil Management

As with any project involving excavation, surplus soil will be generated especially in the shield tunneling and cut and cover tunneling parts of the project. It was computed by the JICA Study Team that that about 5.22 million m^3 of earth will be excavated during construction and with the assumption that soil and clay has a bulk density of 1.8 MT/m^3, it is estimated that 9.4 million MT of surplus soil will be generated throughout the construction phase of the project. This is equivalent to about 522,000 truckloads of soil assuming 10 m^3 trucks are used to haul the soil.

The potential uses of surplus soil within the project include backfilling for the depot and stations. The surplus soil is also planned to be disposed in five (5) identified sites: Barangay Bignay, Valenzuela City, Malabon City, Mandaluyong City, Pasay City and Taguig City as shown in **Figure 1.5-3**.

Figure 1.5-3 Surplus Soil Disposal Sites for the MMSP (Source: JICA Study Team)

1.5.2 Operations

1.5.2.1 Rolling Stock

Rolling stock is a collective term for wheeled vehicles operating on a railway or tracks. For the MMSP, the passenger subway trains or the rolling stock will transport passengers from station to station within the alignment. There are two options for trains to be used for the MMSP. The specifications of the rolling stock options are shown in **Table 1.5-4**.

Table 1.5-4 Rolling stock being considered for the MMSP

Items		Specifications	
Type		Series E233	Series 16000
Major Dimensions (mm)	Lead Car Length	20,150	20,470
	Intermediate Car Length	20,000	20,000
	Body Width	2,770	2,800
Passenger Capacity per Train	Seat	522	522
	Standard	1,474	1,518
Weight per train (empty) (t)		Approx. 310	Approx. 300
Body Material		Light stainless	Aluminum alloy
Interior	Door Number	4 (both side)	4 (both side)
	Open type	Both open: Wide1300	Both open: Wide1300
	Seat type	Long Seats	Long Seats
Maximum train operation speed (kph)		120	110

<table>
<tr><th colspan="3">Items</th><th colspan="2">Specifications</th></tr>
<tr><td rowspan="3">Running Performance</td><td colspan="2">Acceleration/Deceleration (m/s²)</td><td>0.92</td><td>0.92</td></tr>
<tr><td rowspan="2">Deceleration (m/s²)</td><td>Normal</td><td>1.3</td><td>1.0</td></tr>
<tr><td>Emergency</td><td>1.3</td><td>1.3</td></tr>
<tr><td rowspan="5">Propulsion System</td><td colspan="2" rowspan="2">Pantograph</td><td colspan="2">Single-Arm</td></tr>
<tr><td>3 units (per train)
(1 units repair)</td><td>4 units (per train</td></tr>
<tr><td colspan="2" rowspan="2">Control System</td><td colspan="2">VVVF inverter control (IGBT)</td></tr>
<tr><td>3 set (per train)</td><td>4 sets (per train)</td></tr>
<tr><td colspan="2">Main Motors</td><td>induction motor</td><td>PWM (using IGBT)</td></tr>
<tr><td colspan="3">Braking System</td><td colspan="2">Electric command brake equipment with regenerative brake</td></tr>
<tr><td colspan="3">Truck</td><td>Bolsterless</td><td>Bolster</td></tr>
<tr><td colspan="3">Air condition system</td><td colspan="2">Concentrated type on the roof</td></tr>
<tr><td colspan="3">Passenger Information System</td><td>LCD display type: automatically voice information system</td><td>LCD display type: automatically voice information system</td></tr>
<tr><td colspan="3">Transit Information Management System</td><td>TIMS</td><td>TIS</td></tr>
<tr><td colspan="3">Signal System</td><td colspan="2">Cab signal</td></tr>
<tr><td colspan="3">Train protection system</td><td colspan="2">ATC (corresponding)</td></tr>
<tr><td colspan="3">Train radio</td><td colspan="2">Digital radio</td></tr>
</table>

(Source: JICA, 2015)

(1) Trackwork

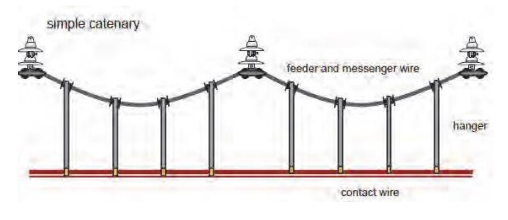
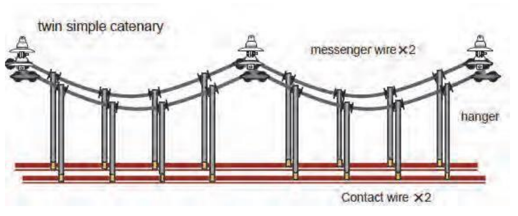
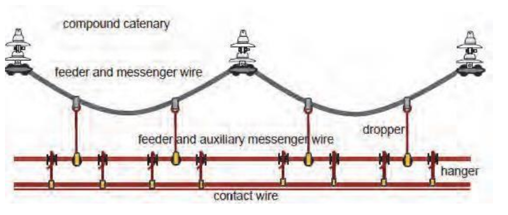
The train tracks are the path on which the train operates. Tracks are designed to absorb the vibration, support the load of the trains and distribute the force to the road bed and other track structures. The specifications for the tracks can be found in **Table 1.4-1**.

(2) Electrical Systems

Power Supply and Distribution Facilities

For the power supply to run the rolling stock a 1,500 V DC Overhead Catenary System (OCS) traction power supply system will be utilized. The OCS is suspended above the trains along the alignment which provides power for the trains. Each motor car will be equipped with a pantograph on the roof that will make contact with the OCS to supply the cars with power. A simple overhead catenary system was selected for the depot while an overhead rigid conductor rail system was selected for the underground tunnels. A comparative visualization of different types of OCS are shown in **Table 1.5-5**. A diagram showing the 1,500 V DC OCS to be used by the project is shown in **Figure 1.5-4**.

Table 1.5-5 Description of Different Types of OCS

OCS Type	Features	Usage
	Messenger wire has a function of feeder wire. This system does not require additional feeder wire. Good for medium speed line (Under 100km/h).	Middle speed main line. Workshop and Depot.
	This system requires additional feeder wire. It is complex structure, and the maintenance costs are higher than the other systems. Good for high speed line. (Under 160km/h).	Congesting line. High speed main line.
	Messenger wire and auxiliary wire have a function of feeder wire. This system does not require additional feeder wires. Japanese Keisei Sky Liner adopts this system. Good for high speed line. (Under 160km/h).	High speed main line.
Overhead Rigid Conductor Rail System 	Because of the simple construction applying formed rigid profile with catenary wire inserted at the bottom, it can decrease tunnel diameter and has advantage for maintainability. Good for subway without high speed operation (under 80km/h).	Subway without high speed operation

(Source: JICA Study Team)

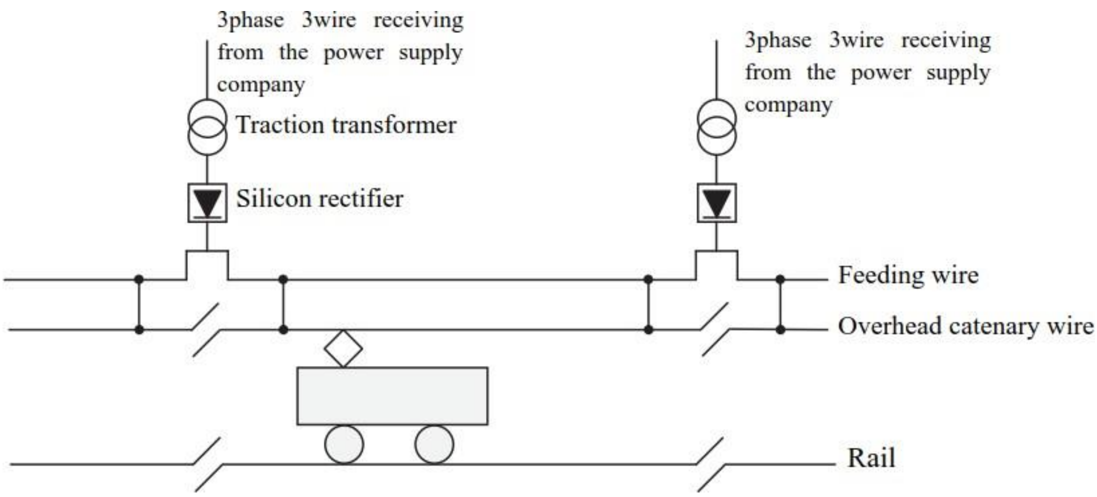


Figure 1.5-4 1,500 V DC OCS (JICA Study Team)

(3) Information and Control Systems

Supervisory Control and Data Acquisition (SCADA) System

The MMSP will employ a Supervisory Control and Data Acquisition (SCADA) System to run station and train operations and also give passengers real time information on train schedule and other relevant data. In general, the SCADA provides control of station and train operations, gathers real-time data, interacts with all system sensors through human interfaces such as workstations and records all events in a database.

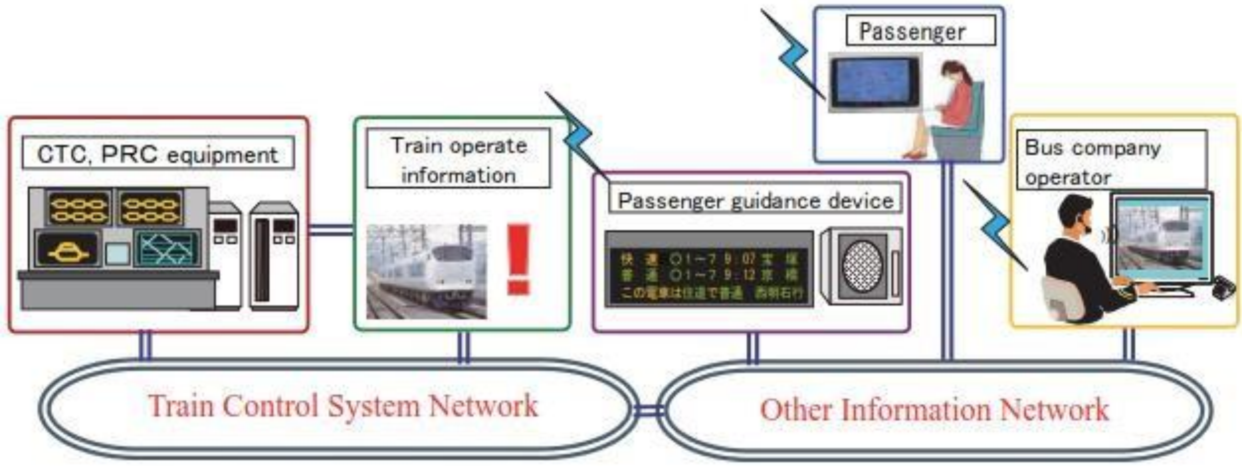


Figure 1.5-5 Diagram of a Railway Operation System Applying Dedicated Optical Fiber Network (Source: JICA Study Team)

Operations Control Center (OCC) Command Communication System

Communication between a train crew and a train dispatcher will be carried out via digital radio for the MMSP. Analog train radio involves the transmission of voice or audio data only. With the advent of digital train radio, it is now possible to transmit various types of data. Railways nowadays are increasingly adopting digital radio due to the advantage of transmitting different types of data as compared to traditional analog communication. A modern digital train radio is capable of performing the following functions:

Call System	• Call to designated train from a dispatcher (multiple lines); • General call to all trains from a dispatcher; and • Call to dispatcher from a train crew.
Emergency System	• Emergency train protection signal sent from a train with stop command sent to nearby trains; • Emergency interruption by a train crew of a dispatcher talking on the phone; and • Emergency train protection signal from a wayside staff with stop command sent to nearby trains;
Maintenance Work System	• Call to various places along the alignment from maintenance crews via cell phone.
Data Transmission System	• Speedy confirmation of images displayed on a cab monitor (operation schedule changes, speed limits, etc.);

- Train operation status information provided to a conductor (condition of connection trains, delay time, etc.);
- Display on LCD in a cabin (traffic information during accidents, delays, etc.); and
- Quick transmission to car depots (information concerning malfunction of on-board equipment)

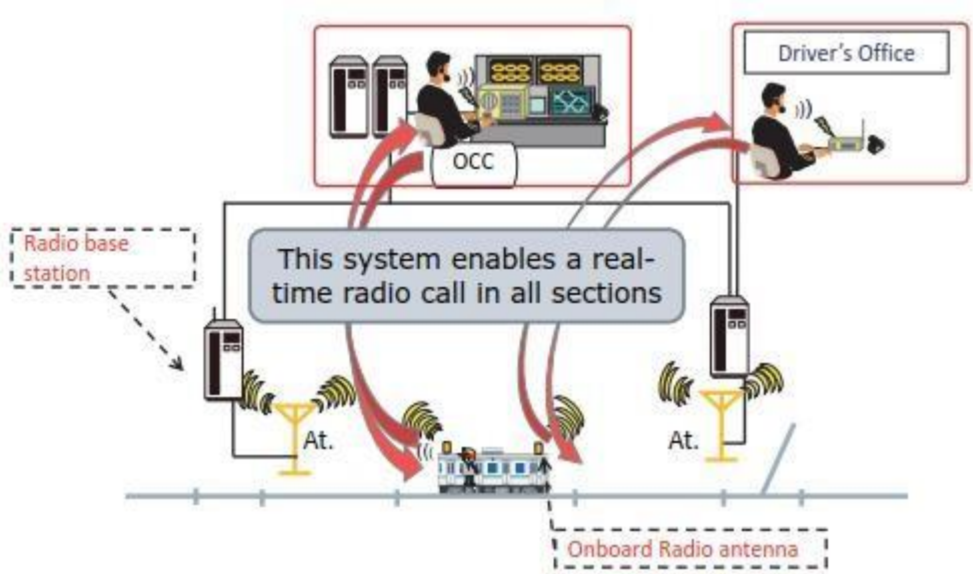


Figure 1.5-6 Diagram of a Digital Train Radio System Operation (Source: JICA Study Team)

1.5.2.2 Subway Stations

(1) Subway Station Access

For the vertical movement of passenger from the surface to the station underground, escalator and elevators will be provided for the subway station. Elevators and escalators are also an effective means giving comfortable access to the elderly, disabled and mobility impaired passengers.

The installation of two-way elevators will be considered in stations with limited space. When elevators are not possible to be installed due to limitations in space, other equipment to assist passengers on wheelchairs will be considered. An image of a typical two-way escalator is shown in **Figure 1.5-7**.

Similarly, the installation of escalators will also be considered for the stations for ease of access into and out of the station. An image of a wheelchair transport is shown in **Figure 1.5-8**.

Figure 1.5-7 Typical Two-Way Elevator (Source: JICA Study Team)

Figure 1.5-8 Typical Escalator/Stairs Accommodating Wheelchair Transport (Source: Toyko Metro)

The easy and universal access for all types of passengers will be incorporated in the station design. Specifically, the following will be considered;

- Flat access for passenger of wheels chairs by providing ramps and/or elevators, balustrades along stairs with two levels for persons of different heights, etc. (**Figure 1.5-9** and **Figure 1.5-10**);
- Women only cars which are exclusive use for women and small children either for the entire day or during peak hours (**Figure 1.5-11**);
- Wheelchair access and space in the car (**Figure 1.5-13**);
- Cars with priority seating for the elderly, disabled and expectant mothers (**Figure 1.5-12**); and
- Braille signage at the Ticket Vending Machine (**Figure 1.5-14**).

Figure 1.5-9 Sloped Ramp (Source: Tokyo Metro)

Figure 1.5-10 Two-Level Balustrade (Source: Tokyo Metro)

Figure 1.5-11 Women Only Cars (Source: JICA Study Team)

Figure 1.5-12 Priority Seating (Source: JICA Study Team)

Figure 1.5-13 Wheelchair Space (Source: Tokyo Metro)

Figure 1.5-14 Braille Signage (Source: Tokyo Metro)

(2) Station Power Supply

Auxiliary power supply for all station electrical facilities will be fed from an auxiliary substation by low voltage, either single phase 220V AC or three phase 480V AC. Power to auxiliary substation will be fed from the traction substation by two route power cables for redundancy. A transformer for the auxiliary substations changes high voltage to low voltage. For the underground stations and the tunnel sections, emergency diesel generator sets may be provided to supply emergency power case of prolonged power outage (JICA, 2015).

There are two types of power distribution systems being considered for the project, the loop system and the parallel system. The loop system is lower in cost and has previously been used in the country, but the parallel system is more reliable. The power distribution system to be used for the MMSP will be finalized in the detailed design stage. The diagrams of the loop and parallel power distribution systems are shown in **Figure 1.5-15** and **Figure 1.5-16.**

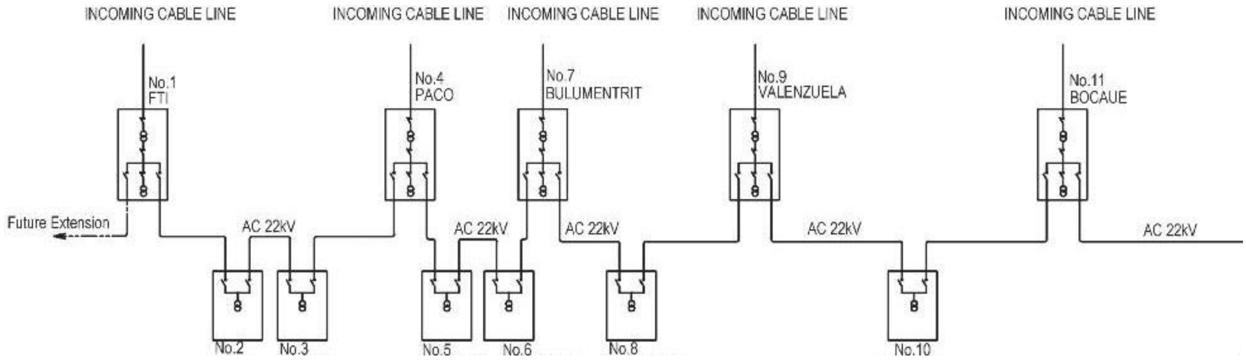


Figure 1.5-15 Loop Type Power Distribution (Source: JICA Study Team)

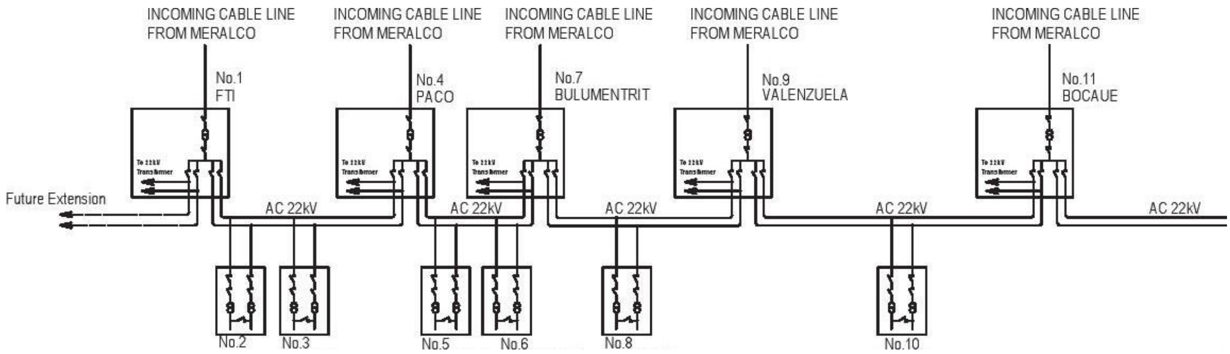


Figure 1.5-16 Parallel Type Power Distribution (Source: JICA Study Team)

(3) Station Lighting

The lighting system level is designed for 200 – 300 lux for the subway platform and concourse. The power supply plan for the lighting system will include the connection to the emergency power system in case of power outages.

(4) Passenger Information Facilities and Terminals

The subway stations will be equipped with terminals that give passengers timely information on train schedules, train operation status and other relevant data at the passenger level. This system will be linked with SCADA and OCC.

A video monitoring system will be employed to smooth out operations especially during rush hours by giving dispatches and controllers real time information from the platforms and concourses of the subway stations.

(5) Platform Screen Doors

Inclusion of a platform screen door (PSD) to improve the safety of the passenger onboarding and alighting trains by preventing them from either falling into the tracks or improperly boarding the cars. Examples of PSDs are shown in **Figure 1.5-17** and **Figure 1.5-18**.

Figure 1.5-17 Full Height Type PSD (Source: JICA Study Team)

Figure 1.5-18 Half Height Type PSD (Source: JICA Study Team)

(6) Automatic Fare Collection System

The automatic fare collection (AFC) system will consist of ticket vending machines (TVMs), automatic gates (AG), automatic fare adjustment machines, data collecting machines and office booking machines. The AGs will utilize a contactless fare cards which can process approximately 60 persons per minute. Although TVMs will be made available, manual ticket sales will still be done by station staff. The AFC will be integrated in the comment ticket collection system in Metro Manila.

1.5.2.3 Water Management

The daily station operations and train maintenance is foreseen to consume water during the operation phase of the MMSP. By 2035, the MMSP is estimated to board & alight about 1.44 million passengers daily. The Water System Design Manual 2009 does not have figures for a railway project, but the airport figure will be a close analog at 3-5 gal/capita day. The project is estimated to have an estimated consumption of 21.8 MLD in 2035 for the operation of all 16 stations. The water demand per station is shown in **Table 1.5-6**.

Table 1.5-6 Estimated Water Demand Per Station during Operation Phase

Station	2035	
	Estimated Boarding & Alighting (capita/day)	Water Demand (MLD)
Quirino Highway Station	116,898	1.77
Tandang Sora Station	17,500	0.26
North Avenue Station	142,272	2.15
Quezon Avenue Station	67,894	1.03
East Avenue Station	72,516	1.10
Anonas Station	166,646	2.52
Katipunan Station	79,720	1.21
Ortigas North Station	101,530	1.54
Ortigas South Station	91,068	1.38

Station	2035	
	Estimated Boarding & Alighting (capita/day)	Water Demand (MLD)
Kalayaan Avenue Station	105,488	1.60
Bonifacio Global City Station	227,908	3.45
Lawton East Station	41,396	0.63
Lawton West Station	65,096	0.99
FTI Station	68,320	1.03
NAIA Terminal 3 Station	73,730	1.12

1.5.2.4 Power Requirements

The power during the operation phase of the project will be sourced from Meralco, the local power utility provider. The power requirements of each station and the Valenzuela Depot are listed in **Table 1.5-7**.

Table 1.5-7 Power Requirement Per Station/Depot during the Operation Phase

Location	Particular	Power Requirement
Valenzuela Depot and Station	Depot	2-400 kW + 5 MVA
Quirino Highway Station	Station	2-400 kW + 5 MVA
Tandang Sora Station	Station	2-400 kW
North Avenue Station	Station	2-400 kW + 10 MVA
Quezon Avenue Station	Station	2-400 kW + 10 MVA
East Avenue Station	Station	2-400 kW + 10 MVA
Anonas Station	Station	2-400 kW
Katipunan Station	Station	2-400 kW
Ortigas North Station	Station	2-400 kW + 10 MVA
Ortigas South Station	Station	
Kalayaan Station	Station	2-400 kW + 10 MVA
Bonifacio Global City Station	Station	
Lawton East Station	Station	2-400 kW + 10 MVA
Lawton West Station	Station	2-400 kW
NAIA Terminal 3 Station	Station	2-400 kW + 10 MVA
FTI Station	Station	2-400 kW + 5 MVA
Bicutan PNR Station (for interoperability)	Interoperability Area	2-400 kW + 5 MVA

(Source: JICA Study Team)

1.5.2.5 General Description of Pollution Control Devices and Waste Management Systems

(1) Wastewater Management

During the operation phase, it is foreseen that much of the wastewater to be generated by the MMSP will be from train maintenance and station operations (lavatories and station maintenance). The amount of wastewater to be treated in 2035 based on the number of passengers is estimated to be 12.8 MLD for the operation of all 16 stations.

The appropriate wastewater treatment facilities will be installed in each station to treat the wastewater generated. Wastewater must be treated to meet DAO 2016-08 standards prior to discharge in to the environment. The proponent will also be required to secure its Discharge Permit (DP) from either the Environmental Management Bureau (EMB) or Laguna Lake Development Authority (LLDA) before it can legally discharge treated effluent.

(2) Solid Waste Management

Non-Hazardous Waste

During the daily operations of the MMSP, passengers will be patronizing all 16 stations on a daily basis. These passengers may be bringing disposable items along such as food, tissues or beverage bottles which may be disposed in the trash bins within the stations. With 973,000 passengers expected to patronize the MMSP by 2035, it may be estimated that 250 MT/day will be generated by the project during the operation stage.

The options for disposal of non-hazardous solid wastes and construction wastes are shown in **Table 1.5-3**. RA 9003 encourages the segregation of wastes, as such, appropriate waste containers must be provided during the operation phase.

Hazardous Wastes

The daily operation of the stations and the depot will generate wastes considered hazardous under RA 6969 and DAO 2013-22. The types of common hazardous waste foreseen to be generated during the operation of the MMSP can be found in **Table 1.5-8**.

Table 1.5-8 Potential Hazardous to be Generated during the Operation Phase of the MMSP

Waste Material	Waste Number
Grease Wastes	H802
Used industrial oil including sludge	I101
Oil-contaminated materials	I104
Paints	M507
Busted fluorescent lamps	M507
Spray canisters	M507
Batteries	M507

The responsibility of getting hazardous wastes collected, treated and disposed belongs to the proponent. Also, the proponent will be registered as a hazardous waste generator with DENR which requires the proponent to secure its Hazardous Waste Generator's ID (HWID).

Any hazardous wastes collected during the construction of the MMSP must be properly collected by a DENR accredited hauler and treated and disposed by a DENR accredited treater.

1.6 Project Size

The MMSP alignment will have components placed in 7 cities of Metro Manila namely the cities of Valenzuela, Quezon, Pasig, Taguig, Makati, Pasay and Parañaque. The general direction of the alignment is north-south with a total alignment length of 36 km. The subway will have a total of 16 stations whose locations are shown in **Figure 1.1-1** and **Table 1.1-1**. Although the detailed design of the subway stations are not yet complete, estimated areas required for each station are shown in **Table 1.6-1**.

1.6.1 Stations and Alignment

Table 1.6-1 Areas of MMSP Stations

Depot/Station	Lot Area (m^2)	Construction Yard Area (m^2)	Gross Floor Area (m^2)
Valenzuela Depot and Station	291,065	-	-
Quirino Highway Station	6,818	6,016	19,995.8
Tandang Sora Station	6,117	7,628	15,354.0
North Avenue Station	11,900	24,242	24,744.4
Quezon Avenue Station	8,095	13,661	19,006.0
East Avenue Station	6,126	10,574 (5,647 for sidewalk and diversion road)	22,288.6
Anonas Station	5,859	8,746	16,590.5
Katipunan Station	6,130	22,084	14,715.4
Ortigas North Station	7,594	13,631 Proposed Land Acquisition 583 Temporary Road and Sidewalk	21,791.0
Ortigas South Station	5,349	7,809	18,916.5
Kalayaan Avenue Station	6,285	3,871	19,424.2
Bonifacio Global City Station	9,888	5,954	26,278.6
Lawton East Station	6,133	16,357	14,481.4
Lawton West Station	7,220	10,895	17,894.1
NAIA Terminal 3 Station	*	35,000	*
FTI Station	30,836	30,375	26,996.0
Interoperability Area w/ Bicutan PNR Station	*	*	*

* No areas available yet since the project is still in its conceptual stage. These will be finalized in the detailed design stage. (Source: JICA Study Team)

1.6.2 Depot

The depot will be located on a parcel of land with an area of approx. 30ha which is located in Barangay Ugong, Valenzuela City. The existing condition on the proposed depot site is shown in **Figure 1.6-1** while the size of the depot is shown in **Figure 1.6-2**.

Figure 1.6-1 Existing Condition of Proposed Depot Site at Barangay Ugong, Valenzuela City (Source: JICA Study Team)

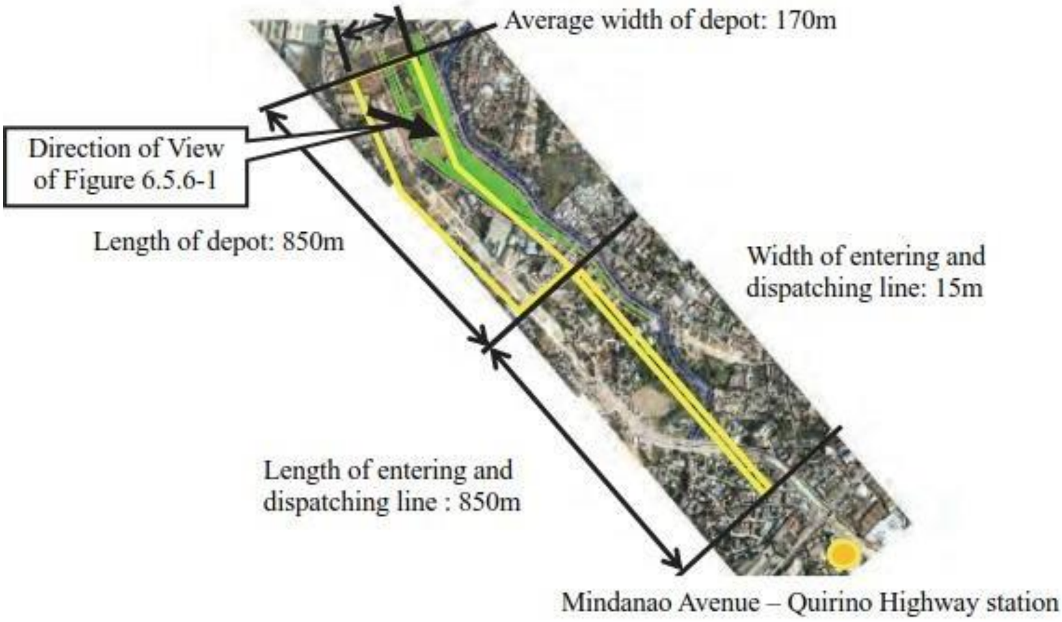


Figure 1.6-2 Dimensions of the Proposed Valenzuela Depot (Source: JICA Study Team)

1.7 Development Plan, Description of the Project Phases and Corresponding Timelines

1.7.1 Project Timeline

The general timeline for the project is as follows:

- The pre-construction and construction phases are set to begin in 2019.
- The construction first three stations (Quirino Highway, Tandang Sora and North Avenue) will be completed and operational by 2022 – Partial Operation (PO) Section
- The rest of the alignment is slated to be constructed and fully operational by 2025.

	Activity	Schedule
Partial Operability Section	Start of Construction	2019
	Start of Operation	2022
Remaining Section	Start of Construction	2022
	Start of Operation	2025

Figure 1.7-1 MMSP Project Indicative Timeline (Source: JICA Study Team)

1.7.2 Pre-Construction Phase

During the pre-construction phase, the acquisition of the right of way (ROW) for the proposed stations, tunnel alignment and the proposed depot covered by a 50 meter distance from the surface to the proposed structures will be conducted.

Site preparation site activities which includes the clearing of vegetation and the removal of existing structures within the alignment will commence during this phase. It is envisioned that the clearing of the space required for the Valenzuela Depot to commence by September 2019

1.7.3 Construction Phase

The construction phase will involve the construction of the depot, the 16 subway stations and the underground tunnels connecting the subway stations together.

1.7.4 Station Construction

The cut and cover method will be used to build box tunnel at the station section. Based on the common conditions observed at the proposed sites for the 16 stations, the use of diaphragm wall as retaining wall is recommended. Construction of the diaphragm wall involves excavating the ground with bentonite slurry or polymer slurry which is effective for ground stabilization. Rebar cages are placed at the excavated holes then concrete is poured to form the diaphragm wall. Top-down method of excavation will be applied. In this method, base slabs of the structure are constructed from top down in parallel with excavation. The structure works as a strut supporting retaining walls.

1.7.5 Tunnel Construction

The method of construction for the station sections of the project is cut in cover while the construction method for the underground tunnel sections is shield tunneling via TBM.

The tunneling plan for the MMSP can be found in Error! Reference source not found.. The yellow arrows in Error! Reference source not found. represent the direction along the alignment in which the TBM will excavate. From the Proposed Quirino Highway Station to the proposed Bonifacio Global City Station the TBM will tunnel from north to south while from proposed FTI Station and proposed NAIA Terminal 3 Station to the proposed Bonifacio Global City Station the TBM will tunnel from south to north.

1.7.6 Depot Construction

The depot is to be located at a higher position than the current ground by embankment. It is necessary to prepare any retaining structures around the embankment in order to ensure a large depot as possible within the limited site area. This is in view of cost and workability, the height of retaining structures and conditions of the foundation ground. The reinforced retaining wall is the wall with reinforced materials (steel plates, cloth, plastics, etc.) in backfill and its walls are constructed to stand at nearly right angles with respect to the ground. During depot construction, the depot construction area would be covered by embankment works for most of the construction period. Retaining wall construction would be conducted at the time in between embankment works.

The first component to be constructed will be the Valenzuela Depot whose clearing of the site will be set to commence September of 2019.

1.7.6.1 Source of Power

Electricity during the construction phase will be supplied whether by connecting to the nearest power source or through the use of generator sets.

1.7.6.2 Source of Water

For the water supply during the construction phase, the project will be connecting with the local water utility provider.

1.7.7 Operation Phase

1.7.7.1 Subway Operation Plan

The subway operation plan for the MMSP was put together referring data and experience from subways in other countries. The following operating conditions for the MMSP were decided:

- The subway service will be provided for 18 hours per day (4:30 a.m. to 10:30p.m.). After closure for the day, facilities and equipment maintenance will be conducted.
- Peak hours and high demands are expected in the mornings and evenings on the planned MMSP route. It is assumed that the peak hour of the passenger concentration is from 6 to 8 a.m. in the morning and it is expected that there will be 12.5% more passengers than normal hours.
- The acceptable congestion rate based on “7 passengers/m^2” which is the standing room limit.
- Two train services will be available: Express and Local train services.

Local trains will stop at all 16 stations with a total travel time of 42 min 20 sec from the proposed Quirino Highway Station to the proposed FTI station. Express trains will only stop at 7 stations, namely, Quirino Highway, North Ave., Quezon Ave., East Ave., Anonas, Ortigas North, BGC and FTI, making its travel time shorter at 31 min 5 sec.

1.7.7.2 Daily Train Operation

The number of operated trains during peak hours is dependent upon the passenger demand while number of operated trains during off-peak hours is dependent upon passenger convenience though the actual number of trains operation will be slightly more than the passenger demand. Most railway operators set the number of operated trains during off-peak hours to 50-60% of the number that are operation during peak hours. **Table 1.7-1** shows the estimated daily number of operated trains in 2025 and 2030.

Table 1.7-1 Estimated Daily Number of Trains Operated in 20205 and 2030

Time	Hourly Rate	2025		2030	
		Express	Local	Express	Local
4:30-4:59	0.9%	-	1	-	1
5:00-5:59	5.3%	2	3	2	4
6:00-6:59[a]	12.5%	3	6	4	8
7:00-7:59[a]	10.8%	3	6	4	8
8:00-8:59	7.2%	2	4	2	6
9:00-9:59	4.4%	1	3	3	4
10:00-10:59	4.2%	2	3	2	4
11:00-11:59	3.0%	1	3	2	4
12:00-12:59	2.8%	2	3	2	4
13:00-13:59	4.1%	1	3	2	4
14:00-14:59	3.6%	2	3	2	4
15:00-15:59	4.2%	1	3	2	4
16:00-16:59	5.5%	2	3	2	4
17:00-17:59[a]	10.6%	3	6	4	8
18:00-18:59	6.5%	2	4	3	6
19:00-19:59	5.8%	2	3	2	4
20:00-20:59	4.3%	1	3	2	4
21:00-21:59	2.2%	1	2	1	2
21:00-21:30	0.9%	-	1	-	1
	Sum	31	63	41	84
	Total	94		125	

a – peak hours (Source: JICA Study Team)

1.7.7.3 Train Travel Time

Train travel time of express trains and local trains are calculated through a computer model. The rolling stock specifications and the alignment data which are decided in this study are used for this simulation. Travel time is defined based on calculated time adding some recovery time and is shown in **Table 1.7-2**.

Table 1.7-2 Train Travel Time

Service Type	Section	No. of Station to be Serviced	Travel Time	Scheduled Speed
Express Train	Quirino Highway - FTI	7	31 min 5 sec	48.5 kph
Local Train	Quirino Highway - FTI	16	42 min 20 sec	35.6 kph

(Source: JICA Study Team)

1.7.7.4 Source of Power

Electricity during the operation phase will be supplied whether by connecting to the nearest power source. To ensure high reliability of power supply during the operation, adequate redundancies in the transmission and distribution will be incorporated in the detailed design stage.

1.7.7.5 Source of Water

For the water supply during the operation phase, the project will be connecting with the local water utility provider.

1.7.8 Abandonment Phase

The subway is estimated to operate for about 50 years, semi-permanently. During abandonment, there will be no major changes that will be done on the structures and land.

1.8 Manpower

Approximately 5,000 skilled and non-skilled workers will be needed during the pre-construction and construction phases of the project. The actual number of workers needed during the pre-construction and construction phases will be contingent upon the construction period and the number of construction machines. The project is estimated to provide employment for approximately 1,400 people who will be working at the stations either in operations or maintenance of the project. As the project transitions into the detailed design stage, the manpower quan1tity for the pre-construction, construction and operation stages will be finalized.

Table 1.8-1 MMSP Estimated Manpower Requirements

Phase	Estimated Manpower Requirement	Nature of Opportunities
Pre-construction	~5,000 skilled and non-skilled workers	Foremen, construction workers, machine operators, general laborers, etc.
Construction		
Operation	~1,400 workers	Station operations and maintenance

(Source: JICA Study Group)

A portion of the technical personnel will be provided by Japanese consultants since Japanese technology will be employed for the project. A majority of the technical staffing will be hired by Japanese consultants while manpower required for construction will be sourced through the local construction companies involved with the project.

DOTr is very committed to provide equal opportunities for men and women in compliance with the labor laws of the Philippines including but not limited to the Presidential Decree No. 442 (PD 442) also known as the Labor Code of the Philippines, Republic Act No. 10911 (RA 10911) also known as the Anti-Age Discrimination in Employment Act, and Republic Act No. 7277 (RA 7277) also known as the Magna Carta for Disabled Persons on the basis of ability, knowledge, skills and qualifications rather than gender, age and disability. As much as practicable, the labor requirements of the project will be sourced within Metro Manila with the priority of the hiring will be given along the project alignment. Local contractors will be held to the policies set forth in policies within the terms of reference and contracts to ensure compliance.

1.9 Project Investment Cost

Indicative Project Cost: PhP 356,964,.17

CHAPTER 2 BASELINE CONDITIONS, IMPACT ASSESSMENT AND MITIGATION

2. Baseline Conditions, Impact Assessment and Mitigation

2.1 The Land

This section provides the results of technical studies for land use and classification, geology, geomorphology (landforms) and geohazards, pedology and terrestrial ecology (flora and fauna).

2.1.1 Land Use and Land Cover Classification

Categorization of land parcels according to usage and utility for development and at the same time conservation can be considered as Land Use Classification. Furthermore, area budgeting and management of the current utility of the land to meet sustainable growth can be considered as Land Use Planning. This can be done through the efficient assessment of land capabilities and opportunities, effective consultative processes to stakeholders as well as incorporating the development plans in the regional and national level. Consideration of the regional and the national development plan would beneficial in making sure that the local development would be in harmony and is anchored to the plans for the higher level or scope, which in this case the National Capital Region and the Philippine Development Plan (PDP).

By looking at the described Primary Function and Regional Roles of the cities/municipalities in the National Capital Region (NCR), it can be assessed its each contribution to the socio-economic growth of the region. **Table 2.1-1** presents the regional goals for each city included in the MMSP alignment. Moreover, the it can be concluded that NCR has a rising socio-economic growth in the South-east Asia. Makati City and Taguig City alongside with Pasig City are considered the Central Business Districts (CBDs) of Metro Manila. There is a high economic activity in the region. With the economic development lift, demands on social welfare and health also emerge. There is a need for better services like in transportation which is resonant as part of the call for improvements in infrastructure (e.g. roads, airports, and sea ports) and in developing the urban landscape/structure. Urban landscape improvement includes the development in the livability/preexisting conditions of the Metropolis (e.g. pollution and traffic). A need for the solution to the emerging urbanization problems of the metro, alongside with the rapid economic growth, will be taken with serious consideration (MMDA, 2018).

Table 2.1-1 Regional Roles of Cities in Metro Manila (MMDA, 2018)

City	Regional Role Description
Valenzuela City	Northern Gateway to Metro Manila
Quezon City	Green, Knowledge, and Health Hub
Pasig City	Emerging Regional Center
Makati City	National/Global Business Hub
Taguig City	Emerging International Business Hub
Pasay City	Cross Roads of Metro Manila
Parañaque City	Emerging Mixed-Use Hub

Study Area

The 32-km Metro Manila Subway Project (MMSP) alignment will pass through the cities of Valenzuela, Quezon, Pasig, Taguig, Makati, Pasay, and Parañaque. Metro Manila being the National Capital Region is a highly urbanize and prime location for a lot of development which includes political, cultural, economic and infrastructure growth. NCR being the center of commercial and business in the whole country lifts urban landscape change. Opportunity at the center would magnetize growth and would create population imbalance on the sub-urban up to the rural areas.

The exact development area of the whole alignment/ transit network of the MMSP including its components, the station box and the construction yards will be the Direct Impact Area (DIA) of the development. It is understood that the direct impact of the MMSP would be more during the construction phase of the project. Structures will be built within the area of the construction yards as passage way for the people going in and out of each MMS stations.

The IIA of the MMSP alignment is set at 800 meters from the perimeter of each of the station boxes, construction yard, staging area and the underground tunnel portions in between the stations, **Table 2.1-2**. The 800-meter radius around the perimeter of the MMS station boxes and the interconnection alignment between stations is considered as the IIA for the proposed transit project. The perimeter radius from the MMS station components is set in consideration of the impact during the construction as well as the operation phase of the project in terms of disturbance to the vehicular and foot traffic within the project vicinity. Significant change in traffic schemes as well as certain deviation on land uses had been presumed in the conduct of the environmental studies including land use and classification.

Methodology

The Land Use Classification were determined by consolidating secondary data coming from open sources as well as from the collection of the land use and zoning maps from the respective Comprehensive Land Use Plans (CLUPs) of the different cities to which the Metro Manila Subway alignment will pass through. The concerned cities, from north to south, are Valenzuela City, Quezon City, Pasig City, Taguig City, Makati City, Pasay City, and Parañaque City. The maps were then digitized for the area computation, for each land use classes. Open source satellite imageries (e.g. Google Earth), where also utilized to confirm the recentness of the Land Use and Zoning maps, hence, the development of the Land Utilization maps. The satellite images were the average of the images from the year 2018 and 2019. Land Utilization is a project specific land classification based from the actual uses of area parcels on-ground. Also, as part of the ground truthing strategy, the use of the Open Street Map (OSM) was done. This is to efficiently check by providing images of the project alignment from a reliable platform. OSM is a free source application which includes a global data of 3-dimentional images of the main road networks. This allows rapid assessment of the land utilization where the project alignment will be placed. The OSM images were at-most 2 years old.

A study by Malarvizhi (2016) defended the efficiency of using Google Earth (GE) satellite imageries in the assessing the land use of the an urban area in Tamil Nadu, India. The use of the GE images is more efficient than the use of a higher resolution imageries like Quick bird imageries and the Landsat 8 imagery. GE imagery has a comparable result with high resolution imageries in land use mapping as stated by Hu (2013). The rate of urbanization can still be covered by images taken 2 years ago. This is based from the rate of urbanization in Metro Manila from 2007 to 2017 which only ranges from 45.3% to 46.6% as stated by an article (Urbanization in the Philippines 2017, 2019).

The development of the Land Utilization Classification from satellite imagery and the utilization of the OSM data would address and minimize inconsistencies and overlap with the uses of land in some areas. Also, to provide concrete evidence on the actual utilization of the area intersecting the alignment/network of the proposed interconnectivity/transport project within the urban landscape of Metro Manila, OSM was used as a reference.

Baseline Environment

Summary of Findings

Baseline Information	Key Findings and Conclusions
Land Cover	The whole region of Metro Manila is classified under the Land Cover type of Built-up areas and Arable lands crops mainly cereals and sugar. Parts of the MMSP alignment traverse across the land classification of Arable lands (7.5%) while majority of the alignment falls under the Built-up zone classification (74%).
Land Use	The identified Land Use of the MMSP disturbance footprint are Residential (40%), Mixed Use (17%), and Commercial (16%). This is based from the consolidated Zoning Plans from the different cities which will be affected by the project.
Land Utilization	Upon visual inspection of the Google Earth images, it can be concluded based from this study that the MMSP Components (construction yard, underground station boxes, and the interconnection between stations) that the actual land use in the ground would mostly affect Commercial lands and Institutional zones, in general. The area of the proposed depot can be generalized as an Industrial zone. While, the FTI Station is within the Medium-density Residential zone.
Protected Area	The nearest declared Protected Areas (PAs) from the MMSP is the Ninoy Aquino Parks and Wildlife Center (NAPWC), which is around 740 meters southwest north-east away from MMSP, and the Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA) which is around 5.3 km south-west away from MMSP. The MMSP has no significant influence to both declared PAs.
Impact to the Land Use	The impact of the MMSP during pre-construction would be the displacement of the residents within the Residential zones especially with the envisioned transportation hub in FTI Station. Also, right-of-way of the villages (entrance and exit) along East Service Road would be a possible impact alongside with the potential vehicular traffic congestion during construction of the project. Furthermore, during the earl stage of the operation, the vehicular traffic would be displaced to the other roads/routes. The development of a Station within the vicinity of McKinley West Village (Lawton East Station) will be a threat to the amenities (e.g. solemnity and privacy of the place; and view value from the real estate properties) would eminent. Though, it is expected that land values would rise near the alignment of the project.

Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construction	Construction	Operation	Closure	
Impact in terms of compatibility with existing land use					
Some of the locations of the MMSP Station is within Residential zones, and most of the areas are within Commercial zones. Displacement of the residents within the Direct Impact Area of the station developments (transport hubs and station plazas) will be done.	✓	✓	x	x	Doing the right practices with regards to the negotiations with the concerned parties pertaining to land acquisition will be done. Fair market value will be determined by providing a clear reference to the applicable legal instrument.
Potential impact of the project to the other Subway Projects in Metro Manila (e.g. Makati Subway Project), such as intersection of the alignments.					The DOTr will continuously coordinate with the LGUs and other related government agencies (e.g. DPWH, MMDA) and secure the necessary permits, endorsements, and clearances required for the construction. The depth of the underground activity of the project will be closely coordinated with the authorities handling the other Subway Projects within Metro Manila.
Land disputes with the private land owners especially in the Residential and Commercial areas					Secure easement agreements with the owners of the properties in the vicinity to have safety net in response to tenurial issues over the development area for the project.
Impact on compatibility with classification as an Environmentally Critical Areas (ECA)					
MMSP has no significant influence to the determined ECAs, both NAPWC and LPPCHEA. An undated study by DENR-NCR related to LPPCHEA stated that MMSP has no influence on the declared Protected Area	✓	✓	x	x	Maintain an environmentally sound measures during construction phase of the project.
Impact in existing land tenure issue/s					
MMSP is not within any land under tenurial instrument.	x	x	x	x	There are no identified lands in Metro Manila that is under land tenure.
Impairment of visual aesthetics					
MMSP has no significant or any effect at all to any visually important structures or land forms. Development of the design indicated in the key plan by the JDT within the Residential areas, especially the development in FTI Station will consider right of way and alternative routes will be provided in the construction phase of the project.	x	x	x	x	Maintain the current alignment plan in the project key plan. There are no visually important structures and land forms within the alignment of the project. Majority of the project area is within Industrial, Commercial and Residential areas. Existing built-up

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-	Construction	Operation	Closure	
					structures are already evident within the DIA and IIA.
Devaluation of land value as a result of improper solid waste management and other related impacts					
The land value of the area within the vicinity of the station development is expected to increase.	✓	✓	✓	x	Limit/control the commercialization of the planned mixed-use developments within the planned Station Plazas to some of the stations

2.1.1.1 Impact in terms of compatibility with existing land use

The Land Use Classification for MMSP is done by overlaying the MMS alignment, including the station components, over the consolidated zoning map for each of the concerned city. **Table 2.1-2** presents the list of the land classification intersected the DIA identified from each city. The area in hectares of each land class is also computed as shown below. Also, it is specified to which land use classification each station would be categorized.

Upon intersecting the land classes with the DIA coverage (120 ha) for the whole alignment and its components, the impact to the land use would be generally categorized to Commercial (25%.), Residential (17%.), and Mixed Use (16%). As for more specific land use classification, the impact of the MMS alignment would be categorized to Commercial (12%), Medium Intensity Industrial Zone (7%), and Residential (7%). This is based from the consolidated Land Use Zones from the different cities as presented in the Land Use Map shown in **Figure 2.1-1**.

Table 2.1-2 Identified Land Use Classes within the DIA

City	Land Use Classification	General Classification	Area in hectares	Subway Component
Valenzuela City	Commercial-2	Commercial	14.29	Depot
	General Industrial	Industrial	2.89	
	Max Residential-3	Residential	1.37	
Quezon City	Medium Intensity Industrial Zone	Industrial	8.89	
	Minor Commercial Zone	Commercial	7.62	Quirino Hway Station
				Tandang Sora Station
				East Ave. Station
				Anonas Station
	Institutional Zone	Institutional	6.89	North Ave. Station
				Anonas Station
				Katipunan Station
	Major Commercial Zone	Commercial	5.74	Quirino Hway Station

City	Land Use Classification	General Classification	Area in hectares	Subway Component
				Tandang Sora Station
				Anonas Station
	Special Urban Development Zone	Mixed Use	4.52	Quezon Ave. Station
	Low Density Residential Zone	Residential	3.58	
	High Density Residential Zone	Residential	0.99	Anonas Station
	Medium Density Residential Sub Zone	Residential	0.27	Quirino Highway Station
	Transport and Utilities Zone	Utility	0.18	
	Medium Density Residential Zone	Residential	0.07	
Pasig City	Residential	Residential	4.33	Ortigas North Station
				Ortigas South Station
	Commercial-1	Commercial	1.51	Ortigas North Station
				Ortigas South Station
	Institutional	Institutional	1.18	Ortigas North Station
	Idle Land	Green Space	0.39	Ortigas South Station
	Commercial-2	Commercial	0.26	Ortigas North Station
				Ortigas South Station
	Green Space	Green Space	0.04	
Makati City	Special Mixed Use	Mixed Use	7.33	Kalayaan Station
	Cemetery	Utility	0.93	
	Residential	Residential	0.36	
	Industrial	Industrial	0.35	
	Institutional	Institutional	0.24	
	Government Center Zone	Institutional	0.15	
	Parks and Open Spaces	Green Space	0.11	
Pasay City	Original Villamor Airbase Area	Mixed Use	4.93	NAIA Terminal 3 Station
	Airport Area	Utility	0.83	
Taguig City	General Residential Devt Zone 2	Residential	5.68	Lawton East Station
				Lawton West Station
	Institutional	Institutional	3.37	Kalayaan Station
				Lawton West Station
	Open Space	Green Space	2.26	
	Military Zone	Institutional	1.91	
	Controlled Growth Corridor	Mixed Use	1.80	BGC Station
	Urban Core Zone	Mixed Use	0.84	
	General Residential Dev't Zone 1	Residential	0.63	
	Light Industrial Zone	Industrial	0.48	
Parañaque City	Residential	Residential	3.53	FTI Station
	Commercial	Commercial	1.53	
	Industrial	Industrial	0.44	

Indirect Impact Area (IIA) is delineated 800 meters perimeter around the MMS alignment including its components (shown in **Figure 2.1-1**), as part of the consideration of the effect of the MMSP to the social, commercial, traffic activities and the land use change. The IIA upon computation of the area, has a figure of 5,159 hectares. The IIA considers all the project components from the construction up to the operation stage of the project. It is presumed that during construction, a great impact would be eminent to the current vehicular and foot traffic flow within the vicinity of the project area. Generally, most of the intersected area within the IIA are Residential (40%), Mixed Use (17%), and Commercial (16%). And according to the consolidated Land Use Map, majority of the IIA would be under the classification of cluster of Low to High-density Residential Zones (36%); cluster of Special Mixed Use, Controlled Growth Area, and Priority Development (7%), and Institutional Zone (5%).

Table 2.1-3 Identified Land Use Classes within the IIA

City	Land Use Classification	General Classification	Area in hectares	Subway Component
Valenzuela City	Commercial-2	Commercial	115.2	Depot
	General Industrial	Industrial	71.4	
	Max Residential-3	Residential	24.6	
	Residential-5	Residential	17.6	
	Cemetery	Utility	8.2	
	Max Residential-2	Residential	3.4	
Quezon City	Low Density Residential Zone	Residential	327.5	
	High Density Residential Zone	Residential	309.2	Anonas Station
	Institutional Zone	Institutional	271.3	North Ave. Station
				Katipunan Station
	Medium Density Residential Zone	Residential	256.8	Quirino Hway Station
	Minor Commercial Zone	Commercial	227.1	Quirino Hway Station
				Tandang Sora Station
				East Ave. Station
				Anonas Station
	Major Commercial Zone	Commercial	196.2	Quirino Hway Station
				Tandang Sora Station
				Anonas Station
	Special Urban Development Zone	Mixed Use	178.9	Quezon Ave. Station
	Medium Density Residential Sub Zone	Residential	139.2	
	Medium Intensity Industrial Zone	Industrial	97.5	
	Low Density Residential Sub Zone	Residential	33.5	
	Transport and Utilities Zone	Utility	27.0	
	Metropolitan Commercial Zone	Commercial	22.7	
	Cemetery	Utility	20.9	
	Socialized Housing Zone	Residential	8.7	
	Low Intensity Industrial Zone	Industrial	0.0	

City	Land Use Classification	General Classification	Area in hectares	Subway Component
Pasig City	Residential	Residential	312.9	Ortigas North Station
				Ortigas South Station
	Commercial-1	Commercial	103.2	Ortigas North Station
				Ortigas South Station
	Commercial-2	Commercial	48.1	Ortigas North Station
				Ortigas South Station
	Mixed Use	Mixed Use	36.1	
	Institutional	Institutional	26.5	Ortigas North Station
	Industrial	Industrial	23.7	
	Green Space	Green Space	20.1	
	Idle Land	Green Space	18.8	Ortigas South Station
Makati City	Residential	Residential	305.3	
	Special Mixed Use	Mixed Use	294.4	Kalayaan Station
	Cemetery	Utility	53.9	
	Industrial	Industrial	32.6	
	Recreational	Green Space	27.0	
	Government Center Zone	Institutional	20.2	
	Commercial	Commercial	18.4	
	Institutional	Institutional	9.2	
	Parks and Open Spaces	Green Space	6.0	
	Utility	Utility	1.0	
Pasay City	Original Villamor Airbase Area	Mixed Use	207.5	NAIA Terminal 3 Station
	Airport Area	Utility	196.5	
	Proposed International Cargo Terminal	Utility	11.9	
	Area for Priority Development	Mixed Use	10.0	
	Original Settlement Area	Residential	1.5	
Taguig City	General Residential Devt Zone 2	Residential	231.7	Lawton East Station
				Lawton West Station
	Urban Core Zone	Mixed Use	223.1	
	General Residential Devt Zone 1	Residential	205.5	
	Open Space	Green Space	119.8	
	Institutional	Institutional	92.6	Kalayaan Station
				Lawton West Station
	Military Zone	Institutional	85.5	Lawton East Station
	Controlled Growth Corridor	Mixed Use	64.8	BGC Station
	Light Industrial Zone	Industrial	54.6	
	Low Density Development Zone	Commercial	48.2	
	Socialized Housing	Residential	3.6	

City	Land Use Classification	General Classification	Area in hectares	Subway Component
Parañaque City	Residential	Residential	98.3	FTI Station
	Industrial	Industrial	78.6	
	Commercial	Commercial	55.1	
	Utilities	Utility	1.3	

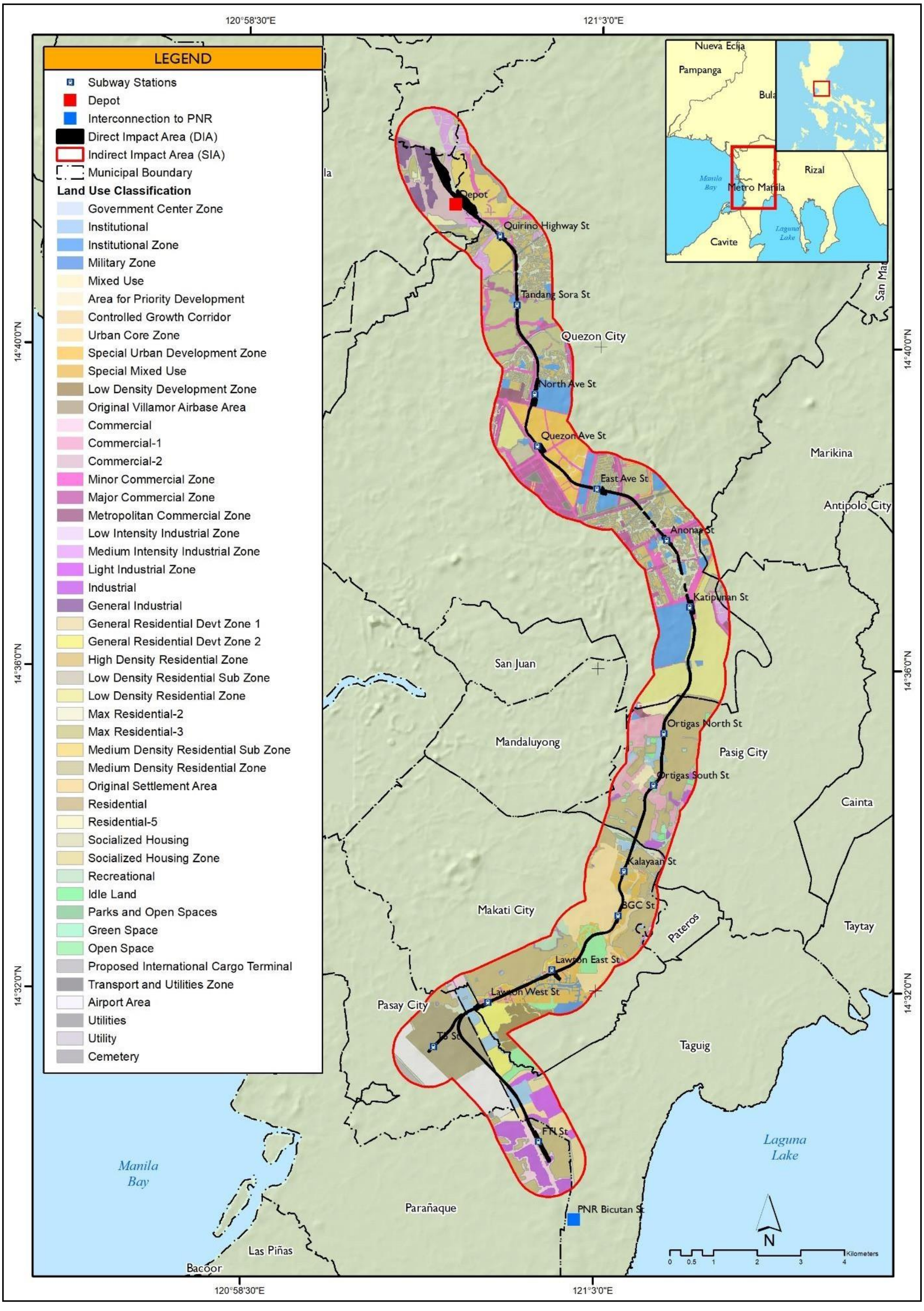


Figure 2.1-1 MMSP Land Use Map (DIA and IIA) (EIS, 2017; Taguig City, Pasay City, Makati City, Parañaque City)

Land Cover Classification

The National Mapping and Resources Information Authority (NAMRIA) had three (3) initiatives in mapping the resources of the Philippines through a massive land cover mapping with the use of the available high-grade satellite imageries and the remote sensing technology. These initiatives were in the year 2003, 2010, and 2015. But officially, the 2010 version of the land cover classification was released by the NAMRIA. The mapping agency recommends the use of the 2010 version instead of the most recent (2015), while NAMRIA is currently implementing another mapping effort from 2017-2020. The 2010 version contains the original 21 Land Cover Classification that is aggregated in to 14 classes. On the other hand, the 2015 NAMRIA Land Cover Map only contains the aggregated 12 classes, hence, making the 2010 version more useful with 89% overall accuracy (Santos, 2018).

Upon overlaying the Land Cover Classification from NAMRIA (2010) in ArcGIS 10.2, it is determined that there are two land cover classes over the National Capital Region (NCR). As shown in **Figure 2.1-2**, Metro Manila was categorized majority under the Built-up classification (72%). On the other hand, only 4.5% of the total land area of Metro Manila was classified under Arable lands. These areas classified under arable lands can be found in Makati, Taguig, Pateros, and extends up to the Province of Rizal. Arable lands are lands that are plough-able for planting of agricultural crops like cereal, sugar, and other crops.

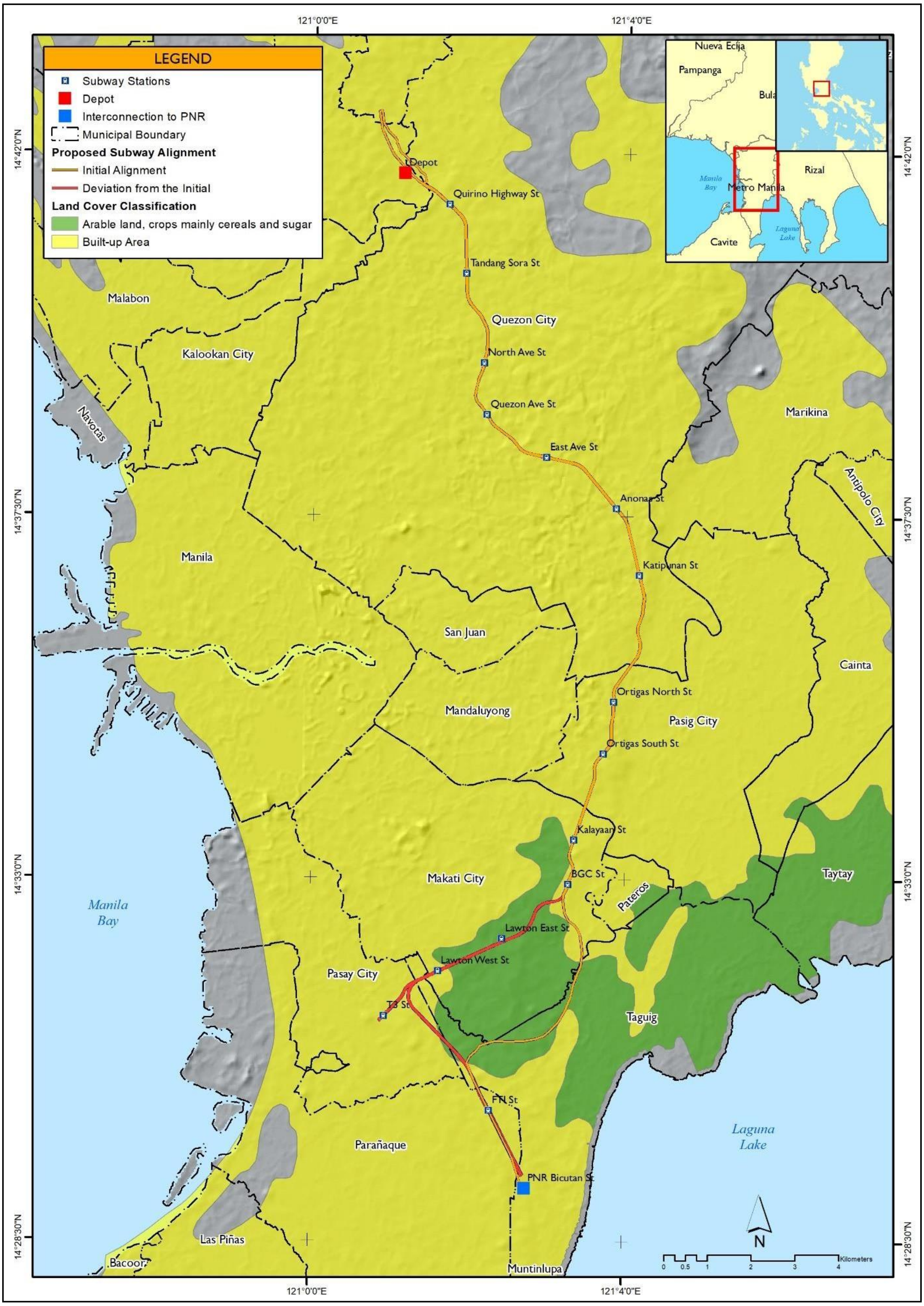


Figure 2.1-2 Metro Manila Land Cover Map (NAMRIA, 2010)

Land Use Utilization Assessment

The station stops as well as the railway interconnecting each stations of the MMS being constructed underground and only stairways up and down the stations will be put up to each station, the significant impact during construction and the operation phase of the MMSP will be at the development areas where Mixed-use/Commercial establishments, transportation hubs, as well as the entry and exit structures will be built especially at the proposed FTI Stations. Visual observation of the location/vicinity of the MMS stations based from Google Earth Pro images, was done to intimately inspect the land use utilization or the existing land use based from the most recent satellite images. Hence, the study can be defined as an inspection of the actual land use over the disturbance footprint (also defined as the DIA) of the MMSP. The actual land use of the area within the DIA of the project is termed as Land Use Utilization in this study.

The images where investigated visually according to its use. The classification of Commercial, Medium-density Residential, High-density Residential, Industrial, Institutional, Mixed-use, Recreational, Open Space, Green Space, etc. Some key establishments like hospitals, private schools, churches and shrines, and other significant establishments that would be affected by the alignment were also labelled accordingly. The MMS components were also plotted in Google Earth Pro which are shown in colored lines in the images. Green boundary lines symbolize the boundary of the construction yards, yellow lines symbolize the subway alignment interconnecting each station. While, the red lines represent the station boxes. This is where the underground stations would be located.

Key structures and signs were the basis in the visual inspection of the satellite images. Structures like shopping malls, corporate buildings and areas for commerce were classified under Commercial. Areas with significant lump of house roofs were identified as Residential. The density is classified based on the spaces between the houses. Small in between spaces were classified as High-density Residential, while the areas with houses that have more spaces in between is classified under Medium to Low-density Residential. Industrial areas include government offices, public schools and public hospitals. Industrial includes area where factories and warehouses can be located. While the Mixed-use classification is used for areas with a mix of mostly commercial and residential areas. And the classifications of Recreation, Open Spaces, Green Spaces can be easily determined because of the presence of trees shown as lumps of greens on the images.

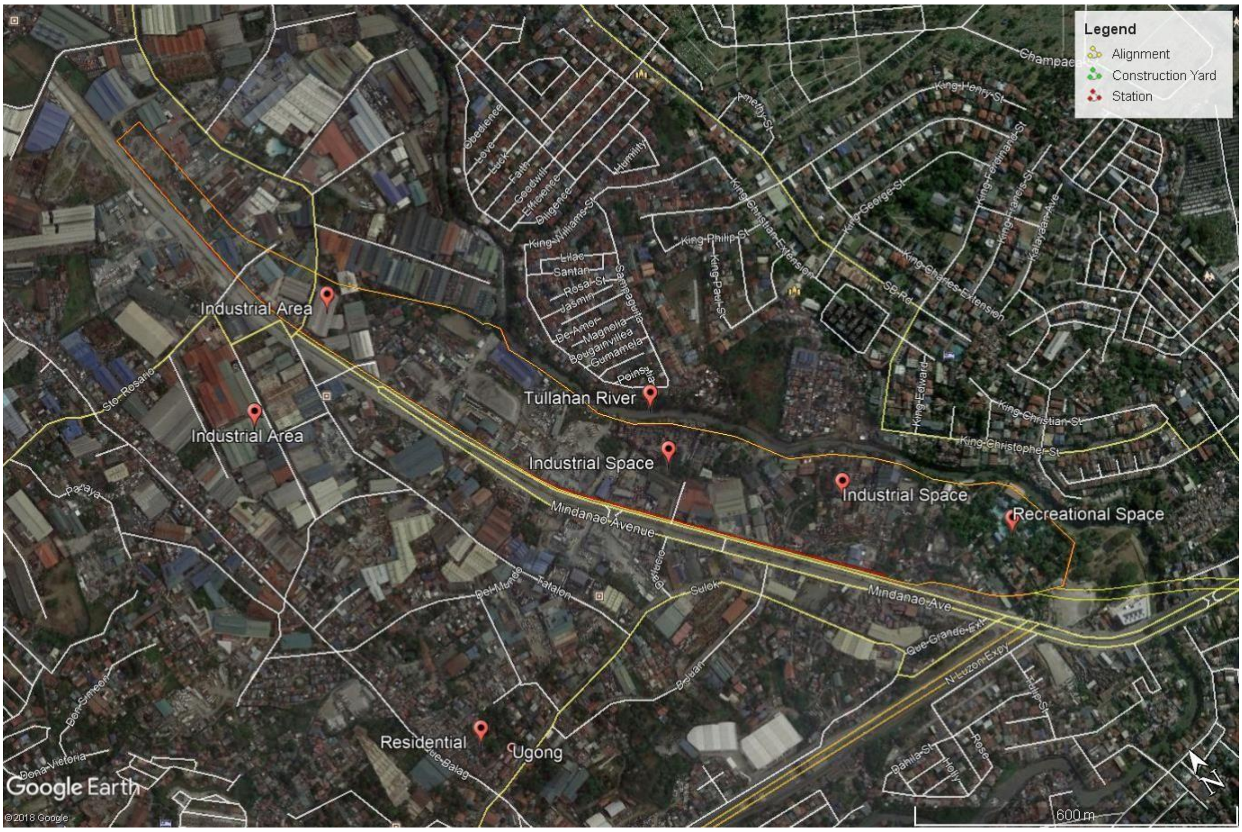


Figure 2.1-3 Satellite imagery of the Depot in Barangay. Ugong, Valenzuela

The planned Depot is located within the vicinity of industrial spaces. The right-side border of the Depot is parallel to Tullahan River, as seen from **Figure 2.1-3**. Areas where warehouses can be located was also observed. There is an observed recreational space located southern end of the perimeter of the Depot. The nearest observed Residential Space is about 500 meters away from the western side of the Depot perimeter.

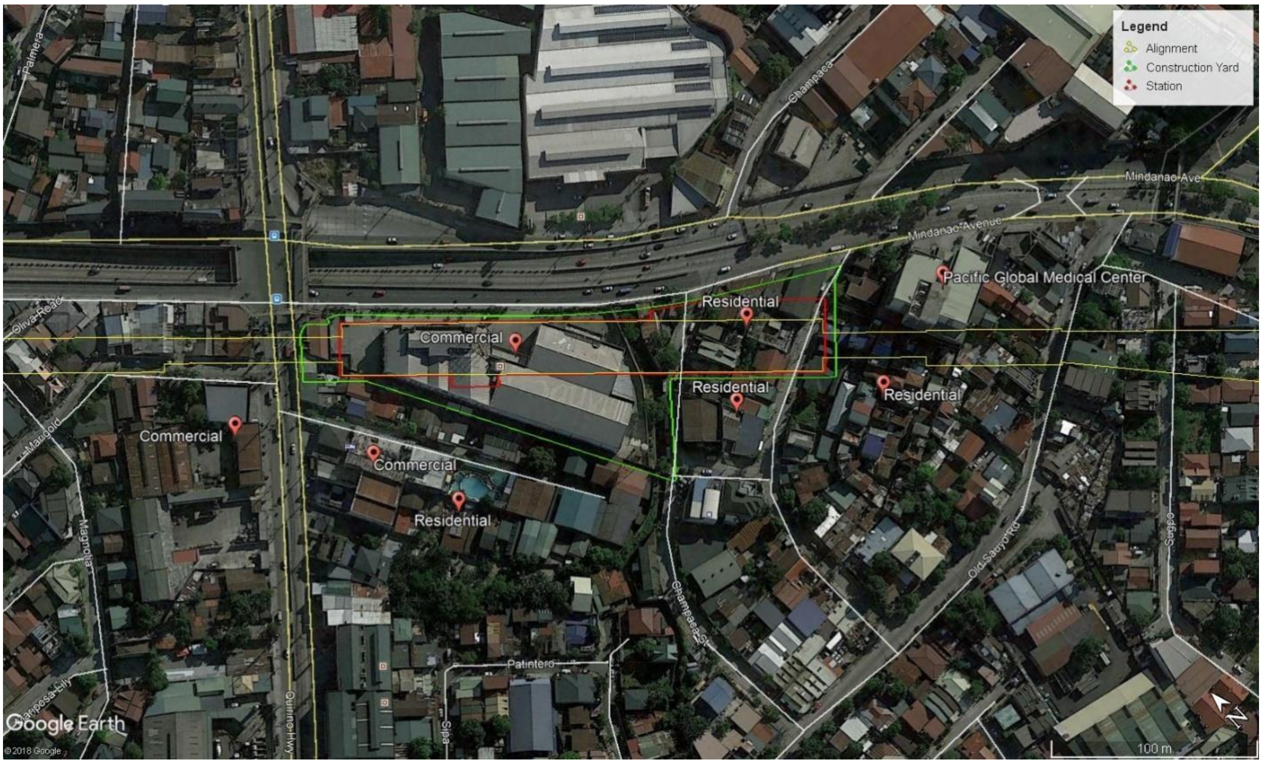


Figure 2.1-4 Satellite imagery showing the Quirino Ave. Station in Baramgay. Talipapa, Quezon City

As seen from **Figure 2.1-4**, the location where the planned Quirino Station will be built, will intersect a zone that is classified as Commercial located at the left-side north-bound of Mindanao Avenue in Barangay Talipapa, near the underpass going to the direction of NLEX-northbound. The land classifications vicinity is composed of Residential, Commercial up to the Mixed-Use Classification. Also observed, commercial establishments were eminent near the major roads (e.g. Mindanao Avenue).

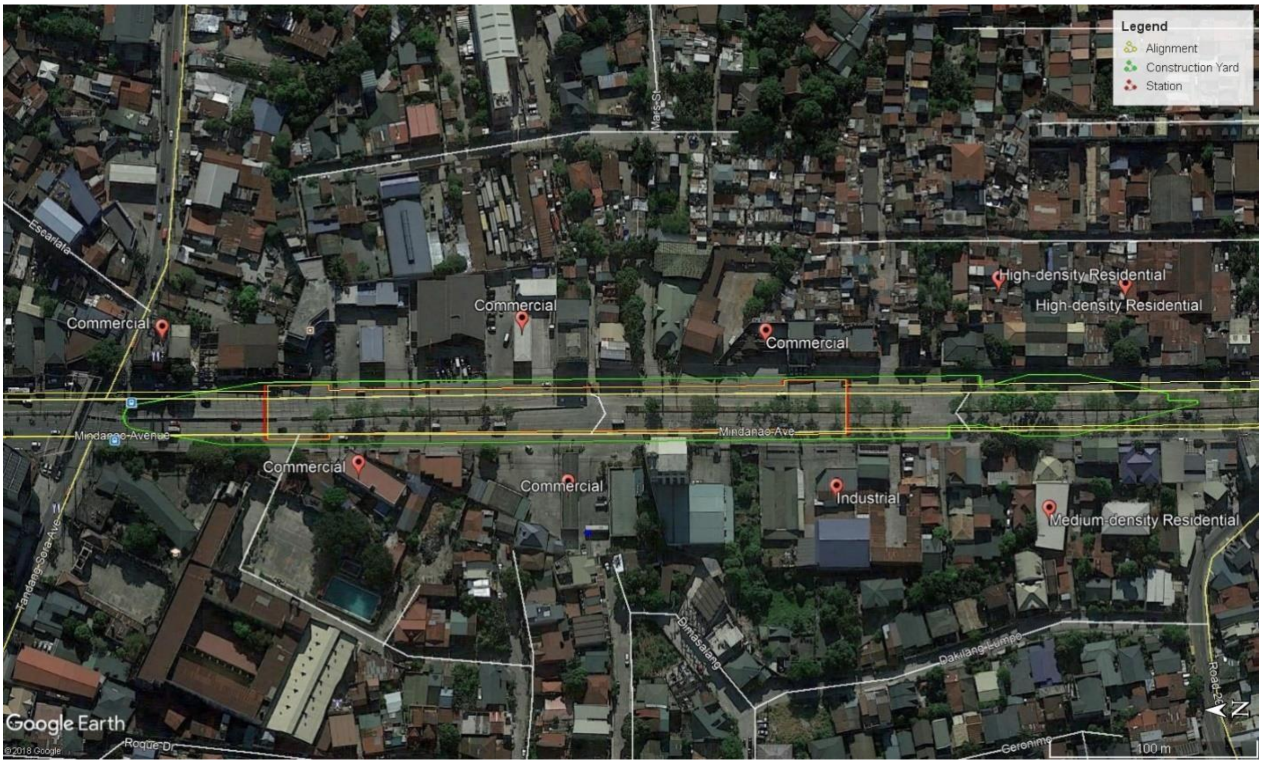


Figure 2.1-5 Satellite imagery showing the Tandang Sora Station in Barangay Tandang Sora, Quezon City

The area along the Mindanao Ave. in Barangay Tandang Sora where the location of an MMSP station will be located is composed of mix of Industrial and Commercial zones which are mainly along the Mindanao Avenue. In reference to **Figure 2.1-5**, High-density Residential can be located near the south-end of the station (both bound traffic of Mindanao Avenue).

Figure 2.1-6 Satellite imagery showing the North Ave. Station in Barangay Project 6, Quezon City

The North Ave. Station will be mainly located within the green space inside an Institutional zone. It will be located inside the boundary of the Veterans Memorial Hospital on the corner Mindanao Avenue and North Avenue. Presumably, vehicular and foot traffic will not be much affected by the MMSP. Commercial centers can also be located diagonally and adjacent to the location of the project. Also, High-Medium Residential can also be located west of the boundary of the Veterans Memorial Hospital and along the north-bound area of Mindanao Ave.

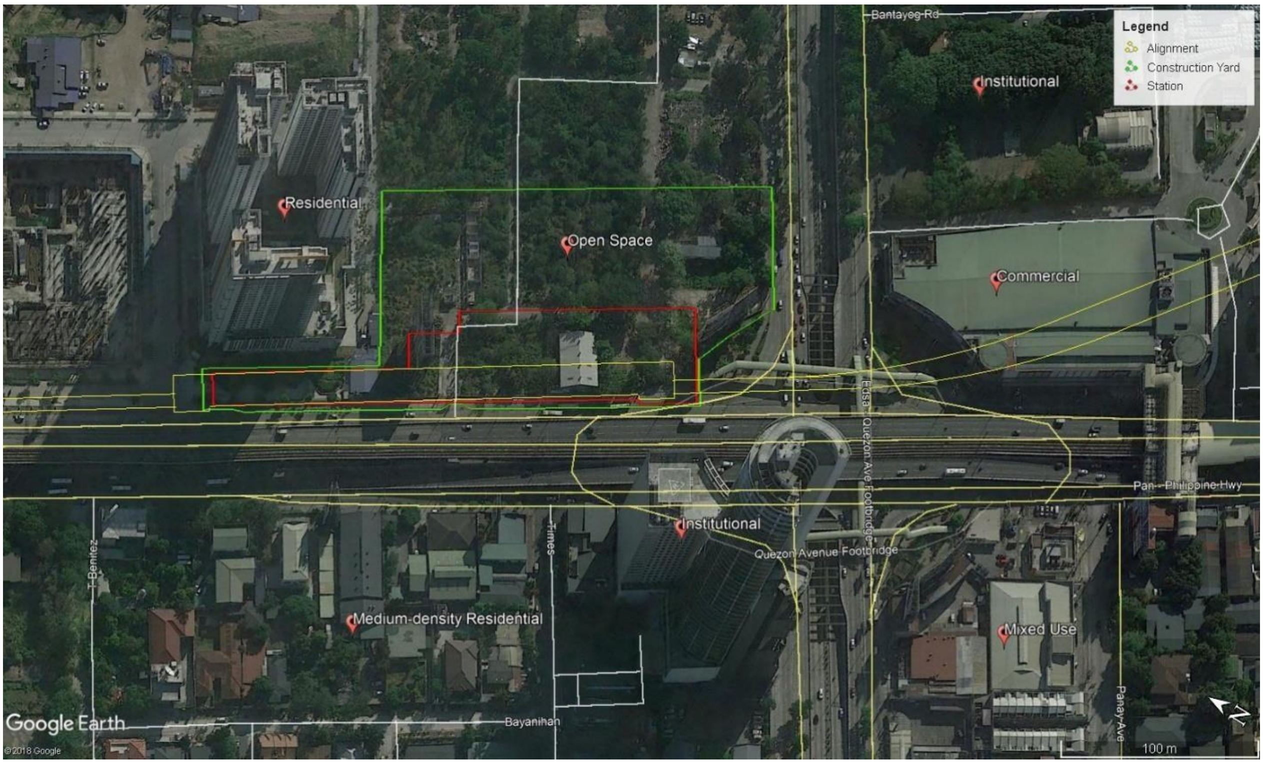


Figure 2.1-7 Satellite imagery showing the Quezon Ave. Station along EDSA corner Quezon Avenue

A portion of area (approx. 1.5 ha.) of an Open Space will be allotted as a construction yard for MMS Quezon Ave. Station. It is within the boundary of an Open Space near the corner south-bound of Quezon Avenue going to EDSA. Adjacent to it is a high-rise condominium classified under Residential. Situated opposite to the project location a commercial space is situated. The project location along EDSA corner Quezon Ave. is a busy space during rush hours (7-10am and 4-7pm).

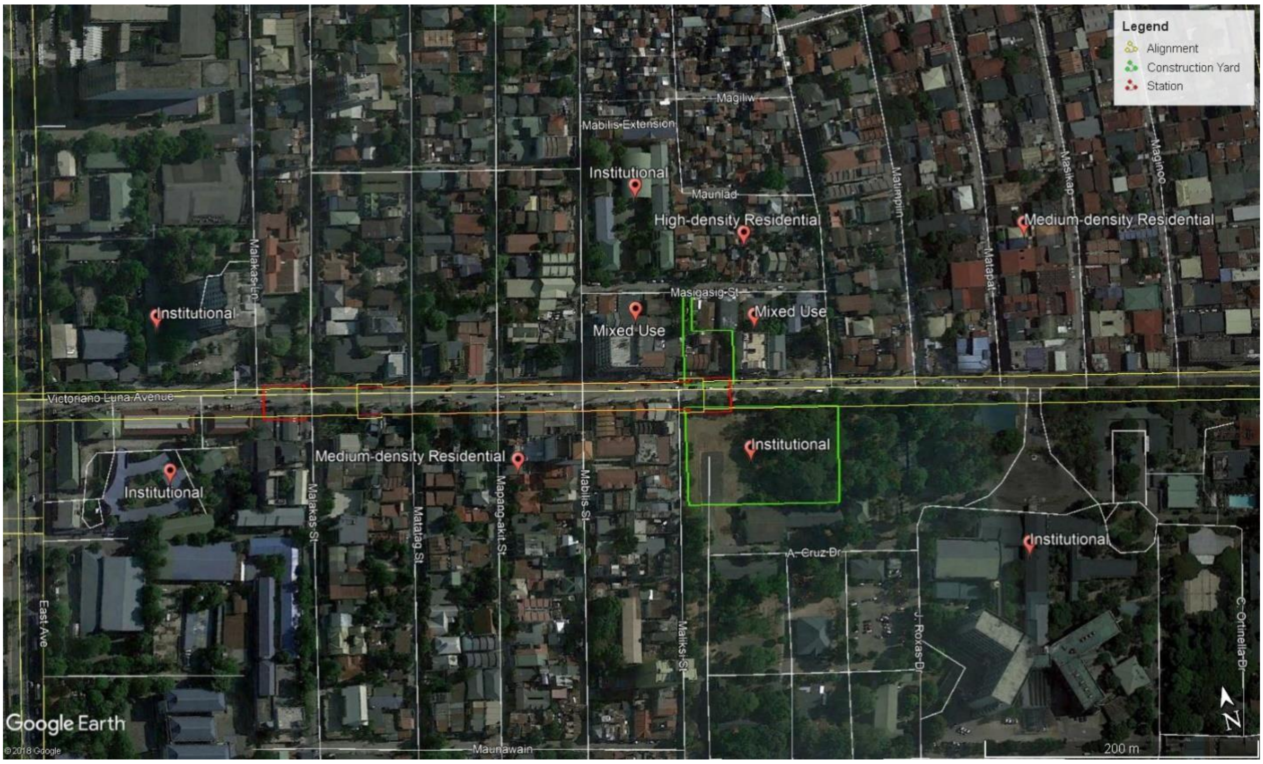


Figure 2.1-8 Satellite imagery showing the East Ave. Station in Barangay Pinyahan, Quezon City

The area along Victoriano Luna Ave. near Malakas and Mapagbigay streets is highly commercial. As evident in **Figure 2.1-8**. Commercial spaces for retail businesses can be in this area. A mix of Residential and Commercial spaces is significant in the area. About a hectare of land is allotted as a construction yard for the East Ave. Station inside the vicinity of AFP Medical Center or also known as V. Luna Hospital.

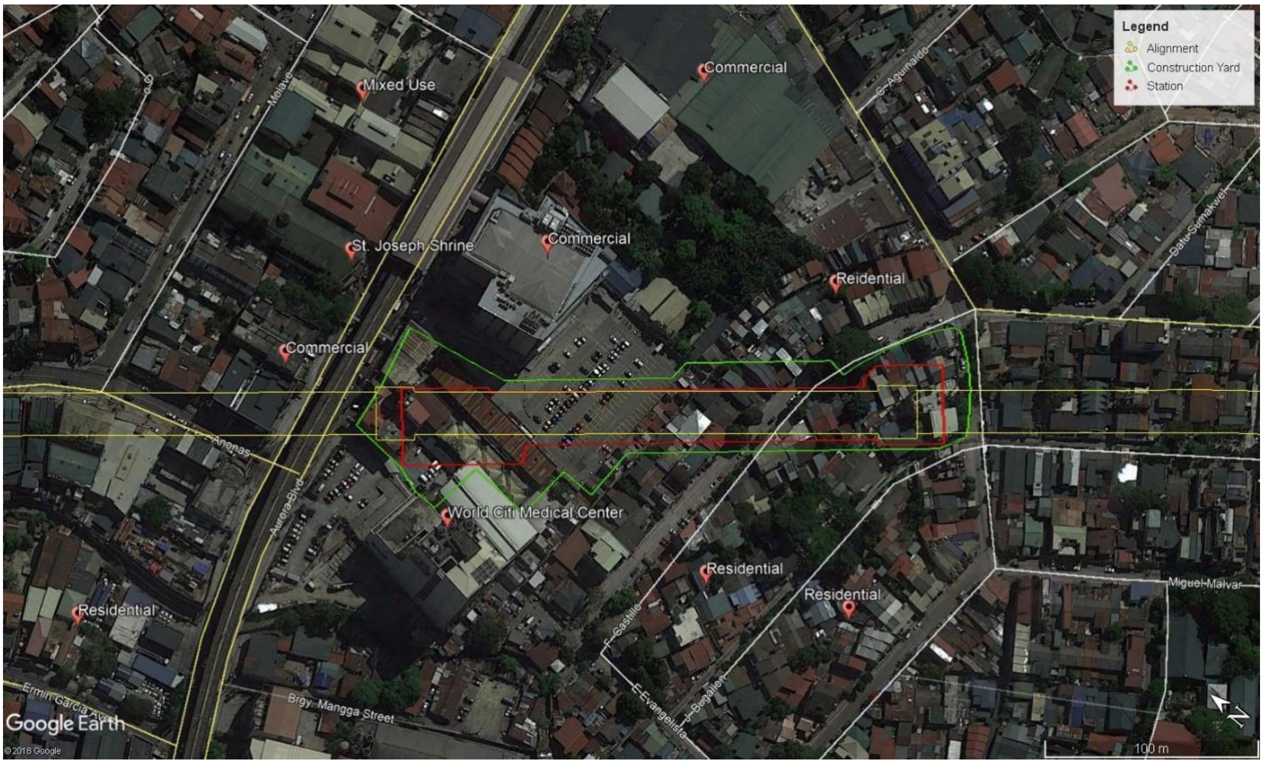


Figure 2.1-9 Satellite imagery showing the Anonas Station in Barangay Bagumbuhay, Quezon City

The construction yard and the station box for the Anonas Station would traverse and area of a Commercial space. LRT-2 Anonas Station Commercial Center (The LRT City Center) will be affected by the project. As shown in **Figure 2.1-9**, the vicinity of the project area along Aurora Blvd. and Anonas can be classified under Commercial and a mix of Residential. A church is also evident near LRT-2 station.

Figure 2.1-10 Satellite imagery showing the Katipunan Station near Barangay Villa Maria Clara, Blue Ridge B, and White Plains, Quezon City

The construction of the MMS Katipunan Station would mainly include area of land part of Camp Aguinaldo. Around 2.2 hectares of land within the AFP Camp Aguinaldo grounds would be allotted for the project which can be considered as an Institutional space. The concerned area for Katipunan station is surround by a Mixed-use, Residential and Institutional land uses, as shown in **Figure 2.1-10**.

Figure 2.1-11 Satellite imagery showing the Ortigas North Station near in Barangay Ugong, Pasig City

Ortigas North Station which will be located along Meralco Ave. The area is known to be part of a Central Business District in Ortigas where center of commerce, corporate building can be located. Also, a few hotels and commercial complex is situated in the area. As shown from **Figure 2.1-11**, the development area which is represented by the boundary of the construction yard, will traverse a Commercial space in its surroundings.

Figure 2.1-12 Satellite imagery showing the Ortigas South Station in Barangay Orando, Pasig City

Ortigas South station is farther south of Meralco Ave. from Ortigas North Station (about 1 km). This station is near Capitol Commons which is known to be a commercial district. Commercial businesses, restaurants, shopping districts can be located in the area. It is adjacent to Estancia Mall. In **Figure 2.1-12**, it can be observed that Value Care Health Systems can be found on the north-east side of the project location.

Figure 2.1-13 Satellite imagery showing the Kalayaan Station in Fort Bonifacio, Taguig City

Kalayaan Station is also located within a business/commercial area location. The proposed station will be developed in an uprising mix of commercial, residential, and corporate location. The vicinity being part of Uptown BGC, is expected to be a developed urban landscape like BGC and its precedent Makati CBD. From **Figure 2.1-13**, it can be argued that generally, the project location is within the commercial land use.

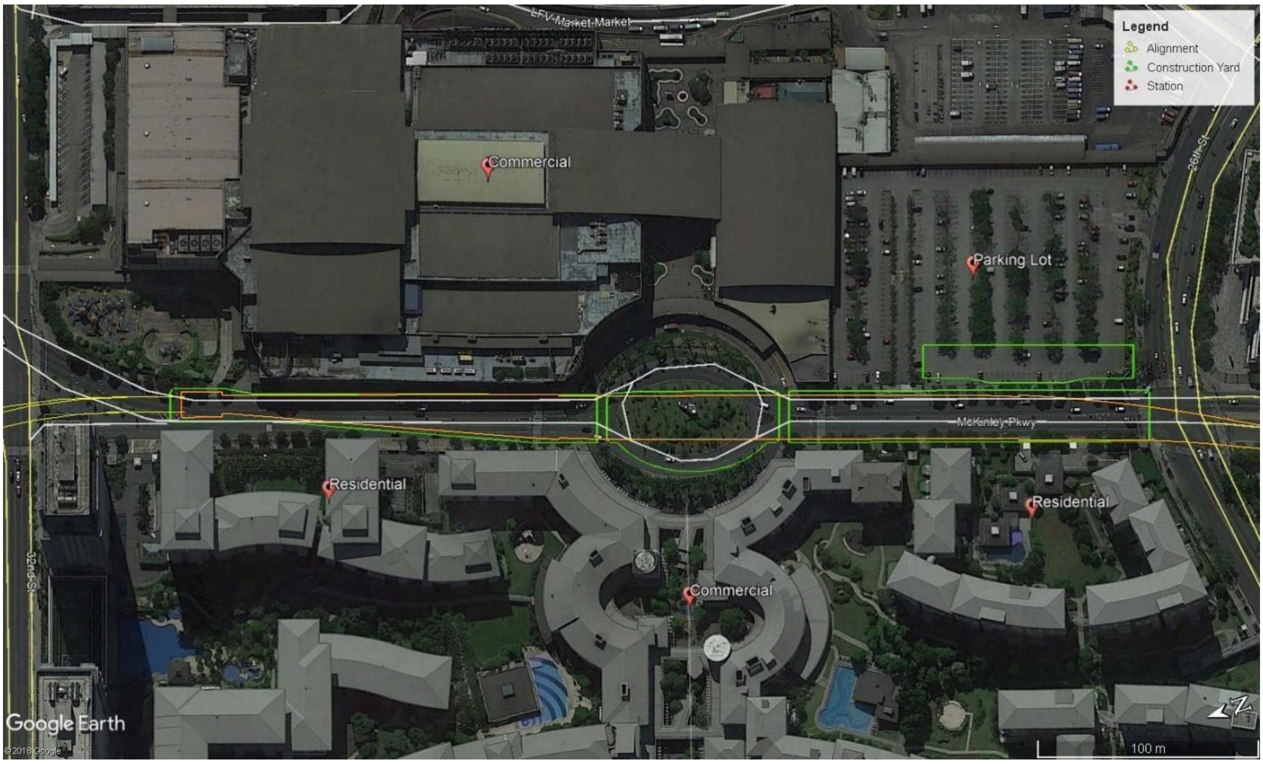


Figure 2.1-14 Satellite imagery showing the BGC Station in Fort Bonifacio, Taguig City

Bonifacio Global City (BGC) in Taguig City is an emerging Central Business District (CBD). Being a CBD, meant that a significant population goes in and out BGC. To which, a mass public transport would be beneficial. A well-planned mass public transportation system would prevent urban sprawl in the vicinity of the CBD. The reason being, that the large number of the population do not need to move permanently or semi-permanently near the business district. The underground station in between a Commercial area (Market Market) and a Residential space (Serendra), and an Entrance/Exit stairway going down the MMSP station would limit the disturbance over the area. During construction vehicular traffic along McKinley Parkway would be shifted/directed. Also, foot traffic would be displaced on the side of Serendra and Market Market Mall. This area where Market Market Mall is located is known to be the transport hub for people coming in and out of BGC.

Figure 2.1-15 Satellite imagery showing the Lawton East in Fort Bonifacio, Taguig City

McKinley West is the adjacent area of development for the Lawton East Station. McKinley West is part of a high-end mix of Residential and Commercial development area, McKinley Hill. It is composed of a Low-density Residential area which is about 1.3 km east of the proposed Lawton East Station. The underground station would be beneath an area right next to the façade entrance of a developing real estate property called The Albany McKinley West. **Figure 2.1-15** presents the actual land use within the vicinity of Lawton East Station which includes an Institutional/Residential (NAMRIA Residential Towers), Residential (Bonifacio Heights Condominium), and some Commercial spaces which include corporate office buildings. The project location is also within the vicinity of a Military Zone area which is also categorized under Institutional.

Figure 2.1-16 Satellite imagery showing the Lawton West in Fort Bonifacio, Taguig City

The location for the proposed Lawton West Station can be described as a backdoor corridor of the Fort Bonifacio Naval Station. The area for the proposed Lawton West Station is about 420 meters north of Lawton Ave. which most of the traffic going area from Taguig (BGC) to Pasay (NAIA), Makati and Manila area and vice versa. There is a boundary wall between Chino Roces Ave. and the boundary of the Philippine Navy grounds. This is the reason for the inaccessibility of the area which makes it to be a backdoor corridor. The area can be said to have a low economic activity. **Figure 2.1-16** shows a rapid assessment of the land use within the area. The development area of the proposed station is generally within an Institutional space. Moreover, the underground station would traverse beneath the Low-density Naval Military/Residential. The area for the development would affect largely the National Nutrition Center. Also, information of the new Senate Building states that it would be near the proposed MMS Lawton West Station.

Figure 2.1-17 Satellite imagery showing the NAIA Terminal 3 Station in New Port City, Barangay 183, Pasay City

The NAIA Terminal 3 is the focus of this particular MMS station in Pasay City. It is expected to service people going in and out the airport. Vehicular traffic situation within Andrews Drive, and near the Villamor Airbase area is sometimes blamed to be the cause of delay for the people who are coming in and out of the Philippines. With the operation of the MMS with a station specifically located near the vicinity of the airport, this would solve the traffic situation in the area. The New Port City, where the proposed station would be traversing, is composed of medium to high rise condominiums, high-end hotels, and other commercial establishments like the Resort World Manila. **Figure 2.1-17** shows that the underground alignment of the MMS will traverse beneath adjacent to Resort Drive leading to Andrews Ave. and will pass along the Shrine of St. Therese which is also a columbarium. The railway alignment would end at the parking lot for people picking up passengers from NAIA Terminal 3.

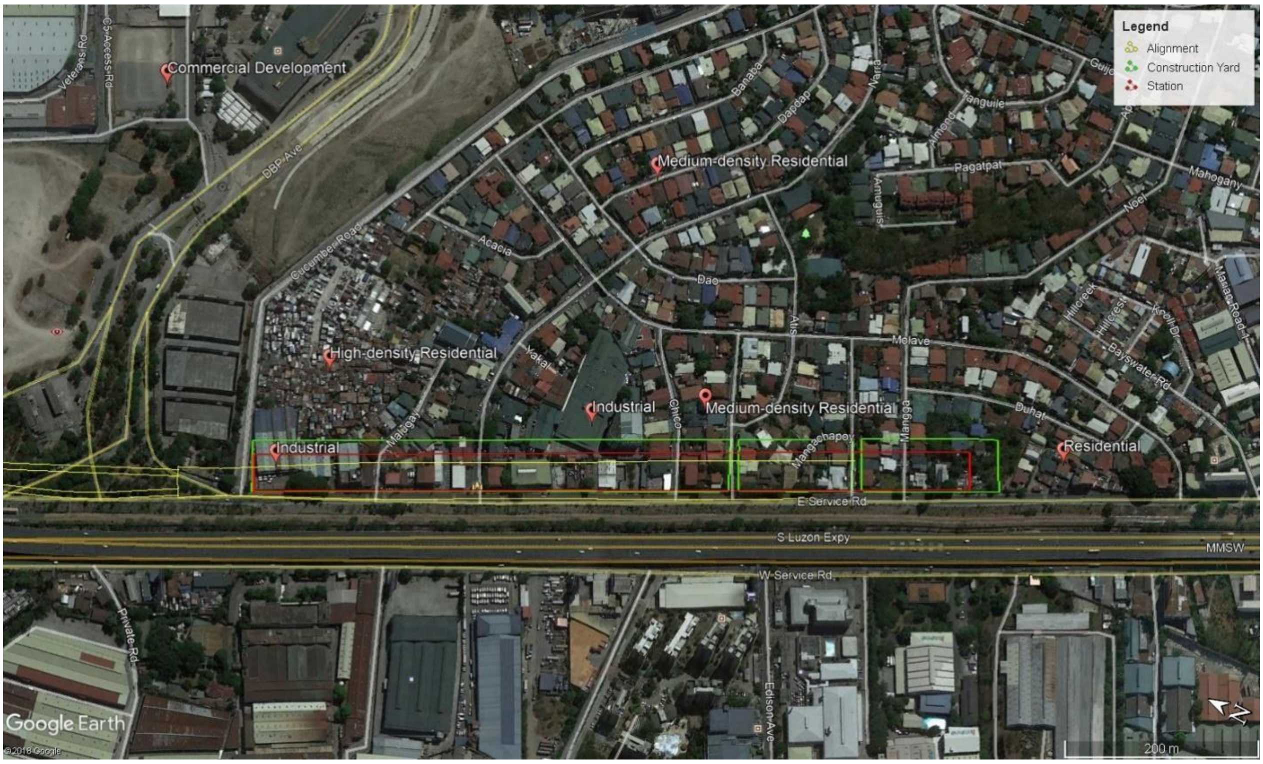


Figure 2.1-18 Satellite imagery showing the FTI Station in Brgy, San Martin de Porres, Parañque

The largest impact when it comes to land utilization will be at Barangay San Martin de Porres. The development plan for the proposed FTI Station would include new Public Utility Vehicle (PUV) hubs. This particular station is foreseen to be an interconnection hub to the other transportation type such as PUVs and the PNR Station. **Figure 2.1-18** shows that the location for the proposed FTI station is surrounded by Medium-density Residential particularly the villages of United Hills Parañaque. Displacement of residents within the development area for the project is presumed.

Land Use Compatibility

The Land Use Compatibility Matrix id prepared to present the compatibility of the proposed MMSP over the Planned Land Use (Land Use Classification) and the Existing/Actual Land Use (Land Utilization Assessment). **Table 2.1-4** presents the observed land utilization per location of each of the proposed MMS Station from Valenzuela City up to the City of Parañaque.

The Land Compatibility Matrix summarized that the Land Use Utilization of most of the proposed MMS stations is located within Commercial and Institutional zones. It also shows that the planned and the existing land use for the location of the proposed FTI Station is within Residential and Commercial. While the proposed Depot in Valenzuela is under the mixture of Industrial and Commercial.

Table 2.1-4 Land Use Compatibility Matrix

Metro Manila Subway Component	Existing Land Use							
	Planned Land Use							
	General Industrial	Commercial	Low-density	Medium-density Residential	High-density Residential	Institutional	Urban Core Zone	Socialized Housing
Depot	✓	✓						
	✓	✓		✓				
Quirino Highway Station		✓		✓		✓		
		✓		✓				
Tandang Sora Station		✓			✓			
		✓						
North Avenue Station						✓		
						✓		
Quezon City Station						✓		
							✓	
East Avenue Station		✓		✓		✓		
		✓						
Anonas Station		✓	✓					
		✓			✓	✓		
Katipunan Station						✓		
						✓		
Ortigas North Station		✓						
		✓		✓		✓		
Ortigas South Station		✓						
		✓		✓				
Kalayaan Station		✓						
						✓	✓	
BGC Station		✓		✓				
							✓	
Lawton East Station			✓			✓		
				✓		✓		✓
Lawton West Station						✓		
				✓		✓		✓
Terminal 3 Station		✓		✓				
						✓		
FTI Station			✓	✓				
		✓		✓				

2.1.1.2 Impact on compatibility with classification as Environmentally Critical Area (ECA)

The nearest Protected Area from the MMSP is the Ninoy Aquino Parks and Wildlife Center (NAPWC), which is tagged as a "Protected Area in the Heart of Quezon City". NAPWC was included in the list of Protected Areas under the National Integrated Protected Areas System (NIPAS) or R.A. 7586 upon its declaration in 2004 pursuant to Proclamation no. 723. The 23.8-hectare NAPWC is approximately 740 meters north-east of MMSP (BMB-DENR, undated).

It was stated from Bureau (2015) that NAPWC being a prime ecotourism is the vision for declaring the area as a PA. Ecotourism site that is consists of activities like biodiversity conservation and education on Philippine endemic and rare wild flora. For years, NAPWC served as a venue utilized for special, social, and educational activities. It also houses a few biodiversity of flora and fauna consisting of several recorded species such as trees and shrubs, birds, reptiles, fish, mammals, and amphibians. The conservation center also serves as a Wildlife Rescue Center where abandoned, donated, rescued, and confiscated wildlife were placed.

Figure 2.1-19 is a map showing the relative distance of the MMSP to the NAPWC. The distance of the MMSP to the protected area is around 740 meters southwest north-east away from MMSP. The nearest station would be the Quezon Ave. station. Looking at the land use, MMSP has no significant impact on the declared protected area. There is no planned development related to the project that would affect the ecology of the protected area in relation to land use.

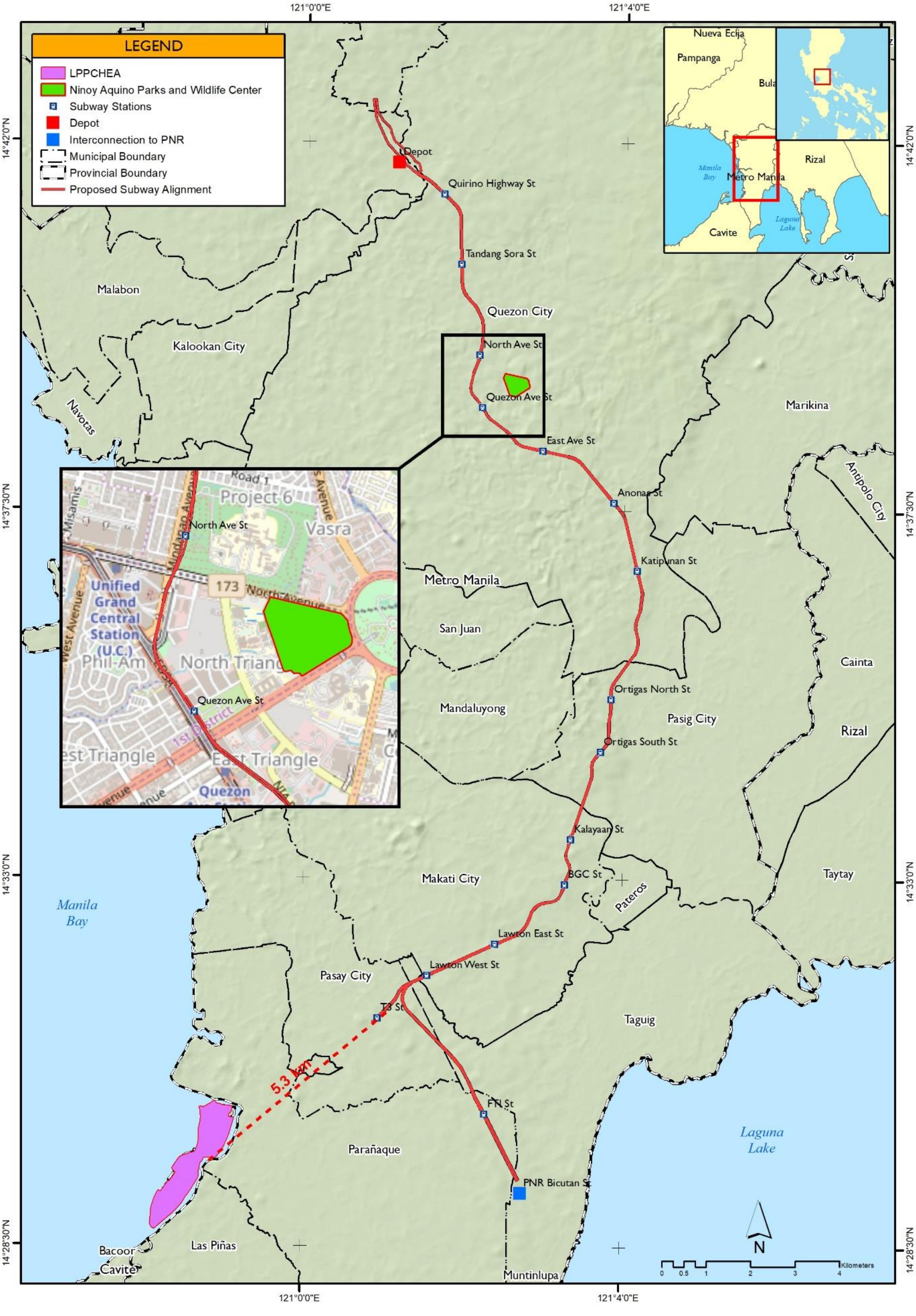


Figure 2.1-19 Protected Area Location Map

The Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA) is about 5.3 km (south-west) away from the MMSP NAIA Terminal 3 Station. It is a bird and mangrove sanctuary located at the boundary of Las Piñas and Parañaque. A number of distinct bird and mangrove species can be found in the area. Because of its rich biodiversity, also being the last of the kind within the area, LPPCHEA is declared as a Critical Habitat as mandated by Proclamation no. 1412 as amended in 2007. Its survival as a biodiversity sanctuary surrounded by a massive urbanization, LPPCHEA is also recognized as a Wetland of International Importance by Ramsar Convention in 2013 (DENR-NCR, Undated).

A study conducted in 2015 done by CTI Engineering Co. Ltd. about the Pre-feasibility Study of the Parañaque Spillway stating about the then planned Mega Manila Subway Project. It was stated that the planned subway project has supposedly no influence on the Parañaque Spillway of which drainage facility has been opted to be located near LPPCHEA. Therefore, relating it to the recent MMSP EPRMP, gives a strong argument that the project has no influence over LPPCHEA (CTI Engineering Co., 2015). The river networks which may interconnect LPPCHEA with MMSP are the Maricaban Creek and Don Galo Creek, both has an outlet in Manila Bay thru LPPCHEA.

2.1.1.3 Impact in existing land tenure issue/s

The proposed MMSP is not under lands over CARP or CADC/CADT/CALC/CALT, nor IFMA/CBFMA, COC, MPSA nor other tenurial instruments and identify corresponding existing tenure issues. Informal settlers are evident to the vicinity of the area based from visual inspection, but not to the exact alignment nor within the Indirect Impact Area (IIA) of the project.

2.1.1.4 Impairment of visual aesthetics

With regards to the parks and recreational areas other than the determined Protected Area, it is part of Chapter 2.1.4 Terrestrial Ecology. The list of green spaces within the IIA and the corresponding approximate distances were discussed in the section. **Table 2.1-5** presents the approximate distances of each green spaces with respect to each of the stations specified. The construction of the stations has minimal to no effect on the specified green spaces. Based from the key plan. The design of each station box would be underground and only an entrance stairway connection from the underground to the ground-level will be developed.

Table 2.1-5 Green Spaces per MMSP Station

Component/Station	Nearest Green Space	Distance (meters)
Quezon Ave Station	Ninoy Aquino Parks and Wildlife Center	915
	Open Space corner EDSA and Quezon Ave.	198
North Ave Station	Veterans Memorial Medical Center	403
Lawton East Station	American Cemetery	1063
	Philippine Army Golf Course and Stadium	533
	Manila Polo Club	800
NAIA Terminal 3 Station	Villamor Air Base Golf Course	666
Depot	Holy Cross Memorial Park	1210
	Bagbag Cemetery	916
Katipunan Station	Camp Aguinaldo Golf Course	1394
Ortigas North Station	Wack Wack Golf and Country Club	1666

2.1.1.5 Devaluation of land value as a result of improper solid waste management and other related impacts

Zonal values may serve as a reference point for assessed value (as established by the LGU for real estate taxes, a purely LGU tax and important source of revenue) and fair market value (as determined by market forces). Zonal values do not necessarily reflect, in fact often not, market values which move faster than assessed and zonal values given current developments. However, the importance of zonal values lies on having a point of reference of in conservatively indicating the value of land considering utilization and prospective land use. Chapter 4 provides further discussion of zonal values and presents a representative spatial distribution in the vicinities potentially impacted by the project footprints.

2.1.1.6 Impacts on climate change mitigation

The National Climate Change Action Plan (2011-2028) is the country's primary basis when it comes to ensuring the climate change-resilient, eco-efficient and environment-friendly industries and services, and sustainable towns and cities. It is indicated that between climate change adaptation and land use development, majority of the urban areas in the country will be mixed-use, medium to high-density integrated land use. The action plan also enacts the promotion of implementing green building principles. With which the MMSP key plan (planned development) is proposing to develop specific use zones/areas into multi-purpose. This is with reference from Chapter 1 in the Project Description. Mixed-use development is part of proposed development in each of the MMSP stations. Station plazas would involve commercial, institutional, parks and green spaces. Through this plan it would demonstrate efficiency in utilization of the land/area. Thus, the efficient utilization of the area would promote efficiency in energy consumption, hence, reduction in greenhouse gases (GHGs) coming from the utilities of the building to be constructed and in creating GHG sinks in the form of the green spaces comprised of a diversity of flora (Manitoba Government, 2012) (Nolan, 2008).

It was also indicated that transport planning will have an eco-efficient design as incorporated to the development of new urban communities (Climate Change Commission, 2010). Mass transportation will support programs towards minimization of private cars in major public roads and highways. Minimization of private vehicles would help in the mitigation of the air pollution. The pollution from the combustion of car engines would be reduced if the people would be encouraged to opt mass transportation over driving personal vehicles. Furthermore, pollution is expected to be lessen with the promotion of an efficient mass transportation especially in the urban areas (Climate Change Commission - NICCDIES, 2018).

Also, mainstreaming climate change adaptation and mitigation in the key plan development of the MMSP stations would be of advantage. Green infrastructure (GI) will be one of the considerations in the visions for the station plaza and other components of the project development. Urban GI is the inclusion of the principles of the landscape ecology to the landscape and in planning the environment. Furthermore, GI can provide solutions with regards to water management and regaining natural water cycle (flood storage, improvement of rainwater infiltration, reduction of run-off, and improvement of water quality), urban heat island mitigation (green corridor, pervious surfaces green roofs and walls or tree planting) and land-cover-planning (Ramyar, 2017).

2.1.2 Geology, Geomorphology and Geohazards

2.1.2.1 Geology, Geomorphology and Geohazards

This section describes the geologic, geomorphologic and geohazard risk aspects associated with the project. Most of the discussion will focus on the characterization of the geology, geomorphology and geohazard risks present in the proposed project sites. Consistent with the government's thrust in ensuring disaster risk reduction (DRR) and climate change adaptation (CCA) of development projects, potential concerns and risks concerning geology and DRR/CAA will be presented. Finally, the proposed project's possible impacts on the sites' geology, geomorphology and geohazard vulnerability, and vice-versa, shall be enumerated together with measures to mitigate these impacts.

2.1.2.2 Methodology

Study Area

The study area covers the revised alignment of the MMSP, starting from the boundaries of Caloocan, Valenzuela and Quezon City in its northern end, passing through the cities of Mandaluyong, Pasig, Makati and Taguig, and terminating at two locations in Pasay and Parañaque cities.

Secondary Data Sources

Secondary information for literature review and subsequent data interpretation were gathered from various sources. Primary reference for this report is the September 2017 Environmental Impact Statement (EIS) of the MMSP. Discussions on geology are based on academic studies and reports from the Philippine Institute of Volcanology and Seismology (PHIVOLCS). Base maps for geomorphologic analysis were taken from the National Mapping Resource Information Administration (NAMRIA). The geohazard assessment references geologic hazard maps (e.g. flooding, rain-induced landslide, volcanic distribution, and active fault traces) released by PHIVOLCS, the Mines and Geosciences Bureau (MGB) and the National Operational Assessment of Hazards of the University of the Philippines (UP NOAH). Supplementary data sources, particularly the Earthquake Hazards Program of the United States Geological Survey (USGS), were used to provide further seismic characterization of the study area.

Field Surveys and Sampling Areas

This report was prepared using desktop review and interpretation of secondary data, particularly the 2017 EIS of MMSP. No firsthand geological fieldworks were conducted for this assessment.

Data Processing and Analysis

Historical Earthquake Distribution

A database of historical instrumental earthquakes (from 1900 to July 16, 2019) exceeding Magnitude (M) 5.0 within a radius of 200km around the project area, was downloaded from the USGS earthquake catalogue as a KMZ file, imported into the Google Earth Pro (v. 7.3.2.5776)) software, and plotted on the default Google Earth Pro base satellite image from Digital Globe and Maxar Technologies (dated May 14, 2019).

Ground Shaking Computation

To assess potential ground shaking intensities from identified earthquake generators (i.e. active faults) within the study area, Peak Ground Acceleration (PGA) values were computed for each identified fault structure. PGA values describe the amount of acceleration that a particle or object on the surface of the earth experiences as it moves irregularly during an earthquake. PGA values are calculated using the formula for ground attenuation devised by Fukushima and Tanaka (1990), as below:

log10A = 0.41M - log10(R + 0.032x100.41M) – 0.0034R + 1.30

where: A = mean of the peak acceleration from two horizontal components at each site (cm/sec2)
R = shortest distance between the project site and fault rupture or earthquake generator (km)
M = surface wave magnitude (or mean credible earthquake value from PHIVOLCS)

Relative Ground Acceleration is represented by the unitless function g. The average g is calculated from the resulting mean of peak acceleration represented by A, divided by the acceleration due to gravity constant. The mean of peak acceleration generally decreases for a particular area as its distance increases from the potential epicentre of an earthquake. This decrease also translates to a gradual reduction in g values as a particular area increases its distance from the same epicentre. Variations in the mean value of g are calculated based on the type of subsurface material underlying the study area, as different materials have different responses to the transmission of earthquake energy. Four general categories, namely Rock, Hard Soil, Medium Soil and Soft Soil were used to determine different response ranges in the study area.

Map Generation

Topographic, hydrographic and slope maps were generated using ArcMap from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (DEM) version 2. It maintains the GeoTIFF format and the same gridding structure as version 1, with 30-meter postings and 1 x 1degree tiles.

Rasterized thematic maps from other sources like PHIVOLCS, MGB and USGS were slightly enhanced and modified for aesthetics and visualization clarity. The content and integrity of the data these maps present remain unaltered.

Comparison to Relevant Regulatory Standards

At present, the MMSP is still in its Feasibility and Design stage—no construction for any of the proposed components has commenced yet. So far, the only groundworks conducted as part of the Feasibility stage are geotechnical borehole drillings performed at key locations along the target MMSP alignment. In terms of geology, geohazards and soils, there are no regulatory standards set for future monitoring parameters. Instead, guidelines are in place to ensure safety during the construction and operation phases of the project. These guidelines include structural design regulations under the National Building Code and National Structural Code of the Philippines. These codes provide standard protocols for on-site and laboratory testing and give guidance in the selection of appropriate variables and parameters for structural design. The most common compliance requirement related to geology, geohazards and soils is the submission of the

Engineering Geological and Geohazard Assessment Report (EGGAR) as per DENR Administrative Order No. 28 Series of 2000 and MGB Memorandum Circular No. 2000-33. Depending on impact and relevance to the existing environment, soil quality and geotechnical monitoring may be included in the project's Environmental Management and Monitoring Plan (EMMoP).

2.1.2.3 Baseline Environment

Summary of Findings

Table 2.1-6 Summary of field surveys and sampling activities – Geology, Geomorphology and Geohazards

Baseline Information	Key Findings and Conclusions
Topography	The MMSP alignment is located within the Central Plateau region of Metropolitan Manila, with elevations ranging from 6 – 54 masl and slope gradients of 0 – 8 %.
Hydrologic Setting	The MMSP alignment will cross at least 11 rivers and creeks, including major rivers like the Pasig River, San Juan River and the Tullahan River.
Geodynamic Setting	The MMSP alignment is located within a seismically active region of the Philippines affected by active subduction (Manila Trench), fault movement (West Valley Fault), and Recent volcanism (Taal Caldera, Mt. Pinatubo and Laguna Caldera).
Geology	The MMSP track will burrow through mostly Guadalupe Formation tuff underlain with up to 10 m residual soil along its alignment. The Vs30 model from PHIVOLCS shows that the East Avenue to Ortigas Stations has shear-wave velocities ranging from 760 – 1500 m/sec, indicating NHERP Site Class B (rock) condition. The rest of the alignment has Vs30 ranging from 360 – 760 m/s, indicating Class C (hard soil) condition.
Pedology	The soils along the Depot to Ortigas South Station belong to the Novaliches series, except for the Katipunan Station which is underlain with Marikina series soil. From the Kalayaan Station down to the NAIA T3 Station and Bicutan Interconnection, the soil cover belongs to the Guadalupe soil series. Both Novaliches and Guadalupe series soils are derived from Guadalupe Formation tuffs (Diliman Tuff member), while the Novaliches series soil developed from alluvial deposits within the Marikina Valley.
Structures	The MMSP alignment has been designed to avoid the known trace of the West Valley Fault. The alignment is closest to this fault along the segment from Ugong Norte to Capitol Commons in Pasig, with distances of 150 – 700 m. Initial borehole scan results show presence of structural defects such as joints, fractures, shears, etc. in each surveyed hole, indicating that the foundation is layered and non-massive.
Seismic Hazards	The MMSP alignment may experience ground shaking of 0.371 – 0.662 g caused by a Magnitude 7.2 movement of the West Valley Fault. This is equivalent to PEIS Intensity VIII (i.e. Very Destructive) shaking. Other potential strong earthquake generators are the East Valley Fault, Laguna – Banahaw Fault, Philippine Fault Zone (Infanta Segment) and the undetermined source of the 1863 Manila earthquake. Probabilistic Seismic Hazard Assessment, as presented in the Philippine Earthquake Model by PHIVOLCS, show 0.35 – 0.5 g shaking along the MMSP alignment with a 10% probability of exceedance in 50 years (i.e. 500-year return period). 0.45 – 0.7 g shaking along the alignment is predicted to have 5% probability of exceedance in 50 years (i.e. 2,500-year return period).

Baseline Information	Key Findings and Conclusions
	The MMSP alignment avoids the known trace of the West Valley Fault, so ground rupture resulting from its movement is unlikely along the track. However, unmapped buried splays of the fault may possibly be encountered while drilling. The MMSP alignment is founded on soil that is generally not susceptible to liquefaction. The exception is along the Pasig River crossing, which is highly susceptible to liquefaction. Most of the MMSP alignment lies within areas that are not susceptible to earthquake-induced landslide, except for segments between the Katipunan Avenue in Pasig and McKinley Parkway in Taguig. The MMSP alignment is not susceptible to tsunami due to its distance (3.8 km at the NAIA T3 Station and 1.9 km from the Bicutan Interconnection) and elevation (13 and 37 masl, respectively) from the coast.
Mass Movements	The MMSP alignment is located in areas that are not generally susceptible to landslide. A higher susceptibility rating (i.e. Low) is given to significant portions of the proposed alignment within Quezon City, from Quirino Highway Station down to Katipunan Station. The proposed stations in Pasig—Ortigas North Station and Ortigas South Station, also are within an area of Low rainfall-induced landslide susceptibility. The southern segment, from Kalayaan Station to FTI Station are not susceptible to landslide. The Depot is the component of the MMSP most susceptible to subsidence, as shown in the PSInSAR map indicating local subsidence in that area due to extensive groundwater extraction.
Hydrological Hazards	The MMSP alignment is located on areas that have generally No to Low flooding susceptibility, except along portions that intersect rivers and creeks where flooding susceptibility can be Moderate to High. Almost the entire segment from Ortigas North Station down to NAIA T3 and Bicutan are located in areas that have Low susceptibility to flooding. The MMSP alignment is not susceptible to coastal hazards such as storm surge, tsunami and sea level rise resulting from climate change or coastal subsidence due to its distance (3.8 km at the NAIA T3 Station and 1.9 km from the Bicutan Interconnection) and elevation (13 and 37 masl, respectively) from the coast.
Volcanic Hazards	The MMSP alignment can be affected by strong ground shaking, resulting from explosive eruptions of Taal Volcano. Being largely underground, it is not susceptible to ashfall.

Pre-Project Geology, Geomorphology and Geohazards Assessment (2017 EIS) and additional data for the EPRMP (2019)

Topography

Geomorphology

Metropolitan Manila is located within an isthmus in the south-central part of Luzon island. It is built upon alluvial deposits of the Pasig River, a tidal estuary that connects Laguna de Bay to Manila Bay, and volcanic deposits from ancient eruptions of Laguna Caldera and Taal Caldera. It rests on an extensive flood plain bounded by the Central Luzon Basin to the north, the volcanic piedmonts of Macolod Corridor to the south, Laguna de Bay and the rugged basement complex rocks of Rizal to the east, and Manila Bay to the west.

The geomorphology of Metropolitan Manila can be classified into three major forms (**Figure 2.1-20**) (Miura, Midorikawa, Fujimoto, Pacheco, & Yamanaka, 2008):

Coastal Lowland:

- A flat and low plain facing Manila Bay thick, with elevations ranging from 0 to 5 m. It is built from soft sand and clay deposits up to 40 m thick. Landforms associated with the Coastal Lowland include sand bars, back marshes, Pasig River deltas and reclaimed land.

Central Plateau:

- A north-south trending plateau with ground elevations ranging from 20 to 40 m. Its western side is generally lower compared to its eastern side. In its northwest portion, ground elevations range from 70 to over 100 m. The central part of the plateau is transected by the Pasig River; this is the narrowest portion of the plateau. It is built from stiff soils and volcanic deposits.

Marikina Valley:

- Wedged between the Central Plateau and the basement mountains of Rizal and Bulacan that form part of the Sierra Madre Range. Elevations range from 2 m near Laguna Lake at the southern end of the valley, to 30 m on its northern parts near Montalban, Rizal. Associated landforms include deltas, levees, and flood plains.
- The proposed alignment of the MMSP is located almost entirely within the Central Plateau area. It starts at the center in the Depot facility at the north end, and heads toward the eastern margin of the plateau in the southeast portion of Quezon City. It then goes southward towards north Parañaque, mostly following the eastern margin of the plateau. Only the proposed NAIA Terminal 3 Station lies outside the Central Plateau area, being located within the Coastal Lowland. Throughout its alignment, the terrain is generally flat to gently sloping.

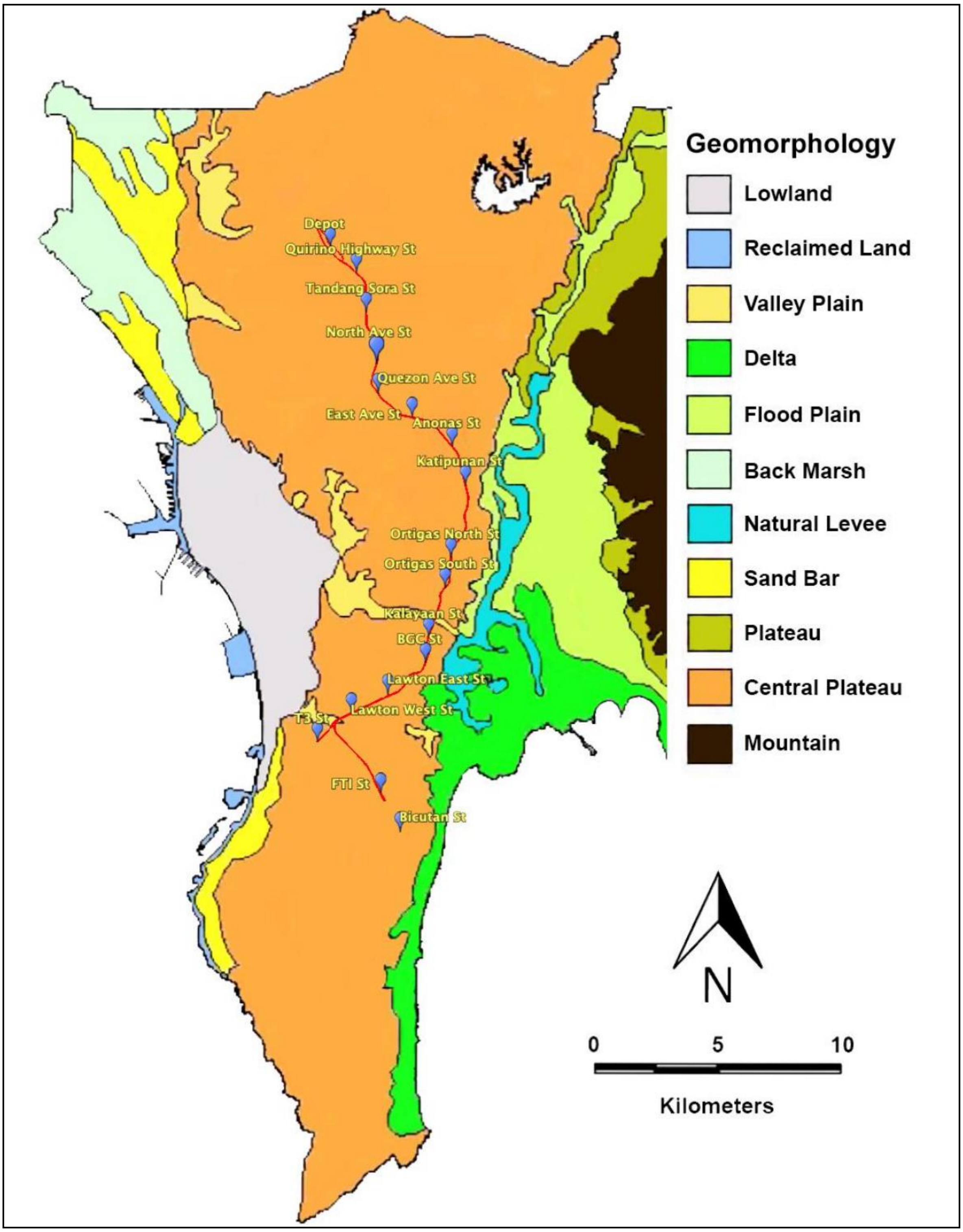


Figure 2.1-20 Geomorphologic classification of Metropolitan Manila (PHIVOLCS, und.)

Hydrologic Setting

Five major river systems traverse Metropolitan Manila: Tullahan River, San Juan River, Marikina River, Pasig River, and Parañaque River. The Tullahan River begins near La Mesa Dam in Quezon City and passes through the cities of Valenzuela and Malabon, ultimately draining into Manila Bay. The San Juan River starts as small tributaries in Culiat and Pasong Tamo, Quezon City. It traverses the central part of Quezon City, and terminates in Sta. Mesa, Manila. The Marikina River starts from the Sierra Madre Mountain in Rodriguez, Rizal and traverses the cities of Marikina, Quezon and Pasig. Both the San Juan and Marikina Rivers are tributaries of Pasig River that connect with it at points of around one-third and two-thirds of its course. Pasig River is the largest river in Metropolitan Manila that serves to drain the central portion of the region. It is the main drainage of Laguna Lake, starting from Napindian, Taguig and meandering through the cities of Pasig, Mandaluyong, Makati and Manila. It empties out into Manila Bay. Estuaries found in the southern parts of Metropolitan Manila, such as the Estero de Tripa de Gallina in the city of Parañaque, combine to form the Parañaque River, which also drains into the Manila Bay.

The track of the MMSP is expected to transect several rivers, creeks and waterways. The proposed Depot is located on the bank of the Tullahan River. It crosses the river as the alignment heads toward the Quirino Highway Station. Within the proposed location of the Quiriono Highway Station lies a creek, provisionally named Talipapa Creek, that is a tributary of the San Juan River. Another tributary of the San Juan River is intersected by the MMSP alignment between its Tandang Sora Station and the Quezon Avenue Station, provisionally named the Tandang Sora Creek. Between Tandang Sora Station and the North Avenue Station, the alignment intersects the San Juan River. About 350 m southeast of the San Juan River intersection is the Sto. Cristobal Creek, a tributary of the former. The alignment will cross another tributary of the San Juan River in Baranga Bagong Pag-Asa, between the North Avenue Station and the Quezon Avenue Station. Heading towards Anonas Station from the East Avenue Station, the MMSP will pass another tributary of the San Juan River called the Diliman Creek. It will next cross a tributary of the Marikina River in Corinthian Gardens, Pasig, between the Katipunan Station and the Ortigas North Station. Between the Ortigas North Station and the Ortigas South Station, the track cuts across a small creek, provisionally named San Antonio Creek. It will cross the Pasig River along its track between the Ortigas South Station and the Kalayaan Station. Lastly, the MMSP alignment between the Lawton West Station and the NAIA T3 Station will intersect the Maricaban Creek, a tributary of the Estero de Tripa de Gallina. The locations of the intersected waterways and their estimated channel width are listed in **Table 2.1-7**.

Table 2.1-7 Waterways transected by the proposed MMSP alignment

Name of Waterway	Track Segment	Latitude	Longitude	Channel Width (m)
Tullahan River	Depot – Quirino Highway	14.692783°	121.024280°	20
Talipapa Creek	Quirino Highway	14.689184°	121.028774°	6
Tandang Sora Creek	Quirino Highway – Tandang Sora	14.682211°	121.032007°	6
San Juan River	Tandang Sora – North Avenue	14.667118°	121.034738°	15
Sto. Cristobal Creek	Tandang Sora – North Avenue	14.664558°	121.034738°	6
Bagong Pag-Asa Creek	North Avenue – Quezon Avenue	14.648036°	121.036264°	6
Diliman Creek	East Avenue – Anonas	14.629388°	14.629388°	7
Corinthian Gardens Creek	Katipunan – Ortigas North	14.593588°	121.067233°	5
San Antonio Creek	Ortigas North – Ortigas South	14.582138°	121.063761°	7
Pasig River	Ortigas South – Kalayaan	14.565028°	121.058283°	100
Maricaban Creek	Lawton West – NAIA T3	14.528183°	121.022056°	4

Geographic Coordinate System: WGS 1984 Web Mercator

Elevation and Slope

Metropolitan Manila has elevations ranging from 0 masl, particularly along the Manila Bay and Laguna Lake coastlines, to 160 masl in the La Mesa Watershed in Quezon City. The elevation gradually rises eastward from the Manila Bay coastline to the edge of the Central Plateau, after which a sudden drop is observed along the Margin of the Marikina Valley. **Figure 2.1-21** shows the elevation map of Metropolitan Manila.

Despite the varying elevations, most of Metropolitan Manila is relatively flat to very gently sloping, having slope gradients that range from 0 to 8%. Patches of moderate slopes (18-30%) can be seen around Pasig River in Sta. Mesa, Manila and in Mandaluyong, San Juan, eastern Pasig and the southern part of Quezon City. **Figure 2.1-22** shows the slope map of Metropolitan Manila.

Elevations along the proposed alignment of the MMSP range from about 6 – 54 masl. The Lawton West Station has the lowest elevation at around 9 masl, while the East Avenue Station has the highest elevation at around 46 masl, among all stations. The slope along the entire alignment is very low, with gradients ranging from 0 to 8%. **Table 2.1-8** lists the elevation and slope based on ASTER DEM data. **Figure 2.1-23** shows the elevation profile of the proposed MMSP alignment.

Table 2.1-8 Elevation and slope in proposed MMSP stations

Station Name	Elevation (masl)	Slope (%)
Depot	14	0 – 8
Quirino Highway Station	38	
Tandang Sora Station	28	
North Avenue Station	29	
Quezon Avenue Station	30	
East Avenue Station	46	
Anonas Station	34	
Katipunan Station	36	
Ortigas North Station	33	
Ortigas South Station	39	
Kalayaan Station	22	
Bonifacio Global City (BGC) Station	25	
Lawton East Station	12	
Lawton West Station	9	
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	13	
Food Terminal Inc. (FTI) Station	22	
Bicutan Interconnection	37	

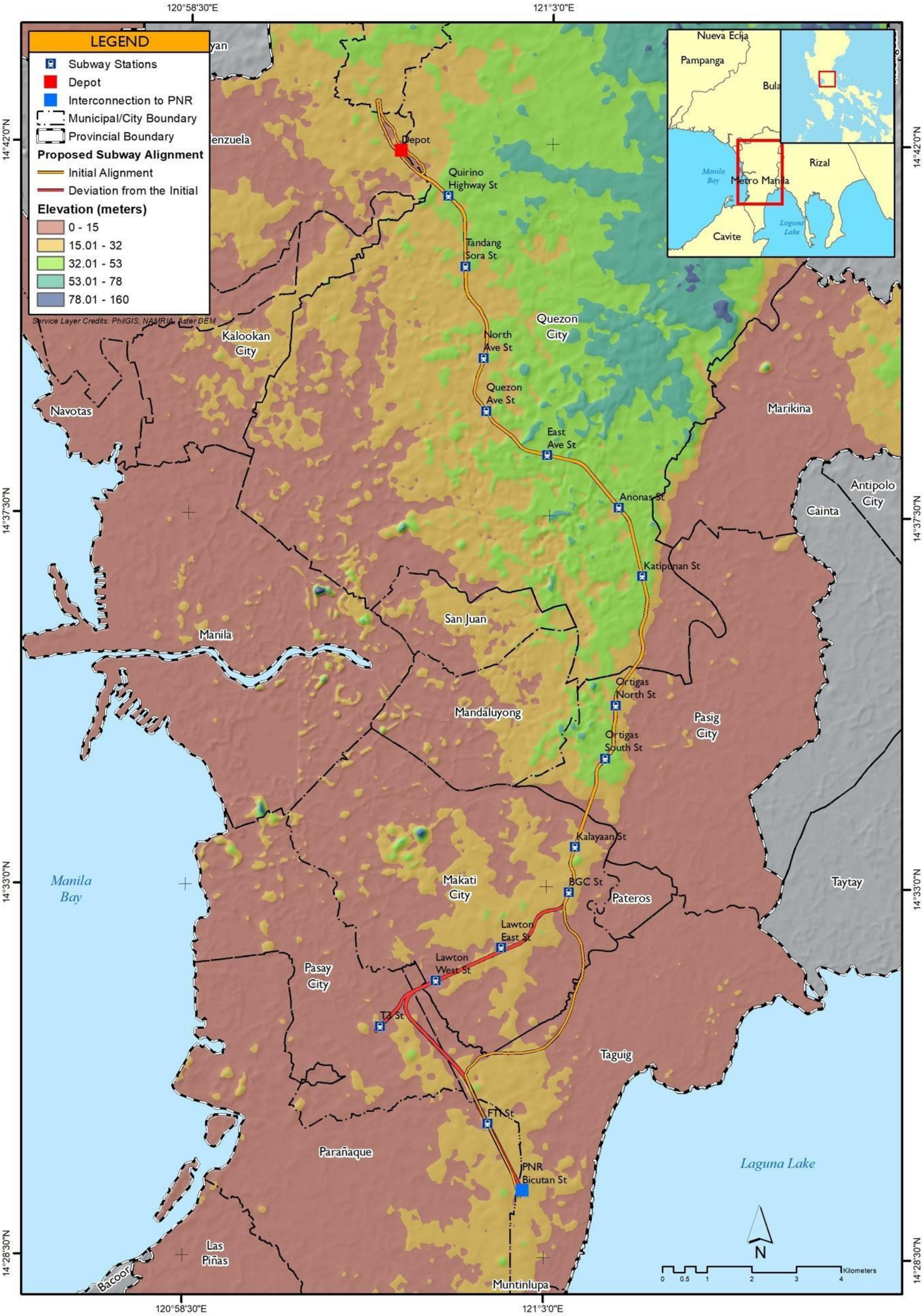


Figure 2.1-21 Elevation map of the proposed MMSP alignment

Figure 2.1-22 Slope map of the proposed MMSP alignment

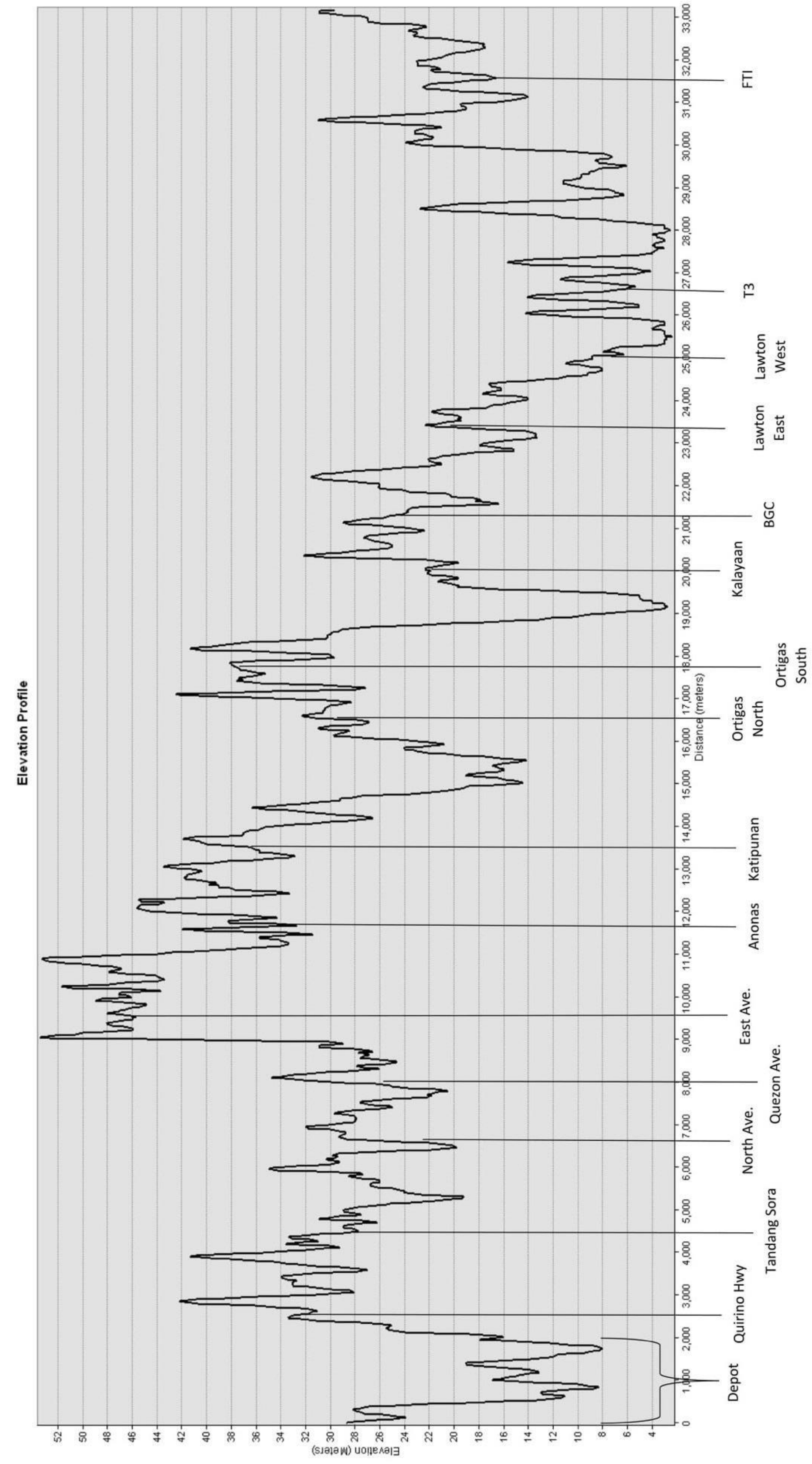


Figure 2.1-23 Elevation profile of the proposed MMSP alignment

Geodynamic Setting

Tectonism

Luzon island comprises the northern part of the geodynamically active Philippine Mobile Belt (PMB), a zone of complex system of collision zones, subduction zones, marginal sea basin openings (Gervasio, 1966) and a complex fault system that runs along the entire length of the Philippine archipelago.

Several collision zones along its eastern and western margins influence the PMB (**Figure 2.1-24**). The Philippine Trench, found along the Pacifica margin of the PMB, is an expression of the subduction-collision dynamics between the Philippine Sea Plate and the PMB (Hamburger, Cardwell, & Isacks, 1983; Cardwell, Isacks, & Karig, 1980; Fitch, 1972). A short subduction zone called the East Luzon Trough, located east of northern Luzon, is considered as the northward continuity of the Philippine Trench. The latter is separated from the main trace of the Philippine Trench by what is attributed to be the East-West Transform Fault (Hamburger, Cardwell, & Isacks, 1983). The convergence angle between the Philippine Trench and PMB varies from nearly westward in the southern PMB, to northwestward near its northern termination in Southeast (SE) Luzon (Hamburger, Galgana, Bacolcol, McCaffrey, & Yu, 2010), with ~50 mm/yr of oblique convergence observed (Hamburger, et al., 2014). On the western margin are the Manila Trench, the North Palawan Continental block, the Negros Trench and the Panay Trench. The Manila Trench delineates the subduction of the South China Sea Basin under the Luzon Arc (Karig, 1973). The North Palawan Continental Block converges with the southwestern Luzon portion of the PMB to form an arc-continent collision boundary (Stephan, et al., 1986; Marchadier, 1988; Rangin, Porth, & Müller, 1989a; Marchadier & Rangin, 1988; Marchadier & Rangin, 1990). The Sulu Sea Basin subducts beneath Negros and Panay islands to form the Negros Trench. Finally, the Cotabato Trench delineates the subduction of the Celebes Sea Basin underneath Mindanao island (Hayes & Taylor, 1978). The near-orthogonal convergence along the Manila Trench decreases southwards, from > 70 mm/yr near 19° N, to less than 20 mm/yr at its termination at Mindoro Island (~ 13° N) (Hamburger, Galgana, Bacolcol, McCaffrey, & Yu, 2010).

Active Volcanism

The active volcanic belts of the Philippines have been attributed to the subduction zones described previously (**Figure 2.1-24**). The volcanoes forming a chain along the length of the Bicol Peninsula, which include Mayon, Iriga and Bulusan, are part of the east Philippine Volcanic Arc that has been related to the subduction of the Philippine Sea Plate along the segment of the Philippine Trench (Aurelio, Tectonics of the Philippines revisited, 2000b) located ~ 210 – 280 km east of the peninsula. On the other hand, subduction of the South China Sea Basin along the Manila Trench caused the formation of a chain of active and inactive volcanoes dotting the western part of the archipelago. Known as the Central Luzon Volcanic Belt, it is further subdivided into smaller segments: (1) the Bataan Arc, which includes Pinatubo, Natib, Mariveles, Arayat, Palay-palay, and Batulao volcanoes; (2) Mindoro Arc, which includes the Laguna de Bay Complex, San Cristobal, Banahaw (older eruptions) and Malindig (or Marlanga) volcanoes, and (3) the Macolod Corridor, which includes Taal Volcano and Caldera, Laguna Celdera, Bulalo volcano, and several monogenetic scoria cones and maar craters (Catane S. G., Taniguchi, Goto, Givero, & Mandanas, 2005). Macolod Corridor is a 40-km-long NE-SW-trending tectonic depression marked by young volcanism, which separates the NW-SE-trending Bataan and Mindoro Arcs. Geochemical analysis of Macolod Corridor lavas reveal chemical compositions different from the other two Central Luzon Belt sub-arcs. Several mechanisms have been proposed to explain the occurrence and behaviour of the Macolod Corridor volcanoes, ranging from subduction-related to a leaky transform fault (Davis, 1983) to pull-apart rifting (Defant, De Boer, & Oles, 1988). Radiocarbon dates collected for the Macolod Corridor points to 2.3 Ma as the earliest possible beginning of volcanism in the area (Oles, et al., 1991).

Fault Systems

Stretching for about 1,200 km from northwestern Luzon to eastern Mindanao is a complex system of strike-slip faults collectively known as the Philippine Fault (Willis, 1937) or Philippine Fault Zone (PFZ) (**Figure 2.1-25**). It has several segments: the Northern Segment spans from northwest Luzon to Lamon Bay; the Central Segment stretches from Bondoc Peninsula to Leyte, and; the Southern Segment which cuts along Eastern Mindanao southwards to Moluccas. Slip rate estimates vary: 24 mm/yr in Surigao (Aurelio, 2000a), ~22 – 36 mm/yr in the Central Visayas (Galgana, Hamburger, McCaffrey, Bacolcol, & Aurelio, 2007); and about 10 to 40 mm/yr in Luzon (Galgana, Hamburger, McCaffrey, Bacolcol, & Aurelio, 2007).

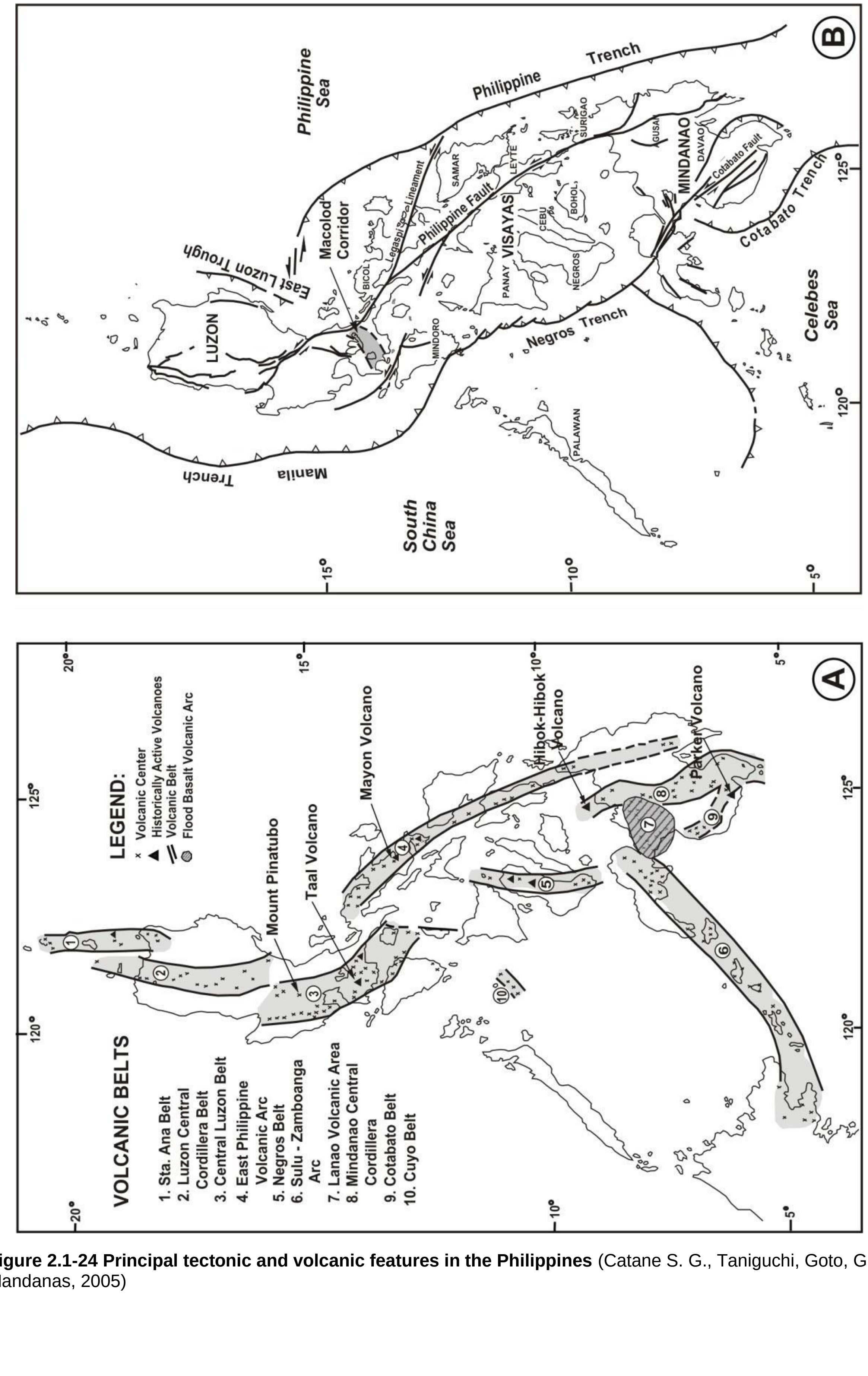


Figure 2.1-24 Principal tectonic and volcanic features in the Philippines (Catane S. G., Taniguchi, Goto, Givero, & Mandanas, 2005)

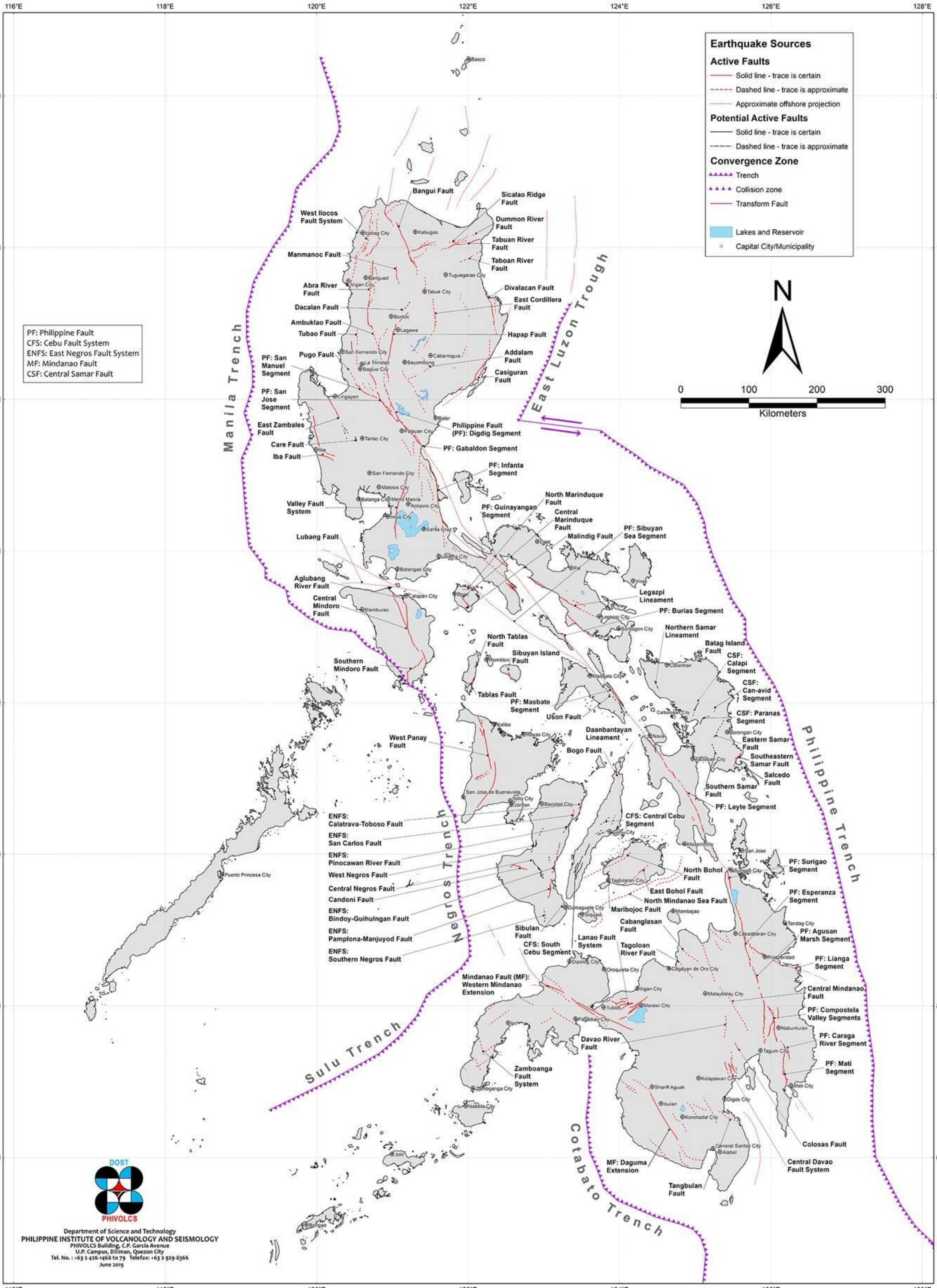


Figure 2.1-25 Distribution of active faults and trenches in the Philippines (PHIVOLCS, 2019)

2.1.2.4 Geology

Regional Geology

Metropolitan Manila, particularly in the Central Plateau region, is underlain by a thick sequence of rocks belonging to the Pleistocene (1.81 Ma) Guadalupe Formation. It is a horizontally bedded rock commonly referred to as "adobe" in the Philippines. It consists of well-laid rock formation of tuffaceous sandstone, tuffaceous siltsone and shale. Stratigraphucally, this formation consists of two members:

Alat Conglomerate:

An extensive belt of conglomerate, sandstone and mudstone that stretches from 3 km north of the Novaliches Reservoir to southeastern Nueva Ecija, with a maximum thickness of 200 m. The conglomerate sub-unit is massive, poorly-sorted with well-rounded pebbles and small boulders of older rocks—diorite, gabbro, basalt, andesite and limestone—cemented by coarse grained, calcareous and sandy matrix. The interbedded sandstone is massive to poorly bedded, tuffaceous, fine to medium grained, loosely cemented, friable, and exhibits cross bedding. The mudstone is medium to thin bedded, soft, silty and tuffaceous (Peña, 2008).

Diliman Tuff:

A 1,300 to 2,000 m-thick sequence of pyroclastic rocks that cover large portions of Pasig, Makati, southern Rizal province, and the area between Santa Maria and Balu Rivers in Bulacan. The sequence is flat-lying, medium to thin bedded, and consists for fine grained vitric tuffs and welded pyroclastic breccias with minor fine to medium grained tuffaceous sandstone. Dispersed in the glassy tuff matrix are dark mafic minerals and bits of pumiceous and scoriaceous materials (Peña, 2008).

In Cavite, located south of the metropolis, Pleistocene to Holocene (0.0115 Ma) Taal Tuff overlies the Guadalupe Formation. It blankets the north-northwestern slopes of Tagatay Ridge, having a maximum thickness of about 200 m near the Tagaytay Ridge that tapers at lower elevations. The Taal Tuff formation is composed of mostly scoria tuff, pumice tuff and andesite lava, all eruptive products of Taal Caldera. Within Metropolitan Manila, the Diliman Tuff member of the Guadalupe Formation is overlain by the Manila Formation, a Holocene sequence of unconsolidated fluvial, deltaic and marine deposits consisting of clay, silt, gravelly sand and tuffaceous silt (Peña, 2008).

The Coastal Lowland and Marikina Valley are underlain with unconsolidated sediments comprising the Quaternary alluvium. In Manila, Caloocan, Pasig, Pasay and Taguig, borehole data indicate its composition of interbeds of sandstone-siltstone-mudstone and channel-fill conglomerates with or without shell fragments. In Marikina, unconsolidated alluvial deposits comprised of clay, silt and sand underlay most of the city (CTI Engineering International Co., Ltd., 2010).

A map of the regional geology of Metropolitan Manila is shown in **Figure 2.1-26**. A regional stratigraphic column is shown in **Figure 2.1-27**.

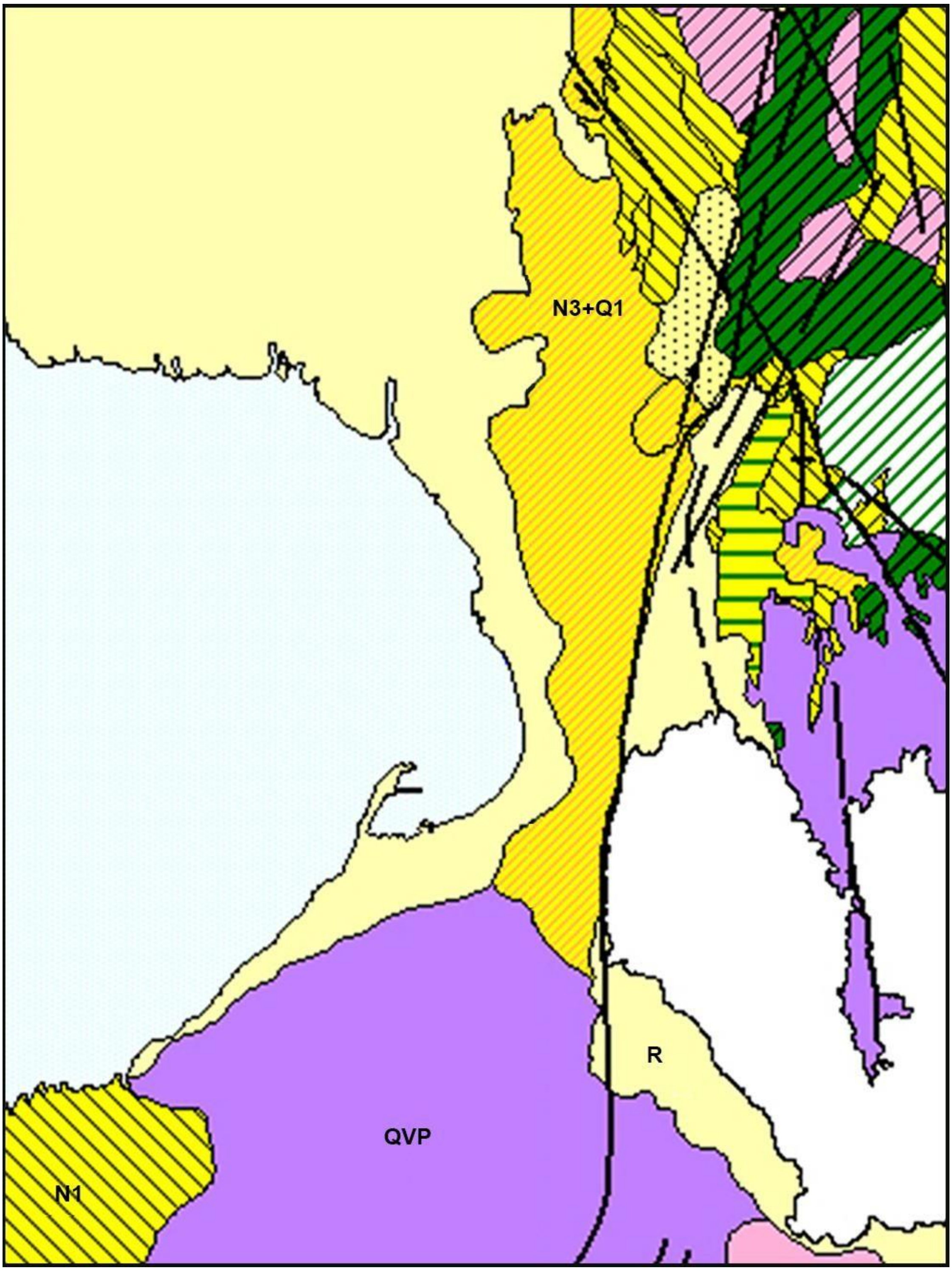
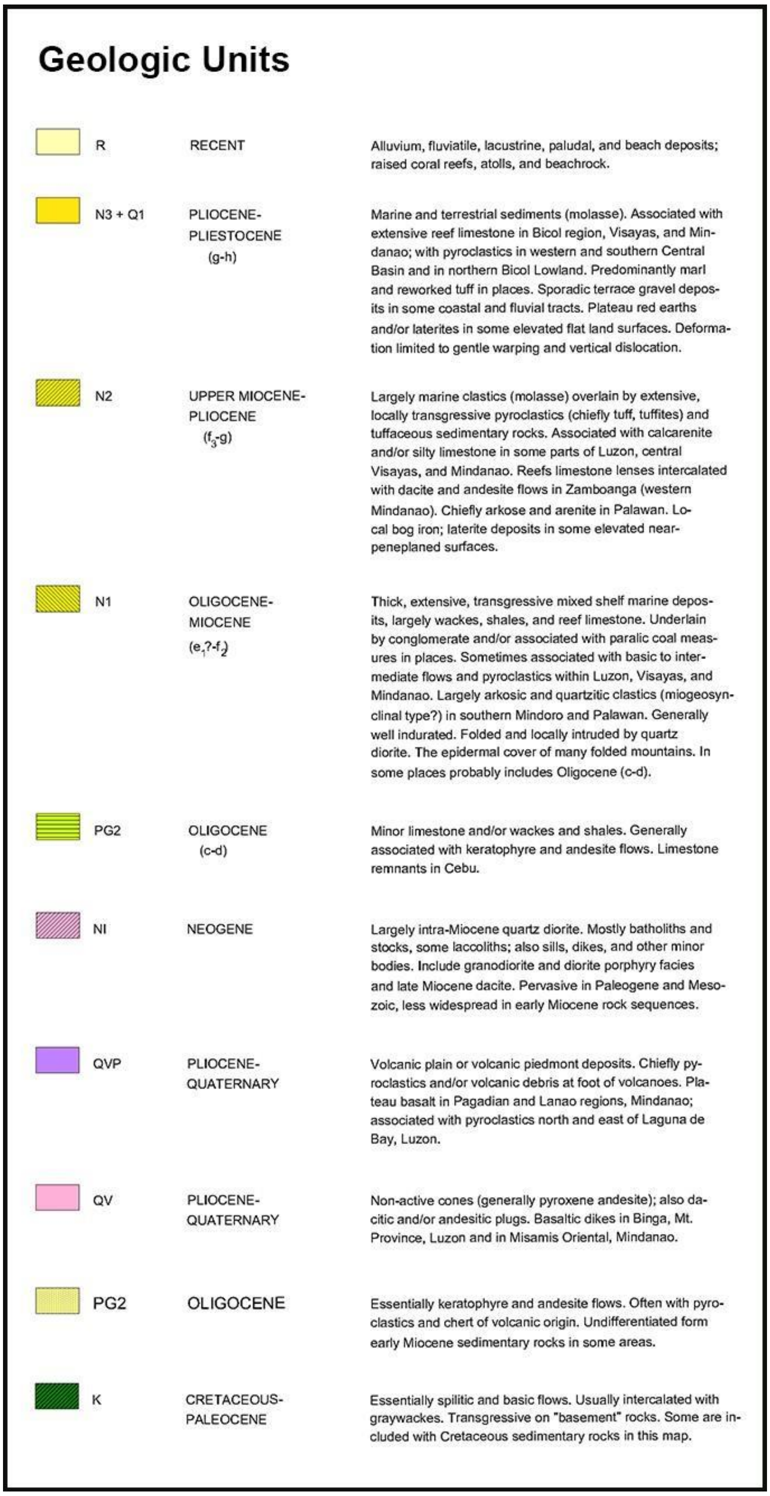


Figure 2.1-26 Regional geologic map of Metropolitan Manila (Mines and Geosciences Bureau, 1963)



Geologic Units

R	RECENT	Alluvium, fluviatile, lacustrine, paludal, and beach deposits; raised coral reefs, atolls, and beachrock.
N3 + Q1	PLIOCENE-PLIESTOCENE (g-h)	Marine and terrestrial sediments (molasse). Associated with extensive reef limestone in Bicol region, Visayas, and Mindanao; with pyroclastics in western and southern Central Basin and in northern Bicol Lowland. Predominantly marl and reworked tuff in places. Sporadic terrace gravel deposits in some coastal and fluvial tracts. Plateau red earths and/or laterites in some elevated flat land surfaces. Deformation limited to gentle warping and vertical dislocation.
N2	UPPER MIOCENE-PLIOCENE (f_3-g)	Largely marine clastics (molasse) overlain by extensive, locally transgressive pyroclastics (chiefly tuff, tuffites) and tuffaceous sedimentary rocks. Associated with calcarenite and/or silty limestone in some parts of Luzon, central Visayas, and Mindanao. Reefs limestone lenses intercalated with dacite and andesite flows in Zamboanga (western Mindanao). Chiefly arkose and arenite in Palawan. Local bog iron; laterite deposits in some elevated near-peneplaned surfaces.
N1	OLIGOCENE-MIOCENE (e_1?-f_2)	Thick, extensive, transgressive mixed shelf marine deposits, largely wackes, shales, and reef limestone. Underlain by conglomerate and/or associated with paralic coal measures in places. Sometimes associated with basic to intermediate flows and pyroclastics within Luzon, Visayas, and Mindanao. Largely arkosic and quartzitic clastics (miogeosynclinal type?) in southern Mindoro and Palawan. Generally well indurated. Folded and locally intruded by quartz diorite. The epidermal cover of many folded mountains. In some places probably includes Oligocene (c-d).
PG2	OLIGOCENE (c-d)	Minor limestone and/or wackes and shales. Generally associated with keratophyre and andesite flows. Limestone remnants in Cebu.
NI	NEOGENE	Largely intra-Miocene quartz diorite. Mostly batholiths and stocks, some laccoliths; also sills, dikes, and other minor bodies. Include granodiorite and diorite porphyry facies and late Miocene dacite. Pervasive in Paleogene and Mesozoic, less widespread in early Miocene rock sequences.
QVP	PLIOCENE-QUATERNARY	Volcanic plain or volcanic piedmont deposits. Chiefly pyroclastics and/or volcanic debris at foot of volcanoes. Plateau basalt in Pagadian and Lanao regions, Mindanao; associated with pyroclastics north and east of Laguna de Bay, Luzon.
QV	PLIOCENE-QUATERNARY	Non-active cones (generally pyroxene andesite); also dacitic and/or andesitic plugs. Basaltic dikes in Binga, Mt. Province, Luzon and in Misamis Oriental, Mindanao.
PG2	OLIGOCENE	Essentially keratophyre and andesite flows. Often with pyroclastics and chert of volcanic origin. Undifferentiated form early Miocene sedimentary rocks in some areas.
K	CRETACEOUS-PALEOCENE	Essentially spilitic and basic flows. Usually intercalated with graywackes. Transgressive on "basement" rocks. Some are included with Cretaceous sedimentary rocks in this map.

Figure 2.1-26 (continued) Legend of regional geologic map of Metropolitan Manila (Mines and Geosciences Bureau, 1963)

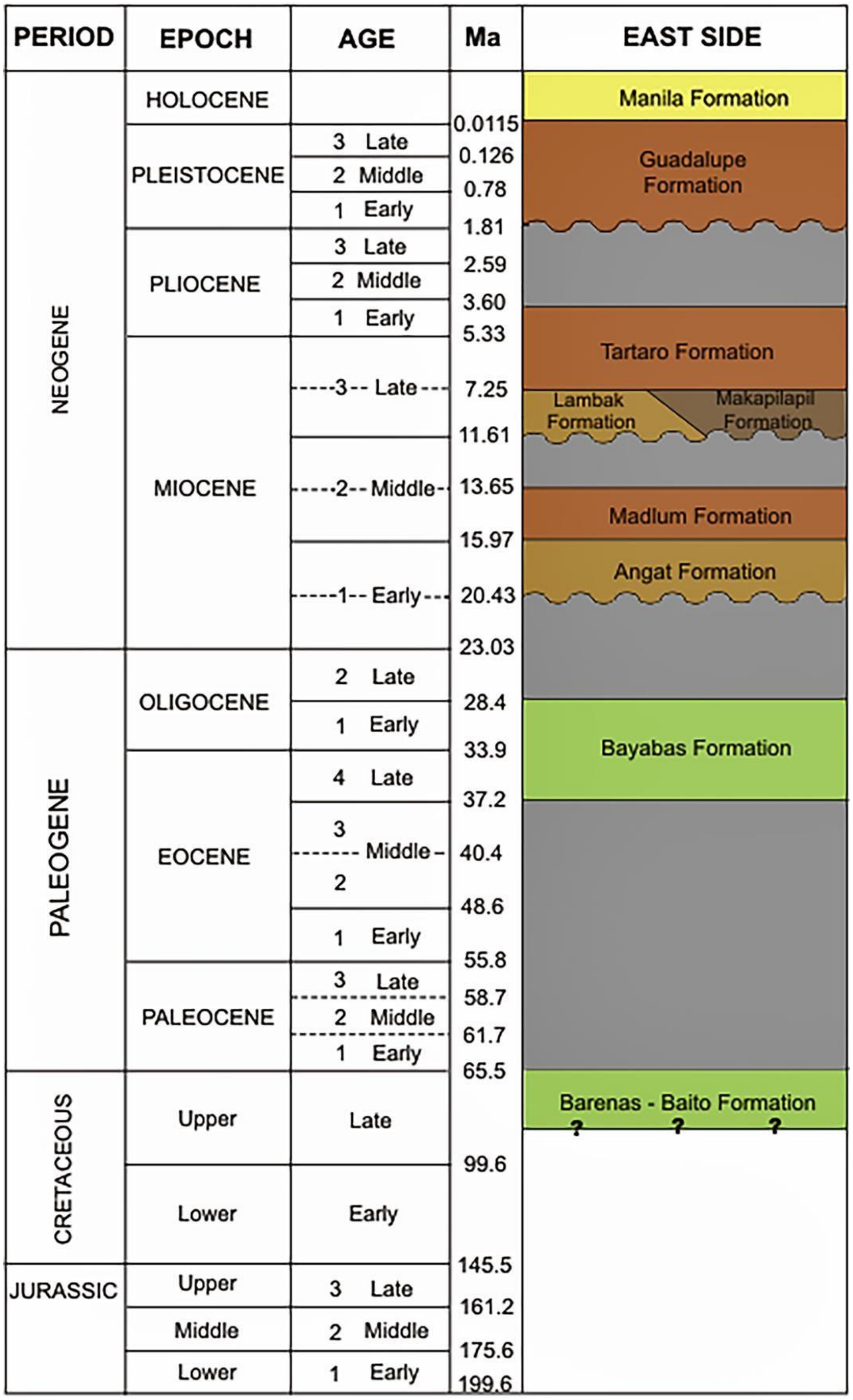


Figure 2.1-27 Regional stratigraphic column of Metropolitan Manila (Mines and Geosciences Bureau, 1963)

Regional Structures

Prominent structural features found around Metropolitan Manila influence the present geological configuration of the area.

The active Valley Fault System (VFS) is a curvilinear structure composed of two subparallel NE-trending dextral faults dipping towards each other and running southwesterly from the foothills of the Sierra Madre Mountain Range in Montalban, Rizal, towards western lobe of Laguna Lake: (1) the West Valley Fault, approximately 90 km long and runs from Montalban and passes along eastern Metropolitan Manila and the western lobe of Laguna de Bay until it terminates at the northeastern end of Tagaytay Ridge; and (2) the East Valley Fault, approximately 15 km long and runs from San Rafael, Rizal down to Montalban, going along the eastern side of Marikina Valley until it terminates in the Pasig area (**Figure 2.1-28**). Splays of the VFS have also been observed in numerous localities along its path, usually from deep excavations for building foundations. These buried faults are mostly unmapped and their activity status (i.e. active or inactive) is largely unknown.

South of the metropolis lies the Macolod Corridor, NNE-SSW-aligned corridor having a noticeable concentration of young volcanic features. Directly observable evidence of the existence of this structure however, is not clear. Only the NE-trending alignment of the Tagaytay Ridge was inferred as a morpho-structural expression of this feature (Mines and Geosciences Bureau, 2010).

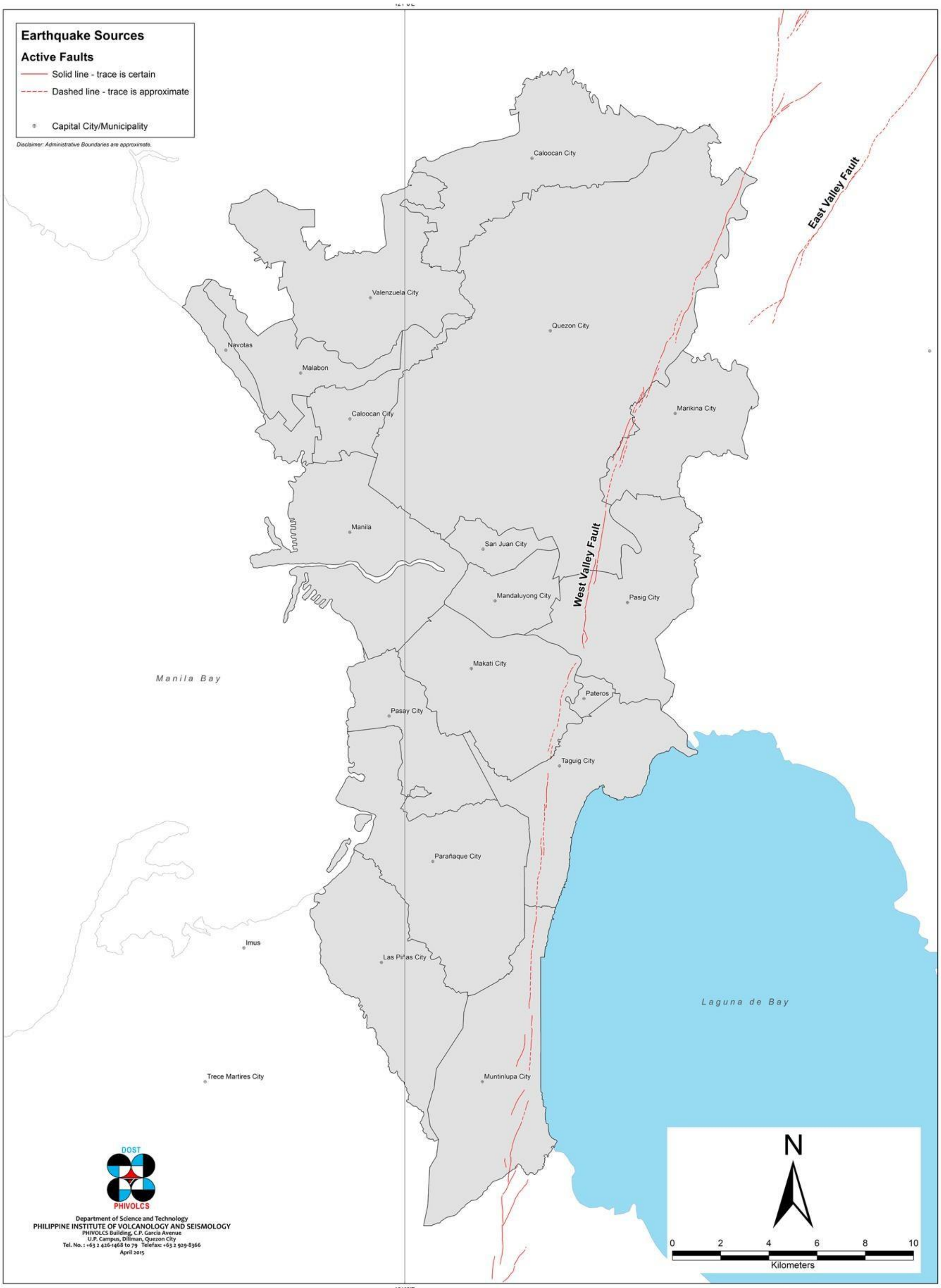


Figure 2.1-28 Distribution of active faults in Metropolitan Manila (PHIVOLCS, 2015)

Local Geology

Geotechnical drilling has been conducted along the proposed alignment of the MMSP to determine the physical properties of the soil and rock which the railway will burrow through. Based on borehole logging of drill cores, the generalized geology at each station are as follows (**Table 2.1-9**):

Table 2.1-9 Proximity of proposed MMSP stations to the Valley Fault System

Station Name	Formation	Residual Soil Mantle Thickness (m)	No. of Boreholes Drilled
Depot	Guadalupe (Tuff)	~ 1.5 – 3.0	10
		~ 3.0 – 6.0	15
Quirino Highway Station	Guadalupe (Tuff)	~ 1.5 – 3.0	4
Tandang Sora Station	Guadalupe (Tuff)	~ 1.5	5
		~ 4.5	1
North Avenue Station	Guadalupe (Tuff)	< 1.5	10
Quezon Avenue Station	Guadalupe (Tuff)	~ 1.5 – 7.25	3
		none	1
East Avenue Station	Guadalupe (Tuff)	~ 1.1 – 3.0	11
		none	1
Anonas Station	Guadalupe (Tuff)	~ 1.35 – 4.30	4
Katipunan Station	Guadalupe (Tuff)	~ 1.25 – 3.00	4
Ortigas North Station	Guadalupe (Tuff)	~ 1.25 – 1.50	3
Ortigas South Station	Guadalupe (Tuff)	~ 1.20 – 2.70	3
Kalayaan Station	Guadalupe (Tuff)	~ 1.0 – 1.5	4
		none	1
Bonifacio Global City (BGC) Station	?	~ 1.0 – 3.15	6
		none	1
Lawton East Station	Guadalupe (Tuff)	~ 1.5	3
Lawton West Station	Guadalupe (Tuff)	~ 1.5 – 4.25	4
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	?	?	not drilled
Food Terminal Inc. (FTI) Station	Guadalupe (Tuff)	1.19 – 10.15	12
		none	2
Bicutan Interconnection	?	?	not drilled

Local Structures

The VFS is the only active fault that passes through Metropolitan Manila identified and mapped by PHIVOLCS to some detail. However, several portions of the VFS—as represented by broken lines on the fault map—are only inferred, having no surface features to allow accurate mapping in these parts. Because of this, there is uncertainty on the position of actual rupture along these sections. In addition, there are numerous splays found throughout the metropolis, but these have only been largely encountered in deep excavations for building foundations. No detailed studies have been conducted for most of these buried faults, so their extent and activity are mostly unknown. Hence, as future drilling for the MMSP progresses, it is expected that some new and buried faults will be encountered.

For the purpose of design planning, one of the primary considerations in proposed building and infrastructure projects in Metropolitan Manila, is the proximity to the VFS. PHIVOLCS recommends a 5-meter buffer zone of avoidance from either side of the trace of VFS. The MMSP alignment has been designed to prevent intersecting any known segments of the VFS, as well as to allow sufficient distance from it. Based on the proposed alignment, the south-central line of the MMSP follows the general trace of the VFS, with distances ranging from 150 (Ugong Norte, Pasig) to 700 m (Capitol Commons, Pasig) to the west of the fault. It is along this segment of the MMSP alignment where it is closest to the VFS. **Table 2.1-10** lists the distance of each MMSP station (central location) from the VFS. Proximity maps of the MMSP stations that are less than 1 km from the known trace of the VFS are shown in **Figure 2.1-29** to **Figure 2.1-34**.

Table 2.1-10 Proximity of proposed MMSP stations to the Valley Fault System

Station Code	Station Name	Distance (km)
1	Depot	8.80
2	Quirino Highway Station	7.40
3	Tandang Sora Station	6.40
4	North Avenue Station	5.20
5	Quezon Avenue Station	4.80
6	East Avenue Station	3.20
7	Anonas Station	1.50
8	Katipunan Station	0.71
9	Ortigas North Station	0.64
10	Ortigas South Station	0.72
11	Kalayaan Station	0.87
12	Bonifacio Global City (BGC) Station	0.64
13	Lawton East Station	1.80
14	Lawton West Station	3.00
15	Ninoy Aquino International Airport (NAIA) Terminal 3 Station	4.30
16	Food Terminal Inc. (FTI) Station	1.60
17	Bicutan Interconnection	0.72

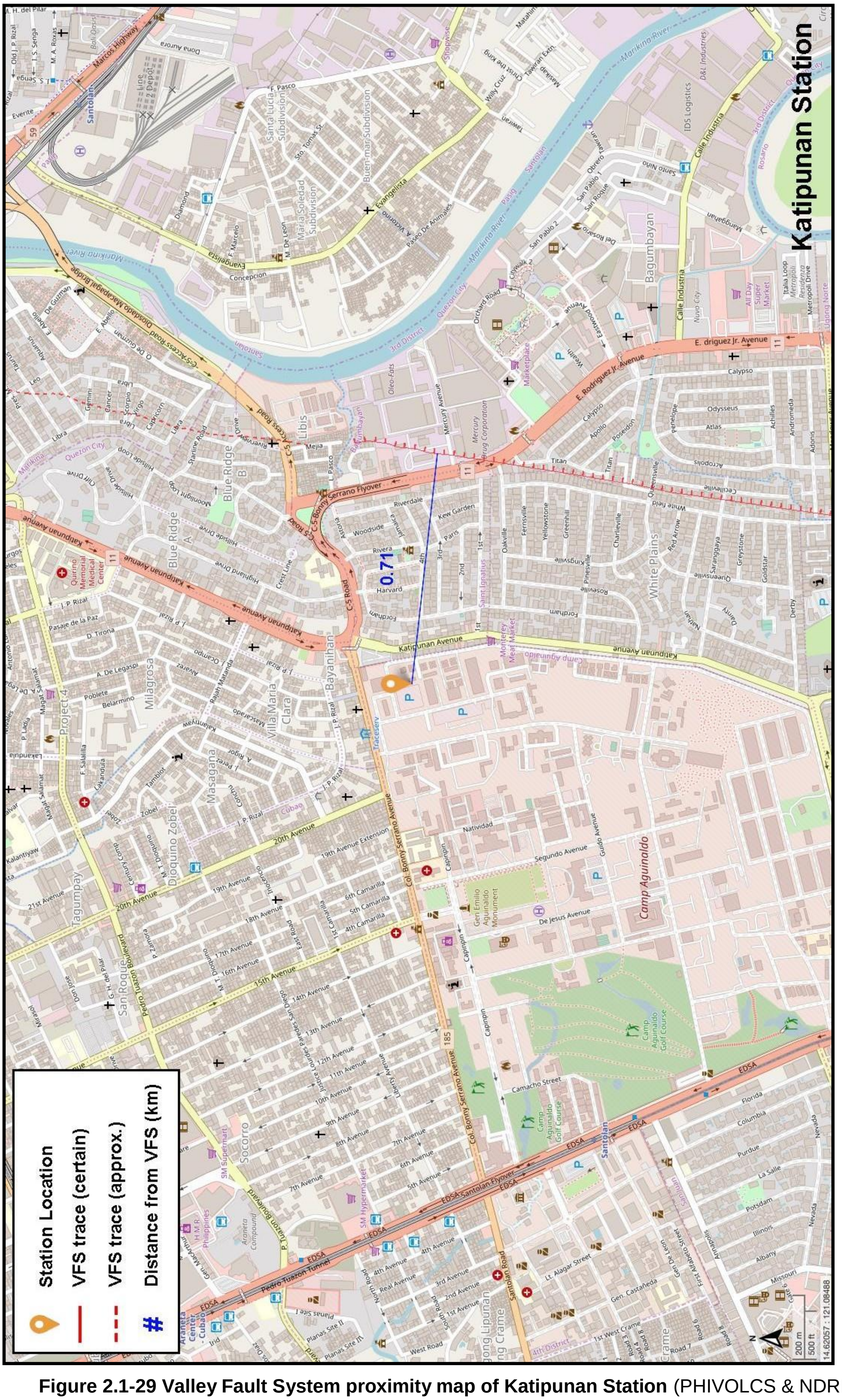


Figure 2.1-29 Valley Fault System proximity map of Katipunan Station (PHIVOLCS & NDRMMC, 2015)

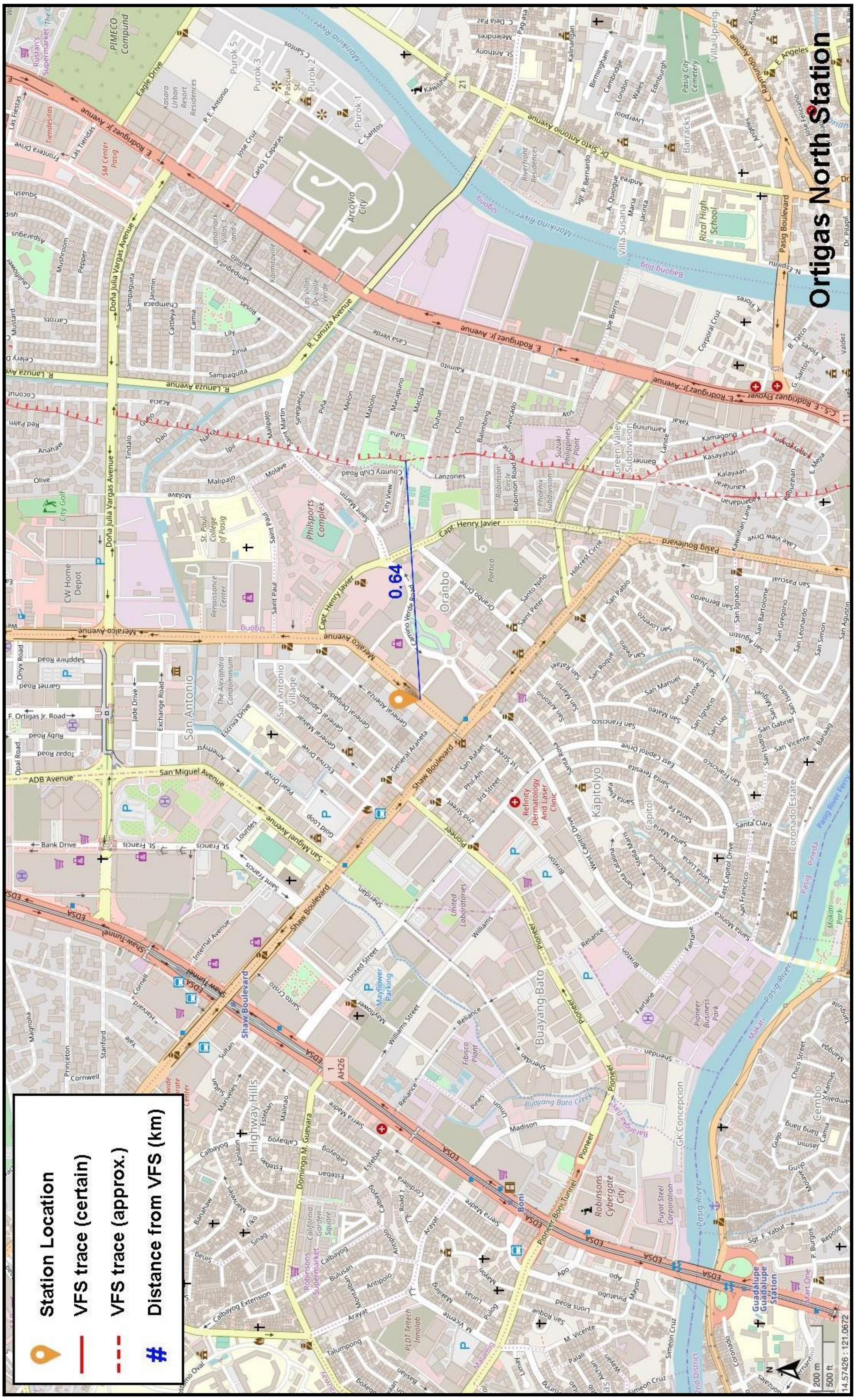


Figure 2.1-30 Valley Fault System proximity map of Ortigas North Station (PHIVOLCS & NDRMMC, 2015)

Figure 2.1-31 Valley Fault System proximity map of Ortigas South Station (PHIVOLCS & NDRMMC, 2015)

Figure 2.1-32 Valley Fault System proximity map of Kalayaan Station (PHIVOLCS & NDRMMC, 2015)

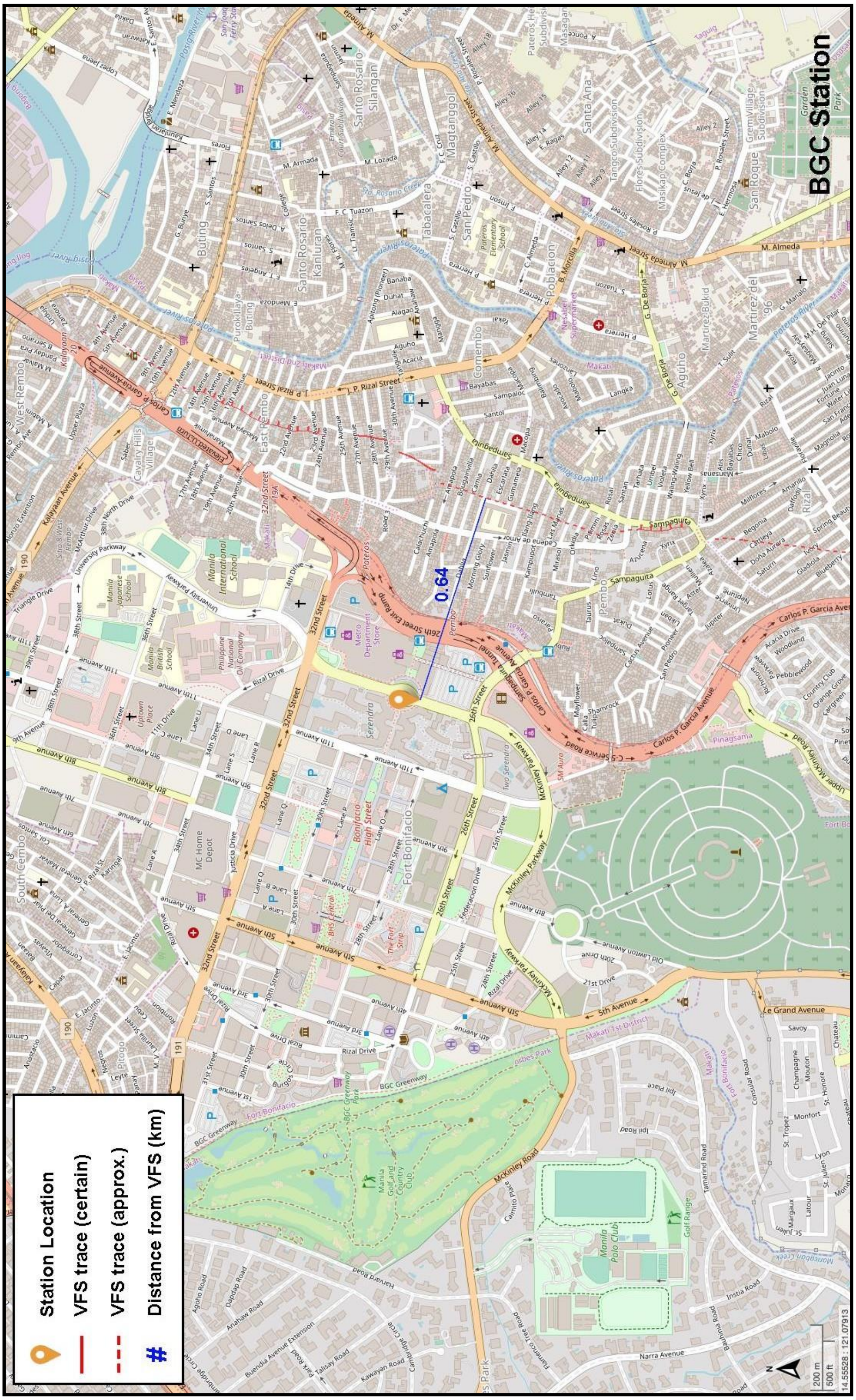


Figure 2.1-33 Valley Fault System proximity map of BGC Station (PHIVOLCS & NDRMMC, 2015)

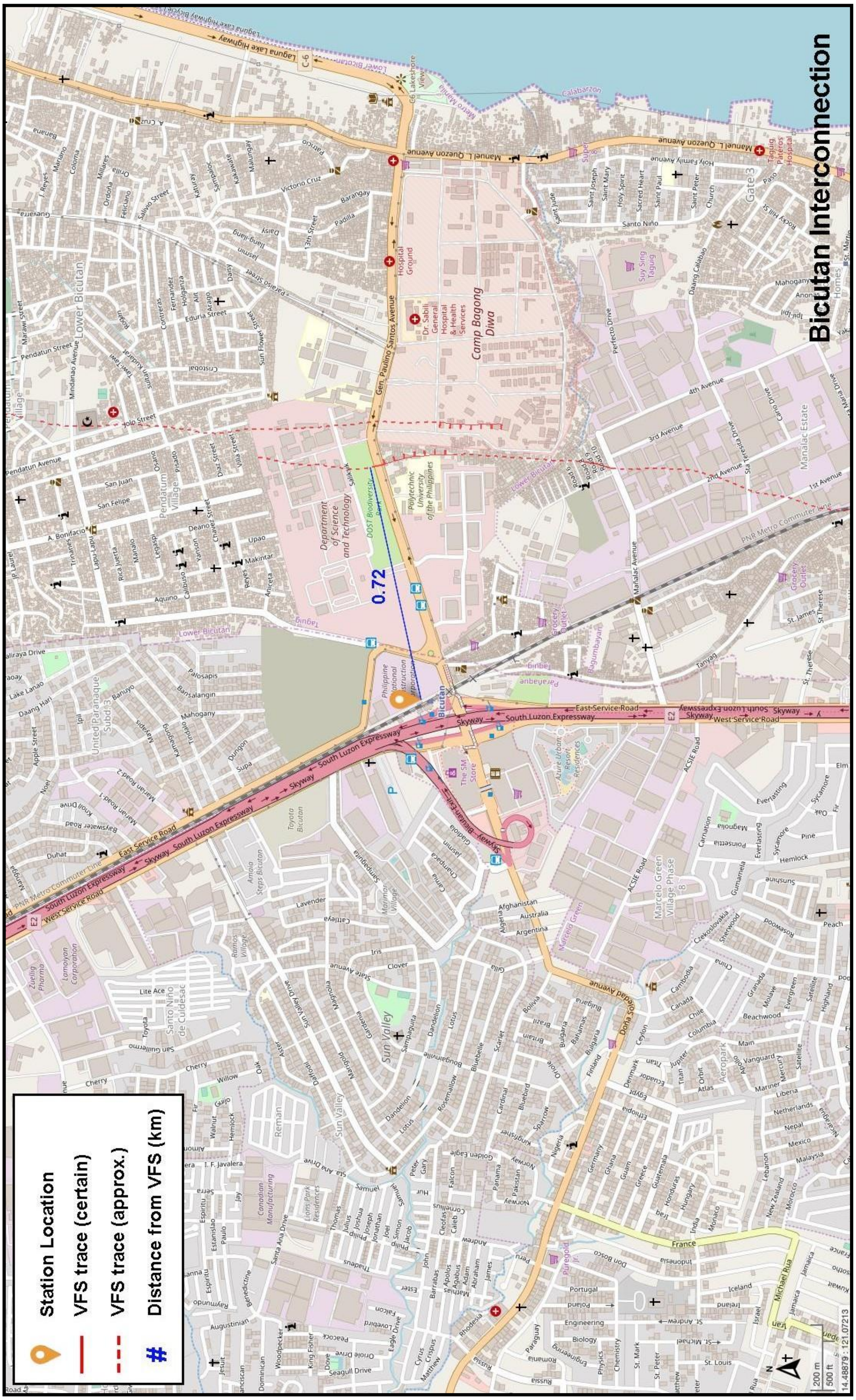


Figure 2.1-34 Valley Fault System proximity map of Bicutan Interconnection (PHIVOLCS & NDRMMC, 2015)

Borehole scanning of 14 holes was initially performed to get a better grasp of the underlying rock mass, including hardness, distribution and strike/dip of cracks. Downhole data was acquired using Acoustic Televiewer (ATV) and Optical Televiewer (OTV) and processed to identify and measure the orientation of structural defects, such as bedding planes, bedding fractures, joints, shears, fracture zones, etc. This, in turn, can be used to interpret the presence of buried faults that may be intersected by the proposed alignment. The results of the borehole scanning survey is still preliminary as detailed geotechnical investigations are still ongoing.

So far, the interpretations provided in the borehole scanning reports are limited to each specific hole. No correlative or comprehensive interpretation, i.e. the presence of continuous structural defects across several boreholes, have been presented yet. But based on the initial results, joints, shears, bedding planes and fractured zones can be seen scattered throughout each borehole, indicating that the bedrock is layered and non-massive. An example of a borehole scan is shown in **Figure 2.1-35**.

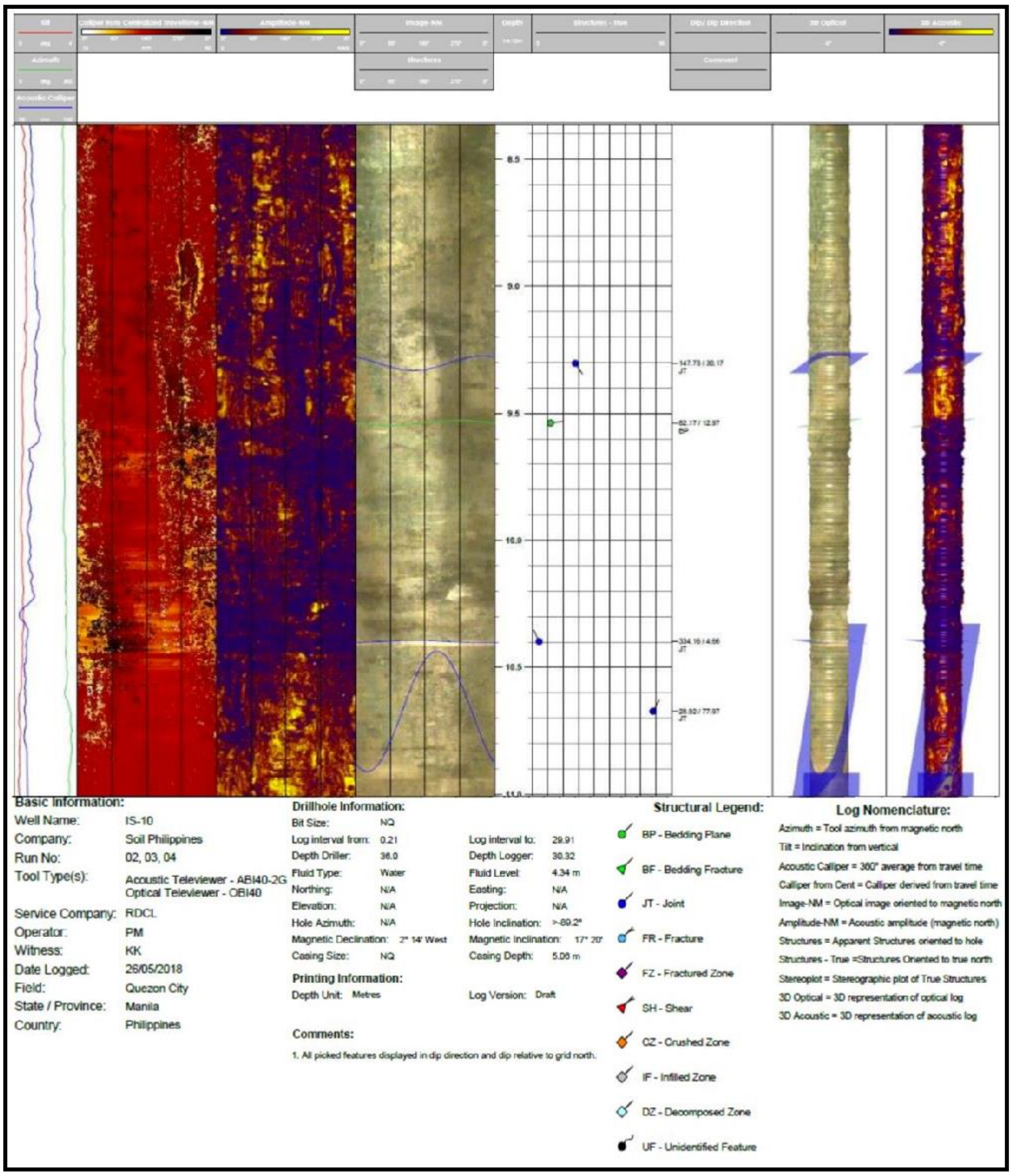


Figure 2.1-35 Borehole scan of IS-10 (between Depot and Quirino Highway Station)

2.1.3 Pedology

Soils in the Central Plateau region of Metropolitan Manila are mostly derived from volcanic tuff belonging to the Guadalupe formation which underlies the area, while soils within the Marikina Valley developed mostly from alluvial deposits. Along the proposed alignment of the MMSP, there are three soil series: Novaliches, Marikina and Guadalupe.

Novaliches soils are found on undulating to rolling dissected tuffaceous plateau. They are derived from volcanic tuff. Novaliches series are classified as fine, mixed, isohyperthermic Typic Eutropepts. It consists of moderately deep well-drained clayey soils. It has a surface layer of about 10-20 cm thickness, and has very dark brown, dark grayish brown, grayish brown clay or clay loam. The subsoil reaches down to a depth from 50 to 70 cm, and is a dark browm or brown, sticky, plastic, firm clay or clay loam with a few to common weathered tuffaceeous rock fragments. The substratum below 50 – 100 cm is dark grayish brown, pale gray, brownish yellow clay or clay loam, with yellowish brown mottles and partially weathered rock fragments that become strongly weathered down the profile. Below the substratum is hard volcanic tuff (Carating, Galanta, & Bacatio, 2014).

The Marikina series is a member of the fine, mixed, isohyperthermic family of UdorthenticChromusterts. The soils are deep, somewhat poorly drained occurring on level to nearly level (0.0–2.0 % slopes) minor alluvial plain. The A horizon, not more than 30 cm thick, is gray, light gray to gray, greenish gray clay with strong brown yellowish red, brown to dark brown mottles. Mottling is an indication of fluctuating water table. The cambic B-horizon is yellowish brown, dark yellowish brown, brown to dark brown, grayish brown clay with distinct clear gray, dark gray, light olive gray, or yellowish-brown mottles. Few thin continuous and discontinuous slickensides commonly occur. Few soft iron manganese concretions and highly weathered tuffaceous fragments occur with increasing depth. The C-horizon below 100–150 cm depth is dark yellowish brown or yellowish-brown clay. There are also mottles here, brown, dark brown, strong brown, or gray in color. Few small iron manganese concretions and highly tuffaceous fragments can be found. Few thin discontinuous slickensides sometimes occur in the C-horizon. The Marikina series is derived from allivual deposits and occur on level to nearly level minor alluvial plains. Marikina soils are somewhat poorly drained or have lighter color. They have slow permeability, so the external drainage is poor and the internal drainage is somewhat poor, which makes it suitable for growing rice (Carating, Galanta, & Bacatio, 2014).

Guadalupe series is residual soil of water laid volcanic tuff. These soils are generally found on rolling to gently rolling areas of volcanic footslopes but they are also found on some flat areas of slightly degraded tuffaceous plains of the residual volcanic footslopes. Often times, these Guadalupe soil series on volcanic plains are extinct, buried by urban development and industrialization. The soil was first described in barangay Guadalupe, what is now Makati City. The Guadalupe series in lowland rice areas is normally classified as fine, montmorillonitic, isohyperthermic Leptic Udic Haplustert. However, when found in rolling to undulating areas, it is classified as Lithic Troporthents. These are shallow to moderately deep poorly drained clayey soils. The surface soil is dark brown to nearly black clay, with depth reaching down from 2 to 3 cm. The subsoil is light brownish black clay, and spherical tuffaceous concretions are present.

Depth is from 50 to 80 cm from the surface. The substratum is light grayish brown tuffaceous materials of varying degrees of weathering. Tuffaceous concretions are present. Below this layer is hard and massive tuff. Guadalupe soil series developed from the Diliman Tuff member of the Guadalupe Formation (Carating, Galanta, & Bacatio, 2014).

Table 2.1-11 lists the different soil types within the proposed MMSP stations. A map showing the distribution of soil types along the proposed MMSP alignment is shown in **Figure 2.1-36**.

Table 2.1-11 Soil series and types along the proposed MMSP stations

Station Name	Soil Series & Type
Depot	Novaliches clay loam
Quirino Highway Station	Novaliches clay loam adobe
Tandang Sora Station	Novaliches clay loam adobe
North Avenue Station	Novaliches clay loam adobe
Quezon Avenue Station	Novaliches clay loam adobe
East Avenue Station	Novaliches clay loam adobe
Anonas Station	Novaliches clay loam adobe
Katipunan Station	Marikina clay loam
Ortigas North Station	Novaliches clay loam adobe
Ortigas South Station	Novaliches clay loam adobe
Kalayaan Station	Guadalupe clay adobe
Bonifacio Global City (BGC) Station	Guadalupe clay adobe
Lawton East Station	Guadalupe clay adobe
Lawton West Station	Guadalupe clay adobe
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	Guadalupe clay
Food Terminal Inc. (FTI) Station	Guadalupe clay adobe
Bicutan Interconnection	Guadalupe clay adobe

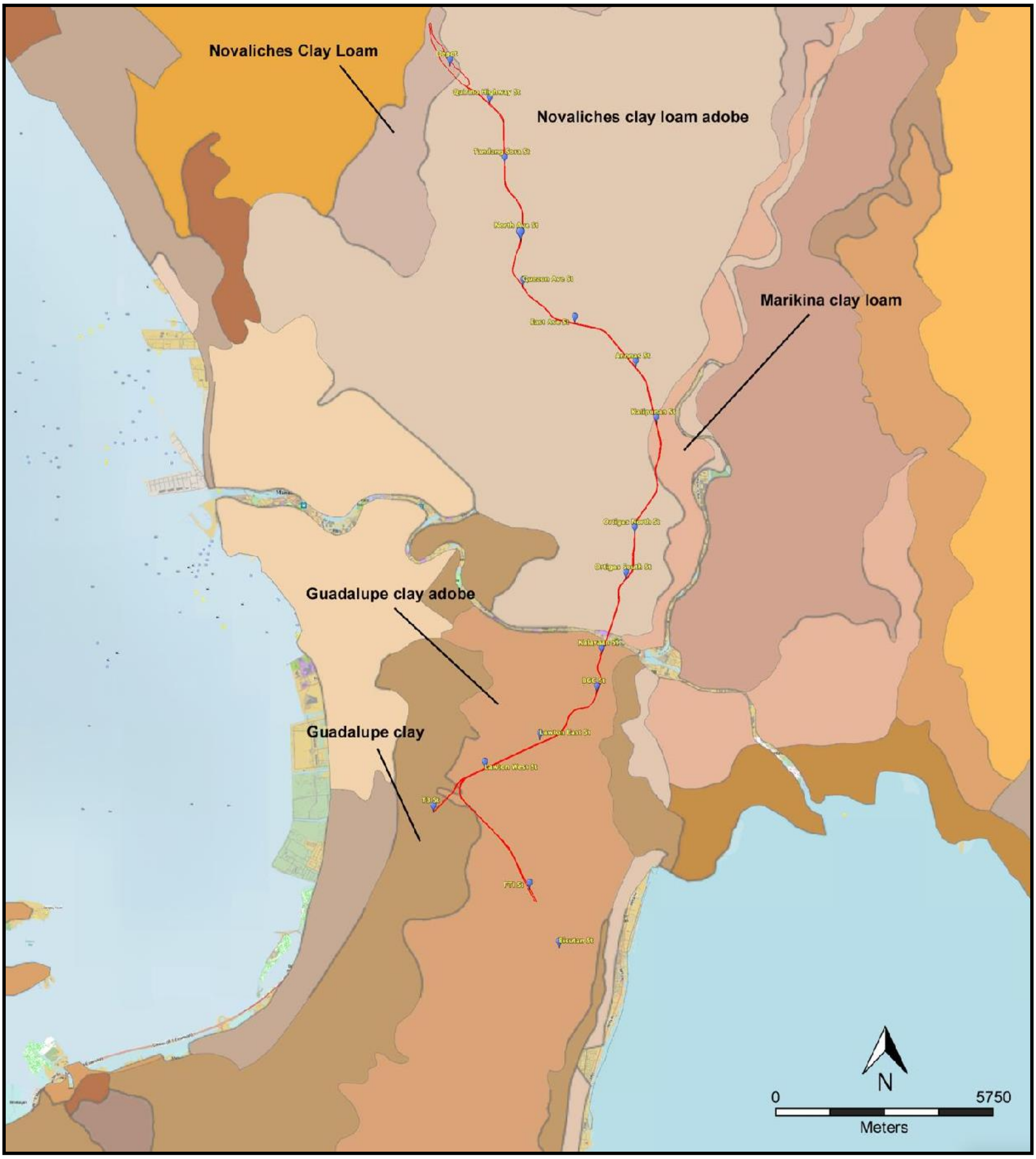


Figure 2.1-36 Soil types along the proposed MMSP alignment (BSWM, 2019)

2.1.3.1 Geologic Hazards

Seismic Hazards

Movements along several active faults and trenches around south-central Luzon can potentially induce different seismic hazards to the MMSP. Some of the prominent structural and tectonic features include the VFS, the Manila Trench, the Lubang-Verde Island Passage Fault, the Laguna-Banahaw Fault, the Casiguran Fault, the East Zambales Fault and the PFZ. **Figure 2.1-37** shows the distribution of historically destructive earthquakes around Central Luzon from 1645 to 2019 (USGS, 2019; JICA-MMDA-PHIVOLCS, 2004;

Bautista & Oike, 2000). The location of historical earthquakes discussed in the succeeding paragraphs are depicted on the map by red pulse symbols and a number label corresponding to the year of occurrence. The location of the MMSP alignment is enclosed within the blue rectangle.

The VFS is a system of two curvilinear NE-trending dextral faults, the West Valley and East Valley Faults, which transects the eastern long axis of Metropolitan Manila. Records indicate the last movements of the VFS took place in 19 August 1658 for the West Valley Fault and 01 February 1771 for the East Valley Fault, generating earthquakes of Ms 5.7 and 5.0, respectively.

Far south of the proposed sites, the Lubang-Verde Island Passage Fault slices through the Mindoro Strait located between Batangas and Mindoro island. This sinistral strike-slip fault transforms to a transpressional fault as it cuts through the southern section of the Manila Trench (Mines and Geosciences Bureau, 2010). A notable seismicity along this fault took place in 08 April 1942, having generated an earthquake measuring Ms 7.5.

The Manila Trench is the crustal manifestation of the subduction of the West Philippine Sea beneath the Philippine Mobile Belt. It loosely follows the configuration of the western coast of Luzon island, following a N-S strike between 14°-16° N latitude, and bends to a SE direction between 12.5-14° N latitude. Notable seismicities attributed to these segments of the Manila Trench were recorded on 25 April 1972 (12.5°-14° N) and 07 December 1677, having generated earthquakes measuring Ms 7.2 and 7.3, respectively.

The Laguna-Banahaw Fault is a linear structure that can be traced along the base of the Caliraya Plateau which sits on the eastern edge of Laguna de Bay. This strike-slip fault is believed to have caused the Ms 7.5 earthquake that occurred on 20 August 1937.

The Infanta Segment of the 1,200-km sinistral PFZ traces the Pacific coastline of Luzon island from Infanta to Lucena City in the province of Quezon. It had a notable activity in 18 July 1880, which generated an earthquake that measured Ms 7.6. A more recent significant earthquake triggered by movement along another segment of the PFZ—Digdig Fault—took place on 16 July 1990. With a measure strength of Ms 7.8, this is the deadliest earthquake on Luzon island in the last 29 years.

An earthquake measuring Ms 7.3 rocked the town of Casiguran, Aurora on 02 August 1968. It brought significant damage around the city of Manila, particularly in the Binondo and Escolta districts, causing the collapse of the Ruby Tower and structural damage to major buildings. Another earthquake of Ms 7.3 took place in Baler, Aurora on 07 April 1970. This caused the collapse of a school building, as well as structural damage to other buildings in Manila. Both earthquakes are believed to have been triggered by movement along the Casiguran Fault.

On 03 June 1863, a strong, Ms 6.5 earthquake levelled the city of Manila. Records indicate that this event originated from somewhere near Sangley Point in Manila Bay, near the proposed sites for the project. The movement is believed to be strike-slip, although no surficial evidence of an active fault that traverses this area has been observed to date.

The most recent strong earthquake that affected Metropolitan Manila took place on 22 April 2019. It measured Ms 6.1 and was centered to the east of Castillejos, Zambales. This earthquake caused widespread destruction around the Central Luzon region.

The earthquake events discussed in the previous paragraphs are summarized in **Table 2.1-12**.

Table 2.1-12 Significant earthquake events that affected Metropolitan Manila

Year	Month	Date	Magnitude (Ms)	Generating Fault	Shortest Distance of Epicenter to MMSP (km)
2019	04	22	6.1	East Zambales Fault (?)	57
1990	07	16	7.8	PFZ – Digdig Segment	98
1972	04	25	7.2	Manila Trench (12.5° - 14° N)	147
1970	04	07	7.3	Casiguran Fault	137
1968	08	02	7.3	Casiguran Fault	205
1942	04	08	7.5	Lubang-Verde Island Passage Fault	153
1937	08	20	7.5	Laguna-Banahaw Fault	46
1880	07	18	7.6	PFZ – Infanta Segment	59
1863	06	03	6.5	Unknown Manila Bay source	15
1771	02	01	5.0	East Valley Fault	9
1677	12	07	7.3	Manila Trench (14° - 16° N)	167
1658	08	19	5.7	West Valley Fault	3

from (USGS, 2019; JICA-MMDA-PHIVOLCS, 2004; Bautista & Oike, 2000)

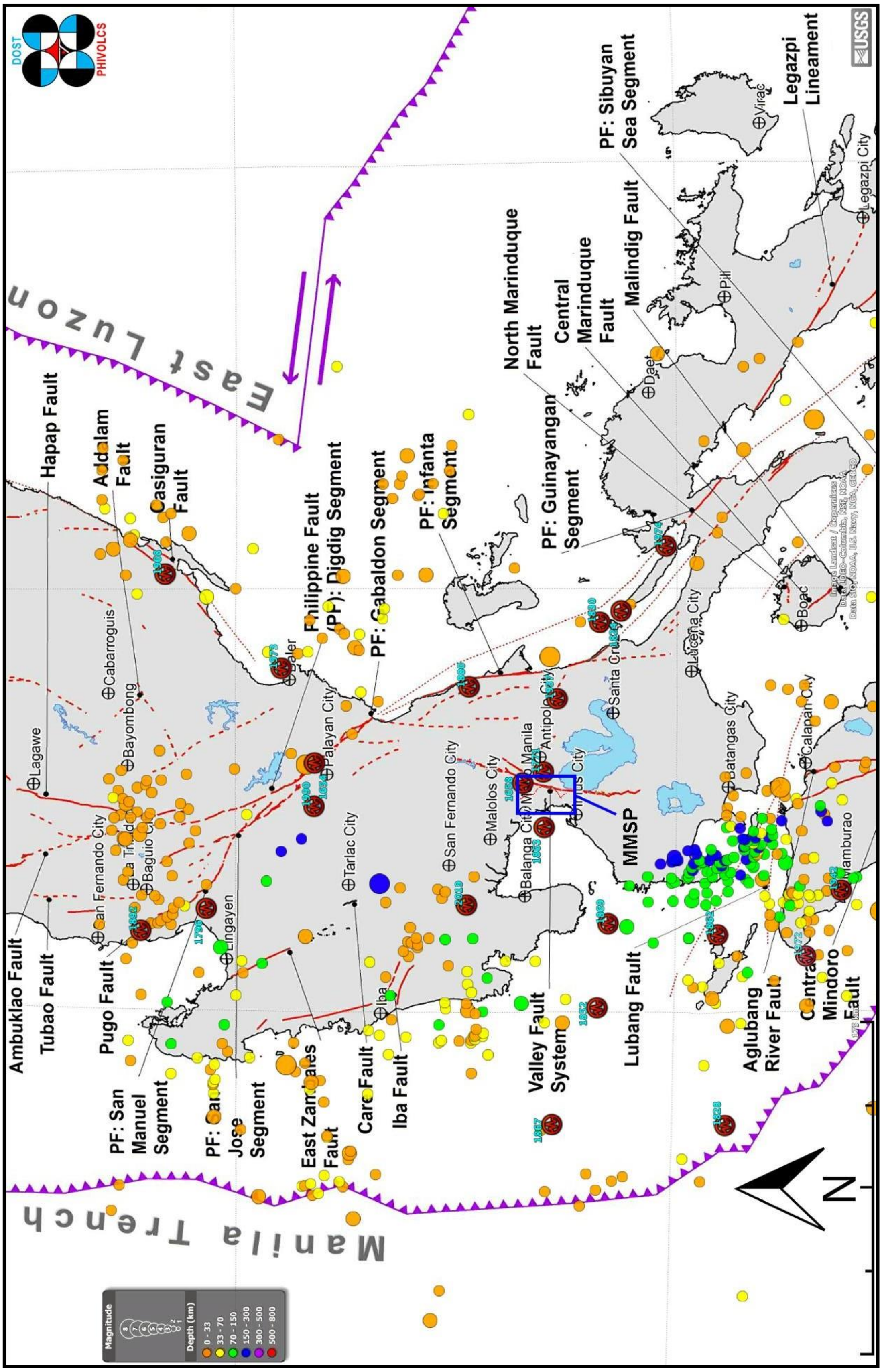


Figure 2.1-37 Historical and instrumental earthquakes > Ms 5.0 around Metropolitan Manila (USGS, 2019; JICA-MMDA-PHIVOLCS, 2004; Bautista & Oike, 2000)

Figure 2.1-37 also shows the locations of instrumental seismicities spanning from 27 April 1919 to 04 May 2019 from the Global Earthquake Catalog of the USGS (USGS, 2019). The data was filtered to include only events greater than Ms 5.0—the minimum magnitude that is shown to cause damage to structures (Koo, Mote, Manlapig, & Zamora, 2009). The earthquake epicenters are indicated by colored circles on the map—varying diameters of the circles correspond to instrumental magnitudes, while the different colors indicate ranges of focal depths. Based on the data represented on the map, Metropolitan Manila does not have a record of instrumental seismicities > Ms 5.0; instead, only the three historical events were plotted within the area—1658, 1771 and 1863—which all pre-dated modern instrumentation. Two of these events were attributed to the VFS; the source of the 1863 event is still unknown.

Epicenters are seen clustering (1) between Mindoro island and Batangas, (2) offshore west of Zambales, **(3)** north of Bataan peninsula, and (4) along the PFZ. There is a general eastward / northeastward increase in focal depth (as indicated by the color distribution) in the offshore Zambales and Mindoro-Batangas clusters, which may be attributed to the dip direction of subduction along the Manila Trench. For the latter, some of the shallower events may have been triggered by movement along the Lubang-Verde Island Passage Fault, the Central Mindoro Fault, or the Aglubang River Fault. The earthquake swarm seen to the north of Bataan peninsula corresponds to volcanic earthquakes leading to and following the eruption of Mt. Pinatubo in 1991. Lastly, the linear trend of shallow earthquakes (0 – 33 km) along the PFZ shows proof of its active nature. The deep earthquakes the took place around Tarlac City, are probably tectonic in origin, such as the subduction along the Manila Trench.

Figure 2.1-38 shows the Philippine earthquake density map from USGS (USGS NEIC, 2012). It depicts the average number Ms 5 and greater shallow (0 – 70 km depth) earthquakes per year per 12,300 km2. Despite the occurrence of numerous moderate to strong shallow earthquakes around Metropolitan Manila (Figure 2.1-37), such events do not happen more than once in a year within the region. By comparison, northeast Mindanao (including Agusan del Norte, Agusan del Sur, Surigao del Norte and Surigao del Sur) experiences an average of 4 shallow earthquakes of at least Ms 5 every year.

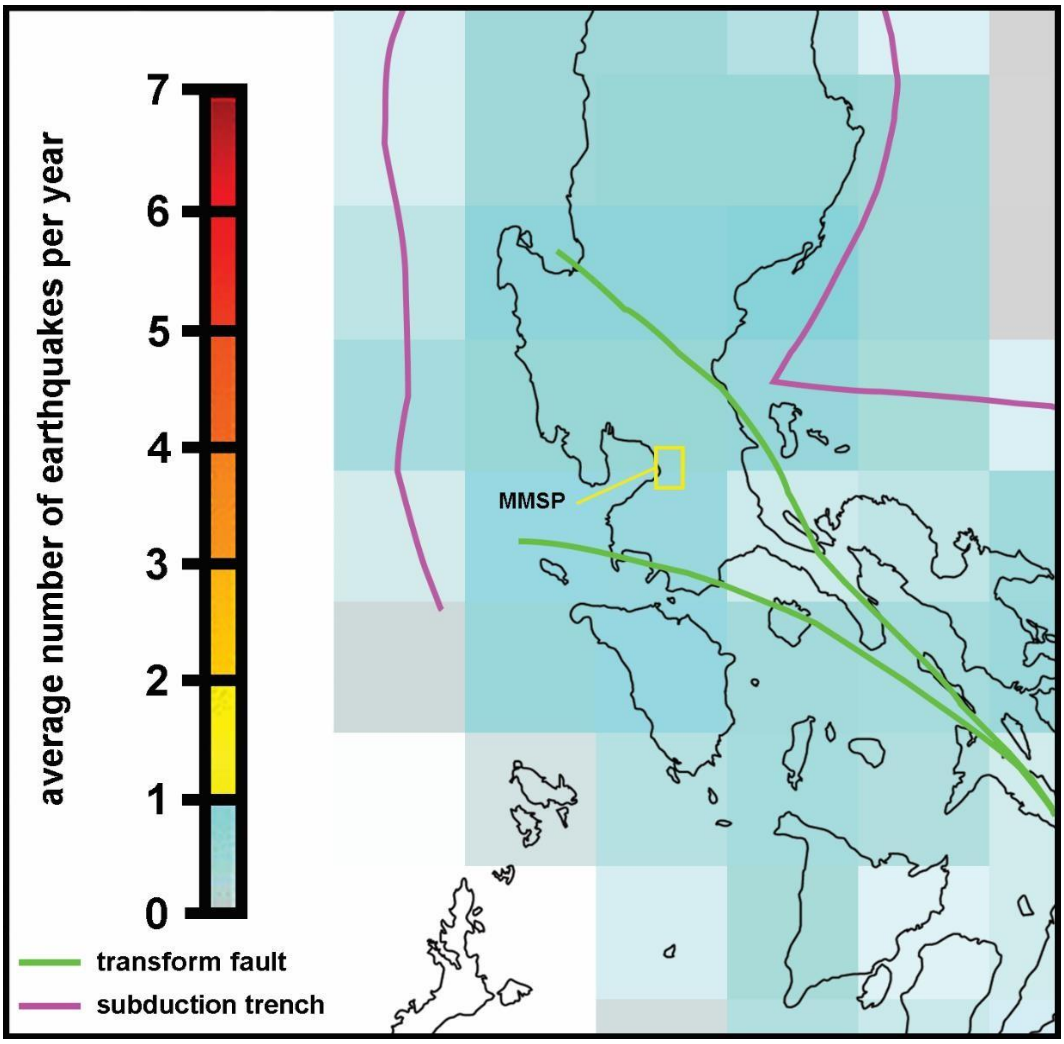


Figure 2.1-38 Earthquake density map of the Philippines (USGS NEIC, 2012)

Ground Shaking

Ground shaking is the hazard most commonly associated with seismic events. The vertical and horizontal movement of the ground following a seismic event is a manifestation of the propagation of waves emanating from the epicentre. The heaving and lurching of the ground causes foundations and structures to shift and settle from a previously static state. Buildings can lean or tip over. Foundations can subside or be thrust upward. The ground can liquefy or rupture. Ground shaking itself can be a trigger for these other hazards.

Ground shaking hazard assessment is done to identify the potential effects of seismic movement over a particular area by determining the characteristic response of the ground during an event. One method, the Deterministic Seismic Hazard Assessment (DSHA), uses data from known seismic sources to simulate ground motion during discrete, single-valued events. It was first applied for seismic hazard analysis of nuclear power plants and is still commonly used in the evaluation of worst-case scenarios for other large structures like dams. DSHA, however, does not factor in the probability of occurrence of an earthquake of a certain magnitude occurring at a specific area over a given finite period of time, nor the uncertainties in the values needed to compute ground motion characteristics.

One example of DSHA is the determination of seismic response expressed as peak ground acceleration (PGA) in a specific site using the maximum credible magnitude that can be generated by an earthquake source (i.e. active fault), the seismic generator's distance from the site, and the attenuation of the substrate in that area, using the formula developed by Fukushima and Tanaka (1990). The potential earthquake generators around the project site, the estimated perpendicular (or shortest) distance between the seismic generator and the project site (based on the median location of the proposed sites), and the maximum credible earthquake (MCE) (JICA-MMDA-PHIVOLCS, 2004) are presented in **Table 2.1-13**. This table contains scenario parameters of the faults and trenches previously discussed, including possible seismic sources not currently classified under the active faults list of PHIVOLCS, such as the Laguna-Banahaw Fault and the inferred Manila Bay source of the Ms 6.5 03 June 1863 event.

The average PGA value is calculated from the resulting mean of peak acceleration divided by the acceleration due to gravity constant. In general, the average PGA in an area decreases the farther away from the earthquake source, given the same magnitude.

Seismic waves propagate differently across various substrate compositions, resulting in attenuation of ground acceleration. Investigations of acceleration attenuation in strong-motion stations in Japan recognized a divergence of observed measurements from predicted peak horizontal accelerations. By classifying the ground condition and segregating the data, the attenuation or amplification factor was estimated. The four general types of ground conditions used in the Japanese study are Rock, Hard Soil, Medium Soil and Soft Soil (Fukushima & Tanaka, 1990). The three soil types are described as follows (Earthquake Engineering Committee, the Japanese Society of Civil Engineers, 1988):

- Hard Soil: ground before the Tertiary period or thickness of diluvial deposit above bedrock is less than 10 m
- Medium Soil: thickness of diluvial deposit above bedrock is greater than 10 m, or thickness of alluvial deposit above bedrock is less than 10 m, or thickness of alluvial deposit is less than 25 m and thickness of soft deposit is less than 5 m
- Soft Soil: other soft ground such as reclaimed land.

Table 2.1-14 shows the computed peak ground acceleration values and ground shaking attenuations on different ground conditions using the median location of the three site options, based on the formula of Fukushima and Tanaka (1990) and the information provided in **Table 2.1-13**.

Based on the results derived from the computation, a Ms 7.2 earthquake originating from the central part of the West Valley Fault would generate the strongest shaking compared to the other even scenarios considered. Strong shaking may also be felt from scenario events from the East Valley Fault, the 1863 Manila Earthquake and the Laguna-Banahaw Fault.

For a more realistic assessment, site-specific ground conditions are selected to estimate the ground motion attenuation and site amplification. The selection of the appropriate site response is done through determination of the shear-wave velocity of the upper 30 m of soil layer, Vs30. Traditionally, it is determined by seismic measurements in boreholes, using the downhole, crosshole or suspension logging methods. In lieu of actual testing, the Vs30 site model map generated by PHIVOLCS is used as reference (PHIVOLCS, 2017). The map, in turn, uses a 1-km by 1-km site model generated by Grutas and Yamanaka (2012). **Figure 2.1-39** shows the alignment of the MMSP overlain on the PHIVOLCS Vs30 site model map.

Table 2.1-13 Scenario earthquakes for deterministic seismic hazard assessment

Seismic Source	Maximum Credible Earthquake (M)	Shortest Distance from MMSP (km)	Nearest Station
West Valley Fault (central)*	7.2	0.64	Ortigas North
East Valley Fault*	6.3	9.5	Anonas
Lubang – Verde Island Passage Fault*	7.7	93	Bicutan
Manila Trench (12.5°-14° N)*	7.9	192	Bicutan
Manila Trench (14°-16° N)*	7.9	209	NAIA Terminal 3
Laguna – Banahaw Fault	7.5	46	Ortigas South
Philippine Fault Zone (Infanta Segment)*	7.6	57	Katipunan
Philippine Fault Zone (Digdig Segment)*	7.9	115	Depot
Manila Bay source (1863 Earthquake)	6.5	15	NAIA Terminal 3
East Zambales Fault*	7.4	140	Depot
Casiguran Fault	7.8	210	Depot

* Classified as active by PHIVOLCS

Table 2.1-14 Scenario earthquakes for deterministic seismic hazard assessment

Seismic Source	Calculated PGA Values				
	Average (g)	Rock (0.6 g)	Hard Soil (1.07 g)	Med. Soil (0.87 g)	Soft Soil (1.39 g)
West Valley Fault (central)*	0.619	0.371	0.662	0.538	0.860
East Valley Fault*	0.332	0.199	0.356	0.289	0.462
Lubang – Verde Island Passage Fault*	0.101	0.061	0.109	0.088	0.141
Manila Trench (12.5°-14° N)*	0.032	0.019	0.034	0.028	0.044
Manila Trench (14°-16° N)*	0.026	0.016	0.028	0.023	0.036
Laguna – Banahaw Fault	0.201	0.120	0.215	0.175	0.279
Philippine Fault Zone (Infanta Segment)*	0.172	0.103	0.184	0.150	0.239
Philippine Fault Zone (Digdig Segment)*	0.084	0.050	0.090	0.073	0.117
Manila Bay source (1863 Earthquake)	0.281	0.168	0.300	0.244	0.390
East Zambales Fault*	0.042	0.025	0.045	0.037	0.059
Casiguran Fault	0.024	0.014	0.025	0.021	0.033

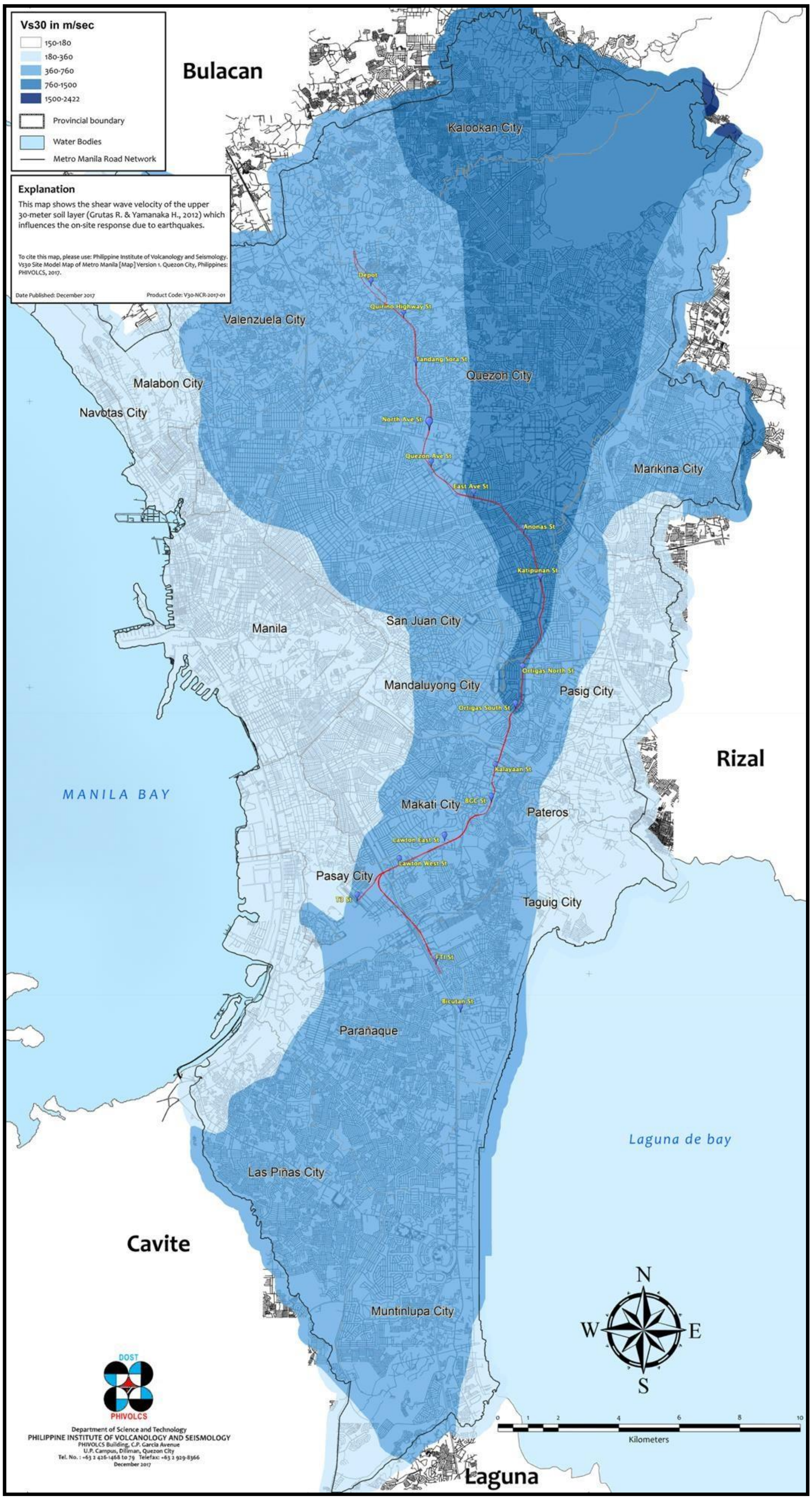


Figure 2.1-39 Vs30 site model map of Metropolitan Manila (PHIVOLCS, 2017)

The Metro Manila Vs30 site model map shows that the shear-wave velocity of the upper 30 m of the soil layer along most of the MMSP alignment ranges from 360 – 760 m/sec. About 8.5 km of the alignment, stretching from the proposed East Avenue Station to Ortigas South Station, has a Vs30 range of 760 – 1500 m/sec. The United States National Earthquake Hazard Reduction Program (NEHRP) formulated a classification scheme for shear-wave velocity for seismic design (Building Seismic Safety Council, 2004). The site classes are defined in **Table 2.1-15**.

Based on the NHERP classification, most of the MMSP alignment will burrow through Class C soil (i.e. Hard Soil), while the segment between East Avenue Station and Ortigas South Station will drill through Class B soil (i.e. Rock). Going back to **Table 2.1-14**, the PGA generated by maximum credible earthquake

7.2 earthquake originating from the central part of the West Valley Fault would generate 0.371 – 0.662 g shaking. When translated to the PHIVOLCS Earthquake Intensity Scale (PEIS), it is equivalent to Intensity VIII shaking, described as Very Destructive. **Table 2.1-16** shows the equivalent intensities of PGA ranges across various intensity scales.

This finding is consistent with the ground shaking hazard assessment for Metropolitan Manila performed by the multi-agency Risk Analysis Project, composed of PHIVOLCS, MGB, NAMRIA, PAGASA, the National Disaster Risk Reduction and Management Council (NDRMMC) and the Department of National Defense (DND), using the Magnitude 7.2 earthquake scenario along the West Valley Fault. **Figure 2.1-40** shows that the entire alignment of the MMSP is within the area that can experience Intensity 8 shaking in the event of such an earthquake. Only a short segment of the MMSP, where the main line branches into the NAIA T3 Station and the FTI Station falls within a higher intensity rating(High 8).

Table 2.1-15 NHERP Site Classes

Class	Soil Description	Vs30 Range (m/sec)
A	Hard rock	Vs30 > 1500
B	Rock	760 < Vs30 < 1500
C	Very dense soil and soft rock	360 < Vs30 < 760
D	Stiff soil	180 < Vs30 < 360
E	Soft soil	Vs30 < 180
F	Soils requiring site-specific evaluation	Vulnerable to failure

Table 2.1-16 Modified Mercalli Intensity, De Rossi-Forel and PHIVOLCS Earthquake Intensity Scales (NOAA National Centers for Environmental Information, 2015; PHIVOLCS, 2008)

%g	MMI	De Rossi-Forel	Perceived Shaking (MMI)	Potential Damage (MMI)	PEIS	Description (PEIS)
< 0.17	I	I	Not Felt	None	I	Scarcely Perceptible
0.17 – 1.4	II – III	I-II	Weak	None	II	Slightly Felt
		III			III	Weak
1.4 – 3.9	IV	IV-V	Light	None	IV	Moderately Strong

%g	MMI	De Rossi-Forel	Perceived Shaking (MMI)	Potential Damage (MMI)	PEIS	Description (PEIS)
3.9 – 9.2	V	V-VI	Moderate	Very Light	V	Strong.
9.2 – 18	VI	VI-VII	Strong	Light	VI	Very Strong
18 – 34	VII	VIII-	Very Strong	Moderate	VII	Destructive
34 – 65	VIII	VIII+ to IX-	Severe	Moderate to Heavy	VIII	Very Destructive
65 – 124	IX	IX+	Violent	Heavy	VIII	
> 124	X - XI	X	Extreme	Very Heavy	IX	Devastating
	XII				X	Completely Devastating

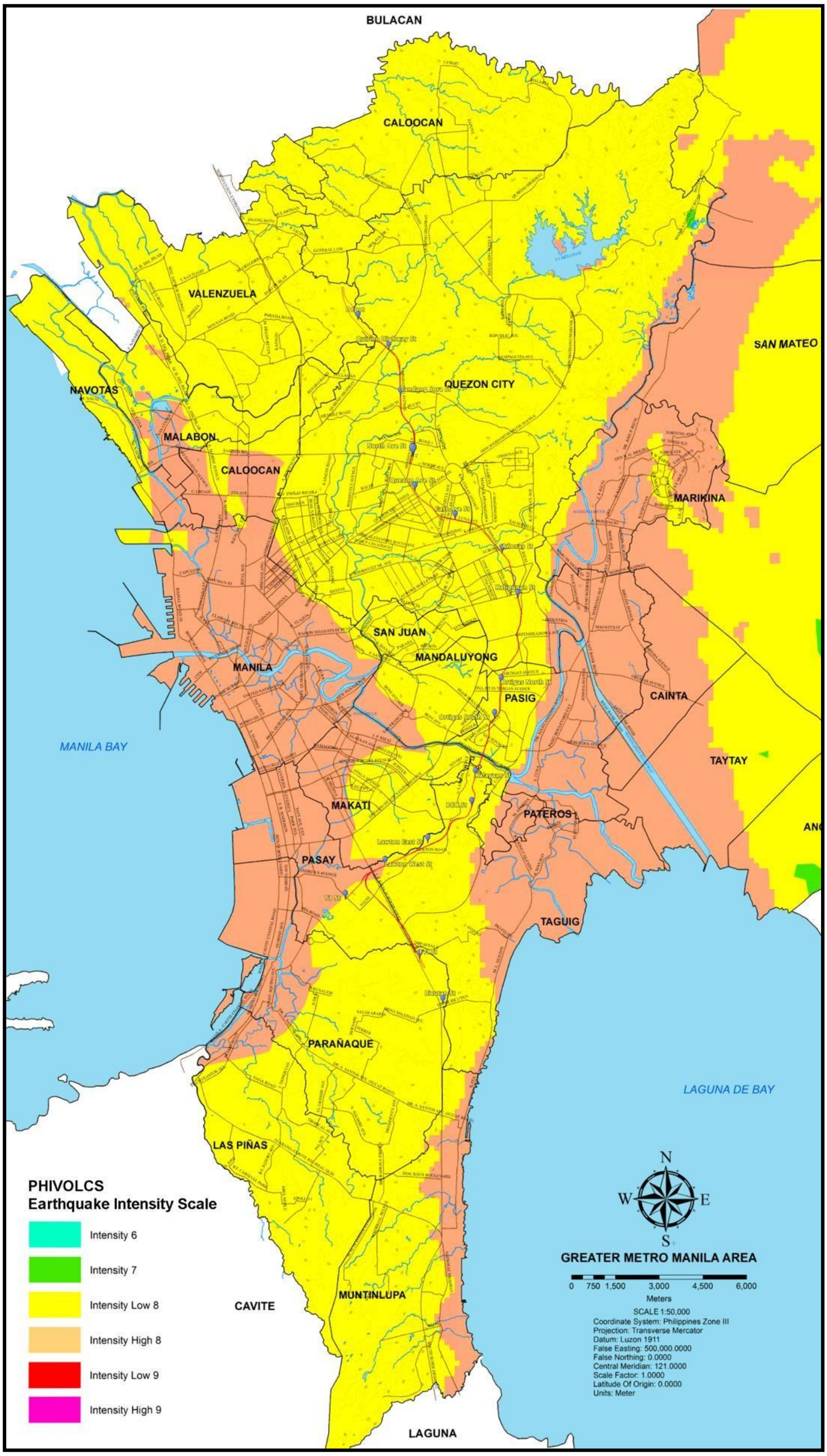


Figure 2.1-40 Ground shaking hazard map for Ms 7.2 West Valley Fault earthquake scenario in Metropolitan Manila (Risk Analysis Project, 2013)

Probabilistic Seismic Hazard Assessment (PSHA) is another method of seismic hazard assessment that was developed to incorporate a temporal aspect by factoring the occurrence probabilities of seismic events. In addition, the PSHA also allows for uncertainties in size, location and recurrence rates of earthquakes (Anbazhagan, 2007).

Probabilistic seismic hazard maps typically show the critical level of earthquake ground motion (i.e. peak acceleration) in a specific area for a given probability of exceedance (or inversely, the return period). It is useful in setting design thresholds for structures within their expected useable life. The peak acceleration is computed essentially the same way as in the DSHA. PHIVOLCS came up with the Philippine Earthquake Model (PEM)—a PSHA of the Philippines—to evaluate the "probability of occurrence of a certain earthquake ground motion integrating combined uncertainties in magnitude, location and intensity measure using the Total Probability Theorem:

$$P(IM > x) = \int_{m_{min}}^{m_{max}} \int_{r_{min}}^{r_{max}} P(IM > x \mid m, r) f_{M_i}(m) f_{R_i}(r \mid m) dr dm$$

where x is the acceleration due to gravity, g calculated as a function of magnitude, m and distance, r from all possible seismic sources that may affect a particular point of interest at relevant return periods" (PHIVOLCS, 2017). The PSHA performed by PHIVOLCS was aimed to promote adherence to the minimum design requirements in building structures as stipulated in the National Structural Code of the Philippines (NSCP), a referral code of the National Building Code of the Philippines (NBCP). It was also designed to be used as a tool for disaster mitigation and risk reduction efforts of local government units, homeowners, urban planners, developers and by the insurance industry.

PHIVOLCS produced probabilistic PGA maps using the Vs30 site model for Metropolitan Manila, at 10%, 5% and 2% probability of exceedances, or 500-year, 1,000-year and 2,500-year return periods respectively. It was calculated from available historical and instrumental seismicities of Mw 5.2 and above plotted within a 300 km radius, updated active faults, area sources and trenches parameters, recent paleoseismic studies and geophysical monitoring results. The 500-year return period map shows ground acceleration contours using the Vs30 site model with 10% probability of exceedance in 50 years. It indicates the maximum site acceleration response from a most probable earthquake (i.e. realistic earthquake). The 1,000-year return period map shows ground acceleration contours with a 5% probability of exceedance in 50 years. Lastly, the 2,500-year return period map shows ground acceleration contours with a 2% probability of exceedance in 50 years. It can be used to approximate the worst-case scenario earthquake from the West Valley Fault.

Figure 2.1-41, **Figure 2.1-42** and **Figure 2.1-43** show the MMSP alignment superimposed on the PGA contour map with the above return periods. Based on the 500-year return period PGA map, the MMSP alignment transects areas with PGAs ranging from 0.35 to 0.5 g. The PGAs that can be encountered along the MMSP alignment with a 1,000-year return period range from 0.45 to 0.6 g. Lastly, the 2,500-year return period PGA map indicates ground accelerations of 0.45 to 0.7 g, the higher end of which may be experienced at the Kalayaan and FTI Stations during a worst-case scenario.

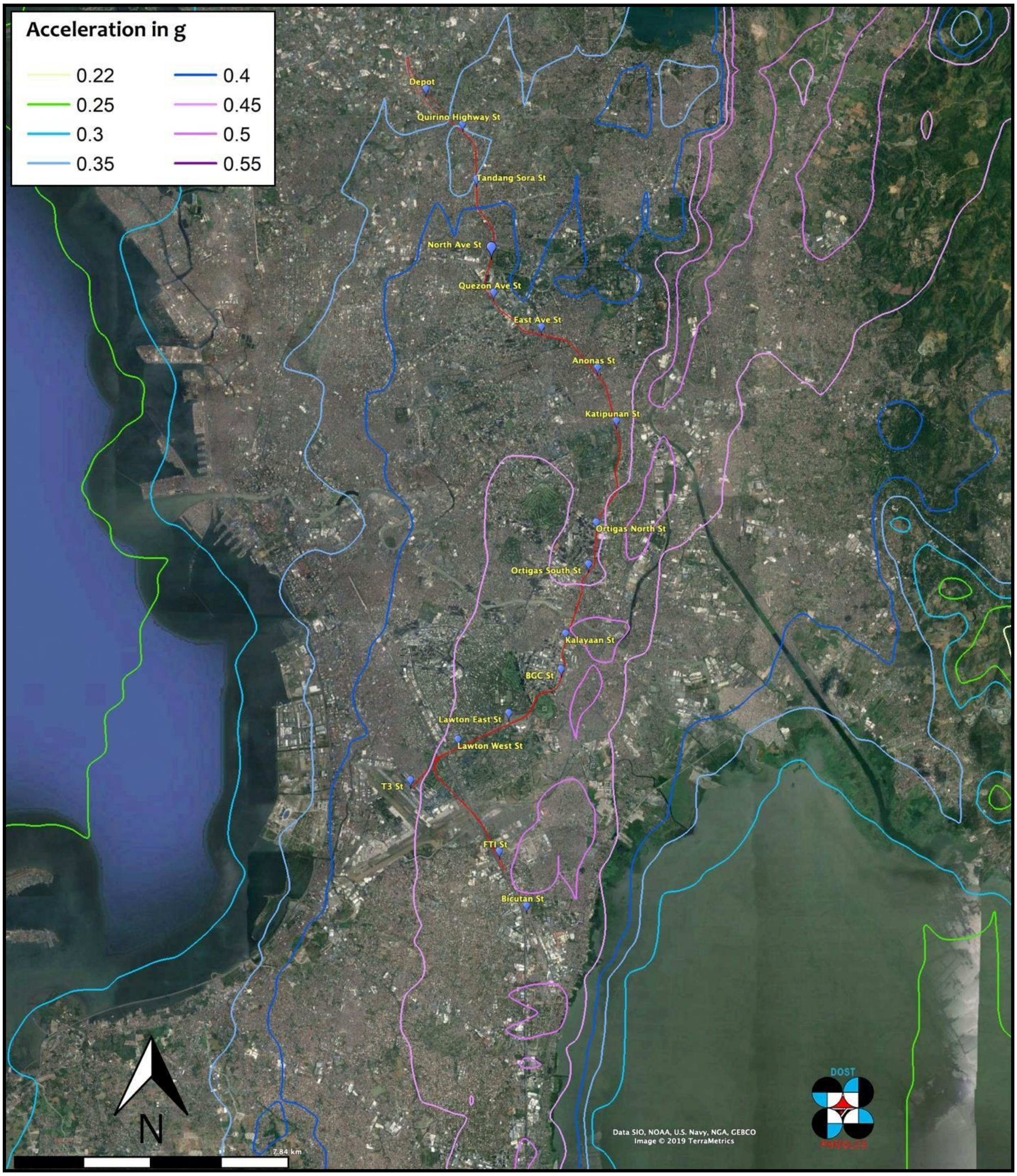


Figure 2.1-41 500-year return period peak ground acceleration map of Metropolitan Manila (PHIVOLCS, 2017)

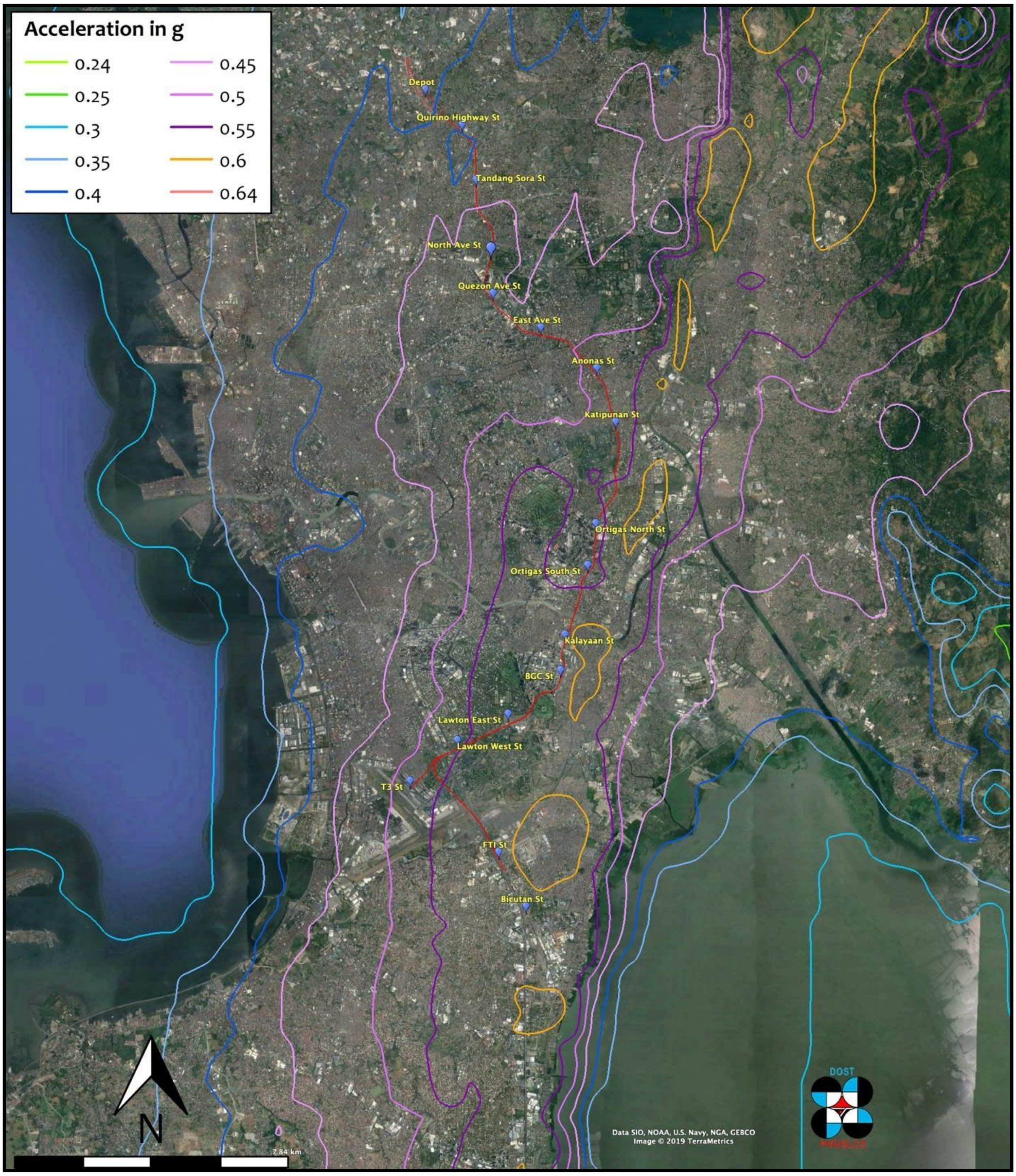


Figure 2.1-42 1,000-year return period peak ground acceleration map of Metropolitan Manila (PHIVOLCS, 2017)

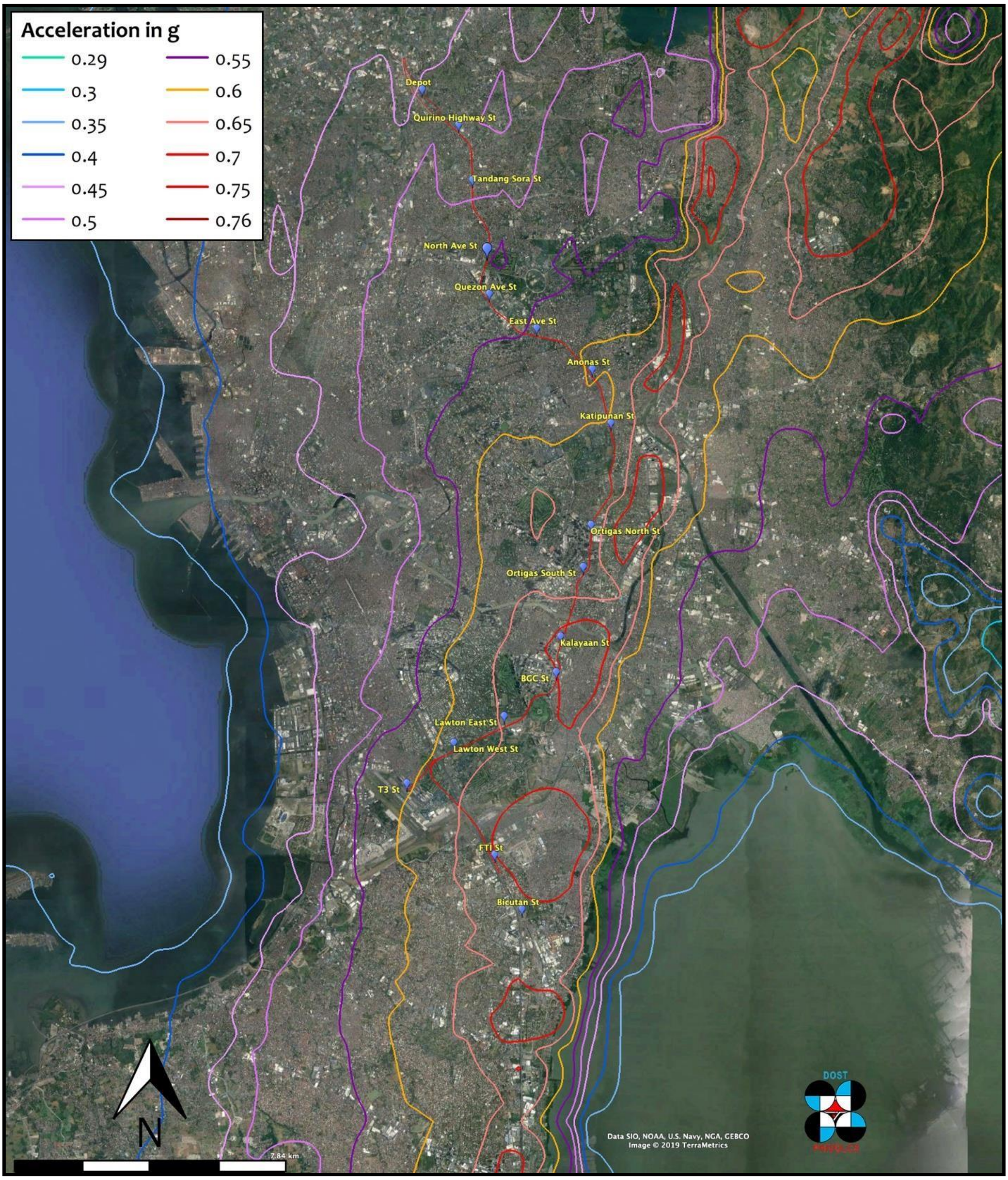


Figure 2.1-43 2,500-year return period peak ground acceleration map of Metropolitan Manila (PHIVOLCS, 2017)

Ground Rupture

Ground rupture is the breakage of ground surface as a result of movement along a fault. It may occur suddenly during an earthquake, or gradually as an effect of fault creep progression. There is displacement on either side of a ground rupture: dip-slip faulting have surface ruptures that feature vertical offset, while strike-slip faulting has a lateral displacement. It is also possible to have a combination of horizontal and vertical slippage. Ground ruptures almost always follow pre-existing faults. Developments along identified or hidden fault zones are at risk of structural damage if old fault lines are reactivated.

Statistically, ground ruptures caused by seismic events occur along pre-existing fault traces, and that movement conditions of newer earthquakes are almost similar to previous events. The West Valley Fault is the nearest active fault to the MMSP alignment, with distances ranging from 150 m at Ugong Norte, Pasig to 9.5 km at the northernmost point of the Depot. The distance of the stations, depots and interconnections are listed in **Table 2.1-10**, while proximity maps of stations less than 1 km from the West Valley Fault are shown in **Figure 2.1-29** to **Figure 2.1-34**.

There are no known local active faults within the vicinity of the proposed stations and track alignment, so the risk of ground rupture ensuing from future fault movement of the West Valley Fault is low. However as previously discussed, buried faults that may or may not be splays of the West Valley Fault, had been exposed in excavations for building foundations (such as in Bonifacio Global City [BGC] in Taguig). It is not known if these faults are active or not since in most cases, such discoveries are not reported to PHIVOLCS. The ground rupture hazard map of Metropolitan Manila is shown in **Figure 2.1-44**.

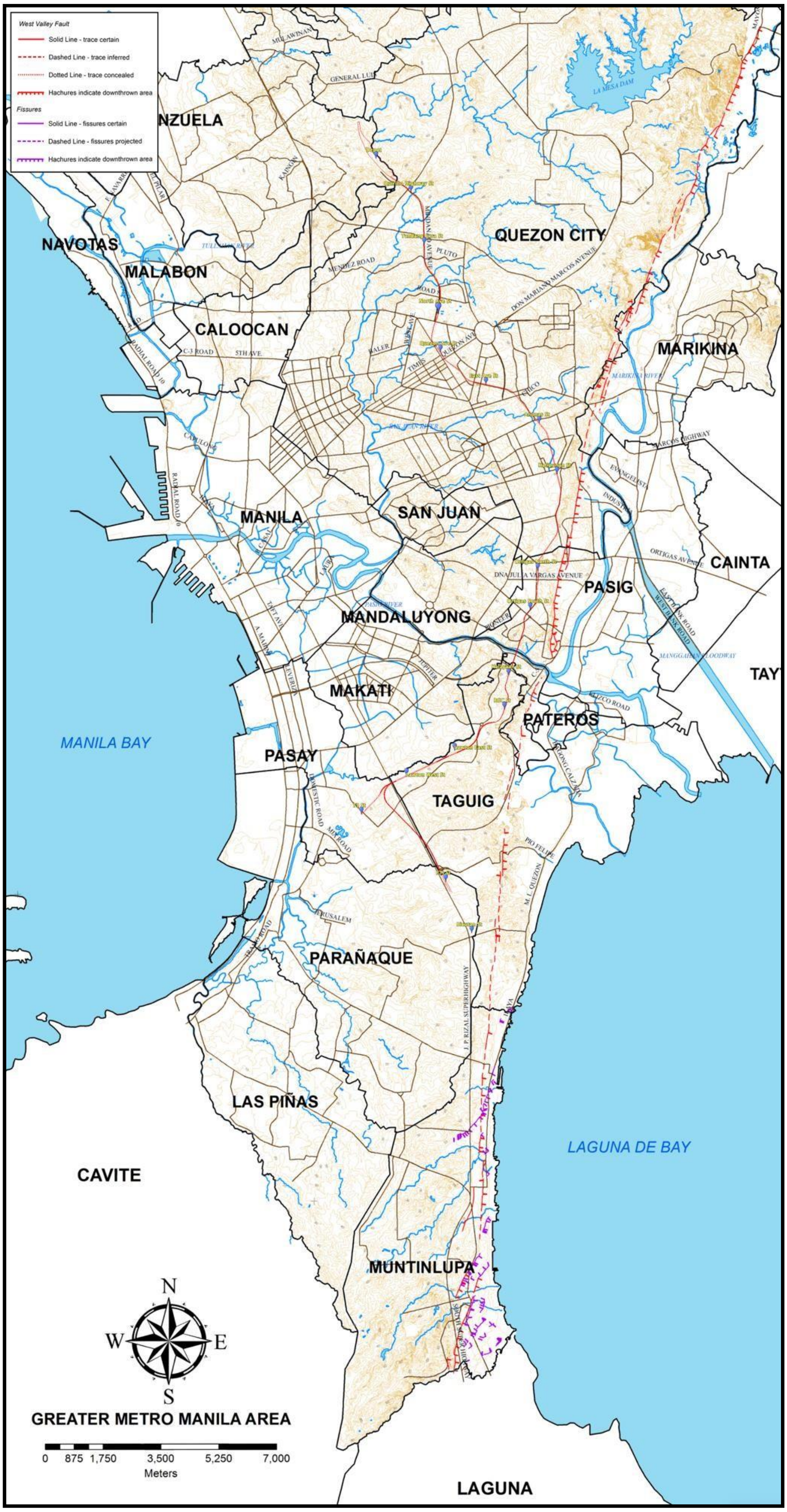


Figure 2.1-44 Ground rupture hazard map of Metropolitan Manila (READY for GMMA Project, 2013)

Liquefaction

Under static conditions, the water pressure of saturated soils—soils in which the space between individual particles is completely filled with water—is relatively low, so that the individual grains that comprise the soil rest on the framework of the grain contacts (Pacific Northwest Seismic Network, 2019). The soil is solid and is able to support structures above it.

When rapid loading occurs, such as during earthquake shaking, the pore water pressure in the saturated substrates builds up and the effective stress of grains may be exceeded, resulting in the grains becoming buoyant and floating in water. At this point, the soil completely loses its strength and begins to act like a solid. The bearing strength of the soil is drastically reduced, and it can no longer support the same amount of weight as it did when it is a solid (BRANZ, 2019). High overburden pressure can force the liquefied soil upwards and escape through cracks and fissures, causing sand boils that contain silt, sand and groundwater. This often leads to flooding and formation of cavities. The consequences to structures and utilities of earthquake-induced liquefaction include (Pacific Northwest Seismic Network, 2019):

- Non-uniform and differential settlement of structures often resulting in cracking;
- Loss of bearing support;
- Flotation of buried structures such as sewer lines, tanks and pipes;
- Strong lateral forces agains retaining structures;
- Lateral spreading (limited lateral movement); and
- Lateral flows (extensive lateral movement).

There are no standardized criteria to identify liquefiable soil. However, there are four key elements present that lead to the occurrence of liquefaction (BRANZ, 2019):

- Soil particles are loose and cohensionless, and will move closer together when shaken;
- Soil particles are sized between coarse silt to fine sand approximately 0.01 – 1.00 mm in diameter;
- Ground is saturated (particularly material that is below the water table); and
- Sufficient shaking occurs.

The multi-agency READY for GMMA Project produced a liquefaction hazard map used spatial analysis and interpolation of estimated liquefaction probability of borehole logs computed based on geotechnical properties, geology, geomorphology, hydrology, earthquake zones, preliminary microtremor survey data and historical accounts of liquefaction (READY for GMMA Project, 2014). The liquefaction potential—rated as Low, Moderate and High—was computed using ground shaking values based on the Magnitude 7.2 scenario earthquake along the West Valley Fault. The map (**Figure 2.1-45**) shows that the Central Plateau area Metropolitan Manila is generally not susceptible to liquefaction, with the exception of a narrow strip along the banks of Pasig River (Moderate to High susceptibility) and San Juan River (Low to Moderate susceptibility). A small portion of Lawton West has also been assessed as having Moderate liquefaction susceptibility. The proposed MMSP alignment is generally located in areas that are not prone to liquefaction, with the exception of the segments crossing the Pasig River and the near the Lawton West Station and the NAIA T3 Station. Geotechnical testing may yield properties indicative of liquefiable soils, in which case, additional liquefaction tests are recommended.

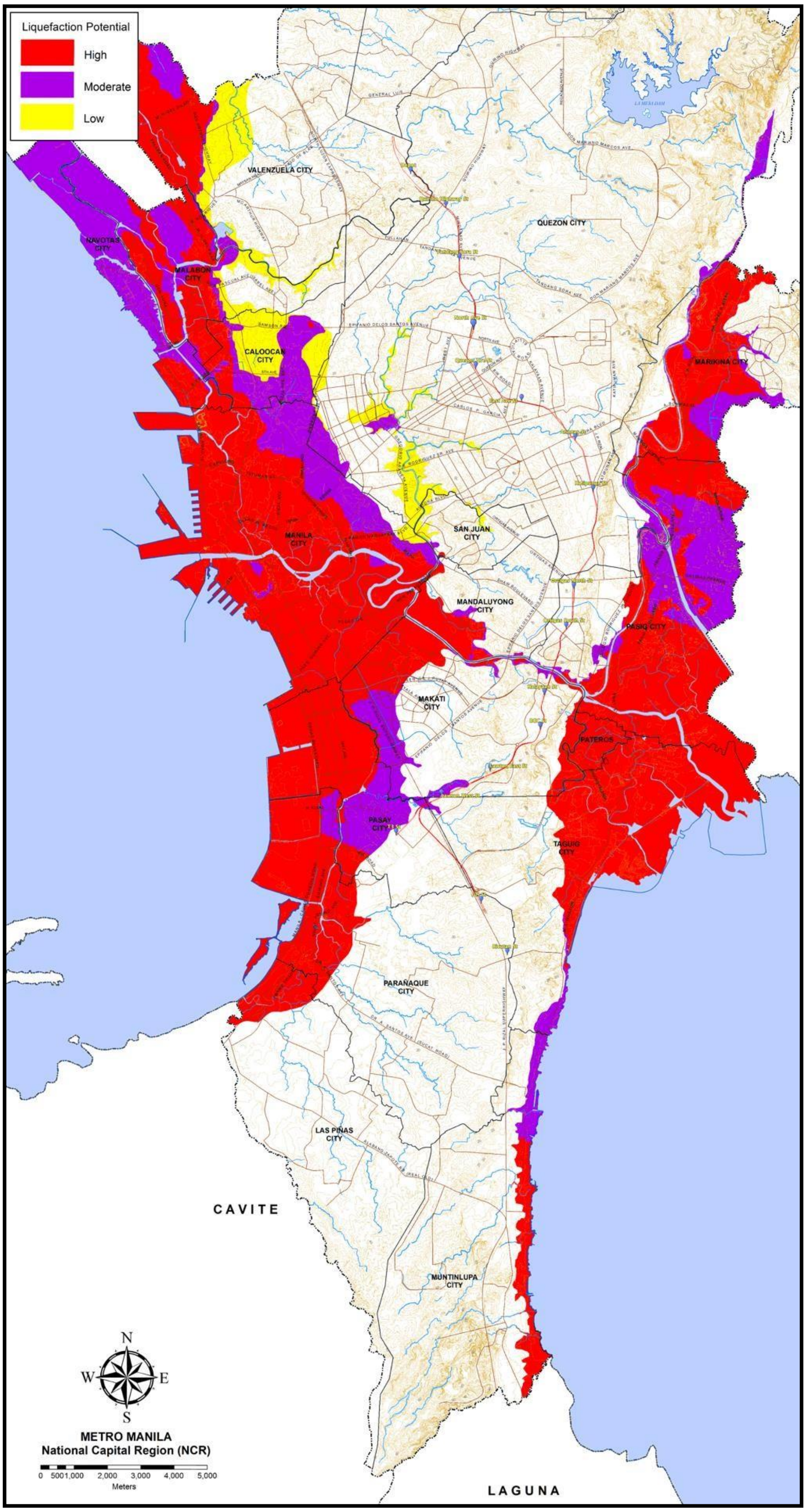


Figure 2.1-45 Liquefaction hazard map of Metropolitan Manila (READY for GMMA Project, 2014)

Earthquake-Induced Landslide

A landslide is defined as the downslope movement of a mass of rock, debris or earth under the direct influence of gravity. Landslides can be described by the dominant mode of slope movement (e.g. falls, topples, slides, spreads and flows), as well as the type of geologic material that is moved (e.g. bedrock, debris or earth). A landslide can have multiple causes, but the underlying trigger for all is when the downslope force (i.e. gravity) exceeds the strength of the material that comprise the slope (USGS, 2019).

Failure of slope faces of topographically high land features such as mountains can be triggered during earthquakes. Ground shaking destabilizes slopes, causing landslides and rockfalls. Earthquake ruptures along steep mountain faces may also cause mass wasting if the substrate comprising displaced blocks break apart and lose strength. Secondary landslides may develop due to increased water penetration and saturation resulting from the formation of wider cracks and weaker intergranular cohesion bonds after an earthquake. Structures built on the side or at the foot of unstable slopes may face significant damage when foundations fail or are hit directly by landslide debris.

Metropolitan Manila is largely a flat plain that rises eastward gradually from sea level along the coast of Manila Bay to elevations ranging from 30 m (Muntinlupa) to 80 m (northwest Quezon City) along the edge of the Central Plateau (or the trace of the West Valley Fault). Due to this, most of Metropolitan Manila is not susceptible to earthquake-induced landslide. This is shown on the earthquake-induced landslide hazard map generated by the READY for GMMA Project, which was produced by simulating the largest possible earthquake magnitude occurring in the area (i.e. Magnitude 7.2 triggered by the West Valley Fault). Landslide potentials reported on the map were calculated using computed Factor of Safety, simulation of ground shaking by Fukushima and Tanaka (1990) and critical acceleration of slope by Newmark method (READY for GMMA Project, 2013). The map also indicates that the scarp that traces the West Valley Fault has a greater rating of earthquake-induced landslide susceptibility compared to the rest of Metropolitan Manila, ranging from Low to Moderate susceptibility along the central to southern portions (Katipunan to Muntinlupa) to Low to High susceptibility along the central to northern portions (Barangay Loyola Heights to Barangay Bagong Silang, Quezon City).

Figure 2.1-46 shows the proposed alignment of the MMSP superimposed on the READY for GMMA Project earthquake-induced landslide hazard map. From this, it can be seen that only the following segments of the MMSP are within earthquake-induced landslide susceptible areas:

- Katipunan Avenue and Temple Drive, Pasig;
- Barangay Kapitolyo, Pasig;
- Barangay West Rembo, Makati; and
- McKinley Parkway, Taguig;

No station is directly within the landslide susceptible areas. Track segments that intersect these areas are underground and will not cause ground surface disturbance that would heighten susceptibility to earthquake-induced landslide.

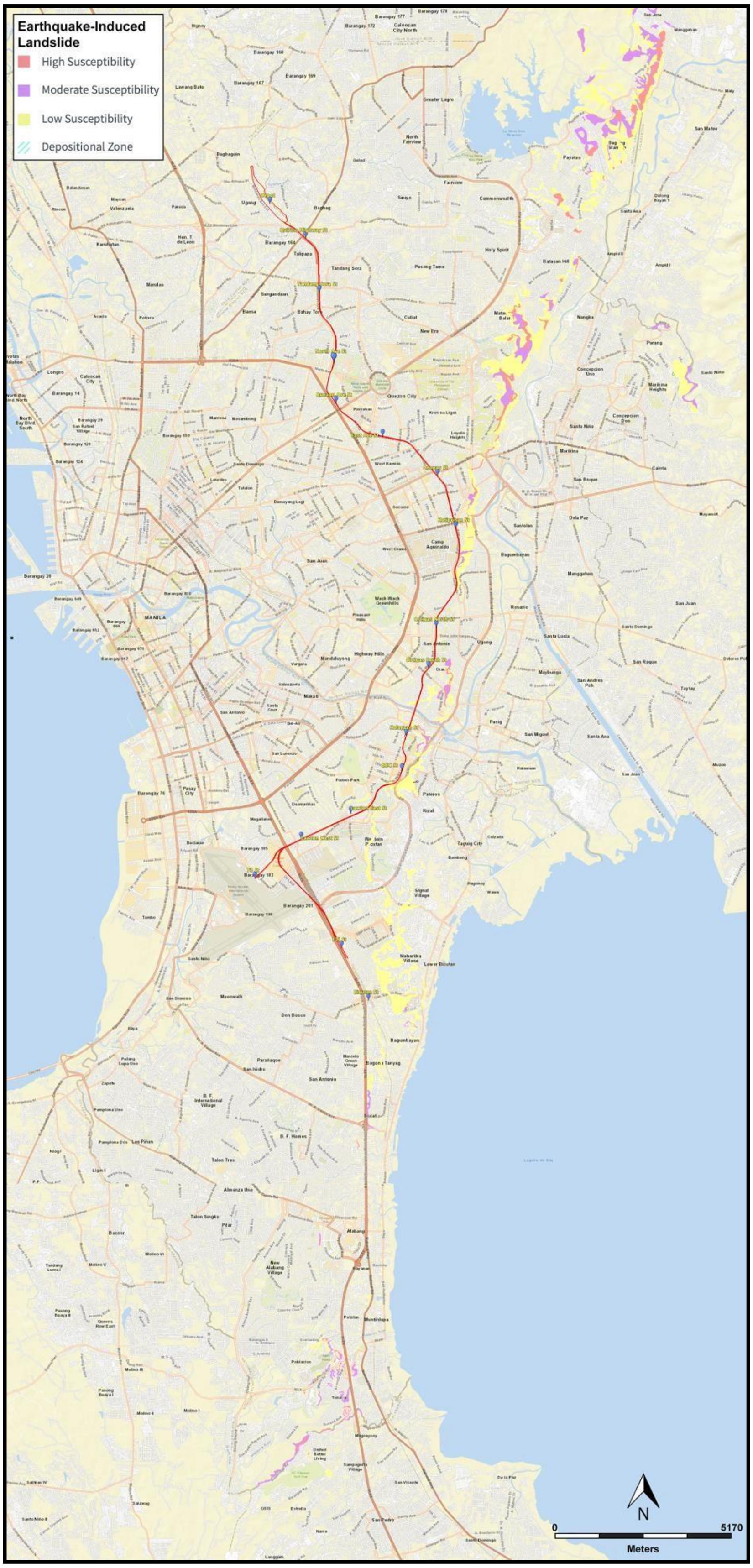


Figure 2.1-46 Earthquake-induced landslide hazard map of Metropolitan Manila (READY for GMMA Project, 2013)

Tsunami

Tsunamis are a series of waves caused by the sudden displacement of a large volume of water by natural phenomenon such as earthquakes, volcanic eruptions, underwater landslides or meteorite impacts. The waves can travel across open waters at vast distances and great speeds, building into shorter period but higher amplitude waves as they approach shallow bathymetries near the coast. On land, tsunamis can crash into structures and incorporate debris to form destructive slurries that can travel several kilometers inland.

Records show that of the 36 historical and recent earthquakes that caused damage to Metropolitan Manila, two were described to have generated a tsunami in Manila Bay –the Ms 7.2 1677 earthquake (Model 13) and the Ms 6.5 1863 Manila earthquake (Model 18) (JICA-MMDA-PHIVOLCS, 2004). The tsunami damage analysis for Manila Bay coastal areas was performed by JICA, MMDA and PHIVOLCS using earthquake scenarios from these two events, as well as from a Ms 7.2 West Valley Fault earthquake source (Model 8). As indicated in **Table 2.1-17**, a maximum 4-m tsunami height (average of 2 m) may be generated under Model 13 conditions (Ms 7.9, Manila Trench).

Table 2.1-17 Tsunami hazards of earthquake model scenarios

Parameters	Model 8	Model 13	Model 18
Magnitude	7.2	7.9	6.5
Fault Source	West Valley Fault	Manila Trench	Manila Bay source
Tsunami Hazard (along Manila Bay)	Will not occur	4 m max 2 m average	Small effect

from (JICA-MMDA-PHIVOLCS, 2004)

A more recent tsunami hazard assessment conducted under the READY for GMMA Project assumes a shallow, Magnitude 8.3 earthquake from the 14-16° segment of the Manila Trench. Under this scenario, up to 6 m of inundation may be experienced along the coast of Navotas, Port Area and Las Piñas. In the case of Navotas, tsunami flooding can reach 5.5 km inland, due to its low elevation.

The MMSP alignment is not susceptible to tsunami because of its elevation range (6 – 54 masl) and distance from the Manila Bay coastline, based on the assessment of the READY for GMMA Project (2014). NAIA T3 Station is the station nearest to the coast, with an approximate distance of 3.8 km. The farthest a tsunami generated by the Magnitude 8.3 earthquake scenario can inundated inland is 2.8 km, providing a buffer of about 1 km from the NAIA T3 Station.

Meanwhile, the Laguna Lake is not expected to directly generate a tsunami from fault movement. Tsunamis from this body of water may possibly be triggered by large landslides, although no such physical evidence of such an occurrence in the past has been found in the geologic record. The Bicutan Interconnection is the MMSP component closest to the coast of the lake, with a distance of about 1.9 km.

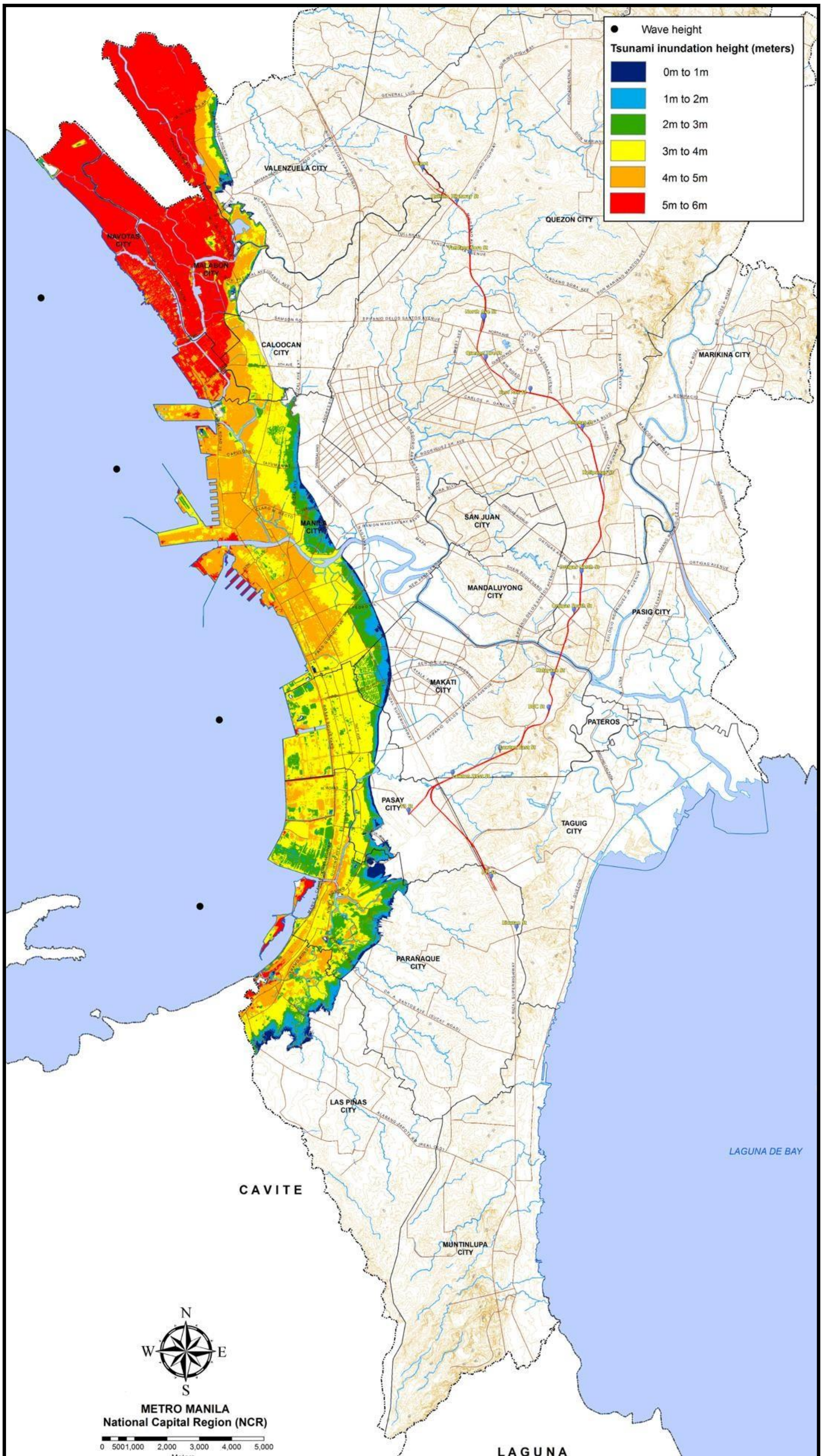


Figure 2.1-47 Tsunami hazard map of Metropolitan Manila (READY for GMMA Project, 2014)

Mass Movements

Rain-Induced Landslide

Rainfall is the most common cause of landslides in the Philippines. Slope failures in hilly or mountainous areas are frequently reported following short rain showers, lengthy monsoon rains, or intense typhoon events. Saturation of slope soil alters the ratio between shear strength (friction and cohesion) and shear stress (weight of overlying material and slope angle) (Dellow, 2013). As the pore spaces between particles are filled with water during rain events, pore water pressure increases, producing hydraulic uplift that counteracts the weight of the material that contributes to slope stability. At the same time, water acts as a lubricant that reduces intergranular friction and cohesion, allowing the particles to slip more freely.

Slope gradient also influences failure susceptibility. The angle of repose, which is the steepest angle of descent or dip of the slope relative to the horizontal plane when material on the slope face is on the verge of sliding, varies for different kinds of substrates and if conditions are wet or dry. As a rule of thumb, slopes with smaller gradients are more resistant to landslide movement.

As previously discussed, Metropolitan Manila is generally flat, rising gradually to the east at the edge of the Central Plateau (or the trace of the West Valley). As such, most of the metropolis is not susceptible to rainfall-induced landslide, as shown in the landslide hazard map of MGB (**Figure 2.1-48**). However, where elevations rise, higher levels of susceptibility are found. The highest points in Metropolitan Manila are found in northwest Quezon City (Barangay Bagong Silang). In this general area, landslide susceptibility ranges from Low to High. A relatively significant portion of Quezon City has Low landslide susceptibility owing to its undulating topography. The West Valley Fault scarp area in Pasig also has Low landslide susceptibility. Down south in Muntinlupa, the Low susceptibility rating is due to its location at the piedmont of Tagaytay Ridge, coupled with possible vertical displacement by the segment of the West Valley Fault that runs along this area. Areas with Low susceptibility are those that have gentle slopes with no identified landslides. Areas with Moderate susceptibility are those with moderately steep slopes where soil creep and other indications of possible landslide occurrence are present. Areas with High susceptibility are those that have steep to very steep slopes that are underlain by weak materials and with the presence of numerous old or inactive landslides.

The proposed alignment of the MMSP is located in areas that are not generally susceptible to landslide. A higher susceptibility rating (i.e. Low) is given to significant portions of the proposed alignment within Quezon City, from Quirino Highway Station down to Katipunan Station. The proposed stations in Pasig—Ortigas North Station and Ortigas South Station, also are within an area of Low rainfall-induced landslide susceptibility. The southern segment, from Kalayaan Station to FTI Station are not susceptible to landslide.

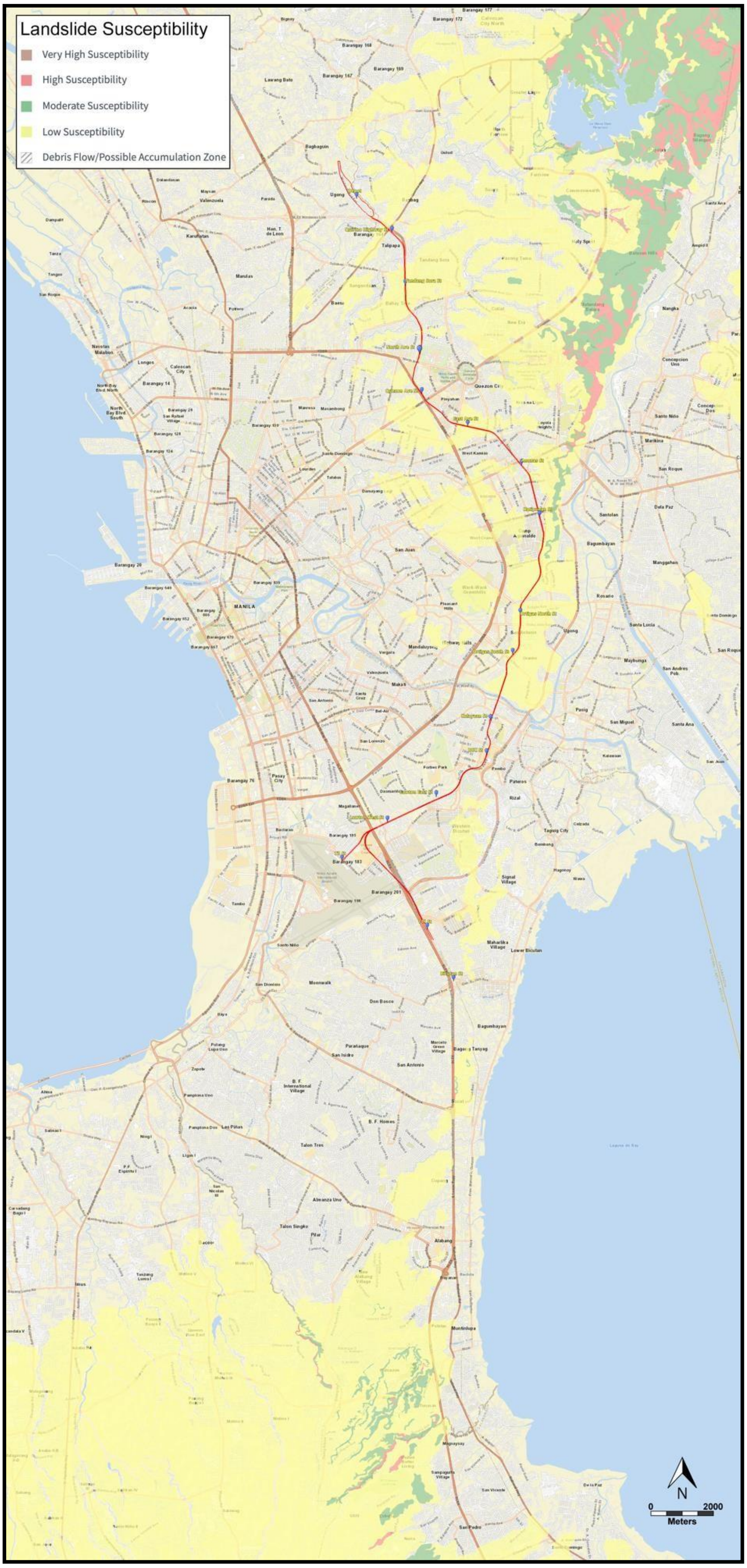


Figure 2.1-48 Rainfall-induced landslide hazard map of Metropolitan Manila (MGB, 2019)

Differential Settlement / Ground Subsidence

Substrate materials having different geotechnical properties from one another may have distinct weight-bearing responses when subjected to similar forces. If the ground in a particular area is composed of heterogeneous layers of varying thickness, the surface may settle unevenly, as some constituents may be more resistant to the pull of gravity or to overburden stress than others. In other cases, subsurface voids such as caves in karst areas or existing tunnel workings may cave in due to loss of support, causing the sinking of overlying material. Differential settlement can lead to structural damage of overlying buildings or facilities, in the form of tilting, cracking or even total collapse.

The uneven settlement of foundations can be caused by several reasons (The Balance Small Business, 2019)

- Underlying soil has weak bearing capacity;
- Soil foundation is poorly compacted or consolidated;
- Changes in soil moisture content;
- Presence of subsurface voids; and
- Vibration.

A type of settlement most commonly associated with changes in soil moisture content is ground subsidence. Although the two are technically the same, the latter has been widely correlated to ground deformation resulting from excessive withdrawal of groundwater. In concept, subsidence is the opposite of liquefaction, such that the loss of pore water pressure (as a result of groundwater extraction) helping support the foundation as a whole, leads to compression of the individual particles of sediments / soil into the spaces left behind by water. The cumulative filling of intergranular spaces eventually results in the sagging of the ground surface—subsidence.

The coastal plains surrounding the northern part of Manila Bay are underlain by river-delta muds with lesser layers of sand and gravel that are several hundreds of meters thick (Rodolfo, On the geological hazards that threaten existing and proposed reclamations of Manila Bay, 2014). Natural settling and compaction of the land results in subsidence estimated at a few millimeters per year. However, excessive withdrawal of groundwater has rapidly increased the rate of subsidence in this area. Leveling data from NAMRIA reveals areas in Metropolitan Manila that sank 0.68 – 1.34 m within 30 years (1979 to 2009) (Lagmay, 2011). Other studies have documented sinking by as fast as 9 cm/yr along the coastal areas surrounding Manila Bay (Rodolfo & Siringan, 2006; Siringan & Rodolfo, 2003; Rodolfo, Siringan, Remotigue, & Lamug, 2003). Analysis of Persistent Scatterer Interferometric Synthetic Aperture Radar (PSInSAR) data revealed that the subsidence rate in Metropolitan Manila from 2003 to 2006 reached 5.5 cm/yr in the Valenzuela, Malabon and Navotas areas (**Figure 2.1-49**) (Eco, Lagmay, Siringan, & Rodolfo, 2013).

Superimposing the MMSP alignment over the PSInSAR vertical movement map shows that the Depot is the most susceptible in terms of subsidence, with sinking rates of 4.5 – 5 cm/yr. The segment from Quirino Station to Quezon Avenue Station may also experience subsidence, but at lower rates. The rest of the alignment is shown to be not susceptible to ground subsidence.

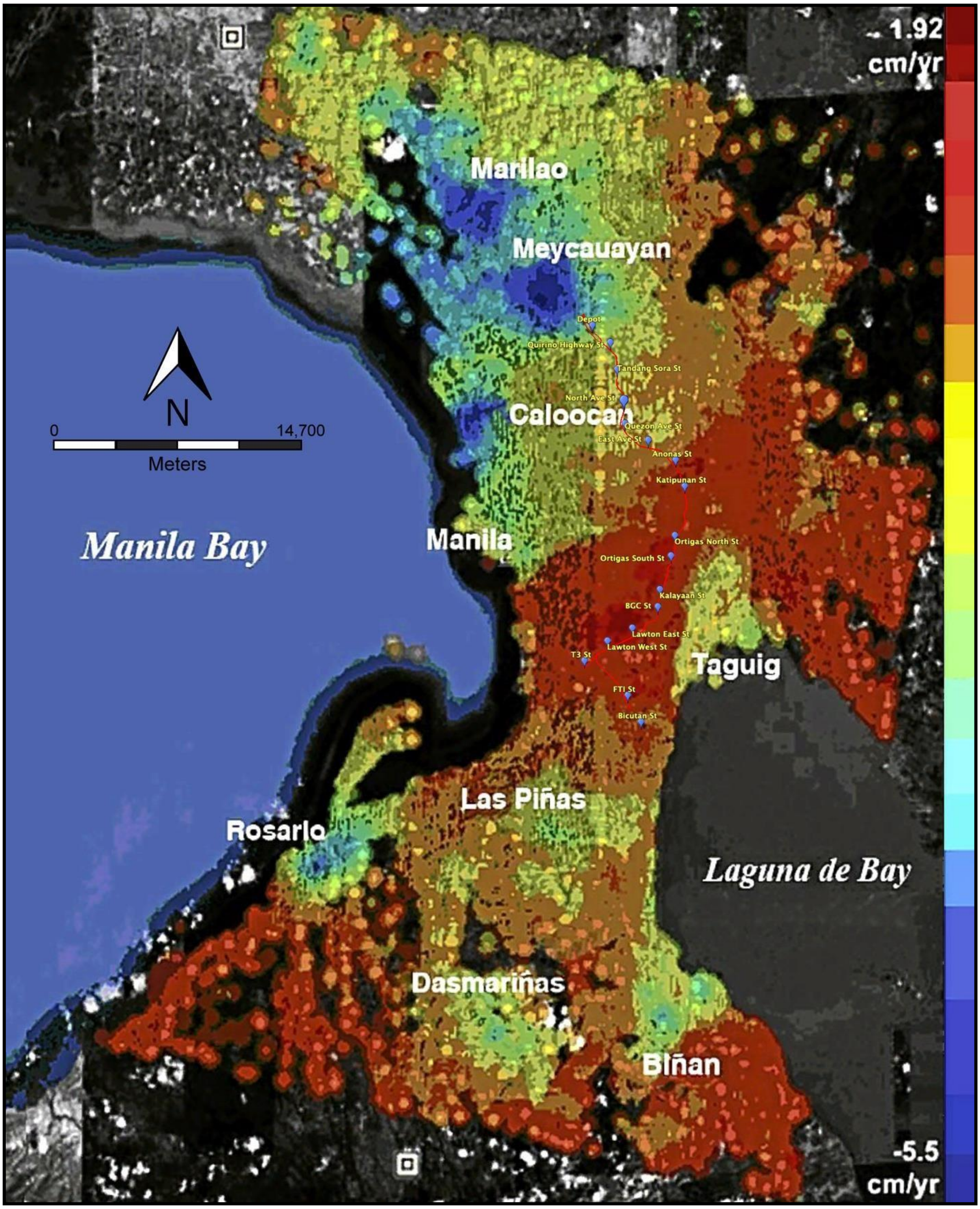


Figure 2.1-49 Vertical movement of Metropolitan Manila through PSInSAR. Blue color depicts ground sinking, while red color corresponds to upward or lateral movement toward radar satellite (Eco, Lagmay, Siringan, & Rodolfo, 2013; Lagmay, 2011)

Hydrological Hazards

Flooding

Flooding is one of the costliest natural disasters in the Philippines, causing displacement of people, and partial to complete damage to structures and properties. Aside from inundation by high water, flooding can also bring about torrential flows that collide with objects, erode riverbeds and riverbanks, and deposit large amounts of debris. It is common in low-lying floodplains or along river channels following intense precipitation brought by typhoon or monsoon rains.

Metropolitan Manila falls under the Type I Climate based on the Modified Coronas Classification, having two pronounced seasons, dry from November to April, and wet during the rest of the year, with maximum rains falling from June to September. An average of two storms pass through the general area of Metropolitan Manila every year. In the Science Garden station, the mean annual rainfall from 1981 to 2010 is 2,574.4 mm (PAGASA & Geoscience Australia). Climatological normals for Metropolitan Manila indicate a peak rainfall period from June to August, with 1170.2 mm of rain (PAGASA, 2018). Historical records of climatological extremes of rainfall from 1961 to 2010 from the Science Garden station show that the greatest rainfall in Metropolitan Manila occurred on August 6-8, 2012 during the onslaught of monsoon rains enhanced by Typhoon Haikui (locally dubbed Habagat 2012), with a measured accumulated rainfall of 1007.4 mm (Rappler.com, 2013).

The READY for GMMA Project flood hazard map of Metropolitan Manila (**Figure 2.1-50**) (READY For GMMA Project, 2013) shows that the majority of the metropolis has at least Low flood susceptibility, particularly over much of Taguig, Parañaque, Las Piñas, Makati, Pasay, San Juan and eastern Caloocan. Areas rated as having Low flood susceptibility are likely to experience flood heights of less than 0.5 m and/or flood duration of less than 1 day. Moderate flood susceptibility areas include most of Manila and Mandaluyong. These are areas likely to experience flood heights of 0.5 to 1 m and/or flood duration of 1 to 3 days and are subject to widespread inundation during prolonged and extensive heavy rainfall or extreme weather condition. Valenzuela, Pasig, Pateros, Marikina and Malabon have High flood susceptibility—these are likely to experience flood heights of 1.0 to 2.0 m and/or flood duration of more than 3 days. These areas are immediately flooded during heavy rains of several hours. Areas with Very High flood susceptibility include Navotas, western Marikina, northern Valenzuela and the border between San Juan, Manila and Mandaluyong (where the San Juan River flows). These are areas likely to experience flood heights of greater than 2 m and/or flooding of more than 3 days and are immediately flooded during heavy rains of several hours. These are also prone to flash floods. Quezon City, with its relatively high elevation and good natural drainage, is mostly not susceptible to flooding, except along the banks of its rivers and creeks.

Based on the READY for GMMA Project flood hazard map, the Quezon City segment of the proposed MMSP alignment is located on mostly No to Low flooding susceptibility, except along portions that intersect rivers and creeks where flooding susceptibility can be Moderate to High. Almost the entire segment from Ortigas North Station down to NAIA T3 and Bicutan are located in areas that have Low susceptibility to flooding.

Flood hazard analysis was also conducted by the Nationwide Operational Assessment of Hazards of the University of the Philippines (UP NOAH), for 5-, 25- and 100-year return period events. The 5-year flood hazard map of UP NOAH **Figure 2.1-51** shows practically the same susceptibility ratings and distribution as the READY for GMMA Project flood hazard map. Meanwhile, the 25- and 100-year return period maps (**Figure 2.1-52** and **Figure 2.1-53**) indicate higher and more widespread flood susceptibility in most of the city of Manila, as well as within the floodplain of San Juan River, Parañaque River and estuaries in Pasay. For the rest, flood susceptibility is mostly increased only along the immediate banks of rivers and creeks. The UP NOAH maps presented in this report do not include flood susceptibility layers for the Marikina Valley watershed.

Table 2.1-18 shows the flood susceptibility ratings in the proposed MMSP stations based on the READY for GMMA Project and UP NOAH hazard maps.

Table 2.1-18 Flooding susceptibility in proposed MMSP stations

Station Name	READY for GMMA Project	UP NOAH 5-Year Map	UP NOAH 25-Year Map	UP NOAH 100-Year Map
Depot	Low to Moderate	Medium	Medium to High	High
Quirino Highway Station	Low	Low to Medium	Medium	Medium to High
Tandang Sora Station	Not Susceptible	Low	Low to Medium	Low to Medium
North Avenue Station	Low	Low	Low	Low
Quezon Avenue Station	Moderate	Low	Low	Low to Medium
East Avenue Station	Not Susceptible	Low	Medium	Medium
Anonas Station	Low to Moderate	Low to Medium	Medium to High	Medium to High
Katipunan Station	Low	Low	Low	Low to Medium
Ortigas North Station	Low	Not Susceptible	Not Susceptible	Not Susceptible
Ortigas South Station	Low	Low	Low	Low to Medium
Kalayaan Station	Low	Not Susceptible	Not Susceptible	Low
Bonifacio Global City (BGC) Station	Low	Not Susceptible	Not Susceptible	Low
Lawton East Station	Low	Low	Medium	Medium to High
Lawton West Station	Low	Low to Moderate	Medium	Medium to High
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	Low	Not Susceptible	Low	Low to Medium
Food Terminal Inc. (FTI) Station	Low	Low to Moderate	Low to Medium	Low to Medium
Bicutan Interconnection	Low	Low	Low	Low to Medium

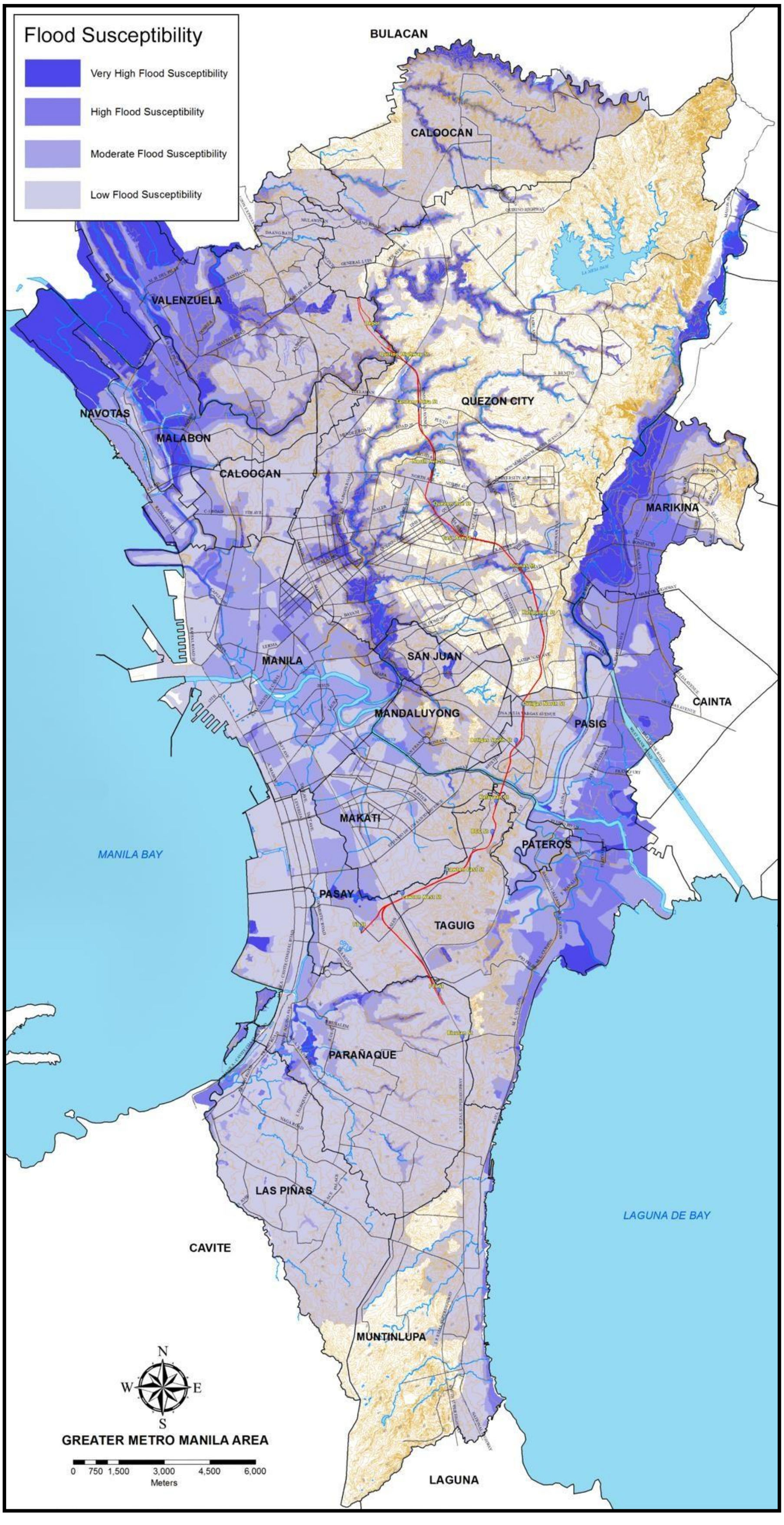


Figure 2.1-50 Flood hazard map of Metropolitan Manila (READY For GMMA Project, 2013)

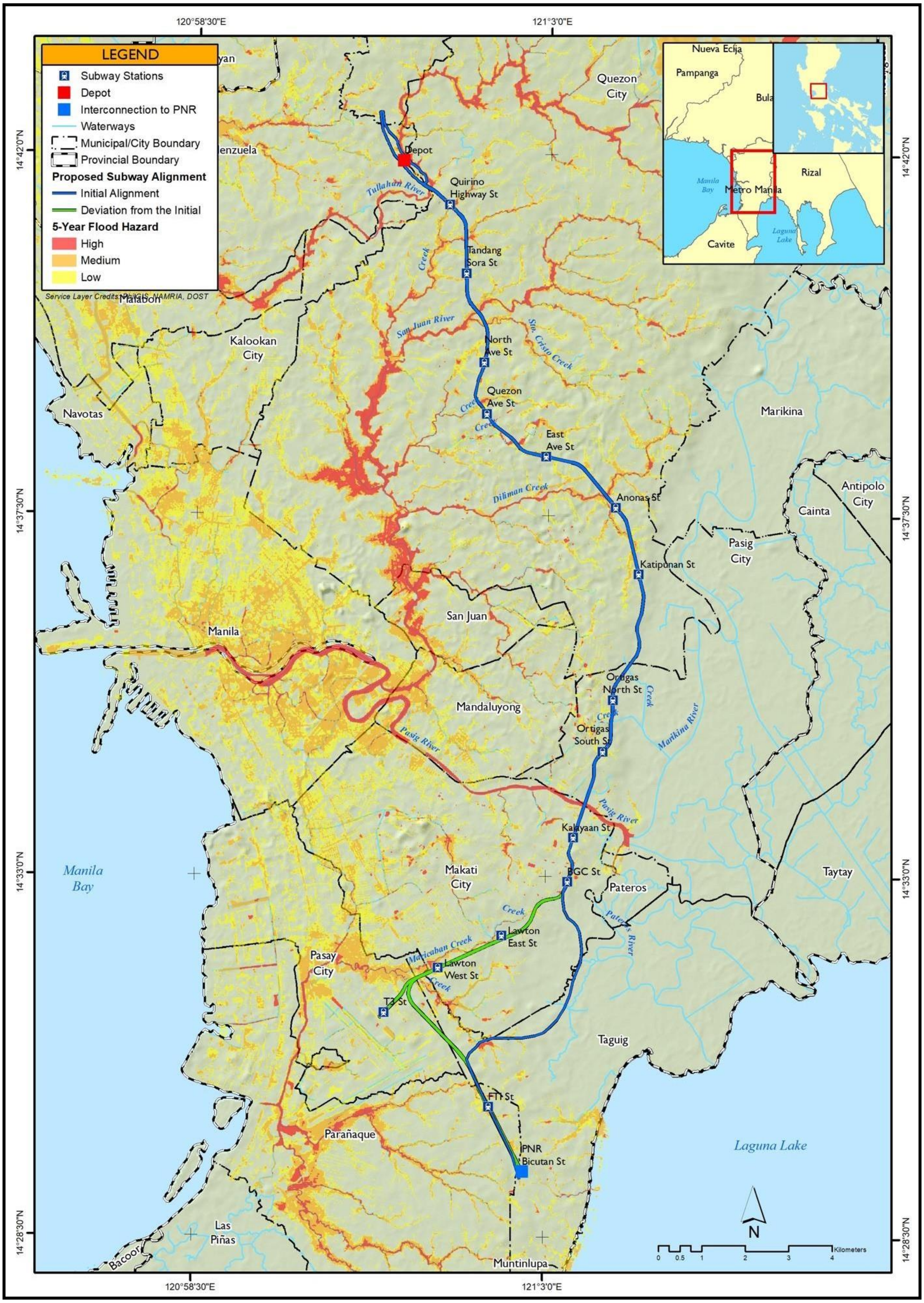


Figure 2.1-51 5-year flood hazard map (UP NOAH, 2019)

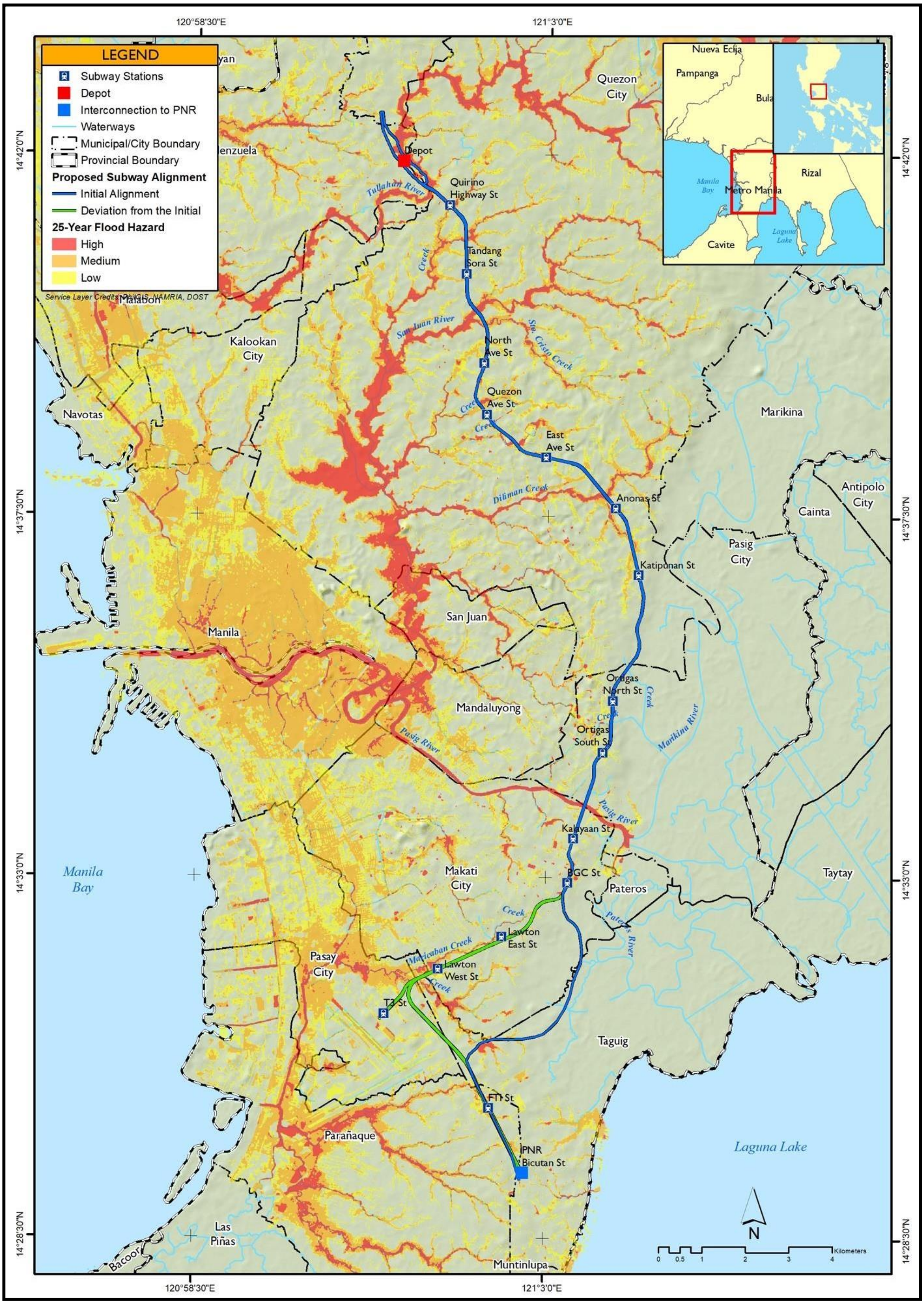


Figure 2.1-52 25-year flood hazard map (UP NOAH, 2019)

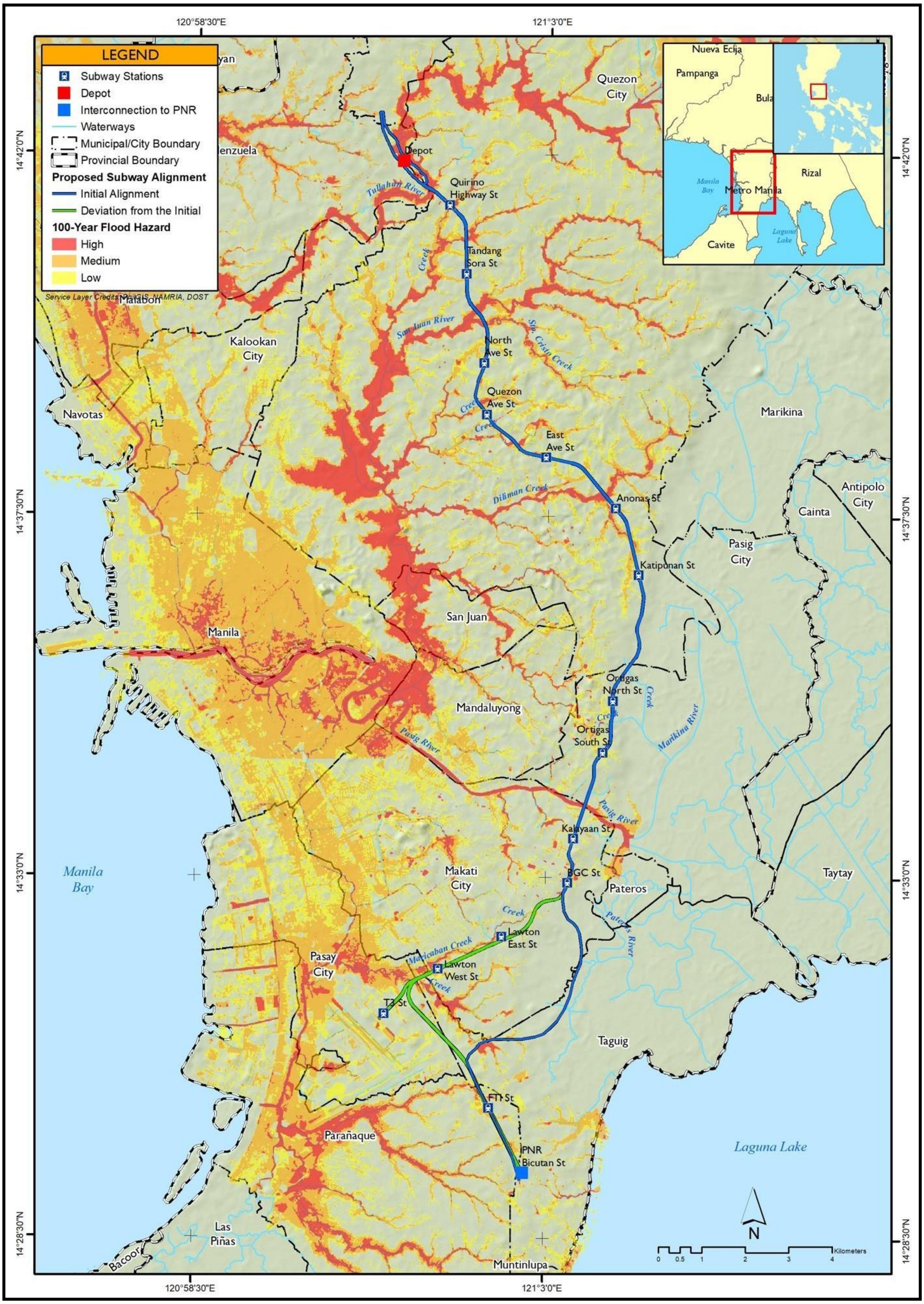


Figure 2.1-53 100-year flood hazard map (UP NOAH, 2019)

Coastal Hazards

Areas lying along the coast and fronting huge bodies of water are exposed to a variety of hazards mostly related to inundation by seawater. These include flooding, storm surge, tsunami and sea level rise resulting from climate change or coastal subsidence. Other hazards include coastal erosion, coastal sedimentation and submarine landslide. In Metropolitan Manila, the most vulnerable places to these hazards are Las Piñas, Pasay, Manila and Navotas.

As previously discussed, the proposed MMSP alignment is located centrally within Metropolitan Manila and does not approach either the coastline of Manila Bay or Laguna Lake. The MMSP stations and interchanges closest to these bodies of water are the NAIA T3 Station (3.8 km) and the Bicutan Interconnection (1.9 km). Both stations are also considerably elevated (13 and 37 masl, respectively) such that landward progression of inundation from seawater is unlikely to reach these places.

Volcanic Hazards

Volcanic processes prior, during, and succeeding eruptions give rise to numerous volcanic hazards that can have different types and magnitudes of impacts on people and property. Commonly known volcanic hazards such as lava flows, pyroclastic flows, lahars, ground rumbling, ashfalls and volcanic landslides typically affect areas immediately surrounding active volcanoes where these originate. In some instances, the effects of a volcanic eruption may reach great distances, especially if the eruption is powerfully explosive, and physical conditions are optimal. Volcanic quakes are just like tectonically-caused earthquakes that could cause destruction of structures resulting from strong ground movement and instability. Ashfalls, especially when mixed with water, can cause structural failure due to excess loading.

Underlying the Holocene alluvial deposits in the coastal areas of Metropolitan Manila are the widely distributed tuffaceous deposits comprising the Pleistocene Diliman Tuff. Petrographic and geochemical analyses of this deposit indicates emplacement by a volcanic origin. However, comparison with the trace and major element chemistries of Taal- and Laguna Caldera-derived volcanic rocks yielded distinct characteristics, so the vent source for the Diliman Tuff has not yet been determined. Regardless of origin, eruptions of such magnitude that produce deposits of this extent are extremely rare, with the last caldera-forming eruptions of Taal and Laguna Caldera occurring some 5,000 to 6,000 years ago (Catane S. G., Taniguchi, Goto, Givero, & Mandanas, 2005). More recent depositions of eruptive products by other active volcanoes have since been recorded in Metropolitan Manila, such as during the 1911 eruption of Taal Volcano and the 1991 eruption of Mt. Pinatubo, but these were mostly thin ashfall deposits that posed little threat to structures.

It will be noted, however, that volcanic hazards are not limited to the deposition of volcanic material. Metropolitan Manila has also been affected by strong ground shaking resulting from the explosive eruption of faraway active volcanoes. Taal Volcano, with its frequent Plinian activity, has been known to occasionally cause strong ground shaking in Manila. In the 18th century alone, three separate eruption events of Taal Volcano, in 1716, 1749 and 1754, shook the city and caused significant damage to property (Masó, 1910). There is a high probability that future eruptions of Taal Volcano may similarly affect Metropolitan Manila.

2.1.3.2 Environmental Performance, Potential Impacts, and Options for Prevention, Mitigation, and/or Enhancement

Environmental Performance

At present, the MMSP is still in its Feasibility and Design stage—no construction for any of the proposed components has commenced yet. So far, the only groundworks conducted as part of the Feasibility stage are geotechnical borehole drillings performed at key locations along the target MMSP alignment. In terms of geology, geohazards and soils, there are no regulatory standards set for future monitoring parameters. Instead, guidelines are in place to ensure safety during the construction and operation phases of the project. These guidelines include structural design regulations under the National Building Code and National Structural Code of the Philippines. These codes provide standard protocols for on-site and laboratory testing, and give guidance in the selection of appropriate variables and parameters for structural design. The most common compliance requirement related to geology, geohazards and soils is the submission of the EGGAR as per DENR Administrative Order No. 28 Series of 2000 and MGB Memorandum Circular No. 2000-33. Depending on impact and relevance to the existing environment, soil quality and geotechnical monitoring may be included in the project's Environmental Management and Monitoring Plan (EMMoP).

Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement

Table 2.1-19 Summary of potential impacts and options for prevention, mitigation, and/or enhancement – Geology,

Geomorphology and Geohazards

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construction	Construction	Operation	Closure	
Change in surface landform / geomorphology / topography / terrain / slope					
Although largely underground, some surface works, such as cut and cover, will be entailed during pre-construction. This can slightly alter the original topography along the alignment.	✓				Minimize ground disturbance through avoidance of unnecessary excavations. Ensure that roads repaired after surface works would follow the same slope conditions prior to construction.
Voluminous amounts of soil and rock will be excavated during pre-construction, which will have to be transported to a storage facility.	✓				Regular hauling of excavated materials and storage in pads with appropriate soil protection facilities or management systems Surplus soils can be repurposed for use in other project Prepare traffic plan to manage the ingress and egress of soil/rock hauling machines
Change in subsurface geology / underground conditions					
Tunneling will alter existing underground stress distributions	✓	✓	✓		Perform tunnel deformation analysis to determine how the hollowing of ground will affect underground stress regimes

Installation of buried facilities and introduces new material types to the ground which can react with the soil		✓	✓		Use non-reactive materials for pipes and other buried components to ensure that soil contamination is prevented.

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construction	Construction	Operation	Closure	
Solid wastes generated can be cause of pollution that would impact the quality of surrounding soil/ ground	✓	✓	✓		Implement proper waste management and disposal system to prevent contamination of surrounding soil and water.
Excavation and tunneling may accidentally hit buried facilities such as pipelines that could spill contaminants to the groundwater and soil.	✓				Perform due diligence and utilities survey Adjust design to avoid utilities or coordinate with utility owner on how to transfer these to another location.
Buried pipeline may leak water underground		✓	✓		Use strong and durable materials for pipes to prevent leakage.
Inducement of subsidence, liquefaction, landslides, mud/debris flow, etc.					
Tunneling will leave an underground void which will affect pore water pressure of overlying materials, leading to possible ground subsidence	✓	✓	✓		Perform tunnel deformation analysis to determine how the hollowing of ground will affect underground stress regimes Install piezometers to monitor groundwater pressure around the tunnel, Ensure that the tunnel is sufficiently supported and lined to prevent failure and ingress of groundwater.
Leakage from pipes may saturate the ground, causing it to soften and subside.		✓	✓		Use strong and durable materials for pipes to prevent leakage.
Continuous operation of heavy machinery produces vibration that may induce liquefaction.	✓	✓	✓		Perform liquefaction tests on segments found to have indications of liquefiable soil. Use vibration dampers, if necessary.
Inducement of flooding					
Excavation and tunneling sites may collect rainfall and groundwater, creating pools of water.	✓	✓	✓		Do not let excavation pits and trenches collect water. Provide necessary drainage (e.g. pumps) in excavated components.
Burst pipes can leak significant amounts of water to the surface, which could cause flooding.	✓	✓	✓		Use strong and durable materials for pipes to prevent leakage.
Inducement of soil erosion					
Erosion of stockpiled excavated or burrowed soil due to exposure to rainfall and air can lead to dust generation and increased siltation of water bodies.	✓	✓			Regular hauling of excavated materials and storage in pads with appropriate soil protection facilities or management systems

Soil Contamination

Site preparation activities during the pre-construction phase will generate waste such as concrete debris, rebars, and rubbles from the demolition, soil and other land clearing debris, such as stumps, rocks and dirt. The generated solid wastes in the demolition areas (as part of land preparation) can contaminate soil and water bodies. Recycling of wastes will be implemented, as much as possible, through sorting, stockpiling and containing recyclable wastes. Where appropriate, leftover concrete and metals will be used for suitable alternative projects. Contaminated solid wastes will be disposed through an accredited transport, storage and disposal (TSD) facility.

Soil may become contaminated during pre-construction works due to leaks and accidental spills of cleaning materials for equipment, fuels and lubricants from construction vehicles and machineries. Use of inadequate chemical injection method can also pose potential soil contamination. Releases due to leaks may result in relatively insignificant amount of contaminants in the soil. Potential large spills from fuel and lubricants for the machineries, and other chemicals could cause a more serious effect.

To prevent negative adverse impact to the quality of soil during construction, contractors must be required to:

- Implement proper handling and management of chemicals
- Practice good housekeeping at construction sites
- Establish and implement an emergency and contingency plan in case of spills as well as health and safety management plan
- Store bulk chemicals, such as fuel, lubricants and other chemicals, in an impermeable area and with appropriate secondary containment and,
- Comply with environmental permitting requirements for the storage, transport, treatment and handling of hazardous substances and wastes.

During tunneling and excavation through cut and cover method, the presence of artificial subsurface structures will be considered in the design phase to prevent damage and subsequent soil contamination. Aside from the presence of sewers along the alignment, the FPIC gas pipeline is one example of a subsurface structure that could be encountered during construction of underground walkway, specifically from West Service Road going to the proposed FTI Station. The presence of these subsurface structures is currently being studied through a Utility Survey conducted by another JICA consultant, as part of the MMSP feasibility study. Based on results of the Utility Survey, adjustments in depth or slight realignment of the subway structure during the design phase, if necessary, will minimize the risk of soil contamination due to damage of potential gas pipelines or other structures which can release toxic substances when damaged.

Generation of Excavated Soil

An estimated volume of 5.22 million cubic meters (m3) of surplus soil will be generated over the entire construction period, estimated at 5 years. Excavation through cut and cover at the stations is estimated to generate 130 m3 of excavated soil per day per construction party, while excavation through tunnel boring machine (TBM) will approximately generate 200 m3 of excavated soil per day for each TBM. Given this scenario, the estimated number of dump trucks needed to haul the surplus soil at a rate of 10 m3/truckload is as follows **Table 2.1-20**.

Table 2.1-20 Estimated daily soil hauling requirement

Method	Estimate Rate of Extraction (m3/day)	No. of Hauling Trucks Needed (per day)
Cut and cover	130 (per construction party)	13 (per construction party)
Tunnel Boring Machine	200 (per TBM unit)	20 (per TBM unit)

A more detailed shield excavation plan specifying how many TBMs and construction parties will operate simultaneously will be established during the DED phase. Nevertheless, in order to gain a rough picture of the potential impact of surplus soil generation, the operation of 15 TBMs per day at 20 working hours/ day will be used as an example. Considering this scenario, a total of 3,000 m3 of spoils will be generated per day, which translates to 300 trucks required to haul the spoils per day, or about 30 trucks that will be running the road per hour from the construction site route to the recipient site.

Hence, if not managed properly, the generation of spoils will cause severe traffic congestion. Likewise, the number and frequency of heavy trucks plying the road from the construction site to the disposal/ re-use site will easily cause damage of roadways.

Other impacts of surplus soil if not properly mitigated are increased sedimentation in nearby bodies of water if it is discharged to water bodies through run-off, and devaluation of land value.

As one of the mitigating measures, the surplus soil can be used as (1) backfilling of quarry sites in the province of Rizal; (2) projects involving elevation of low-lying areas by the PDRRMC in Regions III and IV; (3) projects of DPWH and DOTr, and (4) reclamation projects to be coordinated with the PRA and LGUs within Metro Manila. The least prioritized option will be the disposal of soil in a landfill. It is of utmost importance that recipients of surplus soil be identified and well-coordinated prior to the construction phase to prevent delay in the tunneling works and most importantly to avoid the adverse environmental impacts of surplus soil generation.

The management of surplus soil will also be integrated in the detailed construction plan to consider the timing of generation of excavated soil and backfilling in other stations, the ingress and egress of excavated soil, and the immediate hauling of excavated soil to recipient sites where these are needed. The detailed construction plan shall also be the basis for establishing a Traffic Management Plan, which will be coordinated with the Metro Manila Development Authority (MMDA) and relevant LGUs.

The MMSP is bound to comply with the JICA Environmental and Social Guidelines, thus, to ensure that the excavated soil does not contain traces heavy metals that area beyond the acceptable standards, periodic analysis of heavy metal levels in surplus soil shall be conducted. If considerable high level of heavy metal is identified, proper management and disposal to an accredited TSD facility shall be implemented.

Soil Erosion

Due to the uncovering of land during pre-construction, soil erosion is expected to increase with higher soil exposure to rainfall and air. This is especially true with the residential and commercial areas that will be affected during this phase of the project. Constructing a temporary or even a permanent drainage will decrease the effects of added soil exposure to rainfall. Shortening the time between the pre-construction phase and the construction phase may also decrease the added erosion expected to occur.

Proper planning and scheduling of works will be done to ensure that excavated soil is immediately transported to recipient sites. This measure will prevent stockpiling of spoils along the project area, which could otherwise cause changes in the topography of the area. A soil stockpile facility with appropriate erosion control measures will be selected, to prevent causing erosion and/or sedimentation in that area. To prevent further erosion, a good drainage system can also be installed along the project area. This will prevent possible flooding in the area as well.

Flooding

Excavations and tunneling result in the formation of depressions and voids into which water, by the force of gravity, tends to go into. Pits can get filled up and form pools when rain water accumulates with no sufficient drainage. Burrowing below the water table will let groundwater to ingress into the void and cause flooding that can potentially cause tunnel failure. In either case, it is important to provide sufficient drainage to allow water to escape. Clean water can be discharged into natural waterways through gravity pipes or mechanized pumps after securing a Discharge Permit from the DENR or the Laguna Lake Development Authority (LLDA). When the water has been tested to be non-compliant to water quality guidelines of DENR, it may be necessary to install a water treatment system or facility to remove undesirable constituents prior to discharge. Some segments of the alignment have a higher susceptibility to surface flooding, so it is necessary to have the proper equipment for monitoring and dewatering. Flood emergency response system must also be instituted and implemented throughout all phases of the MMSP.

Change in Subsurface Conditions

The greatest impact of tunneling is the creation of a void that would greatly alter the distribution of underground pressure. The loss of voluminous amounts of rock and soil material would greatly reduce the bearing capacity of the rock and soil material that would be left to shoulder additional stresses. The creation of a space will also encourage groundwater to seep into the void, which in turn, would alter pore water pressures if the tunnel is below the water table. Deleterious consequences of these changes include subsidence of the ground surface, mud rush, tunnel collapse and loss of groundwater supply.

Tunnel deformation analysis must be conducted to simulate the stress changes brought about by tunneling.

This will help determine the selection of appropriate support structures to prevent tunnel deformation and collapse. A good understanding of groundwater flows and pressures can help anticipate the volume of water ingress so that the correct type of tunnel lining will be used. This will also help ensure that pore water pressures are kept at stable levels that would prevent the occurrence of subsidence (when pore water pressure is significantly decreased) or liquefaction (when pore water pressure is significantly increased).

To ensure that the tunnel will not collapse, the tunnel must be suitably supported using appropriate methods. **Table 2.1-21** shows some support recommendations based on rock mass conditions.

Table 2.1-21 Recommended tunnel support types per rock class

Rock Class	Rock Mass Condition	Support Type
Class I	Fair rock condition	Steel fibre reinforced shotcrete (10 cm) + systematic bolting 2x2 m grid 4 m long
Class II	Fair to poor rock conditions	2.5-3.0 cm first shotcrete layer to be applied immediately after excavation to prevent slaking of the mudstone layers Steel fibre reinforced shotcrete 15 cm + systemic bolting 1.5 m x 1.5 m 4 m long Steel ribs with 1.5 m spacing where required
Class III	Poor to very poor rock conditions	2.5-3.0 cm first shotcrete layer to be applied immediately after excavation to prevent slaking of the mudstone layers Top hat sections (yielding) steel ribs with sliding joints Invert support installed to control floor heave and to provide a footing for the steel sets Shotcrete 15-20 cm Self-drilling rock bolts as required 1x1 m grid 12 m long grouted fibre glass dowels to reinforce the rock immediately ahead of the face where required (sheared mudstone)
Class IV	Very poor rock conditions	Forepole umbrella with 12 m-long pipes (4 m overlap) 2.5 to 3.0 cm first shotcrete layer to be applied immediately after excavation to prevent slaking of the mudstone layers Steel ribs to support the forepole umbrella and the rock mass (installed as close as possible to the tunnel face) Invert support installed to provide a footing for the steel sets 1x1 m grid 12 m-long grouted fibre glass dowels to reinforce the rock immediately ahead of the face where required (weathered mudstone)

Piezometers must be installed during tunnel construction to understand the expected groundwater regime and pressures. These will be monitored throughout the duration of the construction, and if possible, during operation. Level metering must also be conducted during construction to monitoring changes in ground elevation caused by tunnel-induced deformation. These surface monitoring works will carry on throughout operations as a manner of early detection of ground deformation.

2.1.4 Terrestrial ecology

This terrestrial ecology assessment was accomplished following the requirements of the Technical Scoping and Screening Form signed on 16 July 2019 as part of the Preparation and Securing of Environmental Compliance Certificate (ECC) for the MMSP. To comply with DENR-EMB's EPRMP as required in the Philippine Environmental Impact Statement System (PEISS), the assessment was undertaken following Presidential Decree 1586 (PD 1586), and in line with the requirements, procedures, and guidelines outlined in the Procedural Manual for DENR Administrative Order 2003-30 or the Implementing Rules and Regulations of PD 1586, and subsequent memoranda and issuances relevant to the PEISS.

The assessment included both vegetation and wildlife along key sections of the entire project length and immediate greenspaces. Given the location of the MMSP (within highly urbanized cities), available secondary data [i.e. Environmental Impact Statement for the original alignment - Phase 1 (submitted in September 2017), unpublished and published researches, incidental observations, and bird watching activities) were used as the main baseline information for the project. Additionally, supplementary information through rapid site assessments along key stretches of the revised project alignment were included. The rapid site assessments were undertaken by two specialists and assisted by an environmental scientist who have extensive experience in conducting field surveys.

The main objectives of the assessment were to establish baseline ecological values along the entire length of the MMSP. And as part of the impact assessment process, determine potential project impacts and recommend corresponding mitigations. Specifically, the terrestrial ecology assessment aims to:

- Describe existing ecological values (e.g. vegetation communities; available wildlife habitat resources; identify threatened, native and endemic species for both vegetation and wildlife; identify potential bird congregation areas; and others) that may be affected by the project;
- Perform rapid site assessments to determine remaining vegetation and wildlife along key stretches of the revised project alignment;
- Determine potential impacts caused/ influenced by the various phases of the project; and
- Determine best options for prevention and/or mitigation of potential impacts.

a) Study Areas: NCR's Urban Greenspaces, and Vegetated Center Islands and Sidewalks

The National Capital Region (NCR) is the Philippines' seat of power and development. It is comprised of 17 contiguous cities and municipalities with an overall land area of approximately 638 km^{-2} (i.e., 0.20% of the national land area). It is geographically situated in the lowlands of southwestern Luzon Island and is located on the eastern coast of Manila Bay, at the mouth of Pasig River.

The entire MMSP alignment including the revised stretch incorporating the new stations (i.e. Lawton East, Lawton West, T3, FTI and Bicutan Stations) straddles along seven (7) major cities in the NCR. To date, these cities are highly urbanized and original vegetation cover therein which serve as important wildlife habitats have long been removed and converted into development areas. As it is now (without the MMSP), remaining biodiversity along major portions of the entire project length is already depauperate. Some of the major disturbances in these urban environments are growing human population, pollution, and conversion of natural habitats to built-up areas hence, they are simply with low conservation significance (Vallejo *et al*., 2009). However, within this sea of urban development, are few islands of greenspaces which serve as sanctuary for NCR's remaining wildlife. These greenspaces are usually characterized by woodland patches (mostly comprised of exotic species), shrubland interspersed with small trees, well-maintained or manicured lawns with uncut grassy portions, some are with artificial lagoons, some are traversed by a water body, and most are with built-up portions (e.g. office buildings, drainage or stormwater canal, memor ial stones, fences, concrete pathways, and monuments).

In terms of terrestrial ecology assessment for the MMSP, emphasis was given to these gr eens paces and other vegetation patches adjacent or directly on top of the proposed MMSP alignment as they may potentially be affected by the Project's various phases. There were 27 major greenspaces identified in various locations along the entire MMSP alignment (see **Table 2.1-22**). They range in distance from 0.1 to 9.0 km perpendicular distance from the proposed alignment (see **Figure 2.1-54**).

Table 2.1-22 List of Major Greens pa c es Adjacent to the Proposed MMSP Alignment

Name of Greenspace	Approximate Area (ha)	Approximate Distance from MMSP (km)
Filinvest City	195.8	9.231
LPPCHEA	169.7	4.949
Libingan ng mga Bayani	140.0	1.348
Heritage Park	140.0	1.815
Philippine Navy Golf Course	37.1	0.971
Villamor Air Base Golf Course	56.2	0.126
Philippine Army Golf Course and Stadium	18.9	0.509
American Memorial Cemetery	58.4	0.301
Manila Polo Club	22.8	0.756
Manila Golf & Country Club	43.8	0.971
Manila South Cemetery	26.9	3.839
Wack Wack Golf and Country Club	114.0	1.584
Camp Aguinaldo Grounds	20.0	1.137
Camp Aguinaldo Golf Course	2.0	1.384
Marikina River Banks	3.9	1.915
Manila North Cemetery	142.5	5.338
Ateneo de Manila University	38.3	2.608
UP Hardin ng Rosas	14.0	1.476
Open Space corner EDSA and Quezon Ave.	7.0	1.707
Philam Village	3.2	3.182

Ninoy Aquino Parks and Wildlife Center	20.6	0.909
Quezon Memorial Circle	27.8	1.380
UP Diliman	63.8	2.302
Veterans Memorial Medical Center	54.8	0.383
UP Arboretum	18.2	1.660
Bagbag Cemetery	4.9	0.684
Holy Cross Memorial Park	46.2	0.923

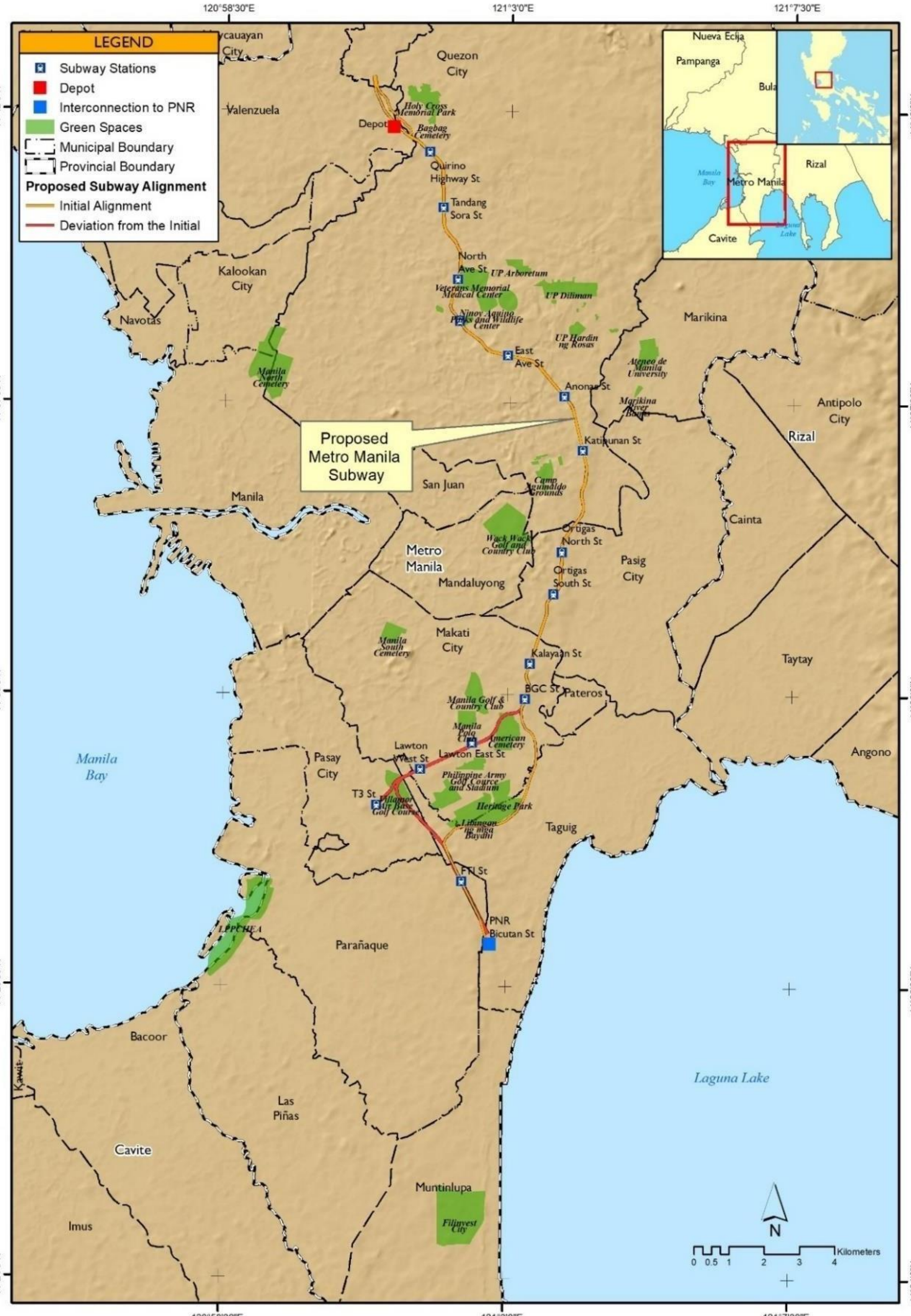


Figure 2.1-54 Site map of proposed Metro Manila Subway relative to major adjacent greenspaces

b) Secondary Data Sources

The Environmental Compliance Certificate (ECC) for the original MMSP alignment was issued by the DENR based on the EIS submitted in 2017. Baseline data contained in the EIS (2017) was utilized in this report to describe the terrestrial ecology (vegetation and wildlife) along key portions of the original alignment. Additional data for both vegetation and wildlife based on rapid site assessments (through transect walk surveys for vegetation and point observations for wildlife) were gathered to characterize the revised alignment of the MMSP. Results of the rapid site assessments were integrated with the baseline data contained in the EIS (2017) to come-up with an overall species list of vegetation and wildlife recorded along and near the original and revised alignment of the MMSP. Moreover, additional secondary data (both published and unpublished) were included to establish a more robust baseline for the wildlife section. It will be noted that the EIS (2017) did not perform primary data collections for wildlife and overall assessment was simply limited for the said section.

The range distributions (including endemicity) and conservation status (Threatened, Near Threatened, and Least Concern) of recorded species were based on scientifically recognized literatures, local legislation (i.e. republic act), and memorandum orders. **Table 2.1-23** presents the list of secondary data sources used in the terrestrial ecology assessment.

Table 2.1-23 Source s of secondary information – Terrestrial Ecology

Information / Data / Document Descript ion or Title	Author and Date Published / Generated
Environmental Impact Statement (EIS) for Metro Manila Subway Project (MMSP; Phase 1)	Department of Transportation 2017 2017
DENR Administrative Order No. 2017 – 11; Updated National List of Threatened Philippine Plants and Their Categories	Department of Environment and Natural Resources 2017
Republic of the Philippines - Congress of the Philippines. Wildlife Act – Republic Act No. 9147 (2001). Metro Manila.	Congress of the Philippines (2001)
International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2019	International Union for Conservation of Nature (2019)
AECOM. 2018 Rapid Site Assessment of Filinvest City as Part of LEED Accreditation Process.	AECOM Philippines Inc. (2018)
Bajarias, A. (2016). A Field Guide to Flight: Identifying Birds on Three School Grounds (pp. 1-142). Quezon City: Ateneo de Manila University Press.	Ateneo de Manila University Press. (2016)
Birds of the Philippines - Ayala Alabang Birds. Retrieved 25 July 2019, from https://www.tonjiandsylviasbirdlist.com/Birds -By-Location/Ayala-Alabang-Birds/	https://www.tonjiandsylviasbirdlist.com/Birds -By-Location/Ayala -Alabang- Birds/ (2019)
Cuyegkeng, A., Favis, A., Gotangco, K., & Tan, M. (2014). Ateneo de Manila University Sustainability Report - July 2014.	Ateneo de Manila University (2014)
de Guia, M. 2018 (unpublished). Bird Watching Observations near the northern perimeter fence of Forbes Park	Michael de Guia (2018)
The Convention on International Trade of Endangered Species of Flora and Fauna| CITES. (2019). Retrieved 25 July 2019, from https://www.cites.org/eng/disc/species.php	CITES (2019)

Information / Data / Document Descript ion or Title	Author and Date Published / Generated
Vallejo, B., Aloya, A., Ong, P., Tamino, A., & Villasper, J. (2008). Spatial Patterns of Bird Diversity and Abundance in an Urban Tropical Landscape: The University of the Philippines (UP) Diliman Campus. Science Diliman, 20(1), 1-10.	Science Diliman (2008)

c) Field Surveys and Sampling Areas

To supplement the EIS (2017) baseline data (as it was limited within the original alignment), additional rapid site assessments were performed along the revised section of the MMSP. Emphasis was given on woodland areas, vegetated sidewalks and center islands, and patches of mixed vegetation as they are the likely areas to harbor high biodiversity concentrations. Moreover, proposed station locations and other areas that will be subjected to vegetation clearing were also included to determine species therein that may potentially be affected by the MMSP.

The geographical location, approximate length, and general description of the four (4) terrestrial vegetation transects to characterize the revised MMSP alignment are listed in **Table 2.1-24** and shown in **Figure 2.1-55** to **Figure 2.1-59.** Also presented in this section is the summary of survey schedules and location map of terrestrial vegetation transects and wildlife observation points (**Table 2.1-25**). It will be noted that wildlife observation points for the MMSP revised alignment are integrated in the vegetation transects to correlate their findings. For comparison of the original and revised MMSP alignment in terms of vegetation cover, we have provided vegetation descriptions of the proposed stations in the original MMSP alignment based on the EIS (2017) were also included (**Table 2.1-26**).

Table 2.1-24 Summary of site descript ion across additional transect s – Terrestrial Ecology

Site Name	Length (km)	Coordinates *	Genera l Description
Transect 1	1.73	**Start**: 14° 29' 22.629" N; 121° 2' 40.818" E **End**: 14° 30' 12.515 " N; 121° 2' 14.156" E	This transect is located between FTI station and Bicutan Station. It is parallel to the train station and primarily composed of a mixture of mature and sapling or pole-sized trees. Patches of grasses between trees can also be observed within the transect. The transect is dominated by *Swietenia macrophylla* (Big leafed mahogany), *Pterocarpus indicus* (Narra) and *Mangifera indica* (Mangga) planted along each side of the road (**Figure 2.1-56**)
Transect 2	1.75	**Start**: 14° 32' 43.920" N; 121° 3' 06.789" E **End**: 14° 32' 11.770 " N; 121° 2' 48.829" E	This transect is located within the vicinity of American Cemetery (perpendicular to the alignment between BGC station and Lawton East Station). The whole stretch of the transect is planted by a mixture of trees and palms. Palms such as *Roystonea regia* (Royal palm) dominates the islands of the road. Similar with Transect 1, Transect 2 is also dominated by a native tree species, *Pterocarpus indicus* (Narra) planted on each side of the road (**Figure 2.1-57**).
Transect 3	0.96	**Start**: 14° 31' 28.814" N; 121° 1' 27.047" E **End**: 14° 31' 49.943 " N;	This transect is located along the perimeter of Villamor Air Base Golf Course (perpendicular to the alignment between Lawton West Station and T3 station). Most of the trees recorded in this transect are located behind

		121° 1' 07.472" E	concrete or metal fences, hence there was a minor difficulty in identifying the species. Similar with the first two transects, it is also dominated by *Pterocarpus indicus* (Narra) with the addition of *Swietenia macrophylla* (Big leafed mahogany) and *Spathodea campanulata* (African tulip) (**Figure 2.1-58**)
Transect 4	0.90	**Start**: 14° 32' 15.597" N; 121° 2' 22.847" E **End**: 14° 32' 03.836 " N; 121° 1' 58.469" E	This transect is located within Bonifacio Heights Condominium (parallel to the alignment between Lawton East station and Lawton West station). It is characterized by having small-, medium- and large-sized trees planted mainly around the condominium, especially the parking lots. Varied sizes of *Terminalia catappa* (Talisai) dominates this transect (**Figure 2.1-59**).

** Projected coordinate system: WGS 1984 UTM 51N*

Table 2.1-25 Summary of field surveys and sampling activities – Terrestrial Ecology

Field Activity	Date Conducted	Map Reference
Vegetation survey at Transect 1	18 June 2019	Figure 2.1-56
Vegetation survey at Transect 2	19 June 2019	Figure 2.1-57
Vegetation survey at Transect 3	19 June 2019	Figure 2.1-58
Vegetation survey at Transect 4	20 June 2019	Figure 2.1-59
Point observations for birds and other wildlife	29 June 2019	Figure 2.1-55
Point observations for birds and other wildlife	30 June 2019	Figure 2.1-55
Point observations for birds and other wildlife	06 July 2019	Figure 2.1-55
Point observations for birds and other wildlife	07 July 2019	Figure 2.1-55

Table 2.1-26 Vegetation description across stations in the original MMSP Alignment (EIS 2017)

Station	General Description
Valenzuela Depot	The vegetation occurring within the proposed depot is primarily a patch mosaic comprised of a mixture of fruit trees and ornamental plants deliberately introduced by local settlers. Corresponding land use is a combination of trucking depots, storage warehouses, batching plants, motor oil factories, garden resorts, slaughterhouses, and residential areas. In addition, the greatest concentration of trees and ornamental plants are situated within garden resorts and consequently provide green spaces in the area.
Tandang Sora Station	Proposed station is located along Mindanao Avenue, between Tandang Sora Avenue and Congressional Avenue. Its center island along Mindanao Avenue is mostly planted with *Pterocarpus indicus* (Narra) and with occasional *Albizia saman* (Akasya). Said tree species are planted at approximately 5 m apart from one another. Further, the understory layer of the site is composed of *Bougainvillea spectabilis* (Bougainvillea), *Tradescantia spathacea* (Rhoeo), *Crinum amabile* (Spider lily), and *Eleusine indica* (Paragis).
East Avenue Station	Proposed station id located along V. Luna Avenue and will cover the frontage of the Armed Forces of the Philippines (AFP) Medical Center, which is densely planted with large diameter *Swietenia macrophylla* (Big leafed mahogany), *Pterocarpus indicus* (Narra), *Diospyros blancoi* (Mabolo), *Toona calantas* (Kalantas), and *Cocos nucifera* (Niyog). Large diameter *Vitex parviflora* (Molave) and *Pterocarpus indicus* (Narra) can also be found situated within the area behind the perimeter fence.

Station	General Description
Kalayaan Avenue Station	Proposed station, located along the 11th St. of the Bonifacio Global City in Taguig City, is mainly occupied by evenly spaced plantings of *Pterocarpus indicus* (Narra) with mean estimated heights equal to 9 m. Bases of trees are covered with trimmed hedge *Phyllanthus myrtifolius*. Also, plantigs of *Michelia champaka* (Champaka) are also reported beyond the interaction near the station.
Bonifacio Global City Station	Proposed station, located in front of Market Market, is populated on both sides of the sidewalk of evenly spaced *Calophyllum inophyllum* (Bitaog) which are approximately 7–8 m tall. The immediate base of each tree is covered by trimmed hedge *Ehretia microphylla* (Tsaang gubat) and *Phyllantus myrtifolius*.
Cayetano Boulevard Station	Proposed station, situated near Pamayanang Diego Silang C-5 Service Road, are made up of an assortment of trees and shrubbery mostly associated with landscaping and urban greening projects, which includes *Ehretia microphylla* (Tsaang gubat), *Duranta repens* (Yellow duranta), *Pedilanthus tithymaloides* (Luhang dalaga), and *Ficus benjamina* (Benjamin's fig). Several native species were also sighted in the identified station such as the wind-dispersed *Wrightia pubescens* (Laniti), avifauna-dispersed *Ficus ulmifolia* (Is-is), and the bat-dispersed *Ficus septica* (Hauli). Occasional individuals of *Vitex parviflora* (Molave) deemed to be deliberately planted were also noted in the area.
FTI Station	Proposed station, located at the East Service Road, has a *Pterocarpus indicus* (Narra) near a gasoline station and an *Adonida merrillii* (Manila palm) on the adjacent property. Most ornamental plots in the site, including but not limited to, *Bougainvillea spectabilis* (Bougainvillea), *Dypsis lutescens* (Butterfly palm), and *Rhapis excelsa* (Lady palm) are raised commercial pots and containers. Lastly, a center island which used to be a nursery is also heavily planted with *Pterocarpus indicus* (Narra), *Syzygium cuminii* (Duhat), *Swietenia macrophylla* (Big-leafed mahogany), and *Vitex parviflora* (Molave) can also be foun along the proposed subway alignment.

d) Approach and Sampling Methodologies

This terrestrial ecology assessment for the MMSP relied chiefly on available secondary data (both published and unpublished) and supplemented with rapid site assessments (i.e. transect walk surveys and point observations) along key portions of the revised project alignment. The vegetation section utilized available data from the Environmental Impact Statement (EIS) 2017 for the original alignment and were incorporated with additional data sets obtained from portions of the revised alignment whereas the wildlife study us ed various data sources conducted within NCR's major greenspaces and combined with data obtained f r om transect walk surveys along the revised alignment.

2.1.4.1 Terrestrial Vegetation

2.1.4.1.1 Transect Survey

The baseline assessment of existing vegetation was undertaken using the transect walk survey method. A total of four (4) transects have been covered by this assessment. All vascular plants including trees, shrubs, vines, grasses, herbs and epiphytes were enumerated and listed in the data sheet. An opportunistic sampling involving listing of species outside the transect area was also carried out to account for the maximum possible species in the area. The same method was employed during the EIS (2017).

2.1.4.1.2 Species Identification

Published books and articles, and repositories of online database were accessed to acquire the needed information on species identification. Relevant literatures such as Co's Digital Flora of the Philippines, Flora Malesiana, Flora of Manila, Enumeration of Philippine Flowering Plants, Lexicon of Philippine Plants, and Leaflets of Philippine Botany were also consulted. Names of the identified species were verified in the International Plant Names Index (IPNI) and standardized based from the Plant List (http://www.theplantlist.org). Distribution and endemism were determined using available online databases such as the Catalogue of Life (http://catalogueoflife.org/), as well as Global Biodiversity Information Facility (http://GBIF.org).

2.1.4.2 Terrestrial Wildlife

2.1.4.2.1 Point Observations

As the revised portion of the MMSP alignment is highly patchy in terms of vegetation cover and disturbances caused by passing traffic is moderate to intense, we employed point observations to better document various wildlife along key sections. At least three (3) observations points were established per transect (coincidental with three vegetation transects) specifically along areas suspected to be least disturbed (thus potentially with the highest number of biodiversity). Each observation point was covered for at least 30 minutes (total of one-and-half hours for the three points) during time periods when birds are most active (between 6:00 am to 8:00 am and 3:30 pm to 5:30 pm) except during heavy rains. The following information were recorded: species, number of individuals, and general health condition (if feasible).

2.1.4.2.2 Species Identification

All included species were identified up to species level using published keys and field guides available, including:

- A Guide to the Birds of the Philippines (Kennedy, R.S., Gonzales, P.C., Dickinson, E.C., Miranda, Jr., H.C., and T.H. Fisher, 2000);
- A Key to the Bats of the Philippine Islands (Ingle and Heaney, 1992); and
- A Synopsis of the Mammalian Fauna of the Philippine Islands (Heaney, et al, 1998).

For birds, taxonomic order and nomenclature follows Clements, version 2018 as presented in https://www. avibase.bsc-eoc.org/. Each scientific name was then double-checked and compared with the list pr ovided by the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species 2019 (The IUCN Red List of Threatened Species. Version 2019-1. <www.iucnredlist.org>. Downloaded on 25 July 2019). In cases of variations (e.g. *Bubulcus ibis* vs. *Bubulcus coromandus*, and *Anthus richradi* vs. *Anthus rufulus*), the version (e.g. in terms of range distribution, and treatment of species, subspecies and race) presented in the IUCN was adopted.

2.1.4.2.3 Comparison to Relevant Regulatory Standards

The vegetation assessment based the conservation status of identified species mainly from the assessment of International Union for the Conservation of Nature (IUCN) and the Philippine Plants Conservation

Committee of BMB. The IUCN Red List (2019-1) and the Updated List of Threatened Plants and their Categories (DAO 2017-11) were accessed. Ecologically important plant species, especially those included in IUCN Red List and Philippine Red List were geotagged and mapped to visualize the distribution of threatened species relative to the MMSP (original and revised) alignment.

For wildlife, the range distributions of recorded species (i.e. resident breeders, endemics, introductions , migratory, migratory with resident breeding population/s, and native but non-endemic) were based on published references: Kennedy et al., 2000; Heaney et al., 1998 (https://www.fieldmuseum.org/synops is - philippine-mammals*), and IUCN 2019. Conservation status (e.g.* threatened species, Least Concern, and not yet been assessed) were adopted from the IUCN Red List of Threatened Species 2019 (The IUCN Red List of Threatened Species. Version 2019-1. <www.iucnredlist.org>. Downloaded on 25 July 2019) , and the Philippine Wildlife Act of 2001 (RA 9147) and DENR Administrative Order 2004-15. Moreover, the list provided in the Convention on International Trade of Endangered Species (CITES) of Wild Flor a and Fauna 2019 (http://www.cites.org/) was also considered. Note that species included under CITES (specifically Appendices I and II) automatically falls within the list of Philippine Wildlife Act of 2001 (RA 9147) and DENR Administrative Order 2004-15.

2.1.4.2.4 Data Analyses

From the vegetation data, plant abundance, density, basal area, species dominance, and species evennes s were calculated following the enumerated formulas in **Table 2.1-27**.

Table 2.1-27 Standard formula for ecological parameter calculation – Terrestrial Vegetation

Ecological Parameter	Standard Formula
Shannon diversity index (H)	$-\sum (ni / N) \ln (ni / N)$
Pielou's evenness index (J)	$H / \ln S$
Dominance index (C)	$\sum (ni / N)^2$
Relative abundance (RA)	*(abundance of Species A / overall abundance) x 100*
Relative density (RDen)	*(density of Species A / overall density) x 100*
Relative dominance (RDom)	*(basal area of Species A /overall basal area) x 100*

where ***ni*** refers to the total number of individuals per plant species; ***N*** is the total number of individuals; ***S*** is the total number of plant species.

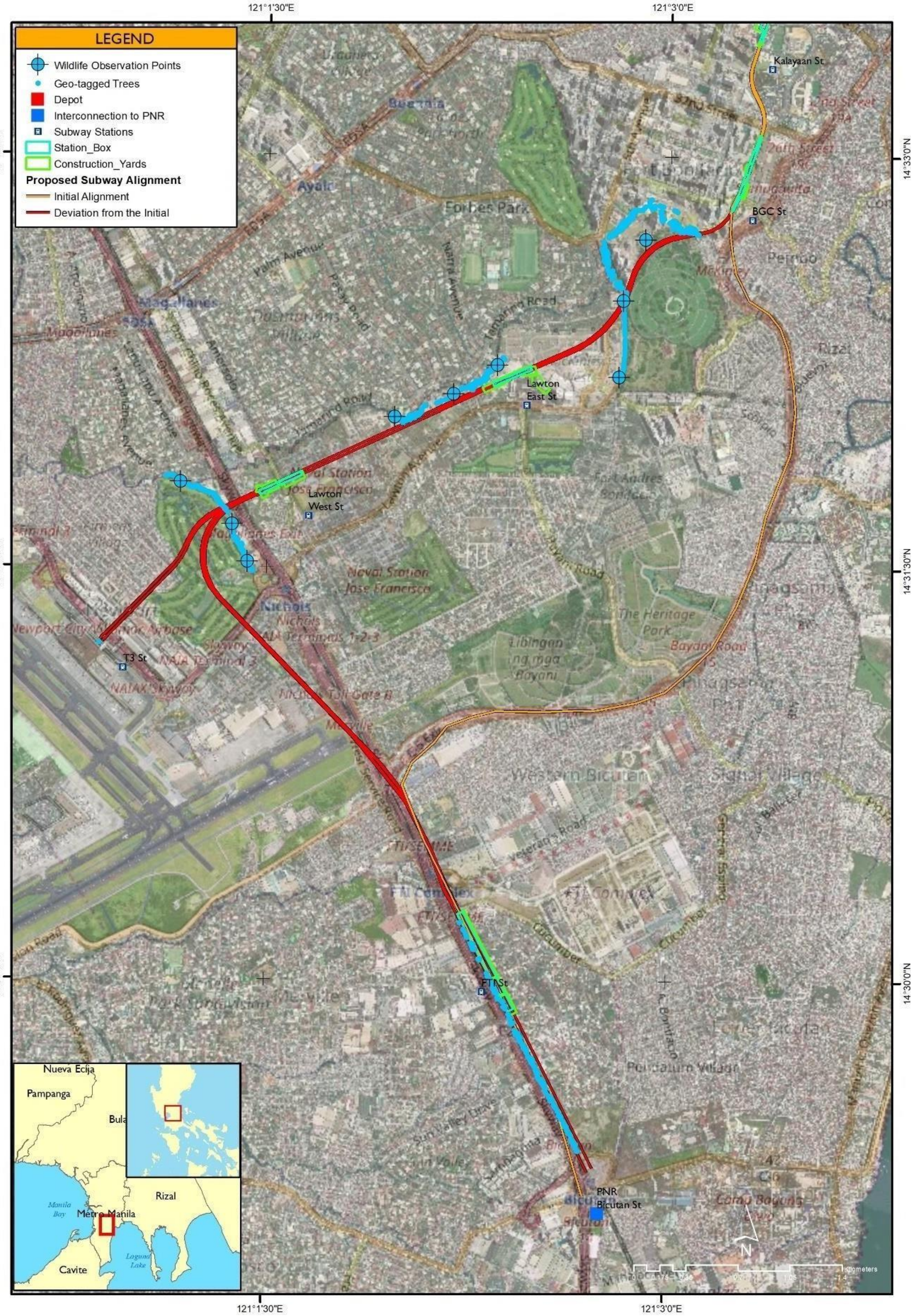


Figure 2.1-55 Location map showing wildlife observation points and vegetation transect routes along the revised MMSP alignment

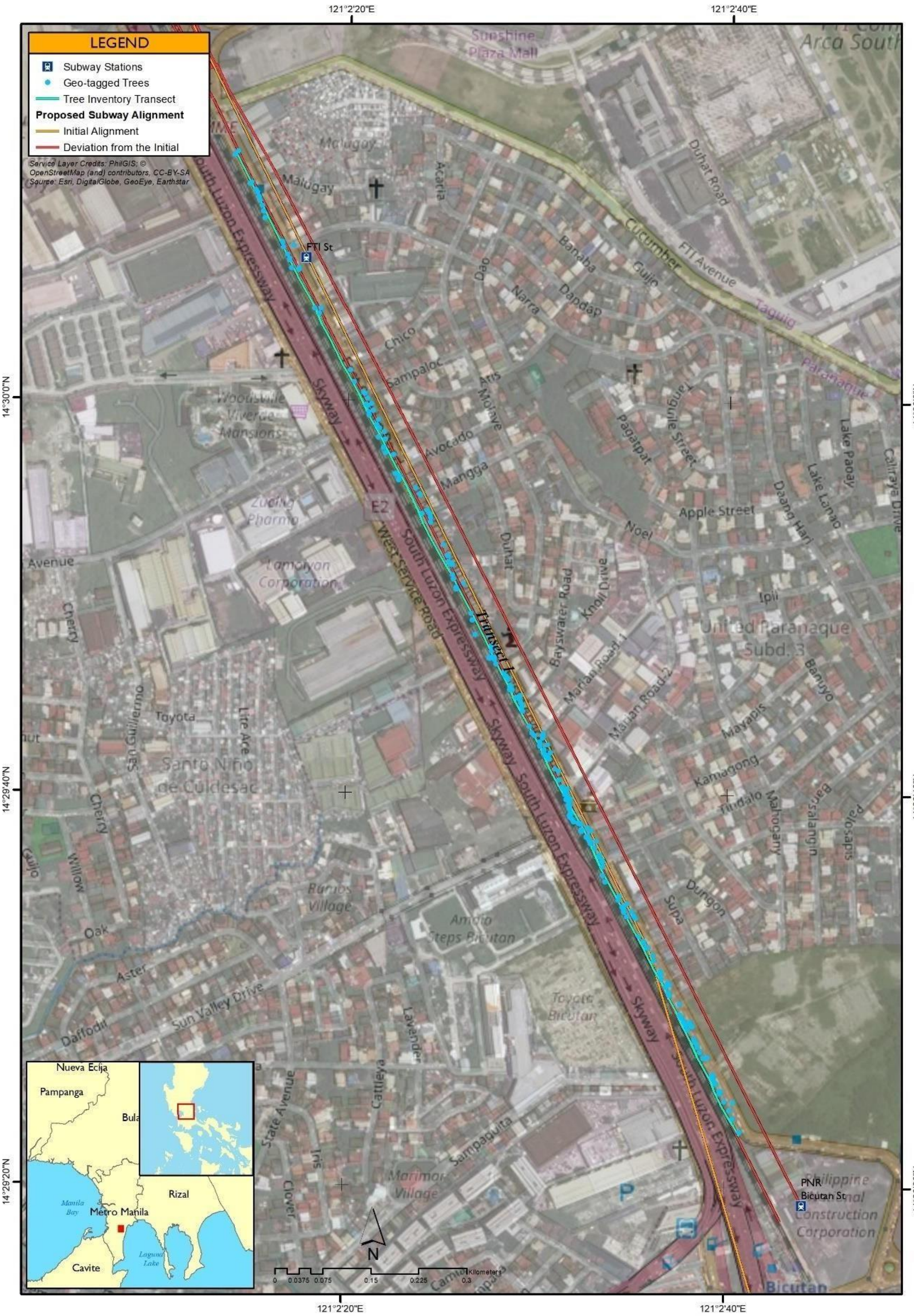


Figure 2.1-56 Site map showing Vegetation Transect 1 (between FTI and Bicutan Stations)

Figure 2.1-57 Site map showing Vegetation Transect 2 (between BGC and Lawton East Stations)

Figure 2.1-58 Site map showing Vegetation Transect 3 (between Lawton West and T3 Stations)

Figure 2.1-59 Site map showing Vegetation Transect 4 (between Lawton East and Lawton West Stations)

2.1.4.3 Baseline Environment

2.1.4.3.1 Summary of Findings – Terrestrial Vegetation

Table 2.1-28 Key Findings and conclusions – Terrestrial Vegetation

Baseline Inform at ion	Key Findings and Conclusions
Land Cover and Terrestrial Vegetation Community Structure	Two unique land cover types were identified from the most recent land cover map from NAMRIA, which includes (1) built-up areas and (2) arable lands for crops. Based on the vegetation surveys (EIS 2017 and additional studies (2019), vegetation communities were mainly comprised of arborescent species interspersed in the remaining green spaces in the NCR.
Flora Species Inventory	**EIS (2017)** Recorded a total of 217 plant species belonging to 88 genera and 69 Families along the proposed 13 stations and train depot. Taxa richness were as follows: 86 species of trees, 43 species of herbs, 39 species of shrubs, 16 species of climbers, 13 species palms, 12 species of fodder grasses, 3 species of ferns, 2 species of erect bamboos, one (1) species of sedge, one (1) species of pandan, and one (1) species of orchid. **Additional Assessment (2019)** A total 98 morpho-species in 82 genera and 36 Families were recorded along the four (4) transects. Dominant families were Fabaceae (13 species), Moraceae (10 species), Arecaceae (6 species), and Myrtaceae (5 species). The most frequently occurring species were *Pterocarpus indicus* (Narra; 272 individuals), *Swietenia macrophylla* (Big leafed mahogany; 97 individuals), *Terminalia catappa* (Talisai; 77 individuals), *Albizia saman* (Akasya; 66 individuals), and *Delonix regia* (Fire tree; 35 individuals).
Endemicity and Conservation Status	**EIS (2017)** Of the 217 species, only three (3) species were Philippine endemic, namely *Ficus ulmifolia* (Is-is), *Artocarpus blancoi* (Antipolo), and *Caryota mitis* (Pugahang Sui). Sixty-three species (29%) were considered indigenous/native to the Philippines, with existing natural distributions extending beyond the region. The remaining 151 species (70%) are all introduced/ex otic. A total of nine (9) species were categorized under IUCN 2019 and DAO 2017-11. Noteworthy among the list were *Adonida merrillii* (Manila palm), *Dypsis lutescens* (Butterfly palm), *Hyophorbe lagenicaulis* (Champagne palm), *Pterocarpus indicus* (Narra), *Vitex parviflora* (Molave), *Swietenia macrophylla* (Big leafed mahogany), *Artocarpus blancoi* (Antipolo), *Ficus ulmifolia* (Is-is), and *Nephelium lappaceum* (Rambutan). **Additional Assessment (2019)** Of the 98 morpho-species, only four (4) species were endemic to the Philippines. These include *Ficus balete* (Balete), *Ficus pseudopalma* (Niog-niogan) and *Ficus ulmifolia* (Is-is). The other endemic species is a Batanes-endemic gymnosperm called *Podocarpus costallis* (Arius). There were eight (8) species recorded that are classified as threatened under the updated national list of threatened Philippine plants and their categories (DAO 2017-11) and/or the IUCN Red list of threatened species (2019-1). These are *Podocarpus costalis* (Arius), *Pterocarpus indicus* (Narra), and *Ficus ulmifolia* (Is-is). *Podocarpus costalis* (Arius), an endemic species from Batanes is categorized as endangered under DAO 2017-11 and IUCN 2019-1. *Pterocarpus indicus* (Narra) is categorized as endangered in

<table>
<tr><th>Baseline Inform at ion</th><th>Key Findings and Conclusions</th></tr>
<tr><td></td><td>IUCN 2019-1 and vulnerable in DAO 2017-11. Lastly, Ficus ulmiforlia (Is-is), an endemic species recorded during opportunistic survey is categorized as vulnerable under IUCN 2019-1.</td></tr>
<tr><td>Density, Frequency, and Dominance</td><td>Summary of the computed species diversity index values for EIS (2017) and the additional assessment (2019) are presented in the tables below:
EIS (2017) and Additional Assessment (2019)
<table>
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<tr><td>Quirino Highway Station</td><td>2.57</td></tr>
<tr><td>Tandang Sora Station</td><td>1.23</td></tr>
<tr><td>North Avenue Station</td><td>2.33</td></tr>
<tr><td>Quezon Avenue Station</td><td>2.07</td></tr>
<tr><td>East Avenue Station</td><td>2.31</td></tr>
<tr><td>Katipunan Avenue Station</td><td>2.39</td></tr>
<tr><td>Ortigas North Station</td><td>2.21</td></tr>
<tr><td>Ortigas South Station</td><td>2.18</td></tr>
<tr><td>Kalayaan Avenue Station</td><td>0.89</td></tr>
<tr><td>Bonifacio Global City Station</td><td>0.00</td></tr>
<tr><td>FTI Station</td><td>2.57</td></tr>
<tr><td>Transect 1 (T1)</td><td>3.35</td></tr>
<tr><td>Transect 2 (T2)</td><td>0.97</td></tr>
<tr><td>Transect 3 (T3)</td><td>1.93</td></tr>
<tr><td>Transect 4 (T4)</td><td>2.17</td></tr>
</table></td></tr>
<tr><td>Vulnerability to Climate Change</td><td>Expected sporadic increases in terms of ambient temperatures and extreme weather conditions (i.e., high precipitation events, strong typhoon-mediated winds, intense irradiance) in the coming decades could potentially impact the optimal growth rate, mortality rate, and survival rate of various tree species found within and near the surveyed areas.</td></tr>
</table>

Land Cover and Terrestrial Vegetation Community Structure

The most recent land cover map of NAMRIA identified two land cover types within the study area (see **Figure 2.1-60**), which includes (1) built-up areas and (2) arable lands for crops. Based on the surveys conducted (EIS 2017 and additional studies 2019), the vegetation communities were mainly comprised of arborescent species interspersed in the remaining greenspaces. Specifically, Transect1 (additional study 2019) was characterized as a mixture of remaining forest patches and local cultivation of fruit trees. In addition, transect 2 is comprised of road side vegetation along the American Cemetery dominated by wide diameter *Pterocarpus indicus* (Narra) and *Albizia saman* (Akasya). Transect 3 is a mosaic of old growth *Pterocarpus indicus* (Narra), *Swietenia macrophylla* (Big leaved mahogany), and *Albizia saman* (Akasya). Transect 4 is a combination of both deliberately planted fruit-bearing trees and vegetation species for greening and aesthetic purposes. For the current site conditions across each transect during the survey period (2019), see **Figure 2.1-61**.

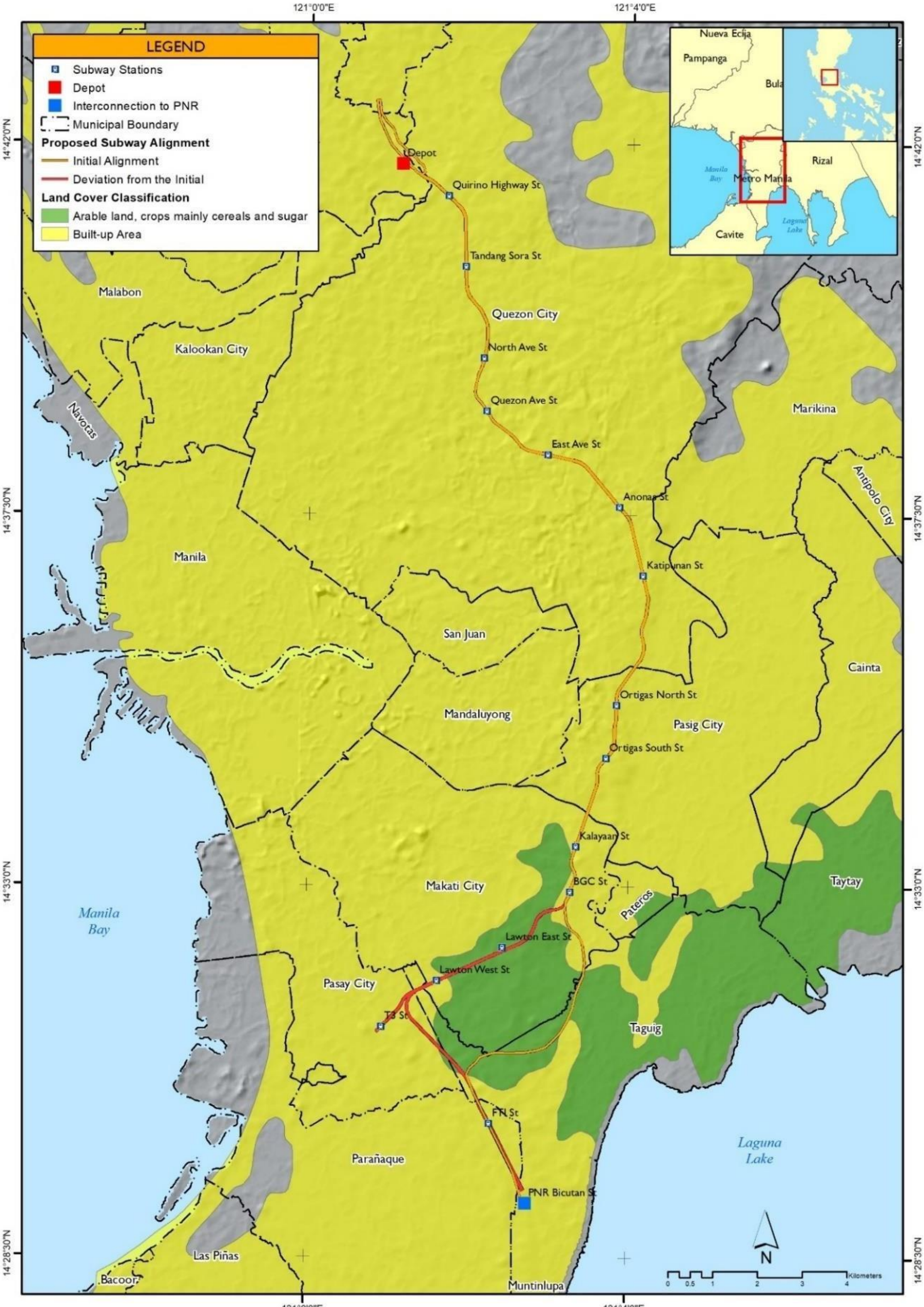


Figure 2.1-60 Land cover map of Metro Manila based on data from NAMRIA (2010)

Figure 2.1-61 Site photographs of each transect during the vegetation survey (2019): A – B = Transect 1 (Between FTI Station and Bicutan Station); C – D = Transect 2 (Between BGC Station and Lawton East Station); E – F = Transect 3 (Between Lawton West Station and T3 Station); and G – H = Transect 4 (Between Lawton East Station and Lawton West Station)

Flora Species Inventory

EIS 2017

Overall, a total of **217 plant species** belonging to **69 families** and **88 genera** have been enumerated f r om the project sites along the proposed 13 stations and train depot. Resulting taxa richness corresponds to 86 species of trees, 43 species of herbs, 39 species of shrubs, 16 species of climbers, 13 species palms , 12 species of fodder grasses, three (3) species of ferns, two (2) species of erect bamboos, one (1) species of sedge, one (1) species of pandan, and one (1) species of orchid. **Annex 2.1-1** and **Annex 2.1-2** presents the taxonomic list of all plant species recorded in the area during the EIS 2017 with details about their local name, conservation status, and endemism.

Additional Assessment 2019

A total **857 tree individuals** belonging to 73 morpho-species, 61 genera and 28 families were recorded inside the four (4) transects. Dominant families were Fabaceae (13 species), Moraceae (10 species), Arecaceae (6 species), and Myrtaceae (5 species). The most frequently occurring species were *Pterocarpus indicus* (Narra; 272 individuals), *Swietenia macrophylla* (Big leafed mahogany; 97 individuals), *Terminalia catappa* (Talisai; 77 individuals), *Albizia saman* (Akasya; 66 individuals), and *Delonix regia* (Fire tree; 35 individuals). **Table 2.1-29** shows the ten (10) most frequently occurring species as well as the transect number where they were recorded. From the top 10 most dominant species, only three (3) species such as *Pterocarpus indicus* (Narra), *Terminalia catappa* (Talisai), and *Lagerstroemia speciose* (Banaba) are categorized as native or indigenous to the country while all others are exotics or introduced from other countries. This only shows that majority of the trees being used for urban planting nowadays are mostly exotics.

Table 2.1-29 Top 10 most frequently occurring specie s in the additional transect s

Numbe r	Species	Comm on Name	Count	Transe ct Numbe r
01	*Pterocarpus indicus*	Narra	272	1,2,3,4
02	*Swietenia macrophylla*	Big Leafed Mahogany	97	1,3,4
03	*Terminalia catappa*	Talisai	77	1,2,3,4
04	*Albizia saman*	Akasya	66	1,2,3,4
05	*Delonix regia*	Fire Tree	35	1,2,3
06	*Mangifera indica*	Mangga	34	1,3,4
07	*Lagerstroemi a speciosa*	Banaba	17	1,3
08	*Moringa oleifera*	Malunggay	17	1
09	*Leucaena leucocephal a*	Ipi-ipil	16	1,2
10	*Spathodea campanulata*	African Tulip	14	1,2,3

Aside from the species recorded inside the transects, **additional 25 species** were **recorded from the opportunistic survey**. Hence, a total of **98 morpho-species** from 82 genera and 36 families were encountered in the area. Only a single specimen of the genus *Calamus* was not identified to species level. This is mainly because the specimen collected is in juvenile stage (seedling/sapling) and/or sterile stage (without flowers/fruits). The presence of fruits/flowers as well as maturity of the species are of prime importance when it comes to identification of flora species. **Annex 2.1-3** and **Annex 2.1-4** presents the taxonomic list of all plant species recorded in the area during the additional vegetation survey with details about their local name, conservation status, and endemism.

Transect 1 (Between FTI Station and Bicutan Station)

Out of the **857 plant individuals** recorded from the four transects, a total of **239 individuals (28.0 %)** were recorded from Transect 1. These plant individuals belong to 49 morpho-species from 43 genera and 23 families. The three (3) most dominant species planted in the transect were *Swietenia macrophylla* (Big leafed mahogany) with 25 individuals; *Mangifera indica* (Mangga) with 24 individuals; and *Pterocarpus indicus* (Narra) with 21 individuals. It is interesting to note that out of all the species planted in this transect, a total of 30 species are exotics and only two (2) tree species (*Ficus balete* & *Ficus pseudopalma*) are Philippine endemics.

Transect 2 (Between BGC Station and Lawton East Station)

From the **857 plant individuals** encountered from the four transects, a total of **271 individuals (31. 6 %)** were recorded from Transect 2. The individuals encountered belong to 10 morpho-species, 9 genera and 5 families. The top three (3) most dominant species planted in this transect were *Pterocarpus indicus* (Narra) with 196 individuals; *Albizia saman* (Akasya) with 35 individuals; and *Delonix regia* (Fire tree) with 27 individuals. Fortunately for this transect, *Pterocarpus indicus* (Narra), a native tree species in the country with a total of 196 individuals, constitutes 72 percent (%) of all the trees planted in Transect 2.

Transect 3 (Between Lawton West Station and T3 Station)

Out of the **857 individuals** recorded from the four transects, a total of **155 plant individuals (18.0 %)** were encountered from Transect 3. The recorded individuals belong to 26 morpho-species, 25 genera and 15 families. The three (3) most dominant species planted in the transect were *Pterocarpus indicus* (Narra) with 35 individuals; *Swietenia macrophylla* (Big leafed mahogany) with 30 individuals; and *Spathodea camapanulata* (African tulip) with 12 individuals. Other dominant species include *Albizia saman* (Rain tree), *Eucalyptus camaldulensis* (Australian red gum), *Delonix regia* (Fire tree), *Gmelina arborea* (Gmelina), and *Mangifera indica* (Mangga). It is very interesting to note that out of the enumerated dominant species in the transect, only *Pterocarpus indicus* (Narra), the most dominant species, is considered native/indigenous in the Philippines while all others are exotics.

Transect 4 (Between Lawton East Station and Lawton West Station)

From the **857 individuals** recorded from the four transects, a total of **192 individuals (22.4 %)** were encountered from Transect 4. These individuals belong to 27 species, 25 genera and 17 families. The three (3) dominant species recorded from the transect were *Terminalia catappa* (Talisai) with 61 individuals; *Swietenia macrophylla* (Big-leafed mahogany) with 42 individuals; and *Pterocarpus indicus* (Narra) with 20 individuals. Although majority of the species planted in this whole transect are exotics, it is also worthy to note that a Batanes-endemic species, *Podocarpus costalis* (Arius), with eight (8) individuals was also found planted in the area. This is a very good sign of utilizing our native tree species rather than exotic ones.

Endemicity and Conservation Status

EIS 2017

Endemic Species

Of the **217 vegetation species** reported, only **three (3) species** were deemed endemic in the Philippines, namely *Ficus ulmifolia* (Is-is), *Artocarpus blancoi* (Antipolo), and *Caryota mitis* (Pugahang Sui). On the other hand, **63 species (29%)** were considered indigenous to the Philippines, with existing natural distributions extending beyond the region; whereas the remaining **151 species** (70%) are introduced.

Threatened Species

A total of **11 flora species** were categorized under IUCN 2017 and DAO 2007-11. Species classified under these lists will be given appropriate conservation actions. Noteworthy among the list were *Adonida merrillii* (Manila palm), *Pterocarpus indicus* (Narra), *Vitex parviflora* (Molave), *Artocarpus blancoi* (Antipolo), *Ficus ulmifolia* (Is-is). **Table 2.1-30** depicts the summary of species with notable ecological status. For the complete list of species with corresponding abundance for each proposed station and their respective location with respect to the alignment, see **Annex 2.1-1**, and **Figure 2.1-62**

Table 2.1-30 List of threatened flora species in EIS 2017 (based on IUCN 2019; DAO 2017 -11)

Family	Species	Common name	Conservation Status	
			IUCN 2017	DAO 2007-1
APOCYNACEAE	*Alstonia macrophylla*	Batino	NA	LR
APOCYNACEAE	*Wrightia pubescens*	Laniti	NA	LR
ARECACEAE	*Adonida merrillii*	Manila Palm	EN	LR
CALOPHYLLACEAE	*Calophyllum inophyllum*	Bitaog	NA	LR
EBENACEAE	*Dipterocarpus blancoi*	Mabolo	CR	VU
FABACEAE	*Pterocarpus indicus*	Narra	CR	VU
LAMIACEAE	*Vitex parviflora*	Molave	EN	VU
MELIACEAE	*Toona calantas*	Kalantas	CR	DD
MORACEAE	*Artocarpus blancoi*	Antipolo	NA	VU
MORACEAE	*Ficus ulmifolia*	Is-is	NA	VU
POLYPODIACEAE	*Drynari aquercifolia*	Kabkab	VU	NA

***CR** = critically endangered; **EN** = endangered; **VU** = vulnerable; **LR** = low risk; **DD** = data deficient; **NA** = not assessed*

Additional Assessment 2019

Endemic Species

One of the very useful information when it comes to conservation studies is the geographic distribution of plant species. The determination of specific management practices and/or strategies for a particular species restricted to a small geographical area will be given importance as these species are more vulnerable to various threats.

Out of the **98 species** recorded, a total of four (4) species (4 %) were found to be endemic to the Philippines. These include three species of *Ficus* such as *Ficus balete* (Balete), *Ficus pseudopalma* (Niog-niogan) and *Ficus ulmifolia* (Is-is). The other endemic species is a Batanes-endemic gymnosperm called *Podocarpus costallis* (Arius). **Table 2.1-31** shows the summary of endemic species with the corresponding transect number where these species were recorded. The complete list of species with corresponding endemism and their respective location with respect to the new alignment is presented in **Annex 2.1-4** and **Figure 2.1-64**. In determining the endemism of species, it will be noted that categorizing species as endemic is very much dependent on availability of published biodiversity data, recent taxonomic revisions, nomenclatural changes, and new evidences from various disciplines used in plant systematics. Thus, estimates of endemism will be interpreted within the context of methodologies and limitations imposed by contributing factors.

Table 2.1-31 List of Philippine endemic species recorded from the four (4) additional transects

Numbe r	Species	Comm on Name	Count	Transect Number
01	*Ficus balete*	Balete	272	1,4
02	*Ficus pseudopalm a*	Niog-niogan	97	1; Opportunistic survey
03	*Ficus ulmifolia*	Is-is	77	4
04	*Podocarpus costalis*	Arius	66	4; Opportunistic survey

Threatened Species

Eight (8) species recorded in the area were found to be threatened under the updated national list of threatened Philippine plants and their categories (DAO 2017-11) and/or the IUCN Red list of threatened species (2019-1). Species categorized in these lists will be given appropriate conservation actions. Noteworthy among the list are *Podocarpus costalis* (Arius), *Pterocarpus indicus* (Narra), and *Ficus ulmifolia* (Is-is). *Podocarpus costalis* (Arius), an endemic species from Batanes is categorized as endangered under DAO 2017-11 and IUCN 2019-1. *Pterocarpus indicus* (Narra) is categorized as endangered in IUCN 2019-1 and vulnerable in DAO 2017-11. Lastly, *Ficus ulmiforlia* (Is-is), an endemic species recorded during opportunistic survey is categorized as vulnerable under IUCN 2019-1. The complete list of threatened species with corresponding threat status is presented in **Table 2.1-32.**

Table 2.1-32 List of threatened flora species in the additional vegetation survey (based on IUCN 2019; DAO 2017-11)

Family	Species	Common name	Conservation Status	
			IUCN 2019	DAO 2017-11
ARAUCARIACEAE	*Araucaria heterophylla*	Norfolk Island Pine	VU	NA
ARECACEAE	*Adonidia merrillii*	Manila Palm	NA	VU
EBENACEA E	*Diospyros discolor*	Kamagong	NA	VU
FABACEAE	*Pterocarpus indicus*	Narra	EN	VU
LAMIACEAE	*Vitex parviflora*	Molave	VU	EN
MELIACEAE	*Swietenia macrophylla*	Big-Leaf Mahogany	VU	NA
MORACEAE	*Ficus ulmifolia*	Is-is	VU	NA
PODOCARPACEAE	*Podocarpus costalis*	Arius	EN	EN

***CR** = critically endangered; **EN** = endangered; **VU** = vulnerable; **LR** = low risk; **DD** = data deficient; **NA** = not assessed*

Combining the number of threatened species recorded during the EIS 2017 to that of EPRMP 2019, a total of **11 species were noted** (see **Table 2.1-33**). Here, **six (6) species** previously included in the threatened list during the EIS 2017, namely: *Alstonia macrophylla* (Batino), *Wrightia pubescens* (Laniti), *Calophyllum inophyllum* (Bitaog), *Dipterocarpus blancoi* (Mabolo), *Toona calantas* (Kalantas), and *Drynari aquercif olia* (Kabkab), were removed from the current species red list as these were no longer regarded as threatened. Moreover, three (3) species recorded during the EIS 2017 but were not classified into any conservation category: *Dypsis lutescens* (Butterfly Palm), *Hyophorbe lagenicaulis* (Champagne Palm), and *Nephelium lappaceum* (Rambutan) were added into the final and updated threatened species list following the IUCN 2019 and DAO 2017-11. Lastly, three (3) additional species were recorded during the EPRMP 2019, namely *Araucaria heterophylla* (Norfolk Island Pine), *Diospyros discolor* (Kamagong), and *Podocarpus costalis* (Arius).

Table 2.1-33 List of threatened flora species in the EIS 2017 and EPRMP 2019 (based on IUCN 2019; DAO 2017-11)

Family	Species	Common name	Conservation Status	
			IUCN 2019	DAO 2017-11
ARAUCARIACEAE	*Araucaria heterophylla*	Norfolk Island Pine	VU	NA
ARECACEAE	*Adonida merrillii*	Manila Palm	NA	VU
ARECACEAE	*Dypsis lutescens*	Butterfly Palm	NT	NA
ARECACEAE	*Hyophorbe lagenicaulis*	Champagne Palm	CR	NA
EBENACEAE	*Diospyros discolor*	Kamagong	NA	VU
FABACEAE	*Pterocarpus indicus*	Narra	EN	VU
LAMIACEAE	*Vitex parviflora*	Molave	VU	NA
MORACEAE	*Artocarpus blancoi*	Antipolo	VU	NA
MORACEAE	*Ficus ulmifolia*	Is-is	VU	NA
PODOCARPACEAE	*Podocarpus costalis*	Arius	EN	EN
SAPINDACEAE	*Nephelium lappaceum*	Rambutan	LC	VU

Density, Frequency, and Dominance

EIS 2017

Diversity index values computed using the data collected from the EIS (2017) are depicted in **Table 2.1-34**. Comparing the resulting index values per station, **Quirino Highway Station** (H = 2.57; J = 0.72) had the highest H and J scores, followed by **FTI Station** (H = 2.57; J = 0.49), **Katipunan Avenue Stat ion** (H = 2.39; J = 0.70), **North Avenue Station** (H = 2.33; J = 0.70), **East Avenue Station** (H = 2.31; J = 0. 46) ,

Ortigas North Station (*H* = 2.21; *J* = 0.55), **Ortigas South Station** (*H* = 2.18; *J* = 0.57), **Quezon Avenue Station** (*H* = 2.07; *J* = 0.60), **Tandang Sora Station** (*H* = 1.23; *J* = 0.35), and **Kalayaan Avenue Station** (*H* = 0.89; *J* = 0.22). On the other hand, index scores calculated from **Bonifacio Global City Station** (*H* = 0.00; *J* = 0.00) values were equal to zero (0) and its corresponding dominance index (C) was equivalent to 1.00, mainly due to the predominance of a single tree species (*Calophyllum inophyllum*; Bitaog) in the area. Nonetheless, majority of the individual stations had index scores ranging from "low" to "moderate" condition ratings.

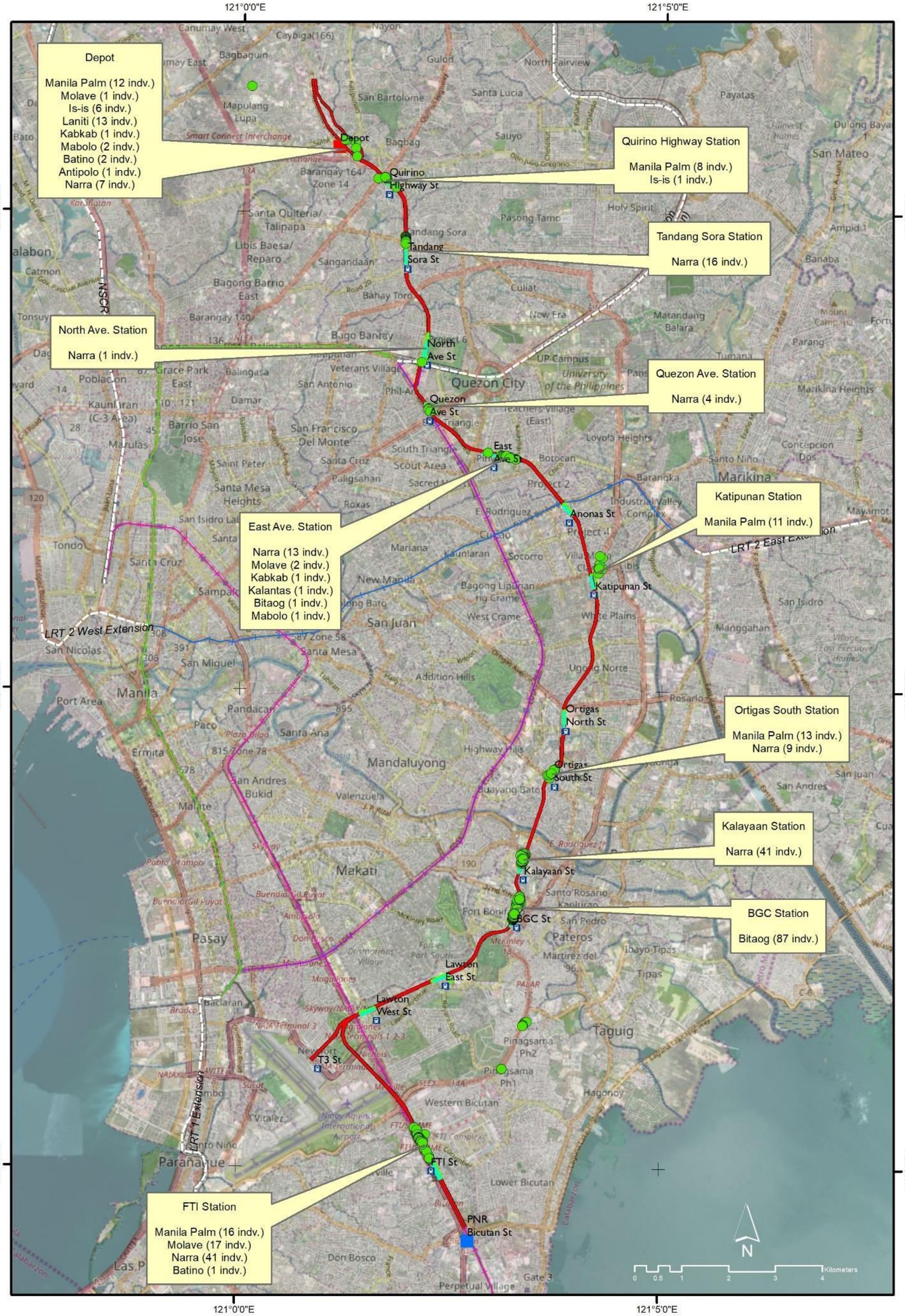


Figure 2.1-62 Site m ap showing 2017 data of threatened species

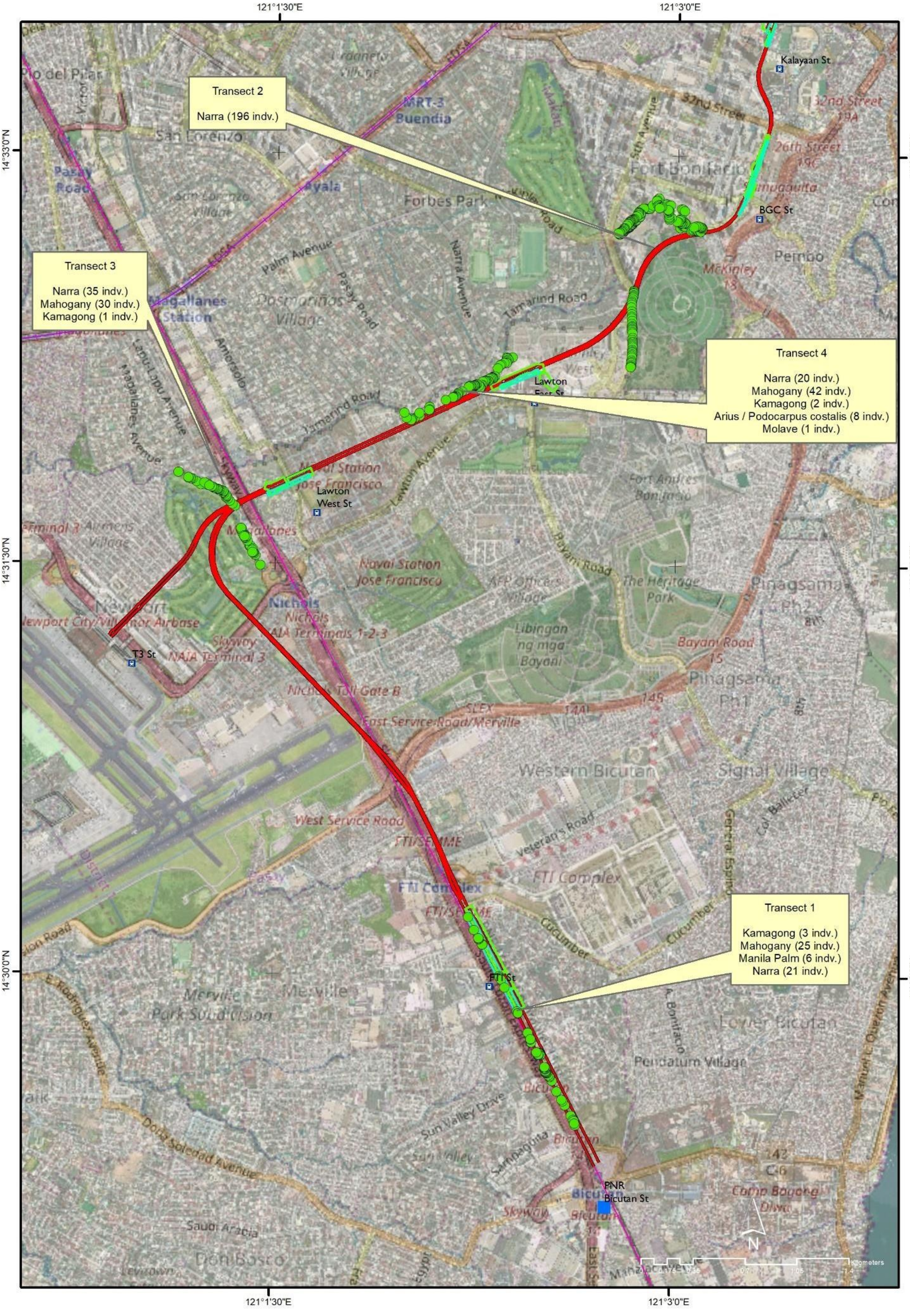


Figure 2.1-63 Site m ap showing 2019 data of threatened species

Table 2.1-34 Summary of diversity indices for the original proposed stations of Metro Manila Subway Project EIS (2017)

Station	Diversity Index (H)	Evenness Index (J)	Dominance Index (C)
Quirino Highway Station	2.57	0.72	0.09
Tandang Sora Station	1.23	0.35	0.32
North Avenue Station	2.33	0.70	0.12
Quezon Avenue Station	2.07	0.60	0.18
East Avenue Station	2.31	0.46	0.15
Katipunan Avenue Station	2.39	0.70	0.14
Ortigas North Station	2.21	0.55	0.14
Ortigas South Station	2.18	0.57	0.16
Kalayaan Avenue Station	0.89	0.22	0.57
Bonifacio Global City Station	0.00	0.00	1.00
FTI Station	2.57	0.49	0.12

Diversity index threshold values: *> 3.50 (**very high**); 3.00 – 3.49 (**high**); 2.50 – 2.99 (**moderate**); 2.00 – 2.49 (**low**); < 1.99 (**very low**)*

Evenness index threshold values: *0.75 – 1.00 (**very high**); 0.50 – 0.74 (**high**); 0.25 – 0.49 (**moderate**); 0.15 – 0.24 (**low**); 0.05 – 0.14 (**very low**)*

With regard to the computed importance values across all surveyed stations, *Pterocarpus indicus* (Narra) had the highest score (93.11), followed by *Swietenia macrophylla* (Big leaved mahogany; 74.17), *Calophyllum inophyllum* (Bitaog; 68.51), *Cocos nucifera* (Niyog; 54.37), and *Mangifera indica* (Mangga; 43.41). Similar with the implications from the additional transec t survey, arborescent species with high importance values relates to those species with characteristic high abundance, high basal area, high computed volume, and high frequency of encounters; which are key variables in ecosystem functioning, ecological stability, and community dynamics. For the complete list of species with notable importance values per station, see **Table 2.1-35**.

Table 2.1-35 List of flora species with highest importance values (IVs) per original proposed station (based on data from EIS 2017)

Site	Species	Comm on name	RDen	RA	RDom	IV
Quirino Highway Station	***Mangifera indica***	**Mangga**	29.90	13.89	13.89	**57.68**
	Adonidia merrillii	Manila palm	5.72	16.67	16.67	39.05
	Syzygium cumini	Duhat	16.35	5.56	5.56	27.46
	Wodyetia bifurcata	Foxtail palm	2.69	11.11	11.11	24.91
	Azadirachta indica	Neem tree	9.98	5.56	5.56	21.09
Tandang Sora Station	***Cocos nucife ra***	**Niyog**	38.34	43.75	43.75	**125.84**
	Mangifera indica	Mangga	45.77	25.00	25.00	95.77
	Dimocarpus longan	Longan	15.65	25.00	25.00	65.65
	Psidium guajava	Bayabas	0.24	6.25	6.25	12.74
	-	-	-	-	-	-
North Avenue Station	***Ficus septica***	**Hauli**	49.61	10.00	10.00	**69.61**
	Sandoricum koetjape	Santol	12.98	15.00	15.00	42.98
	Leucaena leucocephala	Ipil-ipil	17.58	10.00	10.00	37.58

Site	Species	Comm on name	RDen	RA	RDom	IV
	Cocos nucifera	Niyog	4.33	10.00	10.00	24.33
	Tabernaemo nta n a pandacaq ui	Pandakaki	0.59	10.00	10.00	20.59
Quezon Avenue Station	***Ravena la mada gas ca rie nsis***	**Travele r's tree**	57.53	34.38	34.38	**126.28**
	Pterocarpus indicus	Narra	10.55	12.50	12.50	35.55
	Murraya paniculata	Kamuning	1.39	15.63	15.63	32.64
	Mangifera indica	Mangga	19.16	3.13	3.13	25.41
	Ficus benjamina	Salisi	2.84	9.38	9.38	21.59
East Avenue Station	***Swiete nia macrophy lla***	**Big leaved mahoga ny**	16.09	26.67	26.67	**69.42**
	Cocos nucifera	Niyog	17.09	24.00	24.00	65.09
	Pterocarpus indicus	Narra	16.95	10.67	10.67	38.29
	Mangifera indica	Mangga	8.23	6.67	6.67	21.56
	Gmelina arborea	Yemane	5.72	7.33	7.33	20.38
Anonas Station	***Chrys ophy llum cainito***	**Caimit o**	49.99	16.67	16.67	**83.32**
	Mangifera indica	Mangga	36.72	16.67	16.67	70.06
	Averrhoa bilimbi	Kamias	2.83	16.67	16.67	36.17
	Moringa oleifera	Malunggay	2.83	16.67	16.67	36.17
	Pachira aquatica	Guiana chestnut	2.83	16.67	16.67	36.17
Katipunan Avenue Station	***Adonidia merrillii***	**Manila palm**	12.67	32.26	32.26	**77.19**
	Mangifera indica	Mangga	24.66	6.45	6.45	37.57
	Wodyetia bifurcata	Foxtail palm	18.44	6.45	6.45	31.34
	Polyalthia longifolia	India lanutan	5.79	9.68	9.68	25.15
	Dracaena fragrans	Fortune plant	2.32	9.68	9.68	21.68
Ortigas North Station	***Roystone a regia***	**Royal palm**	64.64	27.78	27.78	**120.19**
	Wodyetia bifurcata	Foxtail palm	12.31	12.96	12.96	38.24
	Acacia auriculiformis	Auri	2.48	16.67	16.67	35.81
	Eucalyptus tereticornis	Gray gum	4.06	7.41	7.41	18.88
	Lagerstroemi a speciosa	Banaba	1.74	7.41	7.41	16.55
Ortigas South Station	***Pteroca rpus indic us***	**Narra**	43.93	19.57	19.57	**83.06**
	Adonidia merrillii	Manila palm	9.41	30.43	30.43	70.27
	Swietenia macrophylla	Big leaved mahogany	16.92	6.52	6.52	29.97
	Polyalthia longifolia	India lanutan	5.36	10.87	10.87	27.10
	Mangifera indica	Mangga	4.59	6.52	6.52	17.63
Kalayaan Avenue Station	***Pteroca rpus indic us***	**Narra**	75.98	74.55	74.55	**225.07**
	Roystonea regia	Royal palm	11.42	7.27	7.27	25.97
	Wodyetia bifurcata	Foxtail palm	9.09	7.27	7.27	23.64
	Michelia champaca	Tsampaka	2.06	9.09	9.09	20.24
	Acacia auriculiformis	Auri	1.45	1.82	1.82	5.08
Bonifacio Global City Station	*Calophyllum inophyllum*	Bitaog	100.00	100.00	100.00	**300.00**
	-	-				

Site	Species	Comm on name	RDen	RA	RDom	IV
	-	-				
	-	-				
	-	-				
FTI Station	***Pteroca rpus indic us***	**Narra**	44.58	23.86	23.86	**92.30**
	Swietenia macrophylla	Big leaved mahogany	17.23	17.77	17.77	52.76
	Syzygium cumini	Duhat	9.13	8.63	8.63	26.39
	Vitex parviflora	Molave	3.64	10.66	10.66	24.96
	Adonidia merrillii	Manila palm	8.20	7.61	7.61	23.43

***RA** = relative abundance/frequency; **RDen** = relative density; **RDom** = relative dominance; **IV** = importance value*

Additional Assessment 2019

Results from the additional vegetation survey (2019) showing the calculated diversity index values are summarized in **Table 2.1-36**. Here, the computed overall diversity and evenness index scores of the surveyed four (4) additional transects were **2.74** and **0.41**, respectively; which fall under the "moder ate" condition rating. Comparing the resulting index values per additional transect, **T1** (*H* = 3.35; *J* = 0.62) had the highest *H* and *J* scores, followed by **T4** (*H* = 2.17; *J* = 0.18), **T3** (*H* = 1.93; *J* = 0.41), and **T1** (*H* = 0.97; *J* = 0.17). A possible contributing factor for the observed lower score for T2 and T3 could be as s oc iated with the dominance of *Pterocarpus indicus* (Narra) and *Swietenia macrophylla* (Big leaved mahogany) among these sites, which may have overpowered the percent contribution of other arborescent species.

Table 2.1-36 Summarry of divers it y indices for the additional transect survey (2019)

Site	Diversity Index (H)	Evenness Index (J)	Dominance Index (C)
Transect 1 (T1)	3.35	0.62	0.05
Transect 2 (T2)	0.97	0.17	0.54
Transect 3 (T3)	1.93	0.41	0.00
Transect 4 (T4)	2.17	0.42	0.18
Overall (T1 to T4)	**2.74**	**0.41**	**0.15**

***Diversity index threshold values:** > 3.50 (**very high**); 3.00 – 3.49 (**high**); 2.50 – 2.99 (**moderate**); 2.00 – 2.49 (**low**); < 1.99 (**very low**)*

***Evenness index threshold values:** 0.75 – 1.00 (**very high**); 0.50 – 0.74 (**high**); 0.25 – 0.49 (**moderate**); 0.15 – 0.24 (**low**); 0.05 – 0.14 (**very low**)*

In terms of calculated importance values across the four (4) additional transects, *Pterocarpus indicus* (Narra) had the highest score (100.29), followed by *Swietenia macrophylla* (Big leaved mahogany; 40.13), *Albizia saman* (Akasya; 38.42), *Terminalia catappa* (Talisai; 19.86), and *Delonix regia* (Fire tree; 13. 93). Flora species with high importance values correspond to those species with characteristic high abundance, high basal area, high computed volume, and high frequency of encounters. This particular ecological parameter infer the relative influence of aforementioned species with respect to the plant community structure, ecological partitioning, and ecosystem function (see **Table 2.1-37**).

Table 2.1-37 List of flora species with highest importance values (IVs) per additional transect from the vegetation survey (2019)

Site	Species	Comm on name	RDen	RA	RDom	Importance Value (IV)
Transect 1 (T1)	***Mangife ra indica***	**Mangga**	19.13	10.04	10.04	**39.21**
	Pterocarpus indicus	Narra	20.59	8.30	8.30	37.18
	Swietenia macrophylla	Big Leafed Mahogany	7.53	10.48	10.48	28.49
	Ceiba pentandra	American Kapok	8.46	3.93	3.93	16.32
	Moringa oleifera	Malunggay	2.14	6.99	6.99	16.11
Transect 2 (T2)	***Pteroca rpus indic us***	**Narra**	65.15	71.53	71.53	**208.21**
	Albizia saman	Akasya	20.24	12.77	12.77	45.78
	Tabebuia rosea	Trumpet Tree	9.40	10.58	10.58	30.57
	Psidium guajava	Bayabas	20.24	12.77	12.77	5.52
	Terminalia catappa	Talisai	0.41	2.55	2.55	2.98
Transect 3 (T3)	***Swiete nia macrophy lla***	**Big Leafed Mahoga ny**	27.28	35.78	35.78	**98.84**
	Pterocarpus indicus	Narra	20.63	23.85	23.85	68.34
	Albizia saman	Akasya	21.49	6.42	6.42	34.34
	Eucalyptus camaldulensis	Australian Red Gum	5.68	9.17	9.17	24.03
	Delonix regia	Fire Tree	3.15	6.42	6.42	15.99
Transect 4 (T4)	***Albizia sama n***	**Akasya**	57.59	9.44	9.44	**76.48**
	Terminalia catappa	Talisai	13.10	31.67	31.67	76.44
	Swietenia macrophylla	Big Leafed Mahogany	19.88	23.33	23.33	66.54
	Pterocarpus indicus	Narra	3.00	11.11	11.11	25.23
	Podocarpus costalis	Arius	1.01	4.44	4.44	9.90
Overall (T1 to T4)	***Pteroca rpus indic us***	**Narra**	34.63	32.83	32.83	**100.29**
	Swietenia macrophylla	Big Leafed Mahogany	22.32	8.05	8.05	40.13
	Albizia saman	Akasya	13.71	13.21	13.21	38.42
	Terminalia catappa	Talisai	3.25	8.30	8.30	19.86
	Delonix regia	Fire Tree	4.62	4.65	4.65	13.93

***RA** = relative abundance/frequency; **RDen** = relative density; **RDom** = relative dominance*

2.1.4.3.2 Summary of Findings – Terrestrial Wildlife

Table 2.1-38 Key Findings and conclusions – Terrestrial Wildlife

Baseline Inform at ion	Key Findings and Conclus ions
Wildlife species inventory	• A total of **213** species comprised of six (6) amphibians, 12 reptiles, 184 birds, and 11 mammals was recorded along the MMSP (original and revised) alignment, and nearby major greenspaces. • Recorded birds (184 species) represent approximately 37% of the known total for Luzon mainland (493 species).
Summary of range distribution	• Range distributions was dominated by native but non-endemics/ resident breeding non-endemics with 92 species or 43% of the total. • Other range distributions noted were: migratory birds with 67 species or 31% of the total, endemics with 29 species or 14% of the total, introductions with 19 species or 9% of the total, and migrants with resident breeding populations with six species or 3% of the total. • Endemics were relatively high despite the available habitat.
Conservation Status (Threatened, Near Threatened, and Least Concern)	• Majority of recorded wildlife are Least Concern with 182 species or 85% of the total based on IUCN 2019 and RA 9147/ CITES 2019. • At least 28 species or 13% of the total (composed of four reptiles and 24 birds) are included in various conservation listings based on IUCN 2019 and RA 9147/ CITES 2019. • Five (5) of these threatened species are introduced or not originally from the Philippines. • Three (3) species are Near Threatened based on IUCN 2019.
Hindrance to wildlife access, historical occurrences of pest infestation, forest/grass fire, and/or similar incidences	• The MMSP (original and revised) alignment and surrounding areas are highly urbanized and the original vegetation therein have long been removed and converted into development areas. • Wildlife access across the entire MMSP alignment is fragmented due to the absence of original vegetation and various development. Remaining wildlife habitats are limited within the 27 major greenspaces. • Major disturbances are growing human population, pollution, and conversion of natural habitats and remaining greenspaces to built -up areas.
Vulnerability to Climate Change	• As the NCR area is extra vulnerable to the effects of climate change due to high pollution levels, absence of good vegetation cover, and increased flooding incidents, these may add-up to the projected sporadic increases in terms of ambient temperatures and extreme weather conditions. Said conditions may potentially impact the already limited wildlife populations in the NCR and overall health of the few remaining greenspaces.

Terrestrial Wildlife

In the 2017 MMSP EIS, several wildlife studies (conducted mainly in the Quezon City area) were mentioned. However, there was no data integration performed based on said available secondary data. Thus, there is no clear picture on how many species have been recorded, how many are endemic or with conservation concerns, and other basic information on wildlife. In this terrestrial ecology assessment, we generated a wildlife baseline data which integrates various available studies (whether published or unpublished) conducted within key greenspaces in the NCR.

The combined total from all the studies conducted in NCR's major greenspaces is 221 species comprised of six (6) amphibians, 14 reptiles, 190 birds, and 11 mammals. **Table 2.1-39** presents the integrated wildlife list recorded in the NCR. The range distributions noted were:92 (43% of the total) native but non-endemics (applicable to amphibians, reptiles and mammals) or resident breeding non-endemics (applicable to birds), 67 (31% of the total) migratory birds, 29 (14% of the total) are endemics, 19 (9% of the total) introductions, and six (3% of the total) migratory species with resident breeding populations. Native but non-endemics or resident breeding non-endemics are species that naturally occurred in the Philippines, but their distribution is not limited/exclusive to the country. Endemic species are those restricted in distribution to the Philippines or found nowhere else in the world. There were four (4) Luzon endemics and 25 Philippine endemics noted in the area. These documented endemics remain relatively high despite the available greenspaces being limited in area, fragmented and discontinuous, and with poor vegetation quality (mostly exotics). It is likely that recorded endemics are part of the main-stay species (local wildlife assemblage) which means that they have adjusted to this kind of habitat given its quality and the presence various disturbances hence, their consistent occurrence in the area. Migrant species come to the country to escape the winter season in their place of origin. They usually stay from October to March, although some species may over -winter or stay longer. Migrants with resident breeding populations are mainly present from October to March but some populations stay/breed in the Philippines. Introduced species are not originally from the Philippines but are assumed to stay and breed the entire time in the country since their introduction.

Table 2.1-39 Integrated list of recorded wildlife in the NCR

#	Scientific names	Comm on Names	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)	Range Distribution (Kennedy et al., 2000 and IUCN 2019)
Reptiles				
1	*Gekko gecko*	tokay gecko	LC	NBNE
2	*Hemidactylus frenatus*	common house gecko	LC	NBNE
3	*Hemidactylus stejnegeri*	Stejneger's leaftoed gecko	LC	NBNE
4	*Hemidactylus* sp.	house gecko	CBD	CBD
5	*Hemidactylus platyurus*	flat-tailed house gecko	LC	NBNE
6	*Gehyra mutilata*	common four-clawed gecko	LC	NBNE
7	*Eutropis multifasciata*	many-lined sun skink	LC	NBNE
8	*Sphenomor p hus* sp.	common skink	CBD	CBD
9	*Varanus marmoratus*	marbled water monitor	Appendix II	PE
10	*Naja philippinensis*	Northern Philippine cobra	Appendix II	PE
11	*Rhabdophis spilogaster*	Boie's keelback	LC	PE
12	*Lycodon aulicus*	common wolf snake	LC	NBNE
13	*Cuora amboinensis*	South Asian box turtle	Vulnerable	introduced
14	*Pelodiscus sinensis*	Chinese softshell turtle	Vulnerable	introduced
Amphibians				
1	*Rhinella marina*	cane toad	LC	introduced

#	Scientific names	Comm on Names	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)	Range Distribution (Kennedy et al., 2000 and IUCN 2019)
2	*Hylarana erythraea*	common green frog	LC	NBNE
3	*Limnonectes magnus*	giant Philippine frog	NT	NBNE
4	*Hoplobatrach us rugulosus*	East Asian bullfrog	LC	introduced
5	*Polypedates luecomystax*	common tree frog	LC	NBNE
6	*Occidozyga laevis*	puddle frog	LC	NBNE
Birds				
1	*Accipiter gularis*	Japanese sparrow hawk	Appendix II	migratory
2	*Accipiter soloensis*	Chinese goshawk	Appendix II	migratory
3	*Accipiter virgatus*	besra	Appendix II	RBNE
4	*Acridotheres cristatellus*	crested myna	LC	introduced
5	*Acrocephalus orientalis*	Oriental Reed-Warbl er	LC	migratory
6	*Acrocephalus stentoreus*	Clamorous Reed-Warble r	LC	migratory
7	*Actenoides lindsayi*	spotted wood kingfisher	LC	PE
8	*Actitis hypoleucos*	Common Sandpiper	LC	migratory
9	*Aerodramus amelis*	Ameline swiflet	LC	RBNE
10	*Agropsar philippensis*	Chestnut-cheeke d starling	LC	migratory
11	*Alcedo atthis*	common kingfisher	LC	migratory
12	*Amaurornis olivacea*	Philippine bush-hen	LC	PE
13	*Amaurornis phoenicurus*	white breasted waterhen	LC	RBNE
14	*Anas clypeata*	Northern Shoveler	LC	migratory
15	*Anas luzonica*	Phillipine Duck	Vulnerable	PE
16	*Anthus rufulus*	paddyfield pipit	LC	RBNE
17	*Aplonis panayensis*	Asian glossy starling	LC	RBNE
18	*Apus affinis*	House Swift	LC	RBNE
19	*Apus pacificus*	Fork-tailed Swift	LC	migratory
20	*Ardea alba*	Great Egret	LC	migratory
21	*Ardea cinerea*	Grey Heron	LC	migratory
22	*Ardea purpurea*	Purple Heron	LC	migratory
23	*Ardeola bacchus*	Chinese pond heron	LC	migratory
24	*Arenaria interpres*	Ruddy Turnstone	LC	migratory
25	*Artamus leucorynchus*	white-breasted wood swallow	LC	RBNE
26	*Aythya fuligula*	Tufted Duck	LC	migratory
27	*Bolbopsittacus lunulatus*	Guaiabero	Appendix II	PE
28	*Bubo philippensis*	Philippine eagle owl	Vulnerable	PE
29	*Bubulcus coromandus*	Eastern Cattle Egret	LC	migratory/ resident
30	*Bubulcus ibis*	cattle egret	LC	migratory/ resident
31	*Butastur indicus*	Grey-faced buzzard	Appendix II	migratory

#	Scientific names	Comm on Names	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)	Range Distribution (Kennedy et al., 2000 and IUCN 2019)
32	*Buteo buteo*	common buzzard	Appendix II	migratory
33	*Butorides striata*	little heron	LC	RBNE
34	*Cacatua alba*	Umbrella cockatoo	Endangered	introduced
35	*Cacatua sulphurea*	Sulphur-crest ed Cockatoo	Critically Endanger ed	introduced
36	*Cacomantis sepulcralis*	Rusty-breasted cuckoo	LC	RBNE
37	*Cacomantis variolosus*	brush cuckoo	LC	RBNE
38	*Calidris acuminata*	Sharp-tailed Sandpiper	LC	migratory
39	*Calidris alba*	Sanderling	LC	migratory
40	*Calidris ruficollis*	Red-necked Stint	LC	migratory
41	*Calidris subminuta*	Long-toed Stint	LC	migratory
42	*Caprimulgus affinis*	Savanna nightjar	LC	RBNE
43	*Caprimulgus manillensis*	Philippine nightjar	LC	RBNE
44	*Cecropis striolata*	Striated swallow	LC	RBNE
45	*Centropus bengalensis*	lesser coucal	LC	RBNE
46	*Centropus viridis*	Philippine coucal	LC	PE
47	*Chalcophaps indica*	common emerald dove	LC	RBNE
48	*Charadrius mongolus*	Mongolian Plover	LC	migratory
49	*Charadrius alexandrin us*	Kentish Plover	LC	migratory
50	*Charadrius dubius*	Little-ringed Plover	LC	RBNE
51	*Chlidonias hybrida*	Whiskered tern	LC	migratory
52	*Chlidonias leucopterus*	White-winged tern	LC	migratory
53	*Chrysococcyx xanthorhynchus*	Violet cuckoo	LC	RBNE
54	*Cinnyris jugularis*	olive-backed sunbird	LC	RBNE
55	*Cisticola exilis*	Bright-cappe d cisticola	LC	RBNE
56	*Cisticola juncidis*	Zitting cisticola	LC	RBNE
57	*Collocalia esculenta*	glossy swiftlet	LC	RBNE
58	*Collocalia troglodytes*	pygmy swiftlet	LC	PE
59	*Columba livia*	rock dove	LC	introduced
60	*Copsychus mindanensis*	Philippines magpie-robi n	LC	PE
61	*Copsychus saularis*	Oriental magpie-rob in	LC	RBNE
62	*Corvus macrorhynchos*	large-billed crow	LC	RBNE
63	*Cuculus optatus*	Oriental cuckoo	LC	migratory
64	*Cuculus pectoralis*	Philippine Hawk-Cuckoo	LC	PE
65	*Cyanoptila cyanomelana*	Blue and white flycatcher	LC	migratory
66	*Dendrocopos maculatus*	Philippine pygmy woodpecker	LC	PE
67	*Dicaeum australe*	red-keeled flowerpecker	LC	PE
68	*Dicaeum* sp.	flowerpecker	CBD	CBD

#	Scientific names	Comm on Names	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)	Range Distribution (Kennedy et al., 2000 and IUCN 2019)
69	*Dicaeum trigonostigma*	orange-bel lie d flowerpecker	LC	RBNE
70	*Dicrurus leucophae us*	Ashy drongo	LC	RBNE
71	*Ducula carola*	Spotted imperial pigeon	Vulnerable	PE
72	*Ducula poliocephal a*	Pink-bellied Imperial Pigeon	NT	PE
73	*Dupetor flavicollis*	Black bittern	LC	RBNE
74	*Eclectus roratus*	Eclectus parrot	LC	introduced
75	*Egretta alba*	Great egret	LC	RBNE
76	*Egretta eulophotes*	Chinese Egret	Vulnerable	migratory
77	*Egretta garzetta*	little egret	LC	migratory/resident
78	*Egretta intermedia*	Intermediate Egret	LC	migratory
79	*Egretta sacra*	Pacific Reef-Egret	LC	migratory
80	*Egretta sp.*	Egret	CBD	CBD
81	*Erythropitta erythrogaster*	Philippine pitta	LC	RBNE
82	*Eurystomus orientalis*	Oriental dollarbird	LC	RBNE
83	*Falco peregrinus*	peregrine falcon	Appendix I	migratory/ resident
84	*Falco tinnunculus*	Common kestrel	Appendix II	migratory
85	*Ficedula narcissina*	narcissus flycatcher	LC	migratory
86	*Gallicrex cinerea*	Watercock	LC	RBNE
87	*Gallinago megala*	Swinhoe's snipe	LC	migratory
88	*Gallinago sp.*	Snipe species	CBD	CBD
89	*Gallinula chloropus*	Common moorhen	LC	RBNE
90	*Gallirallus philippensis*	Buff-banded rail	LC	RBNE
91	*Gallirallus striatus*	slaty-breastede d rail	LC	RBNE
92	*Gallirallus torquatus*	barred rail	LC	RBNE
93	*Gallus gallus*	red junglefowl	LC	RBNE
94	*Geokichla cinerea*	Ashy thrush	Vulnerable	LE
95	*Geopelia striata*	zebra dove	LC	RBNE
96	*Gerygone sulphurea*	golden bellied gerygone	LC	RBNE
97	*Glareola maldivarum*	Oriental pratincole	LC	migratory
98	*Gracula religiosa*	Hill myna	LC	RBNE
99	*Halcyon coromanda*	ruddy kingfisher	LC	migratory/ resident
100	*Halcyon smyrnensis*	white-breasted kingfisher	LC	RBNE
101	*Haliastur indus*	Brahminy kite	Appendix II	RBNE
102	*Heteroscelus brevipes*	Grey-tailed Tattler	LC	migratory
103	*Hierococcyx sparverioides*	Large Hawk-cuckoo	LC	migratory
104	*Himantopus himantopus*	Black-winged stilt	LC	migratory
105	*Hirundapus celebensis*	purple needletail	LC	RBNE

#	Scientific names	Comm on Names	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)	Range Distribution (Kennedy et al., 2000 and IUCN 2019)
106	*Hirundo rustica*	barn swallow	LC	migratory
107	*Hirundo tahitica*	Tahiti swallow	LC	RBNE
108	*Hypotaenidia torquata*	barred rail	LC	RBNE
109	*Ixobrychus cinnamomeus*	cinnamon bittern	LC	RBNE
110	*Ixobrychus sinensis*	yellow bittern	LC	RBNE
111	*Ixos philippinus*	Philippine Bulbul	LC	RBNE
112	*Lalage nigra*	pied triller	LC	RBNE
113	*Lanius cristatus*	brown shrike	LC	migratory/ resident
114	*Lanius schach*	long-tailed shrike	LC	RBNE
115	*Larus ridibundus*	Black-heade d Gull	LC	migratory
116	*Lewinia striata*	slaty-breastede d rail	LC	RBNE
117	*Limosa lapponica*	Bar-tailed Godwit	LC	migratory
118	*Locustella ochotensis*	Middendorff's Warbler	LC	migratory
119	*Lonchura atricapilla*	Chestnut munia	LC	RBNE
120	*Lonchura leucogastra*	white-bellied munia	LC	RBNE
121	*Lonchura malacca*	tricoloured munia	LC	RBNE
122	*Lonchura punctulata*	scale-feathere d munia	LC	RBNE
123	*Loriculus philippensis*	Philippine hanging-pa rak e et	Appendix II	PE
124	*Luscinia calliope*	Siberian Rubythroat	LC	migratory
125	*Lyncornis macrotis*	Great eared nightjar	LC	RBNE
126	*Macropygia tenuirostris*	Philippine Cuckoo-Dove	LC	RBNE
127	*Megaliama haemaceph al a*	coppersmith barbet	LC	RBNE
128	*Megalurus palustris*	striated grassbird	LC	RBNE
129	*Megalurus timoriensis*	tawny grassbird	LC	RBNE
130	*Melopsittacus undulatus*	Budgerigar	LC	introduced
131	*Merops philippinus*	Blue-tailed bee eater	LC	RBNE
132	*Merops viridis*	Blue-throate d bee eater	LC	RBNE
133	*Monticola solitarius*	blue rock thrush	LC	migratory
134	*Motacilla alba leucopsis*	White wagtail, male	LC	migratory
135	*Motacilla cinerea*	grey wagtail	LC	migratory
136	*Motacilla flava*	yellow wagtail	LC	migratory
137	*Motacilla tschutschensis*	Eastern yellow wagtail	LC	migratory
138	*Muscicapa ferruginea*	Ferruginous flycatcher	LC	migratory
139	*Muscicapa griseisticta*	grey-streaked flycatcher	LC	migratory
140	*Nectarinia sperata*	Purple-thro ate d Sunbird	LC	RBNE
141	*Ninox japonica*	Northern Boobook	LC	migratory
142	*Numenius phaeopus*	Whimbrel	LC	migratory

#	Scientific names	Comm on Names	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)	Range Distribution (Kennedy et al., 2000 and IUCN 2019)
143	*Nycticorax caledonicus*	Rufous night heron	LC	RBNE
144	*Nycticorax nycticorax*	black-crowned night heron	LC	migratory
145	*Oriolus chinensis*	black-naped oriole	LC	RBNE
146	*Orthotomus castaneiceps*	chestnut-crowne d tailorbird	LC	PE
147	*Otus megalotis*	Philippine scops owl	Appendix II	LE
148	*Padda oryzivora*	Java sparrow	Endangered	introduced
149	*Pandion haliaetus*	Osprey	Appendix II	migratory
150	*Passer montanus*	Eurasian tree sparrow	LC	introduced
151	*Phaethon rubricauda*	Red-tailed Tropicbird	LC	migratory
152	*Phapitreron leucotis*	white-eared brown fruit-dove	LC	PE
153	*Philomachus pugnax*	Ruff (Reeve)	LC	migratory
154	*Phylloscopus borealis*	Arctic warbler	LC	migratory
155	*Phylloscopus cebuensis*	lemon-throate d leaf warbler	LC	PE
156	*Phylloscopus ijimae*	Ijima's Leaf-warbler	Vulnerable	migratory
157	*Picoides maculatus*	Philippine pygmy woodpecker	LC	PE
158	*Pitta erythrogaster*	Red-bellied pitta	LC	PE
159	*Pluvialis fulva*	Asiatic Golden Plover	LC	migratory
160	*Pluvialis squatarola*	Grey-Plover	LC	migratory
161	*Poliolimnas cinereus*	White-browed Crake	LC	RBNE
162	*Prioniturus luconensis*	Green-Raq uet- Ta il	Endangered	LE
163	*Psittacula krameri*	Rose-ringed parakeet	LC	introduced
164	*Psittacula sp.*	African Love-bird	CBD	CBD
165	*Ptilinopus leclancheri*	Black-chinne d fruit dove	LC	RBNE
166	*Pycnonotus goiavier*	yellow-vented bulbul	LC	RBNE
167	*Recurvirostra avosetta*	Avocet	LC	migratory
168	*Rhipidura nigritorquis*	Philippine fantail	LC	PE
169	*Rostratula benghalensi s*	Greater painted snipe	LC	RBNE
170	*Saxicola caprata*	Pied Bush Chat	LC	RBNE
171	*Spilornis holosphilus*	Philippine serpent eagle	Appendix II	RBNE
172	*Sterna albifrons*	Little Tern	LC	migratory
173	*Sterna/Chlido ni a* sp.	tern	CBD	CBD
174	*Sterna hirundo*	Common Tern	LC	migratory
175	*Streptopelia bitorquata*	island collared-dov e	LC	RBNE
176	*Streptopelia chinensis*	spotted dove	LC	RBNE
177	*Streptopelia tranquebaric a*	red turtle-dove	LC	RBNE
178	*Surniculus velutinus*	Philippine Drongo Cuckoo	LC	PE
179	*Tachybaptus ruficollis*	Little Grebe	LC	migratory

#	Scientific names	Comm on Names	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)	Range Distribution (Kennedy et al., 2000 and IUCN 2019)
180	*Tanygnathus lucionensis*	Blue-nape d parrot	NT	RBNE
181	*Todiramphus chloris*	white-collared kingfisher	LC	RBNE
182	*Treron vernans*	pink-necked green-pig eo n	LC	RBNE
183	*Tringa glareola*	Wood Sandpiper	LC	migratory
184	*Tringa nebularia*	Greenshank	LC	migratory
185	*Tringa stagnatilis*	Marsh Sandpiper	LC	migratory
186	*Tringa totanus*	Redshank	LC	migratory
187	*Turdus* sp.	thrush	CBD	CBD
188	*Turnix suscitator*	Barred buttonquail	LC	RBNE
189	*Tyto longimembr is*	Grass owl	Appendix II	RBNE
190	*Zosterops meyeni*	lowland white-eye	LC	LE
Mammals				
1	*Cynopterus brachyotis*	common short-nosed fruitbat	LC	NBNE
2	*Ptenochirus jagori*	Philippine musky fruitbat	LC	PE
3	*Rousettus amplexicaud atus*	common rousette	LC	NBNE
4	*Eonycteris spelaea*	dawn bat	LC	NBNE
5	*Myotis muricola*	whiskered myotis	LC	NBNE
6	*Suncus murinus*	Asian house shrew	LC	introduced
7	*Rattus norvegicus*	brown rat	LC	introduced
8	*Rattus exulans*	Polynesian rat	LC	introduced
9	*Rattus tanezumi*	Oriental house rat	LC	introduced
10	*Rattus argentiventer*	ricefield rat	LC	introduced
11	*Callosciurus finlaysonii*	variable squirrel	LC	introduced

LC - Least Concern

NBNE - native but non-endemic

RBNE - resident breeding but non-endemic

PE - Philippine endemic

LE - Luzon endemic

CBD - cannot be determined

NT - Near Threatened

The total recorded birds in NCR's greenspaces was compared with the known birds in the entire Luzon mainland to gauge composition/assemblage relative to other parts in Luzon (with similar habitat types). To date, there are 493 birds recorded in Luzon mainland (*Avibase - Bird Checklists of the World*). Based on habitat requirements, Luzon mainland birds can be divided into:

- 183 species associated with forest;
- 112 species require wetlands;
- 79 species inhabit non-forest areas;
- 74 species are generalists that mainly occupy non-forest areas but transcends to forest patches; and
- 45 species which are mainly wetland dwellers but also occupy non-forestareas.

This means that majority (183 species or 37%) of Luzon mainland birds are strict forest dwellers. The 184 species recorded in NCR's greenspaces represent approximately 37% of the known total for Luzon mainland. However recorded bird-habitat associations from said greenspaces are mainly non-forest, non-forest to marine (coastal), and non-forest to wetlands (inland) birds. Although some forest dwelling birds were recorded, these are the less sensitive types or those that can tolerate various forms of disturbances. Also, they can inhabit small patches of forest as oppose to other forest inhabitants which require large tracts of forest land to survive. In comparing recorded birds in NCR's greenspaces with the Luzon mainland birds, habitat associations will be considered. This means that birds sighted from NCR's greenspaces represent about 59% of the known birds in Luzon mainland (excluding the 181 strict forest birds). Species richness recorded in the greenspaces remains high and represents a typical assemblage comparable to other parts of Luzon mainland with similar habitat types. This emphasizes the critical importance of these remaining greenspaces in terms of conservation. Based on Vallejo et al., 2009, greenspaces in the cities have been previously identified as areas with significant avian biodiversity.

Majority (182 species or 85%) of the documented wildlife in NCR's greenspaces are non-threatened or Least Concern based on IUCN 2019 and RA 9147/ CITES 2019. However, at least 28 species (13%) composed of four (4) reptiles and 24 birds are included in various conservation listings. **Table 2.1-40** provides a list of documented threatened species in NCR's greenspaces. It will be noted that five (5) of these threatened species are introduced or not originally from the Philippines. These are: *Cuora amboinensis* or south Asian box turtle, *Pelodiscus sinensis* or Chinese softshell turtle, *Cacatua alba* or umbrella cockatoo, *Cacatua sulphurea* or sulphur-crested cockatoo, and *Padda oryzivora* or Java sparrow. The other recorded threatened species are with various range distributions, namely: endemics (with 10 species), resident breeding but non-endemics (with four species), migratory (with eight species), and migratory with resident breeding populations (with one species). There are species not included in the IUCN 2019 listing but are classified as either Appendix I or II species based on CITES 2019 hence, are automatically categorized as Critically Endangered and Endangered, respectively. This is based on RA 9147 (Wildlife Act of 2001).

Table 2.1-40List of Threat e ne d species recorded in selected NCR's greenspaces

Scientific Name	Common Name	Range Distribution (Kennedy et al., 2000 and IUCN 2019)	Conservation Status (IUCN 2019 and/or CITES 2019/ RA9147)
Reptiles			
Varanus marmoratus	Marbled Water Monitor	PE	Appendix II
Naja philippinensis	Northern Philippine Cobra	PE	Appendix II
Cuora amboinensis	South Asian Box Turtle	Introduced	Vulnerable
Pelodiscus sinensis	Chinese Softshell Turtle	Introduced	Vulnerable
Birds			
Accipiter gularis	Japanese Sparrowhawk	Migratory	Appendix II
Accipiter soloensis	Chinese Goshawk	Migratory	Appendix II
Accipiter virgatus	Besra	RBNE	Appendix II
Anas luzonica	Phillipine Duck	PE	Vulnerable
Bolbopsittacus lunulatus	Guaiabero	PE	Appendix II
Bubo philippensis	Philippine Eagle Owl	PE	Vulnerable
Butastur indicus	Grey-faced Buzzard	Migratory	Appendix II
Buteo buteo	Common Buzzard	Migratory	Appendix II
Cacatua alba	Umbrella Cockatoo	Introduced	Endangered
Cacatua sulphurea	Sulphur-crest ed Cockatoo	Introduced	Critically Endanger ed
Ducula carola	Spotted Imperial Pigeon	PE	Vulnerable
Egretta eulophotes	Chinese Egret	Migratory	Vulnerable
Falco peregrinus	Peregrine Falcon	Migratory/Resident	Appendix I
Falco tinnunculus	Common Kestrel	Migratory	Appendix II
Geokichla cinerea	Ashy Thrush	LE	Vulnerable
Haliastur indus	Brahminy Kite	RBNE	Appendix II
Loriculus philippensis	Philippine Hanging-Par ak eet	PE	Appendix II
Otus megalotis	Philippine Scops Owl	LE	Appendix II
Padda oryzivora	Java Sparrow	Introduced	Endangere d
Pandion haliaetus	Osprey	Migratory	Appendix II
Phylloscopus ijimae	Ijima's Leaf-warbler	Migratory	Vulnerable
Prioniturus luconensis	Green Raquet-tail	LE	Endangere d
Spilornis holosphilus	Philippine Serpent Eagle	RBNE	Appendix II
Tyto longimembr is	Grass Owl	RBNE	Appendix II

PE – Philippine endemic; LE – Luzon endemic; RBNE – Resident but non-endemic

We highlight the presence of introduced species in NCR's greenspaces. At least 19 species (two turtles, one toad, one frog, nine birds, one shrew, four rats, and one squirrel) were documented by various studies. While most were accidentally introduced during the late 1800s, some were intentionally released (by the government) mainly for aesthetic purposes. However, noteworthy are the recent introductions (either accidental or intentional) of parrots, cockatoos and a squirrel mostly in the affluent areas of NCR. It is likely that they were pets that escaped captivity or pets that were intentionally released by the owner. Recorded and confirmed present during an AECOM rapid biodiversity assessment inside Filinvest City was a s mall population of *Pelodiscus sinensis* or Chinese softshell turtle in Alabang Creek. Also, there were several individuals of *Cacatua sulphurea* or sulphur-crested cockatoo, *Psittacula krameri* or rose-ringed parakeet, and *Callosciurus finlaysonii* or variable squirrel observed and recorded near the American Memorial Cemetery, Villamor Air Base Golf Course, and Manila Golf & Country Club. Currently, there are no f ield researches which establishes the potential impacts of these introductions but potentially they may c aus e concerns on resource competition and spread of diseases.

2.1.4.3.3 Vulnerability to Climate Change

The 2020 and 2050 Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Climate Change Projection for the NCR show extremes between dry and wet seasons. Rainfall is expected to decrease during the dry season and increase during the wet season making the dry season drier and the wet season wetter. There is also an increasing temperature trend in 2020 and 2050. Temperature is expected to increase during the dry season. In general, all areas in the Philippines will get warner more so during the relatively warmer summer months.

The projected climate extremes and variability has the potential to negatively affect vegetation and wildlife in the entire NCR. There are no specific studies conducted in the NCR which documents such negative effects thus, observations in other areas are presented. In general, as climate warms, various vegetation communities and their dependent organisms (e.g. birds, insects) may be expected to shift in their distribution to follow their preferred microclimates. This means that at certain times of the year, it is likely that certain plant groups together with their wildlife inhabitants may fluctuate in number. Moreover, their local population in a given geographical location my increase or decrease depending on the prevailing microclimate.

There are studies which have shown that recent climate change has already affected populations of birds. The effects include earlier breeding, changes in timing of migration, changes in breeding performance (egg size and nesting success), changes in population size, changes in population distributions and changes in selection differentials between components of a population (Crick 2004, Robinson et al. 2005). Other effects include disruption of species interaction and communities, synergism with other stresses (e.g. disease, invasive species, habitat degradation), changes in ranges (shifting, contracting, disappearing), and change in population distribution/ land use.

2.1.4.3.4 Historical Occurrence of Pest Infestation, Forest/Grass Fires

The original vegetation along the MMSP alignment has long been removed and converted to built-up areas. Majority of the vegetation that presently characterize the NCR landscape is planted for aesthetic purposes and comprised almost exclusively of exotic species. The main disturbances that affects both vegetation and wildlife in the NCR are growing human population, pollution, and conversion of natural habitats and remaining greenspaces to built-up areas.

Based on the accounts of residents interviewed during the rapid site assessments, incidents involving tree/vegetation mortalities due to pest infestation and/or forest/grass fires were uncommon. However, unaccounted mortalities may have been present throughout the MMSP alignment because of the increasing rate of urbanization and land use conversion in the NCR.

2.1.4.3.5 Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement

This section describes the potential impacts of the MMSP to the terrestrial ecology along and across nearby areas (**Table 2.1-41**). Their projected occurrence is identified following the four (4) major project implementation phases. Additionally, corresponding mitigating measures are enumerated to minimize and/or off-set these impacts.

Table 2.1-41Potential impact s and options for prevention, mitigation, or enhancement – Terrestrial Ecology

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Closure	
Vegetation removal resulting to loss of potential habitat					
The MMSP will be constructed in a highly urbanized area. However, approximately **63.23 ha** of above ground land area will be cleared of vegetation to give way to stations.	]	]	:	:	• Clear delineation of the extent of vegetation removal on plans and on the ground prior to removal activities. • Secure both tree cutting and earth balling permits from the Department of Environment and Natural Resources (DENR). Replacement of cut trees will be in accordance with the DENR Memorandum Order (DMO) 2012-02. • Impacts and restrictions to the movement of wildlife is not expected since areas that will be cleared are patchy, limited, and mostly occupied by more mobile organisms (capable of flight) hence, they could easily transfer to other areas.

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Closure	
					• Provision of offset sites for all areas that will be cleared. These designated areas will at least be equivalent to the land area affected by the MMSP. It must be jointly identified and selected by DOTr and DENR.
Threat to local existence of endemic and/or threatened plant species					
Eleven (11) threatened plant species were recorded. Twenty-eight (28) threatened wildlife species were recorded.	]	]	:	:	• Securing earth balling permits from DENR prior to vegetation removal activities • Guided transplanting and earth balling activities with the supervision of a horticulturist/agriculturist to ensure high survival rate of transplanted trees. • Appropriate maintenance activities will be conducted to ensure high survival rates of earth balled tree species. • Areas where threatened reptiles were recorded will not be affected by vegetation clearing activities. Recorded threatened birds are highly mobile and could easily transfer to nearby greenspaces.
Indirect effects					
Dust – accumulation of dust on the leaf laminae could inhibit major physiological processes of plants (i.e., photosynthesis, transpiration, respiration, phenology) and could even contribute to physical abrasion. Such may lead to decreased plant fitness and mortalities.	]	]	:	:	• Implementation of regular water sprinkling, especially during the dry season along dusty areas to reduce the harmful effects of dust emissions.
Anthropogenic noise - generated during various development phases which may affect the physiology, behavior, reproduction and the long-term survival of wildlife.	]	]	:	:	• Ensuring all vehicles, and machinery are maintained in proper working order to avoid unnecessary engine, motor or muffler noise.

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Closure	
Light - can potentially affect wildlife behaviour, disrupt seasonal day cues, cause temporary blindness, and disrupt predator-prey relationships.	]	]	:	:	• Use of light source with directional lighting and screens to concentrate light on operations.
Increased weed infestation –weeds prefer disturbed areas, which may likely occur in areas where vegetation has been removed.	]	]	:	:	• Inclusion of weed control measure.

2.1.4.4 Potential impacts

This section presents the key ecological impacts of the MMSP on terrestrial vegetation and wildlife recorded along or on nearby areas of the alignment. Direct impacts are mainly related to vegetation removal.

Project impacts are the following:

- Habitat removal
- Threat to existence of endemic and/or /threatened species
- Indirect effects
    - Fugitive dust
    - Anthropogenic noise
    - Light
    - Increased weed invasion

2.1.4.4.1 Vegetation removal resulting to loss of connecting vegetation

Approximately 63.23 ha of above ground land area will be cleared to give way for the proposed subway stations. As available greenspaces in the NCR are highly fragmented, small patches of vegetation located in-between serve as important "stepping-stones" to maintain connection and exchange of wildlife species among them. Vegetation removal may potentially impact established flight routes of birds and bats which may affect breeding, feeding and roosting behaviors. Moreover, vegetation removal may potentially affect micro-climate in the proposed subway stations.

2.1.4.4.2 Threat to local existence of endemic and/or threatened species

Table 2.1-42 below summarizes the number of recorded endemics and/or threatened species for both vegetation and wildlife.

Table 2.1-42 Endemic and threatened species of vegetation and wildlife

Terrestrial Ecology Groups	Number of Ende mics	Number of Threatened Species
Vegetation	6 endemics	11 (2 endemics)
Wildlife	29 endemics	28 (10 endemics and 5 introduced))

We foresee that only endemic and/or threatened plant species (15 species) will be affected by vegetation removal. Most of the Threatened wildlife species are birds (24 species) hence, could easily transfer/move to other nearby greenspaces and thus will not be directly affected by the project. Threatened reptiles (4 species) were recorded from Ateneo de Manila University and Filinvest City (see **Figure 2.1-64**). Both areas are not affected by the proposed MMSP. Removal of endemic and/or threatened plant species may reduce their local abundance in the area.

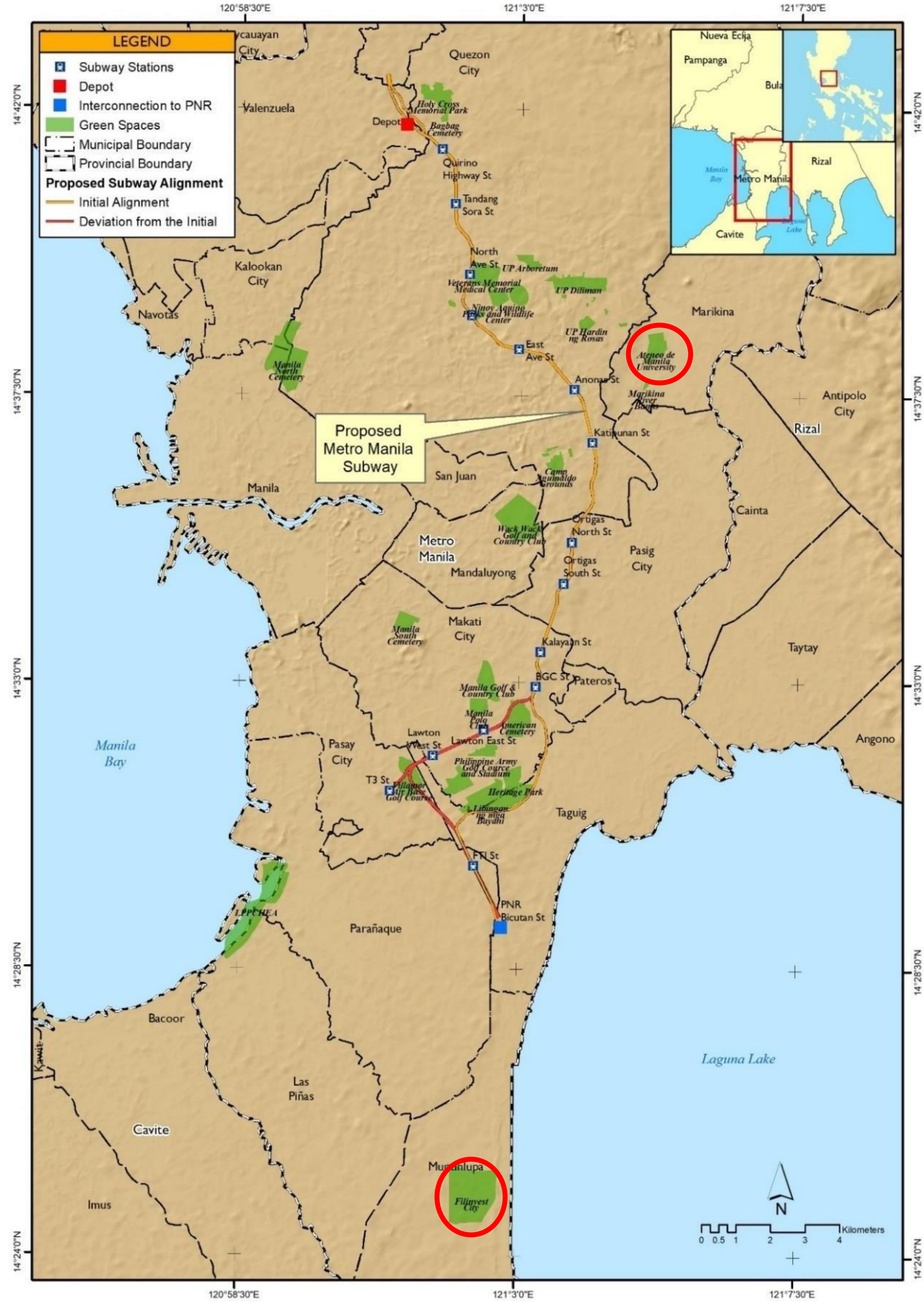


Figure 2.1-64 Site map of the location of the Identified Reptiles

2.1.4.4.3 Indirect Effects – Fugitive Dust, Anthropogenic Noise, Light and Increased Weed Invasion

The MMSP will also have indirect effects on the ecological values along the alignment, including fugitive dust, anthropogenic noise, light, and increased weed invasion. As it is, the current environment along the MMSP alignment already poses challenges to existing vegetation and wildlife hence, additional stress or s may further impact their overall survival and productivity. These indirect effects are discussed below.

Fugitive Dust

When dust settles out of the air, it accumulates on leaf surfaces, thereby negatively affecting various plant processes such as photosynthesis, respiration and transpiration. Dust may also physically affect plants through blockage and damage to stomata, shading, abrasion of leaf surface, which may lead to cumulative effects. Also, dust accumulation on leaf surface increases water loss (transpiration) due to higher absorption of incident radiation (Hirano et al, 1995). These conditions may lead to decreased plant health, decreased productivity, and decreased vigor which means that they become more susceptible to disease and pathogens.

Wildlife species are affected by dust deposition since leaves or fruits covered with dust become less palatable. Moreover, it leads to decreased plant health which may result to change in community structure leading to reduced available habitat

Anthropogenic Noise

Impacts from noise will likely be localized close to construction and staging areas, and other development sites. It is unlikely to have significant, long- term impact on wildlife populations. Remaining wildlife along the alignment are most likely used to or have habituated to periodic noise disturbance in the area. Thus, construction and operation phases of the MMSP are likely to only cause temporary disturbance to wildlife.

Light

Effects from night lighting will be particularly localized close to certain development sites that will have 24/7 operations. It is likely that remaining wildlife along the alignment are used to or have habituated to periodic light sources in the area.

Increased Weed Invasion

Clearing of existing vegetation along the MMSP alignment would mean an opportunity for invasive and introduced weeds to occupy said areas. However, areas that will be cleared of vegetation are limited and is quite inhospitable even for invasive and introduced weeds due to various existing disturbances. Introduced weeds may compete with existing vegetation assemblage along the project site.

2.1.4.4.4 Options for Prevention, Mitigation or Enhancement

This section presents the recommended options for prevention, mitigation or enhancement of impacts relating to terrestrial vegetation and wildlife.

Vegetation removal

Where vegetation removal will take place, the limits of clearing will be clearly identified/delineated on plans and on the ground (using flagging and signage). A clearing plan will be prepared by the proponent prior to construction. The plan will contain detailed clearing and cutting protocols to reduce impacts to the surrounding areas and resident wildlife. It will also include handling and management procedures of the cut logs and /or sustainable practices in disposing vegetation waste. Note that prior to any cutting activities, a tree cutting permit will be secured form the DENR.

Provision of off-set sites for all areas that will be cleared. These designated areas will at least be equivalent to the land area affected. The area must be jointly identified and selected by DOTr and DENR.

Threat to existence of important local species/threatened species

This impact can be mitigated by undertaking ground truthing of the location of endemic and/or threatened plant species. Endemic and/or threatened species will be tagged and identified on site. The proponent will secure both tree cutting and earth balling permits from the Department of Environment and Natural Resources (DENR). Replacement of cut trees will be in accordance with the DENR Memorandum Order (DMO) 2012-02. Appropriate maintenance activities will be conducted to ensure high survival rates of earth balled tree species.

<u>Indirect Effects</u>

Fugitive Dust

The MMSP alignment is mainly surrounded by concrete roads hence, dust problems will be insignificant. However, in extreme cases, regular (or as the need arises) dust suppression shall be implemented. Fugitive dust from vehicular traffic and material handling activities will be controlled by management of vehicle speeds and/or application of dust suppression.

- Sprinkling of access roads including other exposed soils will be implemented during dry weather.
- Vehicle idling and traffic on exposed soils will be minimized.
- All construction vehicles and other vehicles will be cleaned of all loose soil, dust and other debris, including washing of tires, sweeping of exteriors and tailgates prior to leaving the project site

- All trucks loaded with soil or debris will be covered with tarps prior to leaving the site
- Dust generation from exposed fill/stock piles will be covered with tarps or erosion control blankets

Anthropogenic Noise

The following best practice techniques will be considered by the proponent to control noise emission:

- Access roads will be made asphaltic paved.
- A speed limit of 20 km/h within construction sites to control noise generation will be implemented.
- Scheduling equipment movements wherever possible to avoid sensitive times (e.g. night time).
- Ensuring all vehicles, plant and machinery are maintained in proper working order to avoid unnecessary engine, motor or muffler noise.

Light

Mitigating measures to minimize light impact on wildlife are provided below.

- If feasible, anti-glare lighting will be used to minimize disruption to vision of nocturnal wildlife.
- If feasible, use of light source with directional lighting and screens to concentrate light on operations.

Increased Weed Invasion

Appropriate control measures for weeds will be included during operations & maintenance of relevant aboveground MMSP facilities. Regular brushing, cutting and maintenance of open areas will be implemented. All vehicles that might have been from weed-infested areas entering any portion of the project alignment will be washed down to prevent possible introduction of weeds.

Ninoy Aquino Parks and Wildlife Center (NAPWC)

NAPWC has been classified as a National Park since August 21, 2002. Under NIPAS (1992), NPs “refer to a forest reservation essentially of natural wilderness character which has been withdrawn from settlement, occupancy or any form of exploitation except in conformity with approved management plan and set aside as such exclusively to conserve the area or preserve the scenery, the natural and historic objects, wild animals and plants therein and to provide enjoyment of these features in such areas.” NAPC is originally an open/ grassland area with all its original cover and natural features removed. Through time, with the establishment of the Biodiversity Management Bureau (BMB) office (formerly Protected Areas and Wildlife Bureau) in the compound, the area has become a favorite tree planting venue of the DENR. To date, various plants thrive in the area but is mainly composed of exotic or introduced species. Of the 135 species recorded, only seven are endemics while the rest are all introduced. Similarly, species of wildlife kept in the NAPWC are not originally from Metro Manila but from other provinces and even other countries. These wildlife individuals were mostly rescued from illegal traders or were surrendered by residents who keep them as pets or was accidentally captured.

Most of the wildlife and vegetation in the NAPWC are introductions. The original vegetation cover and wildlife assemblage in the area have long been removed. It is also safe to say that most of the species which remain in the area are those adapted to various surrounding disturbances (e.g. noise, light, air, vibration, and solid waste). These species could be described as sturdy and able tolerate various anthropogenic impacts. The MMSP is approximately 740m away from NAPWC. Given the distance, it is likely that potential impacts by the said station to various vegetation and wildlife at the NAPWC will be negligible.

2.2 The Water

2.2.1 Hydrology and Hydrogeology

This section presents the results of the hydrology and hydrogeology assessment of the waterbodies within and adjacent to the original and proposed expansion site of the MMSP. The assessment was undertaken to evaluate the potential impacts of the expansion and realignment of the project and to identify measures for their prevention, mitigation, or enhancement by:

- Updating the baseline hydrometeorological, hydrological, and hydrogeological information of the project site, in consideration of the proposed changes to and expansion of the MMSP;
- Understanding and assessing the existing environmental and community demands on water resources;
- Assessing how the MMSP and its proposed expansion will impact upon the water resources during the construction, operations, and closure phases of the project; and
- Developing mitigation strategies that ensure the necessary community and project water quantity needs are met.

2.2.1.1 Methodology

(1) Regulatory Requirements

The National Water Resources Board (NWRB) is the lead government agency responsible for ensuring the optimum utilization, development, conservation, and protection of the water resources of the Philippines. The NWRB regulates and controls water resources through the implementation of provisions of the Water Code of the Philippines, issued as Presidential Decree No. 1067 (PD 1067) on 31 December 1976. The initial Implementing Rules and Regulations (IRR) of the Water Code was adopted at the 119th meeting of the National Water Resources Council (now known as the NWRB) on 11 June 1979. An amendment to the IRR was adopted during the 29th meeting of the NWRB on 21 March 2005. The underlying principles of the Water Code based on Article 3 of PD 1067 are:

- *"All waters belong to the State;*
- *All waters that belong to the State cannot be the subject of acquisitive prescription;*
- *The State may allow the use or development of waters by administrative concession;*
- *The utilization, exploitation, development, conservation and protection of water resources shall be subject to the control and regulation of the government through the National Water Resources Council, hereinafter referred to as the Council;*
- *Preference in the use and development of waters shall consider current usages and be responsive to the changing needs of the country."*

Water, as used in the Water Code, is defined in Article 4 of PD 1067 as *"water under the ground, water above the ground, water in the atmosphere and the waters of the sea within the territorial jurisdiction of the Philippines."* Articles 5 and 6 of PD 1067 provide a further definition of water belonging to the state and leave no doubt to the fact that all waters are subject to State control.

Usage of water is governed by the rules outlined in the IRR, which state that water may be appropriated for specific purposes. These purposes, listed in decreasing order of priority, are:

- Domestic;
- Municipal;
- Irrigation;
- Power generation;
- Fisheries;
- Livestock raising;
- Industrial;
- Recreational; and
- Other purposes.

The IRR defines the industrial usage of water as the "*utilization in factories, industrial plants, and mines including the use of water as an ingredient of a finished product*." Under the provisions of the Water Code, a Water Permit must be obtained for industrial supply use. This permit is issued by a regional NWRB Office.

(2) Study Area

The MMSP and its proposed expansion and realignment site traverses seven catchments within the Manila Bay Watershed Area in Metro Manila. The hydrological and hydrogeological water resource assessment of these catchments was undertaken through the collection and review of available secondary data and relevant data from the MMSP Environmental Impact Statement (EIS) published in 2017. A walkthrough survey of the creeks in the vicinity of the proposed expansion site was also conducted, along with key informant interviews of representatives from the local government units of Pasay and Taguig City to determine the current water use in the proposed expansion site.

(3) Secondary Data Sources

Secondary data that was used for the water resource assessment include:

- Hydro-meteorological and hydrological monitoring data from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA);
- Groundwater availability map from Mines and Geosciences Bureau (MGB);
- Data from the NWRB;
- Data from the MMSP EIS (2017);
- Data from available Comprehensive Land Use Plans (CLUP) of cities that will be traversed by the MMSP; and
- Data from other published technical information.

(4) Surface and Groundwater Availability Analysis

The proposed project will not be extracting water from wells or abstract water from existing waterways crossed by the MMSP, hence potential water competition is unlikely.

(5) Development of Flood Influence Map

Extent of flooding was based from flood simulations conducted by the Project NOAH of PAGASA-DOST. About nine waterways will be crossed by the MMSP. With the use of TBM for the tunnel sections of the project, it is anticipated that flooding will have minimum to insignificant impact to construction activities.

(6) Climate Change Impacts

Last February 2011, the MDG Achievement Fund, funded by the Spanish Government and implemented through the UNDP, the ADAPTAYO, an IEC campaign program of the DENR in cooperation with PAGASA published a report entitled Climate Change in the Philippines. The report discusses, among others, current climate change trends in the country, climate scenarios and climate projections focusing on climatic variations for temper atur e and rainfall. In general, models were developed to estimate climate projections in the country.

The study estimated that in the National Capital Region from year 2006 to year 2035, a potential decrease in rainfall during the northeast monsoon and summer seasons of about 12.8% and 33.3%, respectively. No decrease or increase (0.0%) is projected during the transition period. An increase of about 8.5% is projected during the southwest monsoon season. From 2036 to 2050, the study projected that the decrease in seasonal rainfall during the months of December to May will continue. It is projected that about 17.3% and 38.5% decrease in seasonal rainfall will be experienced during the northeast monsoon and summer season, respectively. An increase in seasonal rainfall during the transition period (3.7%) and southwest monsoon (21.3%) from 2036 to 2065 was projected.

The impacts of these predicted trends have been considered in the flood influence map generated by Project NOAH.

2.2.1.2 Baseline Environment

(1) Summary of Findings

Baseline Inform at ion	Key Findings and Conclus ions
Drainage system of the project	The entire MMSP project site is located within the Manila Bay Catchment Area, and straddles seven catchments that form part of the Pasig-Marikina-Laguna de Bay Basin. The Laguna de Bay Basin is one of the four major river basins of the Manila Bay Catchment Area. The seven catchments traversed by the MMSP alignment include the Tullahan River Catchment, San Juan River Catchment, Marikina River Catchment, Pasig River Catchment, Pateros River Catchment, Paranaque River Catchment, and Muntinlupa River Catchment. The alignment will cross at least 9 rivers/creeks, albeit underground, except for the Talipapa creek that will be directly crossed by the Quirino Highway Station.
Flooding	The MMSP alignment traverses areas along Metro Manila that have moderate to high flooding susceptibility. These areas include the Valenzuela Depot, Quirino Highway Station, Tandang Sora Station, Quezon Avenue Station, East Avenue Station, Katipunan Station, Anonas Station, Lawton East Station, Lawton West Station, and FTI Station
Groundwater data	The area traversed by the MMSP consists of Class I (B) and Class I (C) aquifers. Class I (B) aquifers are fairly extensive and productive aquifers with moderate to high permeability while Class I (C) aquifers are considered local and less productive aquifers, with well yields mostly about 2 L/s but as high as 20 L/s in some sites. A total of 46 deep wells have been granted by the NWRB within a 1 km radius of the MMSP realignment site. As per the NWRB water listing, the static water level and drawdown of deepwells with available pumping test data located within the 1 km radius of the subway alignment ranged from 21.31 to 141.73 meters below ground level (mbgl) and 5.30 to 21.34 mbgl.
Water resource use	Metro Manila's water supply is provided by the Manila Water Company, Inc. (MWCI), and Maynilad Water Services, Inc. (MWSI). Individual houses in Metro Manila not connected to MWCI's or MWSI's distribution system have their own wells or get their water from communal wells. A walkthrough survey of some of the host communities of the MMSP expansion site in Taguig City and Pasay City identified at least 20 perennial wells with approximate depths ranging from 9 to 20 m (based on information from well owners). These wells are used by residents for domestic purposes such as drinking (boiled prior to consumption), cooking, bathing, and cleaning.

(2) Pre-Project Hydrology and Hydrogeology Assessment (2017 EIS) and additional data for the EPRMP (2019)

Surface Water Environment

Catchment Area and Drainage

The entire MMSP project site including its expansion area is located within the Manila Bay Catchment Area, in the cities of Valenzuela, Quezon, Pasig, Makati, Taguig, Pasay, and Parañaque. Seven catchments were traversed by the project site, including the Tullahan, San Juan, Marikina, Pasig, Pateros, Parañaque, and Muntinlupa catchments (**Figure 2.2-1**). The estimated areas of these catchments are shown in **Table 2.2-1**.

Table 2.2-1 Estimated Catchment Areas Travers e d by the MMSP

Catchment Name	Approximate Catchment Size (ha)	Approximate Length of Subway per Catchment (km)	No. of Stations and Size of each Station (ha) per Catchment	
Tullahan River	6,097.8	8.7	Depot	29.23
			Quirino Highway Station	1.29
San Juan River	7,143.3	12.3	East Ave. Station	1.63
			North Ave. Station	3.60
			Ortgas Ave. Station	2.26
			Tandang Sora Station	1.37
Marikina River	4,633.8	17.9	Anonas Station	1.34
			Katipunan Station	2.50
			Ortigas North Station	1.15
			Ortigas South Station	0.43
Pasig River	2,869.9	3.6	Kalayaan Station	1.10
			Ortigas South Station	0.45
Pateros River	1,805.0	10.5	-	-
Maricaban Creek (sub- catchment of Parana que River)	2,053.1	20.7	Lawton West Station	1.81
			NAIA Terminal 3	0.22
Don Galo Creek (sub- catchment of Parana que River)	2,465.5	1.9	FTI Station	0.27
Parana que River	1,320.0	5.4	FTI Station	3.81
			NAIA Terminal 3	0.39
Muntinlupa River	167.2	0.6	-	-

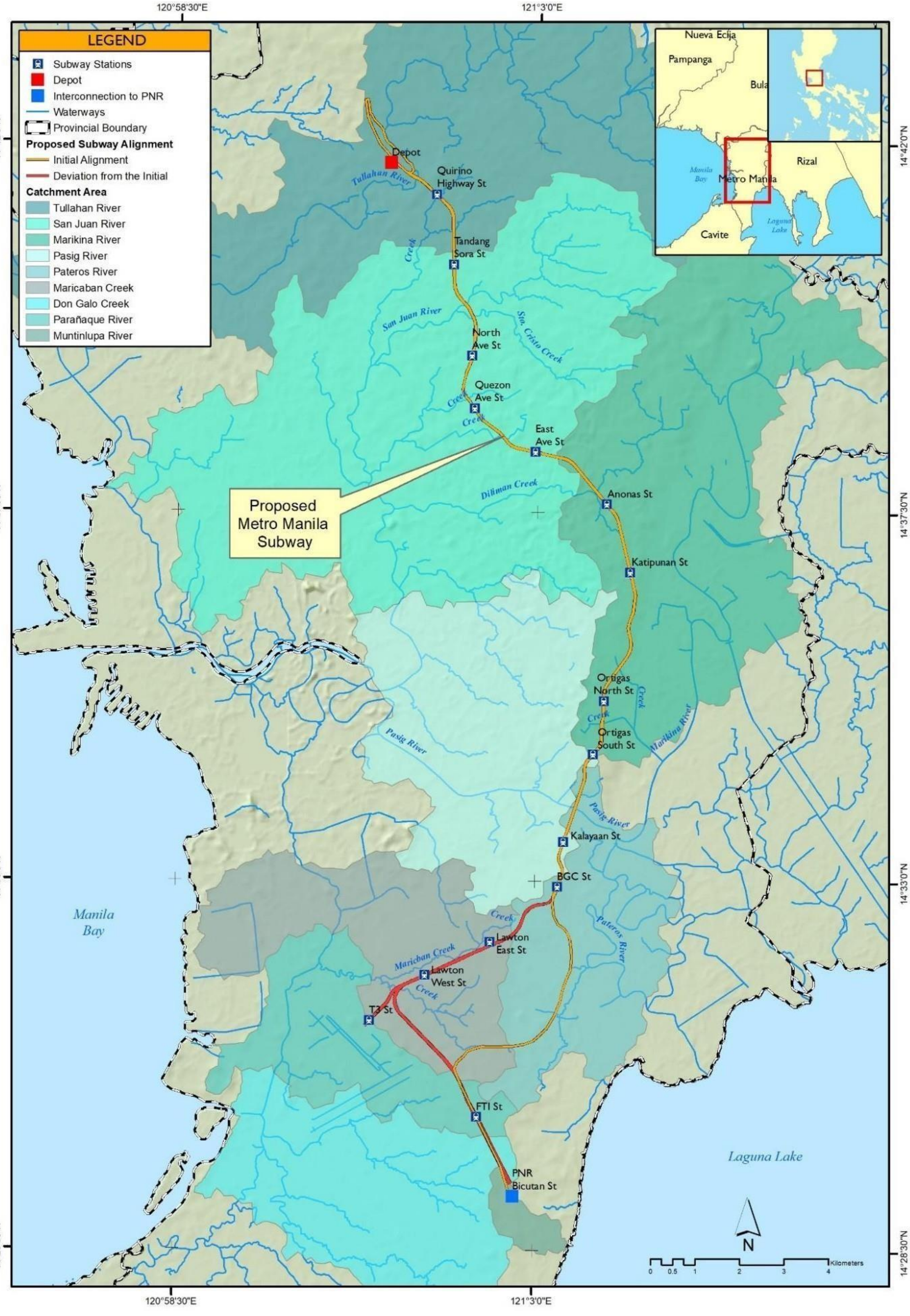


Figure 2.2-1 Project Drainage Map for Major Catchment s

The seven catchments traversed by the project site form part of the Pasig-Marikina-Laguna de Bay Basin, which is one of the four major river basins of the Manila Bay Catchment Area. The Pasig-Marikina-Laguna de Bay bas in has an approximate area of 428,150 ha (including the Laguna Lake Area), and makes up about 22% of the Manila Bay Catchment Area (NEDA, 2018).

The Pasig-Marikina-Laguna de Bay Basin is made up 29 sub-basins, the two largest of which are the Marikina River and Pagsanjan River which have drainage areas approximately of 534.80km^2 and 311.80km^2 respectively. Twenty-two out of the 29 sub-basins drain to Laguna Lake, while the remaining seven river sub-basins in Metro Manila flow to Manila Bay. Laguna Lake is located in the central portion of the basin and has an average depth of about 2.8 m. Historically, the main flow out of Laguna Lake has been the Pasig River (via the Napindan Channel) which connects the lake to Manila Bay. When the lake level is sufficiently low, salt water from Manila Bay flows back along the Pasig increasing salinity within the lake. Both the Marikina River, the largest flow into the system, and the Pasig River, the largest flow out of the system are controlled by hydraulic structures.

The seven catchments within the Pasig-Marikina-Laguna de Bay basin that are traversed by the MMSP project site include the:

- Tullahan River Catchment – the Tullahan River originates from the La Mesa Reservoir in Quezon City and flows westward through Malabon City and Valenzuela City before eventually draining to Manila Bay;
- San Juan River Catchment – the San Juan River is a main tributary of the Pasig-Marikina-San Juan River System and flows southward to the Pasig River through Quezon City, San Juan City, Manila, and Mandaluyong City; the San Juan River joins the Pasig River at approximately 9.9 km upstream from the Pasig River mouth (DPWH, JICA, and Yachiyo Engineering Co. Ltd, 2014)
- Marikina River Catchment – The Marikina River is a tributary of the Pasig River and is one of the main sub-basins of the Pasig-Marikina-Laguna de Bay Basin. It has a drainage area of approximately 534.8 km^2 and flows to Pasig River. The river originates from Rodriguez, Rizal Province. A portion of the flow of Marikina River is diverted to Laguna Lake via the Manggahan Floodway, a flood control channel built in 1988 to mitigate flood damage resulting from the overflow of the lower Marikina River and Pasig River (DPWH, JICA, and Yachiyo Engineering Co. Ltd, 2014). The remaining flow discharges to Pasig River and eventually to Manila Bay.
- Pasig River Catchment – the Pasig River may be considered as the most important river in Metro Manila connecting the Manila Bay with the Laguna Lake (NEDA, 2018). It has an average width of 91 m, a depth ranging from 0.5 to 5.5 m, and average discharge volumes of 12 m^3/s from March to May and up to 275 m^3/s from October to November (NEDA, 2018). Pasig River has four major tributaries including the Marikina River, Pateros-Taguig River, Napindan River, and San Juan River, along with numerous minor tributaries. The river flows north-westward and discharges to Manila Bay, although salt water from Manila Bay als o f low s back along the Pasig River when levels in Laguna Lake are sufficiently low
- Pateros River Catchment – The Pateros River is one of the four major tributaries of Pasig River
- Parañaque River Catchment – The Parañaque River is part of the Parañaque-Las Piñas-Zapote River Bas in and drains to Manila Bay
- Muntinlupa River Catchment – The Muntinlupa River drains to Laguna Lake

The 2017 MMSP EIS identified several water bodies that will be traversed by the project alignment. These include the Tullahan River, San Juan River, Pasig River, and five creeks shown in **Figure 2.2-2 to Figure 2.2-4** below. Waterbodies within and in the vicinity of the expansion area of the MMSP in Taguig, Pasay, and Parañaque City include the Maricaban Creek and Don Galo Creek. The track from Lawton West Station going to FTI Station will cross a tributary of the Maricaban Creek, while the Don Galo Creek is located approximately 100 m west of the track going to FTI Station. Both the Maricaban Creek and Don Galo Creek drain into the Parañaque River, which in turn flow out to Manila Bay. The approximate distances of the depot, stations, and construction staging areas are also presented in **Table 2.2-2** below.

Table 2.2-2 Approximate Distances of the Depot, Stations and Construction Staging Areas from the Nearest Waterbodies

Station Name	Approximate Distance to the nearest waterbody (meters)
Quirino Highway Station	0.0
Depot	16.8
Lawton East Station	33.9
Anonas Station	65.3
Lawton East Station	84.5
Lawton West Station	137.7
Ortgas Ave. Station	173.0
NAIA Terminal 3	254.5
Ortigas North Station	319.7
Kalayaan Station	358.5
East Ave. Station	437.4
North Ave. Station	449.7
Ortigas South Station	451.9
FTI Station	462.6
Tandang Sora Station	476.4
Katipunan Station	593.6
BGC Station	682.0

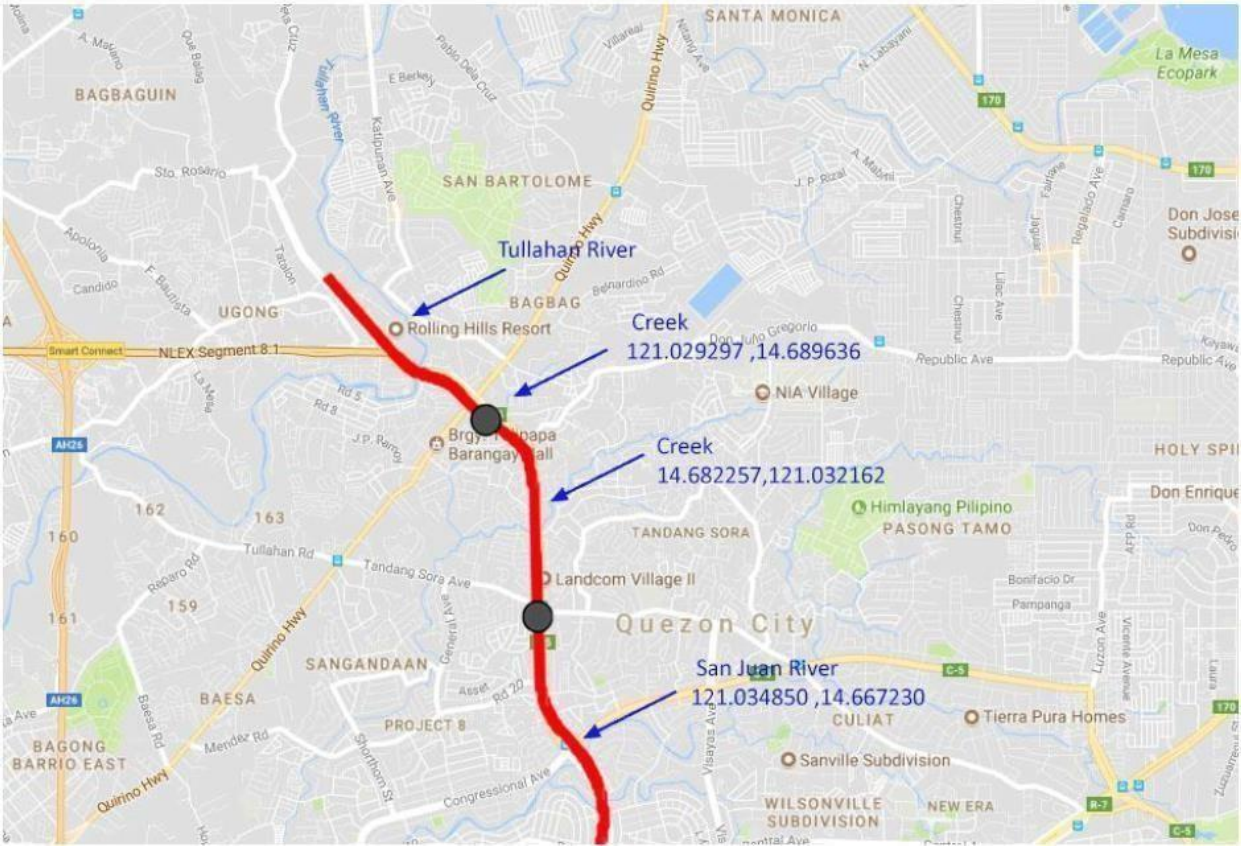


Figure 2.2-2 Creeks and Rivers near the Proposed Quirino Highway and Tandang Sora Stations (Source: 2017 MMSP EIS)

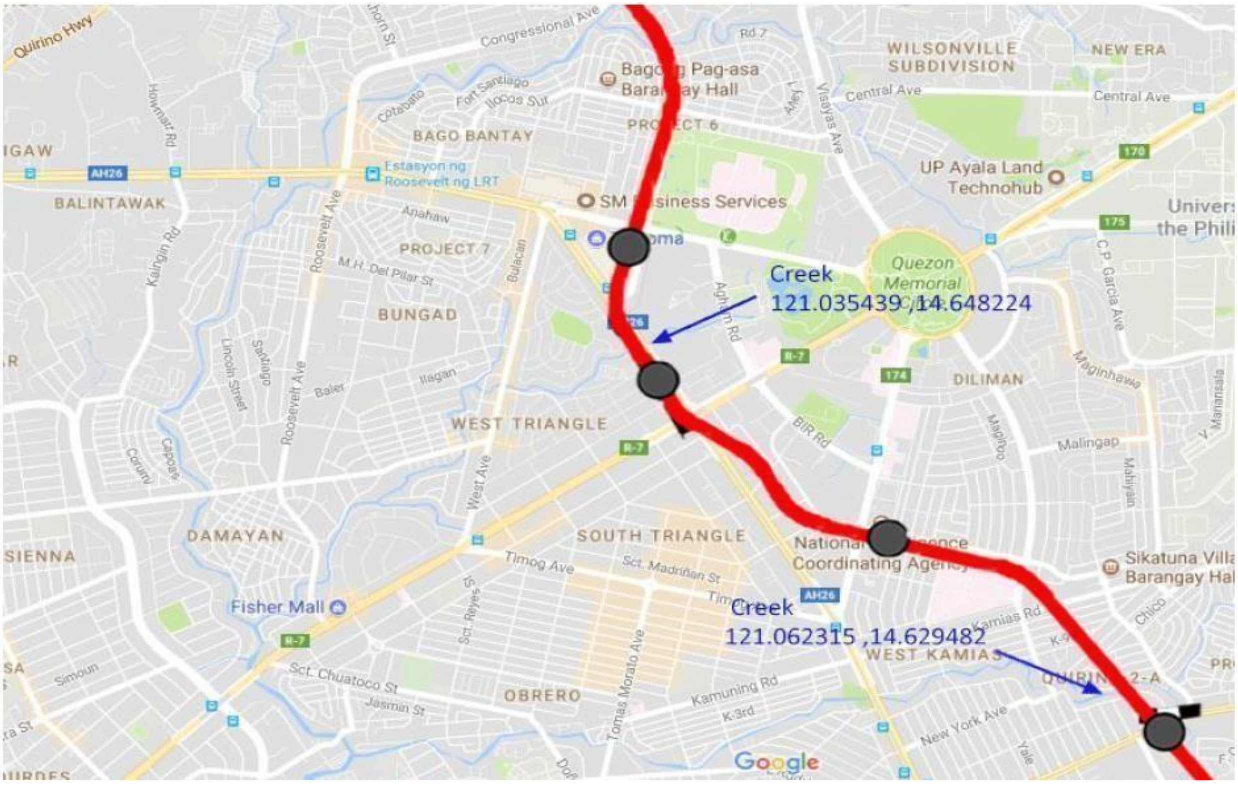


Figure 2.2-3 Creeks and Rivers near the Proposed Quezon Avenue Stations (Source: 2017 MMSP EIS)

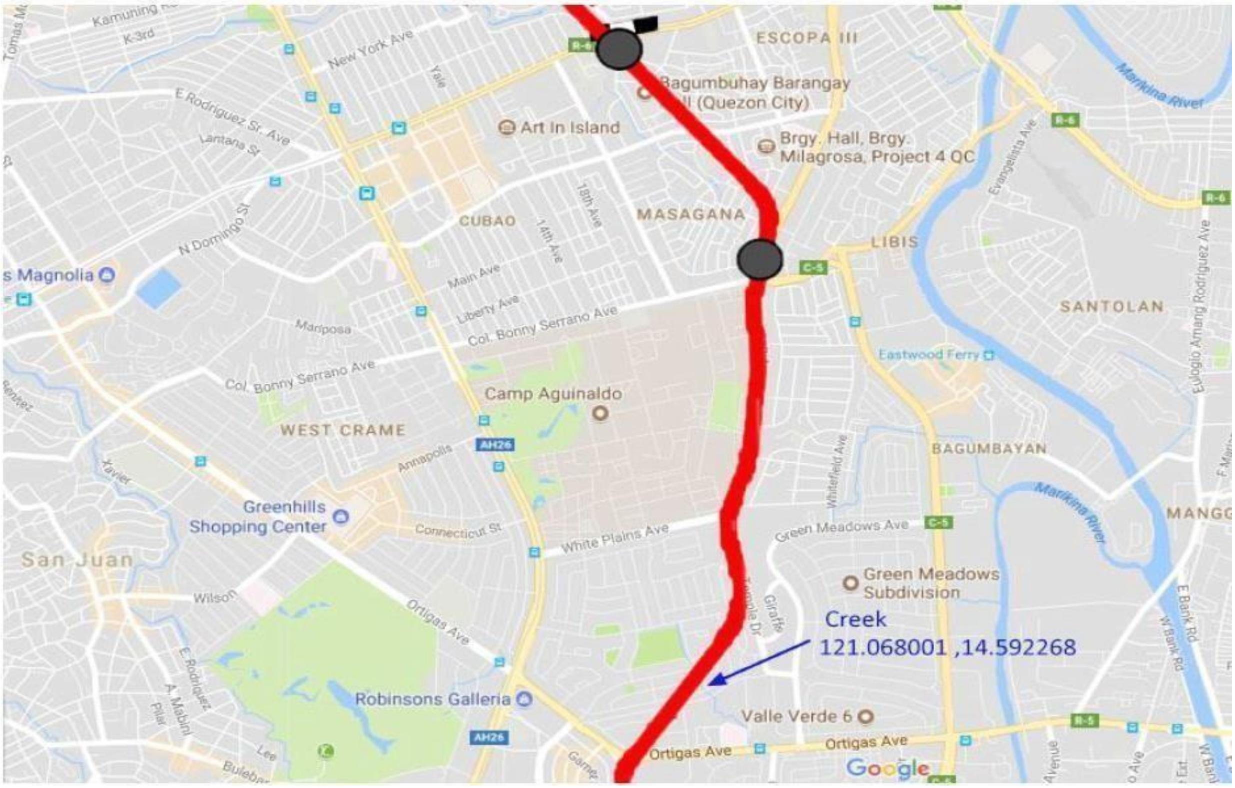


Figure 2.2-4 Creeks and Rivers near the Proposed Ortigas North Stations (Source: 2017 MMSP EIS)

Waterway Morphology

There are four kinds of waterway geomorphic types. These are the Confined System, the Valley Fill System, the Bedrock Controlled Gravel or Boulder System, and the Alluvial Gravel or Boulder System. Rivers that are classified under Valley Fill and Alluvial Gravel systems have an unstable waterway regime and hence potential impacts related to change in waterway regime is anticipated. Rivers under the Confined and Bedrock Control systems on the other hand have stable waterway regime and limited or no changes in river morphology is anticipated. During the walkthrough survey, it was noted that rivers within or are in the vicinity of the MMSP expansion area (i.e. Maricaban Creek and Don Galo Creek) consist of bedrock strata overlain with boulders and can be considered as artificially confined waterways. River bank easements along some sections of both c reeks have been encroached by various types of structures (**Plate 2.2-1 and Plate 2.2-2**).

The Bedrock Controlled Gravel or Boulder system consists of a single, laterally stable channel with bed composed of gravel to boulder sized sediments. Width and alignment controls the channel.

Confined waterways consist of steep gradient channel that are bedrock dominated and have limited depos its of sediments within the channel. These systems are located in the upper catchments, set within a narrow, steep sided valley where floodplains are non-existent. The riverbed is generally composed of bed rock and/or boulders. These are geomorphologically stable and are subject to very slow rates of change due to the high degree of bedrock confinement.

Valley fill systems are characterized by a relatively flat, unincised valley floor surface such that there is no presence of a well-defined channel. Substrates are predominantly comprised of alluvial fine silts and mud. Such features are typically formed by flows that lose their velocity as they spread over an intact valley floor and deposit their sediment load. Material eroded from the catchment is not transported through the reach, which is often on relatively flat longitudinal grade. When disturbed, these systems have the potential to develop a continuous channel through incisional processes, transforming the geomorphic nature of the system and releasing stored sediment to downstream reaches.

Alluvial gravel or boulder system exhibits a channel incised on both sides within wide, continuous floodplains composed of alluvial sediments. The bed consists of gravel to boulder size sediments creating moderate diversity in riverbed material within the channel. Where the bed is composed of boulder sized sediments the channel is relatively straight and there is no defined pool-riffle sequence. Where gravel size material is present, the channel meanders and exhibits defined pool-riffle sequence.

The two waterways within and in the vicinity of the MMSP's revised alignment can be considered as bedrock controlled waterways where the channel's controlling elements are the width and alignment.

Plate 2.2-1 Maricaban Creek (Various Sections)

Plate 2.2-2 Don Galo Creek (Various Sections)

Flooding

The five-year, twenty-five-year and one hundred-year flood hazard maps of Metro Manila is shown in **Figure 2.2-5 to Figure 2.2-6** below. Flood disasters in Metro Manila typically occur during the months of May to November as a result of typhoons and the southwest monsoon ((DPWH, JICA, and Yachiyo Engineering Co. Ltd, 2014). Areas of the MMSP project site that have high to moderate susceptibility to flooding bas ed on the 100 -year flood hazard map include the Valenzuela Depot, Quirino Highway Station, Tandang Sora Station, Quezon Avenue Station, East Avenue Station, Katipunan Station, Anonas Station, Lawton East Station, Lawton West Station, and FTI Station.

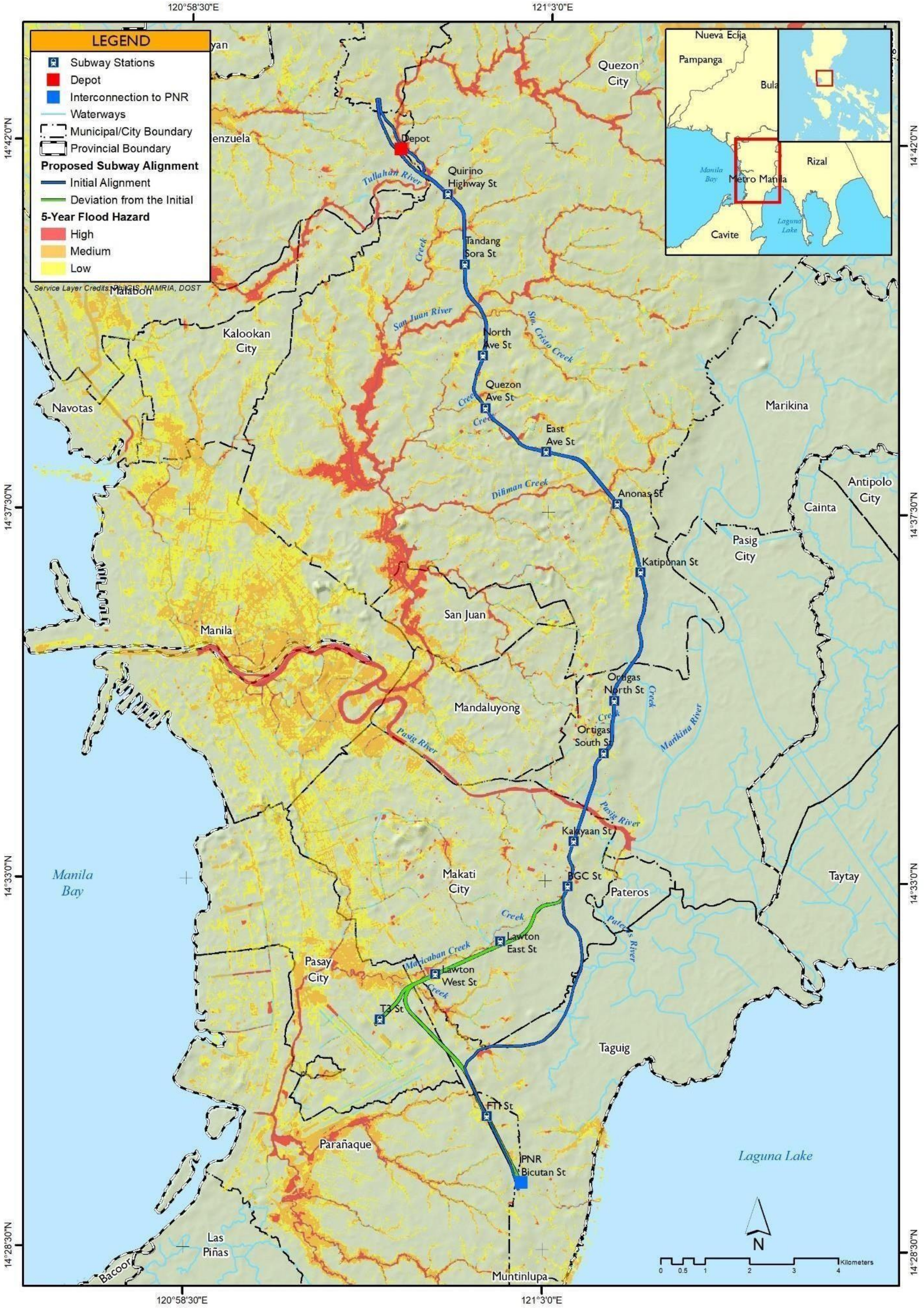


Figure 2.2-5 Five Year Flood Hazard Map

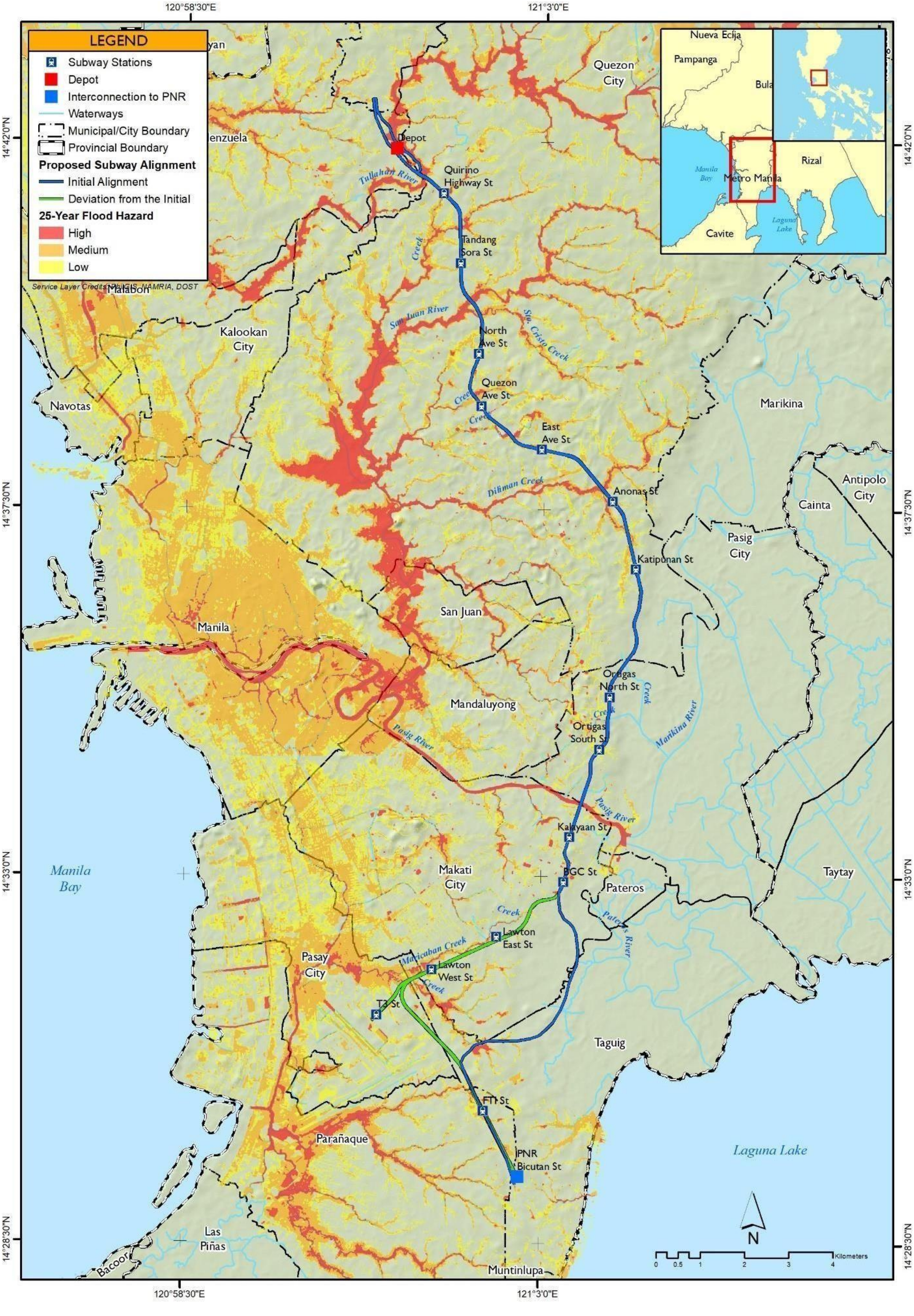


Figure 2.2-6 Twenty- Five Year Flood Hazard Map

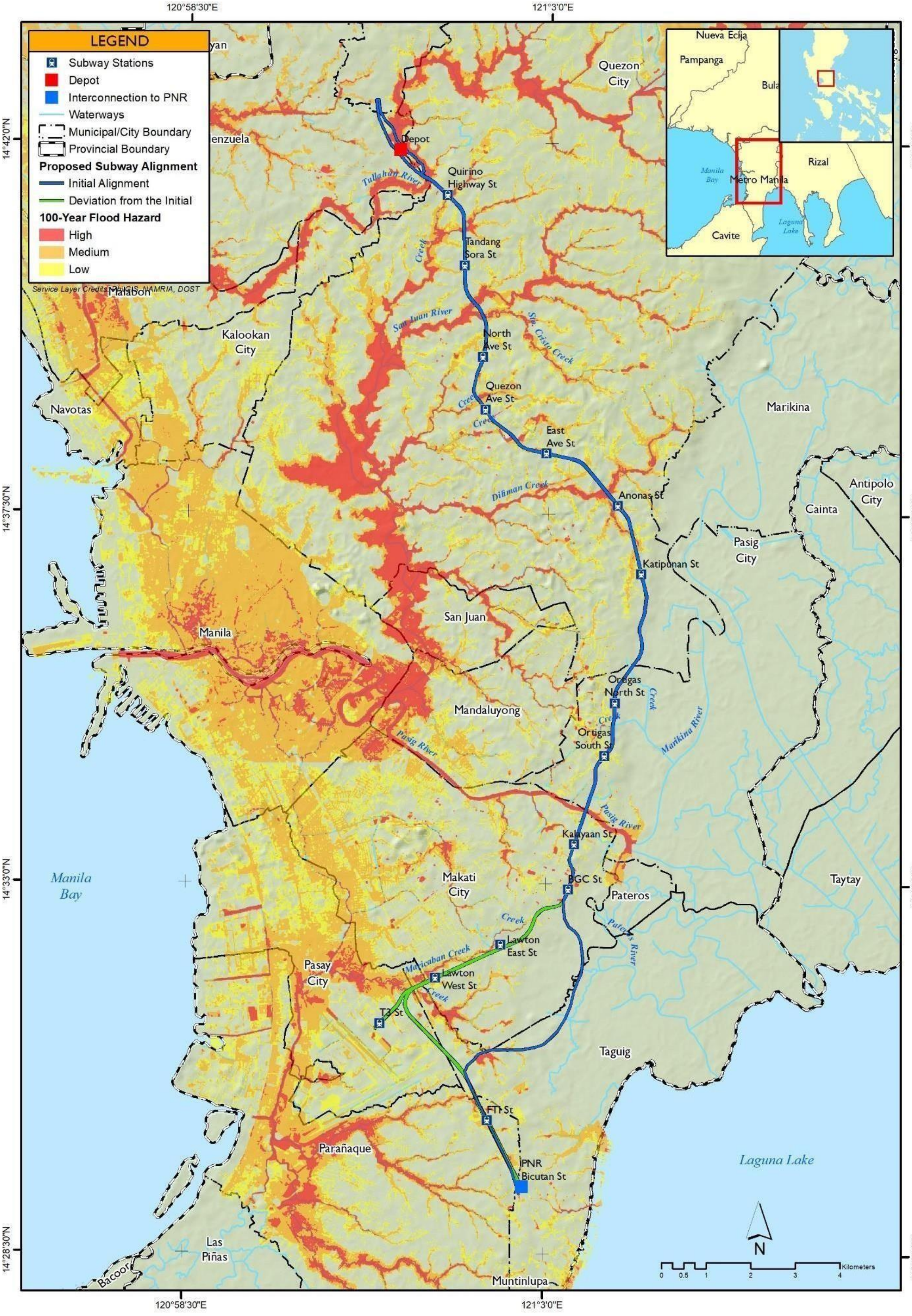


Figure 2.2-7 One Hundred Year Flood Hazard Map

Groundwater Environment

The Mines and Geosciences Bureau (MGB) of the Philippines has classified the groundwater environment regions of the country based on aquifer type and potential yields. These classifications are summarized in a map showing regional groundwater availability based generally on the hydrogeologic characteristics of the area. The regional groundwater availability map for Metro Manila is shown in **Figure 2.2-8** while the various classes of groundwater are summarized in **Table 2.2-3**.

Table 2.2-3 Philippine Groundwater Classes

Class	Descriptio n
Rocks in which flow is dominantly inter-granular	
Class I (A)	Extensive and Highly Productive Aquifers – with an average potential recharge of 0.5 m to 1 m, greater near influent rivers, with known production well yields mostly between 50 to 100 L/s but as high as 150 L/s at some sites. High to very high permeability.
Class I (B)	Fairly Extensive and Productive Aquifers – with average annual potential recharge of 0.3 m to 0.8 m; greater near influent rivers; with known production well yields mostly about 20 L/s but as high as 60 L/s at some sites. Moderate to high permeability.
Class I (C)	Local and Less Productive Aquifers – well yields mostly about 2 L/s but as high as 20 L/s in some sites.
Rocks in which flow is dominantly through fracture and/or solution openings	
Class II (A)	Fairly Extensive and Productive Aquifers with High Potential Recharge – includes limestone with production well flows up to 30 L/s in highly caustic areas and volcanic with production well flows up to 15 L/s and spring flows up to 60 L/s.
Class II (B)	Fairly to Less Extensive and Productive Aquifers with Low to Moderate Potential Recharge – includes massive to bedded limestone with few interconnected solution cavities, little groundwater development with domestic well yields 3 L/s or less. Strong spring yields reported in local but highly fractured rocks.
Local groundwater regions underlain by impermeable rocks generally without significant groundwater except ion residuum, sufficiently leached and/or fractured zone	
Class III (A)	Rocks with Limited Potential, Low to Moderate Permeability – includes Quaternary lava flows, fair to hard consolidated sandstone, shale's conglomerates, met sediments, mudstones etc.
Class III (B)	Rocks without any known significant groundwater obtainable through drilled wells – geological units as above but significantly less fractured, largely untested.

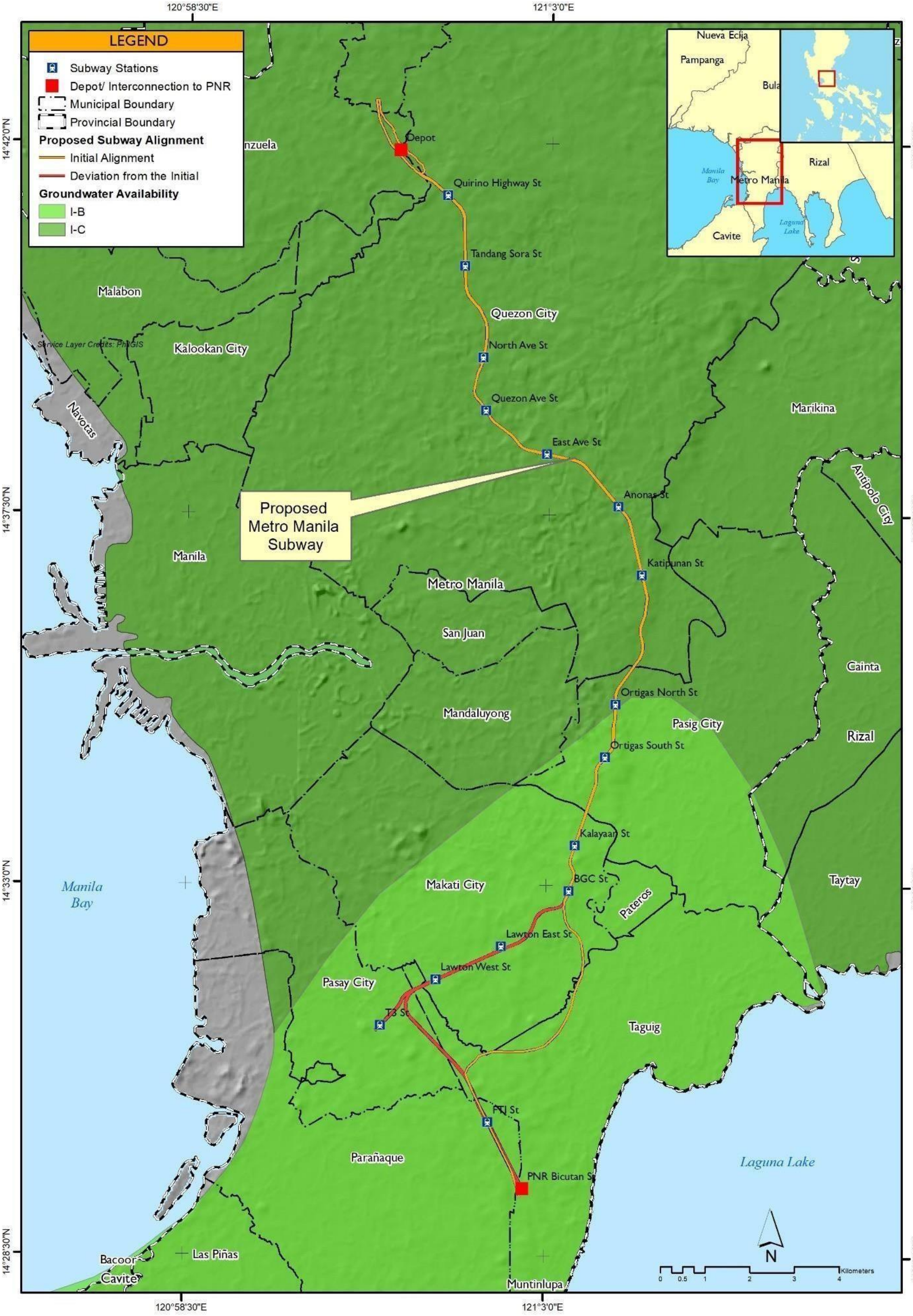


Figure 2.2-8 Regional Groundwater Availability Map (Metro Manila)

The area traversed by the MMSP consists of Class I (B) and Class I (C) aquifers. Class I (B) aquifers are fairly extensive and productive aquifers with moderate to high permeability and are located along the southern section of the MMSP alignment in Pasig City, Makati City, Pasay City, Paranaque City, and Taguig City segments of the MMSP, including the proposed MMSP expansion site and realignment in Makati, Pasay, Paranaque, and Taguig (**Figure 2.2-9**). Class I (C) aquifers in the study area are found in the northern section of the MMSP alignment in Pasig City, Quezon City, and Valenzuela City. Class I (C) aquifers are considered local and less productive aquifers, with well yields mostly about 2 L/s but as high as 20 L/s in some sites.

Based on the results of drilling surveys conducted by Soil Philippines Indes Testing, Inc. most of the geologic al layers to be penetrated by the subway tunnel are solid roc k with low moisture rate, and fracture zone where groundwater can potentially flow were not present (Delta Tierra Consultants, Inc., 2017). A more detailed geotechnical and groundwater investigation which will also cover the MMSP realignment area will be conducted during the DED stage.

In 2004, the NWRB issued Resolution No. 001-0904, *Policy Recommendations for Metro Manila Critical Areas,* which revoked and suspended all water permits or reduced the authorized volume of extraction of existing deep wells in areas adequately served by the Metropolitan Waterworks and Sewerage System (MWSS). The resolution was issued based on findings under the "Water Resources Assessment for Prioritized Critical Areas (Phase I) of the NWRB which covered eight critical areas that were considered in need of urgent attention including Guiguinto, Bocaue, Marilao, and Meycauayan in Bulacan, and North Caloocan, Navotas, Caloocan, West Quezon City, Makati, Mandaluyong, Pasig, Pateros, Paranaque, Pasay, Las Pinas, and Muntinlupa in Metro Manila, and Dasmarinas in Cavite. The assessment determined that the groundwater flow pattern in Metro Manila has been significantly altered by the excessive withdrawal of groundwater and has resulted in the creation of cones of depression especially in Parañaque, Pasig and Valenzuela (Delta Tierra Consultants, 2017). Based on the NWRB Resolution, "*groundwater extraction may be allowed to ensure that operation of vital services are not unduly hampered (e.g. hospitals, firefighting, etc.) provided that extraction shall be made only as back-up to commercial water supply.*

As of June 2019, a total of 46 deepwells have been granted by the NWRB within the 1 km radius from the new MMSP alignment as shown in **Figure 2.2-10**. Three out of the 46 water permittees have available water testing pumping data which are more closely located within the retained original alignment. The nearest deepwell location within the deviation alignment is located approximately 100m from the subway tunnel between Lawton west and NAIA T3 stations.

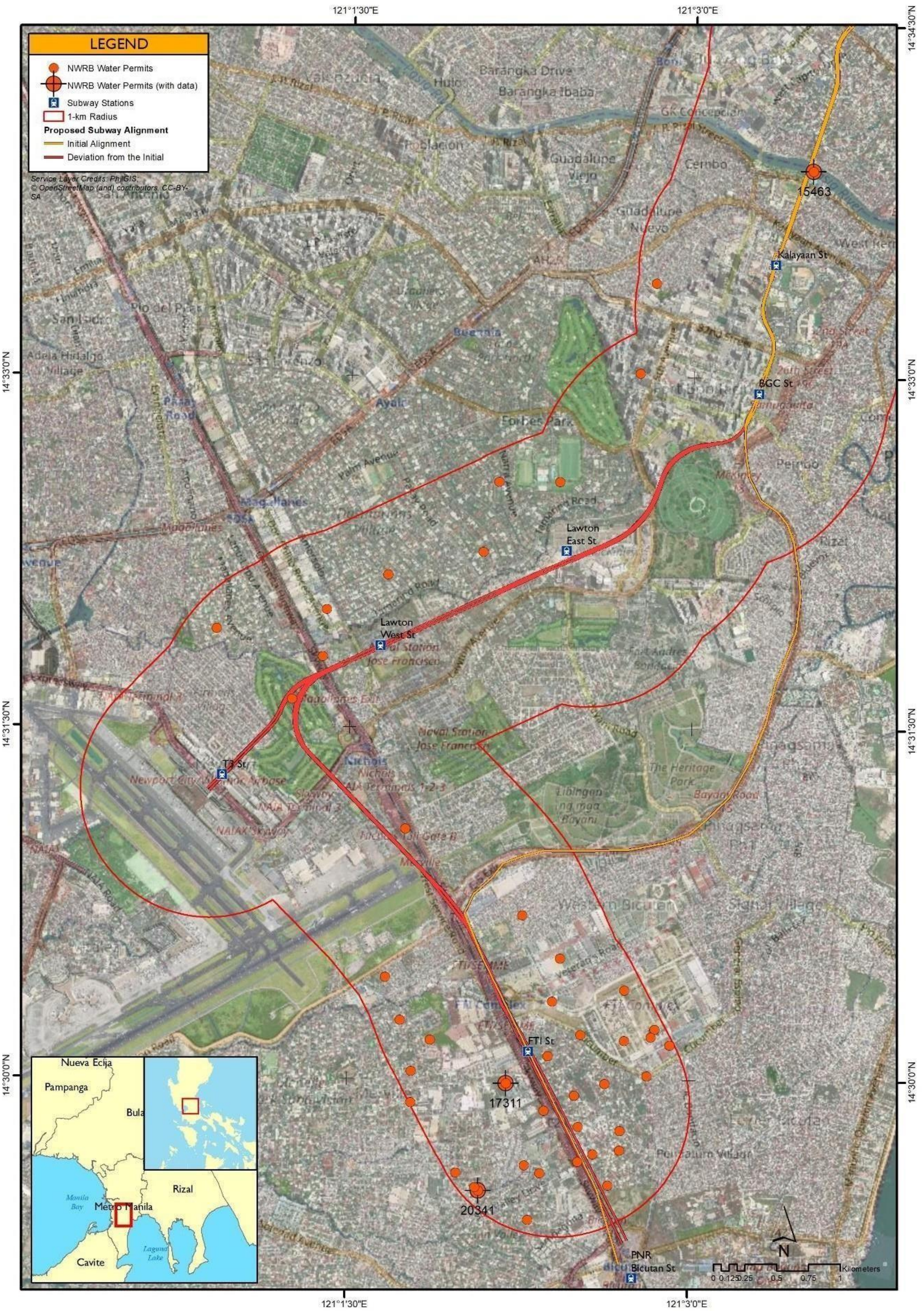


Figure 2.2-9 Water permit grantee (deepwells) locations within the 1 km radius from the MMSP revised alignment

As per the NWRB water listing, the static water level and drawdown of deepwells with available pumping test data located within the 1 km radius of the subway alignment ranged from 21.31 to 141.73 meters below ground level (mbgl) and 5.30 to 21.34 mbgl. Since the MMSP alignment is mostly in the business districts of Metro Manila where adequate supply of water from either Manila Water Company, Inc. (MWCI) or Maynilad Water is available, unauthorized groundwater extraction is not allowed in these areas. **Table 2.2-4** lists the number of deep wells registered with NWRB within a 1-km radius of the new alignment.

Table 2.2-4 Water grantee permittees along the 1km radius from the subway alignment

Stations	No. of Deep Wells within the 1 km radius from the alignment	Purpose
Taguig	16	Domestic – 7; Industrial – 6; Commercial – 2 and Office – 1
Paranaque	22	Domestic – 12; Industrial – 5; Municipal – 3 and Commercial – 2
Makati	8	Domestic – 7 and Industrial – 1
Pasay	0	NA
Total	**46**	

Water Supply and Use

Metro Manila's water supply is provided by the Manila Water Company, Inc. (MWCI), and Maynilad Water Services, Inc. (MWSI). MWCI and MWSI are privately-owned and managed water concessionaires, which were awarded with concession contracts by the MWSS when the Water Crisis Act was passed in 1997 (NEDA, 2018). MWCI operates the East Zone which includes Mandaluyong, Marikina, Pasig, Pateros, San Juan, Taguig, portions of Makati, Manila, Quezon City, and Paranaque. MWSI operates the West Zone which covers Caloocan, Las Pinas, Pasay, Malabon, Muntinlupa, Navotas, Pasay, Valenzuela, parts of Makati, Manila, Paranaque, and Quezon City. The MWSS concession serves about 15 million people in Metro Manila including parts of Rizal Provinc e and Cavite Province as of 2015 (NEDA, 2018). Water sources of MWCI and MWSI include the La Mesa Dam (which is fed by the Angat Dam), the Laguna Lake, and some groundwater wells.

Individual houses in Metro Manila not connected to MWCI's or MWSI's distribution system have their own wells or get their water from communal wells. A walkthrough survey of some of the host communities of the MMSP expansion site in Taguig City and Pasay City identified at least 20 perennial wells with approximate depths ranging from 9 to 20 m (based on information from well owners). These wells are used by residents for domestic purposes such as drinking (boiled prior to consumption), cooking, bathing, and cleaning. The photos of some of these wells are shown in **Plate 2.2-3**.

Plate 2.2-3 Wells within the Host Communities of the MMSP Expansion Area

Rivers and creeks within Metro Manila, because of their poor water quality, are typically only used for drainage, discharges, transportation, and in some cases, fishing and recreation.

(3) Project Water Use

Water supply will be required by the project for a variety of purposes, including water used for concrete mixing, soil conditioning for embankment construction and backfilling works, dust suppression, and potable water use for workers and administration offices and stations, among others. It is anticipated that the project's water requirement will be highest during the construction phase.

Water quality requirements for the project are dependent upon the end use of the water. Two general water types are required for the MMSP – fresh water and potable water.

Fresh Water

Fresh water pertains to untreated water that will not be affected by any project activities. Fresh water will be required during the construction phase of the project for the following uses:

- Construction water;
- Dust suppression and road watering as may be required;
- Vehicle wash-down; and
- Fire control

The water demand for dust suppression, vehicle wash-down and concrete mixing will be finalized during the detailed design stage of the project

Potable Water

Potable water that will be used for the MMSP will conform to the Philippine National Standards for Drinking Water of the Department of Health. Potable water will be required for the temporary project facilities during construction for drinking and domestic use. During operations, potable water will be used for:

- Drinking and domestic use;
- Equipment and plant wash-down; and
- Fire control water.

Flow requirements for drinking water are based primarily on the projected per capita consumption at each site. For the purposes of establishing the total potable water supply requirement, a consumption range of 120L/person/day was assumed for 5,000 workers during the construction period and 1,200 employees during the operations phase. Potable water during the construction period will be sourced from Manila Water and Maynilad Water, or other water services providers in the area. During the operations phase, potable water will be s our c ed from the nearest existing Manila Water and Maynilad Water line in the vicinity of the MMSP alignment.

The potable water supply requirements during the construction and operations phase are shown in **Table 2.2-5**.

Table 2.2-5 Potable Water Supply Requirements

Usage	Average Dema nd (m^3/da y)	Average Dema nd (L/s)
During construction (distributed over various segments of the project site)	600	6.94
During operation (permanent operation, stations, and maintenance offices)	144	1.67

Site Water Balance

The site water balance for the MMSP assessed the available water supply against the combined water requirement of the project and existing water users. The objective of the study was to identify a water management system that would ensure that the existing water users will not be adversely affected by the water supply requirement of the project during the construction and operations phase. The site water balance will be finalized during the detailed design stage of theproject.

2.2.1.3 Potential Impacts, and Options for Prevention, Mitigation, and/or Enhancement

Following the approved Technical Scoping Checklist for this study, the potential impacts of MMSP to water resources that were considered in the assessment include:

- Change in drainage morphology;
- Inducement of flooding or reduction in stream volumetric flow;
- Change in stream depth;
- Depletion of water resources/competition in water use; and
- Ground movement and liquefaction.

A discussion of these potential impacts along with their proposed mitigating measures is provided below. The summary of these impacts and mitigating measures is presented in **Table 2.2-6**. A discussion on the potential effects of climate change on water resources is also provided below.

(1) Change in Drainage Morphology

Ground disturbance during construction activities will consist of the erection of the reinforce concrete diaphragm wall, installation of road decking, and excavation and construction of the structure frame for the subway stations (using cut and cover method), shield tunneling/New Austrian Tunneling Method (NATM) for the construction of sections in between stations, and embankment works and retaining wall construction for the depot.

All trench and foundation excavation will be backfilled and ground restored to its original condition. Any impact in terms of increased volumetric rate of runoff attributed to alteration of ground surface is insignificant and temporary. The tunnel will be located about 16 m underground on average, and tunneling works using TBM are not anticipated to impact river/stream waterflows.

Temporary cofferdams will be required during the construction of the Quirino Highway Station, which encroach on top of Talipapa creek.

(2) Inducement of Flooding/ Reduction in Stream Volumetric Flow

The MMSP alignment will cross four rivers (i.e. Tullahan River, San Juan River, Pasig River, and Maricaban Creek) and several creeks. However, no construction works within waterways is anticipated to occur except in Talipapa creek that traverses the Quirino Highway Station, therefore the inducement of flooding as a result of the constriction of waterways and reduction of flow area is unlikely. Temporary cofferdams will be required during the construction of the Quirino Highway Station. Construction activities along the waterway will be done during the drier months of the year or during low flows whenever practicable. Diversion channels that are designed to adequately convey design flows with minimum if any backwater effect will be used. Temporary drainage and detention cum siltation ponds will be constructed in construction areas if necessary, to mitigate localized flooding.

Along the tunnel alignment and train stations, it is likely that dewatering operations will be conducted to make the construction area workable. Pumped water from dewatering operation may be discharged to existing drainage system if the conveyance capacity is still sufficient to absorb the extra flow. In the event that this cannot already be absorb by the existing drainage system, temporary flood attenuation pond/s will be constructed to contain the pumped water. Excess water from the ponds may be taken by tankers and disposed to designated waterways or disposed to existing drainage system in a gradual manner considering the conveyance capacity of the drainage system.

Temporary flooding from the interaction of groundwater and excavation may potentially occur during the construction phase. Applicable dewatering technique may be considered to address this concern such as well point method, educator wells, open sump pumping and deepwell point method. It is also expected that the following management techniques may be required for the contractors for this project.

- Temporary Drainage

  The Contractor shall design, construct and maintain, at his own cost, an effective system of surface drainage and waste water disposal for the Temporary Facilities. All horizontal surfaces shall be suitably graded such that surface water will fall toward the drainage system. All channels, gullies and gratings shall be kept clear of debris and leaves.

- Flood Mitigation Management

  The Contractor shall ensure that any areas of the site liable to flooding are safeguarded from detrimental events as a result of flood waters. The Contractor shall construct temporary drainage structures such as ditches, culverts and pipe drains to prevent surface and run-off water from having a negative effect on local watercourses.

- Maintenance of Local Water Drainage Capacity

  The Contractor shall ensure that all existing waterways in the construction site are maintained at their existing capacity and that the capacity of waterways in its environs and not negatively affected by the works.

- Control of Waste Water

  The Contractor shall ensure that all waste water arising from the site is disposed of through properly designed and constructed systems to prevent pollution of surface water bodies or pollution of ground water

It is also anticipated that flooding will have minimum to insignificant impacts to construction activities given that a tunnel boring machine will be used for the tunnel sections of the project. Stations will be provided with temporary and permanent bund walls. The permanent bund walls will form part of the permanent structure.

The depot will be located at a higher level than the existing ground surface through formation of embankment. A drainage system will be provided in the depot area to collect surface runoff to designated outfalls and considering the existing drainage pattern.

Improper handling, storage, and hauling of demolition debris/excavated materials may clog existing drainage systems and block creeks, canals, and waterways and aggravate flooding in areas of the alignment that are moderately or highly susceptible to flooding. A Construction Waste Management Plan will be prepared f or the project in order to appropriately handle and dispose excavated materials and demolition debris.

As seen in the Flood Hazard Maps, some sections of the MMSP alignment will traverse areas with moderate to high flooding susceptibility. In order to protect project facilities from flooding hazards, temporary bund walls will be provided enclosing the depot, stations, and ventilation shafts construction areas.

Water-sealed panels at station entrances will be installed, and the use of tempered glass and waterproof iron doors may be considered. Drainage pumping stations will be installed as redundancy in the unlikely event that flood flows infiltrate the stations.

(3) Change in Stream Depth

The project will not involve construction works within waterways except in the Quirino Highway Station. Temporary cofferdams will be required during the construction of the Quirino Highway Station, which encroach on top of a Talipapa creek. Cofferdams constrict waterways and reduce flow area. These may cause a minimal increase in water surface level upstream of the construction area, and if, not constructed properly, may cause flooding in areas adjacent river banks. To eliminate the risk of flooding associated with water level rise, construction activities along the waterway will be done during the drier months of the year or during low f low s whenever practicable. Diversion channels that are designed to adequately convey design flows with minimum if any backwater effect will be used.

The tunnel will be located about 16 m underground on average, and tunneling works are not anticipated to induce changes in stream depth.

(4) Depletion of Water Resources/Competition in Water Use

Considering that the proposed project will not be extracting water from existing surface waters crossed by the MMSP or construct new wells, potential water competition as a result of project activities is unlikely. Bulk of the construction water requirement will be used for concrete mix. Fresh concrete will be sourced from Ready Mix Concrete suppliers who have their own water sources, as mentioned in the preceding section. Water from dewatering operation may also be used as construction water e.g. vehicle wash down and dust suppression, depending on its quality.

Dewatering activities during the construction phase have the potential to result in groundwater drawdown. A detailed assessment of this potential impact will be undertaken during the detailed engineering design phase of the project.

Cut and cover sections may cause groundwater surface drawdown but this will be temporary in nature. Natural ground water levels are expected to recover immediately once the walls are constructed and the dewatering works stopped.

Potable water will be sourced from the local water utility providers (e.g. MWCI and MWSI and other potable water suppliers).

In the unlikely event that existing water supply sources of residents residing alongside the alignment are impacted, the proponent will provide alternative sources of water supply e.g. by tankers or deeper wells for the residents.

(5) Ground Movement and Liquefaction

Ground movement is an expected outcome of tunneling projects. The ground movement anticipated is predominantly settlement (also termed subsidence). Upward ground movement (also termed heave) may also occur.

The causes of ground movement due to tunneling can be classified as:

- Consolidation of the soil profile - due to water inflow in to the tunnel resulting in groundwater drawdown in the overlying soil profile. This results in an increase in stress in the soil matrix as water is lost from the soil pores (settlement only)
- Tunnel induced movement - due to the change in stresses in the surrounding rock mass and ground loss caused by the tunnel excavation (settlement or upward heave)

Potential impacts associated with ground movement and liquefaction are discussed in detail in Section **2.1.2.2**.

(6) Effect of Climate Change

As part of the Philippine Government's commitment to managing climate change, it has created a task force called The Inter-Agency Committee on Climate Change. The task force published a report "The Philippines' National Communication on Climate Change" which discusses how vulnerable the country is to the impact of climate change including the resource needs to adapt to these impending ecological changes. This report outlines the projected temperature increases, magnitude and direction of rainfall change, and frequency of extreme weather events, dry days and extreme rainfall. Highlighted are the baseline climates, key findings of future climate in 2020 and 2050 in the country under three greenhouse emission scenarios and how these future climates would impact the different sectors and systems.

There are two climatological events that influence the amount and intensity of rainfall. These are the occurrence of tropical cyclones and monsoons. The report shows that while the number of tropical cyclones that enter the Philippine Area of Responsibility (PAR) has not increased, the number of cyclones with winds greater than 150 kph has slightly increased. This means that stronger typhoons are expected.

Seasonal rainfall is projected to decrease in the Island of Luzon while seasonal rainfall in parts of southern Visayan and the Mindanao Island is projected to increase. In terms of extreme rainfall events, heavy daily rainfall is predicted to become more frequent in Luzon and Visayas only, while the number of dry days is expected to increase countrywide.

Climate change is a long-term change in the statistical distribution of weather patterns over periods of time that may range from decades to millions of years. These changes may be in terms of average weather conditions or a change in the distribution of weather events with respect to an average, for example, greater or f ewer extreme weather events. Climate change may be limited to a specific region or may occur across the whole Earth[1.]

Admittedly, when it comes to climate change impact modeling, there are insoluble problems. Prepared climate change models can demonstrate anything as long as there are enough information and data available. Published climate change models describe real, physical processes in the earth's atmosphere. Differential equations describe how wind, temperature and air pressure develop in connection with each other. The impact of water – in the form of moisture or clouds, made up of rainfall as well as the role of greenhouse gases like CO2 is taken into account. In the country, CO2 emission, among others, was primarily used as bases in predicting climate change impacts in terms of temperature and extreme rainfall variations. On the other hand, it is a fact that it is not known for sure until the end of 2050 whether climate change predictions made are correct.

The project will require clearing of a micro catchment that is not highly vegetated. Increased CO2 emissions from the construction equipment during construction are also anticipated. To predict project climate change (e.g. increase or decrease in rainfall, occurrences of extreme rainfall events, change in rainfall pattern, increase in temperature, etc.) attributed to the activities undertaken in this project would admittedly be very difficult, and hence will not be attempted in this study. Instead, the document "Climate Change in the Philippines" prepared by DOST/PAGASA was made as reference on how the project will respond to extreme events without catastrophic implications.

[1] National Oceanic and Atmospheric Administration (NOAA)

Table 2.2-6 Potential Impact s and Options for Prevent ion, Mitigation or Enhancement – Hydrology and Hydrogeology

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Closure	
Change in drainage morphology Ground disturbance during construction activities may temporarily disrupt natural drainage flow which may result to the development of new surface runoff paths		✓	✓		• All trench and foundation will be backfilled and ground restored to its original condition • Tunneling works using TBM are not anticipated to impact river/stream waterflows
Inducement of flooding/reduction in stream volumetric flow/ temporary flooding from the interaction of groundwater and excavation Some sections of the MMSP alignment will traverse areas with moderate to high flooding susceptibility		✓	✓		• Temporary drainage and detention cum siltation ponds will be constructed in construction areas if necessary, to mitigate localized flooding. Temporary bund walls will also be provided as necessary • Stations will be provided with permanent bund walls along with water-sealed panels, tempered glass and waterproof iron doors, and drainage pumping stations • The Depot will be provided with a drainage system to collect surface runoff to designated outfalls • A Construction Waste Management Plan will be prepared for the project in order to appropriately handle and dispose excavated materials and demolition debris that may clog drainage systems and waterways • Maintenance of local water drainage capacity. • Applicable dewatering technique may be considered to address this concern such as well point method, educator wells, open sump pumping and deepwell point method. • Maintenance of local water drainage capacity.

Change in stream depth Temporary cofferdams will be required during the construction of the Quirino Highway Station, which will encroach on top of Talipapa creek. Cofferdams constrict waterways and reduce flow area, which may cause a minimal increase in water surface level upstream of the construction area		✓			• Construction activities along the waterway will be done during the drier months of the year or during low flows whenever practicable. Diversion channels that are designed to adequately convey design flows with minimum if any backwater effect will be used • Tunneling works are not anticipated to induce changes in stream depth given that the tunnel will be located about 16 m underground on average
Depletion of water resources and water competition Fresh and potable water will be required during the construction and operation phase of the project		✓	✓		Considering that the proposed project will not be extracting water from existing surface waters crossed by the MMSP or construct new wells, potential water

Potentia l Impact s	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Closure	
which may strain existing water sources used by the community					competition as a result of the project activities is unlikely • Potable water will be sourced from the local water utility providers.
Ground water Drawdown Groundwater dewatering during the tunneling works could potentially induce groundwater drawdown		✓	✓		• Conduct detailed hydrogeological/ groundwater study in the detailed design stage. • Installation of monitoring wells for observation along the subway tunnel and monitor change of the surrounding groundwater levels • If water supply of people relying on groundwater along the alignment decreases, DOTr shall make arrangements to supply affected people with water. • DOTr will coordinate with NWRB regarding tunneling activities along the alignment and its potential effects on the water table • A Dewatering Permit may have to be secured from NWRB prior to tunneling activities.

2.2.2 Water Quality

This section presents the results of the assessment undertaken to evaluate the potential impacts of the MMSP and its proposed expansion to the water quality of waterbodies within and in the vicinity of the project site. The assessment was undertaken to:

- Characterize the water quality of surface water and groundwater resources in the area including additional waterbodies that may be potentially impacted by the expansion of the MMSP;
- Identify potential sources of pollution in the area;
- Assess how the MMSP and its proposed expansion will impact upon the water quality of rivers and groundwater during the construction, operations, and closure phases of the project; and
- Develop mitigation strategies that ensure that water quality impacts are minimized.

2.2.2.1 Methodology

(1) Regulatory Requirements

Republic Act 9275 (RA 9275) or the Philippine Clean Water Act of 2004 is the overarching legislation which sets the objectives and policies for the comprehensive water quality management of water bodies in the Philippines. I t covers all water bodies and primarily applies to the abatement and control of pollution from land-based sources. Guidelines for the implementation of the Clean Water Act are provided in DENR Administrative Order 2005 - 10 (DAO 2005-10).

An important component of water quality management in the country is the classification of water bodies since this forms the regulatory basis for determining allowable water quality limits for discharge waters. The DENR is responsible for classifying or reclassifying all water bodies in the country according to their benefic ial us ages. Water body classifications are defined by the DENR in DENR Administrative Order 2016-08 (DAO 2016- 08), or the Water Quality Guidelines and General Effluent Standards of 2016. Water body classifications for freshwater provided in the DAO 2016-08 are presented in **Table 2.2-7**.

The DAO 2016-08 also provides Water Quality Guidelines (WQG), which refer to "*the level for a water constituent or numerical values of physical, chemical, biological, and bacteriological or radiological parameters which are used to classify water resources and their use, which do not result in significant health risk"* The WQG are not intended for direct enforcement but rather for water quality management purposes only. Enforceable water quality limits are referred to as General Effluent Standards (GES), and are also provided in the DAO 2016-08.

Table 2.2-7 DAO 2016-08 Water Body Classification and Usage of Freshwater

Classification	Intended Beneficia l Use
Class AA	• Public Water Supply Class I – Intended primarily for waters having watersheds, which are uninhabited and/or otherwise declared as protected areas, and which require only approved disinfection to meet the latest PNSDW

Classif ica tio n	Intende d Beneficia l Use
Class A	• Public Water Supply Class II – Intended as sources of water supply requiring conventional treatment (coagulation, sedimentation, filtration, and disinfection) to meet the latest PNSDW
Class B	• Recreational Water Class I – Intended for primary contact recreation (bathing, swimming, etc.)
Class C	• Fishery Water for the propagation and growth of fish and other aquatic resources • Recreational Water Class II – For boating, fishing, or similar activities • For agriculture, irrigation, and livestock watering
Class D	• Navigable waters

Note: For unclassified water bodies, classification shall be based on the beneficial use as determined by the Environmental Management Bureau

(2) Study Area

The water quality assessment considered the catchments that will be traversed by the MMSP and its proposed realignment site. Waterbodies that were studied as part of this assessment include the Tullahan River, the San Juan River, the Pasig River, the Maricaban Creek, and the Paranaque River. The existing water quality of these water bodies were characterized through the review and collection of available secondary data and collection of water quality samples last 2017 from selected sampling sites.

(3) Secondary Data Sources

Secondary data that was used for the water quality assessment include:

- Water quality monitoring data from DENR for Tullahan River, San Juan River, Paranaque River, and Maricaban Creek;
- Water quality monitoring data from the Pasig River Rehabilitation Commission;
- Data from the MMSP EIS (2017);
- Data from available Comprehensive Land Use Plans (CLUP) of cities that will be traversed by the MMSP; and
- Data from other published technical information.

(4) Field Surveys and Sampling Areas

Water quality samples from the Tullahan River, San Juan River, and Pasig River were collected by Delta Tier r a Consultants, Inc. during the preparation of the MMSP EIS in 2017 (**Table 2.2-8**). Groundwater samples were also collected at two locations. The locations of the sampling sites of Delta Tierra Consultants, Inc. are shown in **Table 2.2-8** and **Figure 2.2-10**.

Table 2.2-8 Summary of field surveys and sampling activities – Water Quality

Field Activit y	Date Conducted	Map Reference
Surface water quality sampling		
Tullahan River	01 March 2017	14° 41’ 32” N

Field Activit y	Date Conduc te d	Map Refere nc e
		121° 1' 26" E
San Juan River		14° 40' 1" N 121° 2' 4" E
Pasig River		14° 34' 4" N 121° 2' 54" E
Groundwater quality sampling		
Barangay Ugong, Valenzuela City	22 May 2017	14⁰ 41' 42"N, 121⁰ 1'15.42" E
Barangay Ugong, Pasig City		14⁰ 34'49"N, 121⁰ 4'45"E

Source: Environmental Impact Statement for Metro Manila Subway Project (MMSP) (Phase 1), Delta Tierra Consultants, Inc., 2017

For the expansion area and realignment of the MMSP, the water quality assessment was based on DENR monitoring data for the Maricaban Creek and Paranaque River. The locations of the DENR water quality monitoring sites used for this study are shown in **Table 2.2-9** and **Figure 2.2-10**.

Table 2.2-9 DENR Water Quality Monitoring Stations

Sampling Date	Sampling ID	Sampling Station	Location	Coordina te s
Maricaban Creek				
11 April 2019	S1	Diego Silang	Bridge along Diego Silang St.	N 14°31'11.06" E 121° 1'54.22"
	S2	Maricaban SLEX	Bridge along south super highway	N 14°31'40.55" E 121° 1'25.91"
	S3	Villamor	Bridge along Villamor	N 14°31'4 7. 98 " E 121° 1'5.18"
Paranaque River				
03 June 2019	1	Tramo Station	Aurora-Tram o Bridge, Aurora Blvd., Brgy. 186 Zone 19, Pasay City	N14°31. 9 1 5' E121°0 0. 2 3 3'
	1a	Narra Station	Don Chino Roces Ave, San Antonio, Makati City	N14°33. 7 2 6' E121°0 0. 6 6 1'
	1b	Dilain Creek	C. Jose St., Brgy. 178 Zone 19, Maricaban. Pasay City	N14°31. 9 2 4' E121°0 0. 4 0 0'
	2	MIA Road Station	Airport Road Bridge, Baclaran, Parañaque City	14°34'54.03" N 120°58' 2 1. 4 9 " E
	3	Multinational Station	Multinational Bridge, Sto. Niño, Parañaque City	N14°29. 6 8 3' E121°0 0. 1 3 1'
	3a	Ibayo Creek	Ibayo Bridge, Multinational Village. Kaingin St., Sto. Nino, Paranaque City	N14°29. 9 9 4' E121°0 0. 5 2 6'
	4	Global Station	Global Bridge, San Dionisio, Parañaqu e C ity	N14°29. 7 0 6'

Sampling Date	Sampling ID	Sampling Station	Location	Coordina te s
				E120°5 9. 6 4 8
	4a	AMVEL Station	AMVEL Bridge, AMVEL Land, Inc,.Ninoy Aquino Ave., San Dionisio Paranaqu e City	N14°29. 5 2 3' E120°5 9. 5 3 7'
	5	Sto. Niño Station	Ninoy Aquino Bridge, Sto. Niño, Parañaque City	N14°29. 9 4 2' E121°0 0. 1 3 1'
	6	La Huerta Station	Quirino Ave. Bridge, La Huerta, Parañaque City	N14°30. 1 0 9' E120°5 9. 5 5 9
Tullahan River				
06 June 2019	1	Bangkulasi River Station	Bangkulasi Bridge, Navotas	N14°39.10' E120°56.89'
	1a	Bangkulasi Creek Station	Bangkulasi Bridge, Navotas City	N14˚38'53.56" E120˚57'21.95"
	1b	Tañong River Station	Tañong Bridge, Tañong Malabon City	N14˚39.156' E120˚57.12 7'
	2	Longos River Station	Longos Bridge, Malabon City	N14˚29.283' E120˚57.35 5'
	2a	Borromeo Station	Gen. P. Borromeo St. Longos, Malabon City	N 14°39.4 47 ' E 120°57. 4 0 5
	2b	N. Vicencio Station	N. Vicencio St., Niugan, Malabon City	N 14°40.2 34 ' E 120°57. 2 2 4'
	3	Gov. Pascual Station	Tullahan Bridge, Gov. Pascual, Malabon	N14°39.346' E120°52.96'
	3a	Kaunlaran Station	Kaunlaran St., Concepcion, M alabon City	N 14°40.3 17 ' E 120°57. 1 3 4'
	4	Mc Arthur Station	Tullahan Bridge, McArthur Highway,Marul as, Valenzuela City	N14°29.391' E120°58.235'
	5	North Expressway	N. Expressway Bridge, Sta. Quiteria Extn., Caloocan City	N14˚41.172' E121˚00.12 4'
	5a	Sarmiento Station	Sarmiento St., Sta. Monica, Quezon City	N 14°43.2 11 ' E 121°02. 6 1 5'
	6	Gulod Station	Gulod Bridge, Novaliches, Quezon City	N14˚42.984' E121˚02.64 2'
	6a	Northridge Station	Northridge Park Subd.,Brgy. Sta. Monica, Novaliches, Quezon City	N 14°42.7 65 ' E 121°03. 1 8 9'
	6b	Dahlia Station	Dahlia Ave., Fairview, Quezon City	N 14°41.9 82 ' E 121°03. 8 9 3'
	7	Fairview Station	Fairview Bridge, Fairview, Quezon City	N14˚42.378' E121˚03.99 6'
San Juan River				
10 June 2019	1	**Lubiran**	Lubiran St., Bacood, Manila City	N 14°35'2 2. 6 9" E 121°1'1 7. 9 4 "
	1a	**Buhanginan**	New Panaderos, Manila	N 14°35'2 0. 2 0" E 121°1'2 0. 8 4 "
	1b	**Maytunas**	Kalentong St., Mandaluyon g City	N 14°35'4 3. 1 6" E 121°1'4 0. 8 2 "
	2	**Aurora**	Aurora Blvd., BalongBat o, San Juan City	N 14°36'3 1. 6 7" E 121°1'1 8. 9 0 "

Sampling Date	Sampling ID	Sampling Station	Location	Coordina te s
	2a	**Ermitaño**	Aurora Blvd., Broadway, Quezon City	N 14°36'4 4. 0 7" E 121°1'5 2. 6 0 "
	2b	**Diliman**	Umbel St., Kalusugan, Quezon City	N 14°37'3 4. 1 3' E 121°1'2 6. 1 6 "
	3	**Kaliraya**	Kaliraya St., Tatalon, Quezon City	N 14°37'3 4. 8 8" E 121°1'1 0. 1 0 "
	3a	**Mariablo**	Roosevelt Ave., Sta. Cruz, Quezon City	N 14°37'5 0. 7 0" E 121°0'5 0. 7 8 "
	3b	**Talayan**	Araneta, Talayan, Quezon City	N 14°38'5. 7 5" E 121°1'5. 0 2 "
	4	**Caroline**	M. H. del Pilar St., San Antonio, Quezon City	N 14°39'1 2. 7 2" E 121°0'5 1. 9 1 "
	4a	**Dario**	EDSA, Quezon City	N 14°39'2 7. 7 9" E 121°0'5 6. 0 4 "
	4b	**Culiat**	EDSA, Culiat, Quezon City	N 14°35'2 8. 0 1" E 121°1'8. 0 2 "

Source: Department of Environment and Natura l Resources Environmental Management Bureau, National Capital Region Office

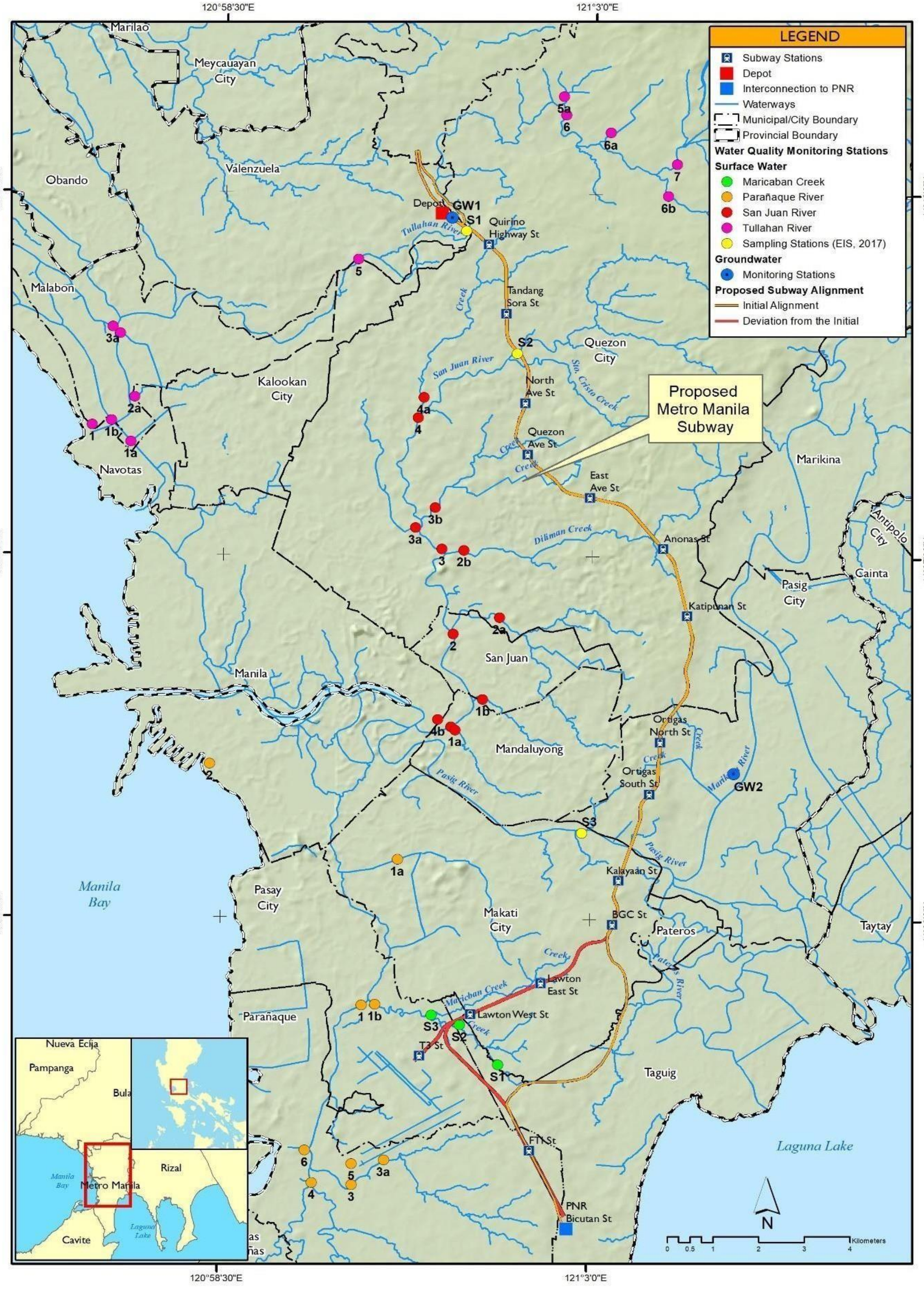


Figure 2.2-10 Location of Groundwater and Surface Water Sampling Stations (DENR-E M B and 2017 EIS)

(5) Comparison to Relevant Regulatory Standards DENR Water Body Classifications

Stream water quality monitoring results were evaluated using the ambient water quality criteria provided in DAO 2016-08 for fresh surface waters based on their DENR classifications (Table x). All rivers that were covered by the assessment are currently classified by the DENR as Class C waters except for Maricaban Creek, which is currently not classified. Class C waters have an intended beneficial use of fishery water for the propagation and growth of fish and other aquatic resources, for boating, fishing, or similar activities, and for agriculture, irrigation, and livestock watering based on DAO2016-08.

Table 2.2-10 DENR Water Body Classification of Study Area Rivers

Name of River	Classif ica tio n	Name of Water Quality Management Area
Tullahan River	C	Malabon-Navotas-Tullahan- Tinajeros River System (DAO 2018-10)
San Juan River	C	San Juan River System (DAO 2012-04)
Pasig River	C	
Maricaban Creek (tributary of Paranaque River)	Not classified	
Paranaque River	C	Las Pinas-Paranaque River System (DAO 2018-12

Source: Department of Environment and Natural Resources Environmental Management Bureau, National Capital Region Office

Water Quality Management Areas

The Tullahan River, San Juan River, and Paranaque River have been designated as Water Quality Management Areas (WQMA) by the DENR. WQMAs are defined in DAO 2005-10 as "*areas that have similar hydrological, hydrogeological, meteorological, or geographic conditions which affect the physicochemical, biological, and bacteriological reactions and diffusions of pollutants in the water bodies, or otherwise share common interest or face similar development programs, prospects, or problems.*" Each WQMA will be governed by a governing board that will formulate strategies *"to coordinate policies necessary for the effective implementation of the Clean Water Act in accordance with those established in the framework and monitor the compliance with the action plan."* A summary of the water quality objectives of the WQMAs traversed by the MMSP project site are presented below:

- Malabon-Navotas-Tullahan- Tinajeros River System (DAO 2018-10)
- *To improve the water quality of the Malabon-Navotas-Tullahan-Tinajeros River System and thereby contribute to the enhancement in the cities of Manila, Navotas, Malabon, Valenzuela, Quezon, and Caloocan so that it can serve a number of ecosystem services and benefits including fishing, industrial, enhance recreation, aesthetic, health (e.g. reduced risk of infection from bathing), opportunities for wildlife and biodiversity and other uses and serve the best interest of communities and stakeholders*
- San Juan River System (DAO 2012-04)
- *To ensure water quality in the San Juan River System for present and future generations*

- Las Pinas-Paranaque River System (DAO 2018-12)
- *To improve the water quality of the Las Pinas-Paranaque River System and thereby contribute to the enhancement in the cities of Manila, Pasay, Makati, Taguig, Las Pinas, Paranaque, Muntinlupa and Bacoor, Cavite so that it can serve a number of ecosystem services and benefits including fishing, industrial, enhance recreation, aesthetic, health (e.g. reduced risk of infection from bathing), opportunities for wildlife and biodiversity and other uses and serve the best interest of communities and stakeholders*

2.2.2.2 Baseline Environment

(1) Summary of Findings

Baseline Inform at ion	Key Findings and Conclusions
Surface water quality	Tullahan River, San Juan River, Pasig River, and Maricaban Creek are currently heavily polluted and have poor water quality, with elevated concentrations of BOD, DO, phosphates, and fecal coliform that exceed the DAO 2016-08 Class C WQG
Groundwater quality	Water from the two groundwater deep wells sampled during the 2017 EIS meet the PNSDW except for fecal coliform levels in the Valenzuela City deepwell. Both deep wells are rarely used by the community and are used only as a backup source of water supply (Delta Tierra Consultants, Inc., 2017).
Existing sources of pollution	Sources of pollution that contribute to the degradation of Tullahan River, San Juan River, Pasig River, Maricaban Creek and Paranaque River include solid wastes from domestic, commercial, and industrial activities, and wastewater discharges from households, commercial/institutional establishments, and industries

(2) Pre-Project Water Quality Assessment (2017 EIS) and additional data for the EPRMP (2019) Surface Water

Results of the water quality sampling conducted for the MMSP EIS last 2017 and DENR's water quality monitoring data show that all rivers covered by the study are heavily polluted and have poor water quality (**Table 2.2-11** to **Table 2.2-15**). Elevated concentrations of biological oxygen demand (BOD), dissolved oxygen (DO), phosphates, and fecal coliform that exceeded the DAO 2016-08 Class C WQG were recorded for all monitoring stations. High BOD concentrations recorded in the rivers ranged from 22 to 141 mg/L, while fecal coliform concentrations ranged from 54,000 MPN/100mL to 2,800,000,000 MPN/100mL. The Tullahan River and Maricaban Creek had the highest recorded fecal coliform concentrations out of all the monitored rivers. The WQG for fecal coliform for Class C Waters is 200 MPN/100mL.

Metro Manila is the highest generator of pollutants in the Manila Bay Area, because pollution load generation is directly proportional to population and urbanization (NEDA, 2018). Factors that contribute to the degradation and poor water quality of the Tullahan River, San Juan River, Pasig River, Maricaban Creek, and Paranaque River as well as to the rest of the rivers draining Metro Manila include inadequate management of wastes from domestic, commercial, and industrial activities and wastewater discharges from households, commercial/institutional establishments, and industries. Metro Manila generates an estimated 1.3 million cubic meters of wastewater per day (NEDA, 2018). As of 2017, MWCI's and MWSI's sewerage coverage in Metro Manila is only at about 15% and 14%, respectively (NEDA, 2018).

Table 2.2-11 to **Table 2.2-12** show the water quality monitoring results for Tullahan River, San Juan River, Pasig River, Maricaban Creek, and Paranaque River. Photos of the water quality monitoring stations of DENR are shown in **Plate 2.2-4** to **Plate 2.2-7**.

Table 2.2-11 Results of the Surface Water Quality Sampling

Parameters	Tullahan River	San Juan River	Pasig River	DENR (Class C) WQG
Metals				
Arsenic (mg/L)	<0.01	<0.01	<0.01	0.02
Cadmium (mg/L)	<0.003	<0.003	<0.003	0.005
Lead (mg/L)	<0.05	<0.05	<0.05	0.05
Mercury (mg/L)	<0.0002	<0.0002	<0.0002	0.002
Dissolved Copper (mg/L)	<0.01	<0.01	<0.01	0.02
Microbiology				
Fecal Coliform (MPN/100ml)	**5,400,000**	**24,000,000**	**54,000**	200
Wet Chemistry				
pH (on-site)	6.8	7.3	7.1	6.5 - 9.0
Temper at ur e (on-site) °C	27.5	28.9	29	25 - 31
Color (TCU)	40	60	15	75
Biological Oxygen Demand (BOD), (mg/L)	**63**	**50**	4	7
Surfactants (MBAS as LAS, MW=348.48 g/mole) (mg/L)	**2.9**	**5.3**	0.3	1.5
Total Suspend Solids (mg/L)	78	66	**86**	80
Oil & Grease (mg/L)	**3.6**	**3.9**	**3.7**	2
Chloride (mg/L)	44	37	141	350
Hexavalent Chromium (mg/L)	<0.003	<0.003	<0.003	0.01
Free Cyanide (mg/L)	<0.02	<0.02	<0.02	0.1
Dissolved Oxygen (on-site, mg/L)	**<2.0**	**<2.0**	5.1	5 (min)
Nitrate - N	0.3	0.2	1.2	7
Phosphate - P	**0.7**	**1.9**	0.1	0.5
Organic Phenols (mg/L)				
2,3,4,5-Tetrachlo ro p he n ol	ND	ND	ND	0.05
2,3,4,6-Tetrachlo ro p he n ol	ND	ND	ND	0.05
2,3,4-Trichloro ph e no l	ND	ND	ND	0.05
2,3,5,6-Tetrachlo ro p he n ol	ND	ND	ND	0.05
2,3,5-Trichloro ph e no l	ND	ND	ND	0.05
2,3,6-Trichloro ph e no l	ND	ND	ND	0.05
2,4,5-Trichloro ph e no l	ND	ND	ND	0.05
2,4,6-Trichloro ph e no l	ND	ND	ND	0.05
2,4-Dichlorop he n ol	ND	ND	ND	0.05
2,4-Dimethylph en ol	ND	ND	ND	0.05
2,4-Dinitroph en ol	**0.06**	0.03	0.05	0.05
2,6-Dichlorop he n ol	ND	ND	ND	0.05
2-Chloroph en ol	ND	ND	ND	0.05
2-Methyl-4,6-Dic hl or op h en ol	ND	ND	ND	0.05
2-Methylphen ol	ND	ND	ND	0.05
2-Nitropheno l	ND	ND	ND	0.05
3,4,5-Trichloro ph e no l	ND	ND	0.009	0.05
4-Chloro-3- Met hyl ph en ol	ND	0.01	0.004	0.05
4-Methylphen ol & 3-Methylpheno l	ND	ND	ND	0.05
4-Nitropheno l	0.003	0.05	**0.08**	0.05
Dinoseb	ND	ND	ND	0.05
Pentachloro ph en ol	0.008	0.007	ND	0.05
Phenol	ND	ND	ND	0.05

Source: Environmental Impact Statement for Metro Manila Subway Project (MMSP) (Phase 1), Delta Tierra Consultant s, Inc., 2017

Table 2.2-12 DENR Water Quality Monitoring Results – Maricaban Creek

Parameters	Station 1 Diego Silang	Station 2 (Maricaban SLEX)	Station 3 (Villamor)	DENR (Class C) Standards
DO, mg/ L	0	0	0	5 (min)
BOD, mg/ L	141	81	81	7
TSS, mg/ L	99	100	61	80
Color, TCU	20	25	25	75
Fecal Coliform, MPN/100mL	$9.20x10^{+08}$	$9.20x10^{+08}$	$2.80x10^{+09}$	200
Nitrates, mg/ L	0.07	0.07	0.08	7
Phosphates, mg/ L	2.17	2.44	3.41	0.5

Table 2.2-13 DENR Water Quality Results -Parañaque River

Stations		Time of Sampling	pH	Temp, °C	TDS, g/L	Turbidity, NTU	Salin ity, ppt	Cond u cti vity, mS/c m	BOD , mg/L	Dissolved Oxygen , mg/L	Color, TCU	Total Suspended Solids, mg/L	Phosphate-Phosphorus, mg/L	Nitrate-Nitroge n, NO3-N, mg/L	Fecal Coliform, MPN/100mL
DENR Standa rds			**6.5 - 9.0**	**25 - 31**	**-**	**-**	**-**	**-**	**7**	**5 min**	**75**	**80**	**0.5**	**7**	**200**
	Tramo Stn	11:55	6.42	29.57	0.42	37.80	0.30	0.66	65	0	25	32	2.92	0.37	9.20E+07
1a	Narra Stn	11:27	6.25	29.64	0.50	74.30	0.40	0.78	109	0	20	64	3.04	0.45	3.50E+08
1b	Dilain Cr.	12:23	6.53	30.08	0.38	39.70	0.30	0.60	41	0	20	36	3.07	0.32	2.20E+07
	Mia Rd	12:52	6.61	30.20	1.38	41.00	1.10	2.16	61	0	25	56	2.97	0.35	5.40E+07
	Multinational Stn	15:09	7.23	31.13	0.58	56.50	5.10	9.15	81	0	25	38	2.96	0.40	1.10E+08
3a	Ibayo Cr.	15:28	7.08	31.13	0.41	67.60	0.30	0.64	95	0	25	48	3.07	0.58	2.80E+08
	Global Stn	15:53	6.97	31.25	8.84	71.20	8.20	14.30	63	0	25	52	3.21	0.90	3.50E+07
4a	Amvel Stn	15:46	6.94	31.74	7.47	104.00	6.70	11.90	52	0	25	44	1.90	1.01	3.50E+07
	Sto. Niño Stn	15:58	7.01	30.80	8.89	50.50	8.30	14.30	58	0	20	42	2.85	0.43	9.20E+07
	La Huerta Stn	16:19	7.04	30.75	7.84	46.30	7.20	12.60	65	0	25	48	2.37	0.38	1.60E+08
Average			**6.81**	**30.63**	**3.67**	**58.89**	**3.79**	**6.71**	**69**	**0**	**24**	**46**	**2.84**	**0.52**	**8.56E+0 7**

Monitoring station 2, April 3, 2019

Monitoring station 3, April 3, 2019

Monitoring station 4, April 3, 2019

Monitoring station 1a, June 3, 2019

Monitoring station 4a, June 3, 2019

Monitoring station 5, June 3, 2019

Plate 2.2-5 Parana que River DENR Water Quality Monitoring Stations

Table 2.2-14 Results of the Laboratory Analysis of Tullahan River

Stations		Time of Sampling	pH	Temp, °C	TDS, g/L	Turbidity, NTU	Salinity, ppt	Conductivity, mS/cm	BOD, mg/L	Dissolved Oxygen, mg/L	Color, TCU	Total Suspended Solids, mg/L	Phosphate-Phosphorus, mg/L	Nitrate-Nitrogen, NO3-N, mg/L	Fecal Coliform, MPN/100mL
DENR Standards			6.5 -9.0	25 - 31	-	-	-	-	7	5 min	75	80	0.5	7	200
1	Bangkula si River	13:24	7.67	30.98	5.12	63	4.5	8.130	41	0	20	89	1.09	0.21	5.40E+07
1a	Bangkula si Creek	13:30	7.8	31.47	4.18	88.1	3.6	6.640	46	0	20	58	1.16	0.22	3.50E+07
1b	Tañong	13:18	7.77	31.3	3.25	77	2.8	5.150	40	0	25	41	1.29	0.18	2.20E+07
2	Longos	13:14	7.64	30.45	4.040	65.1	3.5	6.420	43	0	25	31	1.51	0.2	2.80E+07
2a	Borromeo	13:07	7.78	29.04	2.280	76.8	1.9	3.560	73	0	25	66	2.35	0.15	9.20E+07
2b	N. Vicencio	12:58	7.79	29.55	2.48	59.9	2	3.880	36	0	20	52	1.51	0.18	2.80E+07
3	G. Pascual	12:54	7.62	29.1	2.620	58.1	2.2	4.100	26	0	25	58	1.33	0.22	3.50E+07
3a	Kaunlaran	12:48	7.21	30.52	2.940	113	2.4	4.600	40	0	20	58	1.42	0.30	3.50E+07
4	McArthur	12:27	7.77	28.4	0.295	57.5	0.2	4.100	31	0	20	66	1.39	0.35	5.40E+07
5	Nlex	12:09	7.81	28.60	0.314	51.3	0.2	0.484	24	0	20	52	1.15	0.25	2.80E+09
5a	Sarmiento	11:00	***inaccessible /newly constructed riprap***												
6	Gulod	10:53	8.12	27.93	0.262	45.4	0.2	0.402	26	0	20	42	1.03	0.21	1.10E+07
6a	Northridge	10:33	8.22	28.66	0.265	33.7	0.2	0.408	22	0	20	42	1.03	0.48	1.10E+07
6b	Dahlia	10:10	7.80	27.90	0.378	71.6	0.3	0.590	63	0	25	48	1.95	0.31	9.20E+07
7	Fairview	10:19	8.16	28.38	0.296	78.4	0.2	0.455	28	0	20	32	1.04	0.24	1.60E+07
Average			**7.80**	**29.45**	**2.05**	**67.06**	**1.73**	**3.49**	**39**	**0**	**22**	**53**	**1.38**	**0.25**	**4.39E+0 7**

Monitoring station 6, ongoing riprap construction, April 08, 2019

Monitoring station 1a, dredging activity, April 08, 2019

Monitoring station 5, April 08, 2019

Monitoring station 3a, ongoing floodgate construction, June 06, 2019

Monitoring station 3, June 06, 2019

Monitoring station 2b, June 06, 2019

Plate 2.2-6 Tullahan River DENR Water Quality Monitoring Stations

Table 2.2-15 Results of the Laboratory Analysis of San Juan River

Stations		Time of Sampling	pH	Temp, °C	TDS, g/L	Turbidity, NTU	Salinity, ppt	Conductivity, mS/cm	BOD, mg/L	Dissolved Oxygen, mg/L	Color, TCU	Total Suspended Solids, mg/L	Phosphate-Phosphorus, mg/L	Nitrate-Nitrogen, NO_3-N, mg/L	Fecal Coliform, MPN/100m L
DENR Standards			**6.5 -9.0**	**25 - 31**	**-**	**-**	**-**	**-**	**7**	**5 min**	**75**	**80**	**0.5**	**7**	**200**
1	Lubiran	13:18	8.20	29.1	1.87	96.1	1.5	2.930	73	0	25	52	3.34	0.21	9.20E +07
1a	Buhangi nan	13:06	8.49	29.71	0.525	137	0.4	0.821	133	0	20	48	3.64	0.53	3.50E +08
1b	Maytunas	12:52	8.35	29.57	0.517	161	0.4	0.808	123	0	25	74	3.45	0.21	5.40E +08
2	Aurora	12:39	8.42	29.35	0.415	175	0.3	0.649	56	0	20	32	2.05	0.51	3.50E +07
2a	Ermitaño	11:56	8.62	28.78	0.406	135	0.3	0.634	56	0	20	68	2.64	0.9	5.40E +07
2b	Diliman	11:45	8.52	29.98	0.44	174	0.3	0.687	133	0	20	66	3.09	0.31	1.60E +08
3	Kaliraya	11:35	8.28	28.8	0.371	167	0.3	0.579	67	0	20	34	2.15	0.4	9.20E +07
3a	Mariabl o	10:47	8.48	38.55	0.402	114	0.3	0.628	52	0	25	44	2.4	0.32	3.50E +07
3b	Talayan	10:59	8.41	29.36	0.408	121	0.3	0.637	75	0	20	58	1.83	0.42	9.20E +07
4	Caroline	10:32	8.58	28.28	0.328	107	0.2	0.514	38	0	20	29	2.44	0.36	2.20E +07
4a	Dario	10:16	8.51	27.82	0.339	112	0.3	0.530	31	0	25	36	2.14	0.34	2.20E +07
4b	Culiat	10:21	8.60	27.99	0.323	121	0.2	0.504	37	0	20	32	2.17	0.82	2.80E +07
Average			**8.46**	**29.77**	**0.53**	**135.01**	**0.40**	**0.83**	**72.83**	**0**	**21.67**	**47.75**	**2.61**	**0.44**	**7.25E+07**

Monitoring station 4b, April 10, 2019

Monitoring station 4, April 10, 2019

Monitoring station 3, April 10, 2019

Monitoring station 2, June 10, 2019

Monitoring station 1b, June 10, 2019

Monitoring station 1, ongoing construction of skyway, June 10, 2019

Plate 2.2-7 San Juan River DENR Water Quality Monitoring Stations

Groundwater

Water quality results of the two public deep wells sampled last 2017 by Delta Tierra Consultants, Inc. show that recorded concentrations of the various water quality parameters analyzed meet the Philippine National Standards for Drinking Water (2017) except for fecal coliform in the Valenzuela City deep well (**Table 2.2-16**). Both deep wells are rarely used by the community and are used only as a back-up source of water supply (Delta Tierra Consultants, Inc., 2017).

Table 2.2-16 Results of the Groundwater Sampling

Paramet e rs	Pasig Deepwell	Valenzuela Deepwell	Philippine National Standard for Drinking Water 2017
Metals			
Arsenic, mg/L	<0.01	<0.01	0.01
Cadmium, mg/L	<0.003	<0.003	0.003
Calcium, mg/L	59	16	-
Lead, mg/L	0.004	<0.003	0.01
Magnesium, mg/L	21	2.1	-
Potassium, mg/L	6.2	7.2	-
Sodium, mg/L	37	44	200
Microbiology			
Total Coliform, MPN/100 ml	<1.1	**9.2**	<1.1
Fecal Coliform, MPN/100 ml	<1.1	<1.1	<1.1
Wet Che mist ry			
pH, onsite	6.5	8.2	6.5 – 8.5
Temperature, ºC, on-site	28.7	28.4	-
Color, Apparent CU	5	8	10
Conductivity @ 25.0ºC, µS/cm	676	417	-
Nitrate, mg/L	0.5	0.7	50
Bicarbon at e as $CaC0^3$ @ pH = 4.4, mg/L	251	168	-
Chloride, mg/L	55	14	250
Sulfate, mg/L	43	17	250
Hexavalent Chromiu m, mg/L	<0.003	<0.003	-
Cyanide, Total, mg/L	-	<0.002	0.07

Source: Environmental Impact Statement for Metro Manila Subway Project (MMSP) (Phase 1), Delta Tierra Consultants, Inc., 2017

2.2.2.3 Potential Impacts, and Options for Prevention, Mitigation, and/or Enhancement

Following the approved Technical Scoping Checklist for this study, the potential impacts of the MMSP that may lead to the degradation of surface water and groundwater quality that were considered in the assessment include:

- Siltation and sedimentation of waterways;
- Contamination of groundwater as a result of tunneling activities; and
- Contamination of waterways with hydrocarbons and project wastes.

A discussion of these potential impacts along with their proposed mitigating measures is provided below. The summary of these impacts and mitigating measures is presented in **Table 2.2-17**.

(1) Siltation and Sedimentation of Waterways

Earth moving activities during the construction phase of the project have the potential to cause erosion and increase turbidity and sedimentation in surface runoff and along the Talipapa creek traversing the Quirino Highway Station. Surface runoff with elevated levels of total suspended solids may eventually flow and discharge to these rivers and creeks especially during the rainy season. In order to minimize erosion and sedimentation during construction, erosion and sediment control measures and spill prevention techniques such as silt screens, drain channels, sumps and/or settling ponds will be installed as necessary. Physical barriers and/or bunds around spoil and building material stockpiles will also be provided to minimize silt- laden runoff and dispersion of dust particles to waterways.

It is estimated that about 9.4 million MT of surplus soil will be generated throughout the construction phase of the project. This is equivalent to about 522,000 truckloads of soil assuming 10 m^3 trucks are used to haul the s oil. Surplus soil will be used for backfilling for the depot and stations. Remaining surplus soil after construction is also planned to be disposed in five sites including Barangay Bignay, Valenzuela City, Malabon City, Mandaluyong City, Pasay City and Taguig City.

Regular monitoring of the waterways will also be conducted, focusing on TSS, turbidity, oil and grease, metals, and other relevant parameters.

(2) Contamination of Groundwater as a Result of Tunneling Activities

Tunneling activities including groundwater dewatering may potentially contaminate groundwater resources. Dewatered groundwater from tunneling activities will meet DAO 2016-08 standards prior to disposal. A more detailed groundwater study will be undertaken during the detailed engineering design stage of the project.

(3) Contamination of Waterways with Hydrocarbons and Project Wastes

Small volumes of fuel or oil and grease from vehicles, machinery and heavy equipment may accidentally spill or be discharged into streams and rivers during the construction activities of the project. Fuel storage facilities als o have the potential to contaminate surface waters in case of accidental leaks. Domestic wastes and general refuse may also contaminate waterways if these wastes are improperly disposed. To effectively manage waste materials that will be generated during the construction and operational phase of the project, a waste management program will be developed and implemented for the MMSP. Construction and operational workforce personnel will be briefed on proper waste disposalprocedures.

All vehicles and machinery will be regularly maintained, and vehicle wash downs will occur away from waterways and drainage channels. Fuel storage facilities will have adequate spillage protection (e.g. bunded, double skinned, etc.) to allow safe operational maintenance and servicing. Used oil and other hazardous wastes will be temporarily stored at the work sites in appropriate containers and storage areas and subsequently disposed of through a DENR accredited hazardous waste facility. Accidental spills will be cleaned up immediately following emergency response procedures for spill containment and clean up. Spill containment kits will always be available on-site.

During the TBM tunneling process, slurry will be created as the TMB progressively excavates the tunnel. The slurry generated by the TBM is typically treated in a slurry treatment plant. Lime slurry wastes, if any are produced during the tunnel boring process, is considered hazardous if it has a pH above 12.5. Alkali wastes such as lime slurry will be neutralized and treated prior to disposal. Any hazardous wastes collected during the construction of the MMSP must be properly collected by a DENR accredited hauler, treated and disposed by a DENR accredited treater.

MMSP contractors will be required to submit a wastewater management plan. Temporary sanitation facilities will be installed in the construction camp to manage wastewater. During the operations phase, wastewater will be treated to meet the appropriate DENR standards prior to discharge. Appropriate discharge permits from the DENR or LLDA will be secured prior to discharging treated effluent.

Table 2.2-17 Potential Impacts, and Options for Prevention, Mitigation, and/or Enhancement – Water Quality

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construct ion	Const ruction	Operation	Closure	
Siltation and Sedimentation of waterways Earth moving activities during the construction phase have the potential to increase turbidity and sedimentation in surface runoff which may eventually flow and discharge to nearby rivers and creeks		✓			• Erosion and sediment control measures and spill prevention techniques including silt screens, drain channels, diversion dams, sumps and/or settling ponds will be provided in construction areas as necessary • Spoil and building material stockpiles will be provided with physical barriers and/or bunds to minimize silt-laden runoff • Surplus soil from tunneling will be used as backfill; remaining surplus soil after construction will be disposed appropriately in five identified sites within Metro Manila • Conduct of regular water quality monitoring
Contamination of Groundwater as a Result of Tunneling Activities		✓			• Dewatered groundwater from tunneling activities will meet DAO 2016-08 standards prior to disposal • Conduct of regular water quality monitoring

Potentia l Impact s	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construct ion	Const ruction	Operation	Closure	
Dewatering as part of borehole drilling and tunneling may potentially contaminate groundwater resources					
Contamination of Waterways with Hydrocarbons and Project Wastes Liquid and solid wastes generated by the project including lime slurry wastes that may be produced during the tunnel boring process may contaminate waterways if disposed improperly. Accidental spills of fuel and other hydrocarbon and chemical products may contaminate waterways.		✓	✓		• A Waste Management Program for the construction and operations phase will be developed and implemented for the MMSP. Contractors will also be required to submit a wastewater management plan. • Fuel storage facilities will be provided with adequate spillage protection • Used oil and lime slurry that may be generated during the tunnel boring process will be properly disposed through DENR-accredited hazardous waste transportation and disposal companies • Vehicles and machinery will be regularly maintained and washed away from waterways and drainage channels • Accidental leaks or spills will be immediately cleaned-up in accordance with emergency response procedures for containment and clean-up • Spill containment kits will be provided • Construction camps will be provided with temporary sanitation facilities. • Wastewater that will be generated during the operations phase will be treated prior to discharge • Conduct of regular water quality monitoring

2.2.3 Aquatic Ecology

2.2.3.1 Methodology

(1) Study Area

Of the seven (7) identified catchments traversing the entire length of the MMSP alignment, two (2) (i.e., Maricaban Creek, Don Galo Creek) were subjected to rapid stream assessment using visual habitat predictors and ecosystem quality parameters, as these waterways are under the direct influence of the Project expansion. These waterways are situated at the heart of the highly urbanized area of Metro Manila, which comprises a cocktail of residential houses, industrial parks, road connections, and other built-up structures. Surveyed portions of the Maricaban Creek started from a woodland patch near the Essensa East Forbes Condominium (near BGC Station); followed the sections along the perimeter of Bonifacio Heights Condominium (in between Lawton East and Lawton West Station); and lastly up to the reaches near the perimeter of Villamor Air Base Golf Club (between Lawton West Station and T3 Station). On the other hand, visual evaluation of stream health for the Don Galo Creek started near the vicinity of Merville Park Subdivision and followed along the entire stretch of the Moonwalk Access Road near the C-5 Extension Road.

(2) Secondary Data Sources

Published literature involving rapid stream assessment and visual habitat evaluation were used as a basis in the formulation of a rapid assessment waterways potentially impacted by the project. This assessment is an additional survey, as the previous EIS conducted in 2017 did not perform baseline assessments for select running waters. **Table 2.2-18** summarizes the secondary data sources used in the rapid habitat assessment of stream ecosystems.

Table 2.2-18 Source s of secondary information – Aquatic Ecology

Information / Data / Document Description of Title	Author and Date Published / Generated
Modified Visual Stream Assessment Protocol: A Field Guide	Magbanua et al. (2013)
The use of a Stream Visual Assessment Protocol to determine ecosystem integrity in an urban watershed in Puerto Rico	de Jesús-Crespo, R., & Ramirez, A. (2011).
Australian river assessment system: AusRivAS physical assessment protocol	Parsons, et al. (2002)

(3) Field Surveys and Sampling Areas

The geographical location, approximate channel length, estimated stream width, and approximate distance from the revised MMSP alignment of all surveyed stream sections are listed in **Table 2.2-19** and shown in **Figure 2.2-11** to **Figure 2.2-12** and **Plate 2.2-8** to **Plate 2.2-13**. A total of 30 survey points were assessed using visual stream habitat predictors across Maricaban Creek, whereas an overall of 14 survey points were for Don Galo Creek. The former is approximately 6.3 km in total length and 3.5 m wide, while the latter is about 5.2 km long and 13. 6 m wide. In terms of relative distances with respect to the MMSP alignment, Maricaban Creek's nearest point is approximately 25 m away, while Don Galo's creek nearest streamsection is 550 m away.

Table 2.2-19 Summary of site descript ion across surveyed creeks/waterways– Aquatic Ecology

Site name	Survey Point Number	Latitude	Longitude	Distance from MMSP Alignment (m)
Maricaban Creek	1	14° 32' 32.907" N	121° 2' 46.853" E	120.79
	2	14° 32' 09.304" N	121° 2' 10.451" E	95.90
	3	14° 32' 08.699" N	121° 2' 08.919" E	98.56
	4	14° 32' 08.650" N	121° 2' 08.544" E	101.94
	5	14° 32' 08.352" N	121° 2' 07.590" E	105.78
	6	14° 32' 07.707" N	121° 2' 07.071" E	93.10
	7	14° 32' 06.816" N	121° 2' 05.718" E	86.23
	8	14° 32' 06.023" N	121° 2' 05.019" E	73.05
	9	14° 32' 04.818" N	121° 2' 04.386" E	47.57
	10	14° 32' 04.365" N	121° 2' 03.998" E	39.87
	11	14° 32' 03.862" N	121° 2' 03.030" E	38.20
	12	14° 32' 15.151" N	121° 2' 21.649" E	120.68
	13	14° 32' 03.348" N	121° 2' 02.054" E	36.29
	14	14° 32' 02.387" N	121° 2' 01.104" E	21.62
	15	14° 32' 03.666" N	121° 1' 57.546" E	102.43
	16	14° 31' 47.290" N	121° 1' 14.090" E	203.59
	17	14° 31' 47.178" N	121° 1' 13.716" E	206.56
	18	14° 31' 47.532" N	121° 1' 12.690" E	232.31
	19	14° 31' 48.884" N	121° 1' 09.973" E	313.87
	20	14° 31' 49.763" N	121° 1' 08.724" E	358.20
	21	14° 31' 49.676" N	121° 1' 06.893" E	391.81
	22	14° 31' 49.398" N	121° 1' 06.267" E	398.16
	23	14° 32' 14.859" N	121° 2' 21.503" E	114.22
	24	14° 31' 48.576" N	121° 1' 05.596" E	394.47
	25	14° 32' 14.264" N	121° 2' 20.780" E	106.09
	26	14° 32' 13.444" N	121° 2' 20.130" E	88.07
	27	14° 32' 11.252" N	121° 2' 18.395" E	49.80
	28	14° 32' 10.750" N	121° 2' 17.904" E	41.67
	29	14° 32' 10.124" N	121° 2' 16.433" E	42.71
	30	14° 32' 09.673" N	121° 2' 11.777" E	89.33
Don Galo Creek	1	14° 30' 20.472" N	121° 1' 40.518" E	818.15
	2	14° 30' 08.909" N	121° 1' 00.447" E	1996.70
	3	14° 30' 08.739" N	121° 1' 00.658" E	1998.74
	4	14° 29' 58.720" N	121° 0' 47.296" E	2305.53
	5	14° 29' 59.068" N	121° 0' 32.181" E	2373.75
	6	14° 29' 59.309" N	121° 0' 32.349" E	2365.29
	7	14° 30' 18.962" N	121° 1' 24.763" E	1242.13
	8	14° 30' 18.688" N	121° 1' 25.120" E	1239.18
	9	14° 30' 15.735" N	121° 1' 18.915" E	1440.41
	10	14° 30' 14.250" N	121° 1' 17.676" E	1498.02
	11	14° 30' 10.297" N	121° 1' 13.585" E	1669.79
	12	14° 30' 07.813" N	121° 1' 11.585" E	1764.50
	13	14° 30' 08.324" N	121° 1' 05.967" E	1884.65
	14	14° 30' 08.220" N	121° 1' 06.018" E	1885.49

(4) Sampling Methodology Stream

Visual Habitat Assessment

Using the Modified Stream Visual Assessment Protocol (**Magbanua, et al., 2013**), the major streams/waterways (i.e., Maricaban Creek, Don Galo Creek) located near the proposed stations of the Metro Manila Subway revised alignment (i.e., BGC Station, Lawton East Station, Lawton West Station, T3 Station, FTI Station) were surveyed to evaluate current habitat status and ecological integrity. Opportunistic ocular inspection among accessible areas per stream site was highly considered during course of the rapid site assessment based on 15 habitat predictors of ecosystem health (see **Table 2.2-21)**. No actual sampling of aquatic biota (i.e., phytoplankton, zooplankton, benthic macroinvertebrates, fish fauna, and aquatic macrophytes) was performed during the survey.

Table 2.2-20 Summa ry of field surveys and sampling activities – Aquatic Ecology

Field Activity	Date Conducted	Map Reference
Stream Visual Assessment of Maricaban Creek	17 July 2019	**Figure 2.2-11**
Stream Visual Assessment of Don Galo Creek	17 July 2019	**Figure 2.2-12**

Table 2.2-21 List of 15 habitat parameters for evaluating freshwater ecosystems based on the Modified Stream Visual Assessment Protocol (MSVAP; Magbanua et al., 2013)

Habitat Paramet e r	Descriptio n
Channel flow	amount of water present in the stream channel
Channel alteration	measure of changes in the shape of the stream channel
Velocity/Depth regime	patterns of velocity and depth in the stream
Bank stability	measure of erosion likelihood in the stream banks
Bank vegetative protection	measure of vegetative protection on the stream bank
Riparian vegetative zone width	width of natural vegetation z one along the channel
Canopy cover	visual estimate of the stream reach shaded by the canopy
Water appearance	visual characteristics (i.e., color, turbidity) of water
Nutrient enrichment	measure of algal and macrophyte coverage as signs of nutrient load
Sediment deposition	measure of accumulated sediments in pool sections
Riffle embeddedness	extent to which riffle areas are surrounded by fine sediment
Barriers to species movement	estimate of potential barriers that limit passage of aquatic biota
Fish habitat complexity	microhabitat types suitable for fish fauna
Aquatic invertebrate habitat complexity	microhabitat types suitable for aquatic invertebrates
Aquatic invertebrate habitat community	ability of stream to support diverse invertebrates

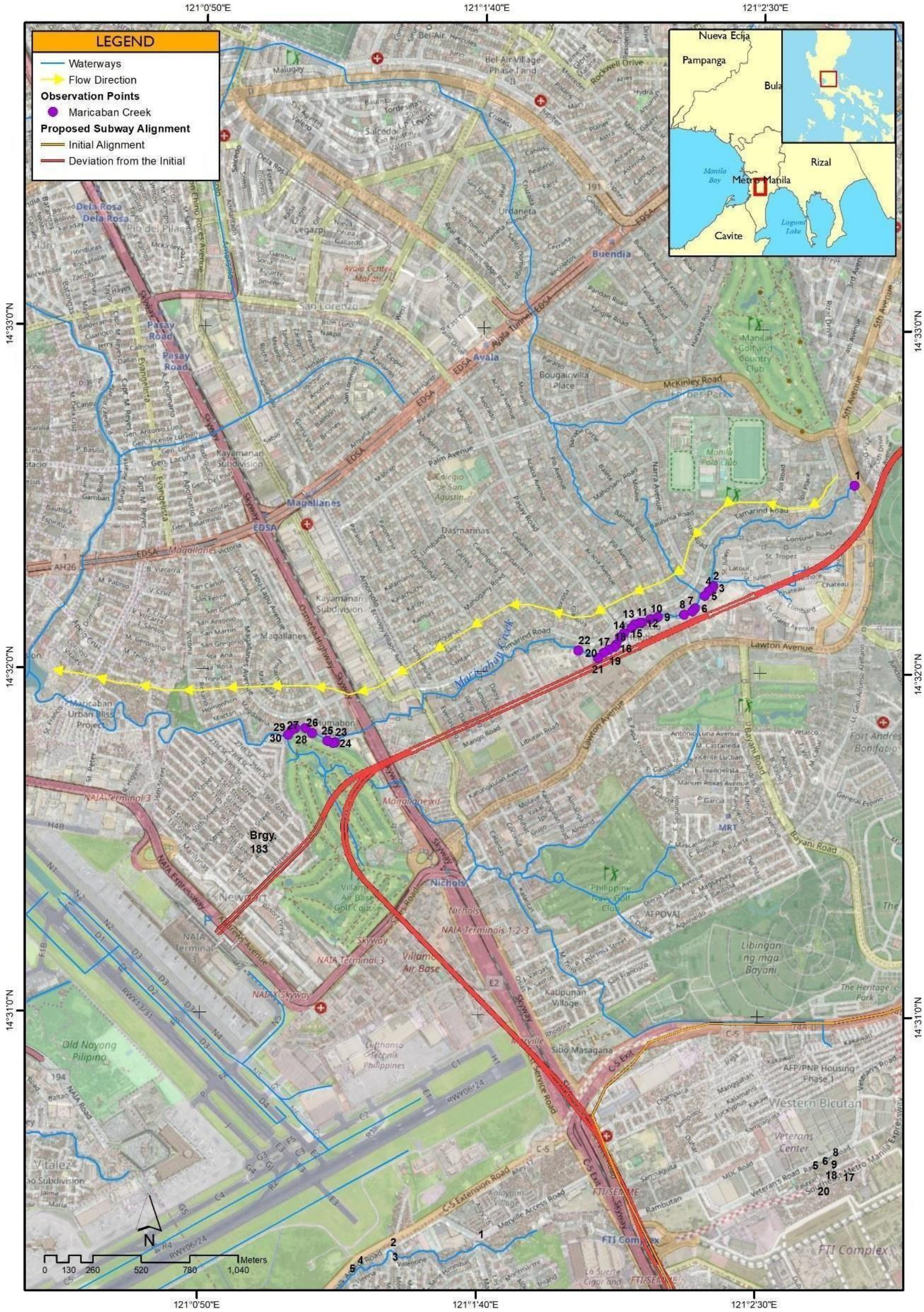


Figure 2.2-11 Site map showing the surveyed point s across Maricaban Creek

Plate 2.2-8 Site photographs of each survey point across the channel of Maricaban Creek (Point 1 to Point 8)

Plate 2.2-9 Site photographs of each survey point across the channel of Maricaban Creek (Point 9 to Point 16)

Plate 2.2-10 Site photographs of each survey point across the channel of Maricaban Creek (Point 17 to Point 24)

Plate 2.2-11 Site photographs of each survey point across the channel of Maricaban Creek (Point 25 to Point 30)

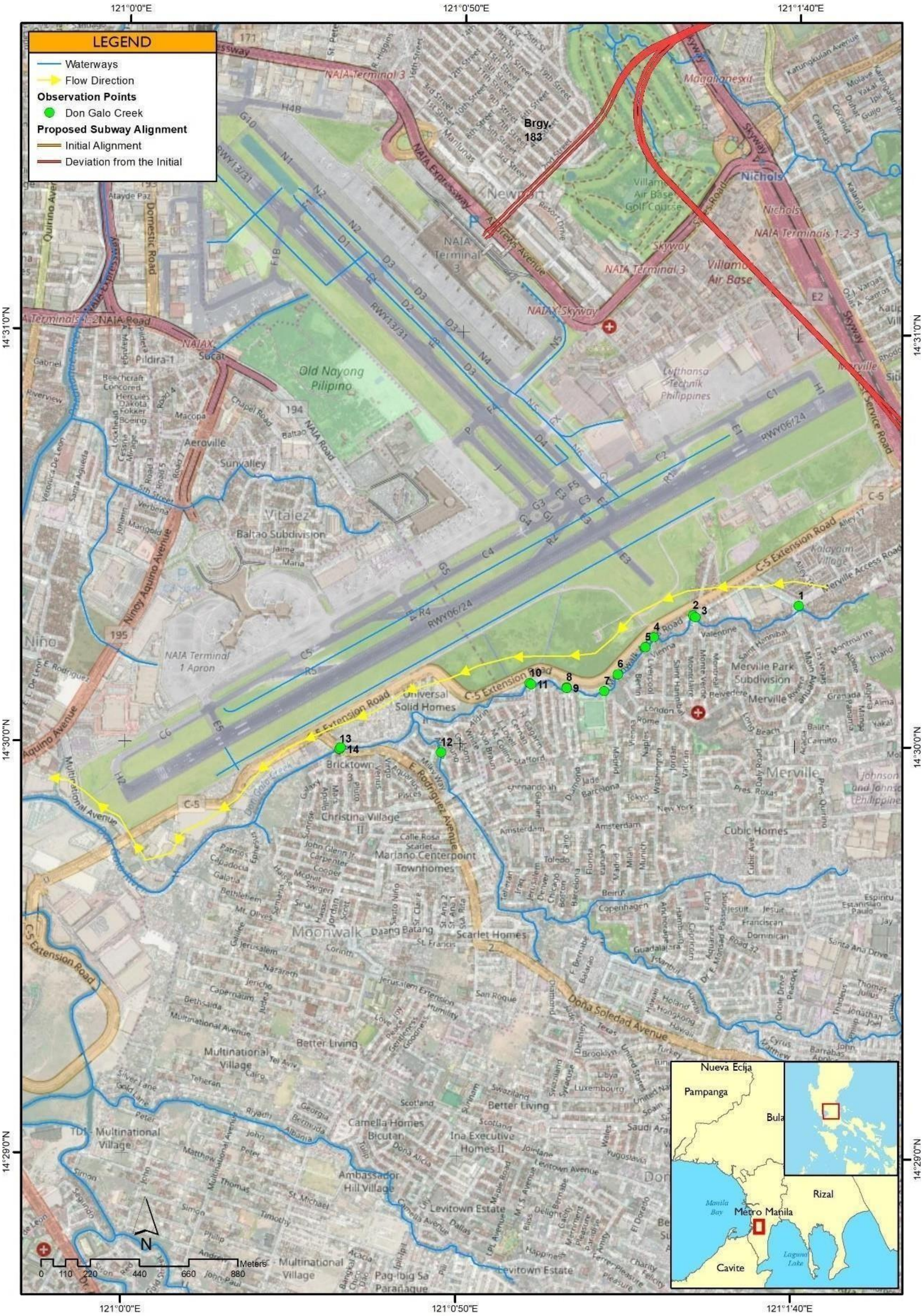


Figure 2.2-12 Site map showing the surveyed point s across Don Galo Creek

Plate 2.2-12 Site photographs of each survey point across the channel of Don Galo Creek (Point 1 to Point 8)

Plate 2.2-13 Site photographs of each survey point across the channel of Don Galo Creek (Point 9 to Point 14)

2.2.3.2 Baseline Environment

(1) Summary of Findings

Baseline Inform at ion	Key Findings and Conclusions
Stream Visual Habitat Assessment	**Maricaban Creek** Channel flow across the waterway is apparently low. Coupled with altered stream channel as a result of built- up concrete structures (i.e., perimeter walls, concrete ledges, bank reinforcements) and having reduced channel flow entails less available microhabitat for resident aquatic biota. stream velocity and depth regime is somehow complex, as evidenced by the mixture of slow-deep and slow-shallow areas. Bank stability is good due to the observable bank strengthening components from both banks. Observed bank vegetative zone was relative good. Notable riparian species include different varieties of the figs (*Ficus* sp.) along the majority of the creek margin, which are important food sources for various insect and pollinator species thriving in the area. Sediment deposition was not common for the most part of the creek and canopy cover was variable. Overall, stream health in Maricaban Creek falls under the poor condition rating. **Don Galo Creek** Low gradient stream courses through a highly residential area, with characteristic bank fortification structures along the entire surveyed stream channel. Channel flow was relatively good and comparatively higher in that the volume of water present in the channel reaches the majority of the stream cross-sectional area. Sparse vegetation communities were interspersed along the margins of the creek, as the bank vegetative zone width is reduced as a result of the construction of concrete-enriched stream banks. Canopy cover was relatively fair and could be attributable to the patchy distribution and dispersed orientation of the vegetation species in the immediate riparian buffer, whereas the vegetation zone width was low. Overall, the stream health in Don Galo Creek falls under the poor condition rating.

(2) Stream Visual Assessment for Maricaban Creek

Based on the results of the stream survey, the low-gradient Maricaban Creek is notably affected by the rapidly growing rate of urbanization in Metro Manila. To illustrate, channel flow across the waterway is apparently low, especially from Point 1 to Point 18. Coupled with altered stream channel as a result of built- up concrete structures (i.e., perimeter walls, concrete ledges, bank reinforcements), having reduced channel flow entails less available microhabitat for resident aquatic biota. Moreover, the stream velocity and depth regime is somehow complex, as evidenced by the mixture of slow-deep and slow-shallow areas. Bank stability is good due to the observable bank strengthening components from both banks; however, such impervious surfaces could potentially directly affect the recovery rate of the corresponding groundwater table in the area. Occurrence of concrete surfaces not only permit the entry of terrestrial run-offs, but also eliminates, if not highly reduces the riparian buffer zone. Observed bank vegetative zone was relative good, as depicted in Point 1 to Point 22. Notable riparian species include different varieties of the figs (*Ficus* sp.) along the majority of the creek margin, which are important food sources for various insect and pollinator species thriving in the area. In terms of water appearance, the creeks possess darkish brown waters with notable strong and distinct unpleasant odor. Sediment deposition was not common for the most part of the creek, except for some portions in Point 24 and Point 25 in which island bars build up around the central portion of the reach. Canopy cover was variable, with relatively good shade availability among Point 8 to Point 23, while sparse vegetation capable of providing food items was low among Point 24 to Point 30. Overall, stream health in Maricaban Creek falls under the poor condition rating.

(3) Stream Visual Assessment for Don Galo Creek

Findings from the visual assessment of the Don Galo Creek showed that the low gradient stream courses through a highly residential area, with characteristic bank fortification structures along the entire surveyed stream channel. Channel flow was relatively good and comparatively higher as opposed to that of Maricaban Creek; in that the volume of water present in the channel reaches the majority of the stream cross-sectional area. Water appearance was also darkish brown in color and has a distinctive pungent odor. Sparse vegetation communities were interspersed along the margins of the creek, as the bank vegetative zone width is reduced as a result of the construction of concrete-enriched stream banks. Canopy cover, in all cases along the reaches of the waterway, was relatively fair and could be attributable to the patchy distribution and dispersed orientation of the vegetation species in the immediate riparian buffer. Vegetation zone width was low, as the houses and road sides fall within 5 m of the left and right stream banks. Despite the low percentage of vegetation cover along the Don Galo Cr eek, overhanging vegetation may be seen as a vital source of allochthonous food items to existing aquatic biota. In terms of potential sources of pollution affecting the waterway, effluents from residential areas, coupled with domestic wastes and run-offs, appears to be the primary point sources. Overall, the stream health in Don Galo Creek falls under the poor condition rating.

2.2.3.3 Potential Impacts, and Options for Prevention, Mitigation, and/or Enhancement

(1) Summary of potential impacts

Table 2.2-22 Potential impacts and options for prevent ion, mitigation, or enhancement – Aquatic Ecology

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construct ion	Construction	Operation	Closure	
Sediment influx in waterways					
Delivery of sediments and other debris into the water column of the stream channel, originating from the activities during the pre-construction and construction phase.	]	]	:	:	• Designation of buffer zones approximately 5 m from each bank to dampen the rapid entry of sediments and organic debris • Development and implementation of a construction plan during earthmoving actives which ensures that the potential delivery of sediments and other particulate matter into the stream channel is kept at minimum.

(2) Potential impacts Sediment influx in waterways

During the pre-construction and construction phase of the project, associated earth-moving activities will be apparent and would likely facilitate in the influx of sediment loads, terrestrial runoff (during periods of high rainfall events), and other organic debris directly into the water column of identified stream channels. Sediment delivery, when unregulated and uncontrolled, could potentially lead to the further deterioration of the habitat integrity and ecosystem services of these unique freshwater ecosystems. Moreover, fine particulates may impede with the feeding apparatus of most aquatic biota potentially thriving in various in- stream microhabitats, as well as eventually cause physiological alterations in terms of breathing, foraging, dispersal, migration, and reproductive processes. If left unchecked, high sediment loads could completely smother the stream substrate in such a way that habitat heterogeneity becomes simple and the number of diverse habitats becomes sparse. These sediments may also carry with them excess nutrients which may indirectly lead to increased eutrophic ation and subsequent water quality deterioration.

(3) Options for Prevention or Mitigation and/or Enhancement Sediment influx in waterways

Stream ecosystems are vulnerable to the deleterious effects of excessive sediment deposition from various anthropogenic activities, usually associated with land use conversion. To limit, if not eliminate, the possible harmful effect of these scenarios, appropriate and good practices will be considered such as:

- Designation of buffer zones approximately 5 m from each bank to dampen the rapid entry of sediments and organic debris; and
- Development and implementation of a construction plan during earth moving actives which ensures that the potential delivery of sediments and other particulate matter into the stream channel is kept at minimum.

2.3 The Air

This section provides the technical studies, specifically the environmental performance, potential impacts, mitigation, and control measures for the following aspects:

- Climate and Meteorology;
- Greenhouse Gas Assessment;
- Ambient Air Quality;
- Ambient Noise; and
- Vibration.

2.3.1 Climate and Meteorology

This section presents the results of the historic and existing climatological and meteorological conditions in Metro Manila. The assessment was conducted as part of the specific requirements of the Technical Scoping Checklist for the project's application for an ECC amendment. This section describes the potential impacts of the project to local climate, the impacts of climate change to the project, and the corresponding proposed mitigating measures to lessen or avoid the identified impacts.

The specific objectives include:

- Characterizing the historic and existing meteorological and climatological conditions in Metro Manila using climate data from Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA);
- Identifying potential impacts of the project to the local microclimate, if any;
- Identifying the impacts of climate change in the Metro Manila and the Project using the PAGASA medium to long term climate change projections; and
- Proposing control measures to avoid, mitigate, and/or compensate the identified impacts.

The legal framework for the identification of climate change impacts, implementing the appropriate mitigation measures, and reducing disaster risk is stated in Article II Section 16 of the 1987 Constitution:

> *"The State shall protect and advance the right of the people to a balanced and healthful ecology in accord to the rhythm and harmony of nature."*

It is in this statement that Republic Act 9729 (otherwise known as the Climate Change Act of 2009) was built upon. The law was primarily conceived to allow the mainstreaming of climate change into government policy formulations, establishment of the Framework Strategy and Program on Climate Change (FSPCC), and the creation of the Climate Change Commission (CCC). The Act recognizes the vulnerability of the Philippines to potential consequences of climate change such as rising sea levels, changing landscapes, increasing frequency and severity of droughts, fires, floods, and storms, damage to ecosystems, and biodiversity loss.

The Philippines started the implementation of the Millennium Development Goals Fund (MDFG) Joint Programme in 2009 entitled "*Strengthening the Philippines' Institutional Capacity to Adapt to Climate Change."* This three-year program, funded by the Spanish Government through the United Nations Development Program (UNDP) Philippines and various UN agencies (i.e. United Nations Environment Program, Food and Agricultural Organization, World Health Organization, and UN Habitat), had three outcomes (PAGASA, 2011):

- climate risk reduction mainstreamed into key national and selected local development plans and processes;
- enhanced national and local capacity to develop, manage, and administer projects addressing climate change risks; and
- coping mechanisms improved through pilot adaptation projects.

To promote Disaster Risk Reduction and Climate Change Adaptation (DDR/CCA) at the project level, the DENR-EMB issued Memorandum Circular No. 2011-005 to incorporate DDR/CCA concerns in the Philippine EIS system. The DRR/CCA enhanced EIA is a mechanism to ensure that projects are resilient and that their environmental impacts do not worsen natural hazards or climate change's effects on human and/or natural systems.

The climate and meteorology assessment was undertaken to characterize the historic and existing climatological and meteorological conditions in Metro Manila for the identification and assessment of potential project impacts in terms of change in local micro-climate. The future climatic conditions as well as the effects of climate change using the PAGASA medium to long term climate change projections were likewise assessed.

2.3.1.1 Methodology

The assessment was conducted by collecting relevant secondary information from the PAGASA Synoptic Weather Stations in Science Garden and NAIA Terminal 3. The descriptions of the information collected from these sources are presented in the subsequent sections.

(1) Study Area

Metro Manila (the NCR is the seat of government and one of the three defined metropolitan areas of the Philippines. It is highly urbanized with a population of around 12.8 million in 2015 (Philippine Statistics Authority, Census of Population (2015)). The increasing expansion of the city has increased its industrialization via an influx of people who have relocated from the provinces (Teposo, Ngoc Dang, & Honda, 2015). Metro Manila has a total land area of approximately 620 km^2 and is the most densely populated region (20,785 persons per km^2). According to the Modified Coronas Classification, Metro Manila is in an area classified as Type I, characterized as having two distinct seasons: dry from November to April and wet during the rest of the year, with maximum rainy periods from June to September.

(2) Secondary Data Sources

Table 2.3-1 summarizes the secondary data sources used in the climate and meteorology assessment.

Table 2.3-1 Sources of secondary information – Climate and Meteorology

Information / Data / Document Description or Title	Author and Date Published / Generated
Modified Coronas' Classification (Climate Map of the Philippines)	Classification first established by Coronas (Coronas, 1920) and slightly modified by PAGASA (Flores & Balagot, 1969; Kintanar, 1984)
Tropical Cyclone Frequency	The Manila Observatory
PAGASA Climate Change Projections	PAGASA (PAGASA, 2011)
Climatological Normals and Extremes	PAGASA Climate and Agrometeorological Data Section (2018)
30-Year Wind Data (Speed and Cardinal Direction)	PAGASA Climate and Agrometeorological Data Section (2018)

Secondary data were collected from the Philippine Atmospheric, Geophysical and Astronomical Services Administration – Climatology and Agrometeorology Data Section (PAGASA-CADS). The climate and tropical cyclone frequency maps of the Philippines were sourced from PAGASA and the Manila Observatory. Long-term climatological normals (1981 to 2010), climatological extremes (as of 2018), and 30-year daily wind speed and direction (1989 to 2018) were obtained from the PAGASA weather stations in Science Garden and NAIA Terminal 3. These weather stations are the nearest PAGASA weather stations to the Project (**Table 2.3-2** and **Figure 2.3-1**). These long-term data are required by EMB to represent the climate and meteorological conditions at the project site.

Table 2.3-2 Description of PAGASA synoptic weather stations

Station	Location	Elevation	Coordinates
Science Garden	PAGASA Science Garden Complex, Agham Road, Diliman, Quezon City	37	121° 2' 39.964" E 14° 38' 37.153" N
NAIA Terminal 3	Ninoy Aquino International Airport Terminal 3, Pasay City	7	121° 0' 28.622" E 14° 30' 53.530" N

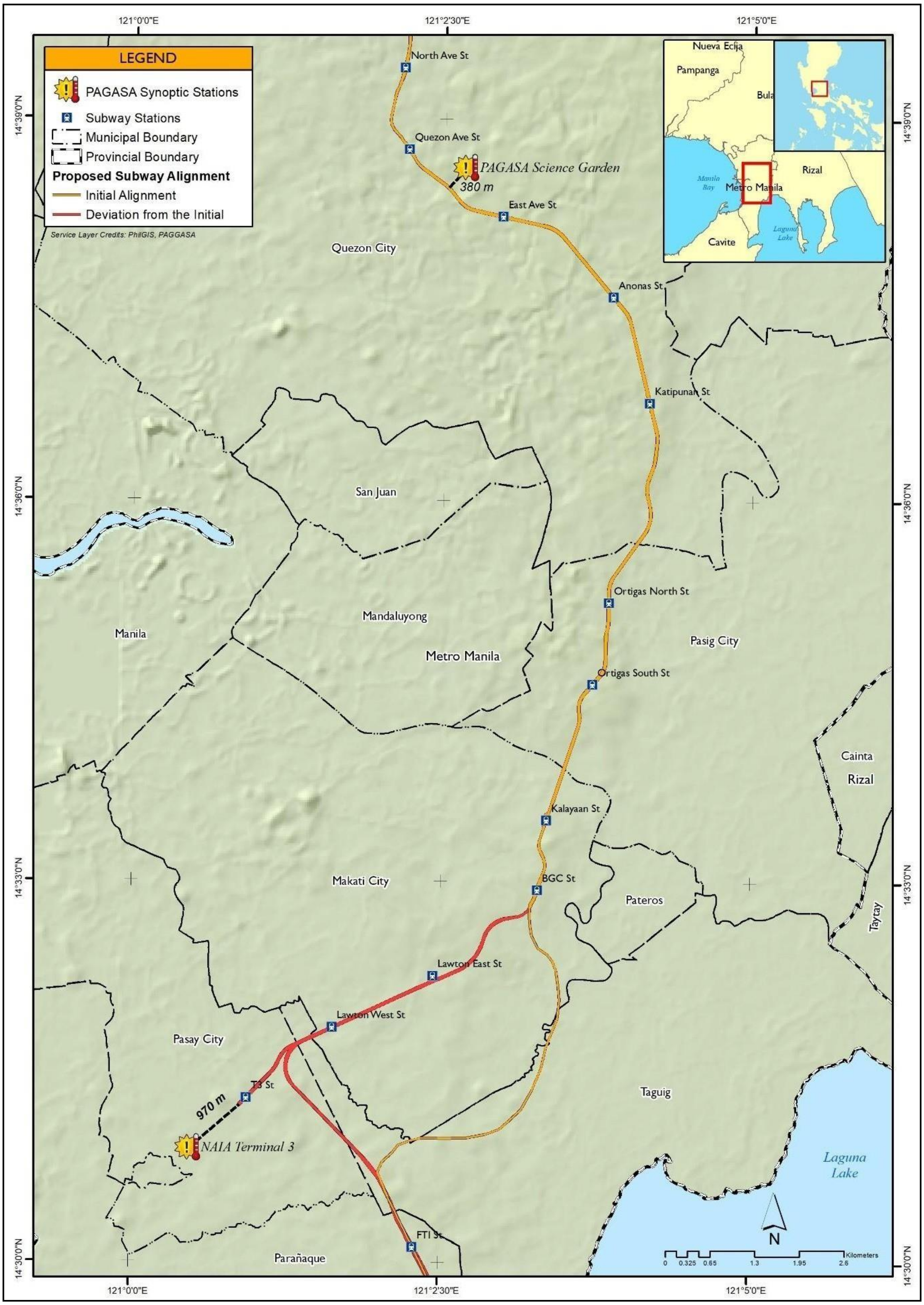


Figure 2.3-1 Location of the PAGAS A synoptic weather stations in Science Garde n and NAIA Terminal 3

(3) Analysis of weather station data

The climatological normals are the period averages of weather parameters computed for a uniform and relative long period consisting of at least three consecutive 10-year periods. The latest climatological normals presented in this assessment are obtained from the PAGASA synoptic weather stations in Science Garden and NAIA Terminal 3 (1981 to 2010) (**Annex 2.3-1**).

Climatological extremes are presented in a matrix of the greatest or highest value of weather parameters recorded for a long period. It consists of the highest and lowest ambient temperature, greatest daily rainfall, and highest wind speed measured in a specific weather station. The latest climatological extremes available from the PAGASA synoptic weather stations in Science Garden and NAIA Terminal 3 are as of 2018 (**Annex 2.3-2**).

The 30-year (1989 to 2018) daily wind data from synoptic weather stations in Science Garden and NAI A Terminal 3 (**Annex 2.3-3**) were analyzed using Windrose PRO3®, a licensed software used to generate wind rose statistics. It summarizes the distribution of winds in each of the 16 wind directions and their corresponding speed. The direction of the rose with the longest spoke represents the direction with the greatest frequency while the color bands show the wind ranges.

(4) PAGASA climate change projections in the Philippines

In addition to historical climate data, the assessment also considered the PAGASA climate change projections (PAGASA, 2011) in 2020 and 2050. The climate change projections present detailed information on plausible future climates such as changes in temperature, rainfall, and frequency of extreme weather events. Climate simulations generate climate change scenarios. These are constructed using climate models which are either global or regional climate models and are mathematical representations of the climate system which simulate the physical and dynamic processes that determine global/regional climate.

The global climate models simulate the atmosphere and oceans and their interactions with land sur f ac es, while regional climate models estimate change in areas in grid boxes that are approximately several hundred kilometers wide. It is uncertain how emission pathways in the future would go. As such, development pathways in all countries are defined by factors such as population and demographic characteristics, access to technology, economic development, and energy use and pursued policies, including outcomes of negotiations on GHG emission reductions. These emission pathways/emission scenarios, known as SRES (Special Report on Emission Scenarios), were developed by the Intergovernmental Panel on Climate Change (IPCC) to give the range of plausible future climate.

Table 2.3-3 presents the four different storylines as defined in the IPCC SRES.

Table 2.3-3 The four storylines developed by the Intergovernmental Panel on Climate Change (IPCC) which defines plausible emission scenarios

Storyline	Descriptio n
A1	Very rapid economic growth; population peaks mid-century; social, cultural and economic convergence among regions; market mechanisms dominate. Subdivisions: A1FI – reliance on fossil fuels; A1T – reliance on non-fossil fuels; A1B – a balance across all fuel sources
A2	Self-reliance; preservation of local identities; continuously increasing population; economic growth on regional scales
B1	Clean and efficient technologies; reduction in material use; global solutions to economic, social and environmental sustainability; improved equity; populations peaks mid -century
B2	Local solutions to sustainability; continuously increasing population at a lower rate than in A2; less rapid technological change than in B1 and A1

Source: PAGASA Climate Change Projections

To generate projections of changes in temperature and rainfall in the Philippines in two time slices centered on 2020 (2006 to 2035) and 2050 (2036 to 2065), PAGASA used the PRECIS (Providing Regional Climates for Impact Studies) Regional Climate Model (RCM) which was developed by the UK Met Hadley Centre in the United Kingdom. Three emission scenarios developed by the IPCC in its SRES were chosen to r un the models: A2 (high-range), A1B (mid-range), and B2 (low-range). High-range emission scenario suggests a society that is based on self-reliance, with continuously growing population, and regionally-oriented economic development but with fragmented per capita economic growth and technological change. Conversely, the medium-range scenario indicates very rapid economic growth accompanied with increasing population which will peak in the middle century and will decline after. The medium-range scenario also assumes fast introduction of new and more efficient technologies with energy generation balanced across all sources. On the other hand, low -range emission scenario connotes a world with local solutions to economic, social and environmental sustainability, with continuously increasing global population, but at a rate lower than of the high-range, intermediate levels of economic development, as well as less rapid and more diverse technological change but oriented towards environment protection and social equity.

In the PAGASA climate change projections, the future climates in 2020 and 2050 under the medium-range scenario are presented in detail since future climates in the next 30 to 40 years will be greatly influenced by the past GHG emissions already there.

The main outputs of the simulations for the three SRES scenarios are as follows:

- projected changes in seasonal and annual mean temperature;
- projected changes in minimum and maximum temperatures;
- projected changes in seasonal rainfall; and
- projected frequency of extreme events.

The seasonal variations are as follows:

- the DJF (December, January, and February or northeast monsoon locally known as *Amihan*) season;
- the MAM (March, April, and May or summer) season;
- the JJA (June, July, and August or southwest monsoon locally known as *Habagat*) season; and
- the SON (September, October, and November or transition from southwest to northeast monsoon) season.

Extreme events are defined as follows:

- extreme temperature (assessed as number of days with maximum temperature greater than 35 °C, following the threshold values used in other countries in the Asia Pacific region);
- dry days (assessed as number of dry days or day with rainfall equal or less than 2.5 mm/day, following the World Meteorological Organization standard definition of dry days used in a number of countries); and
- extreme rainfall (assessed as number of days with daily rainfall greater than 200 mm, which for wet tropical areas, like the Philippines, is considerably intense that could trigger disastrous events).

2.3.1.2 Baseline Environment

(1) Summary of Findings

Table 2.3-4 Key findings and conclusions – Climate and meteorology

Baseline Information	Key Findings and Conclusions
General Climate	The project site is in an area classified as Type I based on the Modified Coronas' Classification. This climate type is characterized as having two pronounced seasons: dry from November to April and wet during the rest of the year. Maximum rain period is from June to September.
Climatological Normals and Extremes	
Rainfall	• The total monthly raindfall at the PAGASA synoptic weather station in NAIA Terminal 3 ranges from 4 mm (March) to 418.4 mm (August). The total annual rainfall amounts to 1,767.90 mm with an annual number of rainy days of 105 days or approximately 29% of the year. The rainfall in the PAGASA synoptic weather station in Science Garden were higher. The total rainfall ranges from 14.6 mm (February) to 504.2 mm (August) with a total annual rainfall of 2,574.30 mm. The annual number of rainy days is 151, corresponding to 41.4% of the year. • The highest daily rainfall recorded at the NAIA Terminal 3 was 472.4 mm on July 20, 1972. For the PAGASA Science Garden weather station. The highest daily rainfall was 455.0 mm on September 26, 2009 during Typhoon *Ondoy* (International name Ketsana)
Temperature	• At NAIA Terminal 3, the mean temperatures ranged from 26.1 °C (January) to 29.7 °C (May), with an annual average mean temperature of 27.8 °C. Although the temperature ranges (difference between maximum and minimum temperatures) are higher in Science Garden, the average annual mean temperature is similar (27.7 °C). The coldest month is January (25.7 °C) while May is the

Baseline Inform at ion	Key Findings and Conclusions
	hottest (29.7 °C). In both weather stations, temperatures are usually higher the MAM period and lower during the DJF period. • The highest temperature recorded in NAIA Terminal 3 was 38.2 °C on May 18, 1969, while the coldest was 14.6°C on February 1, 1962. At the PAGASA Science Garden, the highest temperature was 38.5 °C on May 14, 1987, while the coldest was 14.9 °C on March 1, 1963
Relative Humidity	• The annual average relative humidity are 76% (NAIA Terminal 3) and 78% (Science Garden). August and September are the most humid months with average relative humidity of 76% and 79%, respectively, while the month of April is the least humid at 67% in both weather stations.
Wind	• Long-term wind data indicate that the average wind speeds in NAIA Terminal 3 and PAGASA Science Garden ranges from approximately 2.2 m/s to 3.2 m/s, and 1.9 m/s to 2.3 m/s, respectively. Based on the Beaufort Wind Force Scale, these wind speeds are classified as 'light breeze.' • Wind rose analysis of the 30-year daily wind data at the PAGASA synoptic weather station in NAIA Terminal 3 shows that the prevalent wind direction is to the west, east, and southeast directions. The wind directions are to the east and southeast directions during the months of October to April and starts to shift to the west in May, lasting until September. At the PAGASA synoptic weather station in Science Garden, the wind direction throughout the year is predominantly to the north. From October to April, the predominant wind direction is to the north, and shifts to the south and southwest directions from May to September. These characteristics are consistent with the two principal airstreams that dominate the Philippines: the Northeast Monsoon (*Amihan*) which prevails from October to April and the Southwest Monsoon (*Habagat*) which is prevalent from May to September. • Polynomial trend analysis shows that the average monthly wind speed in NAIA Terminal 3 based on the 1989 to 2018 dataset is highest during the MAM season and lowest in SON. In Science Garden, the windspeeds were highest during the JJA season and lowest during the DJF season.
Natural Disaster	
Tropical Cyclones	The project site is in an area traversed by 24 tropical cyclones in 12 years (two tropical cyclones per year)
Climate Change Projections (PAGASA)	
Rainfall	The simulations indicate that for the medium-range emission scenario, rainfall is expected to decrease during the dry seasons (DJF and MAM) and increase during the wet seasons (JJA and SON) in both time-slices, making the dry season drier and the wet season wetter.
Temperature	The results of the simulation show that ambient mean temperatures have an increasing trend in 2020 and 2050 from the baseline. For the medium-range emission scenario, the temperature will range from 27.1 °C to 29.9 °C in 2020 and 29.3 to 30.9 °C 2050. In both 2020 and 2050 time slices, MAM is projected to be the warmest season every year.

(2) General Climate

a. Climate Type

The project site is in an area classified as Type I based on the Modified Corona's Classification (**Figure 2.3-2**). This climate type is characterized as having two very pronounced seasons: dry season from November to April and Wet during the rest of the year. The maximum rain period is from June to September. Two principal airstreams dominate the Philippines: the Northeast Monsoon (*Amihan*) which prevails from October to April, and the Southwest Monsoon (*Habagat*) which is prevalent from May to September. Since the project site is in the western portion of Luzon, it is more likely affected by *Habagat*. These will be discussed in detail in the subsequent sections.

b. Frequency of Tropical Cyclones

Approximately 20 tropical cyclones enter the Philippine Area of Responsibility (PAR) per year. A tropical cyclone is a non-frontal low-pressure system of synoptic scale developing over warm waters having organized convection and a maximum mean wind speed of 63 km or greater extending more than half-way around near the center and persisting for at least six hours. PAGASA categorizes a tropical cyclone bas ed on the intensity of its maximum winds as it enters the PAR. The project site is in an area traver s ed b y 24 tropical cyclones in 12 years (two tropical cyclones per year) (**Figure 2.3-3**).

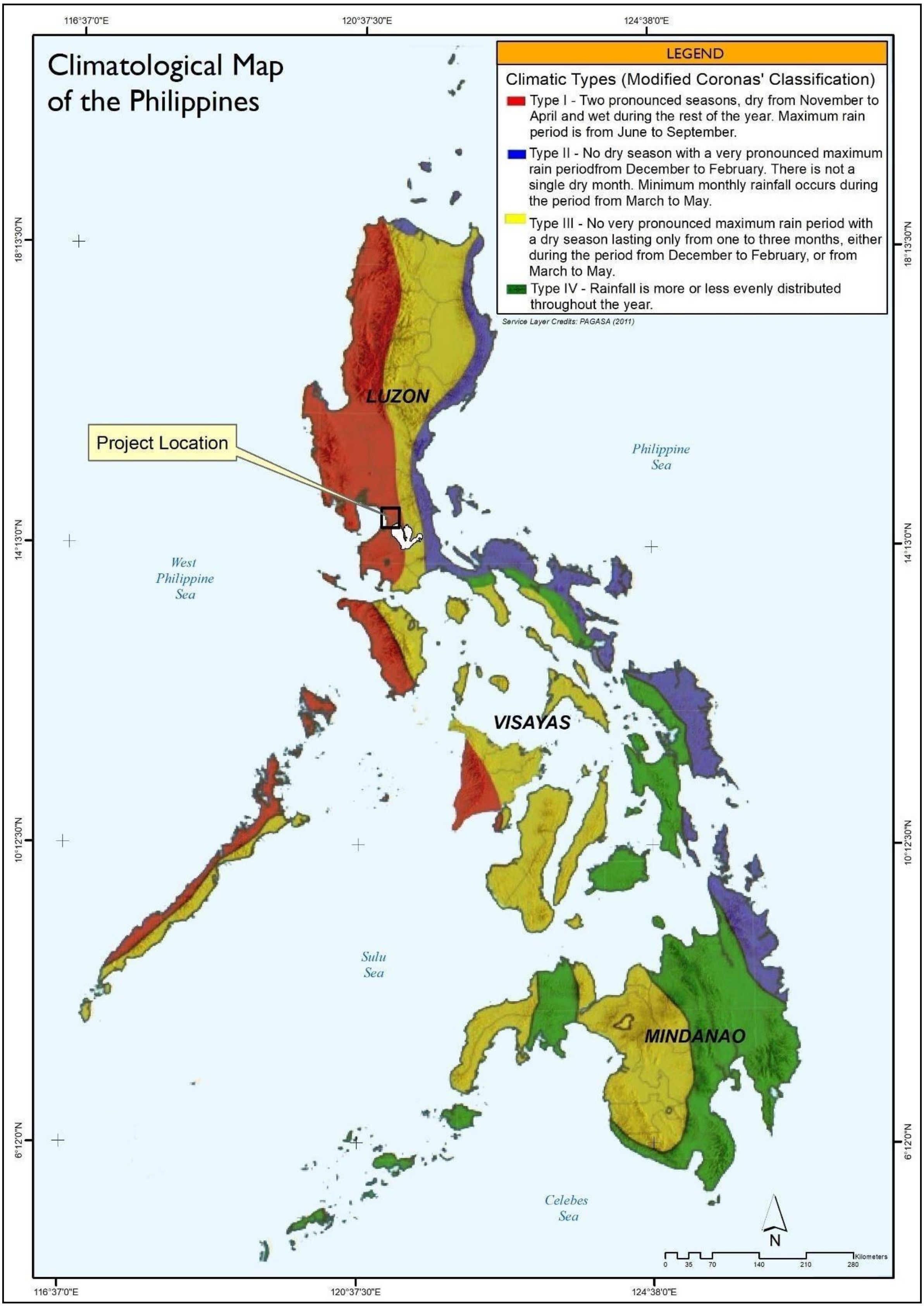


Figure 2.3-2 Climate Map of the Philippines

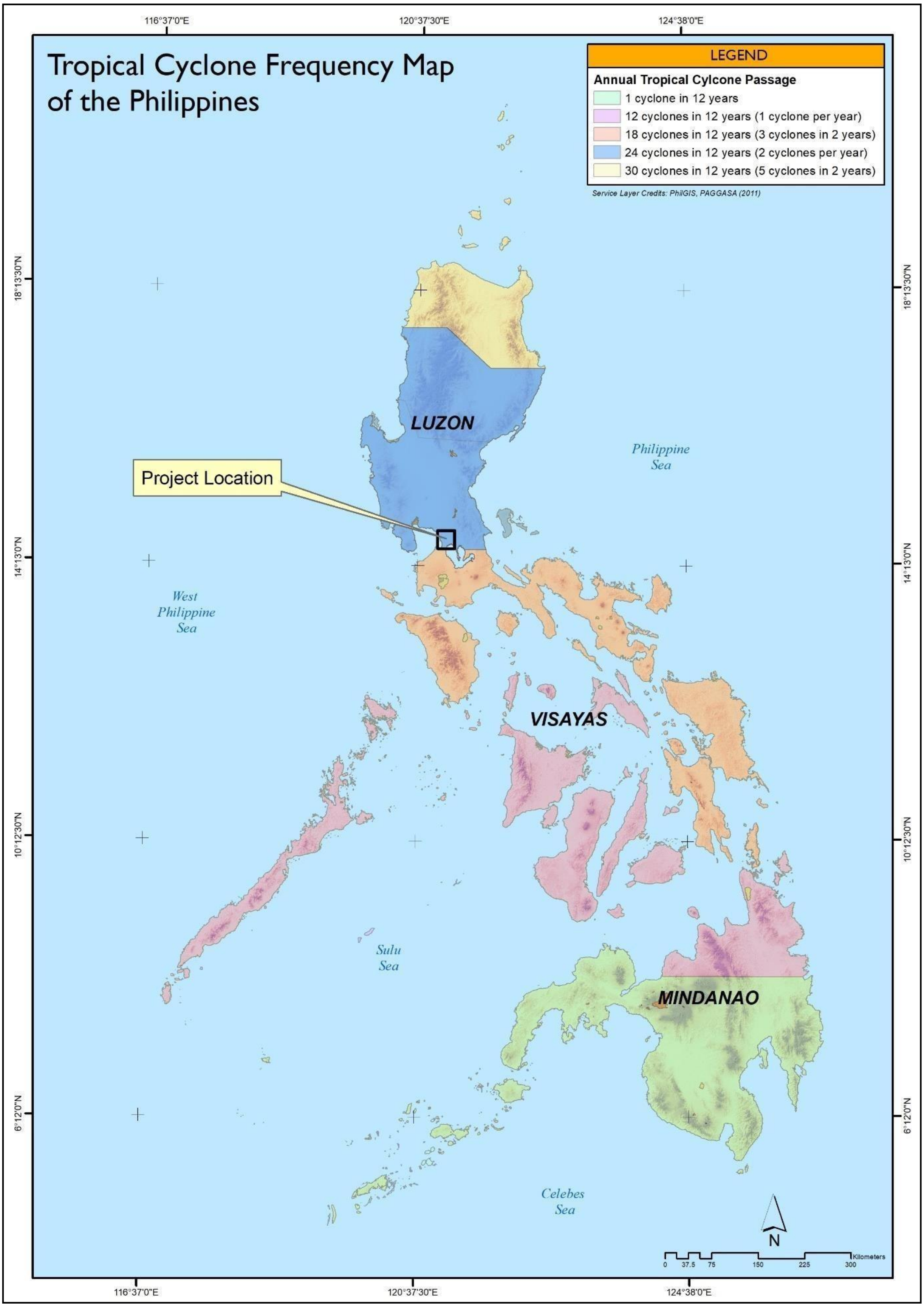


Figure 2.3-3 Tropical Cyclone Frequency Map of the Philippines

(3) Climatological Normals and Extremes

Climatological Normals are three-decade averages of climatological variables including temperature and precipitation produced once every 10 years. The 1981 to 2010 dataset is the latest release of PAGASA' s climatological normals and contains monthly normals of rainfall, temperature, relative humidity, wind speed, wind direction, and number of dry days calculated from observations at different weather stations operated by PAGASA. The climatological normals in the PAGASA synoptic weather stations in Scienc e Garden and NAIA Terminal 3 were used in this assessment (**Annex 2.3-1**).

Climatological extremes are presented in a matrix of the greatest or highest value of weather parameters recorded for a long period. It consists of the highest and lowest ambient temperature, greatest daily rainfall, and highest wind speed measured in a specific weather station. The latest climatological extremes available from the PAGASA synoptic weather stations in Science Garden and NAIA Terminal 3 is as of 2018 (**Annex 2.3-2**).

a. Rainfall

The three-decade climate data shows that the rainfall patterns in Metro Manila has a distinct pattern (**Table 2.3-5** and **Figure 2.3-4**). For both weather stations (although the NAIA Terminal 3 station has les s total rainfall), the total monthly rainfall starts to increase during the month of May, with an increasing trend until peaking during the months of July, August, and September. A decreasing trend in rainfall is observed from October to April. This is consistent with the characteristics of a Type I climate. It is also observable that the number of rainy days is directly proportional to the total monthly amount of rainfall.

The total monthly raindfall at the PAGASA synoptic weather station in NAIA Terminal 3 ranges from 4 mm (March) to 418.4 mm (August). The total annual rainfall amounts to 1,767.90 mm with an annual number of rainy days of 105 days or approximately 29% of the year. The rainfall in the PAGASA synoptic weather station in Science Garden were higher. The total rainfall ranges from 14.6 mm (February) to 504.2 mm (August) with a total annual rainfall of 2,574.30 mm. The annual number of rainy days is 151, corresponding to 41.4% of the year.

The total annual rainfall at the PAGASA synoptic weather station in NAIA Terminal 3 and Science Garden are within the range of other areas in the Philippines classified as Type I climate: Cabanatuan, Nueva Ecija (1,854.9 mm), Clark, Pampanga (2,026.8 mm), Dagupan City, Pangasinan (2,380.9 mm), Iba, Zambales (3,450.7 mm), Laoag City, Ilocos Norte (2,182.8 mm), NAIA, Pasay City (1,767.8mm), Port Area, Manila (2,103.6 mm), Ambulong, Batangas City (1,767.0 mm), and Vigan, Ilocos Sur (2,277.4 mm).

The highest daily rainfall recorded at the NAIA Terminal 3 was 472.4 mm on July 20, 1972. For the PAGASA Science Garden weather station. The highest daily rainfall was 455.0 mm on September 26, 2009 during Typhoon *Ondoy* (International name Ketsana) (**Annex 2.3-2**).

Table 2.3-5 Total monthly rainfall and number of rainy days at the PAGAS A synoptic weather stations in Science Garden and NAIA Terminal 3

Month	NAIA Termina l 3		Science Garde n	
	Rainfall	No. of Rainy Days	Rainfall	No. of Rainy Days
January	6.8	2	18.5	4
February	4.2	1	14.6	3
March	4	1	24.8	4
April	16	1	40.4	5
May	70.4	10	186.7	10
June	265.2	14	316.5	18
July	316.7	16	493.3	22
August	418.4	19	504.2	23
September	255.2	16	451.2	22
October	283.4	14	296.6	18
November	99	8	148.8	14
December	28.6	3	78.7	8
Annua l	**1,767.90**	**105.00**	**2,574.30**	**151.00**

Source: PAGASA CADS

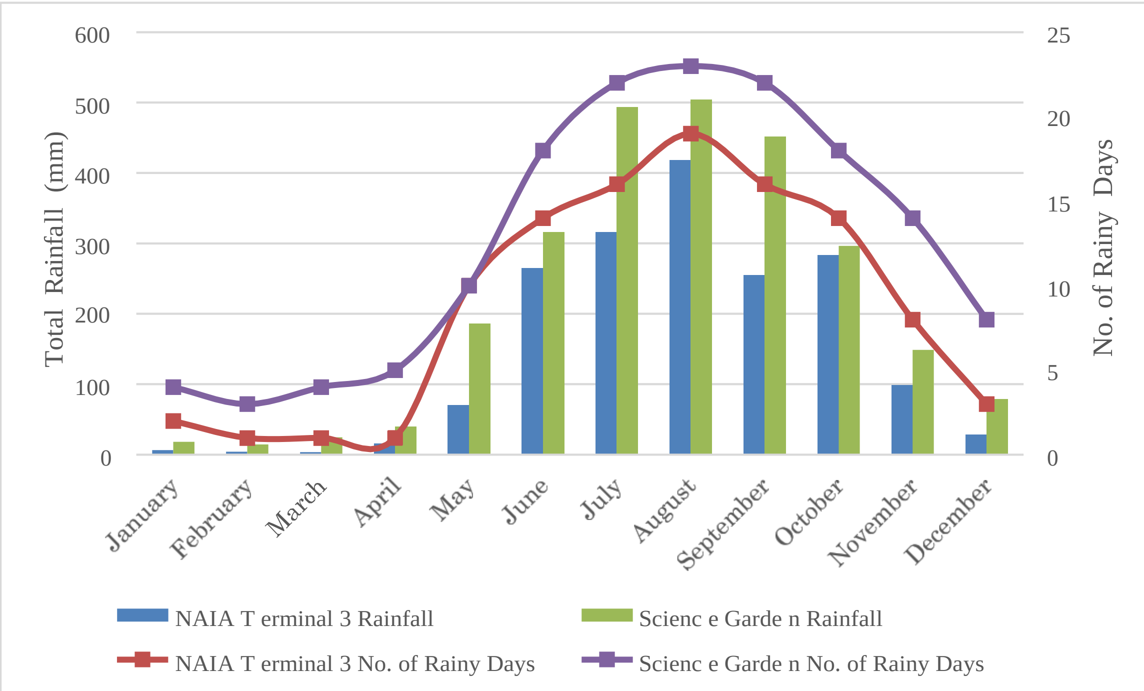


Figure 2.3-4 Total monthly rainfall and number of rainy days at the PAGASA synoptic weather stations in Science Garden and NAIA Terminal 3, 1981 to 2010

b. Temperature

Table 2.3-6, **Figure 2.3-5**, **Figure 2.3-6**, and **Annex 2.3-1** present the maximum, minimum, and mean temperatures (in °C) at the PAGASA synoptic weather stations in Science Garden and NAIA Terminal 3 from 1981 to 2010.

At NAIA Terminal 3, the mean temperatures ranged from 26. 1 °C (January) to 29.7 °C (May), with an annual average mean temperature of 27.8 °C. Although the temperature ranges (difference between maximum and minimum temperatures) are higher in Science Garden, the average annual mean temperature is similar (27.7 °C). The coldest month is January (25.7 °C) while May is the hottest (29.7 °C).

In both weather stations, temperatures are higher during the MAM period and lower during the DJF period.

The highest temperature recorded in NAIA Terminal 3 was 38.2 °C on May 18, 1969, while the coldest was 14.6°C on February 1, 1962. At the PAGASA Science Garden, the highest temperature was 38.5 °C on May 14, 1987, while the coldest was 14.9 °C on March 1, 1963 (**Annex 2.3-2**).

Table 2.3-6 Monthly minimum, maximum, and mean temperatures at the PAGASA synoptic weather stations in Science Garden and NAIA Terminal 3

Month	NAIA Terminal 3			Science Garden		
	Max (°C)	Min (°C)	Mean (°C)	Max (°C)	Min (°C)	Mean (°C)
January	30.2	22.0	26.1	30.6	20.8	25.7
February	31	22.5	26.7	31.7	20.9	26.3
March	32.5	23.6	28	33.4	22.1	27.8
April	34.1	25	29.5	35	23.7	29.4
May	33.8	25.5	29.7	34.7	24.7	29.7
June	32.5	25.1	28.8	33.1	24.6	28.8
July	31.3	24.6	28	31.9	24.1	28
August	30.8	24.6	27.7	31.3	24.2	27.8
September	31	24.6	27.8	31.6	24	27.8
October	31.1	24.3	27.7	31.6	23.5	27.6
November	31.1	23.7	27.4	31.4	22.7	27.1
December	30.2	22.7	26.5	30.5	21.6	26
Annual	**31.6**	**24**	**27.8**	**32.2**	**23.1**	**27.7**

Source: PAGASA CADS

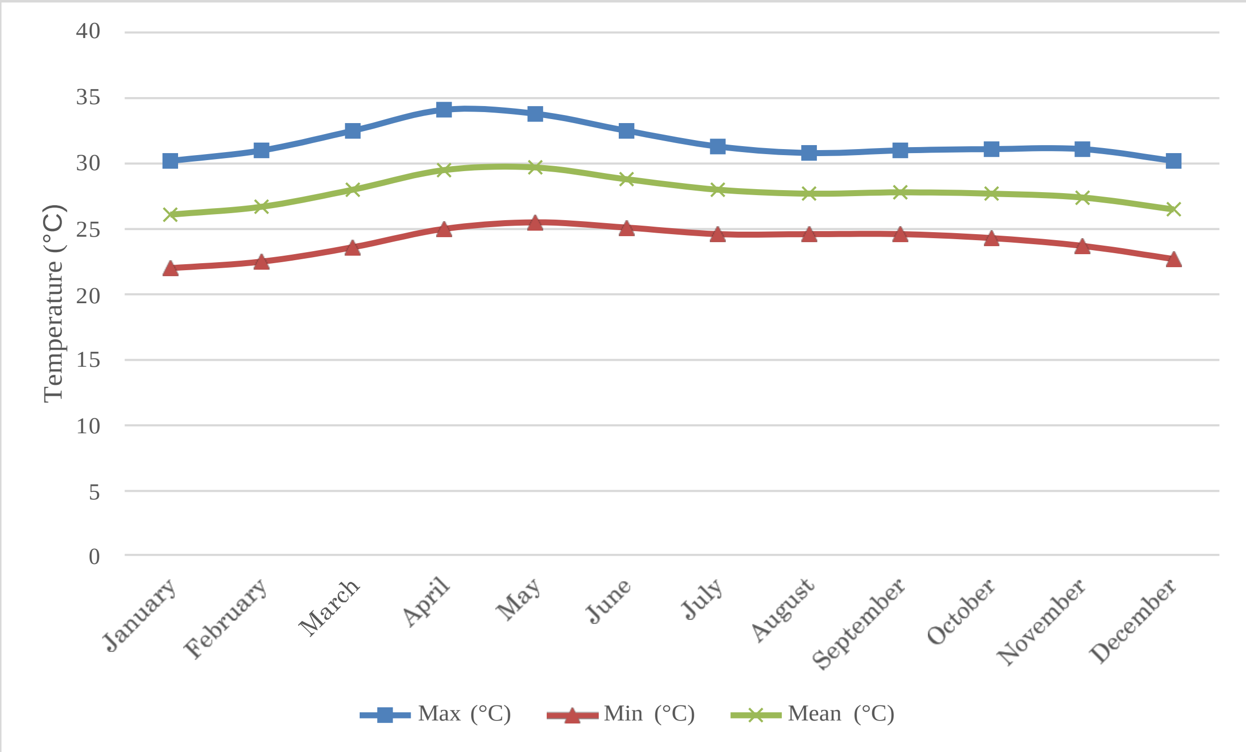


Figure 2.3-5 Monthly minimum, maximum, and mean temperatures at the PAGASA NAIA Terminal 3 synoptic weather station, 1981 to 2010

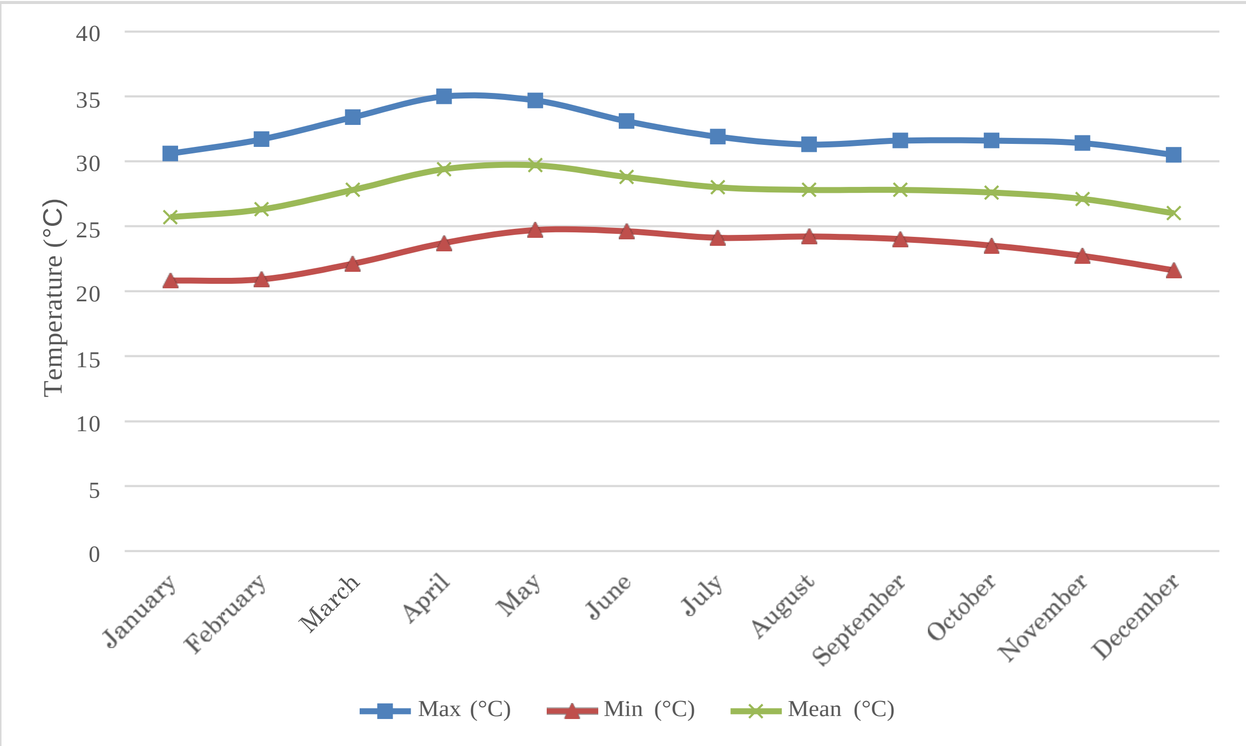


Figure 2.3-6 Monthly minimum, maximum, and mean temperatures at the PAGASA Science Garden synoptic weather station, 1981 to 2010

c. Relative Humidity

Relative humidity is defined as the amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature (Perry, 1973). In general, the relative humidity describes moisture exchange processes of materials or also of people with their surroundings. It is the most important quantity for specifying a pleasant ambient climate and thus for well-being. Being particularly close to large bodies of water (Manila Bay and Laguna de Bay), Metro Manila is likely to exhibit high relative humidity all throughout the year.

Data on relative humidity recorded at NAIA Terminal3 and PAGASA Science Garden (**Table 2.3-7**, **Figure 2.3-7**, and **Annex 2.3-1**), shows the annual average dry and wet bulb temperatures. The dry bulb temperature pertains to the air temperature at the time of observation, while the wet bulb temperature is the temperature of air parcel if cooled adiabatically to saturation at constant pressure by evaporating water in it. The average annual wet and dry bulb temperatures are 243 °C and 27.6 °C, respectively. This translates to an annual average relative humidity of 76% (NAIA Terminal 3) and 78% (Science Garden). August and September are the most humid months with average relative humidity of 76% and 79%, respectively, while the month of April is the least humid at 67% in both weather stations.

Table 2.3-7. Monthly average relative humidity at the PAGAS A synoptic weather stations in NAIA Terminal 3 and Science Garden, 1981 to 2010

Relative Humidity	NAIA Terminal 3	Science Garden
	RH (%)	RH (%)
January	75	76
February	72	73
March	68	69
April	67	67
May	72	72
June	77	79
July	81	83
August	83	84
September	83	84
October	80	83
November	78	82
December	76	79
Annual	**76**	**78**

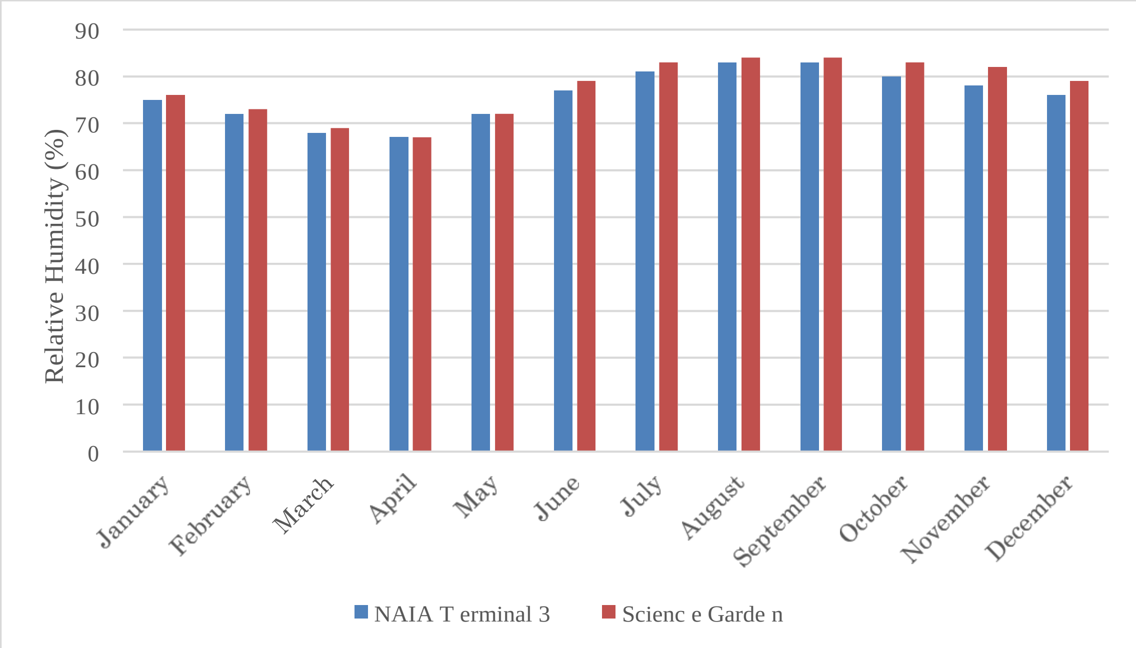


Figure 2.3-7 Monthly average relative humidity at the PAGASA synoptic weather stations in NAIA Terminal 3 and Science Garden, 1981 to 2010

d. Wind Speed and Direction

Long-term wind data indicate that the average wind speeds in NAIA Terminal 3 and PAGASA Science Garden ranges from approximately 2.2 m/s to 3.2 m/s, and 1.9 m/s to 2.3 m/s, respectively. Bas ed on the Beaufort Wind Force Scale **(Annex 2.3-4)**, these wind speeds are classified as 'light breeze.'

Wind rose analysis of the 30-year daily wind data at the PAGASA synoptic weather station in NAIA Terminal 3 (**Annex 2.3-3**) shows that the prevalent wind direction is to the west, east, and southeast directions (**Figure 2.3-8**). The wind directions are to the east and southeast directions during the months of October to April and starts to shift to the west in May, lasting until September (**Figure 2.3-9**, **Figure 2.3-10**, and **Figure 2.3-11**). At the PAGASA synoptic weather station in Science Garden, the wind direction throughout the year is predominantly to the north (**Figure 2.3-12**). From October to April, the predominant wind direction is to the north, and shifts to the south and southwest directions from May to September (**Figure 2.3-13**, **Figure 2.3-14**, and **Figure 2.3-15**). These characteristics are consistent with the two principal airstreams that dominate the Philippines: the Northeast Monsoon (*Amihan*) which prevails f r om October toApril and the Southwest Monsoon (*Habagat*) which is prevalent from May to September.

Polynomial trend analysis shows that the average monthly wind speed in NAIA Terminal 3 bas ed on the 1989 to 2018 dataset is highest during the MAM season and lowest in SON (**Figure 2.3-16**). I n Scienc e Garden, the windspeeds were highest during the JJA season and lowest during the DJ F s eas on (**Figure 2.3-17**).

The highest wind speed recorded in NAIA Terminal 3 is 56 m/s on November 19, 1970 during T yph oon *Yoling* (int. name "Patsy.") In Science Garden, the highest recorded windspeed is 50 m/s on November 3, 1995 during Typhoon *Rosing* (int. name "Angela.") (**Annex 2.3-4**).

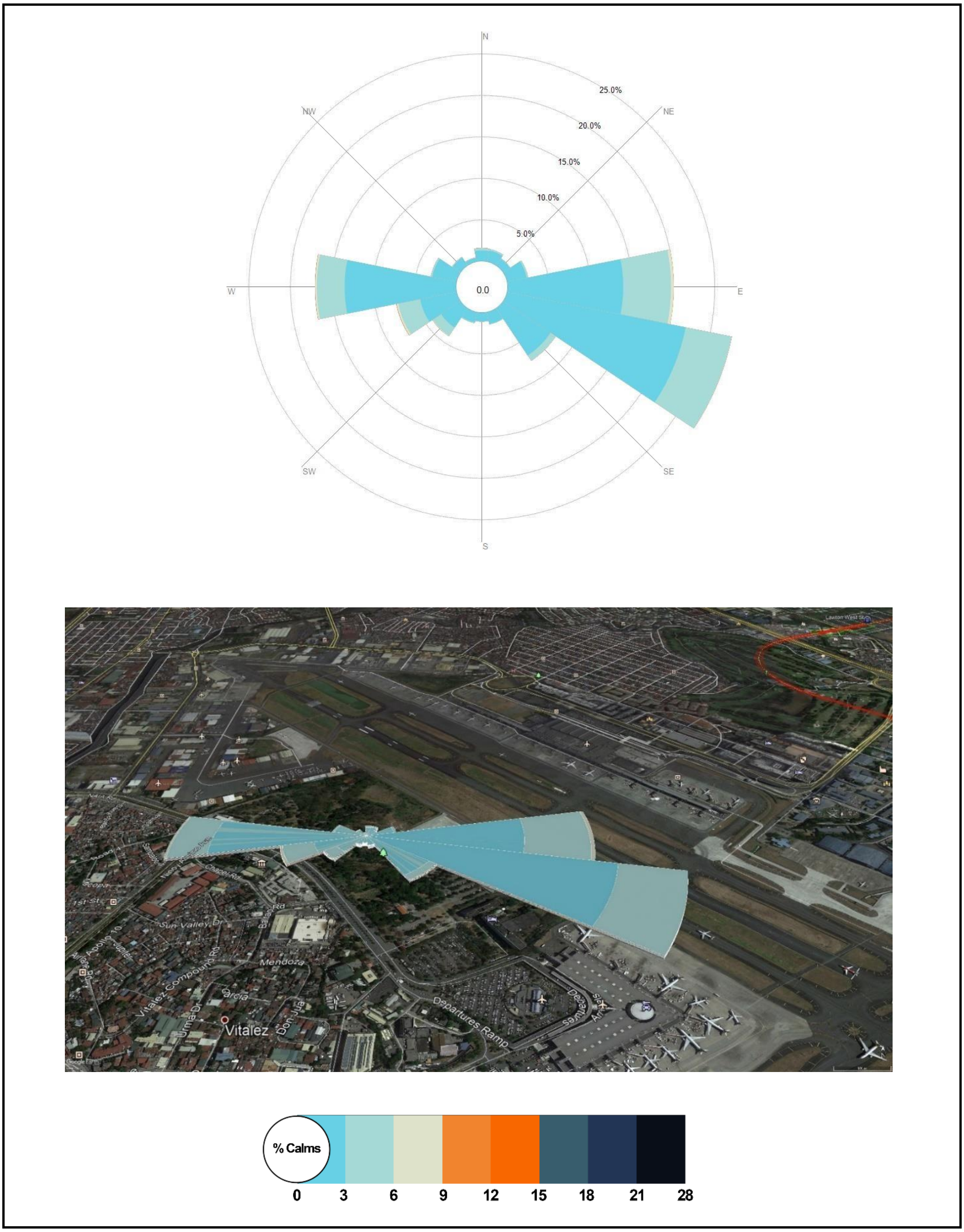


Figure 2.3-8. Annual windrose diagram at the PAGAS A synoptic weather station in NAIA Terminal 3, 1989 to 2018

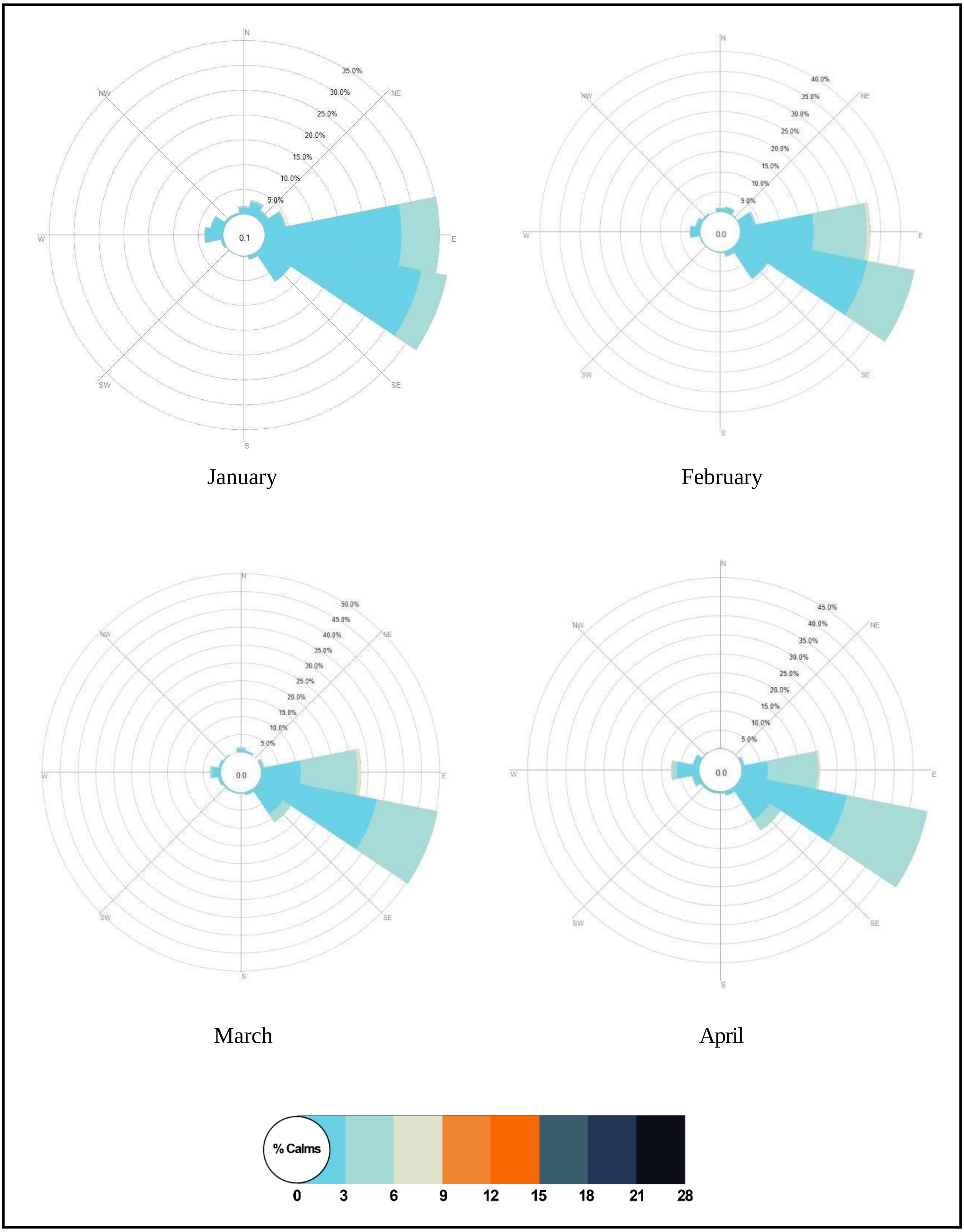


Figure 2.3-9. Windrose diagrams from January to April at the PAGAS A synoptic weather station in NAIA Terminal 3, 1989 to 2018

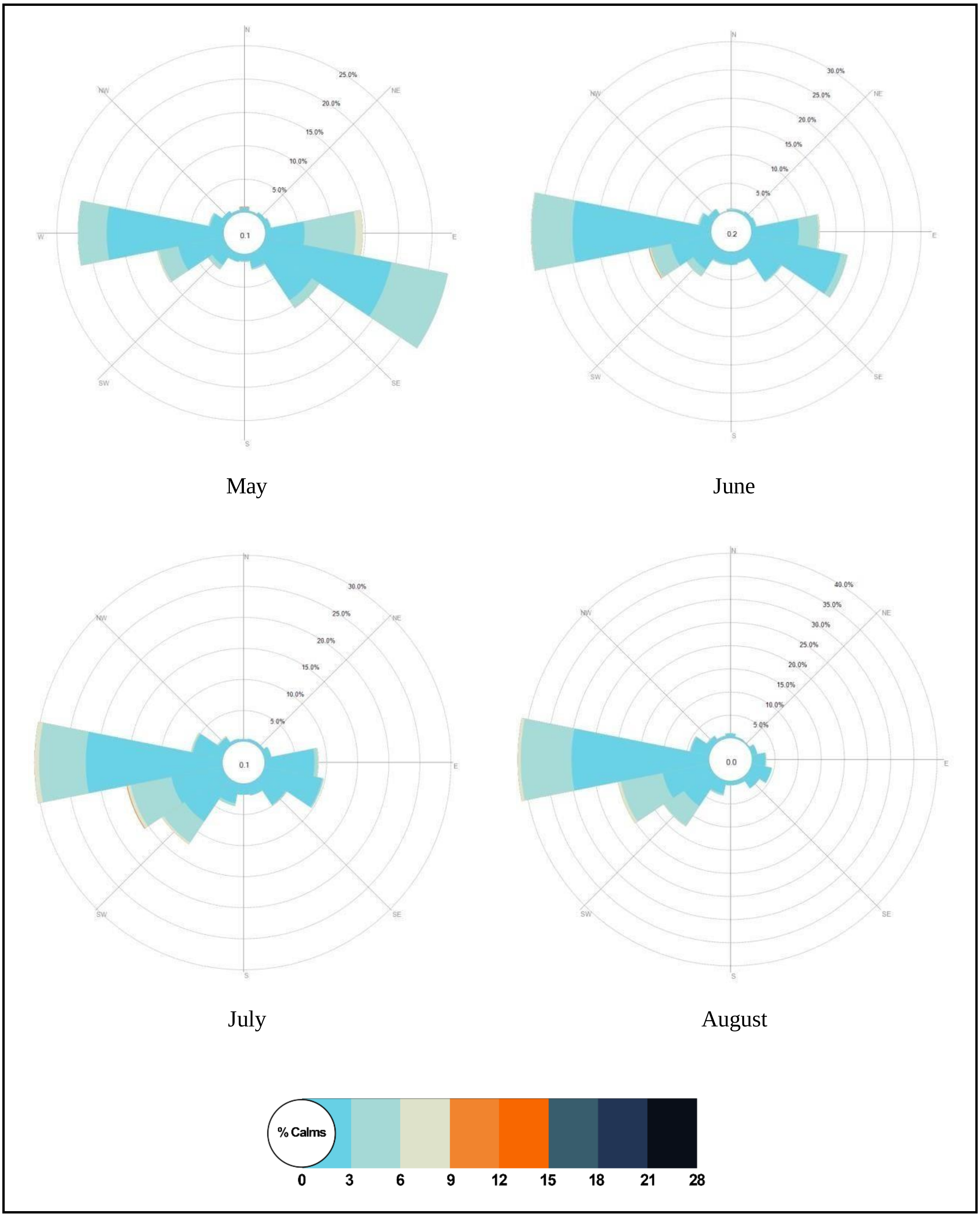


Figure 2.3-10. Windrose diagrams from May to August at the PAGAS A synoptic weather station in NAIA Terminal 3, 1989 to 2018

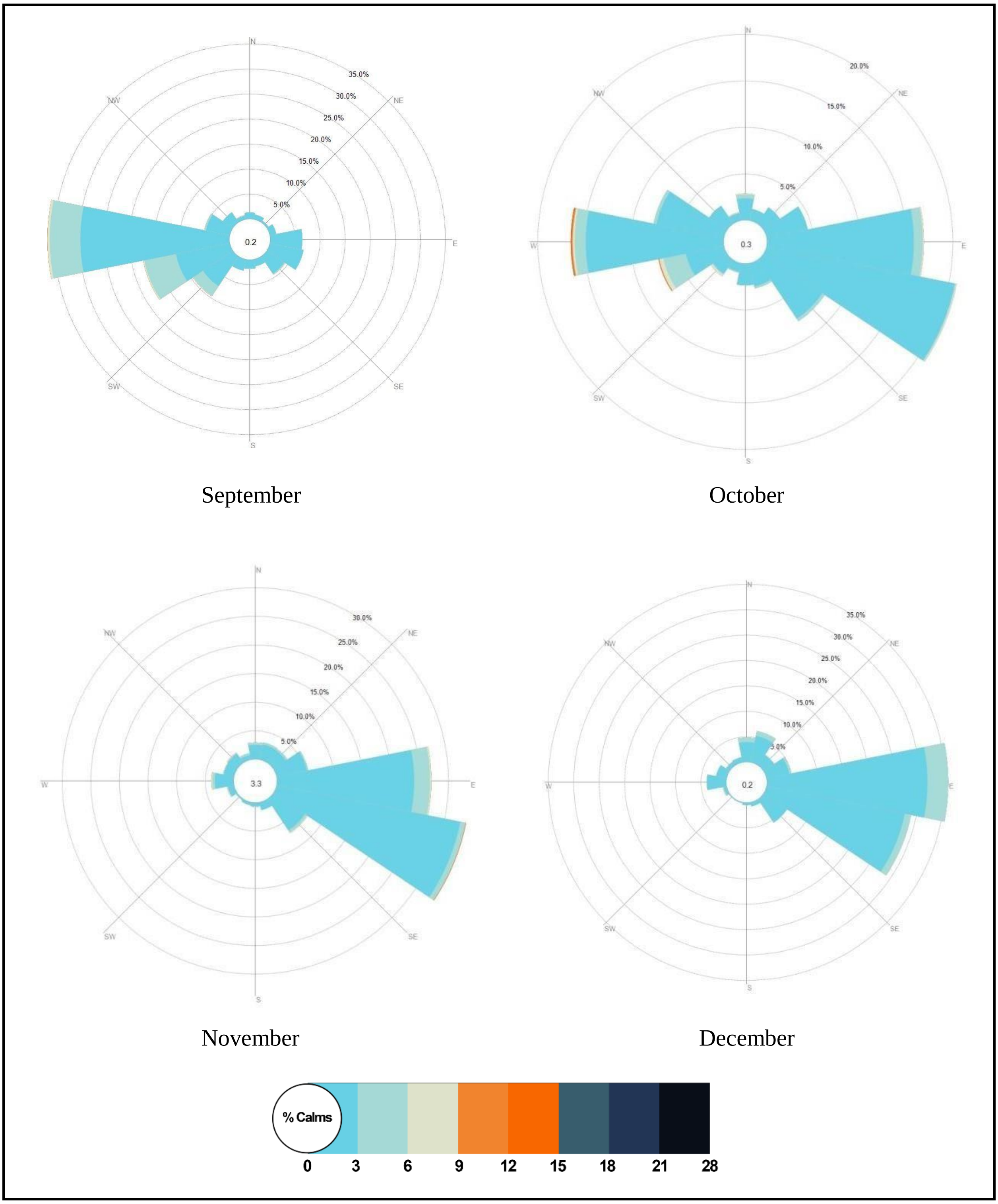


Figure 2.3-11. Windrose diagrams from September to December at the PAGASA synoptic weather station in NAIA Terminal 3, 1989 to 2018

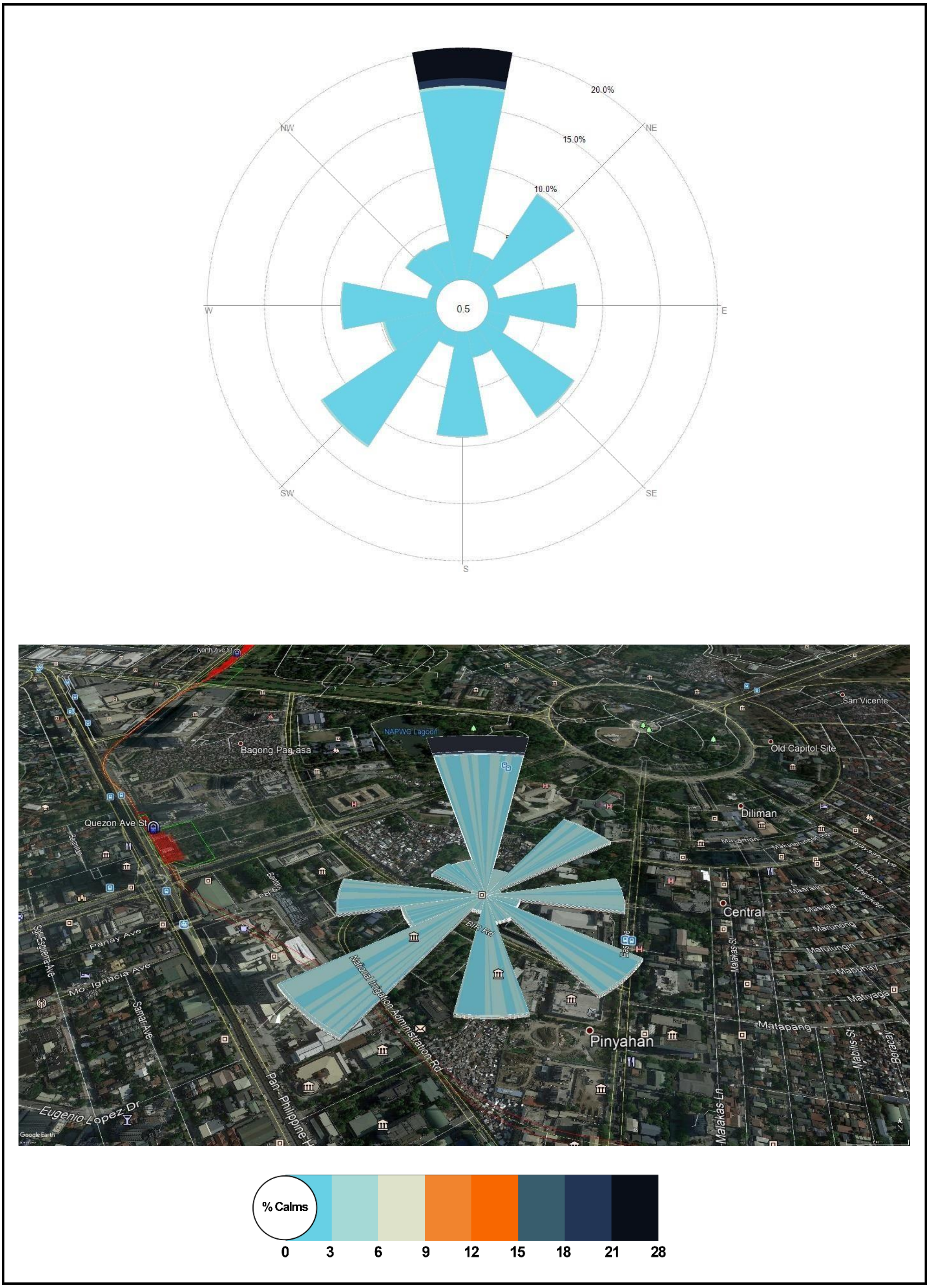


Figure 2.3-12. Annual windrose diagram at the PAGAS A synoptic weather station in Science Garde n, 1989 to 2018

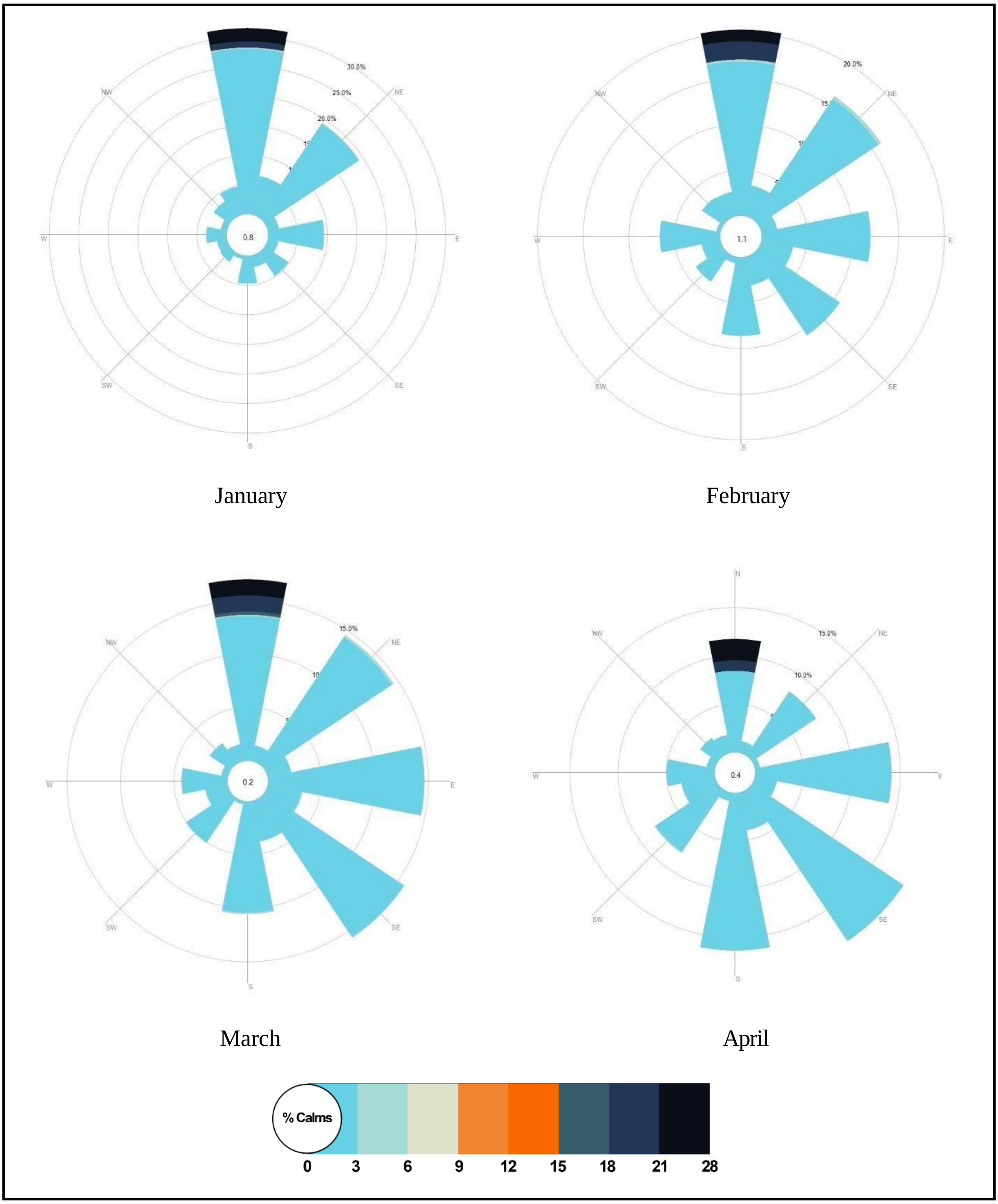


Figure 2.3-13. Windrose diagrams from January to April at the PAGAS A synoptic weather station in Science Garden, 1989 to 2018

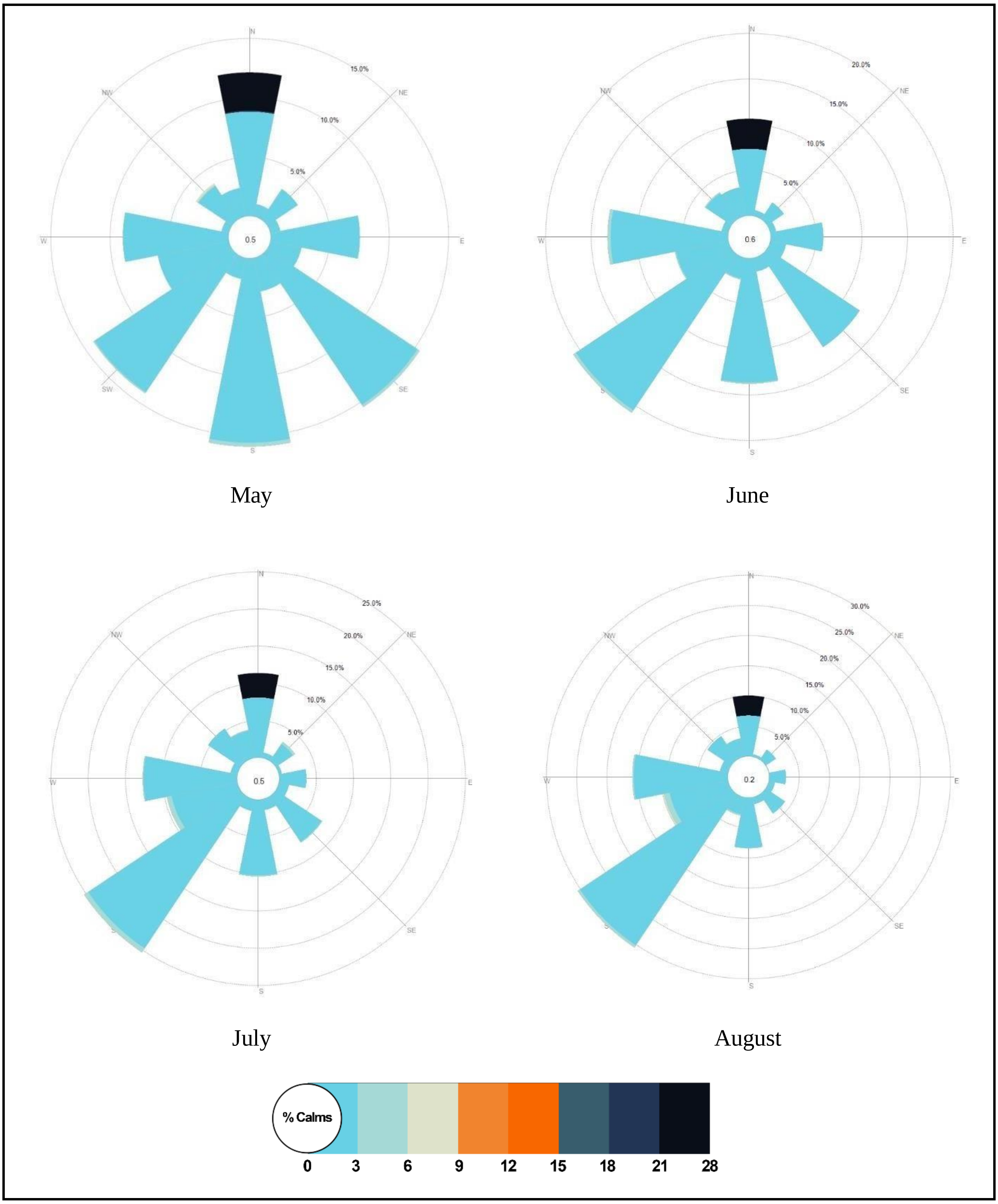


Figure 2.3-14. Windrose diagrams from May to August the PAGA S A synoptic weather station in Science Garde n, 1989 to 2018

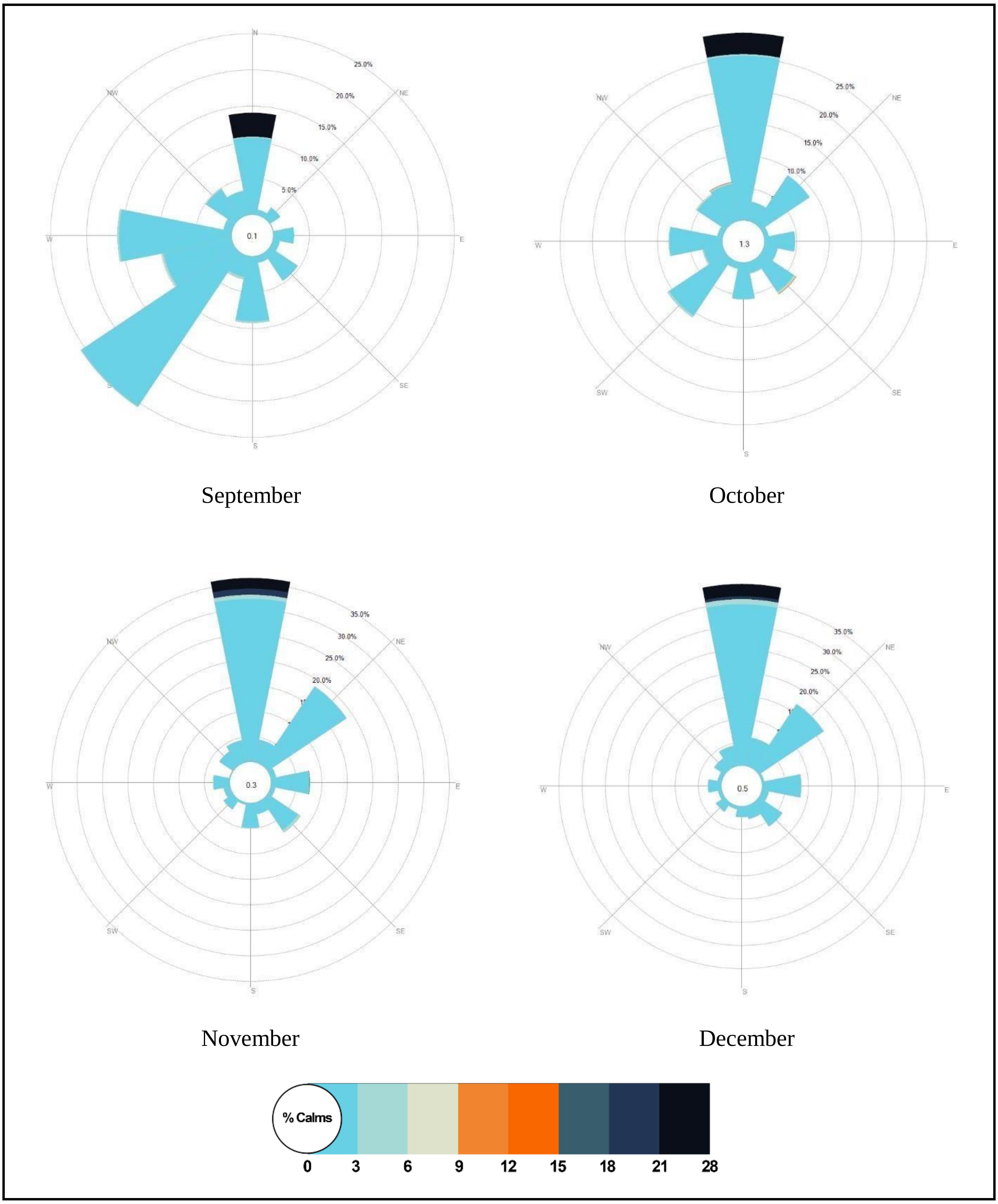


Figure 2.3-15. Windrose diagrams from September to December at the PAGASA synoptic weather station in Science Garden, 1989 to 2018

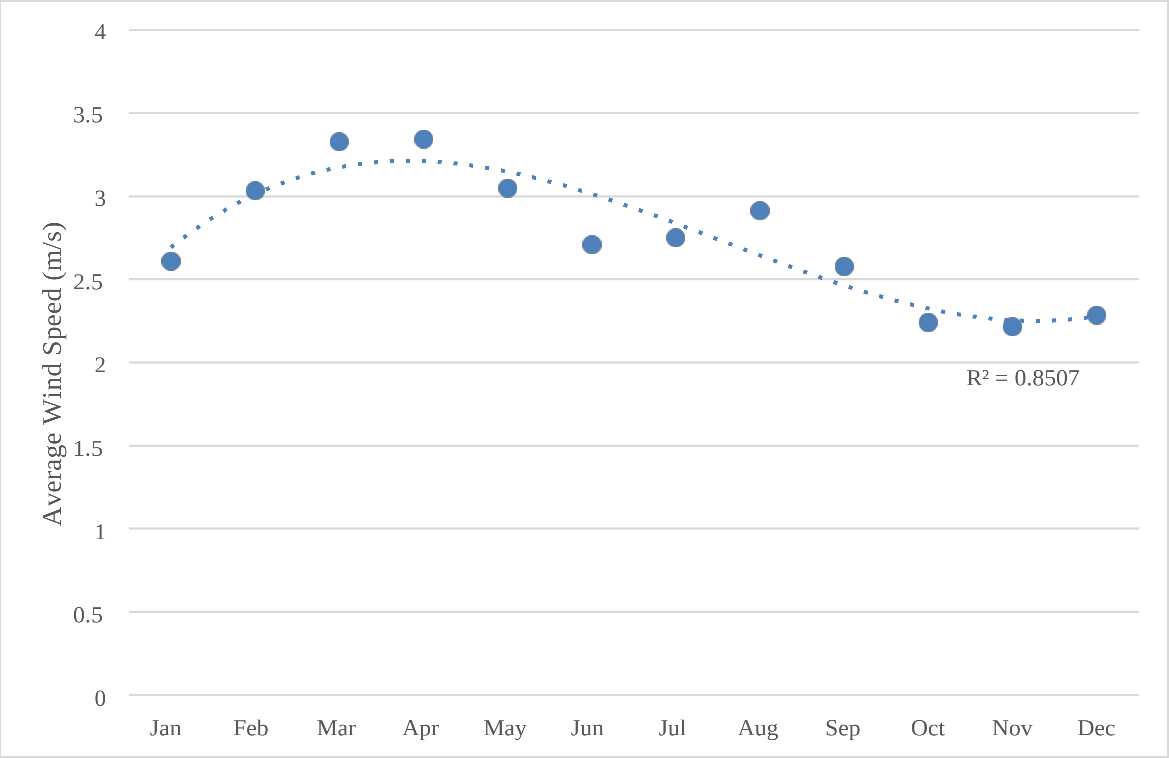


Figure 2.3-16. Average monthly wind speeds at the PAGASA synoptic weather station in NAIA Terminal 3, 1989 to 2018

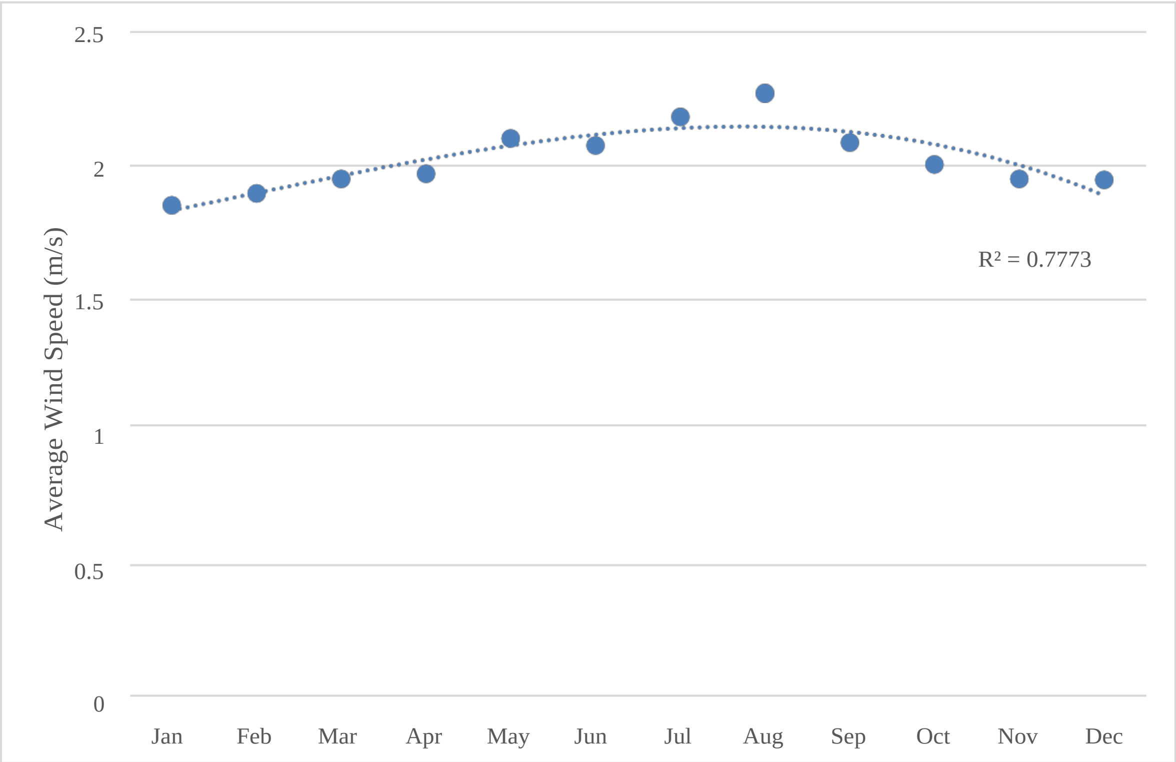


Figure 2.3-17. Average monthly wind speeds at the PAGASA synoptic weather station in Science Garden, 1989 to 2018

(4) Projection of Extreme Weather Events

a. Extreme Temperature, Extreme Rainfall, and Dry Days

The projected frequency of extreme weather events in Metro Manila under the medium-range scenario is presented in **Table 2.3-8**.

Table 2.3-8. Frequency of Extreme Weather Events in 2020 and 2050 under the medium range emission scenario in Metro Manila (Science Garden)

Weathe r Event	Observ e d Baseline (1971 to 2000)	Project e d in 2020 (2001 to 2035)	Project e d in 2050 (2036 to 2065)
No. of Days with T_{max} >35 °C[1]	1,095	1,984	3,126
No. of Dry Days[2]	7,476	6,302	6,220
No. of Days with Rainfall >200 mm [3]	9	13	17

Source: PAGASA Climate Change Projections

b. Frequency of Tropical Cyclones

Trend analysis of tropical cyclone occurrence or passage within the PAR shows that an average of 20 tropical cyclones enter the PAR per year. There is a high variability over the decades but there is no indication of increase in frequency. There is, however, a minimal increase in the number of stronger tropical cyclones with maximum sustained winds greater than 150 kph (typhoons) being exhibited during El Niño events.

(5) PAGASA Climate Change Projections in the Philippines

Climate change is defined as a change in global or regional climate patterns, in particular a change apparent from mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuel.

The 21st session of the Conference of the Parties (COP21) and the eleventh session of the COP serving as the meeting of the Parties to the Kyoto Protocol took place on 30 November to 13 December 2015 in Paris, France. At the Paris climate change conference (COP21), 195 countries (including the Philippines) adopted the first universal, legally binding global climate deal. This agreement (known as the Paris agreement) sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to below 2 °C. The signing of the agreement by the Philippines recognizes the country's vulnerability to the adverse impacts of climate change. Like many of the world's poor countries, the Philippines is one of the most vulnerable to climate change impacts because of its geographic setting, climate-dependent economy, and limited resources. It is therefore imperative to observe changes in climate and predict the probable future climate in order to have a basis for climate change adaptation and disaster risk reduction planning and government policy formulations.

[1] Following the threshold values used in other countries in the Asia Pacific Region
[2] Assessed as number of dry days or day with rainfall equal or less than 2.5 mm per day, following the World Meteorological Organization (World Meteorological Organization, 2011) standard definition of dry days used in a number of countries
[3] Assessed as number of days with daily rainfall greater than 200 mm, which for wet tropical areas, like the Philip pines, is considerably intense that could trigger disastrous events

The Philippine climate is influenced by large-scale atmospheric phenomena that bring substantial amounts of rain all year round. However, due to the uneven distribution of rain with respect to time and space and the occurrences of extreme weather events such as floods and droughts, the Philippines' water resources have in the past experienced imbalances in supply and demand (Jose, Francisco, & Cruz, 1993).

For future climates in 2020 and 2050, outputs of the simulations under the medium-range emission scenario are presented in detail for the sole reason that future climates in the next 30 to 40 years will be greatly influenced by the past greenhouse gas emissions already there. The key findings of the simulation include:

- all areas of the Philippines will get warmer, more so during the relatively warmer summer months;
- annual mean temperatures (average of maximum and minimum temperatures) in all areas in the country are expected to rise by 0.9 ºC to 1.1 ºC in 2020 and 1.8 ºC to 2.2 ºC in 2050;
- likewise, all seasonal mean temperatures will also have increases in the two time slices, during the four seasons (DJF, MAM, JJA, and SON) in all the provinces;
- in terms of seasonal rainfall change, generally, there is a substantial spatial difference in the projected changes in rainfall in 2020 and 2050 in most parts of the Philippines, with reduction of rainfall in most provinces during the summer season (MAM) making the usually dry season drier, while rainfall increases are likely in most areas of Luzon and Visayas during the southwest monsoon (JJA) and the SON seasons, making these seasons still wetter, and thus with greater likelihood of both droughts and floods in areas where these are projected;
- the northeast monsoon (DJF) season rainfall is projected to increase, particularly for areas characterized by Type II climate with potential for more flooding;
- during the southwest monsoon season (JJA), larger increases in rainfall is expected in provinces in Luzon (0.9% to 63%) and Visayas (2% to 22%) but generally decreasing trends in most of the provinces in Mindanao in 2050;
- projections for extreme events in 2020 and 2050 show that hot temperatures (indicated by the number of days with maximum temperature exceeding 35 °C) will continue to become more frequent, number of dry days (days with less than 2.5 mm of rain) will increase in all parts of the country and heavy daily rainfall (exceeding 200 mm) events will also continue to increase in number in Luzon and Visayas.

(6) PAGASA Climate Change Projections in Metro Manila

a. Rainfall

The projected rainfall change in Metro Manila in 2020 and 2050 is presented in **Table 2.3-9** and **Figure 2.3-18**. The simulations indicate that for the medium-range emission scenario, rainfall is expected to decrease during the dry seasons (DJF and MAM) and increase during the wet seasons (JJA and SON) in both time-slices, making the dry season drier and the wet season wetter.

Table 2.3-9. Seasonal rainfall change (in %) in 2020 and 2050 under the medium- range emission scenario in Metro Manila

Season	Observed Baseline (1971-2000), mm	Project e d Rainfa ll in 2020 (2006-203 5) , mm	Project e d Rainfa ll in 2050 (2036-206 5) , mm
DJF	107.5	93.74 (-12.8 %)	88.90 (-17.3 %)
MAM	198.5	132.40 (-33.3)	122.08 (-38.5)
JJA	1,170.2	1,269.67 (8.5)	1,419.45 (21.3)
SON	758.7	758.7 (0.0)	786.77 (3.7)

Source: PAGASA Climate Change Projections

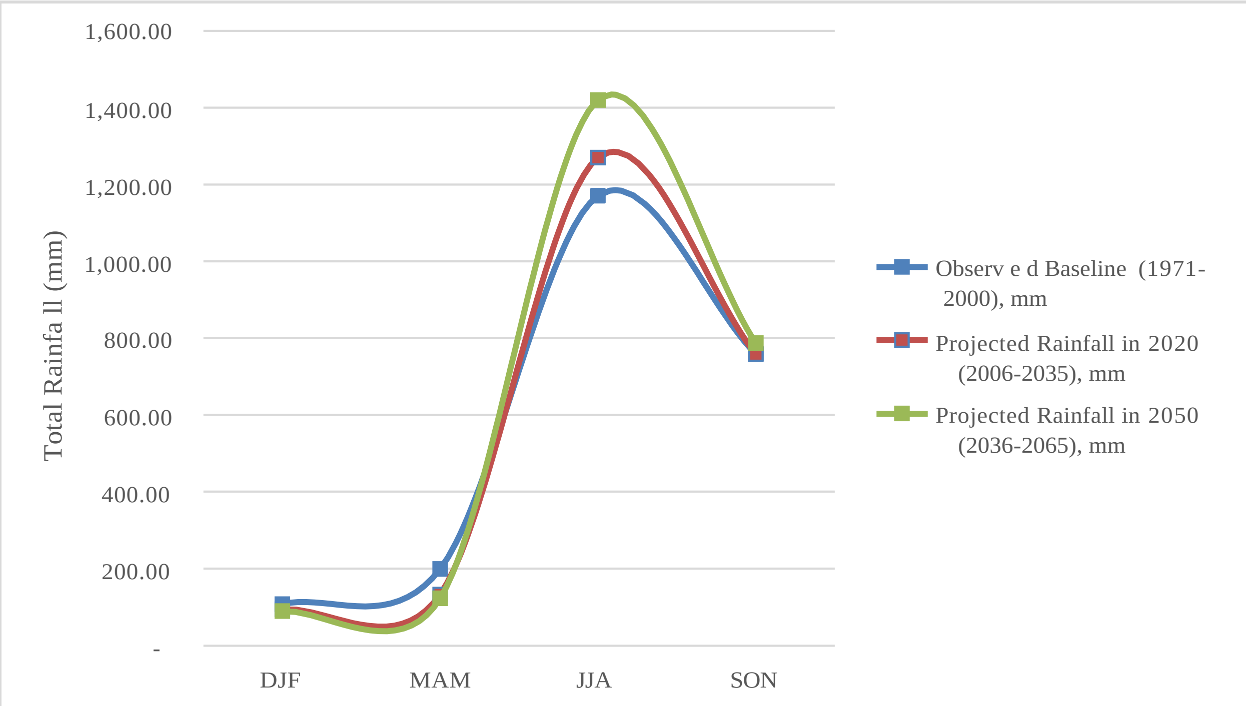


Figure 2.3-18. Seasonal rainfall change (in %) in 2020 and 2050 under the medium- range emission scenario in Metro Manila

b. Temperature

Table 2.3-10 and **Figure 2.3-19** present the projected changes in mean temperatures in Metro Manila in two time slices under the medium-range emission scenario.

The results of the simulation show that ambient mean temperatures have an increasing trend in 2020 and 2050 from the baseline. For the medium-range emission scenario, the temperature will range from 27.1 °C to 29.9 °C in 2020 and 29.3 to 30.9 °C 2050. In both 2020 and 2050 time slices, MAM is projected to be the warmest season every year.

Table 2.3-10. Projected change in mean temperature in 2020 and 2050 under the medium range emission scenario in Metro Manila

Season	Observ e d Baseline (1971-2000), °C	2020: Change in Mean Temperat ure (Projec te d Value) , °C	2050: Change in Mean Temperat ure (Projected Value), °C
DJF	26.1	27.1 (1.0)	28.1 (2.0)
MAM	28.8	29.9 (1.1)	30.9 (2.1)
JJA	28.0	28.9 (0.9)	29.8 (1.8)
SON	27.4	28.4 (1.0)	29.3 (1.9)

Source: PAGASA Climate Change Projections

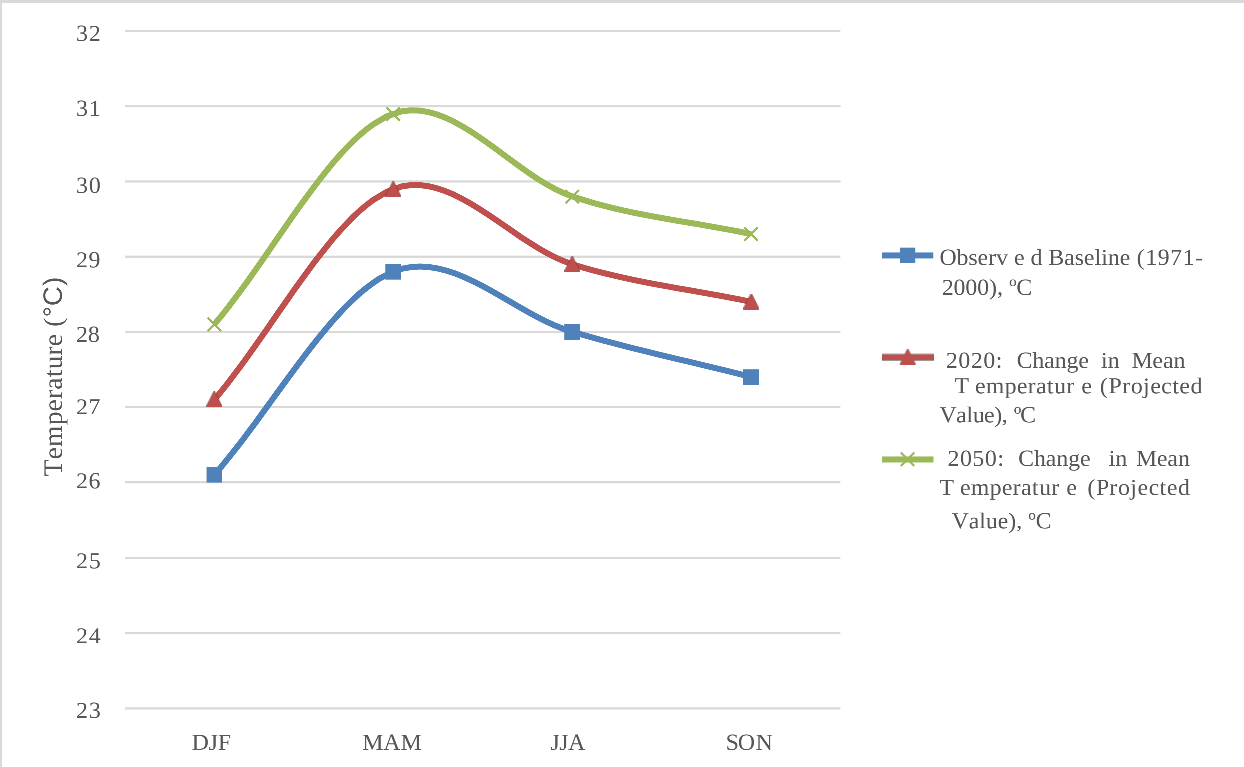


Figure 2.3-19. Project e d change in mean temperature in 2020 and 2050 under the medium range emission scenario in Metro Manila

2.3.1.3 Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement – Climate and Meteorology

The Project is in a highly urbanized area and is not expected to significantly affect the local microclimate. In addition, the Project will not likely increase the impacts of climate change in Metro Manila. However, climate change impacts, especially sea level rise and coastal storm surges, will cause problems to the MMSP. The specific details of the climate change impacts and options for prevention, mitigation, and/or enhancement activities are presented in **Table 2.3-11.**

Table 2.3-11. Potential impacts and options for prevent ion, mitigation, and/or enhancement – Climate and meteorology

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement Pre-construct ion
	Pre-construct ion	Const ruction	Pre-construct ion	Const ruction	
Change in local climate					
The Project will be constructed in a highly urbanized area. The project's above ground disturbance footprint is 120 hectares in high density built-up areas (**Table 2.1-1**) and is not expected to significantly affect the local climate.	✗	✓	✓	✗	Monitoring of any changes in local climate will still be performed, following the frequency of ambient air monitoring.
Climate change impact s					
Discussed in the ERA Section of this EPRMP					

(1) Potential Impacts

a. Change in local climate

The project is proposed to be constructed in Metro Manila, a highly urbanized city. Urbanization tremendously changes the landscape and produces changes in local weather. Albedo, defined as the amount of solar radiation reflected from the Earth's surface, is identified as the primary driver of changes in loc al temperature in highly urbanized areas (Blake, et al.). Land use change and vegetation removal trigger changes to local climate (Li, et al., 2015) affecting the natural albedo and evapotranspiration systems. The albedo in urban areas is significantly lower than natural surfaces due to the prevalence of dark asphalt roadways, rooftops, and urban canyon light trapping. Having lower albedo leads to efficient heat absorption (Blake, et al.).

The project's above ground disturbance footprint is 120 hectares in high density built-up areas (**Table 2.1-1**), much of which is currently urbanized, and is not expected to significantly affect the local climate.

(2) Options for Prevention, Mitigation, and/or Enhancement

a. Change in local climate

Although the Project is not expected to significantly affect the local microclimate, monitoring of any changes in local climate will still be performed, following the frequency of ambient air monitoring as discussed in **Section 2.3.3** of this EPRMP.

2.3.2 Greenhouse Gas Assessment

This section provides a quantitative estimate of the greenhouse gas (GHG) emissions that may be emitted by the MMSP. The projected contributions of the Project to Philippine and global emissions were identified in this assessment, including options for prevention, mitigation, and/or enhancement measures to reduce or offset GHG emissions.

The specific objectives of this assessment include:

- providing credible and unbiased computations of potential GHG emissions due to Project construction and operations;
- comparing project-related GHG emissions to global and Philippine emissions; and
- proposing options for prevention, mitigation, and/or enhancement measures to reduce or offset potential GHG emissions.

The Philippines is highly vulnerable to climate change impacts. Simultaneously, the country's climate, regional differences, land use patterns, population growth rate, poor economy, and political environment all serve to create a high demand of energy with associated GHG emissions.

Being a non-Annex I Country Party to the United Nations Framework Convention on Climate Change (UNFCCC), the Philippines, has no binding obligations to reduce or limit its anthropogenic GHG emissions. The Philippines is not required to report its GHG emissions to the UNFCCC secretariat but shall submit to the Conference of Parties (COP) its National Communications (The Philippines' Initial National Communication on Climate Change, 1999). With respect to global emissions, the Philippines is a minor emitter of greenhouse gases. In 2000, the Philippines emitted 21 million tonnes of carbon dioxide equivalent (CO_2-e) (Greenhouse Gas Inventory Data - Detailed data by Party, n.d.; Climate Change Commission, 2014), net of the amount of sequestered carbon and land use change that year. However, GHG emissions are rising from both energy use and land use changes.

The Philippines however, was one of the first countries to set up a national committee to discuss and develop positions on climate change prior to the establishment of the Intergovernmental Negotiating Committee. The UNFCCC, which was officially ratified in 1998, committed the Philippines to the provisions set for a non-Annex I Country Party. The Philippines has no binding obligations to reduce or limit its anthropogenic greenhouse gas emissions. However, as early as 1991, the country has already started its efforts to address the issue of climate change as clearly seen in its thrust to achieve sustainable development (**Table 2.3-12**). As required by decision 17/CP.8, Non-Annex I Country Parties to the UNFCCC shall provide a gas-by-gas basis and in units of mass, estimates of anthropogenic emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Table 2.3-12 lists the Philippines' GHG emission reduction strategies. The Philippines adopted a model mitigation plan patterned after previous commitments made by Annex I Country Parties for the first commitment period (2008 to 2012) of the Kyoto Protocol to the UNFCCC. The country has adopted a voluntary GHG emission reduction target of 5% by 2012 from the 1990 levels, utilizing similar mechanisms found under the Kyoto Protocol but adapted to the Philippine setting. For the second commitment period (2013 to 2020) of the Protocol, the Philippines did not commit to any GHG emission reduction target.

In October 2015, the Philippines communicated to the UNFCCC its *Intended Nationally Determined*

Contributions (INDC) (Climate Change Commission, 2015). Under this communication, the country stated its intentions of undertaking a 70% GHG emissions reduction by 2030 relative to its business -as-usual scenario of 2000 to 2030.

The project will potentially contribute greenhouse gas emissions mainly through the consumption of fossil fuel and electricity during its construction and operation phases. Therefore, as recommended by the Philippine EIS Technical Scoping Checklist, the Project's application for an ECC amendment will consider its GHG emissions. The GHG assessment was done as part of the specific requirements of the Technical Scoping Checklist for the Project and was prepared with reference to the requirements of the Principles of GHG Accounting and Reporting in the Greenhouse Gas Protocol (World Business Council for Sustainable Development and World Resources Institute, 2004) and ISO 14064.

Table 2.3-12. The Philippine s' GHG Emission Reduction Strategies

Strategy / Activity	Year of Implementation
Formulation of the Philippine Strategy for Sustainable Development (PSSD) and adoption of the Philippine Agenda 21	1991
Creation of the Inter-Agency Committee on Climate Change (IACCC)	1991
Enactment of the Clean Air Act of 1999 (R.A. 8749)	1999
Enactment of the Ecological Solid Waste Management Act of 2000 (R.A. 9003)	2000
Signing of the UNFCCC on June 1992 and ratification on 20 November 2003	2003
Designation of the Department of Environment and Natural Resources (DENR) as the National Authority for Clean Development Mechanism (CDM) by virtue of Executive Order No. 320	2004
Enactment of the Biofuels Act of 2006 (R.A. 9367)	2006
Enactment of Renewable Energy Act of 2008 (R.A. 9513)	2008
Enactment of the Climate Change Act of 2009 (R.A. 9729)	2009
Enactment of the National Disaster Risk Reduction and Management Law of 2010 (R.A. 10121)	2010
Signing of the National Framework Strategy on Climate Change (NFSCC)	2010
Signing of the National Climate Change Action Plan (NCCAP)	2011

Source: Environment and Climate Change Division, National Economic and Development Authority (NEDA) – Agriculture Staff

2.3.2.1 Methodology

(1) Secondary Data Sources

Table 2.3-13 summarizes the secondary data sources used in the GHG assessment.

Table 2.3-13. Source s of secondary information – Greenhouse Gas Assessment

Information / Data / Document Descript ion or Title	Author and Date Published / Generated
Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectors; Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change	(Intergovernmental Panel on Climate Change, 2014)
Climate Change 2014: Mitigation of Climate Change. Contribution of	(Intergovernmental Panel on Climate Change, 2014)

Information / Data / Document Description or Title	Author and Date Published / Generated
Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change	
Philippines. Second National Communication to the United Nations Framework Convention on Climate Change	(Climate Change Commission, 2014)
2006 IPCC Guidelines for National Greenhouse Gas Inventories	(Intergovernmental Panel on Climate Change, 2006)
The Principles of GHG Accounting and Reporting	(World Business Council for Sustainable Development and World Resources Institute, 2004)
ISO 14064-1:2006	(International Organization for Standardization, 2006)
ISO 14064-2:2006	(International Organization for Standardization, 2006)
Guidelines for Estimating Greenhouse Gas Emissions of Asian Development Bank Projects	(Asian Development Bank, 2017)

The GHG assessment for the project was prepared with reference to the requirements of the Principles of GHG Accounting and Reporting in the Greenhouse Gas Protocol (World Business Council for Sustainable Development and World Resources Institute, 2004) and ISO 14064:2006 Parts 1 and 2 (International Organization for Standardization, 2006).

The GHG calculations are aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Intergovernmental Panel on Climate Change, 2006) with reference GWPs referenced from the UNFCCC Fifth Assessment Report (AR5) (Intergovernmental Panel on Climate Change (IPCC), 2014). The calculated projected GHG emissions of the project were compared with the reported global GHG emissions in the UNFCCC AR5 and the Philippine GHG emissions in the Philippines Second National Communication to the UNFCCC (Climate Change Commission, 2014).

(2) Scope Definition

The Greenhouse Gas Protocol (World Business Council for Sustainable Development and World Resources Institute, 2004) defines the emission scopes for GHG accounting and reporting purposes to help delineate direct and indirect emission sources, improve transparency, and provide utility for difference types of organization and different types of climate policies and business goals. There are three emission scopes:

- **Scope 1: Direct GHG Emissions -** Emissions where the point of emission release is owned by the proponent, such as production of electricity, heat or steam; company owned vehicles used to transport materials, products, waste and employees; and fugitive emissions.
- **Scope 2: Indirect GHG Emissions -** Indirect emissions associated from the purchase/import of electricity, heat or steam which is consumed by the proponent.
- **Scope 3: Other Indirect GHG Emissions -** Indirect emissions that are a consequence of the activities of the proponent but occur from sources owned or controlled by another Company or known as “sub-contractors”. Examples of such are: employee business travel; transportation of products, materials, and waste; and employees commuting to and from work.

The purpose of differentiating between the scopes of emissions is to avoid the potential for double counting. Double counting occurs when two or more organizations assume responsibility for the same emissions. Reporting in line with the GHG Protocol requires that organizations report Scope 1 and Scope 2 emissions, but not Scope 3 emissions. Scope 3 emissions may be reported voluntarily.

(3) GHG Inventory Calculation Approach

The GHG calculations in this assessment are aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. There are three calculation methods: Tier 1, Tier 2, and Tier 3. The Tier 1 approach uses default emission factors. The Tier 2 approach uses country specific emission factors derived from national fuel characteristics. The Tier 3 approach considers the fuel type used, combustion technology, operating conditions, and control technology, quality of maintenance and equipment age.

Due to a lack of industry or specific emissions factors for the Philippines, the calculations in this assessment have adopted the Tier 1 methodology, which allows for the use of readily available national or international statistics in combination with the provided default emission factors and additional parameters. The calculations in this assessment use carbon dioxide equivalent (CO_2-e) as it is the universally accepted measure for calculating the global warming potential (GWP) of different greenhouse gases to derive a single greenhouse gas emissions unit. Carbon dioxide is used as the reference gas with a GWP of 1. The GWP of a greenhouse gas is the radiative forcing impact contributing to global warming relative to one unit of carbon dioxide.

The common GHGs together with their corresponding GWPs and Emission Factors are presented in **Table 2.3-14**. **Table 2.3-15** presents the formulas used to estimate the Project's greenhouse gas emissions.

Table 2.3-14. Glob l warming potential and emission factors of common GHGs[4]

Comm on name	Chemica l Formula	GWP* for 100-year time horizon	Emiss ion Factor** diesel (kg/TJ)
Carbon Dioxide	CO_2	1	74,100
Methane	CH_4	28	3
Nitrous Oxide	N_2O	265	0.6

Table 2.3-15. Calculation approach for GHG inventory

CO_2 from Road Transport and Tier 1 Emissions of CH_4 and N_2O

$$Emission = \sum_a [Fuel_a \times EF_a]$$

Where:

Emission	=	Emissions (kg)
$Fuel_a$	=	fuel sold (TJ)

[4] *Sources: *2014 Inter-governmental Panel on Climate Change (IPCC) Fifth Assessment Report*

***2006 Inter-governmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy*

Formula		
EF_a	=	emission factor (kg/TJ)
a	=	type of fuel (e.g. petrol, diesel, natural gas, LPG, etc.)
Source: ***Equation 3.2.1*** *and* ***Equation 3.2.3*** *of the 2006 IPCC Guidelines on National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 3: Mobile Combustion*		
Emissions from Purchase of Electric it y (Scope 2 Emissions)		
$$GHG\ Emissions = \frac{EC \times EF_{elec}}{(1 - \%L)}$$		
Where:		
GHG Emissions	=	Tons of CO_2-e
EC	=	Purchased Electricity (MWh)
EF_{elec}	=	Electricity Emission Factor (for Philippines, 0.592 tCO_2/MWh)
%L	=	Transmission and Distribution Losses
Source: ***Equation 3*** *of the Guidelines for Estimating Greenhouse Gas Emissions of Asian Development Bank Projects, Section II.E - Detailed General Equations for Calculating GHG Emissions*		

(4) Emission Profile

The Greenhouse Gas Protocol developed and promoted internationally accepted GHG accounting and reporting standards. In this assessment, the estimated GHG emissions include Scopes 1 and 2 emissions . Scope 1 emissions during the construction phase are from the consumption of fossil fuel from mobile sources. Scope 2 emissions include electricity purchased during the operations phase.

(5) Geographical Boundary

The geographical boundary set for the GHG assessment of the MMSP covers the emissions associated with the construction and operation of the following project components:

- Subway stations;
- Underground tunnel connections; and
- Other components (depots).

(6) Emission Scope Boundary

Boundaries for greenhouse gas emissions have been set with the aim of providing as complete an emissions inventory as possible where DOTr has operational control. Having operational control means that DOTr is responsible for the greenhouse gas emissions produced that they can introduce and implement operational, environmental, and safety policies.

All Scopes 1 and 2 emissions have been identified and reported as far as possible. Emission sources have been identified based on the size and scale of the project as defined in the Project Description chapter of this EPRMP and published reference documents. Sources included and excluded in the emissions inventor y are outlined below.

Inclusion:

- Fuel consumption for the construction phase of the project (Scope 1 emissions); and
- Purchase of electricity during the construction and operations phases (Scope 2 emissions).

Exclusions:

- Emissions from waste processing and landfill activities;
- Waste water treatment; and
- Scope 3 emissions.

Although some emissions will arise due to on-site waste management activities, these have not been considered in this report as they will be minimal. Upon the commencement of the project, this data will be collected, and emissions calculated as per the relevant national and international calculation methodologies.

(7) Temporal Scope Boundary

The temporal boundary is defined as the period of time that the project's GHG emissions will have an effect on the environment. It is assumed that the potential effect of GHG emissions from the project will be 50 to 200 years once GHGs are released into the atmosphere, corresponding to the maximum lifetime of CO_2 in the atmosphere (IPCC, 2001). The temporal boundary of the GHG assessment for the project will focus on the following time slices:

- Construction phase – 5 years; and
- Operations phase – 50 years.

The GHG calculations focus on the construction and operations phases as majority of the emissions will occur during these times. The emissions during the pre-construction, closure, and post-closure phases will be negligible in comparison.

(8) Assumptions and Limitations

The fuel consumption of the equipment and vehicle fleet estimates (**Annex 2.3-5**) were used to compute for the inventory of GHG emissions. The estimated rates of fuel consumption were based on a study on conceptual construction equipment utilization (ICTF JPA) and a comprehensive study of fuel consumption of non-road construction equipment (Frey, Rasdorf, & Lewis, 2010). The projected GHG emissions of the construction of the Project were calculated assuming that equipment is running at 24 hours a day and 365 days in a year.

Transmission and distribution losses for Scope 2 emissions calculations were assumed to be 20%.

2.3.2.2 Baseline Environment

(1) Summary of Findings

Table 2.3-16. Key findings and conclusions – Greenhouse gas assessment

Baseline Informa tion	Key Findings and Conclus ion
Global Greenhouse Gas Profile	Total anthropogenic GHG emissions have continued to increase over 1970 to 2010 with larger absolute decadal increases toward the end of this period. CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% of the total GHG emission increase from 1970 to 2010, with a similar percentage contribution for the period 2000-201 0. About half of cumulative anthropogenic CO_2 emissions between 1750 and 2010 have occurred in the last 40 years. Annual anthropogenic GHG emissions have increased by 10,000 million tonnes of CO_2-e between 2000 and 2010, with this increase directly coming from energy supply (47%), industry (30%), transport (11%), and buildings (3%) sectors. Accounting for indirect emissions raises the contributions of the buildings and industry sectors. Globally, economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. The contribution of population growth between 2000 and 2010 remained roughly identical to the previous three decades, while the contribution of economic growth has risen sharply. The IPCC Fifth Assessment Report (AR5) estimated that the worldwide anthropogenic greenhouse gas emissions totaled nearly 49 billion tonnes of CO_2-e in 2010.
Philippine Greenhouse Gas Profile	An inventory of GHG emissions conducted in 2000 showed that the Philippines emitted approximately 21.767 million tonnes of CO_2 -e (including LULUCF[5]). The Philippine GHG emissions in the year 2000 due to fuel consumption was estimated to be at 69.67 million tonnes of CO_2 –e (excluding LULUCF[6])

(2) Global Greenhouse Gas Profile

International anthropogenic GHG emissions can provide an idea of the global context to compare the Project's GHG emissions to. Based on the IPCC 5th Assessment Report, the total anthropogenic greenhouse gas (GHG) emissions have continued to increase over 1970 to 2010 with larger absolute decadal increases toward the end of the period. Despite a growing number of climate change mitigation policies, the annual GHG emissions increased on average by 1 billion tonnes of CO_2-e (2.2%) annually from 2000 to 2010 compared to 0.5 billion tonnes of CO_2-e (1.3 %) per year from 1970 to 2000 (**Figure 2.3-20**).

Carbon dioxide emissions from fossil fuel combustion and industrial processes contributed approximately 78% of the total GHG emission increase from 1970 to 2010, having similar percentage contribution for the period of 2000-2010. Fossil-fuel related CO_2 emissions reached approximately 32 (±2.7) billion tonnes of CO_2-e in 2010, and further increased by approximately 3% between 2010 and 2011, and by about 1% to

[5] *Land Use, Land Use Change, and Forestry- is the subset of Agriculture, Forestry and Other Land Use (AFOLU) emissions and removals of GHGs related to direct human-induced land use, land-use change and forestry activities excluding agricultural emissions and removals*

2% between 2011 and 2012. Of the 49 (±4.5) billion tonnes of CO_2-e per year in total anthropogenic GHG emissions in 2010, CO_2 remains the major anthropogenic GHG accounting for 76% (38±3.8 billion tonnes of CO_2-e per year). Methane (CH_4) accounts for 16% (7.8±1.6 billion tonnes of CO_2-e per year), 6.2% (3.1 ± 1.9 billion tonnes of CO_2-e per year) from nitrous oxides (N_2O), and 2.0% (1.0 ± 0.2 billion tonnes of CO_2-e per year) from fluorinated gases (**Figure 2.3-20**). Annually, since 1970, approximately 25% of anthropogenic GHG emissions have been in the form of non-CO_2 gases (Intergovernmental Panel on Climate Change, 2014).

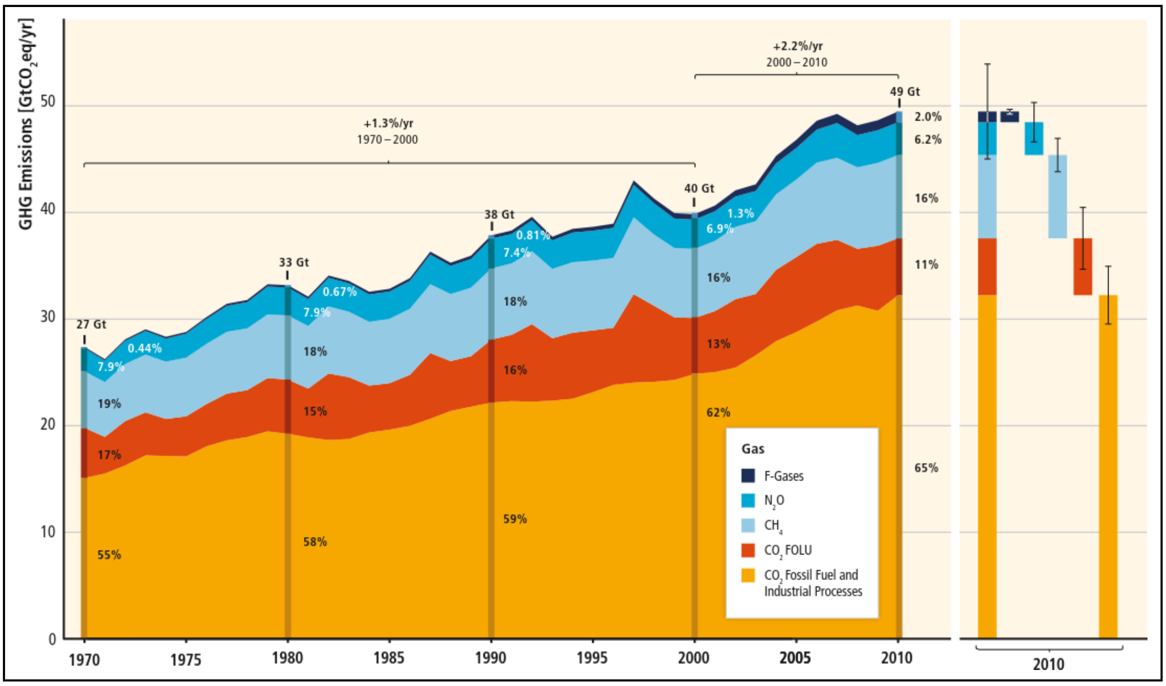


Figure 2.3-20. Total annual anthropogenic GHG emissions (billion tonnes of CO_2-e per year) by groups of gases from 1970 to 2010 (from IPCC Fifth Assessment Report (Intergovernmental Panel on Climate Change , 2014))

Approximately 50% of the cumulative CO_2 emissions between 1750 and 2010 have occurred in the last 40 years. In 1970, the cumulative CO_2 emissions from fossil fuel combustion, cement production, and flaring since 1750 were 420±35 billion tonnes of CO_2. In 2010, that cumulative total had tripled to 1,300±110 billion tonnes of CO_2. Cumulative CO_2 emissions from Agriculture, Forestry, and Other Land Use (AFOLU) since 1750 increased from 490±180 billion tonnes of CO_2 in 1970 to 680±300 billion tonnes of CO_2 in 2010.

The annual anthropogenic GHG emissions have increased by 10 billion tonnes of CO_2-e between 2000 and 2010, with the increase directly coming from the energy supply (47%), industry (30%), transport (11%), and buildings (3%) sectors. Accounting for indirect emissions raises the contributions of the buildings and industry sectors. Since 2000, GHG emissions have been growing in all sectors, apart from AFOLU. Of the 29 (±4.5) billion tonnes of CO_2-e emissions in 2010, 35% (17 billion tonnes of CO_2-e) of GHG emissions were released in the energy supply sector, 24% (12 billion tonnes of CO_2-e net emissions) in AFOLU, 21% (10 billion tonnes of CO_2-e) in industry, 14% (7.0 billion tonnes of CO_2-e) in transport, and 6.4% (3.2 billion tonnes of CO_2-e) in buildings. Emissions from electricity and heat production are attributed t o the sectors that utilize the final energy, the shares of the industry and buildings sectors in global GHG emissions are increased to 31% and 19%, respectively (**Table 2.3-17** and **Figure 2.3-21**).

The projected Project-related GHG emissions will be compared to the total global GHG emissions as well as the emissions of the Transport sector. Annex II.9.1 of the IPCC Fifth Assessment Report (AR5) (Intergovernmental Panel on Climate Change, 2014) clearly maps the emission sources to their respective sectors throughout the WGIII AR5. The Transport sector primarily involves fossil fuels burned for aviation, road, rail, marine transportation, and non-road vehicles. The IPCC Fifth Assessment Report (AR5) estimated that the worldwide anthropogenic greenhouse gas emissions totaled nearly 49 billion tonnes of CO_2-e in 2010 (Intergovernmental Panel on Climate Change, 2014).

Table 2.3-17. Summa ry of anthropogenic GHG emission shares of five economic sectors in 2010

Category	Greenho us e Gas Emissio ns (in Gt CO_2-e)	Direct GHG Emiss ion Shares (%)
Electricity and Heat Product ion	12.25	25.00
AFOLU	11.76	24.00
Buildings	3.136	6.40
Trans port	6.86	14.00
Industry	10.29	21.00
Other Energy	4.7	9.6
Total	*49.00*	*100.00*

** Note: Agriculture, Forestry, and Other Land Use*

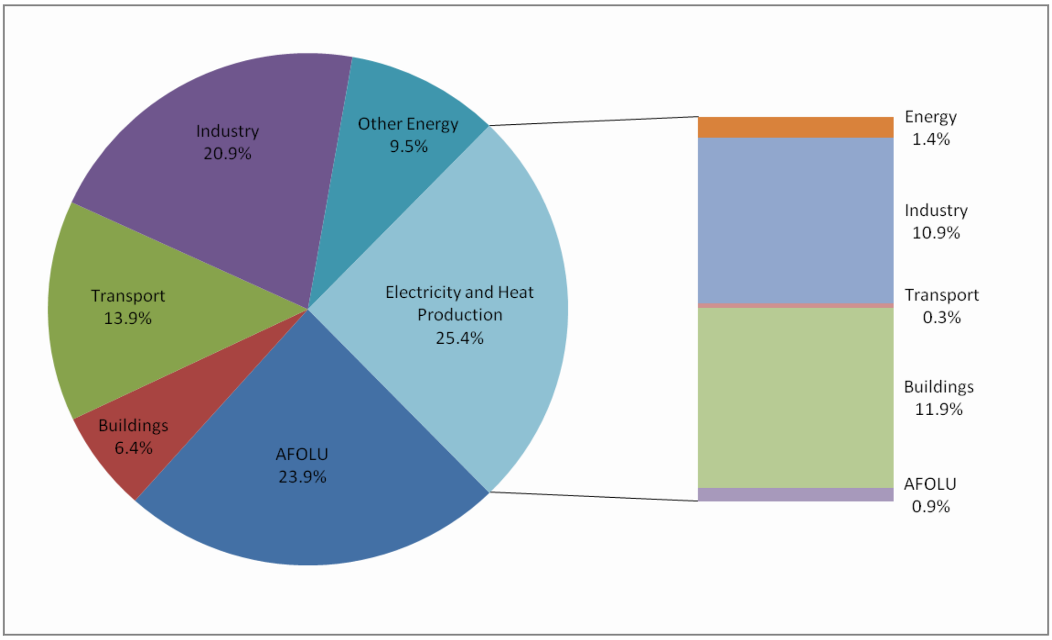


Figure 2.3-21. Total anthropogenic GHG emissions (billion tonnes of CO_2-e per year) by economic sectors in 2010[6] (from *IPCC Fifth Assessment Report* (Intergovernmental Panel on Climate Change , 2014))

[6] *Main circle shows direct GHG emission shares (in% of total anthropogenic GHG emissions) of five economic sectors in 2010. Pull-out bar shows how indirect CO_2 emission shares (in % of total anthropogenic GHG emissions) from electricity and heat production.*

(3) Philippine Greenhouse Gas Profile

a. Total Philippine GHG Emissions

In 2000, the Philippines emitted 21.76734 million tonnes of CO_2-e due to the combined effect of GHG emissions from the four sectors of Energy, Industry, Agriculture, and Wastes, and the net uptake (sink) of GHGs from the Land Use, Land Use Change and Forestry (LULUCF) sector.

Without the contribution of the LULUCF sector, the national GHG total amounts to 126.87871 million tonnes of CO_2-e (Philippines. Second National Communication to the United Nations Framework Convention on Climate Change, 2014). Of the four non-LULUCF sectors responsible for the Philippines' GHG sources, the Energy sector is the most significant, accounting for approximately 55% of the national total. This is followed by the Agricultural sector's contribution of approximately 29%. The Wastes and Industrial Processes sectors follow with respective contributions of 9% and 7% of the total (**Table 2. 3- 18** and **Figure 2.3-22**).

In contrast with these four sectors which act as GHG sources, carbon sequestration associated with LULUCF in the Philippines contributed approximately 105.11 million tonnes of CO_2-e to GHG sequestration (sink) **(Table 2.3-19** and **Figure 2.3-23).**

The Project's greenhouse gas emissions will be compared to the total Philippine emissions and the energy sector.

Table 2.3-18. GHG Emissions from the four non-LULU CF sectors of Energy, Industry, Agriculture, and Wastes in the year 2000[7]

Sector	Greenhouse Gas Emissions (in tonnes of CO_2-e)	Direct GHG Emission Shares (%)
Energy	69,667,240	54.91
Industrial Processes	8,609,780	6.79
Agriculture	37,002,690	29.16
Wastes	11,599,000	9.14
Total	*126,878,710*	*100.00*

Source: United Nations Framework Convention on Climate Change (UNFCCC) (Greenhouse Gas Inventory Data - Detailed data by Party, n.d.) *and* (Philippines. Second National Communication to the United Nations Framework Convention on Climate Change, 2014)

Table 2.3-19. Net GHG emissions in the Philippine s including the LULUC F sector (in tonnes of CO_2-e)[8]

Category	1994	2000
Energy	50,040,330	69,667,240
Industrial Processes	10,602,930	8,609,780
Agriculture	33,128,670	37,002,690
Land Use, Land Use Change, and Forestry (LULUCF)	-126,490	-105,111,37 0
Wastes	7,094,780	11,599,000
Total	*100,740,220*	*21,767,340*

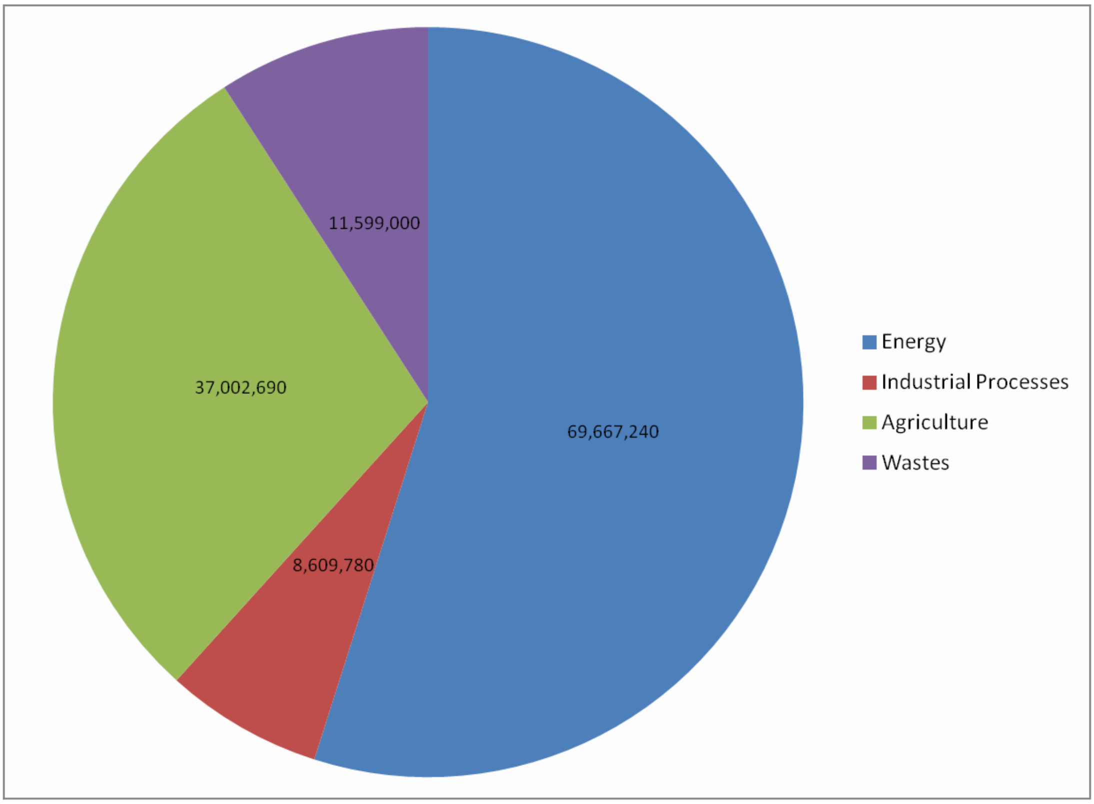


Figure 2.3-22. Overall GHG emissions contribution by non-LUL UCF sectors in 2000 (in tonne s of CO2-e)

[7] *Source: United Nations Framework Convention on Climate Change (UNFCCC)* (Greenhouse Gas Inventory Data - Detailed data by Party, n.d.) *and* (Philippines. Second National Communication to the United Nations Framework Convention on Climate Change, 2014)

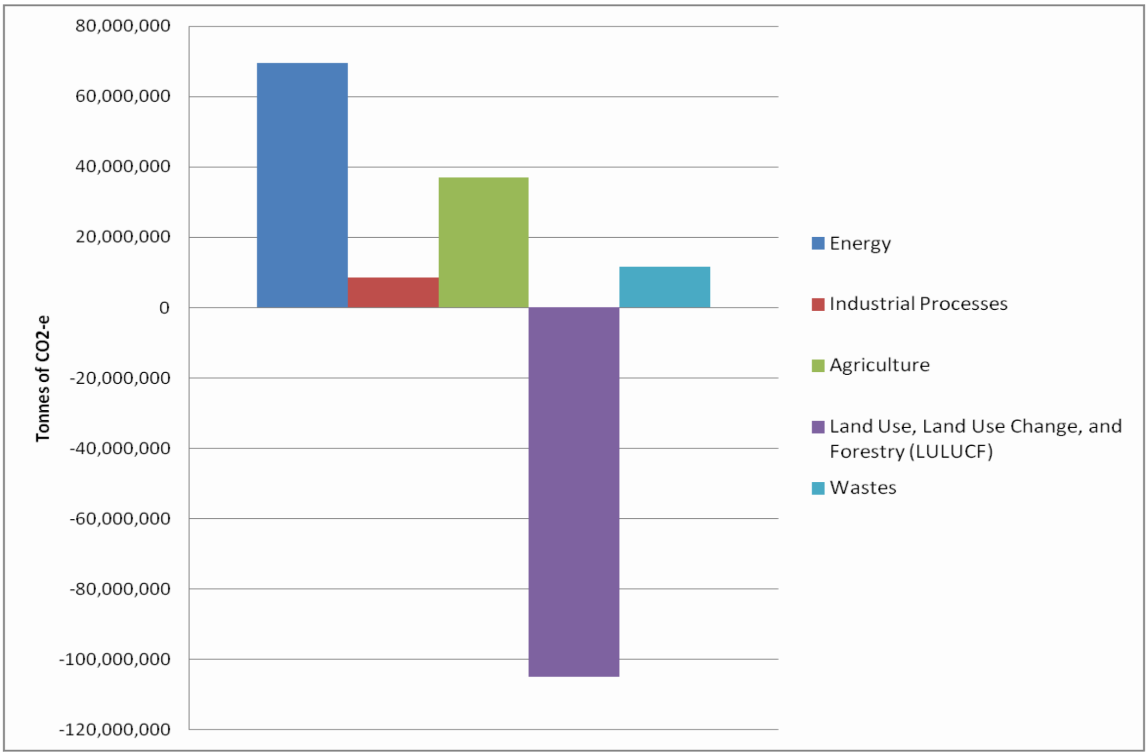


Figure 2.3-23. The Philippine forests are a significant carbon sink. In 2000, approximately 105,111,370 tonnes of CO_2-e were sequestered by the LULUCF sector

b. Philippine GHG Emissions from the Energy Sector

The energy sector in 2000 released approximately 69,667,240 tonnes of CO_2-e (Philippines. Second National Communication to the United Nations Framework Convention on Climate Change, 2014) (**Table 2.3-20**). The transport sub-sector contributed the highest GHG emissions share with 37.23% of the total energy sector (25,935,780 tonnes of CO_2-e). This was followed by the energy industries with 30.46% (21,219,450 tonnes of CO_2-e) while the rest of the sub-sectors combined to approximately 32.31% of the total GHG shares (22,512,010 tonnes of CO_2-e) to the Philippine energy sector (**Figure 2.3-24**).

Table 2.3-20. Philippine GHG emissions from the Energy Sector in the year 20009

Sub-Se ct or	Greenhouse Gas Emissions (in Tonnes of CO_2-e)	GHG Emission Shares to Energy Sector Emissions (%)
Energy Industries	21,219,450	30.46
Manufacturing Industries & Construction	9,142,210	13.12
Transport	25,935,780	37.23
Other Sectors	9,839,910	14.12
Solid Fuels	33,600	0.05
Oil & Natural Gas	3,496,290	5.02
Total	*69,667,240*	*100*

[8] *Source: Philippines. Second National Communication to the United Nations Framework Convention on Climate Change (2014)*

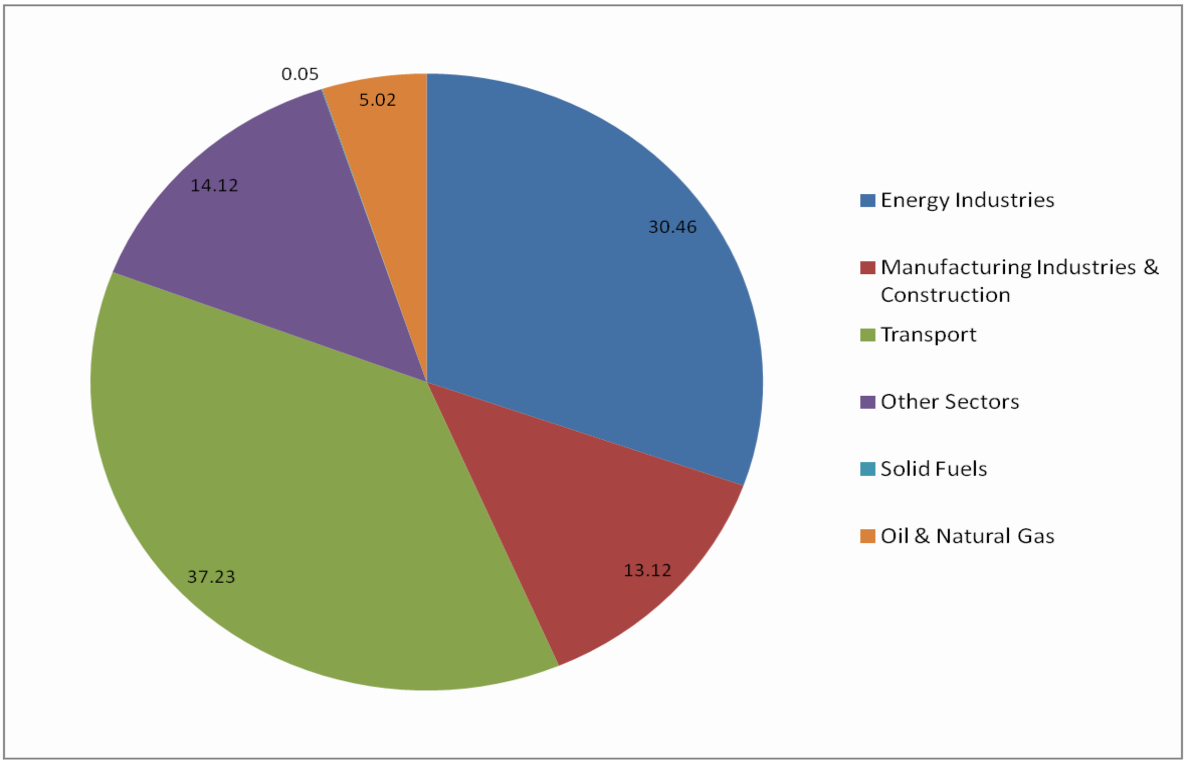


Figure 2.3-24. Percent contribution of the different sub-sectors to the total Philippine energy sector GHG emissions in 2000

2.3.2.3 Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement – Greenhouse gas assessment

Table 2.3-21. Potential impacts and options for prevent ion, mitigation, and/or enhancement – Greenhouse gas assessment

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement Pre-construct ion
	Pre-construct ion	Const ruction	Pre-construct ion	Const ruction	
Contributions in terms of greenhouse gas (GHG) emissions					
Scopes 1 and 2 Emissions					
• Carbon dioxide (CO_2) accounts to the highest GHG emission share (9,352.79 tonnes of CO_2-e per year) among the three common GHGs associated with the combustion of fossil fuel during the construction phase. This is followed by nitrous oxide (N_2O) and methane (CH_4) with GHG emission shares of 20.07 tonnes of CO_2-e and 10.60 tonnes of CO_2-e per year, respectively.	✗	✓	✓	✗	• consideration of fuel and equipment efficiency prior to construction and operation activities; • maximising fuel efficiency through scheduling of vehicle and equipment movement to minimise both idle time and distances travelled; • optimization of equipment and vehicle loadings through accurate monitoring and calculation of fuel and electricity requirements to reduce fuel weight and improve fuel efficiency; • regular maintenance of vehicles and construction equipment will be done to increase efficiency,

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement Pre-construct ion
	Pre-construct ion	Const ruction	Pre-construct ion	Const ruction	
• Scope 1 emissions (direct GHG emissions) total 9,383.46 tonnes of CO_2-e per year due to the combustion of fossil fuel. Scope 2 emissions (indirect GHG emissions) total 14,497.89 tonnes of CO_2-e from the purchase of electricity. For the operations phase, the total annual GHG emissions are 109,021.00 tonnes of CO_2-e per year.					reduce fuel and electricity use, and help reduce costs associated with equipment downtime; • close monitoring of equipment dispatches to eliminate unnecessary use and to increase efficiency of use; • Compensate the release of GHG during construction and operation by means of implementing carbon dioxide capture and sequestration through progressive rehabilitation (within or outside the project site). This will be undertaken as soon as areas for rehabilitation become available. Rehabilitation areas will at least be equivalent to the areas cleared of vegetation through the established National Greening Program, and/or the carbon sequestration program as discussed in **Section 2.1.4** of this EPRMP; and • Monitoring of carbon release by following the frequency of ambient air monitoring as discussed in **Section 2.3.3** of this EPRMP.

(1) Potential Impacts

Table 2.3-22 shows the annual GHG emissions of the project during the construction and operations phases. By gas, carbon dioxide (CO_2) accounts to the highest GHG emission share (9,352.79 tonnes of CO_2-e per year) among the three common GHGs associated with the combustion of fossil fuel during the construction phase. This is followed by nitrous oxide (N_2O) and methane (CH_4) with GHG emission shares of 20.07 tonnes of CO_2-e and 10.60 tonnes of CO_2-e per year, respectively. Scope 1 emissions (direct GHG emissions) total 9,383.46 tonnes of CO_2-e per year due to the combustion of fossil fuel. Scope 2 emissions (indirect GHG emissions) total 14,497.89 tonnes of CO_2-e from the purchase of electricity. For the operations phase, the total annual GHG emissions are 109,021.00 tonnes of CO_2-e per year.

Table 2.3-22. Annual GHG emissions of the Project – by gas and Scope, construction and operations phases

	CO_2 Emissions (Tonnes of CO_2-e/Year)	CH_4 Emissions (Tonnes of CO_2-e/Year)	N_2O Emissions (Tonnes of CO_2-e/Year)	Total Annual Cumulative GHG Emissions (Tonnes of CO_2-e)
Const ruc t ion Phase				
Scope 1 Emissions	9,352.79	10.60	20.07	9,383.46
Scope 2 Emissions	14,497.89			14,497.89
Opera tio ns Phase				
Scope 1 Emissions	-	-	-	-
Scope 2 Emissions	109,021.00	-	-	109,021.00

Table 2.3-23 presents the GHG emissions by sector. The project is expected to contribute approximately 0.092% to the Philippine Transport Sector and 0.00035% to the Global Transport Sector during the construction phase. For the operations phase, the project is expected to contribute approximately 0.42% to the Philippine Transport Sector and 0.0016% to the Global Transport Sector.

Data on aggregated GHGs for the Philippines and globally show that the project is expected to contribute approximately 0.11% to the total annual Philippine GHG emissions and 0.00005% to the total annual global GHG emissions during the project's construction phase (**Table 2.3-24**). For the operations phase, the Project is expected to contribute approximately 0.5% to the total annual Philippine GHG emissions and 0.0002% to the total annual global GHG emissions.

Table 2.3-23. Annual GHG emissions of the Project – by sector, construction and operations phases

Sectors	Annual GHG Emissions (Tonnes of CO_2-e)	Percentage (%)
Percentage of Annual Emissions to Philippine Trans port Sector (%)[10]		
Construction Phase	23,881.35	0.09208
Operations Phase	109,021.00	0.42035
Percentage of Annual Emissions to Global Trans port Sector (%)[11]		
Construction Phase	23,881.35	0.00035
Operations Phase	109,021.00	0.00159

[10] Excluding LULUCF
[11] Including AFOLU

Table 2.3-24. Annual GHG emissions of the Project vs. aggregated GHGs, construct ion and operations phases

Sectors	Annual GHG Emissions (Tonnes of CO_2-e)	Percentage (%)
Percentage of Annual Emissions to Total Annual Philippine Emissions (%) [10]		
Construction Phase	23,881.35	0.10971
Operations Phase	109,021.00	0.50085
Percentage of Annual Emissions to Total Annual Global Emissions (%) [11]		
Construction Phase	23,881.35	0.00005
Operations Phase	109,021.00	0.00022

(2) Options for Prevention, Mitigation, and/or Enhancement

Greenhouse gas emissions for the project are predominantly from the combustion of fossil fuel and the purchase of electricity during the project's construction and operations Phases. Minimizing fuel and electricity consumption is an economic as well as an environmental driver for the project, and a number of good practice measures to achieve this are already accounted for from which the emissions calculations are derived. These measures include:

- consideration of fuel and equipment efficiency prior to construction and operation activities;
- maximising fuel efficiency through scheduling of vehicle and equipment movement to minimise both idle time and distances travelled;
- optimization of equipment and vehicle loadings through accurate monitoring and calculation of fuel and electricity requirements to reduce fuel weight and improve fuel efficiency;
- regular maintenance of vehicles and construction equipment will be done to increase efficiency, reduce fuel and electricity use, and help reduce costs associated with equipment downtime;
- close monitoring of equipment dispatches to eliminate unnecessary use and to increase efficiency of use;
- Compensate the release of GHG during construction and operation by means of implementing carbon dioxide capture and sequestration through progressive rehabilitation (within or outside the project site). This will be undertaken as soon as areas for rehabilitation become available. Rehabilitation areas will at least be equivalent to the areas cleared of vegetation as required by the National Greening Program, and/or the carbon sequestration program as discussed in Section 2.1.4 of this EPRMP; and
- Monitoring of carbon release by following the frequency of ambient air monitoring as discussed in Section 2.3.3 of this EPRMP.

In addition to these measures, DOTr will continually seek opportunities to reduce further GHG emissions by the project.

2.3.3 Ambient Air Quality

This section presents the results of the ambient air quality assessment for the project. The results were compared to the National Ambient Air Quality Guideline Values (NAAQGV) and National Ambient Air Quality Standards (NAAQS) to analyze project compliance to emission guideline values and limitations. The specific objectives of the assessment are to:

- identify and assess the air quality in the project site;
- set the baseline ambient air quality for future monitoring;
- address all impacts and other relevant issues of the Project; and
- propose options for prevention, mitigation, and/or enhancement measures to reduce the impact of the Project to the air quality in the area.

The ambient air quality assessment was performed at 14 locations along the alignment in 2017 and three stations in 2019. The assessment was done as part of the requirements of the Technical Scoping Checklist for the project's application of an environmental compliance certificate (ECC) amendment.

The ambient air quality impact assessment focuses on the construction phase as majority of the emissions will occur during this time. The pollutant emissions during the pre-construction, operations, closure, and post-closure phases are negligible in comparison.

2.3.3.1 Methodology

(1) Study Area

The project site is in Metro Manila, a highly urbanized non-attainment area. Metro Manila is located in the Metro Manila Airshed as stated in DAO 2007-07.

(2) Secondary Data Sources

Table 2.3-25 presents the sources of secondary information for the ambient air quality impact assessment.

Table 2.3-25. Source s of secondary information

Information / Data / Document Descript ion or Title	Author and Date Published / Generated
Environmental Impact Statement (EIS) for Metro Manila Subway Project (MMSP) (Phase 1)	Delta Tierra Consultants, Inc. (2017)
Republic Act 8749 (Philippine Clean Air Act of 1999)	(Philippine Clean Air Act of 1999)
DENR Administration Order No. 2000-81 (Implementing Rules and Regulations of the Philippine Clean Air Act)	(Implementing Rules and Regulations of the Philippine Clean Air Act of 1999)

a. Desktop review of relevant air quality criteria

Legislation relevant to the project relating to ambient air quality are included. For this assessment, the following Philippine legislations were considered:

- Republic Act 8749, otherwise known as the "*Philippine Clean Air Act of 1999*"; and
- DENR Administrative Order 2000-81, Implementing Rules and Regulations of the Philippine Clean Air Act of 1999.

The Philippine 1987 Constitution declares that:

"It is the policy of the State to protect and advance the right of the people to a balanced and healthful ecology in accord with the rhythm and harmony of nature."

Republic Act 8749 recognizes and outlines these principles and sets out national ambient air quality guidelines for criteria pollutants and national ambient air quality standards for source-specific air pollutants from industrial sources/operations. These guidelines and standards were adopted as criteria for this assessment.

Pursuant to the provisions of Section 51 of RA8749, the Department of Environment and Natural Resources (DENR) adopted and promulgated DAO No. 2000-81, otherwise known as the *Implementing Rules and Regulations for RA No. 8749*. The purpose of which is to provide guidelines on the operationalization of RA 8749 and lays down the functions and powers of the DENR and other concerned agencies.

b. Baseline information data

The accuracy and usefulness of the baseline and monitoring data obtained were carefully evaluated and verified before adopting their use in the report. The references for baseline information and monitoring results are as follows:

- Environmental Impact Statement (EIS) for Metro Manila Subway Project (MMSP) (Phase 1) by Delta Tierra Consultants, Inc.
    - The EIS was submitted to the DENR-EMB in 2017 for an application of ECC for the Project
    - The 2017 baseline data were used to supplement the primary baseline data collected on June 20 to 23, 2019.

(3) Field Surveys and Sampling Areas

The characterization of baseline ambient air quality was done by conducting air quality sampling of ambient air quality pollutants described in **Section 2.3.3.2**. The sampling was conducted in 17 pre-established monitoring stations along the MMSP alignment on March to July 2017 and on June 2019. The details of the sampling activity are presented in **Table 2.3-26**. The locations of the sampling stations are presented in **Table 2.3-27**, **Plate 2-15** to **Plate 2-17**, and **Table 2.3-27**.

Table 2.3-26. Summary of field surveys and sampling activities – Ambient Air Quality

Field Activity	Date Conducted	Map Reference
Ambient air quality and noise sampling	20 to 23 June 2019	**Figure 2.3-25**
Ambient air quality and noise sampling (wet season 2017)	10 to 15 July 2017 17 to 19 July 2017 26 to 27 July 2017	
Ambient air quality and noise sampling (dry season 2017)	27 to 31 March 2017 3 to 5 April 2017 3 to 5 May 2017	

Table 2.3-27. Ambient air quality and noise monitoring stations

Station ID	Location	Coordina te s [12]
A1	Depot (Barangay Ugong, Valenzuela)	14° 43' 10.82" N 121° 0' 46.83" E
A2	Pacific Global Medical Center, Quirino Highway	14° 41' 16.33" N 121° 1' 47.42" E
A3	Landcom Village II, Barangay Tandang Sora, Quezon City	14° 40' 44.85" N 121° 1' 56.11" E
A4	Avida Towers, EDSA Quezon Avenue	14° 38' 47.63" N 121° 2' 10.96" E
A5	World Citi Medical Center, Anonas, Quezon City	14° 37' 39.33" N 121° 3' 47.83" E
A6	Trinoma Open Parking Lot, North Avenue, Quezon City	14° 39' 0.95" N 121° 2' 3.04" E
A7	Estancia Mall, Capitol Commons, Meralco Avenue corner Shaw Boulevard	14° 34' 33.29" N 121° 3' 49.19" E
A8	AFP Medical Center, V. Luna St.	14° 38' 10.02" N 121° 3' 14.42" E
A9	MMDA Impounding Area, Meralco Avenue corner Julia Vargas	14° 34' 59.25" N 121° 3' 51.58" E
A10	Blue Ridge A Multipurpose Hall, Katipunan Avenue	14° 37' 22.40" N 121° 4' 30.45" E
A11	Market! Market!, Bonifacio Global City, Taguig	14° 32' 51.21" N 121° 3' 16.04" E
A12	BCDA Field Office, Cayetano Boulevard	14° 31' 40.8" N 121° 3' 28.36" E
A13	FTI PNR Station	14° 30' 24.84" N

[12] Based on WGS 84 Datum

Station ID	Location	Coordinates [12]
		121° 2' 7.21" E
A14	11th St. Corner 38th St., Bonifacio Global City, Taguig	14° 33' 30.9" N 121° 3' 21.8" E
AN1	Sitio Fort Bonifacio Health Center (Near National Nutrition Council)	14° 31' 46.390" N 121° 1' 28.470" E
AN2	Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City	14° 31' 18.420" N 121° 0' 56.880" E
AN3	Dr. Arcadio Santos National Highschool, Barangay San Martin De Porres, Paranaque City	14° 29' 40.050" N 121° 2' 34.630" E

Plate 2-1 Location of Station A1 – Depot (Barangay Ugong, Valenzuela)

Plate 2-2 Location of Station A2 – Pacific Global Medical Center, Quirino Highwa y

Plate 2-3 Location of Station A3 – Land com Village II, Barangay Tandang Sora, Quezon City

Plate 2-4 Location of Station A4 – Avida Towers, EDSA Corner Quezon Avenue

Plate 2-5 Location of Station A5 – World Citi Medical Center, Anonas, Quezon City

Plate 2-6 Location of Station A6 – Trinoma Open Parking Lot, North Avenue , Quezon City

Plate 2-7 Location of Station A7 – Estancia Mall, Capitol Commons, Meralco Avenue corner Shaw Boulevard

Plate 2-8 Location of Station A8 – AFP Medical Center, V. Luna St.

Plate 2-9 Location of Station A9 – MMDA Impounding Area, Meralco Avenue Corner Julia Vargas

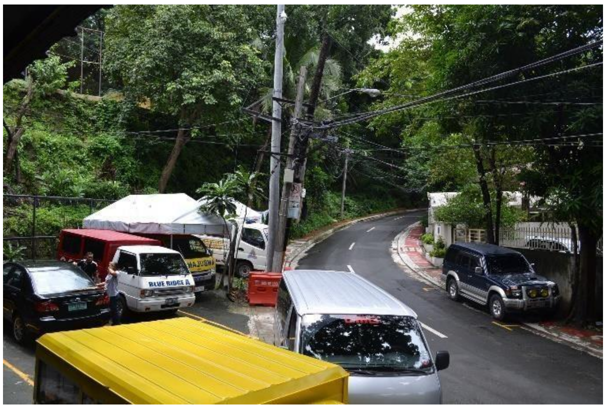


Plate 2-10 Location of Station A10 – Blue Ridge A Multipurpose Hall, Katipunan Avenue

Plate 2-11 Location of Station A11 – Market! Market!, Bonifacio Global City, Taguig City

Plate 2-12 Location of Station A12 – BCDA Field Office, Cayetano Boulevard

Plate 2-13 Location of Station A13 – FTI PNR Station

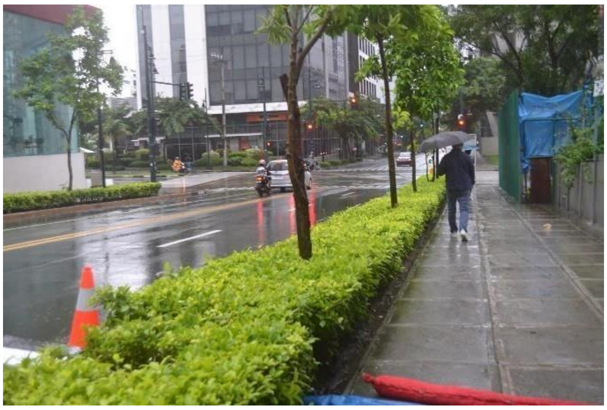


Plate 2-14 Location of Station A14 – 11th St. Corner 38th St., Bonifacio Global City, Taguig

Plate 2-15. Station AN1 – Sitio Fort Bonifacio Health Center (Near the National Nutrition Council)

Plate 2-16. Station AN2 – Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City

Plate 2-17. Station AN3 – Dr. Arcadio Santos National Highschool, Barangay San Martin de Porres, Paranaque City

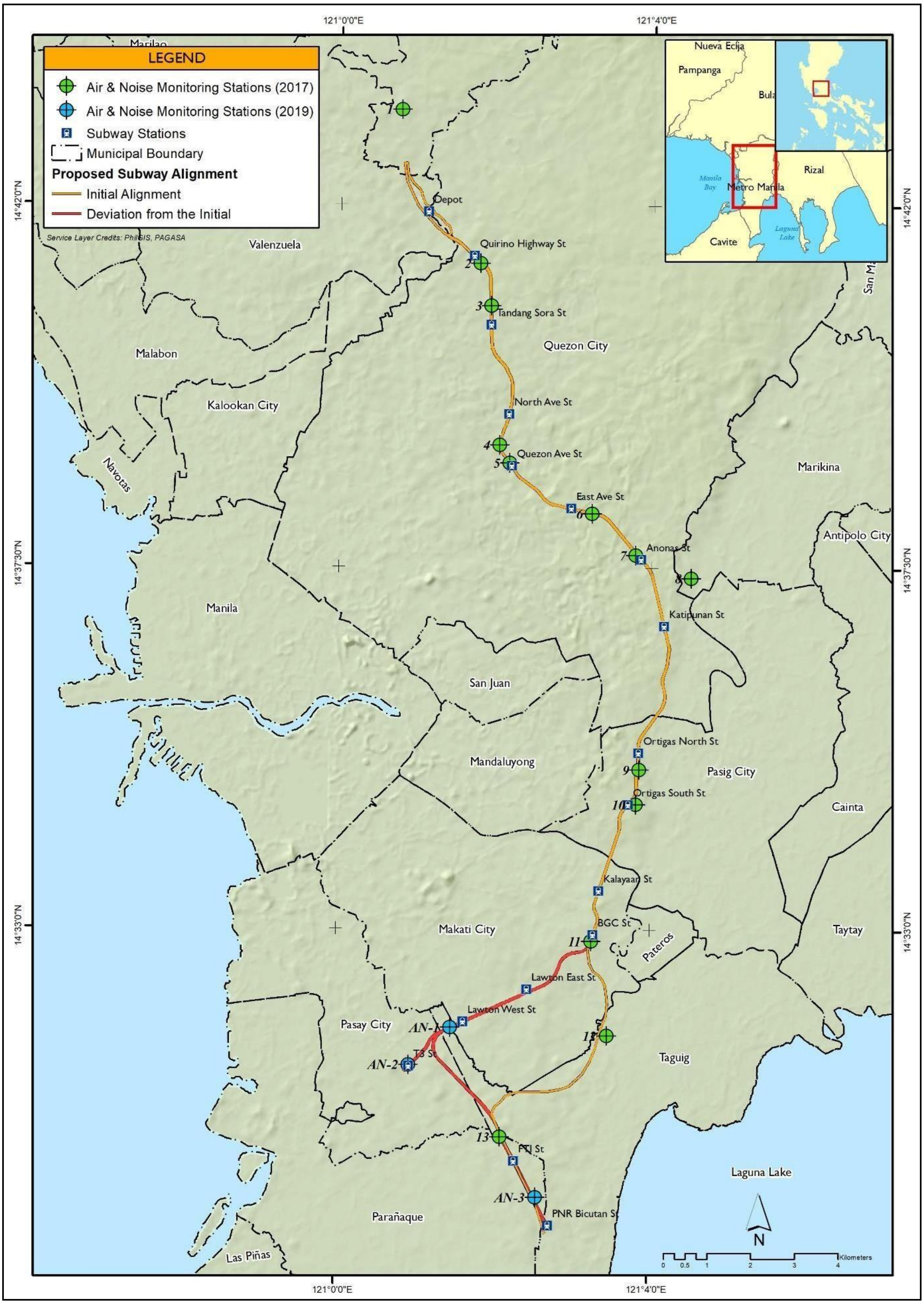


Figure 2.3-25. Location of air quality and noise sampling stations

(4) Sampling Methodology

The ambient air quality sampling was performed with reference to the ambient air sampling protocols and analytical procedures specified in DAO 2000-81 (*Implementing Rules and Regulations (IRR) of the Philippine Clean Air Act of 1999*). The ambient air quality parameters and their corresponding methods of sampling and analyses are summarized in **Table 2.3-28**.

Table 2.3-28. Ambient air quality parameters and methods of sampling analysis

Paramet e rs	Averaging Time	Air Sampling and Analytical Procedures	Source s
TSP	24 hours / 1 hour	High Volume - Gravimetric	USEPA 40 CFR Part 50, App B
PM_{10}	24 hours / 1 hour	High Volume with PM_{10} Inlet - Gravimetric	USEPA 40 CFR Part 50, App J
SO_2	24 hours / 1 hour	Gas Bubbler – Colorimetric Pararosaniline	USEPA 40 CFR Part 50, App A
NO_2	24 hours / 1 hour	Gas Bubbler – Griess-Saltzman	USEPA 40 CFR Part 50, App F

Source: DAO 2000-81. Implementing Rules and Regulations of RA 8749 (Philippine Clean Air Act of 1999)

a. Particulate Matter

Measurement of particulate matter (TSP and PM_{10}) in the air is likely the oldest form of air quality sampling (Wight, 1994). High-volume samplers and PM_{10} samplers all employ filtration sampling and require f low monitoring and sampler air volume measurement. The basic applications of filtration method to particulate air sampling are discussedbelow.

Total Suspended Particulates

Total suspended particulates were collected from the air using a high-volume sampler. The "high-vol" sampler, which utilizes a high flow rate vacuum pump driven by an electric motor, draws a large, accurately known volume of air over a known time through a glass -filter paper (Wight, 1994). The mass of the collected particulates was determined by the difference in filter weights prior to and after sampling. The concentration of TSP is calculated by dividing the weight gain of the glass-filter paper by the volume of air sampled (Robson & Foster, 1962; Olin & Kurz, 1975).

Figure 2.3-26 presents a flow diagram of the routine operating procedure of particulate matter sampling. The glass-filter papers used in the collection were pre-assigned with specific ID numbers, dried for 48 hours, and pre-weighed prior to the sampling activity. The filters were separately placed between two clean lint - free papers and stored in manila envelopes to minimize contamination. During field sampling, the filters were secured and installed in the high-volume sampler and the flow rate was adjusted to 1.10 m^3/min. Sampling conditions such as the sampling date, elapsed time, initial flow rate, atmospheric pressure, meteorological conditions, relative humidity, and ambient temperature were also noted. After sampling, the filters which contained the samples were retrieved, folded lengthwise with the exposed side inward, and were inserted in their respective containers.

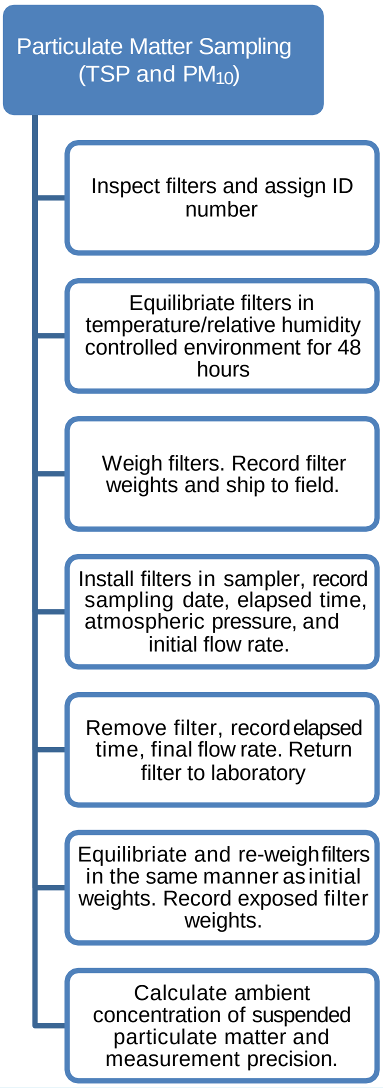


Figure 2.3-26 Routine diagram for particulate matter sampling

Coarse Particulates

Coarse particles, or particulate matter with <10 µm (PM_{10}) in aerodynamic diameter were collected using a *Staplex* PM_{10} sampler. The PM_{10} sampler functions basically the same fashion as high-volume samplers and requires the same or more care in flow rate and volume measurement but modified to remove the lar ger particles before the air reaches the filter through variously designed impaction or settling chamber inlets (Wight, 1994). Sampling protocols, including handling procedures and QA/QC protocols are the same with TSP sampling. The samples were shipped to a DENR accredited laboratory for analyses.

b. Gaseous Pollutants

Gas-liquid absorption is the technique used for nearly all gaseous pollutant (SO_2 and NO_2) sampling (Wight, 1994). Absorption of air pollutants in a liquid and later analysis is still the reference method approved by DENR for NO_2 and SO_2. Using a *Kimoto Handy Gas Sampler*, air was continuously impinged and bubbled into absorbing solutions inside midget impinger tubes with frits.

Nitrogen dioxide (NO_2) is absorbed in azo dye forming reagent (Saltzman, 1954) while Sulfur dioxide (SO_2) is absorbed in a solution of 0.7 M potassium tetra chloromercurate (TCM) (Dasgupta & DeCesare, 1982). The impingers containing the azo dye forming reagent and 0.7 M TCM were partially submerged in an improvised ice bath to maintain good absorption and prevent the solutions from degrading.

The gas sampler flow rate was adjusted to 0.4 L/min for NO_2 and SO_2. After sampling, the absorbing solutions were carefully transferred to their containers and stored in ice coolers for preservation. Samples were sent to the laboratory for analysis. The absorbance of the samples was measured and compared with standard absorbance curves of NO_2 and SO_2. Concentrations of NO_2 and SO_2 were determined by taking the ratio of the total mass analyzed to the total volume of air sampled.

c. Lead

Lead (Pb) particulates are collected on a TSP filter as described in US EPA CFR 40 Part 50, Appendix B. Sampling protocols, including handling procedures and QA/QC protocols are the same with TSP and PM_{10} sampling. The US EPA CFR 40 Part 50, Appendix G describes the procedures for analyzing Pb from TSP filters.

(5) Comparison to Relevant Regulatory Standards

The results of the ambient air quality sampling were compared to the DAO 2000-81 guidelines and standards. The NAAQS of the DAO 2000-81 was the basis of comparison of the one-hour averaged ambient air quality monitoring results. The NAAQS is intended for the protection of public health, safety and general welfare which must be complied throughout the project lifetime. The 24-hour averaged monitoring results were compared to the DAO 2000-81 NAAQGV. The NAAQGV are typically used during the baseline studies to assess the air quality of an airshed or a region/locale prior to the implementation of the project. The existing ambient air quality conditions in the area were classified using the DAO 2000-81 Air Quality Indices (AQI) (Annex A of the DAO 2000-81) (**Table 2.3-29**).

Table 2.3-29. Air quality indices

Type / Classification	TSP, µg/NCM (24-hour average)	PM_{10}, µg/NCM (24-hour average)	SO_2, ppm[13] (24-hour average)	NO_2, ppm[13] (one-hour average)
Good	0 to 80	0 to 54	0.00 to 0.034 (0 to 88.8)	[14]
Fair	81 to 230	55 to 154	0.35 to 0.144 (91.4 to 376.2)	[14]
Unhealthy for sensitive groups	231 to 349	155 to 254	0.145 to 0.244 (378.8 to 627.4)	[14]
Very unhealthy	350 to 599	255 to 354	0.255 to 0.304 (587.8 to 794.2)	[14]
Acutely unhealthy	600 to 899	355 to 424	0.305 to 0.604 (796.8 to 1,577.9)	0.65 to 1.24 (1,220.5 to 2,328.3)
Emergency	900 and above	425 to 504	0.605 to 0.804 (1580.5 to 2,100.3)	1.25 to 1.64 (2,347.0 to 3,079.3)

Source: Annex A of the DAO 2000-81

2.3.3.2 Baseline Environment

The project's EIS 2017 was considered in this assessment to establish the baseline ambient air quality along the Project's alignment. **Table 2.3-31** and **Table 2.3-32** summarizes the results of the ambient air quality monitoring conducted in 2017 and 2019. The laboratory certificates of analysis are attached as **Annex 2.3-6**. The monitoring involved collection of TSP, SO_2, NO_2, Sb, and O_3 samples. The data collected were considered as the baseline data for the project. Detailed discussions of the monitoring results are presented in the subsequent sections.

The requirements of the technical scoping checklist for the project's application for an ECC amendment details specific parameters for the characterization of ambient air quality. A gap analysis was performed, and ambient air quality was monitored in additional stations to supplement the project's 2017 baseline data. The monitoring of additional stations involved the collection of one-hour and 24-hour averaged TSP, PM_{10}, SO_2, and NO_2 concentrations along the new alignment of MMSP.

[13] Values in parenthesis are expressed in units of µg/NCM, conversion factor for SO_2: 1 ppm = 2,612.4 µg/NCM, for NO_2: 1 ppm = 1,877.6 µg/NCM; DAO 2000-81
[14] No prescribed index

(1) Summary of Findings

Table 2.3-30. Key findings and conclusion – Ambient air quality

Baseline Inform at ion	Key Findings and Conclusions
Particulate Pollutants	• The 24-hour ambient air quality monitoring along the MMSP's alignment ranges from 57.5 µg/NCM (Station A1) to 204.3 µg/NCM (Station A13) during the dry season, and 51 µg/NCM (Station A14) to 521 µg/NCM (Station A1). All ambient air quality monitoring stations are within their DAO 2000-81 NAAQGV (230 µg/NCM) except for Stations A1 (521 µg/NCM), A2 (248 µg/NCM) and A10 (265 µg/NCM). Based on Annex A of DAO 2000-81. The ambient air quality along the Project's alignment in terms of TSP is 'good' to 'acutely unhealthy.' • The 1-hour TSP in the three stations were 25 µg/NCM, 31 µg/NCM, and 32 µg/NCM, respectively. All monitoring stations are within the DAO 2000-81 NAAQS (300 µg/NCM). • PM_{10} concentrations ranged from 37.2 µg/NCM (Station A6) to 81.4 µg/NCM (Station A13) during the dry season and 25.2 µg/NCM (Station A14) to 209 µg/NCM (Station A1) during the wet season in the stations along the MMSP. All ambient air quality monitoring stations are within their DAO 2000-81 NAAQGV (150 µg/NCM) except for Stations A1 (209 µg/NCM), A2 (191 µg/NCM), and A12 (193 µg/NCM). Based on Annex A of the DAO 2000-81, the ambient air quality in the stations along the MMSP alignment in terms of PM_{10} is 'good' to 'unhealthy to sensitive groups.' • The 1-hour PM_{10} concentrations in Stations AN1, AN2, and AN3 where 19 µg/NCM, 21 µg/NCM, and 25 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (200 µg/NCM).
Gaseous Pollutants	• The 24-hour NO_2 concentrations in all monitoring stations ranged from 15.7 µg/NCM (Station A1) to 37.3 µg/NCM (Station A11) during the dry season and 4.5 µg/NCM (Station A3) to 86 µg/NCM (Station A10) during the wet season. All stations were within the DAO 2000-81 NAAQGV (150 µg/NCM). • The1-hour NO_2 concentrations in Stations AN1, AN2, and AN3 were 17 µg/NCM, 64 µg/NCM, and 20 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (260 µg/NCM). Annex A of DAO 2000-81 has no prescribed index for NO_2 concentrations below 1,220.5 µg/NCM. • The concentrations of 24-hour SO_2 ranged from below detection limit (<4 µg/NCM) (Stations A9 and A13) to 5.3 µg/NCM (Station A1) during the dry season and below detection limit (<4 µg/NCM) (Stations A2, A3, A4, A5, A7, A9, A11, AN1, and AN2) to 17.1 µg/NCM (Station A1) during the wet season. All stations are within the DAO 2000-81 NAAQGV (180 µg/NCM). Based on Annex A of the DAO 2000-81, the ambient air quality in the monitoring stations along the MMSP alignment is 'good.' • The 1-hour SO_2 concentrations were 16 µg/NCM, 20 µg/NCM, and 23 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (340 µg/NCM).
Lead and Ozone	• Lead (Pb) and Ozone (O_3) were monitored for the dry season in 2017 in Stations A1, A5, A6, A9, A11, and A13. The concentrations of Pb and O_3 were undetected in all monitoring stations and below the DAO 2000-81 NAAQGV for Pb (1.5 µg/NCM) and O_3 (140 µg/NCM)

Baseline Inform at ion	Key Findings and Conclus ions
Existing Sources of Pollutants	❑ TSP and PM_{10} are generated when fossil fuel is consumed by vehicles. In addition, fugitive emissions of these particulate pollutants are released into the environment through wheel entrained dusts from roads. Dust kicked up by vehicles traveling on roads may make up 33% of air pollution. Road dust consists of deposits of vehicle exhausts and industrial exhausts, particles from tire and brake wear, dust from paved roads or potholes, and dust from construction sites. Road dust is a significant source contributing to the generation and release of particulate matter into the atmosphere. Control of road dust is a significant challenge in urban areas, and in other locations with high levels of vehicular traffic upon unsealed roads, such as mines and landfill dumps. ❑ SO_2 and NO_2 are generated from the combustion of fossil fuel by vehicles.

Table 2.3-31. 24-hour ambient air quality sampling results (2017 and 2019)

Station ID	Location	Dry Season						Wet Season			
		TSP	PM_{10}	Pb	NO_2	SO_2	O_3	TSP	PM_{10}	NO_2	SO_2
		µg/NCM						µg/NCM			
A1	Depot (Barangay Ugong, Valenzuela)	57.5	44.2	ND	15.7	5.3	ND	521	209	26.8	17.1
A2	Pacific Global Medical Center, Quirino Highway							248	191	20.8	ND
A3	Landcom Village II, Barangay Tandang Sora, Quezon City							85.9	41.3	4.5	ND
A4	Avida Towers, EDSA Quezon Avenue							94.9	78.7	8.2	ND
A5	World Citi Medical Center, Anonas, Quezon City	93.6	57.1	ND	28.3	2	ND	72.7	29.1	17.9	ND
A6	Trinoma Open Parking Lot, North Avenue, Quezon City	103.1	37.2	ND	31.9	3.5	ND	66	47.2	6.7	1.8
A7	Estancia Mall, Capitol Commons, Meralco Avenue corner Shaw Boulevard							60	34	10.3	ND
A8	AFP Medical Center, V. Luna St.							67.4	40.2	5	0.9
A9	MMDA Impounding Area, Meralco Avenue corner Julia Vargas	159.7	77.4	ND	28.3	ND	ND	60	34	10.3	ND
A10	Blue Ridge A Multipurpose Hall, Katipunan Avenue							265	86.3	86	1.4
A11	Market! Market!, Bonifacio Global City, Taguig	112.5	54.7	ND	37.3	1.6	ND	110.4	193	21	ND
A12	BCDA Field Office, Cayetano Boulevard							74.6	71.5	14.6	1.7
A13	FTI PNR Station	204.3	81.4	ND	37.2	ND	ND	209.7	34.8	27.3	2
A14	11th St. Corner 38th St., Bonifacio Global City, Taguig							51	25.2	9.8	1.4
AN1	Sitio Fort Bonifacio Health Center (Near National Nutrition Council)							58	47	6.1	ND
AN2	Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City							52	45	9.1	ND
AN3	Dr. Arcadio Santos National Highschool, Barangay San Martin De Porres, Paranaque City							54	47	10	3
NAAQGV		**230**	**150**	**1.5**	**150**	**180**	**140**	**230**	**150**	**150**	**180**

Values in red indicate exceedance to the NAAQGV

Table 2.3-32. 1-hour ambient air quality sampling result s (2019)

Station ID	Location	TSP	PM_{10}	NO_2	SO_2
AN1	Sitio Fort Bonifacio Health Center (Near National Nutrition Council)	25	19	17	16
AN2	Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City	31	21	64	20
AN3	Dr. Arcadio Santos National Highschool, Barangay San Martin De Porres, Paranaqu e City	32	25	20	23
NAAQS		**300**	**200**	**260**	**340**

(2) Particulate Pollutants

a. Total Suspended Particulates

Total suspended particulates (TSP) represent a complex mixture of organic and inorganic substances (European Environment Agency, 2016), covering a wide range of diameters, from<0.1 µm to 100 µm. The mass and composition of TSP is divided into two principal groups: Coarse Particulates (>2.5 µm in aerodynamic diameter) and Fine Particulates (<2.5 µm in aerodynamic diameter). Fine particles contain secondarily formed aerosols (gas to particle conversion), combustion particles, and re-condensed organic and metal vapors, while the larger particles usually contain crystal materials and fugitive dusts from roads and industries. The major sources of TSP are industrial processes, road traffic, domestic burning, incineration, resuspension of road and construction dust, and emissions from power plants. TSP is removed from the atmosphere by wet and dry deposition.

The results of the monitoring (**Table 2.3-31** and **Figure 2.3-27**) show that the 24-hour ambient air quality monitoring along the MMSP's alignment ranges from 57.5 µg/NCM (Station A1) to 204.3 µg/NCM (Station A13) during the dry season, and 51 µg/NCM (Station A14) to 521 µg/NCM (Station A1). All ambient air quality monitoring stations are within their DAO 2000-81 NAAQGV (230 µg/NCM) except for Stations A1 (521 µg/NCM), A2 (248 µg/NCM) and A10 (265 µg/NCM).

High concentrations of TSP (and PM_{10}) concentrations in Station A1 and Station A2 is attributed to the proximity of the sampling stations to Mindanao Avenue, a major thoroughfare with heavy traffic. The monitoring station for Station A1 during the dry season is located inside a resort compound located approximately 200 m from Mindanao Avenue. During the wet season, the station was relocated directly along Mindanao Avenue for security purposes. In Station A10, the relatively high TSP concentrations are attributed to construction activities adjacent to the site at the time of sampling.

Based on Annex A of DAO 2000-81 (**Table 2.3-29**), the ambient air quality along the Project's alignment in terms of TSP is 'good' to 'acutelyunhealthy.'

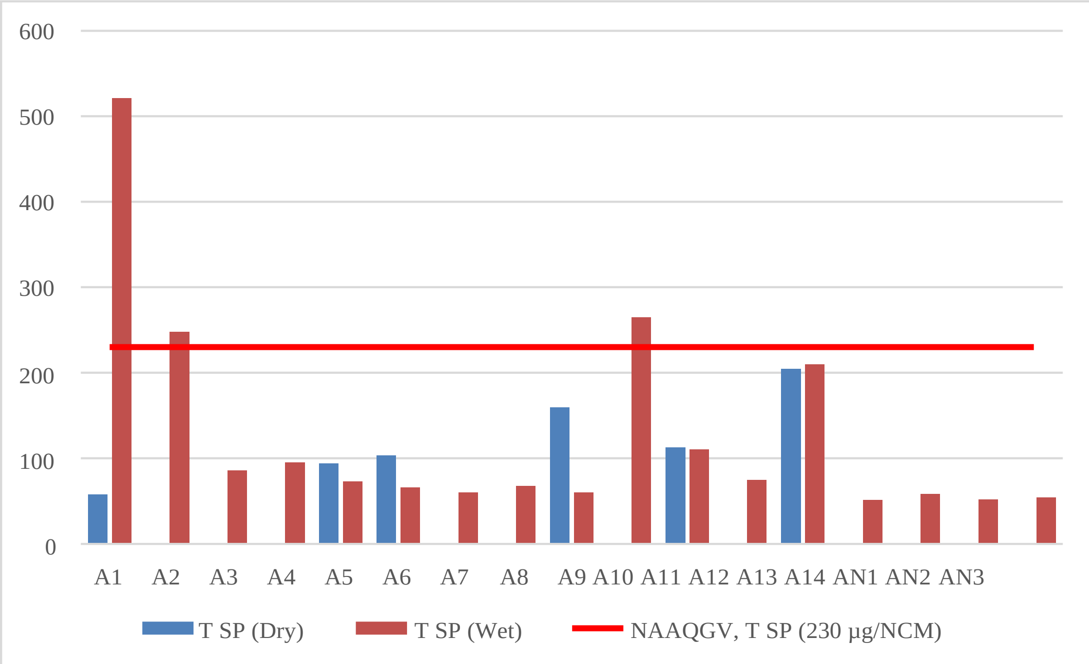


Figure 2.3-27. 24-hour total suspended particulates (TSP) monitoring results , 2017 and 2019

Table 2.3-32 and **Figure 2.3-28** presents the results of the 1-hour ambient air quality monitoring results in stations AN1, AN2, and AN3. The 1-hour TSP in the three stations were 25 µg/NCM, 31 µg/NCM, and 32 µg/NCM, respectively. All monitoring stations are within the DAO 2000-81 NAAQS (300 µg/NCM).

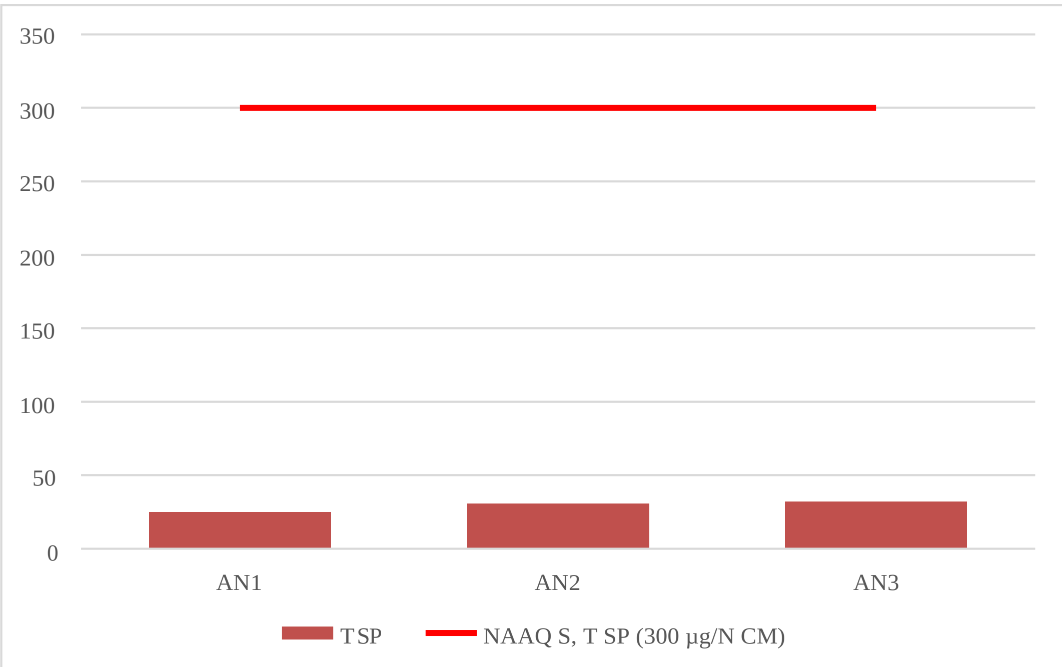


Figure 2.3-28. 1-hour total suspended particulates (TSP) monitoring result s, 2019

b. Coarse Particulates

Coarse particulates (PM_{10}) or respirable suspended particulates in the atmosphere come from a variety of emission sources. In Metro Manila, the majority of PM_{10} emissions are generated through the combustion of fossil fuel such as diesel and gasoline. In addition, wind erosion and wheel entrained dust likewise contribute to PM_{10} emissions. Oxidation of gaseous pollutants in the air (e.g. sulfate formed from the oxidation of SO_2) and photochemical reactions are also likely sources of PM_{10}. It can enter deep into human lungs which detrimentally impact on the human respiratory system. Furthermore, finer particles in PM_{10} have significant effect on visibility.

The results of the 24-hour PM_{10} monitoring ranged from 37.2 µg/NCM (Station A6) to 81.4 µg/NCM (Station A13) during the dry season and 25.2 µg/NCM (Station A14) to 209 µg/NCM (Station A1) during the wet season (**Table 2.3-31** and **Figure 2.3-29**) in the stations along the MMSP. All ambient air quality monitoring stations are within their DAO 2000-81 NAAQGV (150 µg/NCM) except for Stations A1 (209 µg/NCM), A2 (191 µg/NCM), and A12 (193 µg/NCM).

The high concentration of PM_{10} in Station A11 during the wet season can be attributed to high wind velocities at the time of sampling. High wind velocities result to turbulence. This has the potential to scour dust and other particles from the ground and suspended them in air. The smaller particles can get effectively transported over long distances.

Based on Annex A of the DAO 2000-81 (**Table 2.3-29**), the ambient air quality in the stations along the MMSP alignment in terms of PM_{10} is ‘good’ to ‘unhealthy to sensitive groups.’

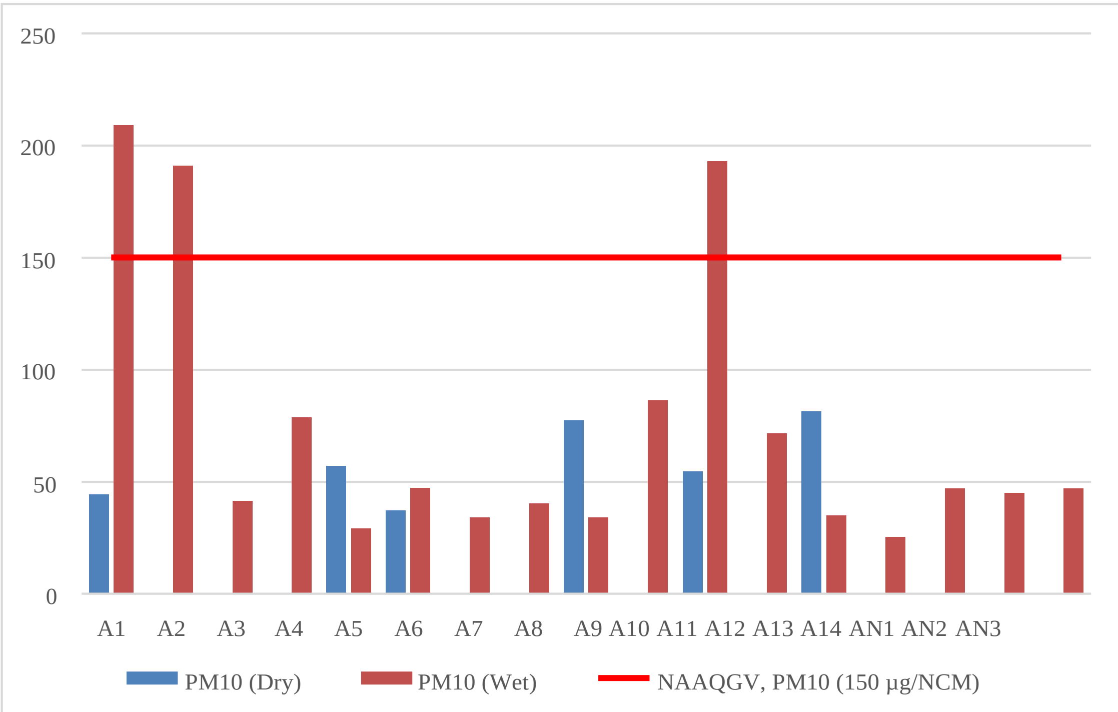


Figure 2.3-29. 24-hour PM10 monitoring results, 2017 and 2019

The 1-hour PM_{10} concentrations in Stations AN1, AN2, and AN3 where 19 µg/NCM, 21 µg/NCM, and 25 µg/NCM, respectively (**Table 2.3-32** and **Figure 2.3-30**). All stations are within the DAO 2000-81 NAAQS (200 µg/NCM).

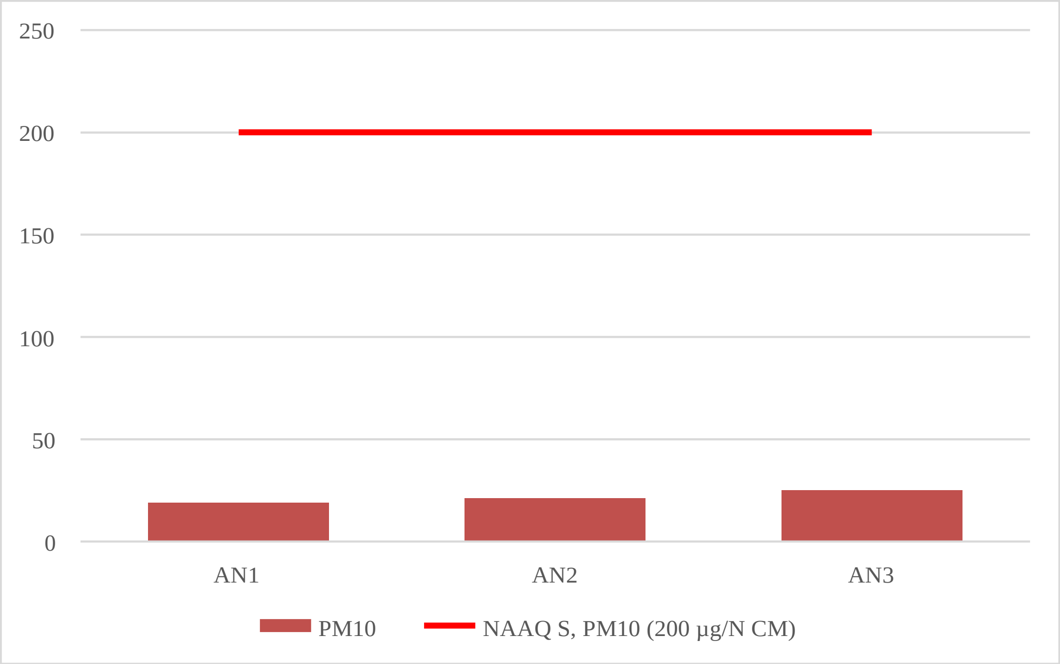


Figure 2.3-30. 1-hour PM10 monitoring result s, 2019

(3) Gaseous Pollutants

a. Nitrogen Dioxide

Nitrogen dioxide (NO_2) is mainly formed from oxidation of nitric oxide (NO) emitted in the process of combustion. Apart from its impacts to the human respiratory system, NO_2 can also be oxidized in the air to form nitrate, which has significant impact on the levels of particulate matter, acid rain, and visibility.

The 24-hour NO_2 concentrations in all monitoring stations ranged from 15.7 µg/NCM (Station A1) to 37.3 µg/NCM (Station A11) during the dry season and 4.5 µg/NCM (Station A3) to 86 µg/NCM (Station A10) during the wet season (**Table 2.3-31** and **Figure 2.3-31**). All stations were within the DAO 2000-81 NAAQGV (150 µg/NCM).

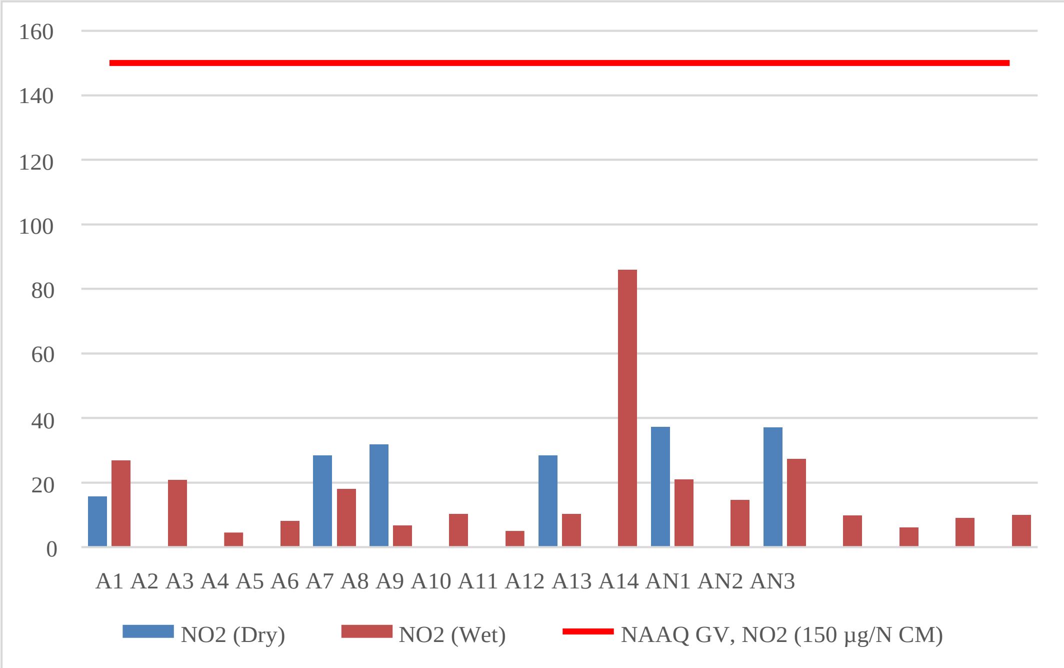


Figure 2.3-31. 24-hour NO2 monitoring result s, 2017 and 2019

The1-hour NO_2 monitoring results are presented in **Table 2.3-32** and **Figure 2.3-32**. The NO_2 concentrations in Stations AN1, AN2, and AN3 were 17 µg/NCM, 64 µg/NCM, and 20 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (260 µg/NCM). Annex A of DAO 2000-81 (**Table 2.3-29**) has no prescribed index for NO_2 concentrations below 1,220.5 µg/NCM.

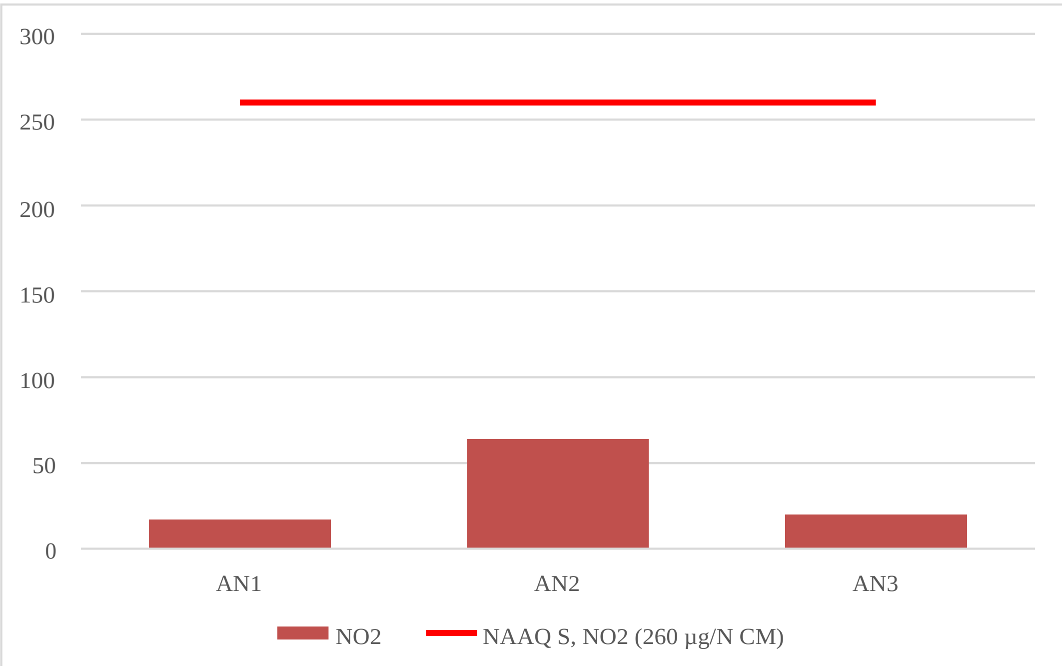


Figure 2.3-32. 1-hour NO2 monitoring results, 2019

b. Sulfur Dioxide

Sulfur dioxide (SO_2) is generated mainly from the combustion of sulfur-containing fossil fuel. Apart from its impact on the human respiratory system, SO_2 can also oxidize in the air to form sulfate, which has a significant impact on the concentrations of particulate matter (TSP and PM_{10}), acid rain, and visibility in the area.

Table 2.3-31 and **Figure 2.3-33** present the results of the 24-hour SO_2 monitoring. The concentrations of SO_2 ranged from below detection limit (<4 µg/NCM) (Stations A9 and A13) to 5.3 µg/NCM (Station A1) during the dry season and below detection limit (<4 µg/NCM) (Stations A2, A3, A4, A5, A7, A9, A11, AN1, and AN2) to 17.1 µg/NCM (Station A1) during the wet season. All stations are within the DAO 2000 - 81 NAAQGV (180 µg/NCM). Based on Annex A of the DAO 2000-81 (**Table 2.3-29**), the ambient air quality in the monitoring stations along the MMSP alignment is 'good.'

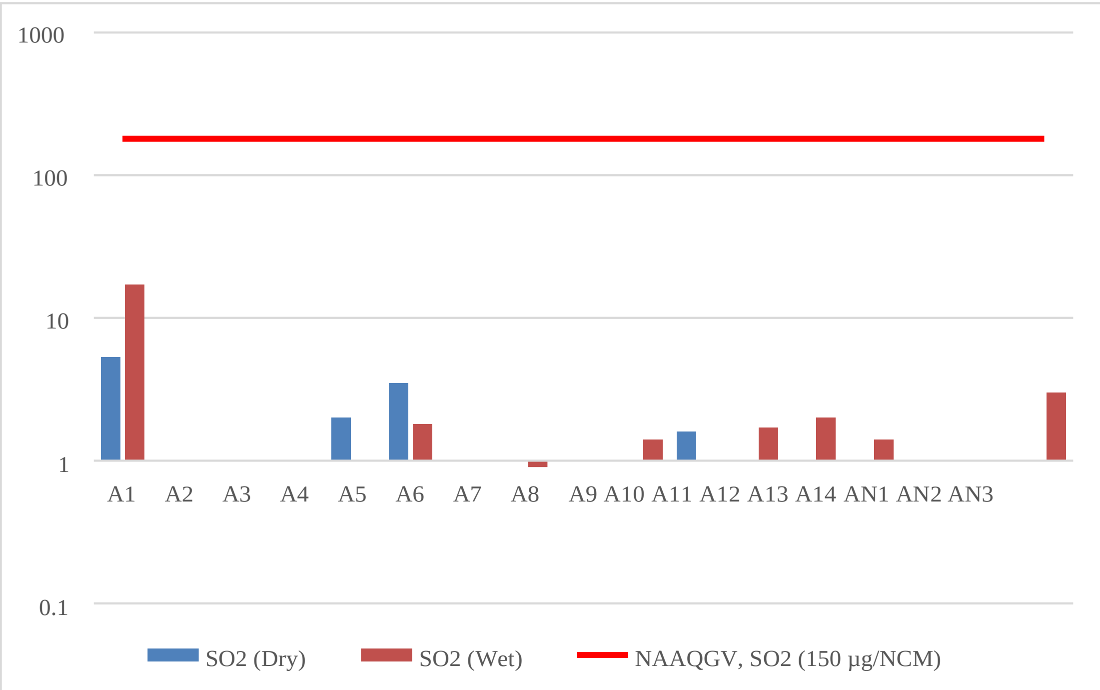


Figure 2.3-33. 24-hour SO2 monitoring results, 2017 and 2019

Table 2.3-32 and **Figure 2.3-34** presents the results of the 1-hour SO_2 monitoring in stations AN1, AN2, and AN3. The SO2 concentrations were 16 µg/NCM, 20 µg/NCM, and 23 µg/NCM, respectively. All stations are within the DAO 2000-81 NAAQS (340 µg/NCM).

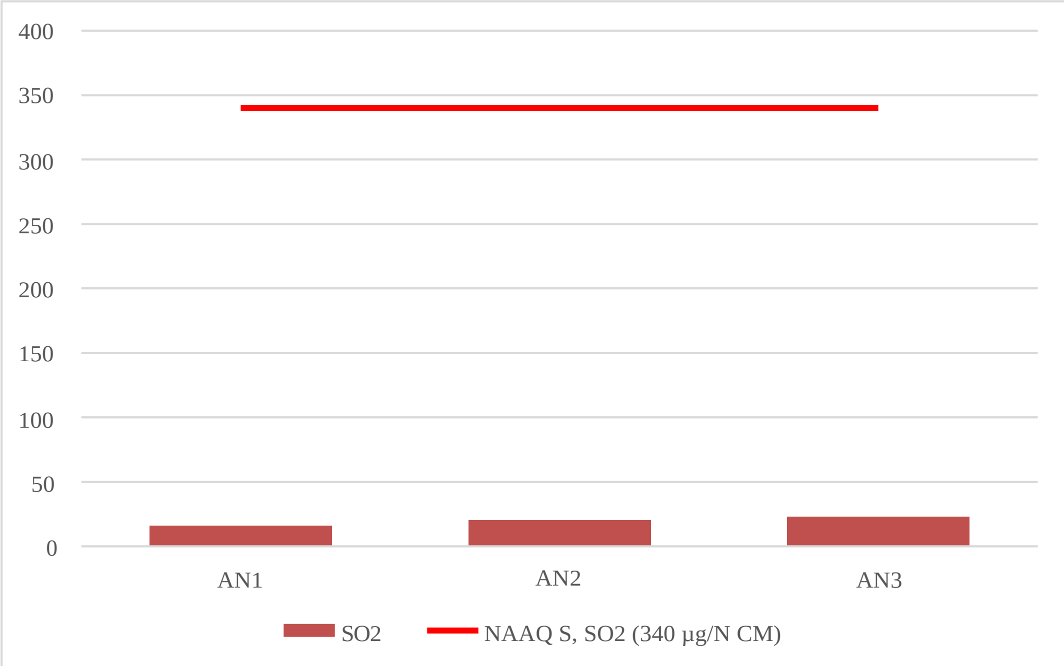


Figure 2.3-34. 1-hour SO2 monitoring results, 2019

c. Lead and Ozone

Lead (Pb) and Ozone (O_3) were monitored for the dry season in 2017 in Stations A1, A5, A6, A9, A11, and A13. The concentrations of Pb and O3 were undetected in all monitoring stations and below the DAO 2000-81 NAAQGV for Pb (1.5 µg/NCM) and O_3 (140 µg/NCM) (**Table 2.3-31**).

(4) Existing Sources of Pollutants

The project site is in Metro Manila which is a highly urbanized area. Vehicular traffic and congestion of people are the most common sources of pollutants. The high concentrations of particulate and gaseous pollutants have the potential to cause adverse health risks. The sources of common air pollutants such as TSP, PM_{10}, SO_2, and NO_2 are summarized in **Table 2.3-33.**

Table 2.3-33. Existing source s of pollutants

Pollutants	Sources
Total suspended particulates (TSP)	These are generated when fossil fuel is consumed by vehicles. In addition, fugitive emissions of these particulate pollutants are released into the environment through wheel entrained dusts from roads. Dust kicked up by vehicles traveling on roads may make up 33% of air pollution. Road dust consists of deposits of vehicle exhausts and industrial exhausts, particles from tire and brake wear, dust from paved roads or potholes, and dust from construction sites. Road dust is a significant source contributing to the generation and release of particulate matter into the atmosphere. Control of road dust is a significant challenge in urban areas, and in other locations with high levels of vehicular traffic upon unsealed roads, such as mines and landfill dumps.
Coarse particulates (PM_{10})	
Sulfur dioxide (SO_2)	These are generated from the combustion of fossil fuel by vehicles
Nitrogen dioxide (NO_2)	

2.3.3.3 Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement

Table 2.3-34. Potential impacts and options for prevent ion, mitigation, and/or enhancement – ambient air quality

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement Pre-construct ion
	Pre-construct ion	Const ruction	Pre-construct ion	Const ruction	
Degradation of air quality					
Fugitive emissions generated from wheel entrained dusts, dusts generated from unpaved roads, storage and handling of construction material, and wind erosion from exposed surfaces and construction material stockpiles may increase the ground level concentration of dusts (TSP and PM_{10}) in the area. The project is not expected to significantly affect the air quality during its operations phase.	✗	✓	✗	✗	• Fugitive dust from vehicular traffic and material handling activities will be controlled by management of vehicle speeds and application of regular water suppression to unpaved roads and stockpiles whenever visible dust is observed; • Trucks and vehicles that deliver construction material will be covered to prevent potential fugitive emissions of dust; • Regular ambient air quality monitoring will be performed in all monitoring stations as shown in **Figure 2.3-25**; and • Workers will be provided with the appropriate personal protective equipment pursuant to BWC-DOLE Occupational Safety and Health Standards (Department of Labor and Employment, 1989) to protect them from disease associated with dusts.

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement Pre-construct ion
	Pre-construct ion	Const ruction	Pre-construct ion	Const ruction	
Particulates and gaseous pollutants may be emitted through fossil fuel consumption of construction equipment which may increase the Ground Level Concentrations (GLCs) of the identified pollutants.	✗	✓	✗	✗	• Requiring sub-contractors to undergo and pass the government vehicle emission tests prior to contract award; • Exhaust fumes from vehicles, construction equipment, and other fuel burning equipment will be managed through the use of low sulphur fuel where possible; • Traffic management guidelines will be incorporated in worker's and subcontrac tor's induction seminar. Guidelines will include control in vehicle speed and spraying of road routes and work sites as well as transport routes near the host communities; • Fuel efficiency will be maximised through scheduling of vehicle and equipment movements in order to minimise both idle time and distances travelled; • Equipment and vehicle loadings will be optimised through accurate monitoring and calculation of fuel requirements in order to reduce fuel weight and improve fuel efficiency; • Vehicles and construction equipment will be regularly maintained in order to increase efficiency, reduce fuel use, and help reduce costs associated with equipment downtime; • Equipment dispatch will be monitored closely in order to eliminate unnecessary use and to increase efficiency of use; • Standard occupational health and safety practices will be implemented pursuant to BWC-DOLE Occupational Safety and Health Standards (Department of Labor and Employment, 1989); and • Regular ambient air quality monitoring will be performed in all monitoring stations as shown in **Figure 2.3-25**.

(1) Potential Impacts

a. Construction Phase

Fugitive dusts

Airborne emissions occur during each stage of the project, especially during the construction phase. Construction of the station boxes will mobilize large amounts of material, and soil stockpiles containing small size particles are easily dispersed by wind.

The largest sources of dusts and particulates during construction are fugitive emissions that may be generated from wheel entrained dusts, dusts generated from unpaved roads, storage and handling of construction material, and wind erosion from exposed surfaces and construction material stockpiles. These may increase the ground level concentration of dusts (TSP and PM_{10}) along the MMSP alignment.

Among the significant impacts are the fugitive emissions are: wheel entrained dusts, wind-blown dusts from vehicles used for the delivery of materials needed for the construction (i.e. procurement of materials from long distances), from machineries/equipment used during construction and operation, and f r om the vehicles for staff and employees.

Particulate matter larger than 10 µm are not expected to travel far from the source but particulate matter less than 10 µm are lighter and can stay suspended in the air for days and travel very far depending on weather conditions. The NAPWC is about 740 m from the nearest planned subway alignment construction. Although fugitive dust may affect NAPWC, this is only more likely during the dry season when precipitation events are infrequent and during the months of February and March when the direction of the wind is predominantly northerly and northeasterly. The subway construction is not a permanent and thus effects of fugitive dust to the NAPWC, if any, will be temporary and minimal.

Emissions due to the consumption of fossil fuel from construction equipment

Based on published studies, emissions from traffic and vehicles are considered to have a foremost input of particulate matter that may cause degradation of air quality (Wahlin, Palmgren, & Dingenen, 2001). Fine particles are generated mainly from the vehicle exhausts (Vallius, Ruuskanen, Mirme, & Pekkanen, 2000). In addition to particulates, gaseous pollutants are also emitted through fossil fuel consumption, increasing the GLCs of the identified pollutants.

b. Operations Phase

The project is not expected to significantly affect the air quality during its operations phase.

(2) Options for Prevention, Mitigation, and/or Enhancement

a. Construction Phase

Fugitive Dusts

Fugitive emissions by the project is the most significant source of dust and particulate pollutants (TSP, and PM_{10}) during the project's construction phase. To mitigate fugitive emissions, dust control measures will be implemented in good practice. Measures to manage this would include:

- Fugitive dust from vehicular traffic and material handling activities will be controlled by management of vehicle speeds and application of regular water suppression to unpaved roads and stockpiles whenever visible dust is observed;
- Trucks and vehicles that deliver construction material will be covered to prevent potential fugitive emissions of dust;

- Regular ambient air quality monitoring will be performed in all monitoring stations as shown in **Figure 2.3-25**; and
- Workers will be provided with the appropriate personal protective equipment pursuant to BWC-DOLE Occupational Safety and Health Standards (Department of Labor and Employment, 1989) to protect them from disease associated with dusts.

<u>Emissions due to the consumption of fossil fuel from construction equipment</u>

Particulates and gaseous pollutants may be emitted by the project through consumption of fossil fuel by vehicles and construction equipment. Minimizing fuel consumption is not only economic; it may also have the potential to reduce GHG emissions and particulate and gaseous pollutants. Measures to achieve this include:

- Requiring sub-contractors to undergo and pass the government vehicle emission tests prior to contract award;
- Exhaust fumes from vehicles, construction equipment, and other fuel burning equipment will be managed through the use of low sulphur fuel where possible;
- Traffic management guidelines will be incorporated into all worker's and subcontractor's induction seminars. Guidelines will include control in vehicle speed and spraying of road routes and work sites as well as transport routes near the host communities;
- Fuel efficiency will be maximized through scheduling of vehicle and equipment movements in order to minimize both idle time and distances travelled;
- Equipment and vehicle loadings will be optimized through accurate monitoring and calculation of fuel requirements in order to reduce fuel weight and improve fuel efficiency;
- Vehicles and construction equipment will be regularly maintained in order to increase efficiency, reduce fuel use, and help reduce costs associated with equipment downtime;
- Equipment dispatch will be monitored closely in order to eliminate unnecessary use and to increase efficiency of use;
- Standard occupational health and safety practices will be implemented pursuant to BWC-DOLE Occupational Safety and Health Standards (Department of Labor and Employment, 1989); and
- Regular ambient air quality monitoring will be performed in all monitoring stations as shown in **Figure 2.3-25**.

2.3.4 Ambient Noise

Metro Manila is considered as one of the rapidly urbanizing countries worldwide. According to the data from 2015 Census of population of the Philippine Statistics Authority, Metro Manila accounts for 12.7% of the total population of the Philippines, and 24.89% of the total urban population of the Philippines (Philippine Statistics Authority, 2019). Urbanization involves the development of cities due to industrial and economic activities, and it is usually visible in underdeveloped and developing countries (Regmi, 2017). This phenomenon has also been linked to several environmental problems (Regmi, 2017; Zhao, Da, Fang, Song, & Fang, 2006; Uttara, Bhuvandas, & Aggarwal, 2012), such as unregulated ambient noise (Singh, Dhiman, Shah, Sarkar, & Patel, 2016). Development of urban zones may be linked to various economic activities that produce different kinds and levels of noise. Extremely loud noises can cause adverse public health effects, such as damage in hearing and mental stress (The Government of Hong Kong, 2019) Implementing noise pollution standards can manage the level of noise produced for the general welfare of the public.

In the Philippines, the primary standard for ambient noise is the National Pollution Control Commission (NPCC) (1978) noise pollution standard, which has been amended on 1980. The standards are categorized based on the land use and period within a day.

(1) Study Area

Philippine noise standards are classified depending on the land use, as shown on **Table 2.3-35.** Bas ed on the baseline land use compatibilities for the six cities, as provided in the MMSP EIS (Department of Transportation, 2017) impact areas can be generally classified as mixed residential, commercial, and industrial areas.

Table 2.3-35 Area classifications for noise

Classification	Description
Class AA	A section or contiguous area, which requires quietness, such as areas within 100 meters from school sites, nursery schools, hospitals, and special homes for the aged
Class A	A section or contiguous area, which is primarily used for residential purposes
Class B	A section or contiguous area, which is primarily a commercial area
Class C	A section primarily reserved as a light industrial area
Class D	A section which in primarily reserved, zoned, or used as heavy industrial area

Source: Rules and Regulations of the National Pollution Control Commission (1978), Section 78

(2) Secondary Data Sources

The secondary sources used for the ambient noise assessment are shown in **Table 2.3-36.**

Table 2.3-36. Summary of secondary sources

Information/Data /Document Descript ion or Title	Author and Date Publishe d
Philippine Noise Standards	(NPCC, 1978)
EIS for Metro Manila Subway Project (MMSP) (Phase 1) Volume 1	DOTr, (2017)

Informa tion/Da ta /D oc u me nt Descript ion or Title	Author and Date Published
Ambient Noise monitoring data from the EIS for Metro Manila Subway project (MMSP) (Phase 1 Volume 1) for the original fourteen (14) monitoring stations, and noise monitoring data for the additional three monitoring stations	DOTr (2017) and Ostrea Mineral Laboratories, Inc (2019)

(3) Field Surveys, Sampling Areas and methodology

A summary of the field surveys and sampling activities undertaken for the project is shown in **Table 2.3-37**. In the 2017 EIS, all the survey sites for dry season and the first 14 stations for wet season were considered as monitoring sites for ambient noise. These stations were monitored bihourly within 24 hours (**Annex 2.3-6**). Three additional survey sites (NAIA Terminal 3, Sitio Fort Bonifacio Health Center, and Dr. Arcadio Santos National High School) were included as survey sites during wet season for further impact monitoring purposes. Hourly direct reading through a digital sound level meter was used to gather the data for the added sites.

Table 2.3-37. Summary of field surveys and sampling activities - Noise

Field Activity	Date Conducted	Map Reference Project stage
Ambient Noise level monitoring (Dry Season)	March 27 to 31, 2017 April 3 to 5, 2017 May 3 to 5, 2017	EIS 2017
Ambient Noise level monitoring (Wet Season)	July 10-15, 17-19, and 26-27, 2017	EIS 2017
Ambient Noise level monitoring for additional 3 stations	June 20-23, 2019	EPRMP 2019

The sampling coordinates and locations of the ambient noise monitoring stations are the same as identified in **Figure 2.3-25** and **Table 2.3-27**. A total of 9 sites for dry season and 17 sites for wet season were surveyed along the alignment during the 2017 EIS. Ambient noise level was recorded for both wet and dry seasons as the different seasons may affect the kind of activities that can produce noise, such as the weather conditions that affect the volume of cars and therefore, the noise they produce (Gardziejczyk, 2007).

(4) Comparison to Relevant Regulatory Standards

The NPCC (1978) ambient noise standards further classifies noise level standards within a four-time period **Table 2.3-38**. The average of noise level measurements according to their applicable period within the day were used to compare with their respective standards according to area category.

Additionally, the NPCC Memorandum (1978) also indicates a noise correction to be applied on the standards, depending on its proximity to the road **Table 2.3-39**.

Table 2.3-38. The Philippine Noise Standards for each classification

ategory of the Area	Noise levels (dB) Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nightt im e (10:00 PM to 5:00AM)
Class AA	45	50	45	40
Class A	50	55	50	45
Class B	60	65	60	55
Class C	65	70	65	60
Class D	70	75	70	65

Source: Rules and Regulations of the National Pollution Control Commission (1978), Section 78, Table 1. Environmental Quality Standards for Noise in General Areas

Table 2.3-39. Correctio n factor according to proximity to major roads, as suggested by NPCC (1978)

Type of Road	Correction Factor (dBA)
Areas directly fronting or facing a four-lane road	+ 5
Areas directly fronting or facing a four-lane or wider road	+10

Source: Rules and Regulations of the National Pollution Control Commission (1978), Section 78

2.3.4.2 Baseline Environment

(1) Summary of Findings

Table 2.3-40. Summary of findings from the ambient noise baseline data analysis

Baseline Inform at ion	Key Findings and Conclusions
Pre-project measurements from CRL Calabarquez Corporation (2017) ambient noise monitoring report and additional monitoring stations from Ostrea Mineral Laboratories, Inc. (2019)	• For dry season, areas with relatively more residential areas have lower noise pollution levels compared with other stations. However, as some of these stations are situated near major roads, the application of correction factor showed that some of these stations exceeded their respective standards, except for a few residential and parking lot areas. For wet season, the survey sites generally had elevated noise levels except for some residential areas. Across seasons, some survey sites still exceeded the maximum tolerable noise standards, while only two (TriNoma and Brgy. Blue Ridge sites) among the common monitoring stations had significant changes.
Existing Sources of Noise	• Based on the land use categories and the results, noise associated with commercial, residential, and industrial activities can be considered as existing sources of noise pollution.

(2) Pre-Project Noise Measurements (2017 EIS) and additional monitoring stations for the EPRMP (2019)

Average ambient noise level measurements for each station according to season and period of the day are presented in **Tables 2.3-41 to 2.3-46** . Correction factors according to the nearby roads were also incorporated whenever applicable. Those highlighted in red indicates exceedance in standard.

Table 2.3-41. Wet and Dry season 24-hour ambient noise level measurements (dbA) per station and time of the day for stations under Category AA

Station ID	Location	Classification and Standards	Average per time period (dB) - Dry Season				Average per time period (dB) - Wet Season			
			Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Night time (10:00 PM to 5:00AM)	Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Night tim e (10:00 PM to 5:00AM)
A2	Pacific Global Medical Center, Quirino Highway	AA					73.7	74.1	70.6	69.7
A5	World Citi Medical Center, Anonas, Quezon City	AA	66.6	63.5	63.5	63.3	78.4	77.3	75.9	69.4
A8	AFP Medical Center, V. Luna St.	AA					64.3	63.9	66.1	64.8
Standard (AA)			**45**	**50**	**45**	**40**	**45**	**50**	**45**	**40**

Table 2.3-42. Wet and Dry season 24-hour ambient noise level measurements (dbA) per station and time of the day for stations under Category A

Station ID	Location	Classification and Standards	Average per time period (dB) - Dry Season				Average per time period (dB) - Wet Season			
			Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)	Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)
A3	Landcom Village II, Barangay Tandang Sora, Quezon City	A	71.2	72.0	71.8	68.4	74.7	77.3	75.4	71.2
A10	Blue Ridge A Multipurpose Hall, Katipunan Avenue	A	52.9	52.0	53.9	52.1	51.0	53.0	53.2	50.3
AN1	Sitio Fort Bonifacio Health Center (Near National Nutrition Council)	A					55	55	50	45
AN2	Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City	A					57	58	59	54
AN3	Dr. Arcadio Santos National Highschool, Barangay San Martin De Porres, Paranaqu e City	A					39	42	40	37
Standard (A)			**50**	**55**	**50**	**45**	**50**	**55**	**50**	**45**

Table 2.3-43. Wet and Dry season 24-hour ambient noise level measurements (dbA) per station and time of the day for stations under Category B

Station ID	Location	Classification and Standards	Average per time period (dB) - Dry Season				Average per time period (dB) - Wet Season			
			Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Night time (10:00 PM to 5:00AM)	Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Night time (10:00 PM to 5:00AM)
A1	Depot (Barangay Ugong, Valenzuela)	B	53.7	54.3	57.1	55.1	80.0	79.5	77.5	75.5
A4	Avida Towers, EDSA Quezon Avenue	B	63.8	63.1	64.2	62.4	72.3	72.2	73.8	70.9
A6	Trinoma Open Parking Lot, North Avenue, Quezon City	B	63.6	63.5	63.2	56.2	57.3	59.5	59.0	59.7
A7	Estancia Mall, Capitol Commons, Meralco Avenue corner Shaw Boulevard	B	74.6	70.1	64.4	65.8	62.6	61.4	64.2	58.9
A9	MMDA Impounding Area, Meralco Avenue corner Julia Vargas	B					57.8	59.4	69.8	56.0
A11	Market! Market!, Bonifacio Global City, Taguig	B					68.7	70.2	68.5	63.4
A12	BCDA Field Office, Cayetano Boulevard	B	64.6	65.4	64.5	60.1	65.4	66.6	66.7	63.5
A13	FTI PNR Station	B	74.7	75.8	73.8	69.4	85.7	78.3	76.9	79.0
A14	11th St. Corner 38th St., Bonifacio Global City, Taguig	B					62.8	61.6	61.3	59.7
Standa rd (B)			**60**	**65**	**60**	**55**	**60**	**65**	**60**	**55**

Values in red indicate exceedance to the noise standards

Table 2.3-44. Wet and Dry season 24-hour ambient noise level measurements (dbA) per station and time of the day with applied correction factor to the standards for stations under category AA

Station ID	Location	Nearby road/s	Correction factor applied to the standard	Classification and Standards	Average per time period (dB) - Dry Season				Average per time period (dB) - Wet Season			
					Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)	Morning (5:00AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)
A2	Pacific Global Medical Center, Quirino Highway	Mindanao Avenue (eight to ten lane, divided)	10	AA					73.7	74.1	70.6	69.7
A5	World Citi Medical Center, Anonas, Quezon City	Aurora Blvd (four lane)	5	AA	66.6	63.5	63.5	63.3	78.4	77.3	75.9	69.4
A8	AFP Medical Center, V. Luna St.	V. Luna Ave (two-lane road)	N/A	AA					64.3	63.9	66.1	64.8
Standard (AA)					**45**	**50**	**45**	**40**	**45**	**50**	**45**	**40**

Table 2.3-45. Wet and Dry season 24-hour ambient noise level measurements (dbA) per station and time of the day with applied correction factor to the standards for stations under category A

Station ID	Location	Nearby road/s	Correction factor applied to the standard	Classification and Standards	Average per time period (dB) - Dry Season				Average per time period (dB) - Wet Season			
					Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)	Morning (5:00AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)
A3	Landcom Village II, Barangay Tandang Sora, Quezon City	Mindanao Avenue (eight to ten lane, divided)	10	A	71.2	72.0	71.8	68.4	74.7	77.3	75.4	71.2
A10	Blue Ridge A Multipurpose Hall, Katipunan Avenue	Katipunan Avenue (6 lane, divided)	10	A	52.9	52.0	53.9	52.1	51.0	53.0	53.2	50.3
AN1	Sitio Fort Bonifacio Health Center (Near National Nutrition Council)	Metro Manila Skyway/SLEX	10	A					55	55	50	45
AN2	Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City	Resort drive (2-lane), Andrews Ave (four lane divided)	5	A					57	58	59	54
Standa rd (A)					**50**	**55**	**50**	**45**	**50**	**55**	**50**	**45**

Table 2.3-46. Wet and Dry season 24-hour ambient noise level measurements (dbA) per station and time of the day with applied correction factor to the standards for stations under category B

Station ID	Location	Nearby road/s	Correction factor applied to the standard	Classification and Standards	Average per time period (dB) - Dry Season				Average per time period (dB) - Wet Season			
					Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)	Morning (5:00AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)
A1	Depot (Barangay Ugong, Valenzuela)	General Luis (two lane)	N/A	B	53.7	54.3	57.1	55.1	80.0	79.5	77.5	75.5
A4	Avida Towers, EDSA Quezon Avenue	EDSA (eight lanes, divided)	10	B	63.8	63.1	64.2	62.4	72.3	72.2	73.8	70.9
A6	Trinoma Open Parking Lot, North Avenue, Quezon City	EDSA (eight lanes, divided)	10	B	63.6	63.5	63.2	56.2	57.3	59.5	59.0	59.7
A7	Estancia Mall, Capitol Commons, Meralco Avenue corner Shaw Boulevard	Camino Verde road (2 lanes)	N/A	B	74.6	70.1	64.4	65.8	62.6	61.4	64.2	58.9
A9	MMDA Impounding Area, Meralco Avenue corner Julia Vargas	Merlaco Avenue (4 lanes, divided)	5	B					57.8	59.4	69.8	56.0
A11	Market! Market!, Bonifacio Global City, Taguig	McKinley Parkway (6 lanes divided)	10	B					68.7	70.2	68.5	63.4
A12	BCDA Field Office, Cayetano Boulevard	P. Diego Silang (2 lanes)	N/A	B	64.6	65.4	64.5	60.1	65.4	66.6	66.7	63.5

Station ID	Location	Nearby road/s	Correction factor applied to the standard	Classification and Standards	Average per time period (dB) - Dry Season				Average per time period (dB) - Wet Season			
					Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)	Morning (5:00AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)
A13	FTI PNR Station	SLEX, e-service road	10	B	74.7	75.8	73.8	69.4	85.7	78.3	76.9	79.0
A14	11th St. Corner 38th St., Bonifacio Global City, Taguig	11th Ave., 38th St. (2 lanes)	N/A	B					62.8	61.6	61.3	59.7
Standa rd (B)					**60**	**65**	**60**	**55**	**60**	**65**	**60**	**55**

Values in red indicate exceedance to the noise standards

Data from the dry season sampling period suggests that most of the nine monitoring stations on each period exceeded their respective standards except for Brgy, Blue Ridge A, Quezon City, which were within standards in the four-time period. This may be attributed to the presence of residential areas that require quietness, or activities that produce minimal noise to avoid disturbance to other neighbors. Other stations that were within the standards include the daytime period for Trinoma Open Parking Lot and Avida Towers (EDSA Quezon Ave.), and the morning to evening period of the Depot area. There is only a minimal difference between the noise levels of these areas and time compared to their respective standard, which means that there is a possibility for these areas to reach the maximum tolerable level of ambient noise if activities remain unregulated. The highest noise level was recorded during daytime in PNR FTI Station, which may be due to the train operations and proximity to major roads such as South Luzon Expr es sway (SLEX) and E-Service Road. The lowest noise level was recorded during the morning period in the depot area which can be attributed to the presence of residential and resort areas, and their morning routines.

Upon the application of correction factor, data shows that most of the stations still exceeded the maximum tolerable ambient noise level except for the Trinoma Open Parking Lot, Brgy. Blue Ridge A, and Avida Towers stations where noise levels for the four-time period were within the standard. This means that the exceeded noise level of the Trinoma site during morning, evening, and nighttime, without the correction factor, may be caused by surrounding factors such as commercial areas and transportation. Additionally, the lower levels of ambient noise in the Brgy. Blue Ridge site may mostly be due to the surrounding residential area which typically has activities that require quietness. The Avida Towers area, which is classified as a commercial zone, also has noise levels within the standards after the application of correction factor. This may mean that the elevated noise levels around that area during morning, evening and nighttime may be attributed to surrounding observable factors such as traffic and busy roads.

On other hand, Depot area sampling site had noise levels within the standards except for nighttime. This station, although categorized as a commercial area, may have quieter activities as compared to other sampling sites with surrounding commercial zones.

Similarly, most stations for each time of the day exceeded their standards during wet season, except f or a few. Trinoma Open Parking Lot (North Avenue) noise levels were below the standards from morning to evening, as the monitoring station was situated in a parking lot. Noise levels in Estancia Mall and BGC (11^{th} st. cor 38^{th} st.) areas are below the maximum level by around 4 dB, while the noise level in Brgy. Blue Ridge area is 12 dB lower than the standard during daytime. Despite these three stations being categorized as Class B, Brgy. Blue Ridge site's lower noise level can be linked to more residential space compared to BGC and Estancia Mall areas, which are mostly surrounded by commercial zones. Sitio Fort Bonifacio Health Center area exceeded the standard during the morning, while it remained on the standard from daytime to nighttime. Lastly, Dr. Arcadio Santos National High School remained within the standard for all the period, which can be attributed to the school activities that require quietness as compared to other monitoring stations.

After the application of the correction factor, those stations that remained within the standards include; Trinoma parking lot (North Avenue), Katipunan Brgy. Blue Ridge A, and BGC Market Market Parking Lot. As mentioned, these noise levels may be attributed to the sampling site itself. Without the correction factor, some of the noise levels within the four-time period exceeded due to observable factors such as proximity to the road. Dr. Arcadio Santos National High School remained within the standard after the correction factor, which may mean that the area generally does not experience noise pollution.

On the other hand, some of the stations classified as commercial areas, which are Avida Towers, Estancia Mall, and BGC (11thst. cor. 36thst.) stations, had noise levels within the standards during daytime. The Shrine of St. Therese, categorized as a residential area, exceeded noise level standards for all periods except for daytime, which means that there are various activities within the area that contribute to elevated nois e levels beyond the acceptable values.

Across seasons, the following stations still generally exceeded their respective standards: BCDA Field Office, PNR FTI Station Taguig City, Land com Village II, Estancia Mall, and World Citi Medical Center. This may mean that these stations are in busy areas that have various factors contributing to noise pollution, such as traffic, commercial and residential activities, among others. Additionally, these areas remain above the maximum tolerable noise levels regardless of seasonality. These remain true after considering the correction factors.

Meanwhile, stations that had changes in the ambient noise level throughout wet and dry seasons include the TriNoma Open Parking Lot, Katipunan (Brgy. Blue Ridge), Depot area, and Avida Towers sites. During wet season, noise levels in TriNoma area were within the standards from morning to evening, as compared to having its noise level on daytime within standards for dry season. On the other hand, the Katipunan (Brgy. Blue Ridge A) site exceeded the noise level standard for all periods except for daytime, as compared to the dry season where all noise levels were within the standards throughout the day. However, when the correction factor was applied, both stations remained within the four-time period standards for both seasons.

Meanwhile, in the depot area (Brgy. Ugong), noise levels generally exceeded the standards during wet season as compared to the ambient noise levels during dry season. Avida Towers site exceeded all standards for all periods during wet season after the correction factor has been applied, which may mean that more noise-contributing activities were present during the sampling itself. Continuous noise level monitoring will be done to determine the factors that contribute to these changes, whether seasonal or not, as noise levels can vary depending on several observable factors during sampling itself.

(3) Existing Sources of Pollutants

Most of the areas along the project location can be generally described as an urban zone, and the existing sources of noise are expected from daily economic, residential, commercial, and industrial activities. Activities from the pre-construction phase, such as demolition and operation of heavy machineries and equipment (Department of Transportation, 2017), may also increase the noise pollution level along these areas.

2.3.4.3 Potential Impacts, and Options for Prevention, Mitigation, and/or Enhancement

(1) Potential Impacts

Impacts of the project on its immediate environment is determined based on the activities done during preconstruction, construction, and operations phases. A summary of the impact assessment and relevant prevention/mitigation strategies are provided in **Table 2.3-47** and further details of the impacts are described in the following sections.

Table 2.3-47 Summary of potential impacts and options for prevent ion, mitigation or enhancement - Noise

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construction	Construction	Operation	Closure	
Increase in ambient noise level from project activities during the construction and operations phases					
Increase in noise level and ground vibration due to operations of construction machinery, which may cause disturbance to construction workers and nearby communities.		✓			• Using equipment or machines that produce lesser noise, or considerations in using mufflers to minimize noise. • Strategic scheduling of activities per period within a day to minimize effects of noise on nearby residents/public areas. • Maintenance of equipment or machineries used during construction to minimize possible loud noises due to equipment damage. • Conducting a construction noise assessment during the preconstruction stage to determine the noise levels on the areas surrounding the construction site, and the predicted noise levels coming from equipment and machineries. • Construction of wall enclosures on areas that produce a lot of noise to minimize disturbance within the immediate area. • Continuous monitoring of ambient noise levels on the monitoring sites for impact mitigation purposes.
May cause hearing problems to workers who operate nearby machineries or equipment that produce extremely loud noise.		✓			• Strictly implementation of Personal Protective Equipment (PPE), such as ear muffs and ear plugs, during work hours for the safety of the workers. • Taking note of equipment/machines that produce extremely loud noises (beyond tolerable levels – 85 decibels (Fink, 2017)) and keeping these areas off limits from workers for their safety. • Implementing permissible noise levels for construction workers as suggested by Department of Labor and Employment (DOLE).
May cause hearing problems to nearby residents who are a part of the vulnerable groups, and the public.		✓			• Active response of LGU through necessary health programs for vulnerable groups, and massive public information for those areas that can produce noise level beyond tolerable limits of human ears.
May inadvertently cause mental stress t o residents near the project location due to the noise from structures and ground vibration.				✓	• Considerations in the design and operations of the subway to minimize vibration, such as noise barriers. • Continuous monitoring and survey for complaints from residents nearby the areas to assess the extent of the

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construction	Construction	Operation	Closure	
					disturbance coming from the vibrations during operations.

a. **Increase in ambient noise level from project activities during the construction and operations phases**

Construction

The operations of construction machineries may contribute to the increase in noise levels on areas surrounding the construction site. During the pre-construction and construction phases, activities that are expected to elevate noise levels in the surrounding areas include; operating the equipment, machineries, generators, and vehicles for vegetation clearing, demolition, and earthmoving purposes (Department of Transportation, 2017). The noise produced by each equipment or machine depends on their power and characteristics. Different equipment and machineries have predicted noise levels within 50 feet from the source (U.S Environmental Protection Agency, 1971; U.S Department of Transportation, 1981; Rosenberg & Salter, 1971; Fuller & Brown, 1981). Noise produced during the construction phases may vary from air-borne noise to ground-borne noise, and these usually come from activities such as open cut excavation and open shaft for tunneling (JICA Design Team, 2019). It will be noted that while tunneling equipment may produce low frequency ground-borne noise from it impacts to the ground, these activities may prompt nearby communities to file complaints depending on the impacts of machinery and methods used (JICA Design Team, 2019).

Baseline data of ambient noise level on the surrounding areas of the alignment indicates existing elevated ambient noise levels from the standards for most of the stations and period of the day for both seasons. Therefore, construction activities may contribute to the noise level exceedances during the pre-construction and construction phases.

The increase in ambient noise may cause hearing problems to workers who operate nearby machineries or equipment that produce extremely loud noise. Workers in the construction site may be vulnerable to the negative effects of extremely loud noises due to direct exposure. Improper protection from extremely loud noises can result in gradual Noise-induced hearing loss (NIHL), which is commonly experienced by construction workers (Luman, 2016). Therefore, proper mitigation and safety strategies will be done to protect the welfare of the workers.

Additionally, exposure to elevated noise levels may also lead to health problems especially for those who are more vulnerable to its effects. These include groups of people who may be more sensitive to noise, such as infants and children, pregnant women, and those who suffer from hearing problems and mental illnesses (Kamp & Davies, 2013; Center for Disease Control and Prevention, 2017).

Operations Phase

Low frequency noise from the subway may be expected during the operations phase as the subway is located underground. While air-borne noise coming from the subway operations is expected to be at the minimal level (below detectable vibration level, which is 55 dB), noise from structure-borne vibrations may result to complaints from those who live and stay near the subway (JICA Design Team, 2019). This is due to the vibrations that transmit from the ground towards the structure above ground, which includes commercial infrastructures and residential houses.

(2) Options for Prevention, Mitigation, and/or Enhancement.

Construction Phase

To manage the impact of increase in ambient noise level during the construction phase, choosing construction equipment and machineries that produce lesser noise levels will be considered. Construction activities inevitably produce a lot of noise that may increase noise levels on affected areas. As such, selection of machineries and equipment that can minimize the noise produced, such as mufflers and wall enclosures (U.S Environmental Protection Agency, 1971; U.S Department of Transportation, 1981; Rosenberg & Salter, 1971; Fuller & Brown, 1981) is essential before the construction. A construction noise assessment can be done prior to the construction phase to determine or predict the noise levels for the construction activities.

Additionally, considerations in scheduling pre-construction and construction activities to be done within each period within the day may also be used to mitigate noise pollution. Since there are a lot of residential areas and commercial within the subway alignment, it is best to avoid extremely noisy construction activities during nighttime for the sake of the residents, and during rush hours (mornings) as it is linked to traffic jams, and more cars on the road can produce noise.

Maintenance of equipment and machineries can also ensure that these are properly functioning, which can minimize the possibility of occupational hazards during pre-construction and construction phases.

It is also important to strictly implement Personal Protection Equipment (PPE) to protect the workers from the damages that may be caused by direct exposure to the construction noises. Areas nearby equipment that produce loud noises above the tolerable limits of human ears will also be off limits to workers to avoid chances of hearing loss. Additionally, Department of Labor and Employment standards, shown in **Table 2.3-48** indicates the permissible noise exposure of construction workers and the duration of exposure (Department of Labor and Employment, 1989). This will be considered in scheduling the shifts of workers as well as the construction activities to be done and equipment to be used. If applicable, hearing tests and medical check-ups will be done to monitor the wellness of the workers, as well as the effectiveness of PPE.

Table 2.3-48. Permissible noise levels for construct ion workers as suggest e d by DOLE (1989)

Duration per day, hours	Sound levels, dBA, slow response
8	90
6	92
4	95

Duration per day,hours	Sound levels, dBA, slow respons e
3	97
2	100
1-1/2	102
1	105
½	110
¼	115

Source: Department of Labor and Employment, Occupational Safety and Health Standards (Amended 1989), Table 8c

For the effects of the elevated ambient noise level on the surrounding communities, the local government units of the affected areas may conduct health programs to assist the vulnerable groups during the construction phase of the project. Extensive public information about the harmful effects of noise and mitigation efforts can also be one of the options to minimize the harmful effects of loud noises.

Operations Phase

Considerations in the design and operations of the subway, such as noise barriers, will be incorporated to minimize these vibrations. Continuous monitoring of noise levels, in addition to public surveys in line with the structure-borne vibrations, may be done to assess the extent of the effect of the noise from vibrations, and the perception of these stakeholders.

Additionally, it is suggested for LGU to have extensive efforts to inform the public about the effects of elevated noise levels from the construction activities (Department of Transportation, 2017).

2.3.5 Vibration

(1) Study Areas

The areas for vibration assessments are the areas along the alignment where project components are planned to be located and were identified a priori. The study area included the nine (9) sampling stations asses s ed by Tekton Geo Matrix in 2017 and the three (3) study areas assessed by AECOM in 2019. The specific vibration sampling stations are described in **Table 2.3-49** and **Table 2.3-50**.

(2) Secondary Data Sources

The secondary data sources used in this assessment are as follows:

- *Measurement and Assessment of Baseline Vibration Condition at Various Sites if Metro Manila for the Metro Manila Subway Project, Tekton Geo Matrix 2017;*
- *Transit Noise and Vibration Impact Assessment Manual, US FTA 2018;*
- *2017 Environmental Impact Assessment (EIS) for Metro Manila Subway Project (MMSP) Phase 1*

(3) Field Surveys and Sampling Areas

The field surveys conducted by Tekton Geo Matrix in 2017 are detailed in Table **2.3-49**. Tekton Geo Matrix studied the effects of vibration to the alignment as it was in 2017. The changes to the alignment in 2019 reflected in this study were studied by AECOM and are described in **Table 2.3-50**.

Table 2.3-49. List of Vibration Sampling Stations from TMTI 2017 Report

Field Activity	Date and Time Conducted	Map Reference	Corresponding Component
Rolling Hills, Valenzuela	3-4 May 2017	14° 41.7084' N, 121° 1.3466' E	Valenzuela Depot
Tandang Sora Street	2-3 May 2017	14° 39.8917' N, 121° 3.9971' E	Tandang Sora Station
Trinoma, Mindanao Avenue	27-28 March 2017	14° 39.0861' N, 121° 2.0766' E	North Avenue Station
Centris Walk, Quezon Avenue	28-29 March 2017	14° 38.5321' N, 121° 2.4757' E	Quezon Avenue Station
Aurora Blvd, WCMC	3-4 April 2017	14° 37.6418' N, 121° 3.8212' E	Anonas Station
Blue Ridge, Project 4	4-5 May 2017	14° 37.1429' N, 121° 4.3445' E	Katipunan Station
Capitol Commmons, Meralco Avenue	4-5 April 2017	14° 34.5616' N, 121° 3.7442' E	Ortigas South Station
BCDA Field Office	29-30 March 2017	14° 31.6809' N, 121° 3.4459' E	BGC Station
PNR-FTI Station	30-31 March 2017	14° 30.3963' N, 121° 2.1319' E	FTI Station

(Adapted from Source: TGMI, 2017)

Table 2.3-50. List of Vibration Sampling Stations Assessed for this EPRMP

Field Activity	Date and Time Conducted	Map Reference	
Shrine of Saint Therese of the Child Jesus	from 12:36 of 4th July 2019 to 12:36 of 5th July 2019	14° 31' 17.3856" N, 121° 0'58.4814"E	NAIA Terminal 3 Station
American Manila Cemetery	from 17:02 of 5th July 2019 to 17:02 of 6th July 2019	14° 32'38.382" N, 121° 2'54.7476" E	Lawton East Station
Administration Building of United Hills Village	from 17:44 of 6th July 2019 to 17:44 of 7th July 2019	14° 30' 2.6922" N, 121° 2'30.732" E	FTI Station

The details and observations of the measurement sites are described as follows:

Shrine of Saint Therese of the Child Jesus

Shrine of Saint Therese of the Child Jesus is located at 20 Newport Boulevard, where it is adjacent to several main roads namely NAIA Expressway and Andrews Avenue. Agas station is also located behind the shrine. Both are identified as sensitive receptors for vibration.

The measurement point was located at the reception next to the main entrance this building. The people and staff were walking near the reception. Thus, the results of vibrational acceleration will be interfered by the human activities.

The photos records of the circumstance surrounding the Shrine can be found in **Plate 2-18**, **Plate 2-19** and **Plate 2-20**.

Plate 2-18. Outlook of Shrine of Saint Therese of the Child Jesus

Plate 2-19. The Gasoline Station next to Shrine of Saint Therese of the Child Jesus

Plate 2-20. NAIA Expressway and Andrew Avenue

<u>American Manila Cemetery</u>

The American Manila Cemetery is located in Taguig City and is located near the proposed Lawton East Station. This sensitive area is identified as the Office and Conference Room Blocks in the Cemetery. It was observed, that the traffic on Old Lawton Road and Bonifacio Avenue is regarded as a major vibrational contributor during this study

The measurement point was set-up in the conference room behind the visitors build near the main entrance to the cemetery. The room was locked for the duration of the study and this disturbance from human activities during the measurement period was expected to be minimal.

The photo records from this sampling station can be found in **Plate 2-21** and **Plate 2-22**.

Plate 2-21. Conference Room Block of American Manila Cemetery

Plate 2-22. Old Lawton Road outside American Manila Cemetery

Administration Building of United Hills Village Parañaque

The Administration Building of United Hill Village is located in the lower density residential area in

Parañaque City which is located near the proposed FTI Station. The activities in the basketball court next to the Administration Building was identified as the major vibrational contributor to this study.

The measurement point was set up in the administration office of the subdivision. The office has been locked and minimize disturbance from human activities during the measurement period except from the adjacent basketball court.

The photos records of the circumstance surrounding the Administration Building can be found in **Plate 2-23** and **Plate 2-24**.

Plate 2-23. Outlook of Administration Building of United Hill Village

Plate 2-24. Basketball Court near the Administration Building of Unite d Hill Village

Sampling Methodology

The standardized measurement procedures have been followed as listed as below:

To reproduce faithfully the motion of the element or substrate without introducing additional response to the measurement devices, two (2) accelerometers, which have been mounted on the instrument block (steel block), bonded on with flatted rigid floor surface.

The level of vibrational acceleration has been logged from 1 to 80 Hz in 1/3 frequencies bands in every 10 seconds. The whole measurement has been continuously taken place for 24 hours.

For comparing the measured results with related standard, the maximum value of vibrational velocity in each 1/3 octave band can be transformed from measured maximum acceleration by the following formula:

$$V_{max} = \frac{A_{max}}{2\pi \times (\text{concerned frequency in } \frac{1}{3} \text{ octave band})}$$

Two (2) accelerometers and the 2-channels analyzer with fast response mode (acquiring data every 100ms) have been utilized for the measurements. The list of instruments can be found in **Table 2.3-51**. The calibration certificates are attached in **Annex 2.3-8**.

Table 2.3-51. List of Instruments – Vibration

Instrum e nt	Model	Serial No.
Analyzer	B&K 2270	3007965

Accelerometer 1 (Primary)	B&K 4533-B-00 2	30242
Accelerometer 2 (Secondary)	B&K 4533-B-00 2	30180

The setups of measurements in different sites are described as follows:

Shrine of Saint Therese of the Child Jesus

The accelerometers were placed on the marble floor, under the reception desk. The photo record of the setup of instruments can be found in **Plate 2-25**.

Plate 2-25. Setup of the Accelerometer in the Shrine of Saint There se of the Child Jesus

American Manila Cemetery

The accelerometers were deployed on the marble floor in the conference room of Conference Room Block. The photo record of the setup of instruments can be found in **Plate 2-26**.

Plate 2-26. Setup of the Accelerometer in the American Manila Cemetery

Administration Building of United Hill Village

The accelerometers were set on the marble floor in the office of Administration Building. The photo record of the setup of instruments can be found in **Plate 2-27**.

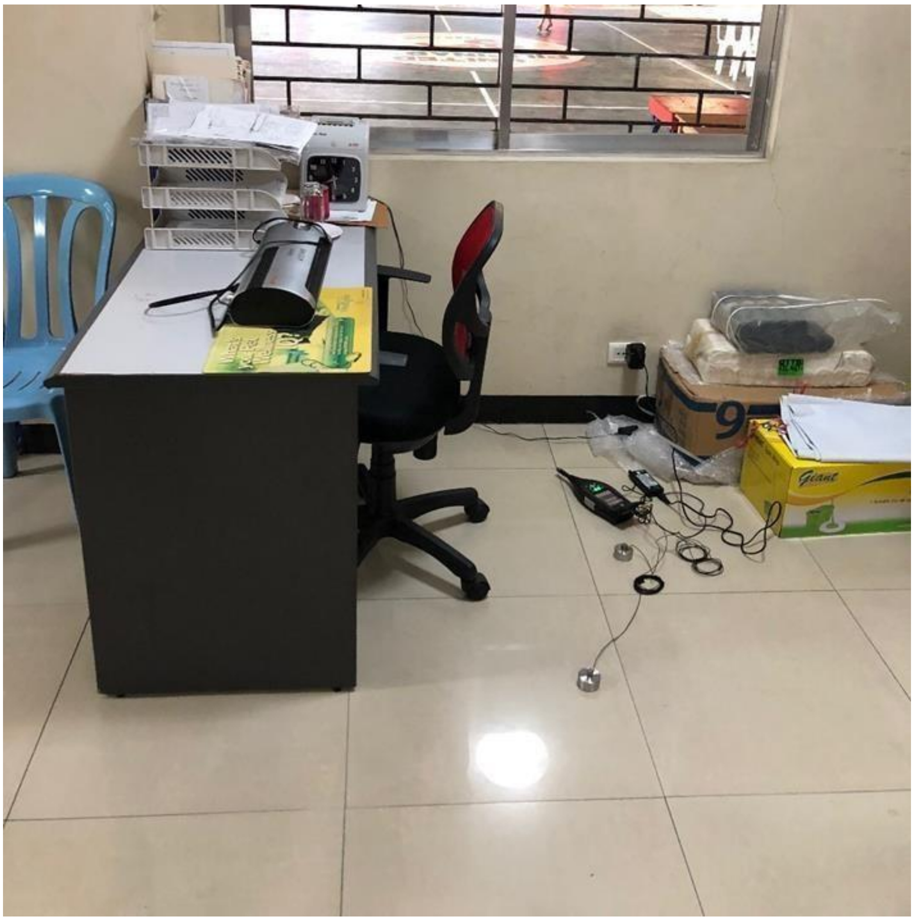


Plate 2-27. Setup of the Accelerometer in the Administration Building of the Unite d Hills Village

Baseline Environment

From the data in the measurement period, the acceleration in ninety (90) seconds of from each accelerometer in each measurement point was extracted in every fifteen (15) minutes. The acceleration in whole measurement period are plotted on **Figure 2.3-35**, **Figure 2.3-36** and **Figure 2.3-37**. The raw data for vibration acceleration for the three sampling stations can be found in **Annex 2.3-7**.

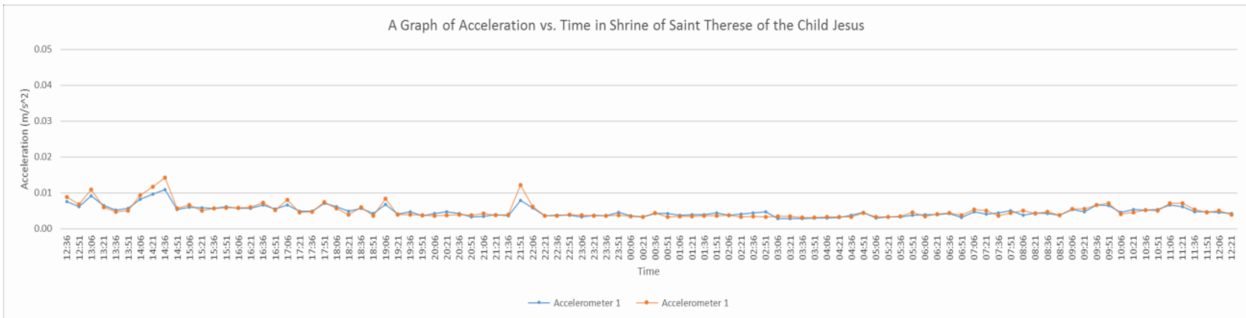


Figure 2.3-35. A Graph of Vibrational Acceleration vs. Time for the Shrine of Saint Therese of the Child Jesus

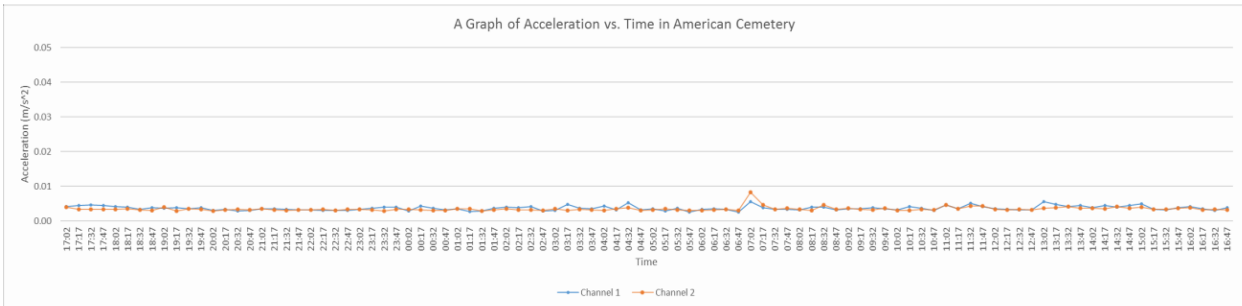


Figure 2.3-36. A Graph of Vibrational Acceleration vs. Time for the American Manila Cemetery

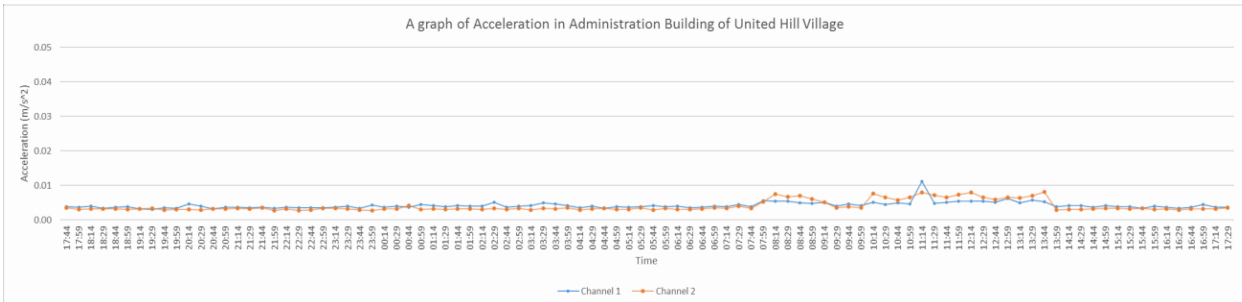


Figure 2.3-37. A Graph of Vibrational Acceleration vs. Time for the Administration Building of Unite d Hill Village

The "slow" time weighting (approximate time-period 1s, described by IEC 61672-1) max. acceleration in all measurement points are summarized in **Table 2.3-52**.

Table 2.3-52. "Slow" Time Weighting Max. Acceleration

Affecte d Area	"Slow" Time Weighting Max. acceleration, m/s2
Shrine of Saint Therese of the Child Jesus	0.5206
American Manila Cemetery	0.1921
Administration Building of United Hill Village	0.1816

Comparison to Relevant Regulatory Standards

Since no regulatory standards about the ground-borne level limit of the affected areas in the Philippine, the related vibration criteria mentioned in "Transit Noise and Vibration Impact Assessment Manual", issued by Federal Transit Administration of U.S. Department of Transportation is adopted. The extraction of the interpretation of vibration criteria for detailed analysis in this manual can be found in **Table 2.3-53**.

Table 2.3-53. Vibration Criteria from US FTA

Criterion Curve	Max Lv,* VdB	Description of Use
Workshop (ISO)	90	Vibration that is distinctly felt. Appropriate workshops and similar areas not as sensitive to vibration.
Office (ISO)	84	Vibration that is fest. Appropriate for offices and similar areas not as sensitive to vibration.
Residential Day (ISO)	78	Vibration that is barely fest. Adequate for computer equipment and low-power optical microscopes (up to 20x).
Residential Night, Operating Rooms (ISO)	72	Vibration is not felt, but ground-borne noise may be audible inside quiet rooms. Suitable for medium -power optical microscopes (100x) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400x), microbalances, optical balances and similar specialized equipment
VC-B	60	Adequate for high-power optical microscopes (1000x) and inspection lithography equipment to 3-micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1-micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capabilities.
VC-E	42	The most demanding criterion for extremely vibration sensitive equipment.

(Source: US FTA, 2018)

The criterion of max. vibration level in VdB for office is referred to compare with the max. vibration levels in 1/3 octave bands from 8 to 80 Hz from measurements in affected areas.

These comparisons are shown in **Table 2.3-54** and **Table 2.3-55** for the affected areas of Initial Alignment and Deviation from the Initial Alignment respectively

Table 2.3-54. Comparison of Measured Vibration Level and Criteria of Affected Areas of Initial Alignment

Affected Area	Max. velocity , VdB	Criteria , VdB	Compliance
Rolling Hills, Valenzuela	112	84	No
Tandang Sora Street	111	84	No
Trinoma, Mindanao Avenue	105	84	No
Centris Walk, Quezon Avenue	91	84	No

Affecte d Area	Max. velocit y , VdB	Criteria , VdB	Complia nce
Aurora Blvd, WCMC	107	84	No
Blue Ridge, Project 4	105	84	No
Capitol Com., Meralco Avenue	97	84	No
BCDA Field Office	102	84	No
PNR-FTI Station	114	84	No

Table 2.3-55. Comparison of Measured Vibration Level and Criteria of Affected Areas of Deviation from the Initial Alignment

Affecte d Area	"Slow" Time Weighting Max. accelerat ion in 8 to 80 Hz, m/s2	Max. velocit y in 8 to 80 Hz, m/s	Max. velocity in 8 to 80 Hz, VdB	Criteria , VdB	Complia nce
Shrine of Saint Therese of the Child Jesus	0.1100	0.0006525	96.3	84	No
American Manila Cemetery	0.02441	0.0001383	82.8	84	Yes
Administration Building of United Hill Village	0.04873	0.0002596	88.3	84	No

Summary of Findings

By following the measurement of analysis, the findings of vibration levels in different affected areas of Deviation from the Initial Alignment are summarized in **Table 2.3-56**. The findings in other affected areas of Initial Alignment can be found in the "Measurement and assessment of baseline vibration condition at various site in Metro Manila for the Proposed Mega Manila Subway Project" prepared by Tekton GeoMetrix.

Table 2.3-56. Summary of Findings of Affected Areas of Deviation from the Initial Alignent

Baseline Inform at ion	Key Findings and Conclus ions
Shrine of Saint Therese of the Child Jesus	The acceleration is relatively high and occasionally occurred the peaks (around 0.011-0.014 m/s2, max. 0.52 m/s2) in the morning, daytime and evening periods, when the Shrine is opened to the public. It has been observed that the high vibration levels are mainly caused by human activities when the people and staff are moving, get in or leaving the Shrine. The acceleration is lower and relatively stable (around 0.0038 m/s2) in the nighttime and dawn.
American Manila Cemetery	The acceleration is relatively stable (around 0.0036 m/s2) in American Manila Cemetery, because of the measurement has been taken place in the controlled room. No significant peaks occur in the whole measurement. The measurement site is also surrounded by a few main roads with heavy traffic. Therefore, some ripples (max. around 0.008 m/s2, max. 0.19 m/s2) are still recorded on the graph.
Administration Building of United Hill Village	The acceleration is also relatively stable (around 0.0035 m/s2) in Administration Building of United Hill Village since the measurement has also been taken place in the controlled room. Meanwhile, the acceleration is higher (around 0.006 m/s2, max. 0.18 m/s2) in 07:30 to 1400 because of the activities holding in the playground.

Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement

Pre-construction Phase

Prior to the final design of the track form, Force Density Level (FDL) testing of the train shall be carried out to update the vibration prediction and mitigation measures. The vibration borehole testing could be carried out at selected locations along the proposed tunnel alignment prior to the commencement of construction works to determine the Line Source Response (LSR) values under certain geological conditions. This will also allow updating of the vibration predictions and the recommendation on mitigation measures as necessary

Construction Phase

Potential vibration impacts may arise from TBM operation and rock breaking/drilling. TBM-induced vibration levels in any project affected areas will be calculated and predicted to assure that the levels w ill not exceed the criteria. The recommended assessment shall be based on “Transit Noise and Vibration Impact Assessment” published by U.S. Department of Transportation Federal Transit Administration. Monitoring at the time of TBM operation is recommended to confirm the vibration level. Strategic scheduling of vibration-induced works will also be planned accordingly.

Operation Phase

Referring to the report of “Metro Manila Subway Project Report on the proposed Manila American Cemetery Alignment” by JICA, the predicted operational vibration levels in project affected areas are within the criteria. Concerning the potential vibration impact due to the uncertainty of the FDL and LSR values , mitigation measures such as incorporation of vibration-insulating sleeper (**Figure 2.3-38**) and weight increase (**Figure 2.3-39**) through construction of secondary lining are recommended in or der to further minimize the vibration levels during operation. The second lining will increase the tunnel weight, hence reducing vibration.

The distance of the subway alignment is approximately 740 m from the NAPWC. Using the prediction formula shown in The ABMC vibration report by JICA in 2019, it was found that at a distance of 740 m, the expected vibration levels will be 14.3 VdB which is well below the FTA criteria in **Table 2.3-53** and the baseline levels found along the alignment **Table 2.3-54** and **Table 2.3-55**. At a distance of 740 m subway operations will have negligible to no effect to the NAPWC.

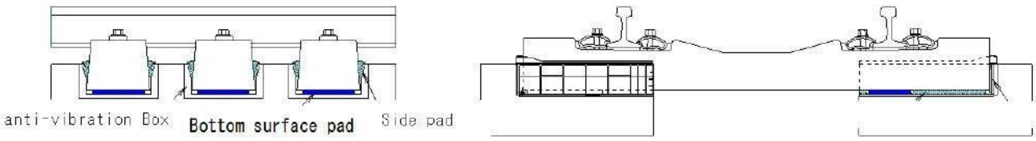
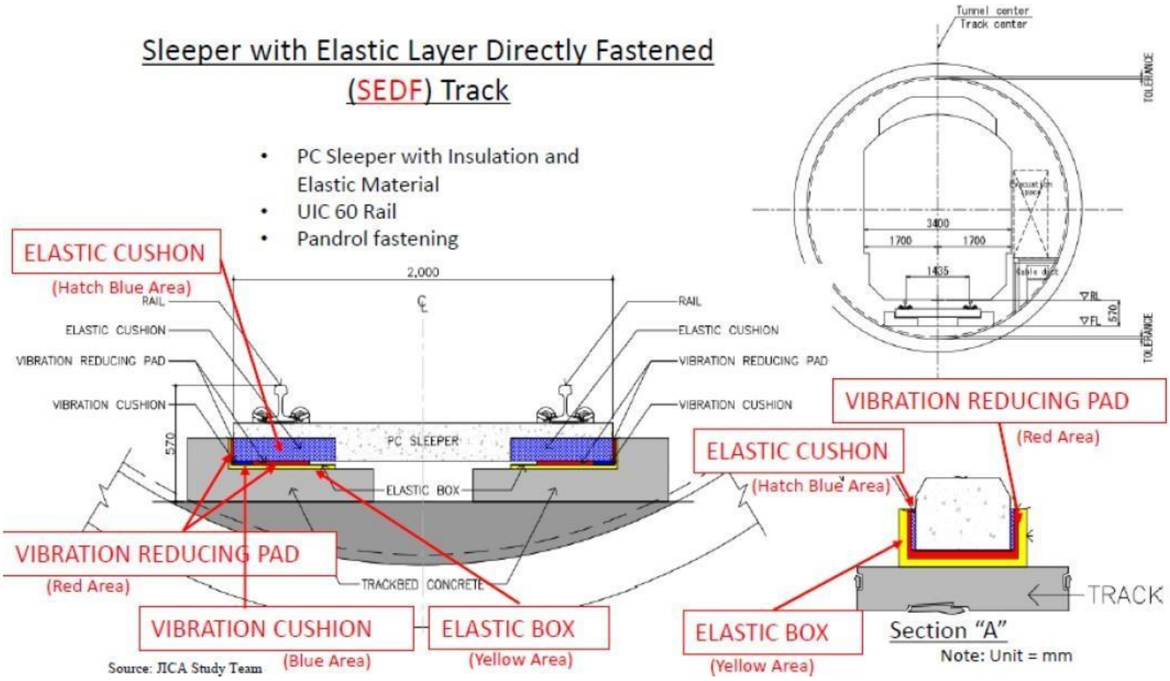


Figure 2.3-38. Vibration Insulating Sleeper



Source: JICA Study Team

Figure 2.3-39. Sleeper with elastic layer Directly fastened track

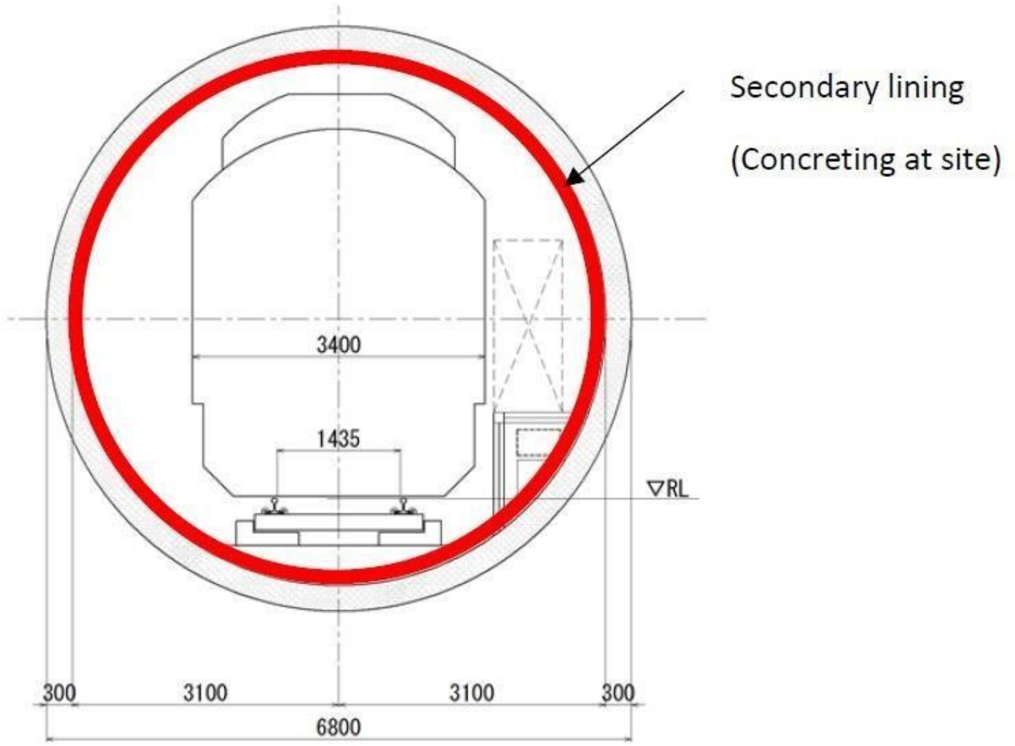


Figure 2.3-40. Sleeper with elastic layer Directly fastened track

Environmental Performance, Potential Impacts, and Options for Prevention, Mitigation, and/or Enhancement

Table 2.3-57. Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construction	Construction	Operation	Closure	
Increase in ground vibration					
TBH and drilling during construction and subway operation may potentially result into an increase of ground vibration	✓	✓	✓	✗	Conduct predicted vibration level study. Strategic scheduling of vibration-induced works. Installation of vibration control measures: • vibration insulating sleeper • sleeper with elastic layer directly fastened track • Secondary lining

2.4 The People

This section describes the baseline demographic, socio-economic and public health conditions of the areas affected by the realignment of Metro Manila Subway Project. The results of a perception survey conducted for the project are also discussed. Stakeholders and their concerns and interests are identified and analyzed. Potential impacts related to people regarding their socio-cultural, economic and public health conditions and their corresponding mitigating/enhancement measures are also provided.

2.4.1 Baseline Demographics and Socio-Economic Profile

2.4.1.1 Methodology

(1) Study Area

Immediate Impact Areas:

- Lawton East Station: immediate vicinity (at least 400 meters) from the Entrance / Exit (E/E) Points including the gated communities along Chateau Road and the office buildings and condominium communities adjacent, e.g., NAMRIA
- Lawton West Station: immediate vicinities of a) the proposed Senate Building in Bonifacio Naval Station along Chino Roces Extension opposite the Nutrition Council of the Philippines Building where there will be E/E Points and b) the Nutrition Council Building
- NAIA / Newport City: immediate vicinity (at least 400 meters) from the E / E Points at a) NAIA Terminal and b) Resort Drive adjacent The Residential Resort
- FTI Station to the PNR Bicutan Station: East Service Road from Cucumber Street to Marian Road 2 including 70 meters to the interior of this stretch to include United Hills Village 1 constituting an estimated area of four hectares which is envisioned to be acquired by the project proponent to initially serve as a construction yard and diversion road and later as an area for mixed development to accommodate passengers from the subway to wait to transfer rides and vehicles to park. From a social perspective, this area will experience the most significant impact principally through displacement of reside ntial, business and institutional establishments and their occupants.

(2) Data-Gathering Approach and Methodology

A combination of a) survey and review of existing documents and b) direct methods (e.g., field visits, household interviews, focus group discussions, key informant interviews and consultation meetings) were used to gather and to confirm information. The data-gathering approach and methodology are presented in the following outline.

Study	Methodology	Source of Information
Socio-economic profiling of the host municipalities and barangays	Review of secondary data, reports, relevant studies and other information Household survey	Comprehensive Land Use Plans (CLUPs) of host municipalities / NCR Regional Development Plan Socio-Economic Profiles Official websites (e.g. host LGUs) Sample households of direct -impact barangays
	Sectoral/stakeholder consultations Public Scoping sessions Key informant interviews (KII) Focus discussions	Key stakeholders Participants in public scoping sessions Key informants (community leaders and local officials) Focus group discussants (community leaders and local officials)
Land Values	Review of secondary data	DOF-BIR Issuances on Zonal Values

Study	Methodology	Source of Information
	Key Informant Interviews	Property Listings
Perception survey	Household survey	Sample households of direct-impact communities Focus group discussants (community leaders and local officials)
Public health	Review of secondary data	Municipal Health Reports of the four host municipalities CLUPs / PhilAtlas / Official Websites of host municipalities
Cultural Heritage	Review of secondary data	Philippine Registry of Cultural Properties Feature articles and videos of Bonifacio War Tunnel

2.4.1.2 Baseline Environment

(1) Summary of Findings

Baseline Information	Key Findings and Conclus ions
Socio-economic Profile	**Taguig City** • Highly Urbanized City • 53.67sqkm (5,367ha) land area; 8.66% of NCR • 28 barangays • First Class City: PHP5.56 Billion regular revenue (fiscal 2016) • Population (2015): 804,915 persons (6.25% of population of NCR) ◦ Barangay Fort Bonifacio: 11,739 persons (1.45% of City) • Annual Population Growth Rate: 4.32% (2010-1015) **Barangay Fort Bonifacio** • 2.4sqkm (240ha); 4.47% of City Includes within its jurisdiction Fort Bonifacio (military camp), Bonifacio Global City (business, financial, and lifestyle district)
	Pasay City • Highly Urbanized City • 13.97sqkm (1,397ha) land area; 2.25% of NCR • 201 barangays • First Class City: PHP3.53 Billion regular revenue (fiscal 2016) • Population (2015): 416,522 persons (3.23% of NCR) ◦ Barangay 183: 32,146 persons (7.71% of City) • Annual Population Growth Rate: 1.12% (2010-2015) **Barangay 183** • 53 hectares; 3.79% of City Formerly part of military base (Philippine Air Force). Includes Newport City (lifestyle district), NAIA Terminal 3
	Parana que City • Highly Urbanized City • 47.69sqkm (4,769ha) land area; 7.69% of NCR • 16 barangays • First Class City: PHP3.75 Billion regular revenue (fiscal 2016) • Population (2015): 665,822 persons (5.17% of NCR) ◦ Barangay San Martin de Porres: 21,181 persons (3.16% of City) including United Hills Village 1: approx. 3,250 persons (approx. 650 households) • Annual Population Growth Rate: 2.39% (2010-2015)
	Barangay San Martin de Porres • 1.5565sqkm (155.65ha); 3.26% of City Includes United Hills Village (United Paranaque I) and United Paranaque II. United Hills will be significantly
	impacted by the project by a right -of-way acquisition potentially displacing about 200-250 households.

(2) Pre-Project Summary of field surveys and sampling activities – Baseline Demographics and Socio- Economic Profile Assessment (2017 EIS) and additional data for the EPRMP (2019)

A summary of the demographic features of the host cities is shown in Table 2.4-1. In all three cities, about half the population is less than 27 years old with the largest population group in age 20 – 29; the lowest, 80 and over. There are about 40 – 45% young (0-14) and old (65 and over) people who are dependent on the working age population (15 – 64). Population growth rate ranges from 1.12% (Pasay, the lowest) to 4. 32% (Taguig, the highest and almost four times the rate of Pasay).

Table 2.4-1 Demographic Feature s of Host Cities

Demogra phic Feature	Taguig	Pasay	Parana que
Median Age	26	27	27
Population Structure: • 0 – 14 • 15 –64 • 64 - over	228,744 (28.42%) 554,185 (68.85%) 29,986 (2.73%)	103,682 (24.94%) 297,303 (71.38%) 15,357 (3.69%)	167,349 (25.13%) 471,360 (70.79%) 27,113 (4.07%)
Largest Age Cohort	25 – 29 (86,432)	20 – 24 (48,729)	20 – 24 (71,256)
Lowest Age Cohort	80 – over (2,594)	80 – over (2,115)	80 – over (4,360)
Dependency Ratio • Total • Youth • Old Age	45.24 41.28 3.97	40.19 34.93 5.17	41.26 35.50 5.75
Population Growth Rate (2010 – 2015)	4.32%	1.12%	2.39%

2.4.1.3 The Local Economy: Fiscal Revenues and Zonal Values

The fiscal economy shows that all cities are classified as First Class with regular revenues of PHP5. 56B f or Taguig; PHP3.53B, Pasay and PHP3.75B, Paranaque. Data are for fiscal2016 and are provided by PhilAtlas from the Bureau of Local Government Finance.

Zonal values of land and property provide a glimpse of the land economy. Although they do not necessarily reflect fair market value, zonal land values suggest the base values on which taxes (especially capital gains tax) are based when the selling price of a land or property is below or above the zonal value. When the selling pric e is below the zonal value, the appropriate tax will be based on the latter; when above, the former**. Table 2.4-2** presents zonal values for a range of land and properties in the vicinities (i.e., the proximate areas of the project footprints) of the host cities. These zonal values are from the latest (2018-2019) issuances of the Department of Finance (https://www.bir.gov.ph/index.php/zonal-values.html) and therefore given their recency approximate land and property values for 2019.

Table 2.4-2 Zonal values of project affected vicinities

City / District Vicinity	Classification	Zonal Value / Sqm (PHP)
Taguig / Fort Bonifacio		
• **Lawton East adjacent NAMRIA and McKinley West Village**	Regular Residential (RR)	150,000
	Commercial Regular (CR)	180,000
• **McKinley West (Jusmag)**	RR	200,000
	CR	300,000
• **Chino Roces Extension area between Nutrition Council Building and proposed site of Senate building**	RR	10,000
	CR	150,000
• **TESDA adjacent East Service Road**	RR	24,000
	CC (Commercial Condominium)	36,000
	X (Institutional)	90,000
Pasay / Newport		
• **Villamor Area**	Regular Residential (RR)	25,000
	Commercial Regular (CR)	35,000
• **NAIA III (Andrews Ave)**	CR	80,000
	X (Institutional)	80,000
• **Newport City**	CR	100,000
	X	100,000
• **Pine Crest Residential Resort**	RC (Residential Condominium)	130,000
	CC (Commercial Condominium)	150,000
	PS (Parking Slot)	100,000
• **Belmont Condominium**	RR	200,000
	CC	250,000
	PS	130,000
• **Montecito Residential Resort**	RC	130,000
	CC	150,000
	PS	100,000
Paranaque / SMDP		
• **East Service Road**	Regular Residential (RR)	40,000
	Commercial Regular (CR)	45,000
	Institutional (X)	30,000
• **Sitio Malugay**	RR	10,000
• **United Hills**	RR	12,000
	CR	20,000
• **Makati South Hills Condominium**	Residential Condominium (RC)	45,000
	Commercial Condominium (CC)	50,000
	PS (Parking Slot)	40,000

The project-affected communities (BGC, Newport City, and the gated communities of Barangay San Martin de Porres) are lifestyle districts. They offer amenities, physical and social, not normally found in other communities. Such lifestyle is more pronounced and evident in BGC and Newport which are newer communities compared to those in SMDP and feature mixed-use and high-rise developments. They have also become destinations for entertainment and business. Residents, property owners and investors including lessees put in money not only to invest on land and property but to also avail and enjoy the amenities these communities as planned, designed and conceived offer. In other words, the quality of living, indeed the lifestyle, is closely linked to the quality of physical and social environment in these communities. Any threat or actual diminution is a negative impact in intangible (e.g., the emotional satisfaction from such a lifestyle) and tangible terms (e.g., the effect on the landscape and streetscape of the project footprints, the intrusion and heightened levels pedestrian traffic generated, value of land and property brought about by a change in the population milieu, etc.).

2.4.1.4 Impact Identification, Assessment and Mitigation

(1) Pre-Construction and Construction

1) Impact on Land Property Values

The prospects of land acquisition, particularly the estimated four hectare at Barangay San Martin de Porres, would effectively freeze the land and property market and limit the market to only one entity: the government. Other buyers would hesitate to invest in property in the area given the risk of land acquisition. Those affected by land acquisition would be forced to sell their properties to government. Granting that their properties are compulsorily acquired even at fair market value, this nonetheless would have the effect of their current owners not being able to participate in the future appreciation of values of their properties.

Within BGC, particularly the areas (Lawton East and West) and Newport City where the re-aligned project footprints will be sited, land would have to be acquired from existing owners thereby either disrupting their and their tenants' business operations or requiring them to reconsider their plans. Such a prospect will force them to relocate elsewhere. Consequently, there will be a demand for alternative land within BGC for these businesses resulting to higher land and property prices including relocation costs.

2) Displacement of Residents, Properties and Business / Institutional Establishments

From a social perspective, the most significant impacts on people will occur as a result of the project footprints adjacent the East Service Road. Land will be acquired along East Service Road from Cucumber to Marian Road 2 for the project and 70 meters inwards along this stretch for an approximate area of four hectares. Residential structures, commercial and institutional structures will be affected. Most of the commercial and institutional establishments are along East Service Road; to the interior are mostly residential structures, mostly single dwelling units especially in United Hills Village, although commercial establishments could be found also to the interior. The southern portion of the Cucumber – Marian Road 2 stretch and their interior feature commercial and light industrial establishments that may likewise be affected by the proposed land acquisition. About 200-250 residential structures excluding residential condominiums may be demolished. The proposed land acquisition will reduce the land area (est. 20ha) of United Hills Village 1 by approximately one-fifth and the number of households (est. 650) by 35%. United Hills will be significantly broken up in terms of land and residents. Key informant interviews suggest that most of the affected households especially near East Service Road have been residents for 40 or more years and quite a number of whom were pioneer households.

An estimated 140 non-residential, mostly business, structures would be potentially impacted directly or indirectly. These structures are along or near the East Service Road and host a broad range of establishments including lodging, automotive, financial services, religious centers (including two churches), education (including a national high school), shopping, recreation and sports, eating and dining, healthcare, public services (including the barangay hall), transport and tourism. The type and scale of these business operations suggest that these are micro (less than 10 employees), small (10-99 employees) and medium (100-199 employees) establishments, **Table 2.4-1** and **Table 2.4-2**. Because of business disruption, livelihood and employment will consequently be affected. Assuming a conservative range of 20 to 50 employees per business establishment, the livelihood and employment of about 2,800 to 7,000 will be put at risk. Six thousand students of the Dr. Arcadio Santos National High School will be displaced. The barangay hall would have to be relocated.

Potential local and temporary employment especially involving the building trades and other skilled workers may be generated during the construction period of the project. The potential for local employment, however, will only be realized with a 'local-first' hiring policy jointly undertaken by the local governments of the host cities and contractors.

A Resettlement Action Plan covering issues of compensation including the cost of relocation and disruption of business operations will be prepared to mitigate the impact of land acquisition for the project.

Table 2.4-1. Nearest Buildings to East Service Road

Nearest Building	Distance (m)
Atlas Copco Philippines Incorporated	369
Bali	1,580
Bandung	1,655
Clubhouse	1,028
Indigo Building	1,094
Olive Building	1,179
Lilac Building	1,015
Magenta Building	1,105
Cerise Building	1,177
Plum Building	1,250
Poblete Compound	540
Lavender Building	1,327
Sun Valley Covered Court	1,366
Uniden Corporation	1,195
Petron	881
Iglesia Ni Cristo	819
Ang Dating Daan Sun Valley	704
Robinsons Supermarket	588
Peer Industrial Corporation	442
Peach Building	1,321
Crimson Building	1,250
Auburn Building	973

Nearest Building	Distance (m)
Citrine Building	1,028
Sunshine Plaza Mall	897
NFA-Food Development Center	941
St. Martin de Porres Parish Church	514
Shell	234
Petron	296
Our Lady of the Most Holy Rosary Parish Church	1,548
Raya Office	1,552
Seaoil	1,397
Culdesac Golezeum Basketball Court	734
The Generics Pharmacy Warehouse	651
Rainchem International, Inc.	914
Dizon Farms	1,080
EMRAM Building	1,190
Toyota Bicutan Parañaqu e	1,133
Southern Police District Highway Patrol Group	1,599
Tricycle Terminal	1,300
Land Bank	1,802

Table 2.4-2. Nearest Service s to the East Service Road

Service s Near East Service Road	Distance (m)
Lodging	
Guest House	1,243
Hostel	1,869
Hotel	2,062
Automotiv e	
Gas station (Shell)	234
Gas station (Petron)	296
Parking (Tricycle terminal for Brgy. Sun Valley)	440
Car Repair (Lyceum Autotronic	2,403
Car Wash (Autocare Carwash)	573
Parking Entrance	1,721
Financia l Services	
Bank (BPI)	642
ATM	870
Religious Centers	
Place of Worship – 107m	107
Educat ion	
School (Dr. Aracadio National High School)	518
College (AMA Computer College)	822
University (Technologic al University of the Philippines)	1,946
Shopping	
Convenience shop	635
Tyres	1,627

Service s Near East Service Road	Distance (m)
Hairdresser	950
Hardware Store	1,429
Electronics	1,362
Supermarket	588
Computer Shop	1,932
Laundry	581
Pawnbroker	1,232
Bayabas	1,630
Bakery	378
Chemist	2,293
Department store	1,405
Mall	1,459
Massage Shop	1,819
Tea Shop	2,368
Outdoor Shop	803
Printing Shop	3,012
Florist	2,381
Car Parts Shop	2,131
Bookstore	1,479
beauty Shop	1,482
Car Shop	1,133
Confectionery	613
Stationery	1,453
Motorcycle Shop	1,472
Butchery	2,330
Pastry Shop	2,018
DIY Shop	902
Bicycles	1,532
Recreat ion and Sports	
Basketball	447
Multi-Sport	626
Tennis	355
Cinema	1,534
BBQ	2,291
Sport Gymnastics	1,567
Eating and Drinking	
Restaurant (Baliwag's Lechon Manok & Liempo)	1,034
Fast Food (Pizza Hut)	150
Food Court	1,538
Bar	2,312
Cafe	1,148
Pub	3,071
Healthca re	
Pharmacy	570
Hospital	1,507

Service s Near East Service Road	Distance (m)
Clinic	1,092
Dentist	1,117
Doctor	2,170
Public Service s	
Post Office	2,124
Community Center	1,174
Townhall	494
Fire Station	1,453
Police	1,072
Post Box	2,340
Childcare	1,209
Trans port	
Taxi	1,474
Taxiway	3,275
Runway	3,150
Hangar	3,957
Airport apron	3,746
Bus Station	1,296
Airport Holding Position	3,299
Touris m	
Apartment	1,696
Museum	2,475
Touristic Attraction	2,677
Chalet	303
Marian Road	2
Other	
Marketplace	935
Veterinary	3,451
Shop Storage Rental	1,747
Money Transfer	2,232
Bayabas	1,630
Toilet	1,819
Shop Water	1,943
Shelter	1,293
Shop Gas	2,403
Shop Video Games	1,488
Telephone	780
Public Building	991
Bench	1,828
Tricycle Station	2,332
Public Market	1,670
FX Station	2,040
Training	2,243

(2) Operation

The increase of pedestrian traffic at the Entrance / Exit Points, particularly at the lifestyle districts of Taguig and Pasay, may impact their amenity values. As mentioned earlier, these districts were conceived, planned and designed to offer upper-tier amenities. Residents and investors put in their money in these districts on the promise and expectation that they would enjoy a lifestyle and workplace style in a built environment specifically catering to the upper and upper middle-classes, and the socially and economically mobile and fast emerging middle class. Mass transport such as the subway by its very character transport masses o f people. The estimated volume of passengers would inevitably result to a diverse milieu of people that may not be quite in keeping with the intended social mix of these lifestyle districts.

2.4.2 Public Health and Sanitation

2.4.2.1 Secondary Data Sources

The CLUPs of Pasay, Taguig and Parañaque.

2.4.2.2 Baseline Environment

(1) Summary of Findings

Baseline Inform at ion	Key Findings and Conclus ions
Public Health Services	Primary, secondary and tertiary health care and services are available in Taguig, Pasay and Paranaque. Primary health care is available in all barangays through the health centers of the municipal government. A world class and international ly accredited tertiary facility, St Luke's, is located in Bonifacio Global City, Taguig. Each city maintains a city -owned hospital.

(2) Public Health and Sanitation Assessment

Data for public health were sourced from secondary sources provided by the various city government (e.g., socio-economic profiles, etc.). Health services consist of three tier: primary, secondary and tertiary are available in all host cities of the project footprints. Primary health care is provided by the city health offices through their network of barangay health centers. All cities have their own city-owned and operated hospitals Taguig is notable in having a world-class and internationally-accredited tertiary health facility, St. Luke' s at BGC. Taguig also operates 24/7 medical emergency response team.

(3) Community Safety and Security

Because BGC and its component office and residential communities are gated enclaves, security and safety services are provided by their respective estate and building managements. Safety and security protocols ae in place at the and company/community levels. While entry to BGC is relatively free, access to horizontal and vertical residential and office communities are controlled and closely monitored. Security is provided by public and private agencies with the latter having a more visible and operational presence consisting of mobile patrols (foot and vehicular), stationary guards, police / security stations. This security apparatus is complemented by security technologies, e.g., security cameras at strategic points. The military zone of Barangay Fort Bonifacio have their own security systems. As a constituent barangay of Taguig City, it is also served by the local police force and corresponding police multipliers (e.g., the 'tanods') at the community level.

2.4.2.3 Impact Identification, Assessment and Mitigation

(1) Pre-Construction and Construction

The workforce including transients (e.g., ambulant vendors, hangers-on, visitors, etc.) in construction sites of project footprints could pose a potential threat to adjacent communities and establishments in terms of public health and sanitation and the safety and security of residential and office communities and their occupants and visitors. Before and during employment, health conditions of personnel at construction sites will be monitored. Contractors will be required to provide adequate security force and safety units and security cameras at construction sites. Workers will have IDs. Access to construction sites will also be controlled and monitored. Management and workers at construction sites will be made aware of, and trained in, the Occupational Safety and Health Code. Compliance with the Code and industry health and safety will also be enforced and monitored.

(2) Operation

Mass transport by their character and purpose transport large numbers of people of diverse backgrounds. For example, the volume of passengers as projected for 2045 at BGC Station is estimated at 233,432 per day; Lawton East, 40,020; Lawton West, 64,436; and FTI, 67,512. The sheer amount and diversity of passengers using the Entrance / Exit Points suggest that some of them could intrude into the vicinities and areas beyond with no legitimate purpose and even engage in anti-social activities thereby posing a risk to legitimate residents and workers. Community safety will also be put at risk in that innocent accidents could happen involving transients, and residents and workers. This threat could be addressed by installing security cameras at strategic places and instituting visible police presence. Local residents and workers could likewise be engaged to be more security and safety conscious and serve as multipliers to the regular security force. Apart from the regular safety units, quick response emergency teams drawn from office workers and residents could be f or med as part of the Corporate Social Responsibility and civic activities of companies and residential communities.

2.4.3 Perception Survey

2.4.3.1 Study Area

The perception survey was undertaken in support of the information, education and communication (IEC) activities in the early stages of the Environmental Impact Assessment (EIA) process and in accordance with DAO 2017-15 that stipulates the guidelines on public participation under the Philippine Environmental Impact Statement (EIS).

The survey was administered in three barangays of the host cities of the realigned sections: a) Barangay 183, which includes the Villamor area and Newport City in Pasay City on 30 May; b) Barangay Fort Bonifacio in Taguig City on 31 May; and c) Barangay San Martin de Porres (SMDP) in Parañaque City on 3 June 2019. A sample size of 300 respondent-households (100 / barangay) was set for the perception survey.

2.4.3.2 Secondary Data Sources

(1) The EIS conducted in2017

(2) The documentation for this EIS

- Initial Perception Surveys and IECs
- KIIs and FGDs
- Public Scoping
- Technical Scoping

These documents are attached in Annex ES.1-2.

2.4.3.3 Baseline Environment

(1) Summary of Findings

Baseline Inform at ion	Key Findings and Conclusions
Perception Survey	**Barangay 183** • The respondents included household members, property owners, tenants, and business owners. A total of 98 respondents were surveyed, 53 of which were female (54 %) and 45, male (46 %). • A slight majority of the respondents (54 %) claimed that they did not have prior knowledge of the project; on the other hand 46 % responded that they were aware of the project **Barangay Fort Bonifacio** • Targeted respondents were office workers near the direct impact areas, vendors, and residents. One hundred respondents were interviewed of whom 58% were males and 42%, females. • An overwhelming majority (72%) were aware of the project, primarily obtaining information from mass media (73 %). Other sources of information included the government and barangay officials (15 %) and relatives, neighbors, and friends (12 %). **Barangay San Martin de Porres** • The respondents were a diverse group of property owners, tenants, business owners and their employees. Apart from the household survey, IEC activities were carried out among barangay officials and community leaders including the Homeowners' Association. • Seventy-six percent of respondents from SMDP stated that they have prior knowledge of the project

(2) Pre-Project Summary of field surveys and sampling activities – Perception Survey (2017 EIS) and additional data for the EPRMP (2019)

This section summarizes the findings of the 'Perception Survey Report' for all three barangays. Salient findings include:

- 49% claiming to have resided in their communities for more than 10 years with the highest in Bgy 183 at 70% and followed by SMDP, 48% and Bgy Fort Bonifacio, 29%. The high proportion of residents in Bgy 183 could be attributed to the long association of the households to the Philippine Air Force Base.
- 70% of respondents said they work within their respective barangays with Bgy 183 leading at 77% followed by SMDP at 77% and Bgy Fort Bonifacio, 63%.
- 54% are aware of the MMSP from mass media (print and broadcast) at 53%. Other sources include government (13%) and neighbors, friends, relatives (11%). Eighty-one percent have not heard of the additional stations / project footprints planned for Taguig, Pasay and Paranaque. Fifty-eight percent were not satisfied with the amount and kind of information they received.
- The most frequently mentioned perceived impacts include 'increased employment', 20% of 587 multiple responses; increased business, 18%; improved mass transportation, 35% and general progress of communities, 17% for a total of 90%.
- The three leading perceived negative impacts are loss of property (19% of 518 multiple responses), and removal of trees and other vegetation and safety issues (12%).
- Perceived mitigating measures are spread out but the five leading and frequently mentioned include: proper relocation and compensation (5% of 208 multiple responses); capability of MMSP to address geotechnical issues, good project planning, ensure good quality construction materials, each at 2.9%) , and avoiding areas with numerous trees and replace affected trees, 5.8%.
- Reasons for supporting the project include: convenience of mass transport (20% of 205 multiple

responses), ease up traffic situation 18%) and overall development of the country and economy, 10%.

- The leading and most frequently mentioned reason for not supporting the project is the loss of property and compensation issues (15% of 94 multiple responses; however, to put things in context, 74% did not respond to the question: 'In your opinion what are the negative effects of the Subway Project to the community?' The finding therefore only reflects 26% of respondents).

2.4.4 Stakeholder Analysis and Major Issues and Concerns

2.4.4.1 Pre-Project Summary of field surveys and sampling activities – Stakeholder Analysis and Major Issues and Concerns (2017 EIS) and additional data for the EPRMP (2019)

There are two major stakeholders with respect to land utilization a) Use Value Stakeholders and b) Exchange Value Stakeholders. **Box 1** explains the concepts of Use Value and Exchange Value. **Table 2.4-3** provides an outline of the features of Use Value and Exchange Value Stakeholders. **Table 2.4-4** is a list of Stakeholders. The Use Value and Exchange Value Model provides a framework for a better understanding regarding the behavior of stakeholders as regard land and property and how to manage their attitude and disposition in this regard.

Box 1: Stakeholders and their Concerns

'Holders of interest on land include the owners of property directly affected or likely to be affected; individuals and groups who are not owners of affected parcels but who will benefit from, or be disadvantaged by any change in the character and use of the area; advocacy groups who seek to promote social justice and equity, environmental integrity and land use sustainability, and other positive values; national government agencies with mandates related to land; and local government units within whose jurisdiction the impact areas are situated

‘Stakeholders who *possess* rights of use and disposition over land are concerned about the possible changes the project might cause on the land or its current use and thereby alter its *use value* and / or its *value in exchange*. The other stakeholders are interested in influencing the decisions of those who possess rights over the affected lands toward adopting the principles and values they advocate.

‘Use Value. Those who are interested in the value of land may be using or intending to use land as a factor of production: as growth bed for agricultural crops and forest plantations, as quarry site for mineral resources, as grazing areas for livestock, as fishponds, or as a site for manufacturing, commercial, office and other establishments from which they extract rent or realize returns on investment. To this group of interest holders the principle of highest and best use is the guiding principle. They are likely to oppose projects that willtend to diminish the capability or suitability of their land to support productive activities on sustainable basis. But they will not oppose projects that will cause land use change provided the new land use will give them higher returns.

‘Another group of interest holders who keep land for its use value are those who may be using land as an environment for living: as a site for residential communities and associated uses for social services, utilities and the like. They are interested in preserving and enhancing the amenity value of the land and are expected to oppose projects that will tend to depreciate that value.

‘What distinguishes those who are interested in the use value of the land is their common desire to hold on to their land and continue to receive benefits from its use. This makes them essentially conservationist.

‘Exchange Value. In contrast, stakeholders who are interested in the exchange value of land regard land as an item of trade and commerce. They are expected to welcome any project or action that will tend to increase the market value of their property and are likely to oppose any project they perceive will depreciate the value of their land in the market.

‘Finally, government agencies and local government units are interested in attaining a balance between conflicting interests in land and thereby safeguarding and promoting the general welfare. They are also interested in the nature of use in so far as this increases the amount or level of real property taxes they can collect’

Source: Ernesto Serote (2004), *Property, patrimony and territory: Foundations of land use planning in the Philippines.* Quezon City: SURP – UP PLANADES.

Table 2.4-3 Outline of Features of Use Value and Exchange Value Stakeholders

Use Value	Exchange Value
• Land as: ▪ Factor of Production ○ Site for agricultural crop / forest plantation ○ Site for manufacturing ○ Site for office, commercial establishments ▪ Environment / Site for Living ○ Residential communities and associated uses (e.g., services, recreation, leisure, etc.) ▪ Guiding / Operating Principle ○ Highest and best use ○ Return on investment ○ Primary source of income and sustenance (especially for beneficial users with no comparative and alternative source of livelihood) ○ Preserve and enhance amenity value of the land ▪ Behavior / Attitude ○ Likely to oppose projects that will tend to diminish the capability or suitability of their land to support productive activities on sustainable basis. For beneficial users whose livelihood and other forms of sustenance is solely or largely land-based, any change to present land-use will likely be perceive as an existential threat ○ Will not oppose projects that will cause land use change provided the new land use will give them higher returns ○ Will oppose projects that will tend to depreciate amenity value of the land ○ Hold on to land to continue to receive ○ amenity values / benefits ○ Will oppose projects that will tend to depreciate amenity value of the land	• Land as an Item for Trade and Commerce ○ Develop ○ Sell ○ Lease • Guiding / Operating Principle ○ Return on investment • Behavior / Attitude ○ Support any project or action that will tend to increase market value of their property ○ Oppose any project that they perceive will depreciate the value of their land in the market ○ Oppose any action or measure that will impede or slow down the availability and release of their property to the market
Source of basic information and adaptation: E. Serote (2004), *Property, patrimony and territory: Foundations of land use planning in the Philippines.* Quezon City: UP SURP – UP PLANADES.	

Table 2.4-4 List of Stakeholder Groups

STAKE H OL DE RS	
Use Value	**Exchange Value**
Barangay Captains (183, Fort Bonifacio, SMDP) Homeowners' Association Property Owners Business Owners LGU Paranaque (Mayor's Office, CPDO) Bonifacio Naval Station	DOTr BCDA

A review of the record of consultations, key informant interviews, focus group discussions and findings of the perception survey highlighted issues regarding land acquisition and compensation. Just as importantly, the emotional and physical disruption of land acquisition was raised by residents of United Village. Of particular concern to property owners is the effect the project footprints and any acquisition resulting from the same on the land values and the amenities of their communities, especially in light of the lifestyle character and expectations of residents of these communities. A summary of the stakeholder issues an d concerns is provided in **Table 2.4-5**.

Table 2.4-5 Stakeholder Issues and Concerns

Stakeholde r Group	Issues / Conce rns /Obs e rv at ions
Barangay Captains	• Land acquisition especially at SMDP which will reduce the land area of UH Village and displaced households (est. 200-250) and businesses • Displacement of informal settlers at Malugay Road • Other options for the site of the construction yard at SMDP and area for passengers to transfer rides. The PNCC lot along the East Service Road was suggested • Compensation: fairness and timeliness in light of experience of similar parties and the track record of government agencies in making timely payments • Dislocation of some 6,000 students of Dr Arcadio Santos National High School
Homeowners' Associations/ Residents	• Same as Barangay Captains • Emotional disruption entailed by displacement considering that many of the residents have been living in their communities for as long as 40 years, especially in SMDP • Effectively freezing the land and property market for residents and limiting them to one buyer: the government and its record as regard timeliness of payment • The lack of options to acquire property of comparable value and amenities in Metro Manila and nearby areas • Anxiety caused by the proposed land acquisition and displacement
Commercial property owners / Business owners and operators	• Same as Barangay Captains and HOAs/Residents • Disruption of business operations and availability of optional sites for their businesses to relocate
Institutions	• Displacement of school facilities of Dr Arcadio Santos National High School and disruption and inconvenience to 6,000 students and staff and teachers
LGUs to include Mayors / CPDO	• Same as Barangay Captains • Same concerns as HOAs / Residents who are their constituents • How project footprints will fit into LGUs infrastructure programs, e.g., Paranaque's plan to put up a sky train near Bicutan
Bonifacio Naval Station	• Security concerns about underground route (e.g., possibility of terrorist acts, etc) • Any relocation will as much as replicate of communities of origin especially with respect to security
DOTr	• Need for land for project footprints for a project of national significance • Right-of-way acquisition issues and the delay resulting from these

Table 2.4-6. presents three types of stakes or interests stakeholders have. These stakes define how stakeholders are to be treated and engaged. Any person or group that will be affected by the project would at least have an interest and therefore has a right to be informed and consulted. DOTr as the project proponent is a major stakeholder as the owner of the project, as do the users/owners of land, business owners, and institutions that will be affected by the project footprints in terms of acquisition or a diminution of amenity values.

Table 2.4-6. Types of stakes and interest s

An Intere st	A Right	Owne rs hip
When a person or group is affected by the project, they have an interest in the project Example: Land development in the project site will affect communities, occupants and beneficial users within; they have an interest in the project	• Legal Right: When a person or group has a legal claim to be treated in a certain way or to have a particular right protected. Example: Families who will be economically and physically displaced are entitled to financial compensation assistance to cover loss of livelihood, assets, transfer costs, inconvenience, etc. • Moral Right: When a person or group thinks it has a moral right to be treated in a certain way or to have a particular right protected Example: A household has been long-time residents of and has established deep roots in the community. The length of their occupancy will be considered in any measure to off-set the inconvenience and disruption resulting from land acquisition	When a person or group has a legal title to an asset or a property Example: DOTr is mandated to carry out policies and programs for mass transportation
Source and adapted from: Carroll, Archie B. and Ann K. Buchholtz (2003), *Business and society: Ethics and stakeholder management.* Mason, OH: Thomson - Southwestern		

Table 2.4-7 characterizes stakeholders according to their ‘use value’ and ‘exchange value’ orientation and suggests corresponding engagement strategies with them.

2.4.4.2 Public Hearing

The Public Hearing meeting of the MMSP was conducted last 03 September 2019 from 9:00 AM to 02:00 PM at the Tandang Sora Function Hall, TESDA Women's Center located at the East Service Road, Taguig City. The Public Hearing was attended by 102 people. The Public hearing was moderated by Atty. Sim C. Flores of the Environmental Management Bureau – National Capital Region. Also present in the Public hearing were representatives of the DOTr and the JICA Design Team (JDT) (the designers and General Consultant of the MMSP), the Review Committee and case handlers of the MMSP.

Majority of the issues and concerns raised during the Public hearing revolved around issues of compensation during the right-of-way acquisitions for the MMSP and issues with resettlement of affected stakeholders along the changed alignment.

Table below presents the summary of issues, concerns and suggestions raised during the public hearing. Attached in **Annex 2.4-1** the public hearing documentation.

Table 2.4-8 Summary of Issues and Concerns

	Module	Questions and Suggestions	Response
1.	People	UPS 1 will be highly affected, so how will DOTr ensure that all the options will be taken into consideration where the homeowners will not be affected by the project?	**USEC Timothy John Batan, DOTr** USEC Batan discussed the overview of the future railway plans of the DOTr and how the MMSP fits within the planned railway network. USEC Batan showed that the MMSP links the railway planned up to Clark in the north and railway planned up to Calamba in the south
2.	Land	I believe there's also a government property in the area that is near where UPS is. If the project is built there, it will not hit any existing community. Or instead, how about if the PNR also goes underground and meet the subway below?	**USEC Timothy John Batan, DOTr** The location of the Taguig intermodal station was key to the decision in choosing FTI as one of the MMSP stations as the intermodal station is foreseen to link riders to the MMSP The underground structures of NAIA X interconnection and SLEX also were a major consideration to choosing the alignment and subway station in the Paranaque area since these structures go several meters underground. The flight path of planes going into and out of NAIA was also considered. These were considered during the consideration and eventual selection of the current proposed FTI station.
3.	Land	Why not construct bridge instead of temporary road. Then shift the construction yard of being instead going through our village maybe we can put it in the north after the construction? Have you explored everything that we can do?	**USEC Timothy John Batan, DOTr** Initially, the proposed PNR station and the proposed FTI MMSP station were envisioned to be side by side occupying the 20 m PNR ROW, the 15 m ROW for the East Service Road an several meters into UHV for the

			temporary and permanent construction areas. However, it is being considered that the MMSP FTI station be located directly under the a proposed PNR station. The stations on top of each other will still occupy the 35 m total of the PNR ROW and East Service Rd. ROW but the East Service Rd. will need to be diverted north which will affect properties 15 m north of the UPS border. The MMSP will also need a temporary yard north of the diverted East Service Rd. with a width of 10 m which will be returned to the owners after the construction.
4.	Land	Your team were asking for another loan for that part of the original FTI station to Bicutan which is about 1.5 km, now why do you have to go down if you're really get set to Bicutan why you have to go down and you can't attain a maximum speed for a high speed train down under because you're now approaching the terminal station which is Bicutan. In the PNR station once you're approaching a terminal the train will go slow, so from FTI, isn't it more logical that you just stay upgrade or in the surface and have a transit station in the FTI. Because you encroach too much in the UHV. And why you can't put the new east service road on top of the subway?	**USEC Timothy John Batan, DOTr** The entire railway network fully funded. With respect to the three major railway project going north-south through Metro Manila (LRT 1 and extensions, PNR and extensions and MMSP an extensions) these stations are envisioned to converge in the Parañaque area due to geographical constraints (Manila Bay to the west and Laguna de Bay and mountain ranges to the east). Two of the lines (MMSP and PNR) are envisioned to converge at FTI. The stations on top of each other will still occupy the 35 m total of the PNR ROW and East Service Rd. ROW but the East Service Rd. will need to be diverted north which will affect properties 15 m north of the UPS border. The MMSP will also need a temporary yard north of the diverted East Service Rd. with a width of 10 m which will be returned to the owners after the construction.
5.	Land	We encourage you to explore diverting the new East Service Rd. into the existing Cucumber Rd. to avoid taking the 15 m permanent works planned which will affect the UHV properties. The are no jeepney riders alighting starting from Paje to Cucumber Rd. We residents of UHV are willing to go down to our houses from Cucumber Road. We the residents of UHV are willing to have present East Service Rd. permanently diverted to Cucumber Rd. to avoid the project affecting our properties.	**USEC Timothy John Batan, DOTr** If we are to pursue this, we have to change our station use assumptions. If this is possible, this means that all entries and exits will come from the side of Cucumber. We will explore this.
6.	Land	Instead of using the properties of the 200 tax payers, try to borrow an area from ARCA south for the temporary construction yard for 5 years.	**USEC Timothy John Batan, DOTr** There's a big construction yard to store all equipment, piling and construction materials but there's also a construction yard that will surround the assets of MMSP. We are exerting effort to minimize the amount of property to acquire for the strip or temporary construction yard.
7.	Land	We're worried that we might experience flooding in the low-lying area of Pasay, if the gathered soil will be placed in the reclamation area of Maricaban.	**Allan Mandanas, AECOM** The site is only an option, but it doesn't mean that it is already decided and agreed to place spoils from the MMSP excavation in the Maricaban area. The storage of spoils

			will require permits also. The are many future projects that could use the MMSP excavation spoils and its storage is not limited to one area.
8.	Land	In the EIA it was found that the soil is soft, so what if flooding occurs during the pre-construction? Instead of having the MMSP alignment go through Barangay 183 why not try to divert it under the Villamor golf course? Aside from less residents to be affected, concerns of vibration can be avoided. Then during the construction, the traffic may bottle neck at St. Therese and how about the private cars that will pass through? For the post-construction, how about our safety?	**Engr. Mikaela Eloisa Mendoza, DOTr** It is part of the consideration, as the option is yet final. It is not just the land/soil were being studied but also the social impacts. DOTr will consider all of it. Traffic impact assessment is also part of the study. We'll investigate it. We're assuring the residents that the security of the communities is part of our plans.
9.	Land	Why was the original plan of establishing a station at FTI changed to Bicutan? What will be our assurance that we will not be affected or disturb by the project, we're just 30 to 40 meters way from the project site construction. Last year, it was stated that only 15 m will be affected. Why has the affected area expanded?	**Engr. Mikaela Eloisa Mendoza, DOTr** This is due to DOTR's plan have its railways interconnected. In the case of MMSP, it is the interconnectivity of the MMSP with the North-South Commuter Railway Project. It is stated under JICA guidelines, that there are certain requirements to be followed socially and environmentally throughout the lifetime of a project. We will strictly follow these guidelines to ensure that any impact would be minimized or mitigated. We're currently studying how we can stay within the PNR right of way to lessen the affected properties
10.	Land	Can we already identify specifically the structures to be affected?	**Christina Fernandez, DOTr** To determine the areas to be affected, a survey and socioeconomic profiling must be conducted first. Currently we only have the drawings. We need to undergo parcellary survey then conduct ground truthing to confirm the results of the parcellary survey. After that we will conduct socio-economic survey. After that we can determine the specific structures that will be affected.
11.	Land	The Nazarene Church will be affected by the project. We are hoping to get compensated within the year to give us enough time to look for another place.	**Christina Fernandez, DOTr** Sir we can't assure that the property will get paid within a year but we're assuring you that there will be no properties to be replace not until DOTr already paid the owner of the properties as this is part of the JICA's guidelines and it is in the Law (RA 10752) that compensation first before clearance/ replacing of the properties. While awaiting for the payment/ appraisal, the property owner must look for another place but when the

			owner did not meet the allotted time given to them by the DOTr in looking for another place, they will be given a temporary rental subsidy wherein the owner were given a extended time to stay and look for a place.
12.	Land	Is there an establish system for compensation (replacement cost of the property, area where the owner can find/ look for another place)? DOTr will not neglect or forsaken the owners of the properties?	**Christina Fernandez, DOTr** We have an entitlement matrix, but we don't have the valuations, so DOTr will be in partnership of government banks such as, Landbank and Development Bank of the Philippines. Then DOTr along with partner bank will do appraisal/ valuation in the affected lot and structures to identify how much will be compensated to the owner. No. DOTr will not neglect the affected owners/ communities, they will be compensated and be paid off in the right amount. As it is part of the agreement with JICA and affected persons. Also, that is why we conduct Resettlement Action Plan (RAP) to identify who will be the properties to be replace and relocated.
13.	Land	What will happen if the owner of the lot and structure is not the same person? Will the owner of the structure can be compensated?	**Christina Fernandez, DOTr** Is the person who develop the structure has a consent or authority from the lot owner to develop a property in the lot? If yes, the next question is if the person who develop the structures has a tax declaration of the improvements of the structure? because that tax declaration will be the basis of the DOTr if that person will be qualified for relocation/ compensation. If the owner of the structure has no tax declaration, DOTr will identified them as an informal settler and will be subject for further process if they will be qualified for the compensation/ relocation.
14.	Land	It was mentioned in Geology that most of the study area is composed of adobe soil, in which this can be brittle if constant activities being done that may cause subsidence.	**Engr. Mikaela Eloisa Mendoza, DOTr** Geotechnical investigations were conducted. The results of the studies showed that the soil is appropriate for the excavation and tunnelling. In terms of vibration, we plan to employ anti-vibration devices such as sleeper tracks to significantly attenuate vibration.
15.	Land	How will compensation will be dispensed if there are several of us who reside within the affected property? We acquired it from our deceased parents, but the title is still in the name of our grandfather.	**Christina Fernandez, DOTr** Any properties that were still owned/ named by dead person must undergo extra judicial settlement. The siblings should discuss how it will be divided. DOTr will recognize the new owner the property and will be the one who will be compensated
16.	People	Has relocation site of the affected residents been decided? How much the compensation for the affected properties? What is the process?	**Christina Fernandez, DOTr** If it has a title, the current value that will be release by GFI will be applied. The resettlement is only informal settlers
17.	Land	Is the Cucumber Road to be considered as a permanent	**Engr. Mikaela Eloisa Mendoza,**

		diversion for the East Service Road? Will the FTI station be removed? Will there be other alternative options in terms of mode of access road?	**DOTr** As mentioned by USEC Batan, the proposed FTI station is being considered to be placed directly under the proposed PNR station to reduce the number affected property along the proposed FTI station. As of now, there were no alternative options as we are avoiding increasing the social impacts, so we're focusing in the east service road, but we will consider the cucumber road for further study.
18.	Land	Will trees need to be cut to make way for the subway stations?	**Kathleen Anne Cruz, AECOM** Based on the map shown earlier most of the right of way is along built-up areas. The trees affected by the alignment will undergo a tree inventory. Prior to tree cutting a cutting permit will be required to be secured form DENR. DOTr will required to replace what trees that will be cut as required by law. **Christina Fernandez, DOTr** In the new law, the trees to be affected must be subjected for payment. With this, appraisal is needed as the owner of whom planted the trees or vegetation will need to be paid.
19.	Land	If a lot was sold to a new owner but the title is still named under the previous owner, how will this be compensated? Also, would like to suggest if you were going to plant trees in every station can we plant fruit bearing bonsai trees?	**Christina Fernandez, DOTr** The limitation of DOTr is the one who is in the Title will be the only one to be compensated. The title will be the DOTr's basis and proof of the ownership of the properties, unless the there's a deed of absolute sale, then must be annotate in the title in the registry of deeds, for whatever, the sale will be registered and for DOTr honor the person who buy the property. It can be required by the DENR to plant fruit bearing in the surroundings of the stations and every trees will be have name for people know what kind of trees it is. We will consider this in our Greenery options.

Table 2.4-7 Stakeholder Mapping

Stakeholder Group	Characteristics	Concerns /Issues /Fears	Stakes (simple, moral, legal)	Power / Influences	Motives	Behavior / Risk Minimization / Engagement / Political Action Strategy (to be carried out by project proponent
Barangay Captains	Premium on Use Value; have local constituencies (expected to take side of their constituents); community mobilizers; some or their relatives and friends may be project-impacted themselves	Displacement of their constituents; break-up of communities; diminution of community amenities; transparency of information	Simple, legal and moral	Community mobilizers; may withhold community consent	Empathy for constituents; maintenance of integrity of their communities	Transparency of Information; consider Use Value and Exchange Value orientation of stakeholders in engaging them
Homeowners' associations / Residents	Premium on Use value; strong emotional attachment to communities; have material, professional and political resources to campaign opposing project	Displacement; poor track record of government re timeliness of payment; diminution of amenity values of property and community; maintenance of integrity of their communities and properties; freezing of property market and limiting options to sell only to government; fair compensation; anxiety during pendency of acquisition; transparency of information	Simple, legal and moral	Community mobilizers; material, professional and political resources to mount an opposition; articulate in presenting their position	Maintenance of integrity of their communities; land values; amenity values	Transparency of Information; consider Use Value and Exchange Value orientation of stakeholders in engaging them
Commercial property owners/ business owners and operators	Premium on Exchange Value; return-on-investments;	Disruption of business operations; viable options for relocation; timeliness of payment; transparency of information	Simple and legal	Have material, professional and political resources to mount an opposition; articulate in presenting their position	Continuation of operations	Transparency of Information; consider Use Value and Exchange Value orientation of stakeholders in engaging them
Institutions	Premium on Use Value	Disruption of operations; viable options for relocation; timeliness of payment; transparency of information	Simple, legal and moral but premium on moral	Moral ascendancy; public support; community mobilization	No disruption in their mission and operations	Transparency of Information; consider Use Value and Exchange Value orientation of stakeholders in engaging them

Stakeholder Group	Charac te rist ics	Conce rns /Issues /Fears	Stakes (simple , mora l, legal)	Power / Influe nce s	Motive s	Behavior / Risk Minimization / Engagement / Political Action Strategy (to be carried out by project proponent
LGUs	Premium on Use Value especially if a) project goes against current plans of LGUs and support of their constituents and b) no tangible and significant support to their constituents	Displacement of their constituents; break-up of communities; diminution of community amenities; transparency of information	Simple but with premium on legal and moral	Community mobilizers; material, professional and political resources to mount an opposition; articulate in presenting their position	Empathy for constituents; maintenance of integrity of their communities	Transparency of Information; consider Use Value and Exchange Value orientation of stakeholders in engaging them
Boniface Naval Station	Premium on Exchange Value if offered viable options	Disruption of operations; viable options for relocation; transparency of information; security concerns	Simple and legal			Transparency of Information; consider Use Value and Exchange Value orientation of stakeholders in engaging them
DOTr	Exchange Value	Implement the project	Legal	Coercive powers of state	To carry out mandate and implement program, projects and policies	

2.4.4.2 Impact Identification, Assessment and Mitigation

(1) Pre-Construction and Construction

1) Psychological Stress, Anxiety, Uncertainty of Households and Property Owners

Households and business and institutional stakeholders will suffer from anxiety, stress and 'fear of the unknown", affecting their physical and emotional well-being, because of the threat of land and property undergoing land acquisition. Plans will be put on hold pending clarification of information regarding land acquisition. Initially, this condition can be addressed by adopting a policy of transparency and timelines s of information.

2.4.5 Cultural Heritage

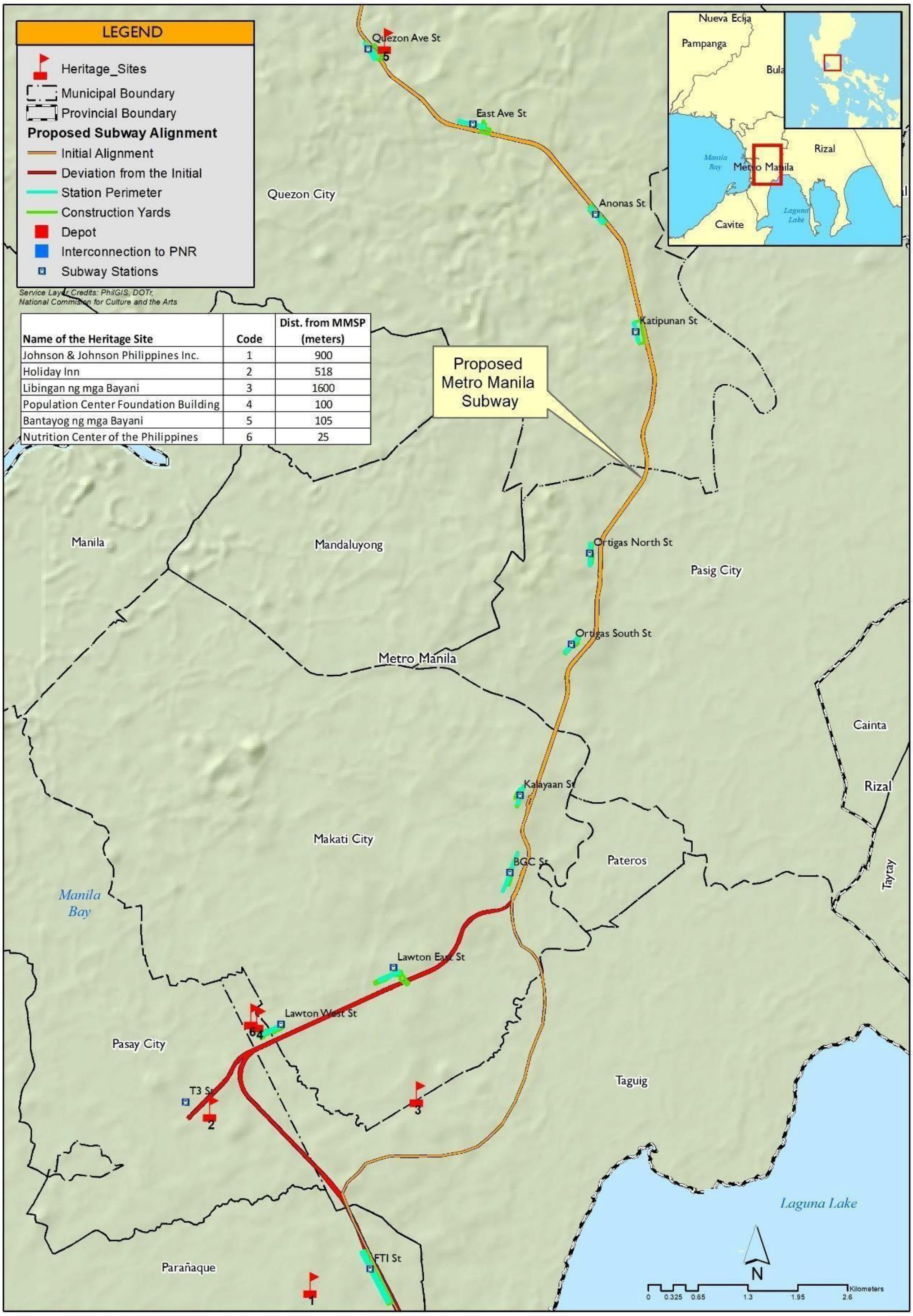
2.4.5.1 Baseline Environment

The Bonifacio War Tunnel, the American War Memorial and Cemetery are two significant historicalsites near the project alignment; however, neither are expected to be impacted by the project footprints. Bonifacio War Tunnelis undergoing engineering assessment and not allsections of the Tunnel have been fully explored. The Nutrition Center of the Philippines is located 25m from the project and is listed in the Philippine Registry of Cultural Properties with the notation 'Interior Design'. It is suggested that an assessment be made as to what aspects of the 'interior design' could be removed and preserved elsewhere. A photo-documentation of the entire 'interior design' will also be made to serve as a historical memory.

Table 2.4-8.and **Figure 2.4-1** present six identified heritage sites near the alignment. Nonetheless only the Nutrition Center of the Philippines Building is at risk of displacement because of a project footprint is planned on its present site; the others will be affected in varying degrees but none as significant as the Nutrition Center.

Table 2.4-8. Cultura l Heritage Sites in the Vicinity of the MMSP Alignment

Herita ge Site	Distance from MMSP (meters)
Johnson and Johnson Philippines Inc.	900
Holiday Inn	518
Libingan ng mga Bayani	1,600
Population Center Foundation Building	100
Bantayog ng mga Bayani	105
Nutrition Center of the Philippines	25



Name of the Heritage Site	Code	Dist. from MMSP (meters)
Johnson & Johnson Philippines Inc.	1	900
Holiday Inn	2	518
Libingan ng mga Bayani	3	1600
Population Center Foundation Building	4	100
Bantayog ng mga Bayani	5	105
Nutrition Center of the Philippines	6	25

Figure 2.4-1 Location Map of the Heritage Sites

2.4.5.2 Impact Identification, Assessment and Mitigation

(1) Pre-Construction and Construction

The Nutrition Center Foundation of the Philippines is directly at risk of being displaced by a station plaza. Because of a notation on ‘Interior Design’ in its entry in the Philippine Registry of Cultural Properties, it is suggested that an assessment of this notation be undertaken in order to identify what aspects or sections of its ‘Interior Design’ can be saved and eventually preserved elsewhere. A photo documentation of the ‘Interior Design’ will likewise be undertaken to preserve it for historical memory.

2.4.6 Transport and Traffic

(1) Study Area

The study area for the transport and traffic study covers the road and public transportation network adjacent to every MMSP stations from Quirino Avenue up to Bicutan Station.

(2) Field Surveys and Sampling Areas

Traffic surveys for the original alignment was done on 26 April2018 (Thursday) and 28 April2018 (Saturday) as reported in “Traffic Impact Assessment and Related Study for Traffic Management Plan for the Detailed Design Study of the Metro Manila Subway Project in the Republic of the Philippines, 2018”. Additional surveys were also done specifically for NAIA Terminal 3 and FTI Stations on 5 July 2019 (Friday) and 8 July 2019 (Monday), respectively.

Table 2.4-1 Summary of field surveys and sampling activities – Trans port and Traffic

Field Activity	Date Conducted	Map Reference
Classified Directional Traffic Volume Count Survey (Original Alignment)	26 to 28 April 2018	Traffic Impact Assessment and Related Study for Traffic Management Plan for the Detailed Design Study of the Metro Manila Subway Project in the Republic of the Philippines (2018)
Classified Directional Traffic Volume Count Survey (Additional Stations)	5 to 8 July 2019	Annex XX.

(3) Survey Methodology

The methodology used in the survey is classified traffic volume count survey. This involves counting of vehicles for each direction at strategic intersections which were further classified as private cars/taxis, Asian Utility Vehicles (AUVs), public utility jeepneys (PUJs), buses, small trucks, big trucks, motorcycles, tricycles, and non-motorized transport (i.e. bicycles, EKS, etc.). Majority of the survey stations for the original alignment and additional stations were done on a 16-hour count which is already sufficient to determine the peak periods of the transport network. Four areas did a 24-hour traffic survey count, namely NAI A T 3, Anonas/Kamias Road, Meralco/Ortigas Ave, and C5/26thAve.

2.4.6.2 Baseline Environment

(1) Transportation Network

Road Network

Metro Manila currently has ten (10) radial roads (R-1 to R-10) and six (6) circumferential roads (C-1 to C-6), which conveys traffic in and out of Metro Manila and surrounding cities/municipalities and to the provinces.

The sixth circumferential road, C-6, which aims to connect the north provinces to the south without the need to ply through Metro Manila, was recently constructed.

The metropolis is likewise linked by expressways to CALABARZON on the south by the South Luzon Expressway (SLEX) and the Skyway System (Skyway), to Central Luzon on the north by the North Luzon Expressway (NLEX) which T-connects to Subic Clark Tarlac Expressway (SCTEX). On the southwest is the Manila Cavite Expressway (CAVITEX) running along the coastline of Manila Bay and Cavite, and the NAI A Expressway which connects to NAIA Airport. Recently constructed are NLEX Harbor Link T ollw ay and Segment 10. Within Metro Manila that are currently under construction or partially constructed are Skyway Stage 3 and NLEX-SLEX Connector Road, both of which aim to provide a seamless and direct connection between NLEX and SLEX which are expected to be operational by 2020.

Railway Network

Currently, there are three (3) elevated and one (1) on-grade railway system operating within Metro Manila:

1. Light Rail Transit (LRT) Line 1 that traverses along R-2 in the southern section and R-9 and C-4 in the northern section which has a potential to connect to North Avenue "Common Station";
2. LRT Line-2 along R-6 Corridor that has a connection to LRT Line-1;
3. MRT Line-3 along C-4 corridor which is also connected to LRT Line-1 and Line-2 which also has a potential to connect to North Avenue "Common Station"; and
4. PNR South Commuter Line from Tutuban in Manila to Alabang in Muntinlupa.

The lines that are currently in under construction are the LRT Line-2 East Extension to be completed in 2019, and MRT Line-7 along R-7 corridor that traverses from North Avenue "Common Station" to San J ose del Monte Station in Bulacan to be operational by 2020. The PNR North Commuter Line was closed in 1984 and is lined up for rebuilding with the expected opening of the North-South Commuter Railway (NSCR) Malolos to Tutuban segment in the latter part of 2021.

The MMSP Stations would also have a potential connection to other existing/on-going construction of rail stations such as MRT3 Quezon Avenue, LRT2 Anonas, NSCR FTI, and LRT1/MRT3/MRT7 North Avenue Common Station.

Air Transportation

Within Metro Manila, one (1) airport with four (4) passenger terminals are present: NAIA Terminals 1, 2, 3, and 4. MMSP aims to connect to the airport via the NAIA Terminal 3 MMSP station.

Since MMSP is planned to connect with NSCR which aims to connect to Clark International Airport (CIA) , both NAIA and CIA will potentially be connected by rail in the future. This is in accordance with the DOTr strategy to adopt a dual airport scheme, where NAIA is seamlessly connected with NAIA to meet increasing demand.

Water Transportation

The Pasig River Ferry Service is currently the only water-based transportation in Metro Manila. It cruises through the Pasig river and its service area stretches from Pinagbuhatan, Pasig City to Intramuros, Metro Manila.

Other Public Transportation

Other modes of public transportation available within Metro Manila area are City and Provincial Buses, Point-to-Point Buses (P2Ps), taxis, Public Utility Jeepneys (PUJs), Asian Utility Vehicles (AUVs) (e.g. GT and UV Express), and tricycles. **Table 2.4-2** shows the matrices of other public transportations available within the 400-meter radius of the proposed MMSP Stations.

Table 2.4-2 Public Transportation Availability within 400-met e r radius of MMSP Stations

Subway Station	Taxis	PUJs	AUVs	City Bus, P2P	Tricyc le s
Quirino Highway	✓	✓	✓	✓	✓
Tandang Sora	✓	✓	✓		✓
North Avenue	✓	✓	✓	✓	
Quezon Avenue	✓	✓	✓	✓	✓
East Avenue	✓	✓	✓	✓	✓
Anonas	✓	✓	✓		✓
Katipunan	✓	✓	✓		
Ortigas North	✓	✓	✓	✓	
Ortigas South	✓	✓	✓		
Kalayaan Avenue	✓	✓	✓	✓	
Bonifacio Global City	✓	✓	✓	✓	
Lawton East	✓	✓	✓		
Lawton West	✓	✓	✓		
NAIA Terminal 3	✓	✓	✓	✓	
FTI	✓	✓	✓	✓	✓

(2) Traffic Survey Results

The numbers from the traffic surveys done in 2018 were projected to 2019 values with an average annual growth rate (AAGR) of 2.07%, as derived from MMDA's historical traffic counts for radial and circumferential roads.

From the surveys, the consolidated results during the weekday found out that traffic peaks from 7:00 AM to 8:00 AM in the AM peak and 6:00 PM to 7:00 PM in the PM peak. In general, the overall traffic volume in the AM peak is 8.22% higher than PM peak. It is observed that majority of the traffic flow during the AM peak are heading towards schools and major central business districts (CBDs) within Metro Manila. While during the PM peak, traffic flow is substantial for both directions.

The vehicle composition for all stations are summarized in **Table 2.4-2**. Generally, the table shows that private cars/taxis has the highest vehicle share, followed by motorcycles. The numbers would serve as basis f or deriving the modal split of boarding and alighting commuters to and from the stations. The numbers would also serve as guide for estimating the potential modal shift of commuters from patronizing automobile transportation towards rail-based transportation, which would potentially improve the overall traffic performance due to reduction in vehicle traffic volume.

Table 2.4-3 Vehicle Compos it ion of Roads near MMSP Stations (%)

Subway Station	Private Cars/ Taxis	PUJ	AUV	Bus	Small Trucks	Big Trucks	Motorcycle s	Tricyc le s	Non-Motorized Transport
Quirino Highway									
Tandang Sora									
North Avenue									
Quezon Avenue	55.8%	7.0%	10.1%	3.5%	0.9%	0.3%	20.7%	0.0%	1.7%
East Avenue	51.1%	10.6%	0.4%	2.2%	1.4%	0.5%	29.1%	3.4%	1.2%
Anonas	39.2%	14.3%	6.2%	0.3%	1.7%	0.4%	34.5%	1.1%	2.2%
Katipunan	53.2%	3.2%	2.2%	0.1%	1.2%	0.2%	38.4%	0.3%	1.2%
Ortigas North	51.1%	3.1%	5.3%	2.1%	1.9%	0.2%	34.2%	0.0%	2.1%
Ortigas South	50.4%	4.0%	4.5%	3.5%	0.7%	0.1%	33.8%	0.0%	2.8%
Kalayaan Avenue	45.3%	6.3%	6.7%	0.8%	2.4%	1.0%	35.2%	0.1%	2.0%
Bonifacio Global City	50.9%	2.4%	1.3%	0.6%	0.4%	0.1%	41.1%	0.0%	3.3%
Lawton East	56.2%	1.9%	0.4%	0.4%	0.6%	0.2%	35.8%	0.1%	4.5%
Lawton West	43.0%	1.5%	1.6%	0.2%	1.0%	0.3%	47.1%	0.2%	5.1%
NAIA Terminal 3	67.3%	0.5%	4.5%	0.7%	1.3%	0.1%	24.6%	0.1%	1.0%
FTI	13.0%	3.6%	0.1%	0.0%	2.9%	0.0%	65.7%	12.8%	1.8%

(3) Baseline Traffic Performance

The roads adjacent to the proposed MMSP stations were evaluated using the prescribed road capacities as shown in **Table 2.4-4**, and the level-of-service (LOS) criteria for Philippine Roads as presented in **Table 2.4-5**. The LOS qualitatively describes the traffic performance of the road network where it is ranged from LOS A (best) to LOS F (worst), as stated in the US Highway Capacity Manual (HCM).

Table 2.4-4 Road Capacities

Area	Road Category	Carriageway Type	Capacity 1-way pcu/day/la ne	Capacity 1-way pcu/hour/lane	Maximum Speed
Inside EDSA	Local Road	Single	2,200	220	30
	Secondary	Single	4,400	440	40
	Primary	Single	6,600	660	45
Outside EDSA; Inside Metro Manila	Secondary	Single	7,700	770	50
	Primary	Single	8,250	825	60
	Secondary	Divided	14,000	1,400	70
	Primary	Divided	16,500	1,650	80
Outside Metro Manila	Local Road	Single	8,000	800	30
	Secondary	Single	11,000	1,100	55
	Primary	Single	15,400	1,540	60
Urban/Intercity	Access/Egress	Single	15,000	1,500	80
	Expressway	Single	17,000	1,700	80
	Expressway	Divided	20,000	2,000	100

Source: JICA Study Team on MUCEP Study (2014

Table 2.4-5 Level- of- Service for Philippine Highway s

Level of Service	Volume-to- Ca pac it y Ratio (V/C)	Rema rk s
A	≤ 0.20	Free flow traffic
B	0.21 – 0.50	Free flow traffic
C	0.51 – 0.70	Moderate traffic
D	0.71 – 0.85	Moderate to heavy traffic
E	0.85 – 1.00	Heavy traffic
F	> 1.00	Forced flow. Stop and go

Source: DPWH Highway Planning Manual (1982)

The 2019 Base Case network performance for AM and PM peak periods are summarized in **Table 2. 4- 6**. I t shows that, on the average, the resulting levels of service would still fall from LOS B to LOS D. This means that on the average, traffic during peak periods would still vary from 'free flow traffic' towards 'moderate to heavy traffic' in the station catchment areas. However, it will be noted that when LOS is calculated individually, there are several road segments that are already experiencing heavier congestion (LOS E to F) due to bottlenecks at intersections and various roadside friction (e.g. PUV loading/unloading, vehicles stalling along the road, etc.).

Table 2.4-6 2019 Base Case Network Performance

Subway Station	AM Peak		PM Peak	
	Overall V/C Ratio	Average LOS	Overall V/C Ratio	Average LOS
Quirino Highway				
Tandang Sora				
North Avenue				
Quezon Avenue	0.85	D	0.78	D
East Avenue	0.61	C	0.38	B
Anonas	0.71	D	0.58	C
Katipunan	0.81	D	0.84	D
Ortigas North	0.79	D	0.85	D
Ortigas South	0.59	C	0.53	C
Kalayaan Avenue	0.75	D	0.73	D
Bonifacio Global City	0.54	C	0.48	B
Lawton East	0.76	D	0.53	C
Lawton West	0.64	C	0.64	C
NAIA Terminal 3	0.77	D	0.62	C
FTI	0.75	D	0.63	C

(4) Summary of Findings

The major findings for transport and traffic are summarized in the table below.

Table 2.4-7 Baseline Summary of Findings – Trans port and Traffic

Baseline Inform at ion	Key Findings and Conclusions
Vehicle Composition near MMSP Stations	Private cars compose the majority of the modal split across all the roads in the study area, ranging from 39%-67% share of the road. Private car modal split is low only in FTI area, at 13%. Motorcycles is the second most used transport mode, ranging from 20%-47% of the modal split (except in FTI where motorcycles account for 65% of the road share). PUVs such as PUJs, AUVs, and tricycles consist of 5%-20% of the modal split if combined. Road share of trucks is around 1%-4%. Non-motorized transport such as walking and biking account for 1%-5% of the modal split.
Traffic Performance Measures	Average volume-to-capacity ratio for the roads adjacent to MMSP stations are ranged from LOS B (free-flow traffic) to LOS D (moderate to heavy traffic) during peak periods. By looking into individual roads, several road segments are experiencing heavy traffic to congestion (LOS E to LOS F) due to bottlenecks at intersections and various roadside friction (e.g. PUV loading/unloading, vehicles stalling along the road, etc.).

(5) Pre-Project Summary of field surveys and sampling activities – Transport and Traffic Assessment (2017 EIS) and additional data for the EPRMP (2019)

Transport and traffic surveys were not done in the 2017 EIS. Therefore, all baseline traffic data used in this report were based on the primary data conducted in 2018 (for the original alignment), and 2019 (f or the additional subway stations in the new alignment).

2.4.6.3 Travel Demand, Potential Traffic Impacts, and Options for Prevention, Mitigation, and/or Enhancement

(1) Travel Demand Projections

The projected daily and peak hour commuter boarding and alighting is presented in **Table 2.4-6**. The boarding and alighting information is translated to commuter trip generation. The peak hour commuter generation of the stations is equivalent to 12.5% of the daily demand. Factoring in the vehicle composition as presented in **Table 2.4-8**, availability of nearby interconnected mass transit station, and the vehicle occupancy as reported in MUCEP, the equivalent vehicle trip generation of commuters using MMSP can be derived.

Table 2.4-8 Project e d Total Commut r Boarding and Alighting per Station ('000 Passengers)

Subway Station	Daily Total Boarding + Alighting			Peak Hour Total Boarding + Alighting		
	2025	2035	2045	2025	2035	2045
Quirino Highway	116	120	117	14.5	14.9	14.6
Tandang Sora	8	17	18	1.0	2.2	2.2
North Avenue	97	143	142	12.2	17.9	17.8
Quezon Avenue	28	65	68	3.5	8.1	8.5
East Avenue	49	71	73	6.2	8.9	9.1
Anonas	132	168	167	16.5	21.0	20.8
Katipunan	75	79	80	9.4	9.9	10.0
Ortigas North	78	97	102	9.7	12.2	12.7
Ortigas South	66	85	91	8.2	10.7	11.4
Kalayaan Avenue	72	104	105	9.0	13.0	13.2
Bonifacio Global City	155	227	228	19.4	28.3	28.5
Lawton East	36	40	41	4.5	5.0	5.2
Lawton West	32	63	65	4.0	7.9	8.1
NAIA Terminal 3	36	69	74	4.5	8.7	9.2
FTI	18	67	68	2.2	8.3	8.5

Source: JICA Study Team

(2) Potential Impacts and Options for Prevention, Mitigation, and/or Enhancement

Traffic Impact During the Construction

Because of the mobilization of heavy vehicles and equipment, construction activities, and staging of construction works, restriction on some roadways and sidewalks will be unavoidable. This will lead to increased traffic congestion and changes in traffic patterns during construction. Motorists, cyclists, and pedestrians might alter their trip routes to their inconvenience in order to avoid heavy traffic in the construction areas.

To address this, a Traffic Management Plan (TMP) that details the activities to adequately manage traffic flow during construction will need to be created and strictly implemented. The TMP will be properly coordinated and approved by the MMDA, LGUs, and other local stakeholders concerned. Some measures that may be included in the plan are rerouting of traffic and proper scheduling of logistics of heavy structures during off-peak periods when there are fewer vehicles on the road.

To maintain the existing road lanes during construction works, roadside lands shall be acquired for the temporary construction yards. The basic method for excavation involves a moving construction yard, depending on the phase of construction. When half of the road is opened for excavation, the flow of traffic will be transferred to the side of the road. After the first half of the road is excavated, it will be covered with pre-cast panels to make it passable. The next half of the road will then be excavated. Afterwards, the traffic will be diverted to the construction yard and the covered portion of the road. It is also important to maintain the number of traffic lanes for each direction to minimize bottlenecking in one area. Employing this proposed excavation method will also ensure that people will have continued access to facilities near the project area.

In the case where the station site has sufficient land adjacent to the station footprint, traffic can be diver ted sideways while the stations are modularly constructed. For the station sites that have minimum land adjacent to the station footprint, some traffic will be diverted to side streets while the stations are modularly constructed. Whenever applicable, another traffic mitigation method that can be considered is to introduce a steel deck on top of the underground works once the side wall(s) are constructed, for the light vehicles to run on top while the construction under the deck can be continued.

Traffic Impact During Operations

The MMSP will generally improve the traffic situation within the project area due to expected shift of commuters from road-based vehicular transport to rail-based mass transit system. The project will also result to a shorter travel time and convenience for commuters especially for those in the nor ther n, central, and southern parts of Metro Manila.

At present, travel time from Quirino Highway to FTI by public bus through EDSA will take approximately 2.5 hours. Using the subway, travel time from Quirino Highway to FTI will only take 43 minutes. Hence, travel time will be shortened by approximately 107 mins/passenger. Considering that the subway can accommodate 365,000 passengers per day during its opening year 2025, the total travel time reduction translates into increase in employee productivity estimated for at least Php 39 M per day.

The project benefit will be enhanced by expanding ridership between various parts of Metro Manila. Thus, the operator will ensure the efficient, reliable and safe operation of the system with zero down time through regular maintenance. Linkages with LRT and MRT railway lines, bus, jeepney, and AUV stations will also be considered for efficient and seamless passenger flow transferring to other modes of transportation. Fares must be affordable to the riding public. Discounts will be extended to students, person with disabilities and senior citizens. In addition, provision of park and ride facilities for bike, motorcycle, and car user scan enhance patronage of the MMSP.

On the contrary, there may be an increase in the roadside friction along the roads adjacent to stations, where commuters are likely to wait, load and unload to and from other modes of road transport. To address this potential increase in traffic due to roadside friction, it is recommended to convert the construction yard areas into people-oriented facilities with sidewalks, internal taxi bays and loading/unloading stations or intermodal central terminal stations for interconnectivity with mass transit and public utility vehicles, as illustrated in **Figure 2.4-1**. Coordination with MMDA, LGUs, and local estate developers could also be done to assign traffic enforcers in critical areas.

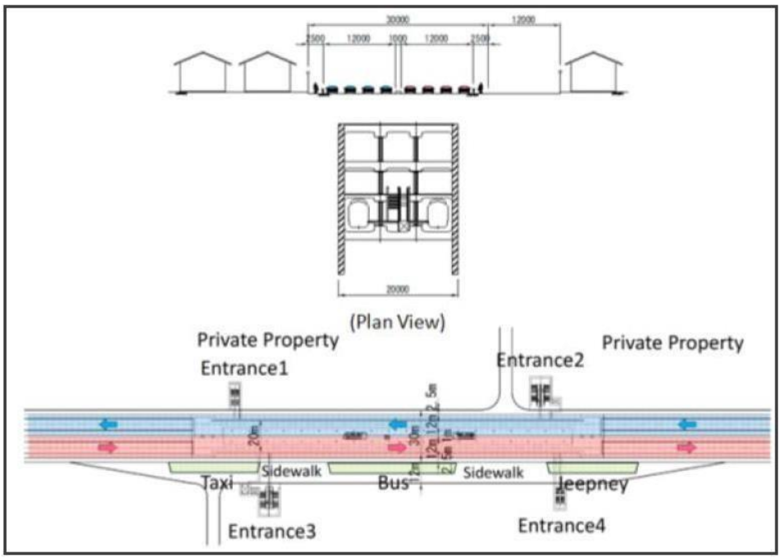


Figure 2.4-1 Illustration of Plan for Conversion of Construction Yard

After the construction works, the acquired lands will be utilized for Transit Oriented Development (TOD). TOD will ensure mobility of people and accessibility to services and activities by promoting seamless connectivity with various transport modes; and will promote compact and energy efficient urban spatial structure at and around the stations. The following TOD concepts will be considered:

- Stations will be designed to provide a safe, convenient and comfortable pedestrian access within a walkable area from the station. Improving accessibility of pedestrian and non-motorized transport to the stations will contribute to increasing public transport usage and reducing private car use.
- Sidewalks and station plazas can be designed into parks with green spaces to encourage walking and social interaction, as well as enhance the urban environment.

- Integrate in the subway design the universal access for all passengers including pregnant women, elderly people, and persons with disabilities or special needs.
- Some of the preliminary TOD concepts for MMSP include:

  - Connection of neighboring business/commercial facilities with the stations;
  - Consider and integrate the design of connection to feeder public transportation services such as buses, jeepneys, and AUVs to improve passenger convenience and expand the transit supportive catchment area. To implement access improvement, coordination with the relevant public sector such as DPWH and LGUs as well as local community is imperative;
  - Conversion of construction yards into facilities with adequate sidewalks, internal taxi bays, loading and unloading stations or intermodal central terminal stations for interconnectivity with mass transit and public utility vehicles;
  - Direct and seamless transfer with stations of other railway systems such as LRT1, MRT3, MRT7 and North Integrated Transport Terminal (ITS) for bus and jeepneys at the North Avenue Station;
  - Direct transfer with MRT3 Quezon Avenue Station and Manila BRT to MMSP Quezon Avenue Station;
  - Direct transfer with LRT2 Anonas Station to MMSP Anonas Station;
  - Direct transfer with North-South Commuter Railway (NSCR) and Taguig ITX (bus, jeepney, AUV), access to ARCA South in FTI Station;
  - Direct access between NAIA Terminal3 to MMSP NAIA Terminal3 Station, access to Newport City
  - Transit terminal connecting BGC Station with the Makati-Pasay-Taguig Mass Transit System Loop (MTSL) Project
  - Potential direct transfer with LRT4 to MMSP Ortigas North Station

Traffic Impact Due to Climate Change

Flooding and heavy rain may pose additional traffic burden. As such, the construction materials and methods must take into consideration the additional risks posed by climate change. This is specifically important in the subway tunnels, where flooding may happen. As such, it is recommended that the engineering design must be prepared to withstand incidents due to climate change. In addition, the stations and station access must have adequate flood control measures in the case of heavy rain. It is also recommended that the design of station plazas and parks with green spaces must also function as water catchment basin to reduce water accumulation during heavy rain.

Potential Traffic Impacts Matrix

The potential traffic impacts and our options for prevention or mitigation or enhancement for all construction and operations phases are summarized in the next table.

Table 2.4-9 Potential Impacts and Options for Prevention, Mitigation, and/or Enhanment – Transport and Traffic

Potential Impacts	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construction	Construction	Operation	Closure	
Increase in traffic congestion due to mobilization of workers, heavy equipment and construction	X	X		X	• Proper traffic management plan (TMP) (road closures, traffic rerouting, etc.) will be applied for all stations.

Potential Impact s	Phases				Options for Prevention or Mitigation or Enhancement
	Pre-construct ion	Construction	Operation	Closure	
materials, transport of demolition debris, and excavated soil.					• Proper coordination and approval of TMP by MMDA, LGUs, and local estate developers concerned. • Implementation of a moving construction yard during different phases of the excavation process to minimize traffic congestion. • Provision of alternate roads/routes to provide supplemental road capacity. • Proper phasing of the construction schedule which will aim to minimize traffic disruption. • Proper scheduling of transport of heavy structures during periods when there are less vehicles on the road as approved by MMDA, LGUs, and local estate developers.
Easement of traffic congestion			X		• Regular preventive maintenance of the subway system to maintain efficient, reliable, and safe subway operation and maintain its economic and social benefits. • Provide convenient and close linkages with stations/stops of other rail lines and PUVs such as buses, jeepneys, and AUV for the seamless and efficient passenger flow transferring to other modes of transportation which will solve the “last-mile” problem and enable travelling around Metro Manila entirely by walking and public transport without reliance on private vehicular transport.
Increased vehicular flow in areas adjacent to stations			X		• Conversion of construction yards into sidewalks, internal taxi bays, loading and unloading stations or central stations for public utility vehicles to reduce or even remove roadside friction. Stations should be properly designed to optimize connectivity with pedestrians and other public transport modes which should further minimize the congestion/ bottlenecks along roads. • Provide better walkability and connectivity with other transport modes in the MMSP station areas to enable travelling around Metro Manila entirely by walking and public transport without reliance on private vehicular transport. This will shift people from using private cars to using walking and public transport, thereby reducing traffic congestion. • Coordination with MMDA, LGUs, and local estate developers to assign traffic enforcers in critical areas • Utilization of acquired lands for TOD.
Increase in traffic congestion due to climate change	X	X	X		• Construction materials and methods must take into consideration climate change impacts, especially flooding on subway tunnels. • Stations and station access must have adequate flood control measures in the case of heavy rain • The design of station plazas and parks with green spaces must also function as water catchment basin to reduce water accumulation during heavy rain.

CHAPTER 3 ENVIRONMENTAL MANAGEMENTPLAN

The Environmental Management Plan (EMP) is a summary of the identified potential impacts and the proposed mitigation. The EMP is a document that must be constantly updated depending on project operations, changes in technology, changes in legislation and current needs. The impacts and mitigations are presented on a per project phase.

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
3.1 Pre- Construction and Construction Phase						
Ground surveys, geotechnical surveys, ground clearing, preparation of the site for facilities, demolition of existing structures and use of heavy equipment	Land	• Alteration of original topography	• Minimize ground disturbance through avoidance of unnecessary excavations. • Ensure that roads repaired after surface works would follow the same slope conditions prior to construction.	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Land	• Generation of surplus soil	• Regular hauling of excavated materials and storage in pads with appropriate soil protection facilities or management systems • Surplus soils can be repurposed for use in otherproject • Preparetraffic plan to manage the ingress and egress of soil/rock hauling machines			
	Land	**Change in vegetation** Potentiall removal of approximately 63.23 ha of above ground land area	• Clearly define the extent ofvegetation removal prior toclearing activities. • Secure tree cutting and earth balling permits from the DENR. • Replacement of cut trees will be in accordance with DMO 2012-0 2.			

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
			• Provision of offset sites for areas that will be cleared.			
Detailed-design and planning stages	Air	Sea level rise, increased intensity of storms, increased temperatures, and exposure to climate change-induced flooding and storm surge	• Establishment of comprehensive management systems for climate adaptation • Include climate risk and opportunities in the risk-identification process • Integration of climate-related risks and mitigating measures • Ensure robust engineering design and construction standards for facilities	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
General construction works (Tunneling, excavation, drilling, Delivery of construction materials, etc.)	Land	Alteration of original topography	• Minimize ground disturbance through avoidance of unnecessary excavations. • Ensure that roads repaired after surface works would follow the same slope conditions prior to construction.	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Land	Generation of surplus soil	• Regular hauling of excavated materials and storage in pads with appropriate soil protection facilities or management systems • Surplus soils can be repurposed for use in other project • Prepare traffic plan to manage the ingress and egress of soil/rock hauling machine s			

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
	Land	Alteration of underground stress distribution	• Perform tunnel deformation analysis to determine how the hollowing of ground will affect underground stress regimes • Install piezometers to monitor groundwater pressure around the tunnel			
	Land	Contamination of soil	• Implement proper waste management and disposal system to prevent contamination of surround in g soil and water. • Use strong and durable materials for pipes to prevent leakage. • Use non-reactive materials for pipes and other buried components to ensure that soil contamination is prevented.			
	Land	Tunnel deformation / failure	• Design and construct facilities according to geomechanical properties of the rock. • Properly line tunnel wall with water-proof material • Install monitoring piezometers to monitor groundwater pressure • Conduct regular leveling surveys and deformational studies			
	Land	Groundwater ingress	• Install piezometers to monitor groundwater pressure around the tunnel,			

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
			• Ensure that the tunnel is sufficiently supported and lined to prevent failure and ingress of groundwater. • Install dewatering pumps and secure necessary discharge permits • Provide necessary drainage in trenchworks			
	Land	Inducement of subsidence	• Perform tunnel deformation analysis to determine how the hollowing of ground will affect underground stress regimes • Install piezometers to monitor groundwater pressure around the tunnel • Regular visual monitoring and level survey to detect sinking of ground			
	Land	**Threat to local existence of endemic and/or threatened plant species** Eleven (11) threatened plant species and twenty-eight (28) threaten e d wildlife species were recorded.	• Secure earth balling permits from DENR • Perform transplanting and earth balling activities with a horticulturist/agriculturist • Maintenance activities will be conducted to ensure high survival rates of earth balled tree species.			
	Land	**Accumulation of dust on the leaf laminae**	• Regular water sprinkling (especially during the dry season along dusty areas)	DOTr Contractor	Included in the construction	Bid Documents/ Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
					cost and DED cost	
	Land	**Unnecessary engine, motor or muffler noise** May affect the physiology, behavior, reproduction and long-term survival of wildlife	• Proper maintenance of construction vehicles, and machinery.	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Land	**Light in g effect s to wildlife** May potentially affect wildlife behavior, disrupt seasonal day cues, cause temporary blindness, and disrupt predator- prey relationships	• Use of light source with directional lighting and screens to concentrate light on operations.	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Water	**Change in drainage morphology** • Ground disturbance during construction activities may temporarily disrupt natural drainage flow which may result to the development of new surface runoff paths • Tunneling works using TBM are not anticipate d to impact river/stream waterflow s	• All trench and foundation will be backfilled and ground-restored to its original condition	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Water	**Inducement of flooding/reduction in stream volumetric flow**	• Temporary drainage and detention cum siltation ponds can be constructed to mitigate localize d flooding.	DOTr Contractor	Included in the construction cost and DED	Bid Documents / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		Some sections of the alignment will traverse areas with moderate to high flooding susceptibility	• Stations will be provided with permanent bund walls • The Depot will be provided with a drainage system • Construction Waste Management Plan will be implemented		cost	
	Water	**Change in stream dept h** • Temporary cofferdams will be required during the construction of the Quirino Highway Station, which will encroach on top of a Talipapa creek. • Cofferdams constrict waterways and reduce flow area, which may cause a minimal increase in water surface level upstream of the construction area • Tunneling works are not anticipated to induce changes in stream depth given that the tunnel will be located about 16 m Underground on average	• Construction activities along the waterway will be conducted during the drier months of the year or during low flows whenever practicable. • Diversion channels will be installed, if appropriate	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Water	**Depletion of water resources and water competition**	• Potable water will be sourced from local water utility providers if necessary.	DOTr Contractor	Included in the construction cost and DED	Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		• Fresh and potable water will be required during the construction and operation phase of the project which may strain existing water sources used by the community • potential water competition as result of the project activities is unlikely			cost	
		Ground water Drawdown Groundwater dewatering during the tunneling works could potentially induce groundwater drawdown	• Conduct detailed hydrogeological/ groundwater study in the detailed design stage. • Installation of monitoring wells for observation along the subway tunnel and monitor change of the surrounding ground water levels • If water supply of people relying on groundwater along the alignment decreases, DOTr shall make arrangements to supply affected people with water. • DOTr will coordinate with NWRB regarding tunneling activities along the alignment and its potential effects on the water table	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
			• A Dewatering Permit may have to be secured from NWRB prior to tunneling activities.			
	Water	**Wastewater generation during earth moving and site preparation**	• Maintain adequate temporary toilet facilities • Strictly require the contractor & workers to observe proper waste disposal and sanitation	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Water	**Sediment influx in waterways**	• Designation of buffer zones approximately 5 m from each bank • Ensure that the potential delivery of sediments and other particulate matter into the stream channel will be carefully handle and kept at minimum	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Water	Hazardous waste generation/ disposal during site preparation	• Everyday monitoring in the site if there were leakages. • Temporary installation of adequate hazard o us waste facilities.	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Air	**GHG Emission** Direct GHG emissions total 9,383.46 tonnes of CO_2-e per year due to the combustion of fossil fuel. Indirect GHG emissions total 14,497.89 tonnes of CO_2-e from the purchase of electricity. For the operations phase, the total annual GHG emissions are 109,021.00 tonnes of CO_2-e per year.	• Regular maintenance of construction vehicles and heavy equipment • Close monitoring of equipment dispatches • Compensate, if necessary, the release of GHG during construction and operation by means of implementing carbon dioxide capture and sequestration through progressive rehabilitation	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
	Air/ People	**Degradation of air quality** Fugitive emissions (TSP and PM_{10}) in the area.	• Implementation of speed limit and water suppression methods to unpaved roads and stockpiles • Delivery trucks will be covered • Regular ambient air quality monitoring • Provision of PPE to workers	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Air	Particulates and gaseous emission	• Subcontractors vehicles to undergo emission testing prior to contract award • Fuel burning equipment will be managed through the utilisation of low sulphur fuel, where possible • Traffic management guidelines will be included in the induction seminar of workers • Fuel efficiency will be maximized through scheduling of vehicles and equipment • Equipment and vehicle loadings will be optimized through accurate monitoring and calculation of fuel requirements • Vehicles and construction equipment will be regularly maintained • Equipment dispatch will be monitored closely in order to eliminate unnecessary use • Standard occupational health and safety practices will be implemented pursuant to BWC-DOLE Occupational Safety and Health	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
			Standards (Department of Labor and Employment, 1989); and • Regular ambient air quality monitoring will be conducted			
	Air	Increase in noise level and ground vibration	• Using equipment or machines that produce lesser noise, or considerations in using mufflers to minimize noise. • Strategic scheduling of activities per period within a day • Equipment or machineries will be maintained regularly • Conduct a construction noise and predicted noise study • Construction of wall enclosures on areas that produce a lot of noise to minimize disturbance within the immediate area.	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Air/People	May cause hearing problems to workers who operate nearby machineries or equipment that produce extremely loud noise	• Implementation of PPE, such as ear muffs and ear plugs, during work hours for the safety of the workers. • Taking note of equipment/machines that produce extremely loud noises (beyond tolerable levels – 85 decibels (Fink, 2017)) and keeping these areas off limits from workers for their safety. • Implement permissible noise levels for	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
			construction workers as suggested by DOLE			
	Air/People	May cause hearing problems to nearby residents who are a part of the vulnerable groups, and the public.	• Active response of LGU through necessary health programs for vulnerable groups, and massive public information for those areas that can produce noise level beyond tolerable limits of human ears.	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	Air	**Increase in ground vibration** TBH and drilling during construction and subway operation may potentially result into an increase of ground vibration	Conduct predicted vibration level study. Strategic scheduling of vibration-induced works. Installation of vibration control measures: • vibration insulating sleeper • sleeper with elastic layer directly fastened track • secondary lining	DOTr Contractor	Included in the construction cost and DED cost	Bid Documents / Contract Agreement
	People	Hazardous Waste Generation	• Registration of the proponent as a hazardous waste generator • Collection of hazardous wastes in proper receptacle • Storage of fuel and chemicals in appropriate storage area provide d with secondary containment in case of spills • Collection of hazardous waste by a DENR accredited hauler • Treatment of hazardous waste by a DENR accredited treater	DOTr Contractor	Included in the operational cost	Bid Documents / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
3.2 Operation Phase						
Subway operation and maintenance activity	Land	Contamination of soil	• Implement proper waste management and disposal system to prevent contamination of surround in g soil and water. • Use strong and durable materials for pipes to prevent leakage. • Use non-reactive materials for pipes and other buried components to ensure that soil contamination is prevented.	DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	Land	Tunnel deformation / failure	• Conduct regular visual inspection and leveling surveys • Update tunnel deformation model to determine changes in underground stress regimes	DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	Land	Groundwater ingress	• Conduct regular visual inspection • Monitor groundwater pressure and levels • Update tunnel deformation model to determine changes in underground stress regimes • Ensure dewatering pumps are working efficiently	DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	Land	Inducement of subsidence	• Conduct regular visual inspection and leveling surveys • Monitor groundwater pressure and levels	DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements	Project Phase / Environmental Aspect	Environmental Component
			• Update tunnel deformation model to determine changes in underground stress regimes					
	Land	Ground movement	• Install seismometers /accelographs • Real-time and continuous measurement of ground movement			DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	Water	Wastewater generation in the subway stations and/ or operations	Wastewater from the domestic use will be coursed through septic vaults installed prior to disposal.			DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	Water/People	Water competition	• Implementationon of rainwater harvesting • Improve efficiency of water supply and distribution system • Regular monitoring of water-use related-complaints			DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	Air	Change in local climate The project's above ground disturbance footprint is in high density built-up areas and is not expected to significantly affect the local climate.	• Monitoring of local climate			DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	Air	May inadvertently cause mental stress to residents near the project location due to the noise from structures and ground vibration	• Considerations in the design and operations of the subway to minimize vibration, such as noise barriers. • Monitoring and survey for complaints from residents nearby the areas			DOTr Contractor	Included in the operational cost and DED cost	Bid Documents / Contract Agreement
	People	Traffic	• Traffic management plan will be implemented			DOTr	Included in the	EGF / Contract Agreement

Project Phase / Environmental Aspect	Environmental Component	Potential Impacts	Options for Prevention, Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
				Contractor	operational cost	
	People	Solid waste generation	• Implementation of waste management plan	DOTr Contractor	Included in the operational cost	Bid Documents / Contract Agreement
	People	Hazardous Waste Generation	• Registration of the proponent as a hazardous waste generator • Collection of hazardous wastes in proper receptaclee • Storage of fuel and chemicals in appropriate storage area provide d with secondary containment in case of spills • Collection of hazardous waste by a DENR accredited hauler • Treatment of hazardous waste by a DENR accredited treater	DOTr Contractor	Included in the operational cost	Bid Documents / Contract Agreement

CHAPTER 4 ENVIRONMENTAL RISK ASSESSMENT (ERA) AND EMERGENCY RESPONSE POLICY AND GUIDELINES

4.0 Background

The Environmental Risk Assessment (ERA) for the Metro Manila Subway Project is prepared under the framework set forth in the Philippines EIS System. The ERA aims to determine the environmental and human health risk posed by the project and to develop mitigation measures of the risks identified. The scope of this section is based on the Technical Scoping Checklist for the Project which contains:

- identification of conditions, events and circumstances which could be significant in safety as well as physical risks;
- description and assessment of possible accident scenarios;
- assessment of whether the project location is projected to have extreme climate events in 2020 and 2050 that could contribute to identified risk scenarios; and
- description of the hazards, both immediate (acute effects) and delayed (chronic effects), f or man and the environment posed by the release of toxic substance, as wells a posed by physical f ailur e of structures, as applicable;

4.1 Conceptual Framework, Approach and Methodology

4.1.1 Terminologies Used

Table 4.1-1 enumerates and defines the different terms used in this section.

Table 4.1-1 Terminology for the Environmental Risk Assessment

Term	Definit io n
Hazard	A hazard is a physical situation with a potential for human injury, damage to the environment or property, or a combination of these. It is the potential for an agent or process to cause harm.
Risk	Risk is the possibility that a harmful event (death, injury or loss) arising from exposure to a chemical or physical agent may occur under specific conditions; or alternatively, the expected frequency of occurrence of a harmful event (death, injury or loss) arising from exposure to a chemical or physical agent under specific conditions (WHO/IPC S , 2004).
Hazard Identification	Hazard identification is the determination of all possible events or processes that could lead to disastrous or fatal incidents, defining inherent and potential hazards of the substances/materials used, as well as the process hazards with potential to adversely affect project personnel, the public and the environment.
Risk Asses s m e n t	Risk assessment is the identification and quantification of the risk resulting from a specific use or occurrence of a chemical or physical agent, considering possible harmful effects on individual people or society of using the chemical or physical agent in the amount and manner proposed and all the possible routes of exposure. Quantification ideally requires the establishment of dose-effect and dose-response relationships in likely target individuals and populations (WHO/IP C S, 2004).
Risk Estimation	Risk estimation is the determination of the outcome of an activity taking into account the probability of occurrence.

Term	Definition
	To obtain risk, the product function of the frequency and consequence analyses must be determined.
Risk Management	Risk management is the logical and systematic method of identifying, analyzing, assessing, mitigating, monitoring and communicating risks associated with any activity, function or process in a manner that would enable the proponent to minimize losses and maximize opportunities

4.1.2 Conceptual Framework

Risk assessment is the scientific determination of the levels of risk related to situations and recognized threats inherent to a project, with the ultimate objective of proposing management solutions to bring risk exposure to acceptable and manageable levels. It involves three basic steps:

- Identification of hazards such as substances, activities, processes and natural phenomena that may cause harm or deterioration of safety;
- Evaluation of the magnitude and frequency occurrence of hazards, and their possible consequences to the environment; and
- Determination of appropriate measures to eliminate or control the hazards.

A conceptual flow diagram for ERA is shown in **Figure 4.1-1**.

Figure 4.1-1 Conceptual flow diagram for qualitative risk assessment

The levels of hazardous substances present at the project site warrants only the preparation of a risk screening study. Faults or failure modes will be tabulated in a matrix along with the consequences and outcomes of such faults. The probability of such consequences and outcomes are identified in an unmitigated scenario. The probability is repeated after safety and mitigation measures are applies.

4.1.3 Approach and Methodology

4.1.3.1 Risk Assessment Methodology

This risk assessment is based on the ERA procedural guidelines prescribed in Annex 2-7e of the Revised Procedural Manual (RPM) of DAO No. 2003-30. The level of assessment to be conducted for a project will be based on the inventory quantity of hazardous substances or hazardous wastes produced or stored by a project. There are three threshold levels of coverage and scoping requirements detailed in Procedural Guidelines for Scoping of ERA as listed below.

- **Level 2** – Required to prepare a Quantitative Risk Assessment (QRA) and an Emergency/Contingency Plan;
- **Level 1** – Required to prepare an Emergency/Contingency Plan only; and
- **Risk Screening Level** – Required to conduct a risk screening study.

Table 4.1-2 lists the hazardous substance categories expected to be used and/or produced by the Project. Based on the thresholds set forth in Annex 2-7e of DAO No. 2003-30, the level of hazardous materials and chemicals stored at the MMSP is not foreseen to exceed Level 1. Thus, only a risk screening study must be conducted to satisfy the requirements in the Technical Scoping Checklist.

This ERA will also consider other applicable local and international regulations on solid and hazardous wastes in connection with subway construction and operations.

Table 4.1-2 Threshold levels of hazardous substances for the Project

Hazard Category	Threshold (MT)		Storage Inventory (MT)	Coverage
	Level 1	Level 2		
Explosives	10	50	0	n/a
Flammable substances	5,000	50,000	<5,000 MT	Will not reach threshold. Risk screening only
Highly flammable substances	50	200	0	n/a
Extremely flammable substances	10	50	0	n/a
Oxidizing substances	50	200	0	n/a
Toxic substances (low)	50	200	0	n/a
Toxic substances (medium)	10	50	0	n/a
Toxic substances (high)	5	20	0	n/a
Toxic substances (very high)	0.2	1	0	n/a
Toxic substances (extreme)	0.001	0.1	0	n/a
Unclassified Type A (substances or preparations that react violently with water)	100	500	0	n/a
Unclassified Type B (substances or preparations which release or liberate toxic gas in contact with water)	50	200	0	n/a

4.1.3.2 Applicable Hazardous Waste/Substance Regulations

(1) DENR Regulations

DENR is the primary agency responsible for the conservation, management, development and proper use of the environment and natural resources of the Philippines. DENR-EMB is responsible for pollution control and environmental impact assessments. Applicable DENR and EMB regulations are listed in **Table 4.1-3**.

Table 4.1-3 Applicable DENR Regulations

Regulation	Coverage
DAO No. Order 2003-30	Implementing rules and regulation of PD No. 1586 of the Philippine EIA System. Annex 2-7e describes the project threshold requirements for ERA
RA No. 6969	Covers the hazardous waste regulations in the Philippines
DAO No. 2013-22	Amended implementing rules and regulations of RA No. 6969 amending DAO No. 2004-36 and DAO No. 1992-29 Covers permitting and reporting requirements for storage, transport and disposal of hazardous wastes
RA No. 9275	Covers the environmental water quality and discharge regulations in the Philippines
EMB MC No. 2015-08	Specific water quality standards and guidelines for surface water, groundwater and effluent. Amended DAO No. 1990-3 4 and DAO 1990- 35
RA No. 9003	Covers the solid waste disposal regulations in the Philippines

4.1.3.3 Qualitative Risk Assessment Methodology

A risk matrix, as shown in **Figure 4.1-2**, is used to determine the risk posed by physical and occupational hazards for the MMSP.

Impact ➔ Probability 🡻	Negligible	Minor	Moderate	Significant	Severe
Very Low	Minimal Risk	Minimal Risk	Low Risk	Moderate Risk	High Risk
Low	Minimal Risk	Low Risk	Low Risk	Moderate Risk	High Risk
Medium	Minimal Risk	Low Risk	Moderate Risk	High Risk	High Risk
High	Minimal Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk
Very High	Low Risk	Moderate Risk	High Risk	Extreme Risk	Extreme Risk

Figure 4.1-2 Risk Matrix

4.2 Hazard Identification

Hazard is defined as a physical situation with a potential for human injury, damage to the environment, damage to property, or a combination of these. The hazards identified in the Project are categorized under physical, chemical and occupational hazards:

- **Physical hazards** include naturally occurring phenomena or events that are triggered by natural physical conditions that pose as threats to people and the environment.
- **Chemical and process hazards** involve materials that can induce hazardous chemical processes that threat the physical safety of people and the environment.
- **Occupational hazards** are objects, events or conditions that may cause physical, emotional, and mental harm to personnel.

4.2.1 Physical Hazards

4.2.1.1 Geologic Hazards

Geologic hazards are natural phenomena triggered by earth processes and influenced by topographic and geologic conditions, resulting in adverse effects on life and property when exposed to these events. This section presents a concise discussion of findings presented in **Section 2.1.2** (Geohazards).

Of the different types of geologic hazards, the following have been identified to have possible occurrences and impacts on the Project:

- ground shaking;
- liquefaction;
- flooding;
- volcanic hazards;
- subsidence; and
- climate change effects.

(1) Ground Shaking

Ground shaking is the hazard most commonly associated with seismic events. The vertical and horizontal movement of the ground following a seismic event is a manifestation of the propagation of waves emanating from the epicentre. The heaving and lurching of the ground causes foundations and structures to shift and settle from a previously static state. Buildings can lean or tip over. Foundations can subside or be thrust upward. The ground can liquefy or rupture. Ground shaking itself can be a trigger for these other hazards.

Calculation of PGA using the formula developed by Fukushima and Tanaka (1990), with variable inputs from a scenario event of a Magnitude 7.2 earthquake generated by the West Valley Fault (the closest striking fault to the proposed MMSP alignment) and the shortest horizontal distance of 0.64 km (as gleaned from the proposed location of the Ortigas North Station), yielded values of 0.371 – 0.662 *g* under rock (Class B) and hard soil (Class C) conditions. The soil classes were determined using the Metro Manila Vs30 site model of PHIVOLCS. This translates to a shaking equivalent to Intensity VIII, or Very Destructive, based on the PHIVOLCS Earthquake Intensity Scale (PEIS). Probabilistically, the high end of this PGA range has a 2% probability of exceedance in 50 years, or a 2,500-year return period.

(2) Liquefaction

Under static conditions, the water pressure of saturated soils—soils in which the space between individual particles is completely filled with water—is relatively low, so that the individual grains that comprise the soil rest on the framework of the grain contacts (Pacific Northwest Seismic Network, 2019). The soil is solid and is able to support structures above it. When rapid loading occurs, such as during earthquake shaking, the pore water pressure in the saturated substrates builds up and the effective stress of grains may be exceeded, resulting in the grains becoming buoyant and floating in water. At this point, the soil completely loses its strength and begins to act like a solid. The bearing strength of the soil is drastically reduced, and it can no longer support the same amount of weight as it did when it is a solid (BRANZ, 2019).

The proposed MMSP alignment is generally located in areas that are not prone to liquefaction, based on a study conducted by the multi-agency READY for GMMA Project (2014), with the exception of the segments crossing the Pasig River and the near the Lawton West Station and the NAIAT3 Station. Ongoing geotechnical testing may yield properties indicative of liquefiable soils, in which case, additional liquefaction tests are recommended.

(3) Subsidence

A type of ground settlement most commonly associated with changes in soil moisture content as a result of excessive withdrawal of groundwater is subsidence. In concept, subsidence is the opposite of liquefaction, such that the loss of pore water pressure (as a result of groundwater extraction) helping support the foundation as a whole, leads to compression of the individual particles of sediments / soil into the s pac es left behind by water. The cumulative filling of intergranular spaces eventually results in the sagging of the ground surface—subsidence.

The coastal plains surrounding the northern part of Manila Bay are underlain by river-delta muds with lesser layers of sand and gravel that are several hundreds of meters thick (Rodolfo, 2014). Natural settling and compaction of the land results in subsidence estimated at a few millimeters per year. Numerous studies have revealed the accelerated pace of ground subsidence in Metropolitan Manila, particularly around the Navotas-Malabon-Valenzuela and Las Piñas areas. APSInSAR vertical movement map by Eco et al. (2013) estimates that from 2003 to 2006, ground elevations in the Navotas-Malabon-Valenzuela area had sunk by a rate of 5.5 cm/yr. Being proximal to this area, the Depot is the most susceptible component of the MMSP to subsidence, with sinking rates of 4.5 – 5 cm/yr. The segment from Quirino Station to Quezon Avenue Station may also experience subsidence, but at lower rates. The rest of the alignment is s how n to be not susceptible to ground subsidence.

(4) Flooding

Flooding is one of the costliest natural disasters in the Philippines, causing displacement of people, and partial to complete damage to structures and properties. Aside from inundation by high water, flooding can also bring about torrential flows that collide with objects, erode riverbeds and riverbanks, and deposit large amounts of debris. It is common in low -lying floodplains or along river channels following intense precipitation brought by typhoon or monsoon rains.

Metropolitan Manila falls under the Type I Climate based on the Modified Coronas Classification, having two pronounced seasons, dry from November to April, and wet during the rest of the year, with maximum rains falling from June to September. An average of two storms pass through the general area of Metropolitan Manila every year. In the Science Garden station, the mean annual rainfall from 1981 to 2010 is 2,574.4 mm (PAGASA & Geoscience Australia). Climatological normals for Metropolitan Manila indicate a peak rainfall period from June to August, with 1170.2 mm of rain (PAGASA, 2018). Historical records of climatological extremes of rainfall from 1961 to 2010 from the Science Garden station show that the greatest rainfall in Metropolitan Manila occurred on August 6-8, 2012 during the onslaught of monsoon rains enhanced by Typhoon Haikui (locally dubbed Habagat 2012), with a measured accumulated rainfall of 1007.4 mm (Rappler.com, 2013).

Based on the READY for GMMA Project flood hazard map, the Quezon City segment of the proposed MMSP alignment is located on mostly No to Low flooding susceptibility, except along portions that intersect rivers and creeks where flooding susceptibility can be Moderate to High. Almost the entire segment from Ortigas North Station down to NAIA T3 and Bicutan are located in areas that have Low susceptibility to flooding. Under a 100-year flood event (UP NOAH, 2019), the following flood susceptibility ratings are determined: Depot—High; Quirino Highway, Anonas, Lawton East, Lawton West Stations—Medium-High; Tandang Sora, Quezon Avenue, Katipunan, Ortigas South, NAIA T3, FTI, Bicutan Interconnection—Low-Medium.

(5) Volcanic Hazards

Volcanic processes prior, during, and succeeding eruptions give rise to numerous volcanic hazards that can have different types and magnitudes of impacts on people and property. Commonly known volcanic hazards such as lava flows, pyroclastic flows, lahars, ground rumbling, ashfalls and volcanic landslides typic ally affect areas immediately surrounding active volcanoes where these originate. In some instances, the effects of a volcanic eruption may reach great distances, especially if the eruption is powerfully explosive, and physical conditions are optimal. Volcanic quakes are just like tectonically-caused earthquakes that c ould cause destruction of structures resulting from strong ground movement and instability. Ashfalls, especially when mixed with water, can cause structural failure due to excess loading.

Underlying the Holocene alluvial deposits in the coastal areas of Metropolitan Manila are the widely distributed tuffaceous deposits comprising the Pleistocene Diliman Tuff. Petrographic and geochemical analyses of this deposit indicates emplacement by a volcanic origin, possibly as recent as 5,000 to 6, 000 years ago. More recent depositions of eruptive products by other active volcanoes have since been recorded in Metropolitan Manila, such as during the 1911 eruption of Taal Volcano and the 1991 eruption of Mt. Pinatubo, but these were mostly thin ashfall deposits that posed little threat to structures. However, volcanic hazards are not limited to the deposition of volcanic material. Metropolitan Manila had also been affected by strong ground shaking resulting from the explosive eruption of far-away active volcanoes. TaalVolcano, with its frequent Plinian activity, has been known to occasionally cause strong ground shaking in Manila, such as during its 1716, 1749 and 1754 eruptions that shook the city and caused significant damage to property (Masó, 1910). There is a high probability that future eruptions of Taal Volcano may similarly affect Metropolitan Manila.

4.2.1.2 Climatic and Atmospheric Hazards

(1) Tropical Cyclone

A tropical cyclone is categorized by PAGASA based on the intensity of its maximum winds when it enters the Philippine Area of Responsibility (PAR). Tropical cyclones with maximum sustained surface winds between 35 and 64 kilometers per hour (kph) are called "tropical depressions". Once a tropical cyclone reaches surface wind strengths between 65 and 118 kph, it is called a "tropical storm". If the surface winds reach 119 to 200 kph, the storm is called a "typhoon".

Natural hazards attributed to climatic factors, such as tropical cyclones, that frequently visited the Philippines. On average, approximately 20 tropical cyclones pass through the PAR annually. Around two tropical cyclones every year cross the region where the project is located (**Figure 4.2-1**). Strong tropical cyclones may lead to facility damage, loss of life, restriction of access, or stoppage of work.

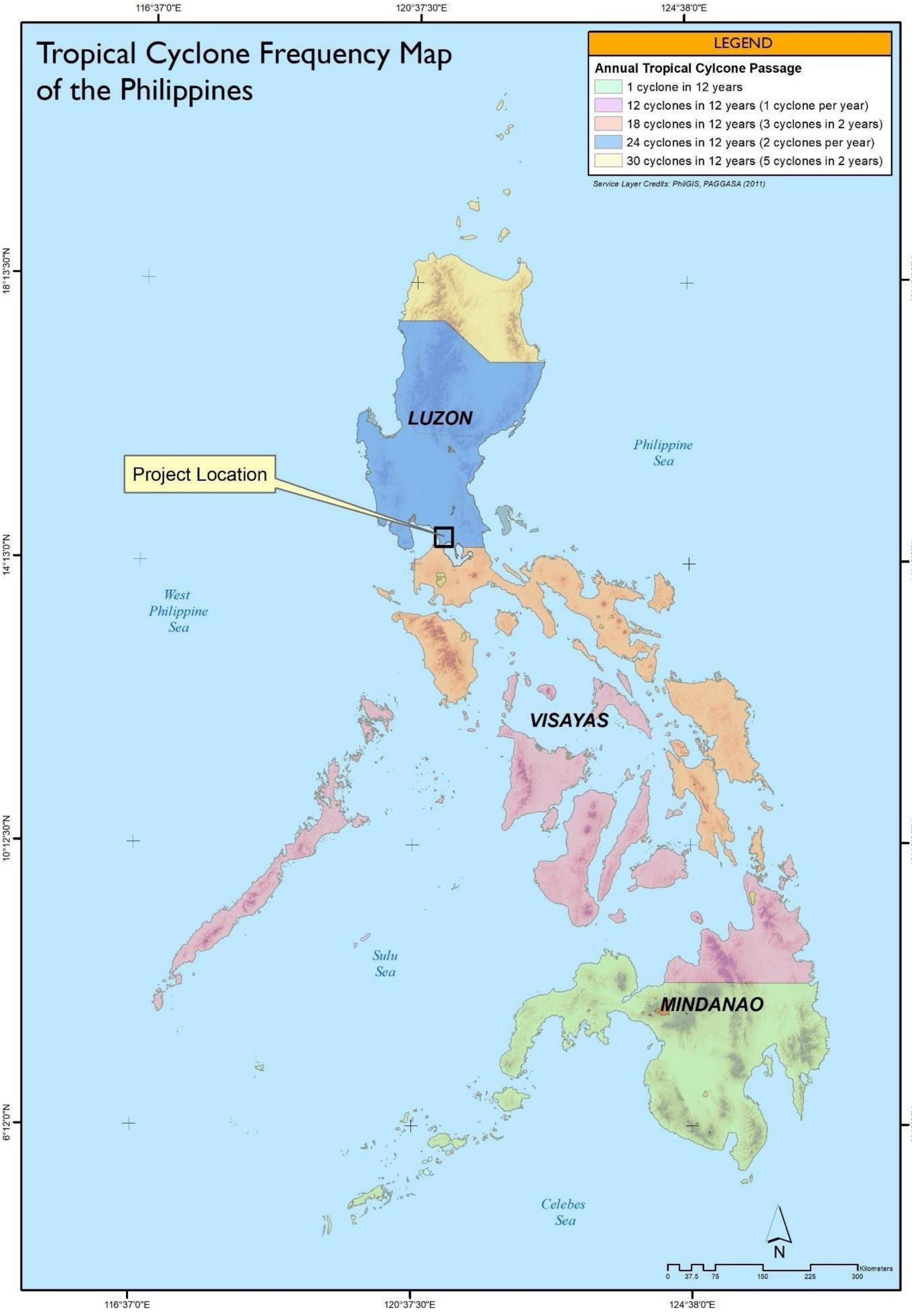


Figure 4.2-1 Typhoon Frequency Map

(2) Heavy Rainfall

Intense precipitation brought forth by monsoons and tropical cyclones often bring other destructive events like flooding and storm surges which could affect project operations, facilities, staff and the surrounding community.

The total monthly rainfall at the PAGASA synoptic weather station in NAIA Terminal 3 which is 970 m from the nearest station ranges from 4 mm (March) to 418.4 mm (August). The total annual rainfall amounts into 1,767.90 mm with an annual number of rainy days of 105 days or approximately 29% of the year. The highest daily rainfall recorded at the NAIA Terminal 3 was 472.4 mm on July 20, 1972.

(3) Strong Wind

Strong winds are often caused by the quick movement of air from an area of high atmospheric pressure to an area of low pressure over short distances. They are usually associated with tropical cyclones, although sudden gusts may also occur randomly especially in high elevations. Strong winds have the capacity to uproot trees and fell transmission lines, generate large ocean waves which can create an unsafe environment to work andoperate.

Normally however, long-term wind data indicate that the average wind speeds in NAIA Terminal 3 and PAGASA Science Garden ranges from approximately 2.2 m/s to 3.2 m/s, and 1.9 m/s to 2.3 m/s, respectively. These winds are classified as a 'light breeze' according to the Beaufort Wind Force Scale (**Annex 2.3- 4**). Wind speeds with these magnitudes will not create an unsafe environment to work and operate f or the project.

(4) Climate Change Impacts

Assuming a minimum operational lifetime of 50 years for the proposed project, it is anticipated that the site will be exposed to the predicted effects of climate change, as projected by PAGASA for 2020 (2006-2035) and 2050 (2036-2065). The intensification of extreme climactic conditions based on the PAGASA predictions is expected to have more significant effects on geologic hazards greatly influenced by hydrologic processes. It can be expected that flooding, storm surges and coastal erosion, identified to be of low significance under current conditions, may become more pronounced or evident in the next few decades.

Metro Manila is susceptible to the impacts of climate change such as sea-level rise (SLR) and increased storm intensity, although the western general location of the project will generally protect it f r om the worst effects of tropical cyclones. Climate change forecasts today range from 0.5 m to 2.0 m of SLR by the year 2100, including an overall shift towards unstable meteorology including changes in storm frequency and intensity (Intergovernmental Panel on Climate Change, 2007; Nicholls, et al., 2007; Rahmstorf, 2007). The rate of SLR is greater in Metro Manila compared to the global mean (Intergovernmental Panel on Climate Change, 2013). Other climate change impacts include changes in mean temperatures, rainfall, and extremes (**Table 2.3-8**, **Table 2.3-9,** and **Table 2.3-10)**. Increases in rainfall during the wet season could cause localized flooding and changes to sedimentation loading.

The MMSP will enhance connectivity, but also raises the question of vulnerability to climate change impacts over the next 50 years. There are few studies on how climate change affects railway systems (Intergovernmental Panel on Climate Change, 2014), but railway system failures are known to be related to high temperatures and storms (Koetse & Rietveld, 2009). Heat impacts are often significant, as subway systems gradually warm due to engine heat, brakes, and passenger loads. Projected changes in temperature highlight the vulnerability of tracks to temperature increases and the accompanying issue of track expansion which can lead to train delays, and in the most extreme cases can lead to derailments (Chinowsky, Helman, Gulati, Neumann, & Martinich, 2019).

The electricity in Metro Manila is mostly provided by the Manila Electric Company (MERALCO). The projected temperature increases (**Table 2.3-10** and **Figure 2.3-19**) may increase total and peak energy demands in the warmer dry seasons caused by increased residential cooling needs. The addition of population growth and air-conditioning penetration in Metro Manila will increase residential cooling demand. This will strain the capacity of electricity transmission and distribution facilities, which may affect MERALCO operations and increasing electricity costs.

Climate change also has the potential to impact worker health and safety conditions for the Project. Rising temperatures may increase the risk of heat-related illnesses and inhibit decision-making, increasing the likelihood of injuries, accidents, and fatalities and decreasing worker productivity. Flooding may also affect employee safety on-site and on roads. Climate change induced flooding and storm surges could potentially flood subway tunnels, severely impacting mobility and economic activity (Blake, Kimberlain, Berg, Cangialosi, & Beven II, 2012).

4.2.1.3 Geotechnical Hazards

(1) Tunnel Deformation / Failure

The greatest impact of tunneling is the creation of a void that would greatly alter the distribution of underground pressure. The loss of voluminous amounts of rock and soil material would greatly reduce the bearing capacity of the rock and soil material that would be left to shoulder additional stresses. Although initial drilling information reveals the occurrence of competent rock through which the MMSP will tunnel, the volcanic deposits underlying Metropolitan Manila are not homogeneous—structural deformities such as joints, bedding planes, shears and fracture zones were identified in borehole scanning surveys performed along the proposed alignment. As such, the bearing capacities of the geologic material that the tunnel will bore through, greatly differ. When a rock unit is adjusting to the underground pressures acted upon it, tunnel deformation can occur, resulting in misaligned tracks or uneven tunnel walls. In extreme cases, total failure can occur when the pressure limits are crossed, leading to total collapse of the tunnel walls.

(2) Groundwater Ingress

The MMSP track is expected to be installed deep underground to avoid disruption and disturbance of surface activities and structures. Initial borehole results indicate the presence of groundwater at various depths from the surface. Groundwater is found in the interstices between individual grains that make up the rock. It can also accumulate and pass through planes of structural deformities, such as beds, joints and fractures. As the TBM burrows through the substrate, groundwater is expected to seep through the tunnel wall and into the created void, especially if the water table is above the level of the track tunnel. When water buried beneath tons of overlying mass experiences high pressure, the sudden lowering of pressure caused by tunneling can result in forceful entry of water into the void. If unmanaged properly, this can lead to underground flooding and possibly, tunnel collapse.

(3) Ground Subsidence

Under static conditions, the pressure of groundwater contributes in supporting the overall framework of the ground, preventing individual particles that comprise the sediment or soil to occupy interstices. Tunneling can impact the groundwater pressure regimes: it can either draw groundwater in or shift it to a different spatial configuration that will equilibrize or stabilize underground pressure conditions. In either case, pore water pressure is altered. If it is sufficiently decreased, it can cause substrate particles to compact and move in closer together. A cumulative effect can ensue, which can cause overlying material to sink in due to gravity. This will result in the lowering of ground elevations which can affect foundations and structure built on the surface.

4.2.2 Chemical and Process Hazards / Industrial Hazards

The identification of chemical hazards associated with the MMSP is based on the physicochemical properties of the hazardous chemicals, substances and wastes that will be stored, handled, or generated during the operation of the project. Since the construction and operation of all the stations and tunnel alignment will essentially be similar to each other the expected chemicals stored and hazardous wastes generated are lumped and are shown in **Table 4.2-1**. The depot is expected to used diesel fuel for the back-up generators. The amount of diesel to be stored will be finalized during the detailed design stage of the project.

Table 4.2-1 List of Chemicals Used and/or Wastes to be Generated by MMSP

Chemical	Category	Storage	Generator	Method of disposal
Waste Oil	Flammable/ Toxic, Low	Steel drums	Operation and Maintenance (Depot and Stations)	Hazardous Waste Treater
Oil Contaminated Debris	Flammable/ Toxic, Low	Steel drums	Operation and Maintenance (Depot and Stations)	Hazardous Waste Treater
Oil Contaminated Water	Flammable/ Toxic, Low	Steel drums	Operation and Maintenance (Depot and Stations)	Hazardous Waste Treater
Diesel	Flammable/ Toxic, Low	Underground storage tanks	Operation and Maintenance (Depot)	Not for disposal. Diesel is stored as fuel for generators

During the tunneling process, a clay and water mixture is pumped to the TMB cutterhead where it helps maintain hydrostatic pressure. Bentonite and other types clay material, carboxymethyl cellulose and dispersants will be stockpiled during the tunneling process. Carboxymethyl cellulose is a chemical generally recognized as safe (GRAS) by the United States Food and Drug Administration (US FDA). Also, the other identified substances are not considered hazardous. As the slurry/soil mixture returns f r om the cutterhead, it goes to the treatment plant where the muck is dewatered. The recovered water is recycled back into the slurry circuit of the TBM and the wastewater is treated prior to disposal.

4.2.2.1 Flammable Substances

Flammables substances are chemicals having a flashpoint of less than or equal to 55˚C (DAO No. 2003 - 30). Flammable liquids are categorized into three classes in DAO No. 2003-30: (1) flammable, (2) highly flammable and (3) extremely flammable. The flammability of a liquid can be determined flash point using either the closed-cup or open-cup method. The criterion for degree of flammability that is used to categorize flammable substances is in Annex 2.7e of DAO No. 2003-30.

To maintain train services during power outages and/or emergencies, the stations and the depot will be equipped with generator sets. These generators will likely run on diesel and are expected to have ample diesel storage to operate the station for an extended amount of time (ie. 12 hrs or 24 hrs). No estimates yet are available on the volume of fuel to be stored at the stations and the depot.

4.2.2.2 Toxic/Hazardous Substances

A waste may be considered hazardous if it exhibits certain hazardous properties such as ignitability, reactivity, corrosivity and toxicity (EPA, 2009). These may be toxic chemicals used by a project or toxic wastes generated by the project. Toxic substances are divided into five classifications based on the level of its toxicity in DAO No. 2003-30: (1) low toxicity, (2) medium toxicity, (3) high toxicity, (4) very high toxicity and (5) extreme toxicity. Toxicity level of a substance is dictated by its chemical state, vapor pressure, boiling point and the lethal concentration 50 (LC_{50}). LC_{50} is the standard measure of the toxicity of the surrounding medium that will kill half of the sample population of a specific test-animal in a specified period through exposure via inhalation (DAO No. 2003-30).

Toxicity is defined through a laboratory procedure called the Toxicity Characteristic Leaching Procedure (TCLP) (Method 1311). TCLP helps identify wastes likely to leach concentrations of contaminants that may be harmful to human health or the environment (EPA, 2009).

4.2.2.3 Emissions

Combustion products are emitted by project's stationary and mobile sources. Combustion products like CO, NO_x, SO_x and VOCs may be considered hazardous to health. During the construction phase, generator sets, and mobile equipment will be used for the MMSP. Estimates of the emissions during the construction phase during the MMSP can be found in **Table 4.2-2**. The emissions of the gensets are expressed in kg/hrs in these will only be used as standby power sources.

Table 4.2-2 Estimate d Amount of Combustion Product s from the MMSP for Opera t ions & Construct ion Phases

Pollutant	Operation Phase (kg/hr)	Construction Phase (MT/y r)
NO_x	*	68.84
CO	*	30.96
SO_x	*	0.33
PM_{10}	*	5.06
VOC	*	8.13

* Generator use in the operation phase will only be during power outages and the testing and maintenance of generators. No estimate is available

4.2.3 Occupational Hazards

Occupational hazards are the threats to the physical, emotional or mental health of personnel involved. Occupational hazards are expected to be present in all phases of the MMSP. The identification of potentially hazardous activities and conditions in all areas of the project site follows.

4.2.3.1 Mechanical Hazards

Mechanical hazards are hazards encountered during the operation of an apparatus or tool of a mechanic al nature. A multitude of hazardous mechanical hazards may be present during the Project especially in the labor-intensive construction and operational phases. These hazards vary from movement of rotating arms and members, moving belts, meshing gears, cutting teeth, shearing parts and any parts may cause mechanical injury. Mechanical hazards present in the Project include generators, crushers, mixers, pumps, compressors, water pipe lines and moving engine parts which may cause injuries such as crushed hands and arms, severed fingers, lacerations, cuts and even blindness.

Effective and proper machine guarding can help reduce or even eliminate mechanical injuries. Machine guarding is a covering for the hazardous areas of a machine to prevent contact with body parts or tocontrol projectile hazards exiting the machine. Some of the guard types that can be used are: fixed guards, interlocked guards, presence sensing device, automatic guards, adjustable guards, self -adjusting guards, distance guards and partial guard.

4.2.3.2 Electrical Hazards

Electrical hazards are hazards brought forth by working closely with sources of electrical power. Electrical hazards present in the project include power lines, generators, energized equipment, wiring and batteries. The severity of electrical injury ranges from just a faint shock to severe burns or even cardiac arrest and possibly even death. The most common electricity related injuries are burns suffered in electrical accidents which may be classified into three types: electrical burns, arc burns, and thermal contact bur ns. All three types of burns could possibly occur simultaneously.

In electrical burns, tissue damage is caused by the heat generated by the current flow through the body. Arc or flash burns, on the other hand, are the result of high temperatures occurring near exposed tissues and are produced by an electric arc or explosion. Finally, thermal contact burns (related to temperature hazards) are those normally experienced when the skin comes in contact with hot surfaces of overheated electric conductors, conduits, or other energized equipment (OSHA, 2008). There is a multitude of method for protecting people from the hazards brought about by electricity. These include insulation, guarding, grounding, wearing electrical protective equipment and safe work practices.

Electric and magnetic fields (EMFs) are emitted by electrical device such as power lines, turbines and generators. Magnetic fields pass through most materials and are difficult to shield. Both electric and magnetic fields decrease rapidly with distance (NIEHS, 2002). There is insufficient information on the biological and health effects of EMF exposure of human populations and experimental animals to provide a rigorous basis for establishing safety factors over the whole frequency range and for all frequency modulations (ICNIRP, 2001).

To properly manage EMF exposures, it is recommended to disseminate information regarding on perceived EMF risks and the levels to be encountered around EMF emitting equipment and devices, identify areas with expected elevated EMF levels and establish safety zones and train workers in the identification of occupational EMF levels and hazards.

4.2.3.3 Pressure Hazards

Pressure hazards include pipes, pressurized vessels, heated vessels, hoses, pumps, explosives and pneumatic and hydraulic equipment. Potential sources of pressure hazards in the project are pumps, pipes, slurry plant and storage vessels. These hazards can be minimized by wearing the proper personal protective equipment and employing safe work practices.

4.2.3.4 Temperature Hazards

Working outside in the heat especially in the summer can bring about hazards related to temperature. Personnel working in enclosed spaces with running machinery may also be vulnerable to temperature related hazards. The four environmental factors which determine heat stress are temperature, humidity, ventilation and radiant heat. In many operations, combinations of these factors may result in serious heat stress to the workers, who may be performing heavy work, and producing large amounts of body heat, thus also exacerbating the heat stress problem.

The most common types of heat disorders are heat stroke, cramps, dehydration and heat exhaustion. This hazard may be minimized by regular crew rotation, provision appropriate ventilation / air conditioning if possible and having access to drinking water.

4.2.3.5 Biological Hazards

Biological hazards are hazards that arise from contact with animals, insects, plants, bacteria, viruses, etc. Trees that will removed may secrete allergenic sap or may host insects that sting or bite. Communicable diseases or sickness can be brought about by bacteria, viruses or their carriers such as certain insects, animals, ill individuals and unsanitary conditions.

To mitigate such hazards, workers assigned to clearing or excavation, for example, will wear appropriate personal protective equipment. The wearing of insect or animal repellent will also help minimize such hazards. In terms of communicable diseases or sickness, the Project area s will maintain good sanitary conditions to help reduce bacteria, viruses and their carriers. Workers will vacate blasting area to an appropriate distance prior to blasting. Workers who are ill will also be advised not to come to work until they are well to minimize the transmission of the contagion to healthy workers.

4.2.3.6 Radiation Hazards

Radiation hazards include lighting, welding arcs, solar radiation, microwaves, lasers, x-rays, etc. Lac k of adequate illumination can present safety problems because obstacles may not be easily identified when visibility is poor. Conversely, too much illumination can cause injuries such as stress and blindness.

Activities such as welding can increase illumination to injurious levels and can be mitigated by wearing appropriately tinted goggles or face mask. While working outside, workers are exposed to solar radiation and will wear protection from solar rays either by wearing long sleeved clothing or lotion with UV protection properties.

4.2.3.7 Noise Hazards

Hazards brought about by noise or sound includes equipment noise, impact noise, vibration, high-pressure release, etc. Continuous exposure to intense noise may cause hearing loss, whether temporary or irreversible. Ear protection, such as ear plugs, will be provided to all employees who work in any situation where high noise levels may be encountered.

Vibration hazards may be encountered in blasting or excavation operations during the use of hand pneumatic tools. Localized vibrations may lead to neurovascular alterations in the hands, bone alterations, including formation of cysts on some of the bones of the hand, weakness and atrophy, etc.

Vibration hazards may be minimized by regular breaks and shift change.

4.2.3.8 Gravity Hazards

Gravity hazards are a group of hazards that include falling objects, collapsing roof, collapsing tunnel tripping, or any hazard exacerbated by the pull of gravity. Working at heights is also a gravity hazard. These types of hazards are very common in almost anyworkplace.

Gravity hazards can be easily mitigated by implementing a policy of strictly wearing hard hats, harnesses and strict policies against unsafe work habits.

4.2.3.9 Motion Hazards

Motion hazards include vehicles, moving equipment, flowing water, wind, and poor work ergonomics. To avoid vehicular accidents, dedicated and well-marked crosswalks will be installed for pedestrians, vehicular speed will be reduced, traffic signs will be installed, driving will be prohibited under the influence of alcohol and other mind-altering substances, headlights will be used during the dark or during rain and workers will be required to wear reflector vests. Moving equipment will be clearly marked so that worker will know to avoid the area. The shafts and tunnels that could potentially become conduits for moving water will be installed with alarms to warn worker of approaching danger. As for work ergonomics, training for proper lifting, pulling, lifting postures and other working procedures will be implemented and reaffirmed regularly.

4.3 Risk Assessment

Risk assessment involves the following analyses: (1) consequence analysis, (2) frequency analysis and (3) risk estimation. Consequence analysis involves the estimation and/or assessment of the effects of a hazard to people, assets and the environment. Frequency analysis is defined as the estimation of the likelihood of occurrence of the identified hazards. Risk estimation determines the outcome of an activity taking it account the probability of occurrence where risk is the product of impact and probability.

Under the ERA Guidelines in Annex 2-7e of the DAO No. 2003-30, only a project risk screening study is to be conducted for this Project based on the amount of chemical and wastes generated/stored. For the risk screening, a Qualitative Risk Assessment was conducted utilizing the risk matrix found in the r is k levels were estimated and presented in **Table 4.3-1**. The risk levels are based on qualitative assessment only and were not lifted from existing standards that require quantitative assessment. The risk assessment considered risk and mitigation on a per site basis but whenever risk and mitigation involves the whole alignment or parts of the alignment, the assessment is generalized to reflect all affected components.

Table 4.3-1 Qualitative Risk Assessment for the MMSP

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
Physical Hazards								
Geologic	Ground shaking	• Stations • Tunnel Alignment • Depot	• Earthquake	• Shaking of foundation, structures • Liquefaction	Injury or death	Moderate Risk	• Avoid building on ground with high seismic attenuation potential • Design and construct facilities according to acceptable standards based on realistic earthquake scenarios • Installation of seismometers • Use strong containment materials/methods for storage of chemicals and Flammable/ explosive substances • Establish an Earthquake Emergency Response Plan	Low Risk
					Damage / destruction of pipelines	Low Risk		Minimal Risk
					Damage / destruction of other facilities	Moderate Risk		Low Risk
					Loss / reduction of access	Low Risk		Low Risk
					Explosion or fire	High Risk		Moderate Risk
	Liquefaction	• Underground tunnel span crossing the Pasig River • Underground tunnel span west of	• Earthquake	• Loosening of ground stiffness	Injury or death	Moderate Risk	• Avoid building on ground with high liquefaction susceptibility • Design and construct facilities according to acceptable standards based on realistic earthquake scenarios • Use strong containment materials/methods for storage of chemicals and flammable/ explosive substances	Low Risk
					Damage / destruction of pipelines	Low Risk		Minimal Risk
					Damage / destruction of other facilities	Moderate Risk		Low Risk
					Loss / reduction of access	Low Risk		Minimal Risk
					Explosion or fire	High Risk		Moderate

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
		Lawton West Station • Lawton West Station					• Establish an Earthquake Emergency Response Plan	Risk
	Subsidence	• Depot	• Groundwater pressure change	• Sinking of ground surface	Injury or death	Moderate Risk	• Properly line tunnel wall with water-proof material • Install monitoring piezometers to monitor groundwater pressure • Conduct regular leveling surveys and deformational studies • Use strong containment materials/methods for storage of chemicals and flammable/ explosive substances	Low Risk
					Damage / destruction of pipelines	Moderate Risk		Low Risk
					Damage / destruction of other facilities	Moderate Risk		Low Risk
					Loss / reduction of access	Low Risk		Minimal Risk
					Explosion or fire	Moderate Risk		Low Risk
	Flooding	As per 5 year flooding map • Depot • Quirino Station • Anonas Station • Lawton West Station	• Intense rainfall	• Submergence by water • Heavy sedimentation in distal downstream areas	Injury or death	Moderate Risk	• Avoid building in low-lying areas and natural drain ways of floods • Construct flood control works • Install an early warning system for floods	Low Risk
					Damage / destruction of pipelines	Low Risk		Minimal Risk
					Damage / destruction of other facilities	Moderate Risk		Low Risk
					Loss / reduction of access	Low Risk		Minimal Risk

Hazard / Threat	Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
	• FTI Station						
Volcanic hazards	• Depot and Stations	• Volcanic eruption	• Accumulation of volcanic ash • Loss of visibility	Loss / reduction of visibility	Low Risk	• Wear protective glasses and inhalation filters • Design facilities that can withstand extra overburden	Minimal Risk
				Structural collapse due to overburden	Moderate Risk		Low Risk
				Respiratory illnesses	Moderate Risk		Low Risk
Tunnel deformation / failure	• Depot and Stations	• Earthquake • Compression of different substrate materials • Exceedance of bearing capacities of rock	• Misaligned tracks • Bulging tunnel wall • Tunnel collapse	Injury or death	Moderate Risk	• Conduct detailed geomechanical investigation prior to construction • Design and construct facilities according to geomechanical properties of the rock. • Use strong containment materials/methods for storage of chemicals and flammable/ explosive substances	Low Risk
				Damage / destruction of pipelines	Moderate Risk		Low Risk
				Damage / destruction of facilities	Moderate Risk		Low Risk
				Loss / reduction of access	Low Risk		Minimal Risk
				Explosion or fire	Moderate Risk		Low Risk
Groundwater ingress	• Depot and Stations	• Tunneling below water table • Improperly lined tunnel walls	• Seepage of water on tunnel wall • Flooding • Tunnel collapse	Injury or death	Moderate Risk	• Properly line tunnel wall with water-proof material • Install monitoring piezometers to monitor groundwater pressure	Low Risk
				Damage / destruction of pipelines	Moderate Risk		Low Risk
				Damage / destruction of facilities	Moderate Risk		Low Risk

	Hazard / Threat	Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
			• Fractures on rock containing water		Loss / reduction of access	Low Risk	• Conduct regular leveling surveys and deformational studies • Use strong containment materials/methods for storage of chemicals and flammable/ explosive substances	Minimal Risk
					Explosion or fire	Low Risk		Minimal Risk
	Ground subsidence	• Depot	• Reduction of pore water pressure • Excessive ingress of water into the tunnel • Heavy abstraction of groundwater	• Sagging of ground from surface	Injury or death	Moderate Risk	• Properly line tunnel wall with water-proof material • Install monitoring piezometers to monitor groundwater pressure • Conduct regular leveling surveys and deformational studies • Use strong containment materials/methods for storage of chemicals and flammable/ explosive substances	Low Risk
					Damage / destruction of pipelines	Moderate Risk		Low Risk
					Damage / destruction of facilities	Moderate Risk		Low Risk
Atmospheric	Tropical cyclones	• Stations • Tunnel Alignment • Depot	• Weather systems	• Intense rainfall • Flooding • Strong winds	Injury or death	Moderate Risk	• Keep updated with the latest weather bulletin • Limit exposure to the elements during extreme weather	Low Risk
					Damage / destruction of pipelines	Low Risk		Minimal Risk
					Damage / destruction of other facilities	Moderate Risk		Low Risk
					Loss / reduction of access	Low Risk		Minimal Risk

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
	Heavy rainfall	• Stations • Tunnel Alignment • Depot	• Tropical cyclones • Monsoon rains	• Flooding	Injury or death	Moderate Risk	• Keep updated with the latest weather bulletin • Provide sufficient drainage system • Limit exposure to the elements during extreme weather	Low Risk
					Damage / destruction of pipelines	Low Risk		Minimal Risk
					Loss / reduction of access	Low Risk		Minimal Risk
	Strong wind	• Stations • Depot	• Tropical cyclones • Natural wind variability	• Storm surge • Strong wind forces	Injury or death	Moderate Risk	• Keep updated with the latest weather bulletin • Limit exposure to the elements during extreme weather	Low Risk
					Loss / reduction of access	Low Risk		Minimal Risk
Geomechanicall	Building Collapse	• Stations • Depot	• Earthquake / fault movement • Seepage / leakage • Heavy rainfall • Poor design or construction • Explosion	---	Injury or death	Moderate Risk	• Avoid building on ground with high seismic attenuation potential • Design and construct according to acceptable standards based on realistic earthquake scenarios • Use strong containment materials/methods for storage of chemicals and flammable/ ex plosive substances • Establish an Earthquake Emergency Response Plan	Low Risk
					Damage / destruction of building	Moderate Risk		Low Risk
					Operational downtime	Low Risk		Minimal Risk
	Tunnel Collapse	• Tunnel Alignment	• Earthquake / fault movement • Seepage / leakage		Injury or death	Moderate Risk	• Avoid building on ground with high seismic attenuation potential	Low Risk
					Damage / destruction of building	Moderate Risk		Low Risk

	Hazard / Threat	Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
			• Heavy rainfall • Poor design or construction • Explosion		Operational downtime	Low Risk	• Design and construct according to acceptable standards based on realistic earthquake scenarios • Use strong containment materials/methods for storage of chemicals and flammable/ explosive substances • Establish an Earthquake Emergency Response Plan	Minimal Risk
	Crane Collapse	• Stations • Tunnel Alignment • Depot	• Earthquake / fault movement • Heavy rainfall • Strong wind • Storm surge • Tsunami	---	Injury or death	Moderate Risk	• Conduct detailed geomechanical investigation prior to construction • Design and construct facilities according to geomechanical properties of the rock. • Provide appropriate drainage and/or dewatering system	Low Risk
					Damage / destruction of equipment	Moderate Risk		Low Risk
					Operational downtime	Low Risk		Minimal Risk
Chemical Hazards								
Chemical	Fire from flammable substances	• Depot • Stations	• Open flames • Smoking • Sparks from hot work	• Fire to surrounding community	Injury or death	Low Risk	• Provide proper containment for fuels and flammable chemicals. • Regular disposal of flammable wastes to DENR accredited hauler/treater	Minimal Risk
					Damage of equipment and property	Moderate Risk		Low Risk

Hazard / Threat	Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
				Damage to community	Low Risk	• Regular fire safety inspection by the LGU and/or BFP • Provide proper equipment and tools for firefighting in the facility • Regular maintenance of containment	Minimal Risk
				Damage to reputation	Moderate Risk		Low Risk
				Loss of income/damage to business	Moderate Risk		Low Risk
Spill of oil, fuel or oily wastes	• Depot • Stations	• Earthquake / fault movement • Accident during excavation • Containment neglected or not maintained • Human error	• Spill of oil or fuel	Injury or death	Moderate Risk	• Provide proper containment for fuels and flammable chemicals. • Regular disposal of flammable wastes to DENR accredited hauler/treater • Regular maintenance of containment	Low Risk
				Morbidity	Moderate Risk		Low Risk
				Damage to environment	Moderate Risk		Low Risk
				Damage to reputation	Moderate Risk		Low Risk
				Loss of income/damage to business	Moderate Risk		Low Risk
Spill of hazardous waste or chemical	• Depot • Stations	• Earthquake / fault movement • Accident during excavation	• Spill of hazardous waste or chemical	Injury or death	Moderate Risk	• Provide proper containment for fuels and flammable chemicals. • Regular disposal of flammable wastes to DENR accredited hauler/treater	Low Risk
				Morbidity	Moderate Risk		Low Risk
				Damage to environment	Moderate Risk		Low Risk

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
			• Containment neglected or not maintained • Human error		Damage to reputation	Moderate Risk	• Regular maintenance of containment	Low Risk
					Loss of income/damage to business	Moderate Risk		Low Risk
Occupational Hazards								
Occupational	Mechanical hazards	• Stations • Tunnel Alignment • Depot	• Forceful movement of sharp/blunt mechanical parts • Equipment malfunction • Human error • Poor quality of machines • Poor protection	• Fire / smoke emission / explosion (from burnt machinery) • Water leakage (from broken pipes / hydraulic pumps) • Oil leakage (from faulty machinery) • Increase in noise levels • Increase in heat emissions	Injury or death	Moderate Risk	• Require personal protective equipment for all workers handling mechanical equipment • Provide first aid kits • Provide emergency medical evacuation • Provide sufficient ventilation • Proper maintenance of machinery and equipment • Restrict usage of mechanical equipment to experienced workers • Provide fire suppression systems • Report incidents and faulty equipment	Low Risk
					Heat stress	Moderate Risk		Low Risk
					Fatigue from repetitive movement	Low Risk		Minimal Risk
					Loss of hearing	Low Risk		Minimal Risk
	Electrical hazards	• Stations	• Fire / explosion		Injury or death	Moderate Risk		Low Risk

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
		• Tunnel Alignment • Depot	• Mechanical malfunction • Electromagnetic surges • Poor quality of electric wirings / power lines • Exposed wirings • Human error • Poor protection	• Fire / explosion (when in contact with combustible / explosive substances) • Power outage • Mechanical breakdown	Electrocution Exposure to electromagnetic fields	Moderate Risk Low Risk	• Require personal protective equipment for all workers • Provide first aid kits • Provide emergency medical evacuation • Proper maintenance of machinery and equipment • Restrict usage of electrical equipment to experienced workers • Provide fire suppression systems • Report incidents and faulty equipment • Establish buffer area around switchyard / transformer areas	Low Risk Minimal Risk
	Pressure hazards	• Stations • Tunnel Alignment • Depot	• Overpressure of pneumatic and hydraulic equipment • Poor protection • Explosions	• Fire / explosion • Mechanical breakdown • Increase in temperature	Injury or death Heat stress	Moderate Risk Low Risk	• Require personal protective equipment for all workers • Provide first aid kits • Provide emergency medical evacuation • Proper maintenance of machinery and equipment • Provide sufficient ventilation • Ensure that pressure gauges, valves, and monitors are all working	Low Risk Minimal Risk

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
							• Restrict usage of mechanical equipment to experienced workers • Provide fire suppression systems • Report incidents and faulty equipment	
	Temperature hazards	• Stations • Tunnel Alignment • Depot	• Increase in natural ambient temperature • Operation of heat-emitting equipment • Confined space with little ventilation • Fire /explosion • Equipment malfunction • Poor protection	• Fire /explosion (of faulty equipment or when in contact with combustible / explosive substances) • Mechanical breakdown	Injury or death	Moderate Risk	• Require personal protective equipment for all workers handling mechanical equipment or working in exposed environments • Provide first aid kits • Provide emergency medical evacuation • Provide sufficient ventilation • Proper maintenance of machinery and equipment • Restrict usage of mechanical equipment to experienced workers • Provide fire suppression systems • Report incidents and faulty equipment	Low Risk
					Heat stress	Low Risk		Minimal Risk
	Biological hazards	• Stations • Tunnel Alignment • Depot	• Animal / insect bites • Contamination by pathogens • Contact with poisonous plants	• Outbreak (for highly contagious diseases) or contamination	Allergic reactions	Low Risk	• Maintain personal hygiene • Confinement / quarantine for infected personnel • Provide animal bite kits	Minimal Risk
					Vomiting / upset stomach from ingested plants	Low Risk		Minimal Risk

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
			• Poor hygiene • Ingestion of spoiled food	• Loss / reduction of movement / mobility	Contraction of communicable diseases	Low Risk	• Provide emergency medical evacuation • Wear appropriate protective equipment when conducting work in highly vegetated areas • Orient workers with dangerous flora and fauna in project site • Avoid contact with unfamiliar plants and animals • Report incidents	Minimal Risk
					Pain from animal bites	Low Risk		Minimal Risk
					Poisoning from animal bites and toxic plants	Low Risk		Minimal Risk
	Radiation hazards	• Stations • Tunnel Alignment • Depot	• Intense illumination • Radiation-emitting devices • Poor protection • Human error	• Intensification of light levels • Increase in temperature	Injury or death	Moderate Risk	• Require personal protective equipment for all workers handling equipment or working in exposed environments • Provide first aid kits • Provide emergency medical evacuation • Provide sufficient ventilation • Proper maintenance of machinery and equipment • Restrict usage of radiation-emitting equipment to experienced workers • Provide fire suppression systems	Low Risk
					Heat stress	Low Risk		Minimal Risk
					Permanent or temporary blindness	Low Risk		Minimal Risk

Hazard / Threat	Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated) Hazard / Threat Component Cause / Fault / Failure	Consequence Event (s)
							• Report incidents and faulty equipment	
	Noise hazards	• Stations • Tunnel Alignment • Depot	• Explosions • Operation of equipment • Faulty equipment • Poor protection	• Increase in ambient noise	Temporary or permanent deafness	Moderate Risk	• Provide ear mufflers for workers exposed to loud operational environments • Proper maintenance of machinery and equipment • Restrict usage of mechanical equipment to experienced workers • Provide noise buffers • Operate noise-generating equipment only at designated areas and during assigned schedule	Low Risk
	Gravity hazards	• Stations • Tunnel Alignment • Depot	• Falling objects • Collapse of foundation / roofing • Loss of support • Shifting of center of gravity • Poor protection	• Impact / collision	Injury or death	Moderate Risk	• Secure objects used at height • Provide sufficient support / footing of scaffolds / ladders, etc. • Provide early warning signs around activities conducted at elevation • Require personal protective equipment for all workers • Provide first aid kits • Provide emergency medical evacuation • Safety training for all employees	Low Risk

Hazard / Threat		Component	Cause / Fault / Failure	Consequence Event (s)	Outcomes	Potential Probability (Unmitigated)	Safety Measure and Mitigation	Potential Probability (Mitigated)
							• Report incidents	
	Motion hazards	• Stations • Tunnel Alignment • Depot	• Loss of control • Poor ergonomics / posture • Poor illumination • Poor protection	• Impact / collision	Injury or death	Moderate Risk	• Provide signages and other early warning signs • Require personal protective equipment for all workers • Provide sufficient illumination • Follow traffic rules • Maintain vehicles regularly • Restrict operation to capable workers • Safety training for all employees • Report incidents	Low Risk
					Fire or explosion	Moderate Risk		Low Risk

4.4 Risk Management

4.4.1 Physical Hazards (Stations and Tunnel Alignment)

4.4.1.1 Design Considerations

Prior to construction of the 16 subway stations and alignment, the appropriate design criteria must be selected to assure structural soundness against realistic worst-case scenarios during the operational lifetime of the MMSP. Being exposed to meteorological and seismic hazards, it is important that the proposed MMSP depot, stations and underground tunnels be designed using parameters that reflect the actual hazard vulnerability of the area. Based on the geohazard assessment conducted for this project, the design criteria that will be adopted for the facilities will consider is presented in **Table 4.4-1**.

Table 4.4-1 Code s and Standard to be used in the Construction of the MMS P Components

Subje c t	Philippine Codes and Standards	Japanese Code s and Standards
Building and Space Planning / Barrier-Free Design (Accessibility)	• National Building Code of the Philippines (NBCP) (Philippines) Presidential • Decree No.1096, 1977 • National Structural Code of the Philippines (NSCP) (Philippines) by ASEP: • Association of Structural Engineers of the Philippines • Referral Codes of the NBCP (both law s and self -regulatory documents) such as • BP344 - Accessibility Law;the Philippine Electrical Code (PEC), the Mechanical • Code, the National Philippine Electrical Code Plumbing Code of the Philippines, • DPWH 2000 architectural code of the Philippines (ACP, as applicable) and the like • DPWH DGCS Vol. 6 Public Buildings & Other Related Structures 2015 • DPWH-promulgated 2015 Philippine Green Building Code (PGBC) • Department of Energy (DoE) Guidelines on Energy Conserving • Design on Buildings, 2008 • RA6716 - rainwater collection • 2016 NBCP: Illustrated data compact disc (CD) applicable standards by other	• The Building Standard Law of Japan, Ministerial Ordinance, Notification, MLIT-J. • Ordinance of the Building Standard Law of Japan • Guideline to Improve Barrier Free Access for Public Transport Passenger Facilities for the Enforcement of 2006 Law N.19. Edited by Ministerial ordinance MLITT of Japan

Subje c t	Philipp ine Code s and Standa rd s	Japa ne s e Code s and Standa rd s
	• infrastructure agencies such as the Department of Transportation (DOTr) • Applicable DOTr standards • RA386, the 1949 New Civil Code of the Philippines • BP 344 - Accessibility Law and its IRR • RA7277, The Magna Carta for Disabled Persons	
Fire Protection and Safety Evacuati o n Design	• RA 9514 - Fire Code of the Philippines (FCP) and IRR of 2008 • Philippine Mechanical Engineering Code • Philippine Electrical Code • DPWH DGCS Vol. 6 Public Buildings & Other Rel. Structures 2015 • Illustrated FCP	• The Building Standard Law of Japan (Ministerial Ordinance, MLITT of Japan) • The Fire Law s of Japan (The Fire Defense Agency of Japan) • Fire Prevention Standards for Underground Stations (Japan)
Buildin g Materials	• 2013 DPWH Standard Specifications • DPWH Bureau of Research & Standards (BRS) certification, if applicable • Dept. of Trade & Industry (DTI) Bureau of Product Standards (BPS) product certification, if applicable	• Japanese Industrial Standards (JIS)
Urban Planning and Environment	• RA7279 - urban development & housing act of 1992 • P.D.s and IRRs (as applicable) e.g. 1586 –. environmental impact statement system; 1216 –open spaces; 1151 –environmental policy; 1152 –environmental code; 1067-water code; 957 –subdivisions & condominiums; 953 – tree planting; 856 –sanitation code; 757 – national housing authority; 296 – clear waterways; • Duly-approved local government unit (LGU) Zoning Ordinance (ZO, w ith official zoning map/ OZM) i.e. based on the duly-approved Comprehensive Land Use Plan (CLUP)	

Subjec t	Philipp ine Codes and Standards	Japanese Code s and Standards
	• Special development-related LGU ordinances, as applicable • Environmental law s and regulations e.g. clean air (RA8749), clean water (RA9275), solid waste management (RA9003), toxic waste (RA6969), climate change adaptation (RA9729), disaster risk reduction & management (RA10121), environmental impact assessment, heritage conservation (RA10066); indigenous peoples (RA8371), environmental planning (RA10587), resettlement & socialized housing (BP220), department of environment & natural resources (DENR) department administrative orders (DAOs), • Housing and Land Use Regulatory Board (HLURB) issuance e.g., guidebooks, guidelines, standards, manuals, etc. • Department of public works & highways (DPWH) Design Guidelines, Criteria & Standards (DGCS) Vol. 6 Public Buildings & Other Related Structures 2015 • Department of Transportation (DOTr) transportation planning studies	
Others	• Other relevant Philippine Codes and standards	

4.4.2 Chemical Hazards (Stations and Tunnel Alignment)

All hazardous substances to be used/generated by the project will be stored and handled in compliance with all applicable Philippine and international regulations. DOTr is committed to preventing, to the greatest extent possible, both inadvertent release of these hazardous substances to the environment and ac c idents resulting from mishandling or mishap.

To insure hazards or risks that may be posed by the project are further minimized, the following measures are recommended:

- Appoint a pollution control officer (PCO) to monitor the compliance to the ECC conditions and monitor the project impact.

- Institute programs for employee training, facility inspection, periodic drills to test systems, and proceduralreview to address deficiencies, accountability, and continuous improvement objectives.
- Actively work towards minimizing the generation of hazardous wastes by investigating alternatives to the use of hazardous materials, by recycling products and containers wherever feasible, and by treating wastes using state-of-the-art technologies before any release to the environment.
- All employees will be expected to comply with all applicable precautions and handling procedures with regard to hazardous materials. Employees are also expected to report any concer ns to their supervisors, the Health and Safety Committee, or senior site management. All staff is encouraged to bring forward suggestions for improvements that can be incorporated into procedure revis ions as appropriate.
- Provide PPEs especially for working with any of the hazards discussed in the previous subsections
- Comply with all permitting requirements relating to generation, handling and disposal of hazardous substances such as the Hazardous Waste Generator's ID, Permit to Transport, Priority Chemical List, Chemical Control Order and other permitting that may be required.

There will be a detailed procedure on the management of hazardous substances/materials for the MMSP will also be in place to ensure the safe use, storage of disposal of hazardous substance in the project. The following will be incorporated in the management procedure:

- Purchasing controls – control of shipping methods, appropriate packaging, shipping schedules, etc.;
- Inventory controls on site – periodic inventory of materials in storage on site to determine usage and to identify and manage any unexpected loss;
- Maintenance of current safe handling and storage procedures (i.e. Material Safety Data Sheet) and this will available to those in contact throughout the operational site;
- Characterization of potential environmental hazards posed by hazardous substances;
- Allocation of clear responsibility for managing shipment, storage, handling and use of potentially hazardous substances;
- Defined methods for transport, storage, handling, and use;
- Identification of disposal methods for hazardous waste generated from use of these products;
- Preparation of contingency and emergency response plans;
- Adequate type and delivery of training for management, workers, and contractors whose responsibilities include handling potentially hazardous materials;
- Maintenance and review of records of hazardous material consumption and incidents in order to anticipate and avoid impacts on personal health and the environment; and
- Procedures to track and manage wastes generated through use of these products, including regular shipments of potentially hazardous waste to appropriate licensed disposal facilities following the provisions set forth by Republic Act 6969 (Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990).

4.5 Emergency Response Policy

As discussed in the 2017 EIS, an Emergency Response Plan (ERP) shall be established by DOTr to define a set of procedures to identify potential accidents, emergency scenarios and catastrophic events which shall be done during the detailed design stage of the project. The ERP will be aligned with the DOTr policies and procedures ensuring a safe and reliable railway transport system. The ERP will be established for both the construction and the operation phases of the project.

4.6 Emergency Response Plan

The scenarios that will be considered while crafting the ERP will be but not limited to the following:

<u>Construction Phase</u>

- Tunnel collapse;
- Tunnel flooding;
- Other construction related accidents;
- Fire;
- Inclement weather; and
- Criminal acts.

<u>Operation Phase</u>

- Collisions;
- Injuries/Fatalities;
- Transport of dangerous goods;
- Criminal/Terrorist acts;
- Fire;
- Floods;
- Climate change impacts such as increased rainfall and increased temperature; and
- Seismic events

The ERP will at minimum contain communications/coordination protocols, emergency reporting protocols, emergency resource planning, evacuation procedures, training protocols, protocols to protect passengers and the public, asset protection procedures and climate change mitigation plans.

DOTr key personnel working during the construction and operation phases shall be required to be trained in the ERP while it is responsibility of DOTr to train all its employees, workers and contractors on its ERPs. The emergency equipment and facilities will be required and maintained at a constant state of readiness while employees, workers and contractors shall be provided the adequate safety equipment appropriate for their respective job functions.

4.6.1 Climate Change Mitigation Plan

Establishment of comprehensive management systems to address climate adaptation

DOTr will establish guidelines for climate change that include commitments related to climate adaptation, such as integration of climate considerations into the Project's strategic plan and working with the LGUs and the Metro Manila Development Authority (MMDA) to develop policy changes that support adaptation. DOTr will identify climate-related risks and opportunities and develop responses that are implemented and monitored using management systems.

Preparation of risk-identification processes to include climate risks and opportunities

DOTr will identify climate change risks as part of its implementation of environmental management systems and standards such as ISO 14001 (Environmental Management System (EMS) standard). Climate change risks will be incorporated into social and environmental management processes.

Integration of climate-related risks and mitigation measures into decisions throughout the project life

DOTr will examine broad impacts of climate issues throughout the project life, particularly upfront in design and decision making.

Ensuring robust engineering design and construction standards for facilities

The design of the facilities and stations will be able to withstand increased frequency and magnitudes of extreme weather events and flooding. To cope with increasing frequency of hot days, substantial investments in ventilation or cooling might be necessary (Love, Soares, & Puempel, 2010).

Design of comprehensive water management measures

DOTr will identify measures to ensure sustained adequate supply, increasing the efficiency of water use through conservation practices, and looking for opportunities for reuse and recycling.

Integrate climate-compatible development into initiatives for sustainable local benefit from Project operations

DOTr will explore development projects that make little or no use of scarce natural resources, strengthen community peace and security programs, build capacity of sound structural engineering, and develop government planning and emergency response.

Initiate cross-agency and cross-industry collaboration on regional adaptation strategies

If feasible, DOTr may explore opportunities to collaborate with the MMDA, the National Disaster Risk Reduction and Management Council (NDRRMC), Local Government Units (LGUs), and other rail and transportation systems (i.e. LRT 1&2, MRT 3, PNR, P2P, etc.) in Metro Manila to share information and costs for climate adaptation, other supporting scientific or technical activities , best practices, and implementation of large-scale adaptation strategies. Opportunities may likewise exist for complimentary work across industries such as food and agriculture, mining, energy, and transportation.

Mitigating impact of climate change to traffic

The construction materials and methods used in the construction of the MMSP must take into consideration climate change impacts, especially flooding on subway tunnels. Stations and station access must have adequate flood control measures in the case of heavy rain. The design of station plazas and parks with green spaces must also function as water catchment basin to reduce water accumulation during heavy rain.

CHAPTER 5 SOCIAL DEVELOPMENT PLAN (SDP) AND INFORMATION, EDUCATION AND COMMUNICATION (IEC) FRAMEWORK

5.1 Social Development Plan / Framework

The Social Development Plan (SDP) Framework is intended for formation in coordination with the City Planning and Development Officers of the cities where the MMSP will pass through, in order to derive from the respective local SDPs of the LGUs, their programs and projects for people's livelihood, health and environment. The MMSP SDP will be aligned with the local SDP to incorporate programs and projects that prevent, mitigate or enhance the Project's negative and positive impacts, especially those relating to livelihoods, health and the environment of the communities affected by the Project.

The development of the SDP will involve government agencies with mandates to deliver services in social development and civil society such as:

- Department of Health (DOH);
- Department of Environment and Natural Resources (DENR);
- Department of Education (DepEd);
- Department of Trade and Industry (DTI);
- Department of Labor and Employment (DOLE);
- Technical Education and Skills Development Authority (TESDA);
- Philippine National Police (PNP);
- Presidential Commission for the Urban Poor;
- NGOs; and
- People Organizations.

The cost estimates for SDP implementation shall be prepared once the specific projects have been identified and processed in consultation with LGUs and sectors concerned. DOTr shall share in the coast of the selected projects.

The SDP will be in the form of a Resettlement Action Plan (RAP) and will also include a Land Acquisition Plan where the list of Project-affected families and corresponding compensation and entitlements for qualified beneficiaries, including timeline, will be found. An outline of the Social Development Framework is shown in **Table 5-1**. The components of the SDP are being developed through the current detailed engineering design phase.

Table 5-1 Social Development Framework for the MMSP

Concern	Responsible Community Member / Beneficiary	Government Agency / Non-government Agency and Services	Proponent	Indicative Timeline	Source of Fund
Preparation of Resettlement Action Plan (RAP)	• Barangay Chairman • Presidents of Homeowners Association	• DOTr • LGU	DOTr Project Management Office (PMO)	Feasibility Study and Detailed Engineering Design	Part of Consultancy Budget

Concern	Responsible Community Member / Beneficiary	Government Agency / Non-government al Agency and Services	Proponent	Indicative Timeline	Source of Fund
	• Property Owners / Business Owners representative			Phase	
Relocation of informal settlers	• Barangay Chairman • Presidents of Homeowners Association	• DOTr • LGU Housing Office	DOTr PMO	Pre-Construction Stage	DOTr
Gender Responsive Livelihood Training Program • Skills training for construction work • Skills training for handicraft making • Skills training for food preparation, etc.	• Barangay Chairman • Barangay Kagawad for Livelihood • Presidents of Homeowners Association • Officers of Women's organizations	• LGU Livelihood Office	DOTr PMO	After ECC Issuance	LGU Livelihood Office
Formation of/Support to Vendors Organizations	• Barangay Chairman • Leaders of Vendors Organizations	• DOTr • DTI	DOTr PMO	Prior to RAP Implementation	LGU Livelihood Office
Health and Safety	• Barangay Chairman • Barangay Kagawad for Health and Safety	• City Health Office • Barangay Health Centers	DOTr PMO	Pre- Construction Stage, Operation Stage	LGU Health Office
Environment and Sanitation	• Barangay Chairman • Barangay Kagawad for Environment and Sanitation	• LGU • DENR	DOTr PMO	Pre- Construction Stage, Operation Stage	LGU
Peace and Order	• Barangay Chairman • Barangay Kagawad for Peace and Order • Homeowners Association • Sergeant at Arms	• LGU	DOTr PMO	Pre- Construction Stage, Operation Stage	LGU
Spiritual	• Barangay Chairman • Parish Pastoral Council • President Homeowners Association • Leaders of other religious groups	• Parish Priests • LGU	DOTr PMO	Pre- Construction Stage, Operation Stage	LGU

5.1.1 Social Impact Assessment

To understand scope of the resettlement impact of the Project, socio-economic survey has been undertaken for the affected LGUs since April 2017, which consists of, (i) Census Survey, (iii) Asset and Land Survey, and (iii) Livelihood and Living Survey. Census will be done on all PAPs, and their assets (land, structures, improvements, crops and trees) willbe inventoried and tagging will be done. Livelihood and Living Survey shall be conducted on 20% of PAPs using the questionnaires, and through focus group discussions.

The cut-off date for the informal settlers has been disclosed to each affected barangays by the relevant LGUs and the barangays have disclosed to their populations. Presidents of Home Owners Association in respective barangays have been contacted to disseminate the information to member ISFs.

The scope of the socio-economic survey under the RAP study is based on the basic design titled as Version 17 and 22. Thus scope of resettlement impacts shall be reviewed during the DED stage which is scheduled to be started in 2018. Therefore, outcomes of the census survey will be verified based on the final Detailed Design accordingly. In case there is no resettlement activities conducted after two years from the said cut-off dates, the census data shall be updated. This is in accordance with the World Bank Operational Policy (OP) 4.12.

At present, the RAP study for the feasibility stage of the subway project is under review and for finalization by DOTr and JICA Study Team.

5.1.2 MMSP's Project Resettlement Policy

The Government of the Philippines will adopt the Project Resettlement Policy (the Project Policy) for the Mega Manila Subway Project (MMSP) specifically because existing national laws and regulations have some gaps with the international practice, including JICA's policy. The Project Policy is aimed at filling in any gaps in order to help ensure that PAPs are able to rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between the Philippines' legal framework for resettlement and JICA's policy on involuntary resettlement, practicable mutually agreeable approaches will be designed consistent with the Philippine Government practices and JICA's policy.

1) Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

2) Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be fully compensated and assisted so that they can improve, or at least restore, their former economic and social conditions.

3) Compensation and rehabilitation support will be provided to any PAPs, that is any person or household or business which on account project implementation would have his, hertheir;
   - Standard of living adversely affected;
   - Right, title or interest in any house, interest in, right to use, any land (including premises, agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
   - Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently;
   - Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

4) All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and

rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business and/or cultivating land within the project impacted areas as of the date of the latest census and inventor y of lost assets (IOL), are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available, and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

5) PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land structures will be agr eed during the planning procession land acquisition and compensation of affected structures.

6) Where a host community is affected by the development of a resettlement site in that community, the host community shallbe involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

7) The resettlement plans will be designed in accordance with Philippines' National Involuntary Resettlement Policy and JICA's policy on involuntary Resettlement.

8) The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups.

9) Payment for land and/or non-land assets will be based on the principle of replacement cost.

10) Compensation for PAPs dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenur e, and upgrading livelihoods of people without legal titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights and may eventually lead to those populations being worse off than without the project.

11) Replacement lands, if available, feasible and the preferred option of PAPs, will be within the immediate vicinity of the affected lands wherever possible and be of comparable productive capacity and potential. As a second option, sites will be identified that minimize the social disruption of those affected; such lands will also have access to services and facilities similar to those available in the lands affected.
12) Resettlement assistance will be provided not only for immediate loss, but also for a transition period needed to restore livelihood and standards of living of PAPs. Such support could take form of short-term jobs, subsistence support, salary maintenance, support similar to those available in the lands affected, or other forms of assistance.

13) The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement (including the poor, those without legal title to land, ethnic minorities, women, children, elderly and disabled) and ensure they are considered in resettlement planning and mitigation measures are identified. Assistance will be provided to help them improve their socio-economic status.

14) PAPs will be involved in the process of developing and implementing resettlement plans.

15) PAPs and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

16) Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the government.

17) Displacement does not occur before provision of compensation and other assistance required for relocation. Sufficient civic infrastructure must be provided in the resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be on-going activities.)

18) Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

19) An appropriate reporting (including auditing and redress functions,) monitoring and evaluation mechanism, will be identified and set in place as part of the resettlement management system. An external monitoring group will be hired by the project and will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

Source: JICA Study Team

Note on Section XVII: In cases where the landowner is unable to complete documentary requirements due to such situations as undocumented inheritance, un-transferred TCTs, Extra- Judicial Partition of Estate, etc., specific policy and procedures will be developed prior to the displacement of PAPs to ensure that the title will be duly transferred to DOTr and proper compensation will be given to the PAPs.

5.1.3 Grievance Redress Mechanism

Grievance refers to any controversy, issue or conflict resulting from the interpretation and implementation of the Subway Project ranging from issues on compensation (lot and structure owners) and eligibility criteria to issues on relocation sites and the quality of services extended by proper authorities and agencies on those sites. Thus, a systematic grievance redress mechanism must be established to address grievances from PAPs. Procedures for grievance redress shall be examined in their simplicity, affordability, and reliability to justify an application of existing procedures or a new procedure for settlement of disputes arising from the resettlement of the Project. If there will be grievances arising from any aspect of the Project, these will be handled through negotiations following the succeeding procedures.

A Grievance Handling Task Force (GHTF) shall be formed within the PMO - Resettlement Implementation Management Team (RIMT) in each traversed City, Makati maybe an exceptional, which is mostly indirectly affected, to facilitate the resolution of the PAPs' grievances. The GHTF's Chairperson shall head this Committee. Each representative from concerned Barangay government shall be his Co-Chairperson(s). The formation of the GHTF shall be towards the end of the Detailed Engineering Design (DED) Stage. The GHTF shall consist of the members set out in

Table 5-2 Expected Composition of the Grievance Handling Task Force

Title	Original Organization
Chairpe rs o n	Chairpe rs o n of PMO-RIM T
Co-Chai r p ers o n s	Barang a y Captains of traversed barangays
Members	DOTr ROW Engine e r DENR-NCR Land Management Section (LMS) Chief or Representative City Assessor City Environment and Natural Resources Officer (CENRO) City Urban Poor Affairs Office (UPAO) RAP Consulta nt (Construct io n Superv isi o n Stage) Represe nt at iv es of NGOs oper ati n g in the area

Grievances from the PAPs related to the resettlement implementation or any related issues to the projec t will be handled, free of monetary charge, through negotiations and are aimed to have consensus decision to the following procedures:

1. Any aggrieved PAP will lodge their grievances by writing to their respective LIAC for immediate resolution. When received verbally, the grievances may be written by the staff of LIAC, LGU, or RIMT, or staff assigned by RIMT, for official submission. The same grievance will be forwarded by the receiving entity to the Resettlement Arbitration Committee, composed of concern agencies created by LIAC and DOTr-PMO/RIMT, for immediate resolution.
2. The receiving entity, however, upon receipt of the complaint, may determine and decide whether the nature of the complaint will fall under the definition of a grievance or not related to the project. Or, the receiving entity will forward immediately to the Resettlement Arbitration Committee for

immediate resolution. However, if his/her complaint is rejected by the receiving entity, the complainant may elevate his/her complaint to the DOTr-PMO.

3. If the complaint is not satisfactorily resolved by Resettlement Arbitration Committee or the PAP does not receive any response from the LIAC within 15 days upon receipt, the PAP can forward the complaint or file an appeal to the DOTr-PMO.
4. If the complaint is not satisfactorily resolved by the DOTC-PMO National Office or the PAF does not receive any response from the DOTr-PMO in 15 days of registry of the complaints, the PAP can file a legal complaint in any appropriate Court of Law.

5.2 Information, Education & Communication Framework

The Information, Education and Communication (IEC) Plan is undertaken to encourage the participation and cooperation not only of affected households but a broader sector of stakeholders and facilitate the establishment of support linkages in the implementation of the subway project from Pre-Construction stage through to the Completion Stage. The IEC will also inform the stakeholders about the progress of the project and provide feedback to the proponent regarding the concerns and issues raised by the stakeholders during the project progress. The IEC methods shall include individual methods (key informant interviews), group methods (focus group discussions), and multi-media (print and social media). The IEC will also inculcate value formation by making members of the community aware of their responsibilities as stakeholders.

A summary of the IEC activities completed after the ECC was been granted is provided in **Table 5-1** and a summary of the IEC Plan for the next phases of the Project is summarized in Table **5- 3**. The details and specifics of the IEC Plan will be finalized during the detailed engineering design phase.

Table 5-3 Summary of IEC completed for the MMS P Project – EPRMP 2019

Date	Topic	Participants		Location
8 October 2018 (am)	Stakeholder Consultation Meeting	42	DOTr Employees, EcosysCorp. Inc, JTD, Corporation Representatives	Training Room, Action Center, Brgy. Dalandanan, Valenzuela City
8 October 2018 (pm)	Stakeholder's Consultation on Meeting with Affected Landowners in the Depot Area	54	DOTr Employees, JICA Design Team, EcosysCo r p. Inc. PAPs	Training Room, Action Center, Brgy. Daland a n a n, Valenzu el a City
9 October 2018 (am)	Stakeholder Consultation Meeting	47	DOTr Employees, EcosysCorp. Inc, JTD, PAPs	Training Room, Action Center, Brgy. Dalandanan, Valenzuela City
9 October 2018 (pm)	Stakeholder's Consultation Meeting with Affected Landowners in the Depot Area	54	DOTr Employees, JICA Design Team, EcosysCo r p. Inc. PAPs	Training Room, Action Center, Brgy. Dalandanan, Valenzuela City
19 December 2018	Newspaper advertisement	General public		Manila Bulletin

Table 5-4 Information, Education and Communication Plan

Target Sector	Objective /Major Topic	IEC Scheme /Methods	Information Medium	Indicative Timeframe and Frequency	Indicative Cost
(1) General Public	Information dissemination about the MMSP Project	Multimedia	TV, Radio, Social Media (FB, Twitter), Print Ads or audio- visual at the stations on MRT, LRT	Starting from Detailed Design Stage up to Operational phase	Cost of public relations (PR) materials (for estimation)
(2) LGUs along the subway alignment	Regular updating of the Progress of the MMSP Project	Meetings and memorandum	Slide Presentation, Minutes of meetings and print materials	All phases of the project, from Detailed Design Stage up to Operational phase	Included in the Consultant's contract
(3) PAPs at Barangay- level (DIA and IIA)	Regular updating of the Progress of the MMSP Project	Meetings or Assembly; Regular Memorandum circulars; Leaflets/Brochures	Multi-sectoral Cluster meetings Print materials	All phases of the project, from Detailed Design Stage up to Operational phase	Included in the Consultant's contract
(4) Affected Sectors (PAPs)					
Land and Structure owners	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation, Minutes of meetings and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
Business Owners	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R.O.W Acquisition	Focus Group Discussion	Slide Presentation, Minutes of meetings and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
Residents	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation, Minutes of meetings and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
Informal Settlers	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation, Minutes of meetings and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
Local Interagency Committees (LIACs) including local POs, NGOs, women's groups, disadvantage groups	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation, Minutes of meetings and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
(5) Barangay -level (at the station areas), in coordination with Barangay Health Centers and LGU Health Units	Information dissemination and preparation for mitigating measures against impact of project on health and safety, e.g noise pollution and increase in vibration level	Meetings or Assembly; Regular memorandum circulars; Leaflets/Brochure	Multi-sectoral Cluster meetings Print materials	Prior to start of Pre- construction and Construction Phase	Included in the Consultant's contract

Target Sector	Objective /Major Topic	IEC Scheme /Methods	Information Medium	Indicative Timeframe and Frequency	Indicative Cost
(6) General Public	Traffic Management Plan, Alternative Routes around the station areas	Multimedia	TV, Radio, Newspaper, Social Media (FB, Twitter)	During the Pre-Construction, Construction phase of the project	Cost of PR materials (for estimation)
(7) General Public	Proper hygiene in all stations; Emergency response plans (e.g. fire, earthquake)	Multimedia	Posters, leaflets, audio-visual presentation at the stations	Operation phase	Cost of PR materials (for estimation)

CHAPTER 6 ENVIRONMENTAL COMPLIANCE MONITORING

This section describes the framework for environmental compliance monitoring and environmental performance indicators, including current progress towards compliance with the ECC. As required by the Department of Environment and Natural Resources (DENR) Administrative Order (DAO) 2003- 30, this framework covers the formation of a Multi-Partite Monitoring Team (MMT), the proponent's commitment for the establishment of an Environmental Monitoring Fund (EMF), Environmental Guarantee Fund (EGF) and Self-Monitoring Plan.

6.1 Environmental Performance

6.1.1 ECC Compliance

The compliance of the existing project to the ECC conditions (ECC-CO-1708-0017) are presented in **Table 6.1-1**. It is noted that construction has not yet begun on the Project as it is still in the detailed design phase, therefore compliance with many of the ECC conditions and requirements is not yet required and impact monitoring has not been conducted.

Table 6.1-1 Summary of compliance to conditions and requirements of existing ECC

Relevant ECC conditions		Reported Status of Compliance (as per submitted CMRs)	Compliance Evaluation
#	Requirement Description		
Project / Coverage Limits / Components			
The ECC covers the construction and operation of Metro Manila Subway Project (Phase 1) comprising of 13 underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Paranaque City, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City, The ECC includes Depot for trains in Brgy. Ugong, Valenzuela City.		Complied	No construction activities started. The Project is currently in its detailed design phase. There will be an additional station in NAIA Terminal 3. Also, the Cayetano Blvd. Station has been replaced by 2 alternate stations (Lawton East & West Stations). An interconnection with the PNR Bicutan Station is under study. An EPRMP is currently being prepared for the ECC Amendment of the Project.
Depot, underground stations and tunnels, entrances/exits, and interconnections (i.e. walkway, PUV bays, footbridges and etc.)		Complied	No construction activities started. The Project is currently in its detailed design phase.
Environmental Management			
1	Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following: a. Project impacts and mitigating measures embodied in its EIS; b. Conditions stipulated in this Certificate; c. Environmental and human safety features of the project, and d. Health consciousness alerts for any project-induced discomfort (from dust, small, noise, vibration) as the	Complied	Nine (9) IEC Meetings were conducted for the new sections on the months of April, May and June 2019 in the cities of Taguig, Pasay & Parañaque. Continuous dissemination of information through various platforms (e.g. social media, news clips, etc.)

Relevant ECC conditions		Reported Status of Compliance (as per submitted CMRs)	Compliance Evaluation
#	Requirement Description		
	project progresses throughout the whole route.		
2	Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis;	Complied	SDP as RAP and LAP (As per EIS, “The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan) Updating of the RAP is ongoing. CMRs have been submitted for July 2018, January 2019 and July 2019
3	Submit detailed waste management program for proper handling, collection and disposal of solid, hazardous and liquid waste to EMB Central Office (CO) and EMB National Capital Region (NCR) within six (6) months prior to project construction. Proof of implementation shall be submitted together with the CMR;	Complied	Construction phase will start in 4th quarter of 2019. The Demolition Contractor that will do the advance works will provide the detailed Waste Management Program Waste management general framework was attached in the previous CMR submitted on July 17, 2018.
4	Ensure that all the existing waterways affected by the proposed project construction are maintained and not obstructed;	Complied	No construction activities started. Once construction commences, all contractors will have this condition in their Terms of Reference.
5	Submit a detailed demobilization plan for the construction yards within six (6) months prior to project construction. The plan will include the following: a. Coordination with concerned local government units to promote compatibility of adjoining land uses with the intended subway project station including its exit and entrance; and b. Allocation of at least 30% of total area of construction yards for green and open spaces, including but not limited to setting up of vertical and pocket gardens, mini open parks system to promote urban biodiversity	Complied	No construction activities started. Draft layout and landscape concept for the PO Section attached in the previous CMR submitted on January 2019. ECC Condition 5b is only applicable to the stations.
6	Submit a detailed plan for earth balling and replanting of mature native/endemic trees within six (6) months prior to project construction. The plan will include the following: a. specific recipient sites which have already been prepared and conditioned b. ensure high degree of survival c. provision for regular maintenance until trees have re-established in their new environment	Complied	Detailed plan for earth balling and replanting will be prepared after the issuance of the tree cutting &earth-balling permit. Tree validation and consolidation of requirements for the tree cutting and earth-balling permit application are ongoing.
7	Submit an approved Resettlement Action Plan (RAP) of the affected communities within six (6) months prior to project construction	Complied	Updating of the RAP is ongoing.
8.1	A readily available and replenishable Environment al Guarantee Fund (EGF) to cover the following expenses: a. for further environmental assessments, compensations/ indemnification for whatever damages to life and property that may be caused by the project; b. rehabilitation and/or restoration of areas affected by the project's implementation; and c. abandonment /decommissioning of the project facilities related to the prevention of possible negative impacts; and as a source of fund for contingency and clean-up activities.	Complied	MMT Formation is yet to be initiated. The EGF amount is to be finalized upon finalization of the MMT MOA.

Relevant ECC conditions		Reported Status of Compliance (as per submitted CMRs)	Compliance Evaluation
#	Requirement Description		
8.2	Establish a Multipartite Monitoring Team (MMT) composed of representative(s) from the local environ mental Non -Government Organization (NGO), POs, and the Local Government Units per DAO 2017-15. The MMT shall primarily oversee the compliance of the proponent with the Environmental Management and Monitoring Plan (EMoP) and the ECC conditions	Complied	MMT members have been identified; to be convene d.
8.3	A replenishable Environmental Monitoring Fund (EMF) to cover all costs attendant to the operation of the MMT such as training, the hiring of technical experts and resource persons, fieldwork and transportation. The amount and mechanics of the EGF, EMF and the establishment of the MMT shall be determine d by the EMB Central Office and the proponent through a Memorandum of Agreement (MOA) which shall be submitted within sixty (60) days upon receipt of this Certificate.	Complied	MMT Formation is yet to be initiated. The EMF Amount will be finalized upon finalization of the MMT MOA.
9	Establish an Environmental Unit (EU) within sixty (60) days from receipt of this Certificate that shall competently handle the environment-related aspects of the project. In addition to the monitoring requirements as specified in the Environment al Management and Monitoring Plan (EMMoP), the EU shall have the following responsibilities: a. Monitor actual project impacts vis-a-vis the predicted impacts and management measures in the EPRMP to include in the TOR for the advance works ESCT to draft TOR for advance works to include this condition b. Recommend revisions to the EMMoP, wheneverr necessary subject to the approval of EMB Central Office; c. Ensure that data gathered during monitoring activities are properly documented, assessed, evaluated and reported in accordance with the standard formats; and c/o ESCT in coordination with DOTr d. Ensure that monitoring and submission of reports to EMB CO are carried out as required c/o ESCT in coordination with DOTr	Complied	EU organization structure has been established and was submitted in the January 2019 CMR
10	The proponent shall ensure that its contractors and sub-contractors are provided with copies of this ECC and that they will strictly comply with the relevant condition s of this Certificate	Complied	Construction for the project has not yet started. ECC and EMP/EMoP to be included in the contractor's agreement/contract.
Restrictions			
11	No activities shall be undertaken until and unless disposal sites of excavated materials have been identified, duly covered by agreement/ s and have been permitted in accordance with law. Proof of compliance shall be filed with the Regional Office having jurisdiction over the disposal area and shall be without prejudice to environmental safeguards that may be prescribed as warranted. Likewise, a copy of which shall form part of the requirement under Condition 3 hereof	Complied	No construction activities started. Coordination with LGUs regarding identification of spoil disposal sites is on-going.
12	No activities shall be undertaken other than what were stipulated in the final EIS. Any expansion and/or modification of the project beyond the project description or change in alignment/rout e that will cause significant impacts to the environment shall be subject to a new Environmental Impact Assessment; and	Complied	No construction activities started. ECC Amendment is in progress
13	In case of transfer of owners hi p of this Project, the same	Complied	Not applicable.

Relevant ECC conditions		Reported Status of Compliance (as per submitted CMRs)	Compliance Evaluation
#	Requirement Description		
	conditions and restrictions shall apply to the transferee or grantee who shall secure in writing the corresponding amendment of this ECC from the EMB Central Office within fifteen (15) working days reflecting such transfer.		
Other Regulatory Requirements / Conditions			
1	Strict compliance with the Revised National Structural Code of the Philippines	Complied	Designs will adhere to the Revised National Structural Code of the Philippines
2	Compliance with the Sanitation Code of the Philippines	Complied	Adhere to the provisions of the Sanitation Code of the Philippines and applicable regulations by the Department of Health (DOH).
3	Compliance with the Labor Code of the Philippines	Complied	Adherence to the applicable regulations of DOLE.
4	Compliance with the Building Code of the Philippines	Complied	Designs and application of permits will adhere to the Building Code of the Philippines.
5	Ensure compliance with the Ecological Solid Waste Management Act	Complied	Waste management plan prepared in accordance with the Ecological Solid Waste Management Act.
Environmental Planning Recommendations for the Proponent			
6	Priority of employment shall be given to qualified local residents. Opportunities for qualified PWDs, women, senior citizens, where possible shall be considered. Adequate public information for jobs available to local residents in the affected areas will be provided.	Complied	No construction has begun hence the employment process has likewise not yet started.
7	Conduct a detailed Traffic Impact Assessment (TIA) in coordination with the Metro Manila Development Authority (MMDA) and concerned LGU for every proposed station prior to project construction integrating proposed road expansion projects (if any) of the concerned government agencies. Part of contractor's CEMMP during construction phase.	Complied	Preparation of the TIA is ongoing for the ECC amendment. DOTr also conducted traffic studies along the alignment
8	An inclined drilling program will be designed and carried out for the segment(s) for the subway along the West Valley Fault (e.g. Cayetano Station). The design of the drilling program and interpretation of results will be done in consultation with PHIVOLCS.	Complied	Cayetano Station no longer part of MMSP. Alignment shifted northwest toward the newly established Lawton East and Lawton West Stations
9	Based on the results of the Detailed Engineering Design, the proponent may consider realignment of subway from the fault while maintaining the Cayetano Station.	Complied	Cayetano Station no longer part of MMSP. Alignment shifted northwest toward the newly established Lawton East and Lawton West Stations
Compliance with Social Development Plan			
	SDP as RAP and LAP (As per EIS, "The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan"	Complied	Updating of the RAP is ongoing.
Compliance with Information Education Communication (IEC)			
	IEC meetings and information dissemination through various platforms.	Complied	Nine (9) IEC Meetings were conducted for the new sections on the months of Continuous dissemination of information through various platforms (e.g. social media, news clips, etc.)

Relevant ECC conditions		Reported Status of Compliance (as per submitted CMRs)	Compliance Evaluation
#	Requirement Description		
Status of Compliance to Contingency /Emergency Response Plan or Equivalent Risk Management Plan			
	Prepare and follow ERP procedures and guidelines.	Complied	The Emergency Response Policy and Guidelines presented in the EIS will serve as general guideline for this project. Contractor will be required to prepare their own ERP to be reviewed by the PMO.

6.1.2 Complaints and Violations

Complaints are managed through the DOTr Help Desk which has been set up and will continue to log inquires and complaints if received. Current records of the Help Desk show the majority of interactions are in relation to submitting documents and queries raised on land acquisition / property issues.

6.2 Self-Monitoring Plan

The primary purpose of the Self-Monitoring Plan is to ensure the Project complies with relevant regulator y requirements through the proposed management measures identified to address project impacts. Specifically, it aims to:

- Monitor Project compliance with the conditions stipulated in the ECC;
- Monitor compliance with the EMP and with applicable laws, rules and regulations; and
- Provide a basis for timely decision-making and effective planning and management of environmental measures through the monitoring of actual project impacts vis-a-vis the predicted impacts in this EIA.

Table 6.2-1 presents the proposed Self-Monitoring Plan/Environmental Monitoring Plan (EMoP) for the Project during the pre-construction, construction and operational phases.

Table 6.2-1 Environmental Monitoring Plan (EMoP) for Metro Manila Subway Project

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Methods	Frequency	Location/s			Alert	Action	Limit	Alert	Action	Limit
PRE-CONSTRUCTION AND CONSTRUCTION PHASE													
The Land													
Solid/domestic wastes generation	Soil pollution and aesthetic impacts	Solid waste management and disposal method	Visual observation, reporting and meeting with contractor	Reporting and Meeting: Monthly or as needed Visual observation: Daily	Construction site and disposal site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
Generation of hazardous (oils and lubricants) waste	Soil pollution and aesthetic impacts	Waste management and disposal method	Visual observation, reporting and meeting with contractor	Reporting and Meeting: Monthly or as needed Visual observation: Daily	Construction site and disposal site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
		Condition of construction equipment, oil and fuel storage, and chemical injection method			Construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
Generation of surplus soil	Soil pollution and aesthetic	Proper management and disposal of surplus soil	Visual observation, reporting and meeting with contractor	Reporting and Meeting: Monthly or as needed Visual observation: Daily	Construction site and disposal site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
		Heavy metal levels in surplus soil: Cd, Cr (VI), Hg, Se, Pb, As, F and B	Toxicity Characteristic Leaching Procedure (TCLP)	5 samples /1km tunnel excavation	Construction site and disposal site	Supervising Consultant, Contractor	~ Php 50,000/ 5 samples	To be established POST-ECC		Cd, Pb, Cr (VI), As: 5 mg/L; Hg: 0.2 mg/L; Se: 1 mg/L; F and B – no standard	To be established POST- ECC		
Topography	Slope failures, landslides and subsidence	Change of ground level	Level survey, Visual observation	Visual observation: Daily Level survey: Weekly or as needed	In and around construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
Clearing operations and vegetation removal	Potential loss of ecologically important, endemic and threatened species	Transplanted tree individuals • Survival rate • Mortality rate	Ocular inspection	Semi-annual during construction or as require by DENR-EMB	Off-site area for the transplant of earth balled species and/or reforestation site for re-planting appropriate seedlings (in a 1:100 exchange ratio), recognized by the proponent or as identified by DENR-EMB	Supervising Consultant, Contractor	Php 50,000 / semi-annual monitoring	30% reduction in the abundance of total plant species recorded from the baseline data 20% plant mortality rate in rehabilitation / reforestation area	50% reduction in the abundance of total plant species recorded from the baseline data 40% plant mortality rate in rehabilitation / reforestation area	60% reduction in the abundance of total plant species recorded from the baseline data 60% plant mortality rate in rehabilitation / reforestation area	Management measures to be established but will follow the general protocol such as: Conduct inspection at said station Determine possible source	Rapidly conduct site assessment, in cooperation with DENR-CENRO to determine the cause of deterioration If related to pest infestation, apply appropriate measures to manage and control the spread of said infestation. Enforce	Rapidly conduct site assessment in cooperation with DENR-CENRO to determine the cause of deterioration If previous measures for pest control (if and when related to pest control were not effective, consider coordinating with LGUs to scout for sustainable

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Methods	Frequency	Locations			Alert	Action	Limit	Alert	Action	Limit
											If source is not from proponent, inform the barangay and MMT regarding potential source of disturbance for their appropriate investigation and coordination with the LGU If source is from proponent, inform the management to perform mitigating measures based on identified impacts	monthly monitoring in the succeeding months until conditions normalize If reduction in abundance is associated with anthropogenic disturbance, escalate immediately to LGU	offset areas to continue with appropriate reforestation activities.
The Water													
Clearing and excavation activities	Increase in suspended sediments in receiving water	DO, TSS and pH of surface water, water turbidity	Analysis using potable water quality meter, Visual observation of turbid water	Water quality analysis: Weekly or as needed Visual observation: Daily	Tullahan River, San Juan River, creek near Tandang Sora Avenue	Supervising Consultant, Contractor	Php200,000 (cost of portable equipment)	75% of DENR limit DO: 3.75ppm; TSS:22.5ppm; pH:	85% of DENR limit DO: 4.25ppm; TSS:25.5ppm; pH:	DO: 5ppm; TSS:30ppm; pH: 6.5 and/ or 8.5	To be established POST- ECC		
Generation of wastewater	Water pollution	BOD, COD, color, TSS, Oil & Grease, Fecal/Total Coliform, pH	Water sampling in accordance with DAO 2016-08 and EMB-DENR Manual for Ambient Water Quality Monitoring	Quarterly	Discharge point	Supervising Consultant, Contractor	Php 20,000/qtr	75% of DENR limit BOD: 37.5ppm COD: 75ppm TSS: 75ppm Oil & Grease: 3.75ppm Fecal Coliform: 300 MPN/100mL Total Coliform: 7,500MPN/ 100mL pH: Color: 112.5 TCU	85% of DENR limit BOD: 42.5ppm COD: 85ppm TSS: 85ppm Oil & Grease: 4.25ppm Fecal Coliform: 340 MPN/100mL Total Coliform: 8,500MPN/ 100mL pH: Color: 127.5TCU	BOD: 50ppm COD: 100ppm TSS: 100ppm Oil & Grease: 5ppm Fecal Coliform: 400 MPN/100mL Total Coliform: 10,000MPN/ 100mL pH – 6.5 to 9.5 Color: 150 TCU	To be established POST- ECC		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Methods	Frequency	Location/s			Alert	Action	Limit	Alert	Action	Limit
Hydrology	Flooding and inundation	Water leakage	Visual observation Installation of dewatering pumps	Visual observation: Daily	In and around construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
	Lowering of groundwater level and pressure	Groundwater level	Water level survey Installation of monitoring boreholes	Visual observation: Daily Water level and pressure monitoring: Daily or as needed	In and above construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
The Air													
Generation of dust and particulate matter from Earth moving and construction activities; Particulate matter (TSP, $PM_{2.5}$, and PM_{10}) and gaseous pollutants (SO_2 and NO_2) emission from vehicles and construction equipment	Air Pollution	Dust level (qualitative)	Visual observation and interview of pedestrians	Visual observation: Daily Interview: Monthly or as needed	In and around construction site	Supervising Consultant, Contractor	To be included in operation and maintenance cost	N/A			N/A		
		• TSP • $PM_{2.5}$ • PM_{10} • NO_2 • SO_2,	1-hour ambient air quality monitoring for: TSP - Hi-volume, Gravimetric $PM_{2.5}$ - Hi-volume with $PM_{2.5}$ inlet, Gravimetric PM_{10} - Hi-volume with PM_{10} inlet, Gravimetric SO_2 – Gas Bubbler, Pararosaniline Method NO_2 – Gas Bubbler, Griess-Saltzman Method	Quarterly during construction, or as required by DENR-EMB	At the 16 ambient air quality and noise monitoring stations listed in Table 2.3-27 and Figure 2.3-25 of this EPRMP (except for station AN13)	Supervising Consultant, Contractor	Php 50,000/ sampling station	Noticeable dust and/ or presence of haze Or TSP – 225 µg/NCM $PM_{2.5}$ – 56 µg/NCM PM_{10} – 150 µg/NCM NO_2 – 195 µg/NCM SO_2 – 255 µg/NCM If concentrations are above the NAAQS, 75% of baseline values	Complaint lodged by community Or TSP – 255 µg/NCM $PM_{2.5}$ – 64 µg/NCM PM_{10} – 170 µg/NCM NO_2 – 221 µg/NCM SO_2 – 290 µg/NCM If concentrations are above the NAAQS, 85% of baseline values	TSP – 270 µg/NCM $PM_{2.5}$ – 68 µg/NCM PM_{10} – 180 µg/NCM NO_2 – 234 µg/NCM SO_2 – 306 µg/NCM If concentrations are above the NAAQS, 90% of baseline values	Continue monitoring and investigate possible causes of increase of particulates and gaseous pollutants	Check efficiency of dust suppression systems and conduct routine preventive maintenance. Investigate cause of complaint and determine and address the root cause. Increase frequency of dust suppression	Consider modifications to dust suppression system (i.e. changes to spray nozzle type, upgrade to air-and - water dust suppression system, etc). Conduct smoke emission tests of vehicles and construction equipment, as necessary. Review traffic management guidelines
Movement and operation of construction machinery	Increase in ambient noise level and ground vibration due to operations from construction	Ambient Noise level (decibel)	Approved method of Ambient Noise Level measurement (AS 1055.1-1998) Approved method of vibration level measurement to be agreed with DENR due to absence of Philippine Standard.	Quarterly during construction, or as required by DENR-EMB	Co-located with air quality monitoring Stations and vibration monitoring stations (where applicable)	MMSP Environmental Officer	5,000/sampling (3rd party)	Negative feedback reported from surrounding communities.	Complaints filed by surrounding communities, commercial areas,	Multiple complaints filed by nearby residential and commercial areas, or by	Determine equipment, machines, and/or activities that caused	Determine cause and address the problem according to the feasible	1. Continuous ambient noise level monitoring 2. Strategic scheduling of

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Methods	Frequency	Locations			Alert	Action	Limit	Alert	Action	Limit
	machinery.								contractors, or employees. These include, but not limited to, health complaints or problems, and disturbances, among others.	contractors and employees. Although the baseline ambient noise data exceeded the standard noise levels in most stations, the safe noise level exposure for the public is known at a maximum of 85 decibels (Fink, 2017).	the complaints.	mitigation measures.	activities per period within a day to minimize effects of noise 3. Using machines with lesser noise produced, or using equipment/structures to minimize noise produced such as noise barriers or mufflers.
	May cause hearing problems to workers who operate nearby machineries or equipment that produce extremely loud noise.	1. Implementation and effectivity of PPE during workhours 2. noise levels of machines (decibel) and ambient noise level (decibel) 3. Projected construction noise levels (decibel)	1. Regular inspection, strict reinforcement and maintenance of PPE 2. Approved method of ambient noise level measurement inside construction sites 3. Approved construction noise assessment (FHWA prediction method)	1. Daily inspection of PPE 2. Quarterly ambient noise monitoring and maintenance of machines 3. one construction noise assessment done before construction phase	Within construction areas	MMSP Environmental Officer	For the PPE and construction noise assessment: part of operations cost For ambient noise level: 5,000/sampling (3rd party)	Noise-related health problems reported by employees and workers on-site, or reported damaged PPE	Verbal or non-verbal complaints filed by employees and/or workers.	Multiple complaints filed by employees and workers on-site, and if the permissible noise levels, as suggested by DOLE, exceeded the limits. Duration per day, hours – Sound levels, dBA 8 – 90 6 – 92 4 – 95 3 – 97 2 – 100 1-1/2 – 102 1 – 105 ½ – 110 1/4 – 115	Determine equipment, machines, or activities that caused the complaints.	Coordinate with construction employees to address the root cause, or; coordinate with a health institution for necessary medical checkup.	1. Maintenance of equipment or machineries used during construction, or using equipment that produce lesser noise. 2. Strategic scheduling of shifts to integrate the permissible noise level exposure in the safety of the workers. 3. Inspection of PPE, and maintenance of damages. 4. Strict implementation of PPE on-site. 5. Recording equipment that produce harmful noise levels, and keeping its nearby area off-limits to workers.
	May cause hearing problems to	Public perception and complaints	Visual observation, survey of nearby residential areas, and survey of residents that are part of	Visual observation: Daily Survey: Once prior to	Communities/areas surrounding the construction sites	MMSP Environmental Officer	Part of the operations cost	Negative feedback from surrounding	Formal complaints filed by	Multiple complains filed by nearby	Investigate the extent of the	Coordinate with the LGUs and relevant	1. Update the affected surrounding

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Methods	Frequency	Location/s			Alert	Action	Limit	Alert	Action	Limit
	nearby residents who are a part of the vulnerable groups, and the general public.		the vulnerable groups	the construction of the project				residential and commercial areas.	surrounding residential and commercial areas.	residential and commercial areas, or by contractors and employees.	damages, and the root cause of the complaint.	stakeholders to properly address the issue.	communities about the actions done to address their complaints through written statements and assemblies. 2. Conducting necessary health programs for vulnerable groups, and massive public information about mitigation measures to avoid damages caused by elevated noise levels. 3. Continuous monitoring and documentation of complaints from residents to assess extent and gravity of disturbance. 4. Continuous ambient noise level and vibration monitoring during operations.
Movement and operation of construction machinery	Nuisance from increase in Noise and vibration level	Noise level (decibel)	Interview of local residents and pedestrians, Noise Meter	Interview: Monthly or as needed Noise meter measurement: Weekly or as needed	At critical areas affected by the construction noise	Supervising Consultant, Contractor	~Php 50,000 (cost of noise meter); personnel cost included in maintenance and operation cost	To be established POST-ECC		Noise level standard in Table 30; Vibration level at daytime: Residential: 60dB Commercial: 65dB	To be established POST- ECC		
The People													
Resettlement/ Land Acquisition	Involuntary resettlement	Progress of resettlement action plan	Site survey and meeting with PAPs	Monthly or as needed	Construction and relocation sites	DOTr, in coordination with LGUs	To be determined and finalized during the RAP updating in	N/A			N/A		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Pers on	Annual Estimated Cost	EQPL Management Scheme					
								EQP L Range			Management Measure		
			Method s	Frequency	Location/s			Alert	Action	Limit	Alert	Action	Limit
							the Detailed Engineering Design Phase						
OPE RA T IO N AL PHAS E													
The Land													
Solid /domestic wastes and hazardous (oils and lubricants) waste generation	Soil pollution and aesthetic impacts	Proper waste management and disposal of surplus soil, construction wastes and genera l garbage	Visual observation and reporting	Weekly or as needed	Station and other facilities	Subway Administrator, Pollution Control Officer	To be included in operation and maintenance cost	N/A			N/A		
Topography	Subsidence	Change of ground level	Visual observation Level survey	Visual observation: Daily Level survey: Quarterly or as needed	In and above construction site	Supervising Consultant, Contractor	Visual observation: Part of operation and maintenance cost Level survey: Php 150,000/qtr	N/A			N/A		
Ground movement	Development of fractures Structural damage Disruption of operations	Ground acceleration	Seismometer / accelerograph reading	Real-time and continuous measurement	Per station/depot and between stations	Structural or Operations Engine e r	To be included in operation and maintenance cost	N/A			N/A		
The Water													
Wastewater effluent	Water pollution of receiving water bodies	BOD5, COD, pH, TSS, Color, Oil & Grease and coliform	Water sampling in accordance with DAO 2016-08 and EMB DENR Manual for Ambient Water Quality Monitoring	Quarterly	Discharge point	Supervising Consultant, Contractor	Php 20,000 /qtr	75% of DENR limit BOD: 37.5ppm COD: 75ppm TSS: 75ppm Oil & Grease: 3.75pp m Fecal Coliform: 300 MPN/100mL Total Coliform: 7,500M PN/ 100mL pH: Color: 112.5 TCU	85% of DENR limit BOD: 42.5ppm COD: 85ppm TSS: 85ppm Oil & Grease: 4.25pp m Fecal Coliform: 340 MPN/100mL Total Coliform: 8,500M PN/ 100mL pH: Color: 127.5TC U	BOD: 50ppm COD: 100ppm TSS:100ppm Oil&Grease: 5ppm Fecal Coliform: 400 MPN/100mL Total Coliform: 10,000MPN/ 100mL pH – 6.5 to 9.5 Color: 150 TCU	To be establish e d POST- ECC		
Hydrology	Lowering of groundwater level	Groundwater level	Water level survey	2 time per year for 2years at 5 locations after completion Total 20 times	Around subway tunnel	Subway Administrator, Pollution Control Officer	To be included in operation and maintenance cost	N/A			N/A		
The Air													
Generator Set Operation	Air pollution	• TSP • PM_{10} • $PM_{2.5}$ • NO_2 • SO_2,	1-hour ambient air quality monitoring for: TSP - Hi-volume, Gravimetric $PM_{2.5}$ - Hi-volume with $PM_{2.5}$ inlet,	Annual or as required by DENR-E M B	At the 16 ambient air quality and noise monitoring stations listed in Table 2.3-27 and Figure 2.3-25 of this EIS (except for station AN13)	Subway Administrator, Pollution Control Officer	Php 30,000/ station	Noticeable dust and/ or presence of haze Or	Complaint lodged by community Or	TSP –270 µg/NCM $PM_{2.5}$ –68 µg/NCM PM_{10} – 180 µg/NCM NO_2 – 234 µg/NCM	Continue monitorin g and investigat e possible causes of increase of point source	Check efficiency of pollution control devices and conduct routine preventive maintenance	Check efficiency of pollution control devices and conduct routine preventive maintenance

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Methods	Frequency	Locations			Alert	Action	Limit	Alert	Action	Limit
			Gravimetric PM_{10} - Hi-volume with PM_{10} inlet, Gravimetric SO_2 – Gas Bubbler, Pararosaniline Method NO_2 – Gas Bubbler, Griess-Saltzman Method					TSP –225 µg/NCM $PM_{2.5}$ –56 µg/NCM PM_{10} – 150 µg/NCM NO_2 –195 µg/NCM SO_2 – 255 µg/NCM If concentrations are above the NAAQS, 75% of baseline values	TSP –255 µg/NCM $PM_{2.5}$ –64 µg/NCM PM_{10} – 170 µg/NCM NO_2 –221 µg/NCM SO_2 – 290 µg/NCM If concentrations are above the NAAQS, 85% of baseline values	SO_2 – 306 µg/NCM If concentrations are above the NAAQS, 90% of baselin e values	emissions	until pollutant concentrations are down to acceptable levels.	until pollutant concentrations are down to acceptable levels.
Structure - borne vibrations and noise during operations	May inadvertently cause mental stress to residents near the project location	Ambient Noise level (decibel) monitoring during operations Vibration	Approved method of Ambient Noise Level measurement (AS 1055.1-19 9 8) Approved method of vibration level measurement (to-be-agreed- with DENR due to absence of Philippine Standard.	Quarterly or as required by EMB	Co-located with air quality monitoring stations.	MMSP Environmental Officer	Part of the operations cost	Negative feedback from surrounding residential and commercial areas.	Formal complaints filed by surround in g residential and commercial areas.	Multiple complains filed by nearby residential and commercial areas, or by contractors and employees.	Investigate (e.g. actual measurement in reference to DENR accepted standards) the extent of the effect/ damages (if any) and the root cause of the complaint	Coordinate with the LGUs and relevant stakeholders to properly address the issue.	1. Update the affected surrounding communities about the actions done to address their complaints through written statements and assemblies. 2. Conducting necessary health programs for vulnerable groups, and massive public information about mitigation measures to avoid damages caused by elevated noise levels. 3. Continuous monitoring and documentation of complaints from residents to assess extent and gravity of

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Methods	Frequency	Locations			Alert	Action	Limit	Alert	Action	Limit
													disturbance. 4. Continuous ambient noise level and vibration monitoring during operations.
Subway operation	Increase in noise and vibration level	Noise level (decibel)	Noise meter	Annually	Ground above subway tunnel in selected stations	Subway Administrator, Pollution Control Officer	Php 50,000 (cost of noise meter)	To be established POST-ECC		Vibration level at nighttime: Residential:55 dB Commercial: 60 dB	To be established POST- ECC		

6.3 Multi-Sectoral Monitoring Framework

The Multi-Partite Monitoring Team (MMT) is a community based multi-sectoral team which is organized to monitor compliance to the conditions stipulated in the Project's ECC, the implementation of the Project's Environmental Management Plan, and general adherence to other applicable environmental laws and regulations.

The EMB-DENR shall provide oversight guidance to the MMT and consider its reports and recommendations in its impact and compliance evaluation. Consistent with the procedural guidelines stipulated in DENR Administrative Order No. 2003-30, the MMT has the following major functions and responsibilities:

- regularly attend meetings, trainings and orientations, and actual monitoring and reporting activities against the conditions stipulated in the ECC and other relevant environmental regulations;
- be able to read and write and is capable of learning the various aspects of environmental monitoring;
- validate ATIB's conduct of environmental self-monitoring;
- prepare, integrate and disseminate simplified monitoring reports for impact communities;
- make regular and timely submission of the MMT report which contains the results of monitoring and relevant findings to DENR-EMB in the agency's approved reporting format; and
- receive and investigate complaints or concerns against the Project by gathering and documenting relevant information and relaying this information in an ethically and acceptable and timely manner to the Proponent and DENR-EMB so these complaints can be addressed.

The organizational structure and membership of the MM is shown in **Table 6.3-1**. A Memorandum of Agreement (MOA) for the MMT has been drafted and the identification of representatives from the member agencies and organizations has begun. Following recent discussion with the DENR during the course of the preparation of this EPRMP, DOTr is proposing for an MMT in the depot area in Barangay Ugong, Valenzuela City.

Table 6.3-1 Organization and Membership of MMT

Role	Agency/ Offices/ Stakeholders
First Cluster – During construction of Depot , PO section and the first year of opera t ion	
Chairman	City – ENRO Valenzuela
Vice-Chairman	Barangay Ugong, Valenzuela City
Representative	Department of Public Works and Highways (DPWH)
Representative	Metro Manila Development Authority
Representative	PO/NGO from Valenzuela City

Since the project area is linear and expands to several cities from Valenzuela in the north and down to Paranaque and Pasay in the south, the formation and management of the MMT for all cities involve will be a huge challenge. Also, since the project will entail mostly underground construction activities, the activities of the MMT will likely to be ceased after construction phase. Hence, DOTr is proposing for the engagement of a Third Party Auditor (TPAs) to undertake environmental monitoring and compliance for all stations and the interstation facilities during the construction phase. Few of the advantages cited in engaging a Third Party Auditor is their technical capability (no need for capacity building) thus, putting the early stage of compliance monitoring up to speed. TPAs are also focused since their work will likely to involve technical personnel who are trained and employed doing environmental audits, they are also deemed objective as they have no personal stake in the project, and unlike usual MMT members which can include elected officials with definite terms, TPAs are not bound by the terms of election or political appointments.

DOTr will submit its proposed operational guidelines to DENR for approval prior to the engagement of the TPA.

6.4 Environmental Guarantee and Monitoring Fund Commitments

6.4.1 Environmental Monitoring Fund

An Environmental Monitoring Fund (EMF) will be established by the Proponent in accordance with the requirements of the DENR A.O. No. 2003- 30. The EMF will be used exclusively to support the activities of the MMT for compliance monitoring of the project. A Memorandum of Agreement (MOA) will be entered into by DENR-EMB and DOTr, with conformity of the MMT members, to establish the EMF. The EMF will be immediately accessible and easily disbursable.

The EMF that will be allocated for the Project will cover all quarterly and semi-annual monitoring activities and laboratory costs. MMSP commits to establish an EMF amounting to Three Million Pesos (PHP 3,000,000.00) (direct from co. + budget for MMT) annually to support the activities of the MMT as described in the EMB-approved Annual Work and Financial Plan (AWFP). However, the actual amount that will be allocated for EMF will be finalized during the completion of the DED phase and with consultation of the MMT. The report on the status of environmental budget allocations and expenses can be found in **Table 6.4-1**.

An account in a government bank will be established for the EMF. The EMF will be managed and administered by the MMT Executive Committee of the project or an equivalent Fund Management Committee. The disbursement of the EMF will be carried out according to the annual monitoring work and financial plan submitted by the MMT, which will be reviewed and concurred with by the proponent and approved by DENR-EMB. The cost of the monitoring and laboratory expenses will be paid directly to the subcontractor (including Third Party Auditors) and will not be part of the EMF deposited in the bank.

6.4.2 Environmental Guarantee Fund

The Environmental Guarantee Fund (EGF) shall be established and used for the following risk-management purposes:

- the immediate rehabilitation of areas affected by damage to the environment and the resulting deterioration of environmental quality as a direct consequence of project construction, operation, and abandonment;
- the just compensation of parties and communities affected by the negative impacts of the project;
- the conduct of scientific or research studies that will aid in the prevention or rehabilitation of accidents and/or risk-related environmental damages; or
- for contingency clean-up activities, environmental enhancement measures, damage prevention program including the necessary IEC and capability building activities to significantly minimize or buffer environmental risk- related impacts.

The EGF will have two components, namely a Trust Fund and a Cash Fund. DOTr proposes that the Contractor's All Risk Insurance (CARI) will serve as the Trust Fund. The CARI will insure the project against actual physical damage or destruction of the work in progress including equipment and machinery within the job site and third party liability. CARI covers several events such as fire, typhoon, flood, earthquake, water damage, construction accidents and negligence. The final coverage and terms of the CARI will be confirmed upon awarding of subcontractors contracts.

Five Million Pesos (5,000,000 PhP) per contract package will be set aside as Cash Fund. This will be required per contract package from contractors. Since the construction of the project will likely involve several contractors, there will be more than one contract package. However, the actual amount that will be allocated will be finalized during the completion of the DED and consultation with the MMT. The report on the status of environmental budget allocations and expenses can be found in **Table 6.4-1**.

Table 6.4-1 Report on Status of Environmental Budget Allocation and Expenses

Expense Item	Budget		Actual Expenses	
	Direct from Co.	Budget for MMT	Direct Co. Expense	MMT Expense
A. Implementation of Management Plans and Programs				
1. Environmental Impact Mitigation Plan	17,000.000.00	0.00	0.00	0.00
2. Social Development Plan	0.00	0.00	0.00	0.00
3. IEC Plan	0.00	0.00	0.00	0.00
4. Enhancement Program (if any)	0.00	0.00	0.00	0.00
B. Implementation of Monitoring Plans				
1. Self-Monitoring	0.00	0.00	0.00	0.00
2. Environmental Monitoring Fund (w/ MMT)	2,700,000.00	300,000.00	0.00	0.00
3. Environmental Guarantee Fund	300,000.00	0.00	0.00	0.00
TOTAL	**20,000,000.00**	**300,000.00**	**0.00**	**0.00**

(Source: July 2019 CMR)

CHAPTER 7 ABANDONMENT, DECOMMISSIONING AND REHABILITATION POLICY

Prior to abandonment of the construction areas, the Contractors must undertake and comply with the following decommissioning/demobilization activities:

- Complete restoration of affected social service utilities (i.e. power and water supply, and telecommunication lines) to their normal functions;
- Complete closure and dismantling of the workers' camps, field offices, and temporary construction facilities;
- Complete dismantling of the temporary sanitation facilities, particularly the portable toilets;
- Clean-up and sterilization of the worker's camps and field offices to ensure that no wastes are abandoned in the sites;
- Remaining muck soils, construction spoils and debris are hauled and disposed to sites duly-approved by the Cities of Valenzuela, Quezon City, Pasig, Makati, Taguig and Parañaque.
- Complete restoration/reconstruction of affected public and cultural and historical structures, if any.

Upon completion of the project, all parties concerned, such as the DOTr, DENR, and the LGUs must inspect the area for compliance to the above activities. The proponent must continuously implement maintenanc e activities to preserve and restore the existing infrastructures in good operating conditions.

Project abandonment is not envisioned in the near future since there is a pressing need for an efficient public transport system in Metro Manila. Nevertheless, an abandonment framework is provided below.

After the expected service life of the Project, parts that are determined to be serviceable will be s alvaged for use in other railway infrastructures or other public facilities. The structures may be retrofitted, if adaptable, for use with newer technology. Otherwise, the major structures will be demolished/ dismantled. The area may be re-developed according to alternative land uses for the site as the government may see appropriate.

The major activities will include removal of all buildings, structures, equipment and any other works. DOTr shall ensure minimal damage that may be caused by the removal of the facilities. An audit of hazardous wastes, particularly at the Valenzuela depot, and environmental site assessment (ESA) w ill be conducted to account for proper disposal and site treatment, if deemed necessary. DOTr shall leave the site in a secure, clean and tidy condition and will ensure that the site is securely enclosed.

A detailed decommissioning or abandonment plan will be developed, as required by the DENR through DAO 2003-30, ninety days prior to the end of operating life of the MMSP.

CHAPTER 8 INSTITUTIONAL PLAN FOR ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION

The Institutional Plan for the Environmental Management Plan Implementation sets up an organization structure that will effectively monitor the implementation of the proposed Environmental Management Plan of the Project. It also aims to provide a mechanism that will reinforce the relationship between DOTr and its stakeholders.

The DOTr as the proponent for the MMSP is the primary policy, planning, programming, coor dinating, implementing and administrative entity of the executive branch of the government on the promotion, development and regulation of a dependable and coordinated network of transportation and communications systems, as well as in the fast, safe, efficient and reliable transportation and communications services. For the MMSP, the DOTr will create a new office or designate one of the railway attached agencies to serve as Project Management Office.

The PMO designated by the DOTr shall be responsible for complying with the conditions stipulated in the Environmental Compliance Certificate (ECC), including the Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP). The PMO will be responsible for the implementation, coordination, supervision, and monitoring activities that will be undertaken by the Contractor as part of the agreement. The specific responsibilities of the PMO shall include:

- Prior to bidding process, prepare the “Environmental Protection Clauses” of the Bid Documents to apply to the project based on the EMP and the ECC for the project;
- Discuss contract environmental clauses with bidders to allow the latter to include realistic costs of complying with contract provisions in their bids;
- Ensure that compliance to all conditions stipulated in the ECC are included as provisions in the Bid Documents to be issued to prospective Contractors;
- Ensure that all engineering interventions in the approved EMP, Resettlement Action Plan (RAP), and ECC issued are included in the Terms of Reference (TOR) of the Detailed Engineering Design

The PMO and Contractor’s implementation of the EMP during pre-construction, construction and operation shall be in coordination with the following entities, as set out in Figure 8-1 to Figure 8-3:

- DENR EMB Central Office
- DENR Forest Management Bureau and Biodiversity Management Bureau (for flora and fauna)
- Department of Public Works and Highways
- Third Party Monitoring Firm

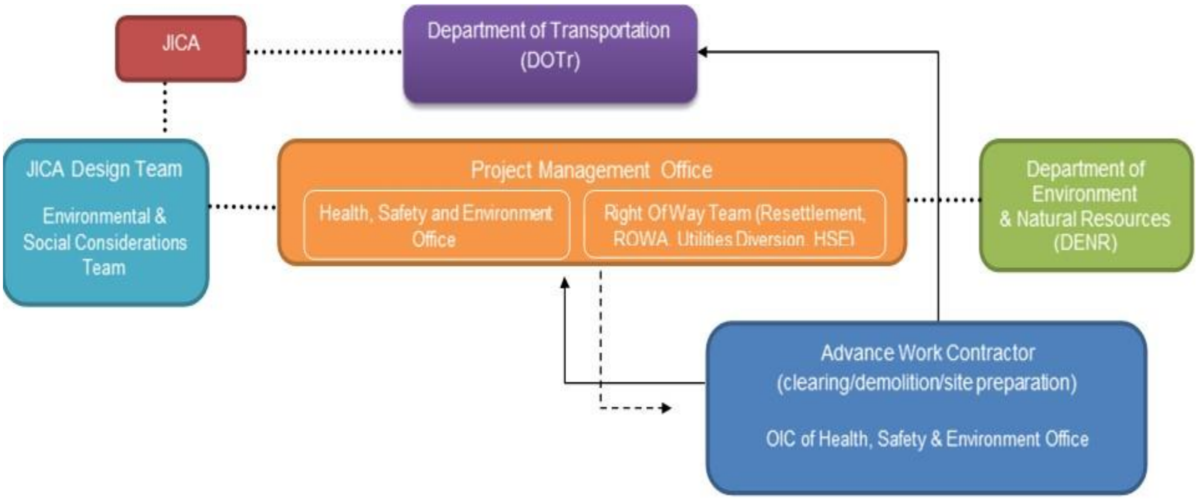


Figure 8-1 MMSP Environmental Unit during Pre- Construction Phase

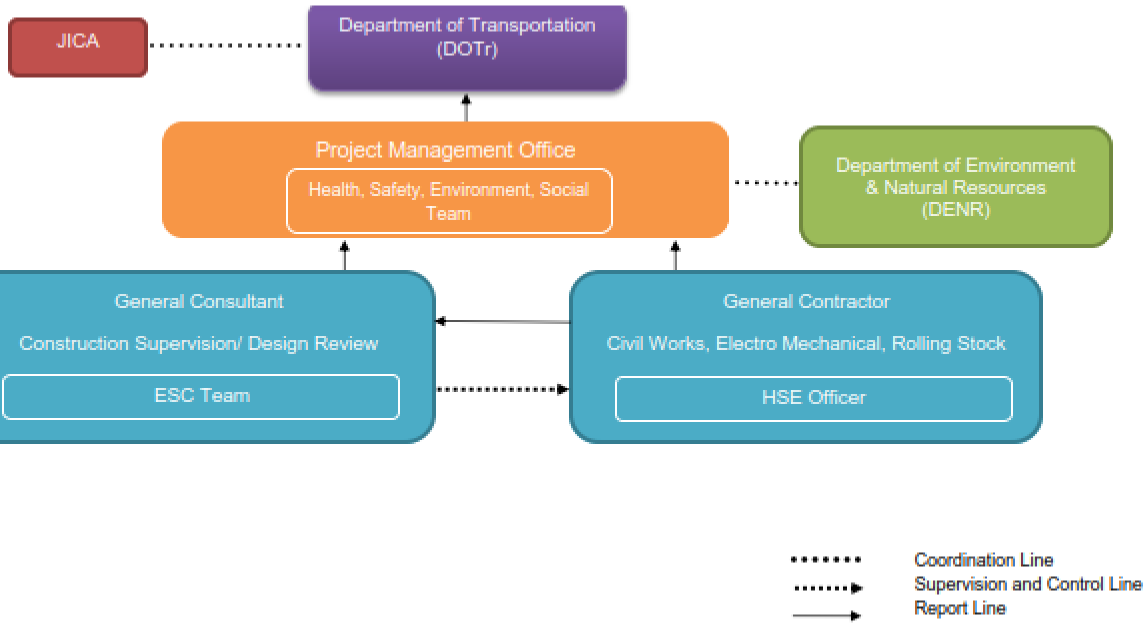


Figure 8-2 MMSP Environmental Unit during Construction Phase

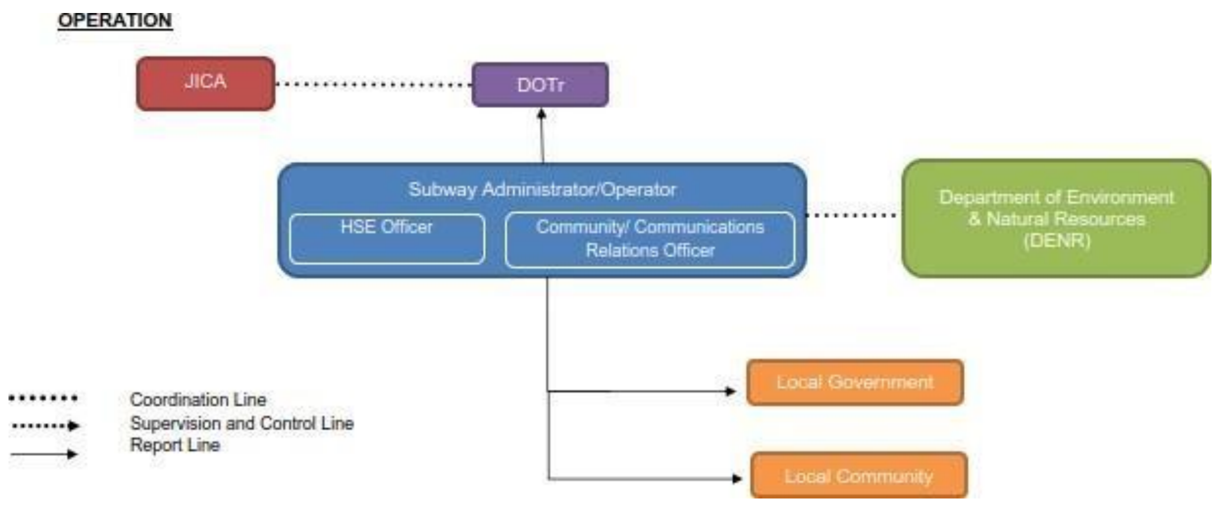


Figure 8-3 MMSP Environmental Unit during Operational Phase

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Metro Manila Subway Project (MMSP) Phase 1

Environmental Performance Report and Management Plan

Volume 2 - Annexes

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Annex ES.1-1

Environmental Compliance Certificate

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632)927-15-17, 928-37-25; Fax No.: (632) 920-22-58
Website: http://www.emb.gov.ph. / Email: mail@emb.gov.ph

25 OCT 2017

ECC-CO-1708-0017

Hon. Arthur P. Tugade
Secretary
DEPARTMENT OF TRANSPORTATION (DOTr)
S. Osmeña Road
Clark Freeport
Mabalacat, Pampanga

SUBJECT: ENVIRONMENTAL COMPLIANCE CERTIFICATE

Dear Sir:

This refers to the Environmental Compliance Certificate (ECC) application for the proposed **Metro Manila Subway Project (MMSP) Phase 1** to be located in Metro Manila.

After satisfying the requirements in the said application and upon recommendation of the Environmental Impact Assessment Review Committee, the Department through the Environmental Management Bureau (EMB), has decided to issue the ECC for the above-mentioned Project.

With the issuance of the ECC, you are expected to fully implement the measures presented in the Environmental Impact Statement (EIS) and the Environmental Management and Monitoring Plan (EMMoP) intended to protect and mitigate the project's predicted adverse impacts on community health, welfare and the environment. Environmental considerations shall be incorporated in all phases and aspects of the project.

This Certificate does not create any right nor be used as an authorization to implement the project and you may proceed with the implementation only after securing all the necessary and relevant permits from other pertinent Government Agencies. This Office shall be monitoring the project periodically to ensure strict compliance with the stipulations cited in the attached ECC.

Please be guided accordingly.

Very truly yours,

By the Authority of the Secretary

ENGR. METODIO U. TURBELLA
Director

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
SENR052673

cc: LGU –Quezon City
LGU –Taguig City
DPWH
PHIVOLCS
LGU –Pasig City
LGU –Parañaque City
MMDA
LGU-Makati City
LGU –Valenzuela City
DOLE

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Department of Environment and Natural Resources
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Website: http://www.emb.gov.ph. / Email: mail@emb.gov.ph

ENVIRONMENTAL COMPLIANCE CERTIFICATE

(Issued under Presidential Decree No. 1586)

ECC-CO-1708-0017

THIS IS TO CERTIFY THAT THE PROPONENT, **DEPARTMENT OF TRANSPORTATION (DOTr)**, as represented by its Secretary, Atty. Arthur P. Tugade is granted this Environmental Compliance Certificate (ECC) for the proposed **Metro Manila Subway Project (MMSP) Phase 1** to be located in Metro Manila by the Department of Environment and Natural Resources (DENR) through the Environmental Management Bureau (EMB).

SUBJECT ONLY to the conditions and restrictions set in this ECC and in the attached documents labeled as Annexes A and B.

PROJECT DESCRIPTION

This Certificate covers construction and operation of Metro Manila Subway Project (Phase 1) comprising thirteen (13) underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Parañaque City with a total subway length of **28.3 km**, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City.

The ECC includes Depot for trains covering about 31.7 hectares of land area in Brgy. Ugong, Valenzuela City.

This Certificate is issued in compliance with the requirements of Presidential Decree No. 1586, and the implementing rules and regulations thereof. Non-compliance with any of the provisions of this Certificate shall be a sufficient cause for its cancellation and/or imposition of a fine in an amount not to exceed Fifty Thousand Pesos (₱50,000.00) for every violation and shall be without prejudice to imposition of fines and penalties under other environmental laws, rules and regulations. The EMB, however, is not precluded from reevaluating, and correcting any deficiencies or errors that may be found after the issuance hereof this Certificate.

Issued at DENR, Quezon City, Philippines, this OCT 25 2017.

Recommending approval:

ATTY. MICHAEL DRAKE P. MATIAS
Chief, EIAM Division

By the Authority of the Secretary:

ENGR. METODIO U. TURBELLA
Director

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
SENR052673

STATEMENT OF ACCOUNTABILITY

I, ***Arthur P. Tugade***, Secretary, representing Department of Transportation with office address located at S. Osmeña Road, Clark Freeport, Mabalacat, Pampanga, take full responsibility in complying with all conditions in this Environmental Compliance Certificate (ECC).

____
Signature

DOTr-OSEC OUTGOING 17-01589

CITY OF MANILA 10 NOV 2017

Subscribed and sworn to before me this ____ day of ________, 2017, the above-named affiant taking oath presenting ____________________ issued on __________ at ________________.

____
Notary Public

264
54
XXXVIII
2017

Atty. Flordeliza Santiago-Reyes
Notary Public for the City of Manila
Until December 31, 2017
Roll No. 30117 Tin 124-300-900
PTR No. 4899807 issued on 12/10/2015, Manila
IBP No. 1012835 issued 12/11/2015
1117 Blumentritt Street, Sampaloc, Manila
Notarial Commission No. ~~2016~~ 072
PTR MLA. 5998917 1/ 4/17

Annex A

I. CONDITIONS

Environmental Management

All commitments, mitigating measures and monitoring requirements, contained in the approved Environmental Impact Statement (EIS) particularly in the Environmental Management and Monitoring Plan (EMMoP) shall be instituted to minimize any adverse impact of the project to the environment throughout its implementation, including the following:

1. Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following:

    a. Project impacts and mitigating measures embodied in its EIS;
    b. Conditions stipulated in this Certificate;
    c. Environmental and human safety features of the project, and
    d. Health consciousness alerts for any project-induced discomfort (from dust, smell, noise, vibration) as the project progresses throughout the whole route.

2. Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis;

3. Submit detailed waste management program for proper handling, collection and disposal of solid, hazardous and liquid waste to EMB Central Office (CO) and EMB National Capital Region (NCR) within six (6) months prior to project construction. Proof of implementation shall be submitted together with the CMR;

4. Ensure that all the existing waterways affected by the proposed project construction are maintained and not obstructed;

5. Submit a detailed demobilization plan for the construction yards within six (6) months prior to project construction. The plan should include the following:
    a. Coordination with concerned local government units to promote compatibility of adjoining land uses with the intended subway project station including its exit and entrance; and
    b. Allocation of at least 30% of total area of construction yards for green and open spaces, including but not limited to setting up of vertical and pocket gardens, mini open parks system to promote urban biodiversity.

6. Submit a detailed plan for earth balling and replanting of mature native/endemic trees within six (6) months prior to project construction. The plan should include the following:

a. specific recipient sites which have already been prepared and conditioned
b. ensure high degree of survival
c. provision for regular maintenance until trees have re-established in their new environment

7. Submit an approved Resettlement Action Plan (RAP) of the affected communities within six (6) months prior to project construction;

GENERAL CONDITIONS

8. The proponent shall set-up the following:

8.1 A readily available and replenishable Environmental Guarantee Fund (EGF) to cover the following expenses:

a. for further environmental assessments, compensations/indemnification for whatever damages to life and property that may be caused by the project;

b. rehabilitation and/or restoration of areas affected by the project's implementation; and

c. abandonment/decommissioning of the project facilities related to the prevention of possible negative impacts; and as a source of fund for contingency and clean-up activities.

8.2 Establish a Multipartite Monitoring Team (MMT) composed of representative(s) from the local environmental Non-Government Organization (NGO), POs, and the Local Government Units per DAO 2017-15. The MMT shall primarily oversee the compliance of the proponent with the Environmental Management and Monitoring Plan (EMMoP) and the ECC conditions;

8.3 A replenishable Environmental Monitoring Fund (EMF) to cover all costs attendant to the operation of the MMT such as training, the hiring of technical experts and resource persons, fieldwork and transportation.

The amount and mechanics of the EGF, EMF and the establishment of the MMT shall be determined by the EMB Central Office and the proponent through a Memorandum of Agreement (MOA) which shall be submitted within sixty (60) days upon receipt of this Certificate;

9. Establish an Environmental Unit (EU) within sixty (60) days from receipt of this Certificate that shall competently handle the environment-related aspects of the project. In addition to the monitoring requirements as specified in the Environmental Management and Monitoring Plan (EMMoP), the EU shall have the following responsibilities:

a. Monitor actual project impacts vis-à-vis the predicted impacts and management measures in the EIS;
b. Recommend revisions to the EMMoP, whenever necessary subject to the approval of EMB Central Office;
c. Ensure that data gathered during monitoring activities are properly documented, assessed, evaluated and reported in accordance with the standard formats; and

d. Ensure that monitoring and submission of reports to EMB CO are carried out as required.

10. The proponent shall ensure that its contractors and sub-contractors are provided with copies of this ECC and that they will strictly comply with the relevant conditions of this Certificate;

II. RESTRICTIONS

11. No activities shall be undertaken until and unless disposal sites of excavated materials have been identified, duly covered by agreement/s and have been permitted in accordance with law. Proof of compliance shall be filed with the Regional Office having jurisdiction over the disposal area and shall be without prejudice to environmental safeguards that may be prescribed as warranted. Likewise, a copy of which shall form part of the requirement under Condition 3 hereof;

12. No activities shall be undertaken other than what were stipulated in the final EIS. Any expansion and/or modification of the project beyond the project description or change in alignment/route that will cause significant impacts to the environment shall be subject to a new Environmental Impact Assessment; and

13. In case of transfer of ownership of this Project, the same conditions and restrictions shall apply to the transferee or grantee who shall secure in writing the corresponding amendment of this ECC from the EMB Central Office within fifteen (15) working days reflecting such transfer.

O.R. No : 8081890
Date : 08/18/2017
Processing Fee : 10,000.00

Annex B

PROJECT ASSESSMENT PLANNING TOOL

For the assistance of the Proponent and the Government Agencies concerned in the management of the Project and for better coordination in mitigation of the impacts of the Project on the surrounding areas, the following are recommended to the parties and authorities concerned for appropriate action.

OTHER REGULATORY REQUIREMENTS/CONDITIONS	CONCERNED GOVERNMENT AGENCIES/ENTITIES
1. Strict compliance with the Revised National Structural Code of the Philippines	LGU concerned
2. Compliance with the Sanitation Code of the Philippines;	Department of Health (DOH) and LGU concerned
3. Compliance with the Labor Code of the Philippines;	Department of Labor and Employment (DOLE)
4. Compliance with the Building Code of the Philippines	LGU concerned
5. Ensure compliance with the Ecological Solid Waste Management Act;	LGU concerned
ENVIRONMENTAL PLANNING RECOMMENDATIONS FOR THE PROPONENT	
6. Priority of employment shall be given to qualified local residents. Opportunities for qualified PWDs, women, senior citizens, where possible, shall be considered. Adequate public information for jobs available to local residents in the affected areas will be provided.	
7. Conduct a detailed Traffic Impact Assessment (TIA) in coordination with the Metro Manila Development Authority (MMDA) and concerned LGU for every proposed station prior to project construction integrating proposed road expansion projects (if any) of the concerned government agencies.	
8. An inclined drilling program should be designed and carried out for the segment(s) of the subway along the West Valley Fault (e.g. Cayetano Station). The design of the drilling program and interpretation of results should be done in consultation with PHIVOLCS.	
8. Based on the results of the Detailed Engineering Design, the proponent may consider realignment of subway from the fault while maintaining the Cayetano Station.	

ATTY. MICHAEL DRAKE P. MATIAS
Chief, EIAM Division

ENGR. METODIO U. TURBELLA
Director

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
SENR052673

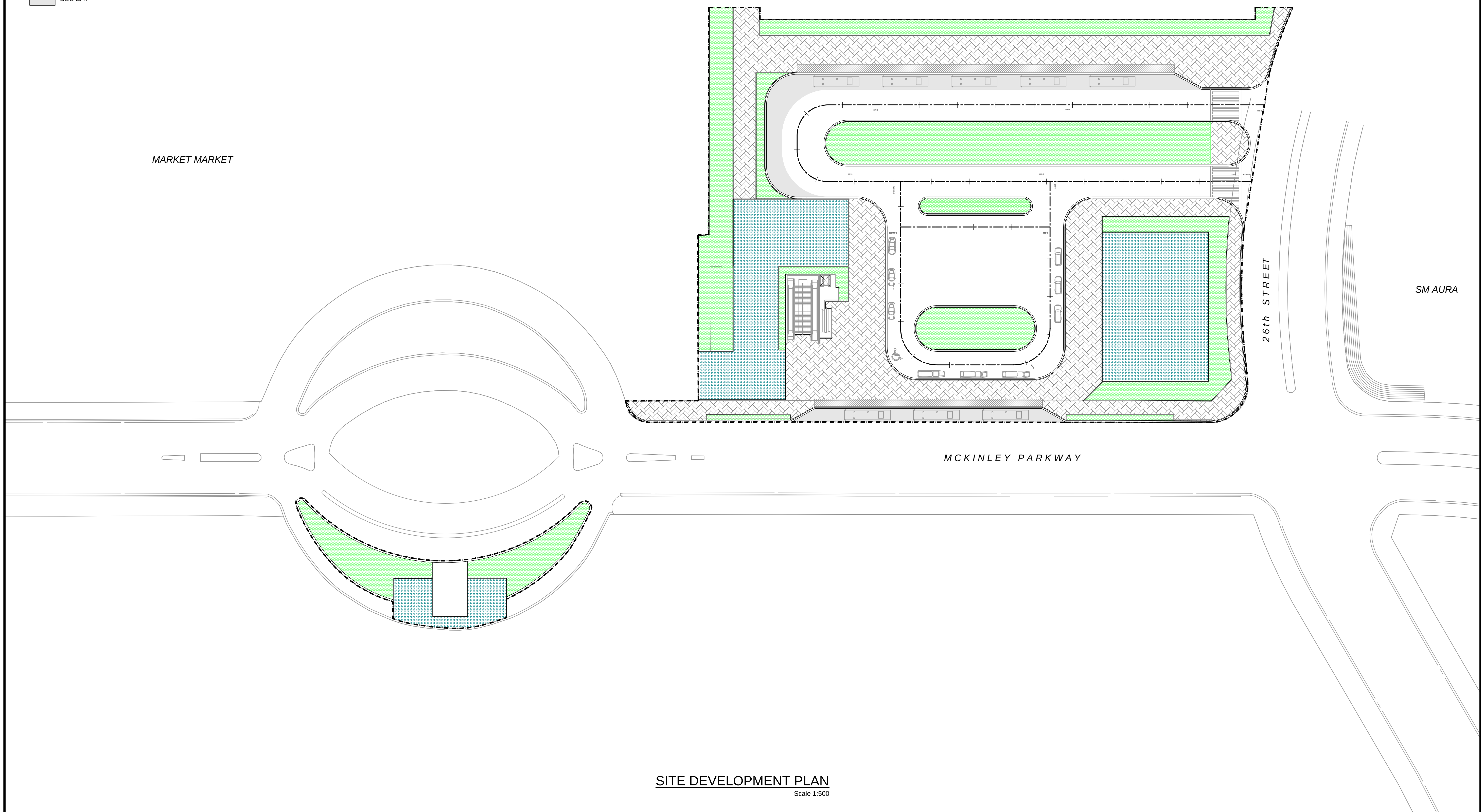
Annex 1.1-1

Site Development Plans

REFERENCE ONLY

LEGEND:

- BUS SHELTER
- GREEN AREA
- PARK AREA
- WALKWAY
- ROADWAY
- BUS BAY



SITE DEVELOPMENT PLAN

Scale 1:500

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

- ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
- TOKYO METRO CO., LTD.
- JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
- ALMEC CORPORATION
- KATAHIRA & ENGINEERS INTERNATIONAL
- PACIFIC CONSULTANTS CO.,LTD.
- TONICHI ENGINEERING CONSULTANTS, INC.

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT

PHASE1 : CP101

BGC STATION PLAZA
SITE DEVELOPMENT PLAN

DATE	21.May. 2019
SCALE	(A1) 1:500, (A3) 1:1000
SHEET No.	
DRG No.	SPL-C-SD-BGC-1001
REV	-

SITE DEVELOPMENT PLAN

Scale 1:250

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

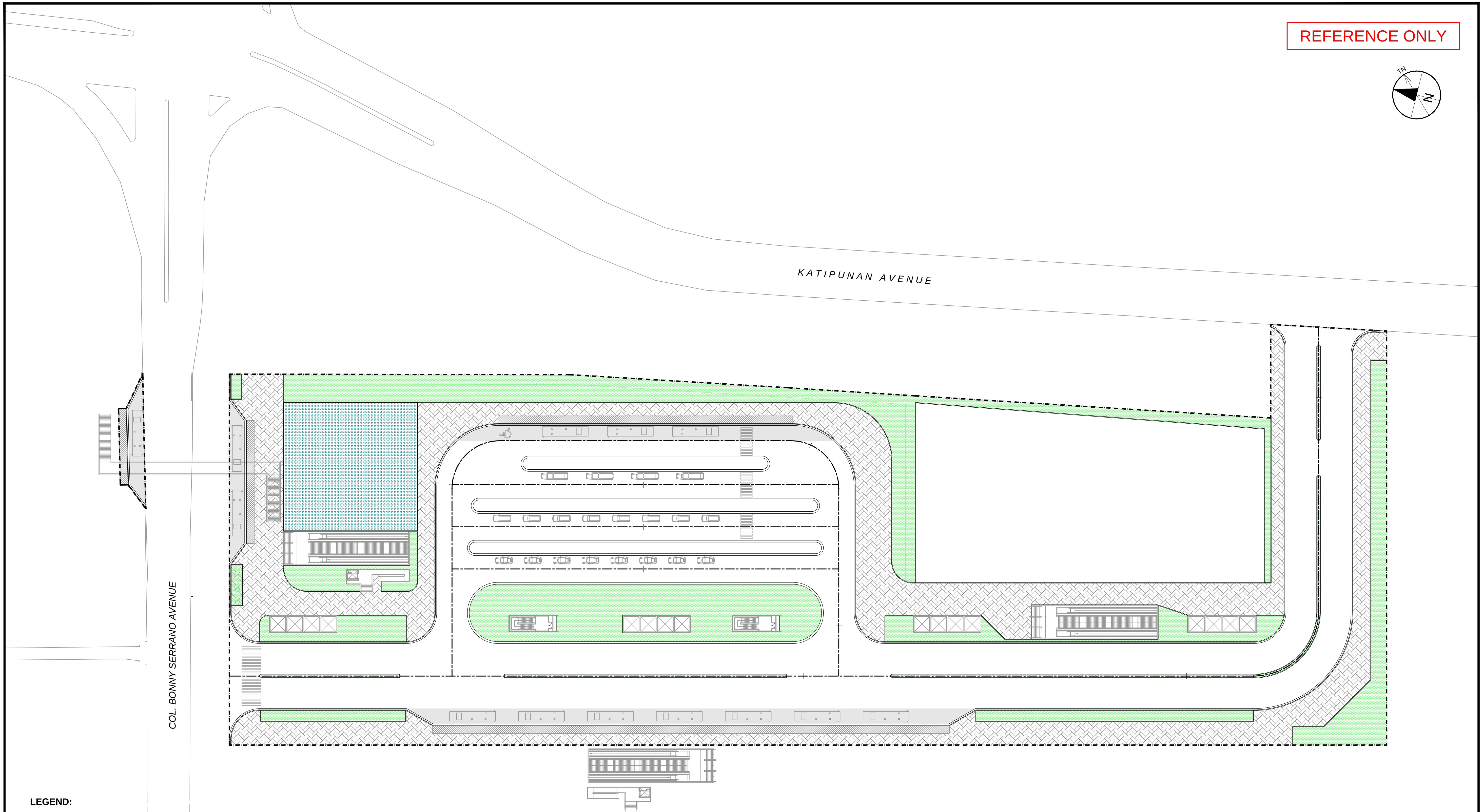
ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
KATAHIRA & ENGINEERS INTERNATIONAL
TOKYO METRO CO., LTD.
PACIFIC CONSULTANTS CO.,LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
TONICHI ENGINEERING CONSULTANTS, INC.
ALMEC CORPORATION

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

EAST AVENUE STATION PLAZA
SITE DEVELOPMENT PLAN

DATE: 10.May. 2019
SCALE: (A1) 1:500, (A3) 1:1000
SHEET No.
DRG No.: SPL-C-SD-EA-1001
REV: -



LEGEND:

- BUS SHELTER
- GREEN AREA
- PARK AREA
- WALKWAY
- ROADWAY
- BUS BAY

SITE DEVELOPMENT PLAN

Scale 1:500

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

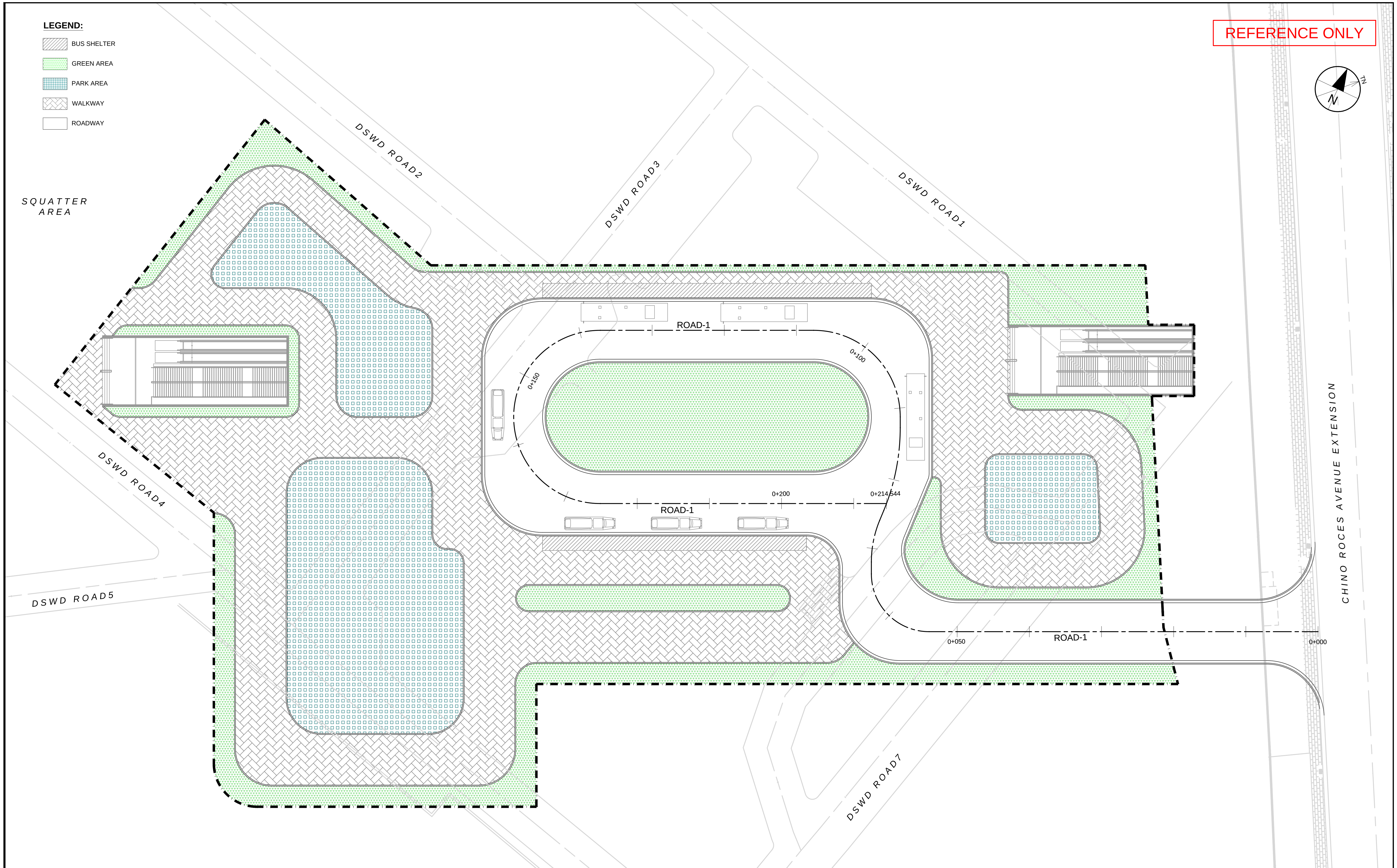
ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
KATAHIRA & ENGINEERS INTERNATIONAL
TOKYO METRO CO., LTD.
PACIFIC CONSULTANTS CO.,LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
TONICHI ENGINEERING CONSULTANTS, INC.
ALMEC CORPORATION

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

KATIPUNAN STATION PLAZA
SITE DEVELOPMENT PLAN

DATE	10.May. 2019
SCALE	(A1) 1:500, (A3) 1:1000
SHEET No.	
DRG No.	SPL-C-SD-KP-1001
REV	-



SITE DEVELOPMENT PLAN

Scale 1:250

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
KATAHIRA & ENGINEERS INTERNATIONAL
TOKYO METRO CO., LTD.
PACIFIC CONSULTANTS CO.,LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
TONICHI ENGINEERING CONSULTANTS, INC.
ALMEC CORPORATION

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

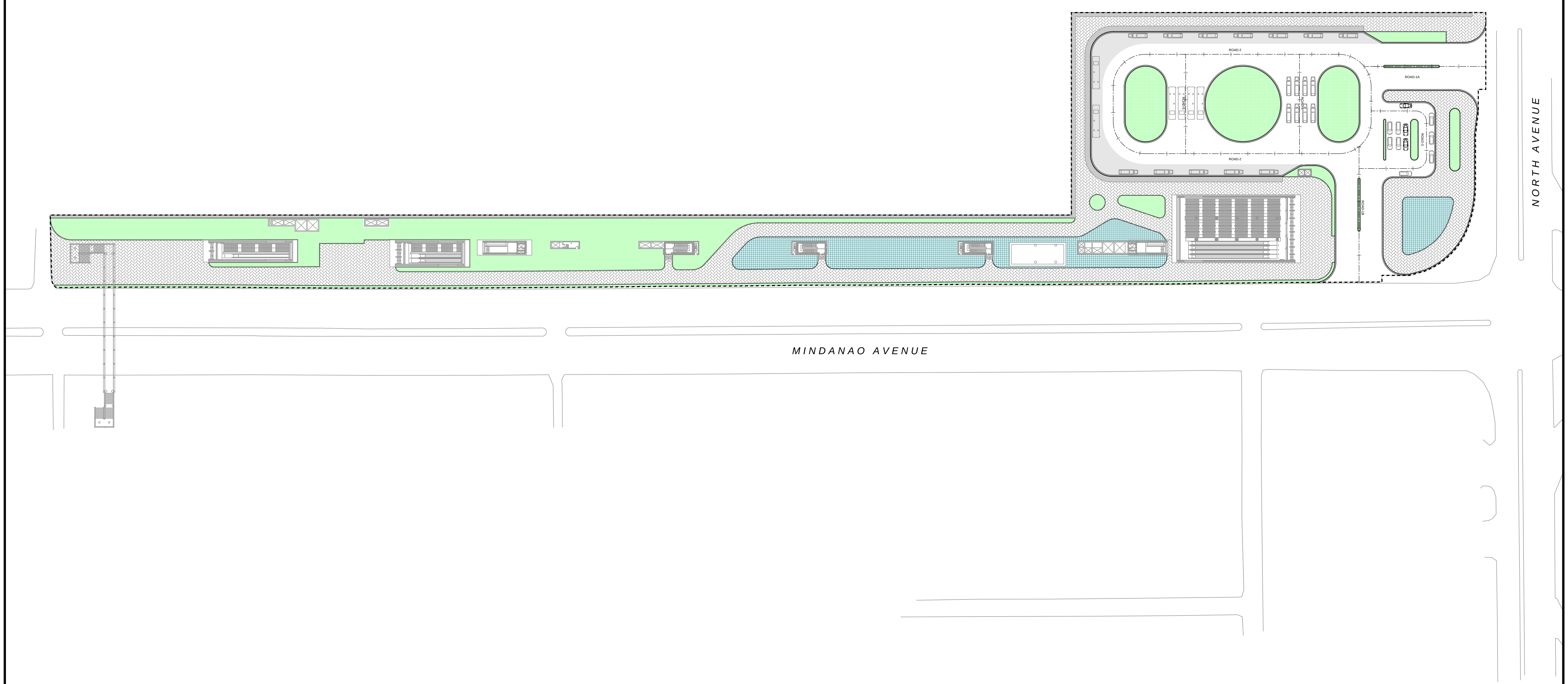
LAWTON WEST STATION PLAZA
SITE DEVELOPMENT PLAN

DATE	24.May. 2019
SCALE	(A1) 1:500, (A3) 1:1000
SHEET No.	
DRG No.	SPL-C-SD-LW-1001
REV	-

REFERENCE ONLY

LEGEND:

- BUS SHELTER
- GREEN AREA
- PARK AREA
- WALKWAY
- ROADWAY
- BUS BAY



SITE DEVELOPMENT PLAN
Scale 1:750

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

- ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
- TOKYO METRO CO., LTD.
- JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
- ALMEC CORPORATION
- KATAHIRA & ENGINEERS INTERNATIONAL
- PACIFIC CONSULTANTS CO.,LTD.
- TONICHI ENGINEERING CONSULTANTS, INC.

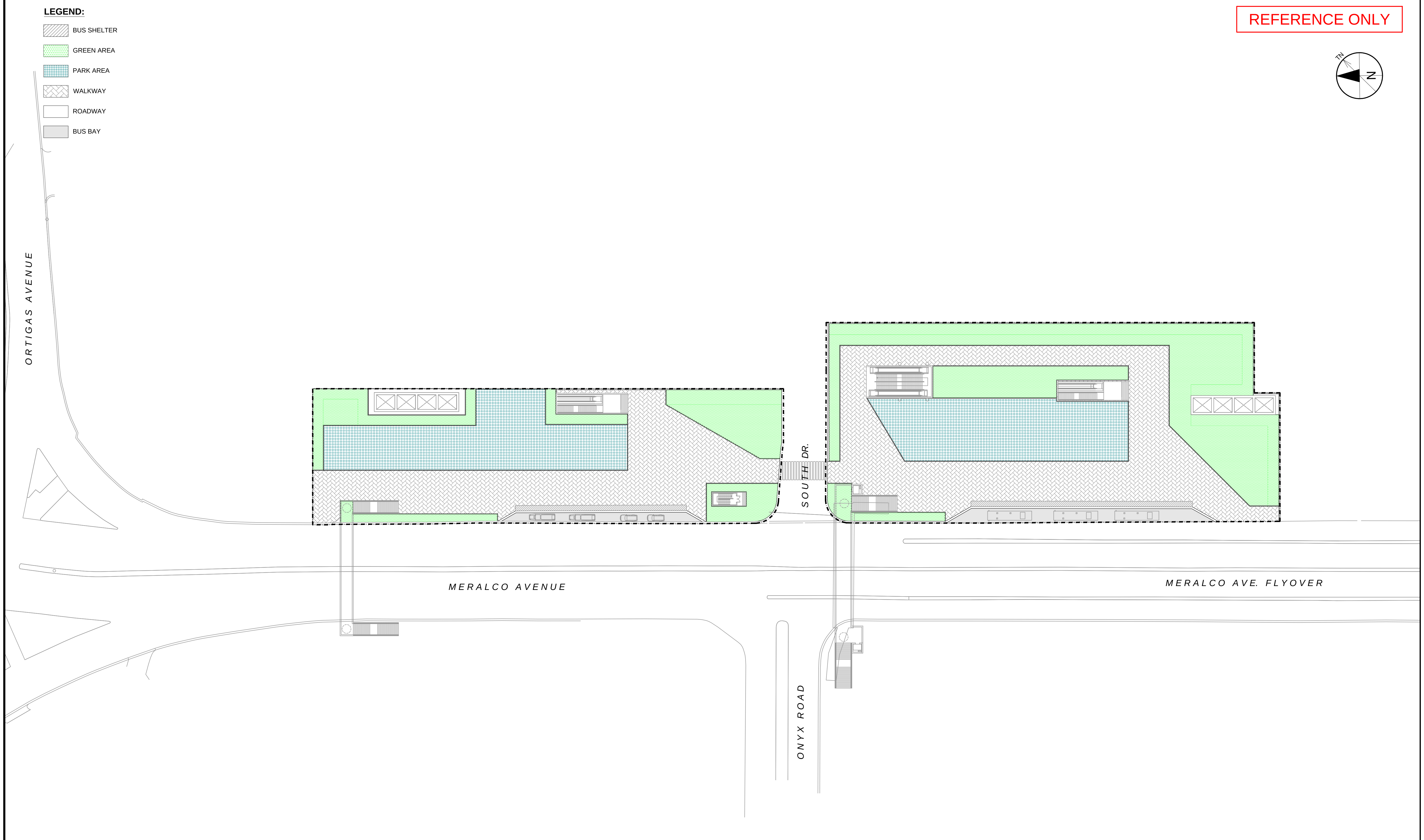
TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

NORTH AVENUE STATION PLAZA
SITE DEVELOPMENT PLAN

DATE: 03.May. 2019
SCALE: (A1) 1:250, (A3) 1:500
SHEET No.
DRG No.: SPL-C-SD-NA-1001
REV: -

REFERENCE ONLY



SITE DEVELOPMENT PLAN
Scale 1:500

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
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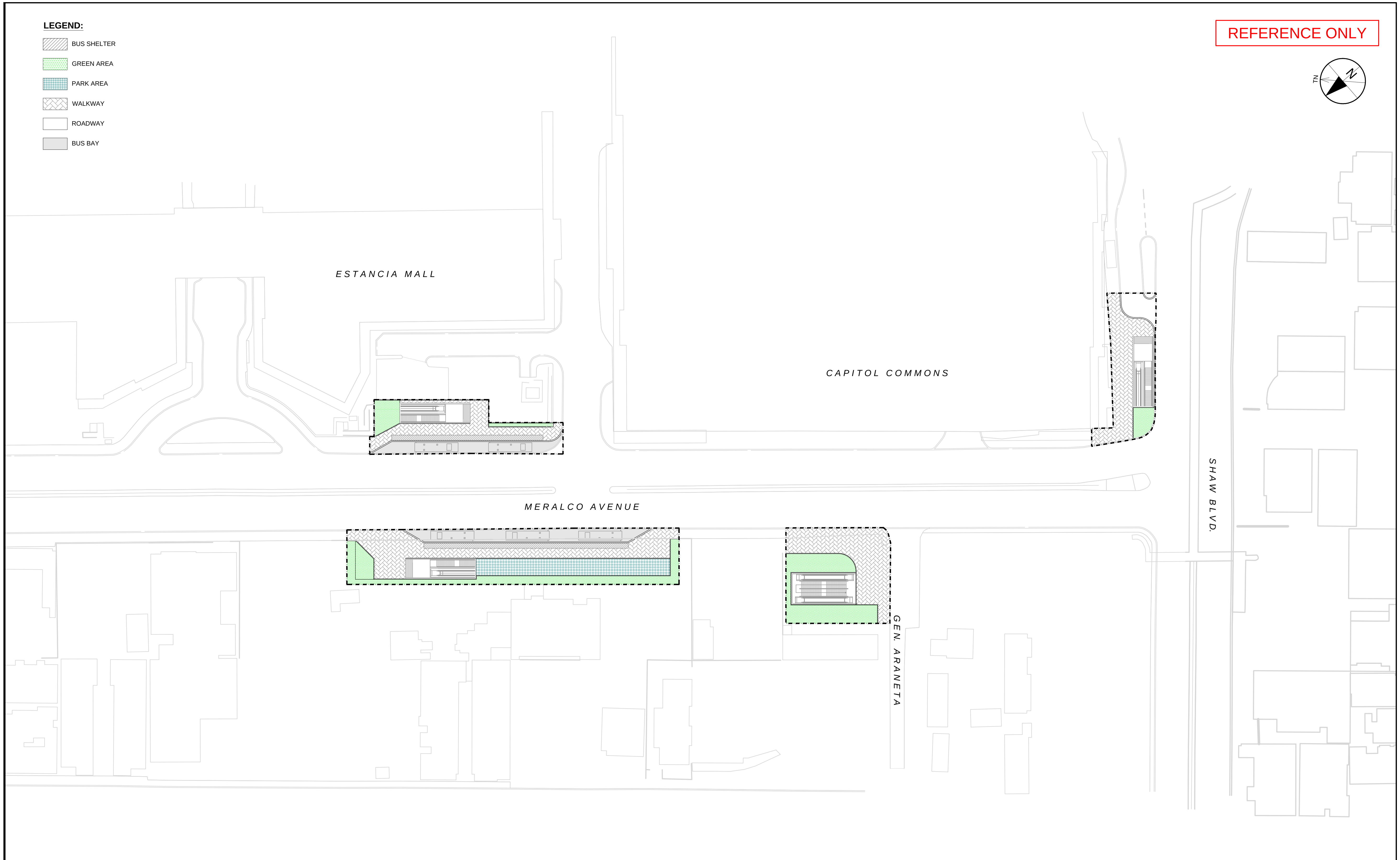
TOKYO METRO CO., LTD.
PACIFIC CONSULTANTS CO.,LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
TONICHI ENGINEERING CONSULTANTS, INC.
ALMEC CORPORATION

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

ORTIGAS NORTH STATION PLAZA
SITE DEVELOPMENT PLAN

DATE 21.May. 2019
SCALE (A1) 1:500, (A3) 1:1000
SHEET No.
DRG No. SPL-C-SD-ON-1001
REV -



SITE DEVELOPMENT PLAN

Scale 1:500

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
KATAHIRA & ENGINEERS INTERNATIONAL
TOKYO METRO CO., LTD.
PACIFIC CONSULTANTS CO.,LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
TONICHI ENGINEERING CONSULTANTS, INC.
ALMEC CORPORATION

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

ORTIGAS SOUTH STATION PLAZA
SITE DEVELOPMENT PLAN

DATE 21.May. 2019

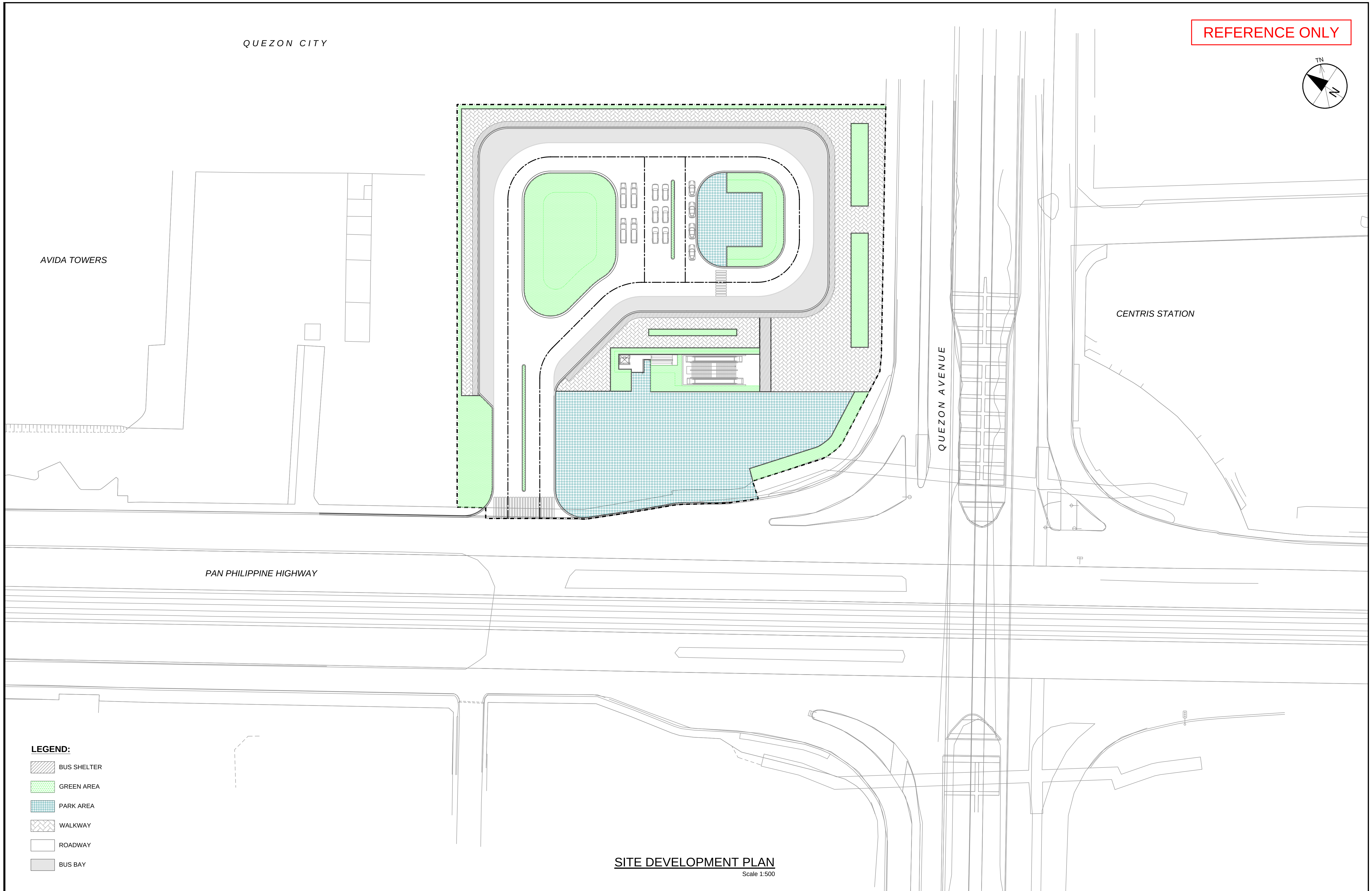
SCALE (A1) 1:500, (A3) 1:1000

SHEET No.

DRG No. SPL-C-SD-OS-1001

REV -

REFERENCE ONLY



SITE DEVELOPMENT PLAN
Scale 1:500

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
KATAHIRA & ENGINEERS INTERNATIONAL
TOKYO METRO CO., LTD.
PACIFIC CONSULTANTS CO.,LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
TONICHI ENGINEERING CONSULTANTS, INC.
ALMEC CORPORATION

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

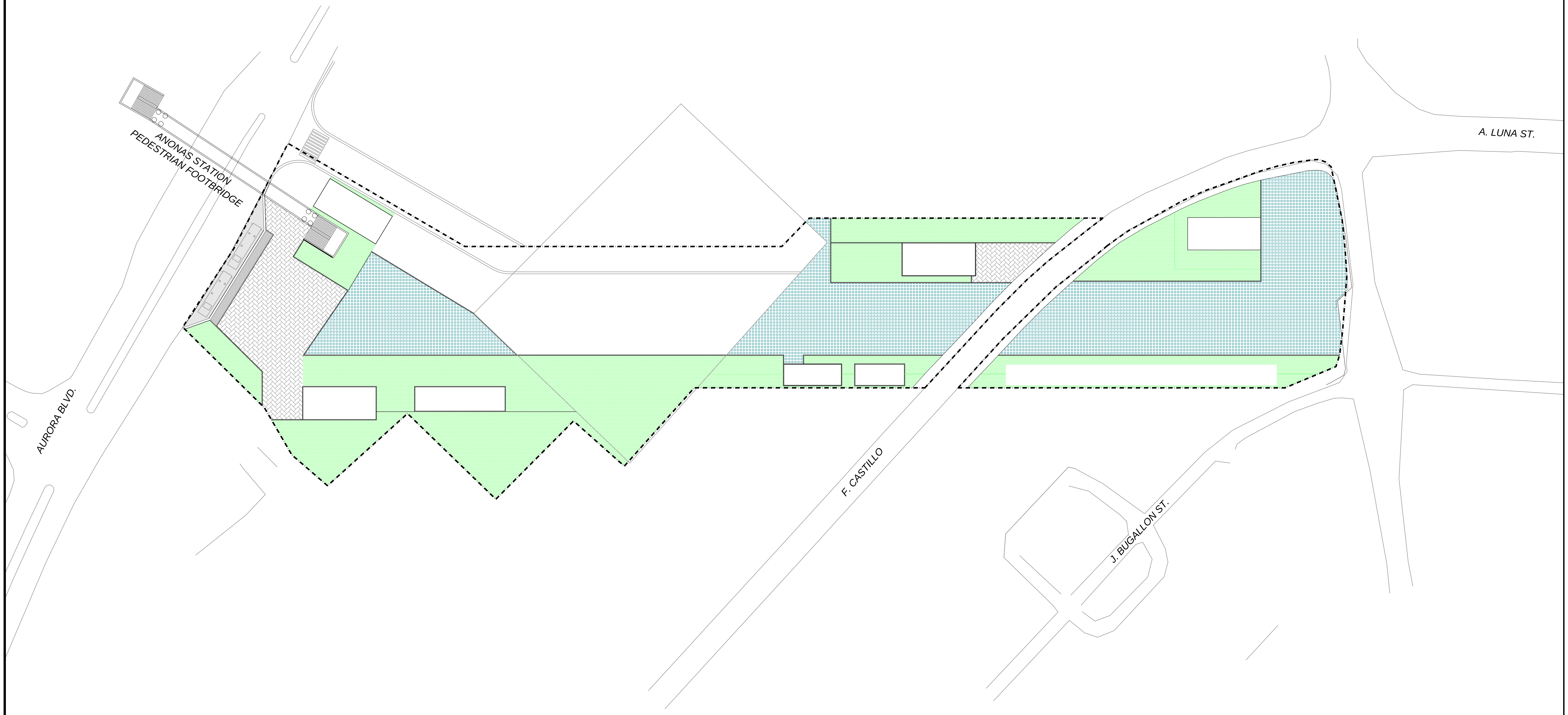
QUEZON AVENUE STATION PLAZA
SITE DEVELOPMENT PLAN

DATE: 10.May. 2019
SCALE: (A1) 1:500, (A3) 1:1000
SHEET No.
DRG No.: SPL-C-SD-QA-1001
REV: -

LEGEND:

- BUS SHELTER
- GREEN AREA
- PARK AREA
- WALKWAY
- ROADWAY
- BUS BAY

REFERENCE ONLY



SITE DEVELOPMENT PLAN
Scale 1:500

VERSIONS	DATE	DESCRIPTION

DEPARTMENT OF TRANSPORTATION (DOTr)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA DESIGN TEAM

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JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
TONICHI ENGINEERING CONSULTANTS, INC.
ALMEC CORPORATION

TITLE	NAME	SIGNATURE
DESIGNER		
CHECK		
TEAM LEADER		
PR. MANAGER		

METRO MANILA SUBWAY PROJECT
PHASE1 : CP101

ANONAS STATION PLAZA
SITE DEVELOPMENT PLAN

DATE
-

SCALE
(A1) 1:500, (A3) 1:1000

SHEET No.

DRG No.
SPL-C-SD-AN-1001

REV
-

Annex ES.1-2

EIA Documentation

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632)927-15-17, 928-37-25; Fax No.: (632) 920-22-58
Website: http://www.emb.gov.ph. / Email: mail@emb.gov.ph

25 OCT 2017

ECC-CO-1708-0017

Hon. Arthur P. Tugade
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S. Osmeña Road
Clark Freeport
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Please be guided accordingly.

Very truly yours,

By the Authority of the Secretary

ENGR. METODIO U. TURBELLA
Director

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
SENR052673

cc:	LGU –Quezon City	LGU –Pasig City	LGU-Makati City
	LGU –Taguig City	LGU –Parañaque City	LGU –Valenzuela City
	DPWH	MMDA	DOLE
	PHIVOLCS		

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
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ENVIRONMENTAL COMPLIANCE CERTIFICATE

(Issued under Presidential Decree No. 1586)

ECC-CO-1708-0017

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SUBJECT ONLY to the conditions and restrictions set in this ECC and in the attached documents labeled as Annexes A and B.

PROJECT DESCRIPTION

This Certificate covers construction and operation of Metro Manila Subway Project (Phase 1) comprising thirteen (13) underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Parañaque City with a total subway length of **28.3 km**, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City.

The ECC includes Depot for trains covering about 31.7 hectares of land area in Brgy. Ugong, Valenzuela City.

This Certificate is issued in compliance with the requirements of Presidential Decree No. 1586, and the implementing rules and regulations thereof. Non-compliance with any of the provisions of this Certificate shall be a sufficient cause for its cancellation and/or imposition of a fine in an amount not to exceed Fifty Thousand Pesos (₱50,000.00) for every violation and shall be without prejudice to imposition of fines and penalties under other environmental laws, rules and regulations. The EMB, however, is not precluded from reevaluating, and correcting any deficiencies or errors that may be found after the issuance hereof this Certificate.

Issued at DENR, Quezon City, Philippines, this OCT 25 2017.

Recommending approval:

ATTY. MICHAEL DRAKE P. MATIAS
Chief, EIAM Division

By the Authority of the Secretary:

ENGR. METODIO U. TURBELLA
Director

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
SENR052673

Protect the environment...

STATEMENT OF ACCOUNTABILITY

I, ***Arthur P. Tugade***, Secretary, representing Department of Transportation with office address located at S. Osmeña Road, Clark Freeport, Mabalacat, Pampanga, take full responsibility in complying with all conditions in this Environmental Compliance Certificate (ECC).

Signature

DOTr-OSEC OUTGOING 17-01589

CITY OF MANILA 10 NUV 2017

Subscribed and sworn to before me this ____ day of ________, 2017, the above-named affiant taking oath presenting ______________________________ issued on __________ at __________________.

Notary Public

264
54
XXXVIII
2017

Atty. Flordeliza Santiago-Reyes
Notary Public for the City of Manila
Until December 31, 2017
Roll No. 30117 Tin 124-300-900
PTR No. 4899807 issued on 12/10/2015, Manila
IBP No. 1012835 issued 12/11/2015
1117 Blumentritt Street, Sampaloc, Manila
Notarial Commission No. ~~2016~~ 072
PTR MLA. 5998917 1/ 4/17

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF ENVIRONMENT
AND NATURAL RESOURCES
SENR052673
17 007484

Annex A

I. CONDITIONS

ENVIRONMENTAL MANAGEMENT

All commitments, mitigating measures and monitoring requirements, contained in the approved Environmental Impact Statement (EIS) particularly in the Environmental Management and Monitoring Plan (EMMoP) shall be instituted to minimize any adverse impact of the project to the environment throughout its implementation, including the following:

1. Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following:

    a. Project impacts and mitigating measures embodied in its EIS;
    b. Conditions stipulated in this Certificate;
    c. Environmental and human safety features of the project, and
    d. Health consciousness alerts for any project-induced discomfort (from dust, smell, noise, vibration) as the project progresses throughout the whole route.

2. Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis;

3. Submit detailed waste management program for proper handling, collection and disposal of solid, hazardous and liquid waste to EMB Central Office (CO) and EMB National Capital Region (NCR) within six (6) months prior to project construction. Proof of implementation shall be submitted together with the CMR;

4. Ensure that all the existing waterways affected by the proposed project construction are maintained and not obstructed;

5. Submit a detailed demobilization plan for the construction yards within six (6) months prior to project construction. The plan should include the following:
    a. Coordination with concerned local government units to promote compatibility of adjoining land uses with the intended subway project station including its exit and entrance; and
    b. Allocation of at least 30% of total area of construction yards for green and open spaces, including but not limited to setting up of vertical and pocket gardens, mini open parks system to promote urban biodiversity.

6. Submit a detailed plan for earth balling and replanting of mature native/endemic trees within six (6) months prior to project construction. The plan should include the following:

a. specific recipient sites which have already been prepared and conditioned
b. ensure high degree of survival
c. provision for regular maintenance until trees have re-established in their new environment

7. Submit an approved Resettlement Action Plan (RAP) of the affected communities within six (6) months prior to project construction;

GENERAL CONDITIONS

8. The proponent shall set-up the following:

8.1 A readily available and replenishable Environmental Guarantee Fund (EGF) to cover the following expenses:

a. for further environmental assessments, compensations/indemnification for whatever damages to life and property that may be caused by the project;

b. rehabilitation and/or restoration of areas affected by the project's implementation; and

c. abandonment/decommissioning of the project facilities related to the prevention of possible negative impacts; and as a source of fund for contingency and clean-up activities.

8.2 Establish a Multipartite Monitoring Team (MMT) composed of representative(s) from the local environmental Non-Government Organization (NGO), POs, and the Local Government Units per DAO 2017-15. The MMT shall primarily oversee the compliance of the proponent with the Environmental Management and Monitoring Plan (EMMoP) and the ECC conditions;

8.3 A replenishable Environmental Monitoring Fund (EMF) to cover all costs attendant to the operation of the MMT such as training, the hiring of technical experts and resource persons, fieldwork and transportation.

The amount and mechanics of the EGF, EMF and the establishment of the MMT shall be determined by the EMB Central Office and the proponent through a Memorandum of Agreement (MOA) which shall be submitted within sixty (60) days upon receipt of this Certificate;

9. Establish an Environmental Unit (EU) within sixty (60) days from receipt of this Certificate that shall competently handle the environment-related aspects of the project. In addition to the monitoring requirements as specified in the Environmental Management and Monitoring Plan (EMMoP), the EU shall have the following responsibilities:

a. Monitor actual project impacts vis-à-vis the predicted impacts and management measures in the EIS;
b. Recommend revisions to the EMMoP, whenever necessary subject to the approval of EMB Central Office;
c. Ensure that data gathered during monitoring activities are properly documented, assessed, evaluated and reported in accordance with the standard formats; and

d. Ensure that monitoring and submission of reports to EMB CO are carried out as required.

10. The proponent shall ensure that its contractors and sub-contractors are provided with copies of this ECC and that they will strictly comply with the relevant conditions of this Certificate;

II. RESTRICTIONS

11. No activities shall be undertaken until and unless disposal sites of excavated materials have been identified, duly covered by agreement/s and have been permitted in accordance with law. Proof of compliance shall be filed with the Regional Office having jurisdiction over the disposal area and shall be without prejudice to environmental safeguards that may be prescribed as warranted. Likewise, a copy of which shall form part of the requirement under Condition 3 hereof;

12. No activities shall be undertaken other than what were stipulated in the final EIS. Any expansion and/or modification of the project beyond the project description or change in alignment/route that will cause significant impacts to the environment shall be subject to a new Environmental Impact Assessment; and

13. In case of transfer of ownership of this Project, the same conditions and restrictions shall apply to the transferee or grantee who shall secure in writing the corresponding amendment of this ECC from the EMB Central Office within fifteen (15) working days reflecting such transfer.

O.R. No	:	8081890
Date	:	08/18/2017
Processing Fee	:	10,000.00

Annex B

PROJECT ASSESSMENT PLANNING TOOL

For the assistance of the Proponent and the Government Agencies concerned in the management of the Project and for better coordination in mitigation of the impacts of the Project on the surrounding areas, the following are recommended to the parties and authorities concerned for appropriate action.

OTHER REGULATORY REQUIREMENTS/CONDITIONS	CONCERNED GOVERNMENT AGENCIES/ENTITIES
1. Strict compliance with the Revised National Structural Code of the Philippines	LGU concerned
2. Compliance with the Sanitation Code of the Philippines;	Department of Health (DOH) and LGU concerned
3. Compliance with the Labor Code of the Philippines;	Department of Labor and Employment (DOLE)
4. Compliance with the Building Code of the Philippines	LGU concerned
5. Ensure compliance with the Ecological Solid Waste Management Act;	LGU concerned
ENVIRONMENTAL PLANNING RECOMMENDATIONS FOR THE PROPONENT	
6. Priority of employment shall be given to qualified local residents. Opportunities for qualified PWDs, women, senior citizens, where possible, shall be considered. Adequate public information for jobs available to local residents in the affected areas will be provided.	
7. Conduct a detailed Traffic Impact Assessment (TIA) in coordination with the Metro Manila Development Authority (MMDA) and concerned LGU for every proposed station prior to project construction integrating proposed road expansion projects (if any) of the concerned government agencies.	
8. An inclined drilling program should be designed and carried out for the segment(s) of the subway along the West Valley Fault (e.g. Cayetano Station). The design of the drilling program and interpretation of results should be done in consultation with PHIVOLCS.	
8. Based on the results of the Detailed Engineering Design, the proponent may consider realignment of subway from the fault while maintaining the Cayetano Station.	

ATTY. MICHAEL DRAKE P. MATIAS
Chief, EIAM Division

ENGR. METODIO U. TURBELLA
Director

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
SENR052673

ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR METRO MANILA SUBWAY PROJECT (MMSP) (Phase 1)

VOLUME II

APPENDICES

SEPTEMBER 2017

DEPARTMENT OF TRANSPORTATION (DOTr)

Table of Contents

APPENDIX A

Documentation of the EIA Process

1. DESCRIPTION OF THE PROJECT'S EIA PROCESS

1.1. TERMS OF REFERENCE OF THE EIA STUDY

The Environmental Impact Assessment (EIA) Study was commissioned by Oriental Consultants Global Co., Ltd. (OCG) through Japan International Cooperation Agency (JICA) and in coordination with the Department of Transportation (DOTr). The scope of the study covers the Central Zone of the Metro Manila Subway Project, which starts at Mindanao Avenue-Quirino Highway in Quezon City and ends in FTI, Taguig City and a portion in Brgy. San Martin de Porres in Paranaque City.

The Study consists of the following components:

1) To collect the baseline information and carry out the field surveys on the project affected area;
2) To identify potential project impacts on natural and social environment, and predict and assess the impacts;
3) To draw up the mitigation measures and monitoring plans;
4) To prepare the materials for, facilitate and assist OCG and DOTr on stakeholder meetings such as Information, Education and Communication (IEC) for local government units (LGUs), and public consultation meetings, in coordination with DOTr and OCG;
5) To prepare the Environmental Impact Statement (EIS) report;
6) To prepare required documents for the application of Environmental Compliance Certificate (ECC); and,
7) To assist DOTr to secure ECC.

1.2. THE EIA TEAM

Delta Tierra Consultants, Inc. is a private consulting firm that provides environmental, energy and sustainability solutions to various industry sectors and public and private institutions. Table shows the EIA Team for the subway project.

Table 1. EIA Team for the Metro Manila Subway Project

Name	Position	Qualifications
Engr. Angelica A. Celicious	Team Leader / Environmental Specialist	M.S. Environmental Engineering (EnE);B.S. Chemical Engineering (ChE)
Ms. Charlotte Jennifer M. Calonge	Environmental & Social Safeguards Specialist	M.S. Environmental Science; B.S. Chemistry
Mr. James Allan P. Reyes	Geologist	B.S. Geology
Engr. Marianito T. Margarito	Air and Noise Quality Expert	M.S. Environmental Engineering (EnE); B.S. Chemical Engineering (ChE)
Mr. Ulysses F. Ferreras	Biology Expert	M.A. Environmental Management (with units); B.S. Biology; B.S. Agricultural Technology
Ms. Milagros S. Antofina	EIA Technical Assistant	B.S. Chemistry

1.3. EIA STUDY SCHEDULE

Table 2 presents the completed activities for the EIA study.

Table 2. Completed Activities of the EIA Study

Activity	Areas Covered	Dates Covered
The Land		
Site survey	The entire MMSP alignment including the proposed depot site in Brgy. Ugong, Valenzuela	January to July 2017
Landscape	Depot site in Brgy. Ugong, Valenzuela	May 5, 2017
Flora survey	Depot site in Brgy. Ugong, Valenzuela and all proposed stations	April 28, July 5-18
Ground Vibration measurements	Along the MMSP alignment in the following areas: • Rolling Hills Resort, Brgy. Ugong, Valenzuela City • Landcom Village II, Tandang Sora, Quezon City • Trinoma Parking Lot, Mindanao Ave., Quezon City • Centris Walk, Quezon Ave., Quezon City • World Citi Medical Center Parking Lot, Aurora Boulevard, Quezon City • Brgy. Blue Ridge A, Project 4, Quezon City • Estancia Mall Parking Lot, Capitol Commons, Meralco, Ave., Pasig City • BCDA Field Office – Pamayanang Diego Silang, Cayetano Boulevard • FTI – PNR Station, Taguig City	March 27 – May 4, 2017
The Water		
Surface water quality sampling	At the rivers along the MMSP alignment in the following areas: • Tullahan River (along Mindanao Avenue) • San Juan River (along Mindanao Avenue, Quezon City) • Pasig River, Makati City	March 1, 2017
The Air / Noise		
Ambient air quality sampling	Along the MMSP alignment in the following areas: • Rolling Hills Resort, Brgy. Ugong, Valenzuela City (dry season) • Hyundai Powerlifter Phils., Inc.,	Dry season (March 27 – May 3, 2017) and Wet season (July 10 – 27, 2017)

Activity	Areas Covered	Dates Covered
	Mindanao Avenue, Valenzuela City (wet season) • Pacific Global Medical Center, Mindanao Avenue, Quezon City (wet season) • Landcom Village II, Tandang Sora, Quezon City (wet season) • Trinoma Parking Lot, Mindanao Ave., Quezon City (wet and dry seasons) • Avida Tower I, EDSA, Quezon City (wet season) • AFP Medical Center, V.Luna St., Diliman, Quezon City (wet season) • Brgy. Blue Ridge A, Project 4, Quezon City (wet season) • MMDA Compound, Julia Vargas Ave., Ortigas, Pasig City (wet and dry seasons) • Estancia Mall Parking Lot, Capitol Commons, Meralco, Ave., Pasig City (wet season) • World Citi Medical Center Parking Lot, Aurora Boulevard, Quezon City (wet and dry seasons) • Market Market Parking Lot, BGC, Taguig City (wet and dry seasons) • BGC Parking lot 11th St. cor. 38th St. (wet season) • FTI – PNR Station, Taguig City (wet and dry seasons)	
Noise measurements	Along the MMSP alignment in the following areas: • Rolling Hills Resort, Brgy. Ugong, Valenzuela City • Landcom Village II, Tandang Sora, Quezon City • Trinoma Parking Lot, Mindanao Ave., Quezon City • Centris Walk, Quezon Ave., Quezon City • World Citi Medical Center Parking Lot, Aurora Boulevard, Quezon City • Brgy. Blue Ridge A, Project 4, Quezon	March 27 – May 4, 2017 and July 10 – 27, 2017

Activity	Areas Covered	Dates Covered
	City • Estancia Mall Parking Lot, Capitol Commons, Meralco, Ave., Pasig City • BCDA Office, Cayetano Blvd • FTI – PNR Station, Taguig City	
The People		
IEC meetings with the LGUs	For pre-scoping activity	December 6 – March 18, 2017
Stakeholders Meeting and Public Consultation	For Public Scoping	March 9 – April 27, 2017
Historical/Cultural Heritage	BGC, Taguig City	May 18, 2017

1.4. EIA METHODOLOGY

The EIA was carried out following Terms of Reference (TOR) agreed with the JICA Study Team. The EIA process was also guided by the DENR Administrative Order No. 30 of 2003 or the Implementing Rules and Regulations of Presidential Decree No. 1586, Establishing the Philippine Environmental Impact Statement System.

1.4.1. Secondary Data Gathered and Sources

The secondary data and information on the baseline environmental conditions for land, water, air, and people of the cities along the MMSP alignment and proposed depot location from Valenzuela City to Taguig City are collected from various sources, mainly from relevant government organizations and academic institutions. Other secondary information was sourced from published documents and literatures from previous studies conducted, and from the internet. Project component and description, and other relevant data on the details of the MMSP were provided by DOTr and the JICA Study Team. Table 3 shows the sources of information collected for this study.

Table 3. Information Collected and Sources of Information

Data/Information Collected	Source
Project description, which includes the background of the project, scope of the alignment including maps and basic design of stations	DOTr, JICA Study Team
Pre-feasibility study of MMSP	JICA Study Team
Comprehensive Land Use Plan (CLUP) of the 7 cities affected by the alignment	City Planning Department of the 7 affected cities
Geohazard Maps, Earthquake hazards and risk assessment	Mines and Geosciences Bureau (MGB), Philippine Institute of Volcanology and Seismology (PHIVOLCS)
Flood hazard maps and landslide-related information	The University of the Philippines Nationwide Operational Assessment of Hazards (UP NOAH)/ Department of Science and

Data/Information Collected	Source
	Technology (DOST) PROJECT NOAH
Groundwater data	National Water and Resource Board (NWRB) Local Water Utilities Administration (LWUA)
Climatological and climate change trends and projections	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA), Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)
National Air Quality Status	Department of Environment and Natural Resources (DENR)
Census and Population Data	National Statistics Office (NSO)
Traffic Data	Land Transportation Office
Information on the Fort Bonifacio War Memorial Tunnel traversing Bonifacio Global City, Taguig City and Brgy. Pembo in Makati City	Bases and Conversion Development Authority (BCDA)

1.4.2. Primary/Baseline Data

Primary data were obtained through ocular site inspection along the MMSP alignment to validate the secondary data and evaluate the existing environmental conditions. Field surveys and sampling/measurements at pre-identified locations were also conducted as shown in Table 2.Methodologies used for the sampling, measurement and analysis are summarized in Table 4.

Table 4. Methodologies for sampling and analysis

Parameter	Sampling Method	Method of Analysis
Surface water quality		
Color	Grab sampling	SMEWW Method 2120B - Visual Comparison
Water Temperature		SMEW Method 2550 - Thermometry
pH		SMEWW Method 4500H$^+$ - Electrometric Method
Dissolved oxygen (DO)		SMEWW Method 4500OC - Azide Modification
Biochemical Oxygen Demand (BOD)		SMEWW Method 5210B - Azide Modification
Total Suspended Solid (TSS)		SMEWW Method 2540D - Gravimetry
Surfactants (MBAS)		SMEWW Method 5540C - Colorimetry
Oil/Grease (Petroleum Ether Extracts)		EPA Method 413.1 - Pet Ether Extraction
Nitrate as Nitrogen		EPA Method 352.1 - Brucine Method
Phosphate as Phosphorus		SMEWW Method 4500PD - Stannous Chloride
Phenolic Substances as		SMEWW Method 5530C - Chloroform

Parameter	Sampling Method	Method of Analysis
Phenols		extraction
Total Coliforms or Fecal Coliforms		SMEWW Method 9221B&E
Chloride as Cl		SMEWW Method 4500ClB – Argentometry
Copper (dissolved copper)		EPA SW846 Method 7210 - Flame AAS
Arsenic		SMEWW Method 3500As – Colorimetry
Cadmium		EPA SW846 Method 7130 - Flame AAS
Chromium (hexavalent)		SMEWW Method 3500CrB – Colorimetry
Cyanide		ISE
Lead		EPA SW846 Method 7420 - Flame AAS
Total Mercury		EPA SW846 Method 7470A - Cold Vapor AAS
Organophosphates		EPA 8141A
Groundwater quality		
Color	Collected groundwater samples from deep well pumps	SMEWW Method 2120B - Visual Comparison
Water Temperature		SMEW Method 2550 - Thermometry
pH		SMEWW Method 4500H^+ - Electrometric Method
Electric Conductivity		SMEWW Method 2510 - Conductimetric
Sodium (Na^+)		EPA SW846 Method 7770 - Flame AAS
Potassium (K^+)		EPA SW846 Method 7610 - Flame AAS
Calcium (Ca^+)		SMEWW Method 2340C - Titrimetry
Magnesium (Mg^+)		Flame AAS
Bicarbonate (HCO^{3-})		SMEWW Method 2320B - Titrimetry
Chloride (Cl^-)		SMEWW Method 4500ClB - Argentometry
Sulfate (SO_4^{2-})		SMEWW Method 4500SO_4^{2-} - Turbidimetric
Nitrate (NO_3^-)		SMEWW Method 4500NO_3^-E - Cadmium Reduction
Arsenic		EPA SW846 Method 7061 - AAS Hydride
Cadmium		EPA SW846 Method 7130 - Flame AAS
Chromium (hexavalent)		SMEWW Method 3500CrB - Colorimetry
Cyanide		ISE
Lead		GFAAS
Total Mercury		EPA SW846 Method 7470A - Cold Vapor AAS
Total Coliforms or Fecal Coliforms		SMEWW Method 9221B&E

Parameter	Sampling Method	Method of Analysis
Ambient air quality		
Total Suspended Particulates (TSP)	High volume sampler, 24 hours sampling	Gravimetry
Particulates (PM10)	High Volume Sampler with 10 micron particle-size inlet, 24 hours sampling	Gravimetry
Nitrogen Oxides (NO_2)	Gas Bubbler, 24 hours sampling	Gravimetry
Sulphur Oxides (SO_2)		Griess Saltzman Reaction
Carbon Monoxide (CO)	1 hour continuous real time sampling / measurement	Pararosaniline
Ozone (O_3)	High volume sampler, 24 hours sampling	Direct Read out analyzer
Lead (Pb)	High Volume Sampler with 10 micron particle-size inlet, 24 hours sampling	Neutral Buffered Pottasium Iodide (NBKI) - Colorimetry
Noise and vibration		
Noise	Noise meter, 24 hours monitoring	Direct read out
Vibration	Geode seismic recorders and Accelerographs; Ground vibration monitoring for periods of up to 30 seconds every 10 minutes over 24 hrs	Spectral analysis using Fourier transform
Flora		
Vegetation survey	Walkthrough, visual observation, measurement of tree diameter and height	Analysis of taxa counts, endemicity and identification of threatened plants

1.4.3. Identification, Prediction and Assessment of Impacts

Potential impacts were identified based on description of project activities, its environmental aspects, and the existing condition of the environment or receptors that are susceptible to impacts. The identified impacts were evaluated in terms of the effects that will be encountered by the receptors, both the environment and people.

In reference to the established baseline environmental conditions, predicted and forecasted impacts will be evaluated against the Philippine standards, and in the absence of such, will be evaluated against international standards. Table 5 presents the reference criteria/standards of environmental quality and natural environment used for evaluating the identified impacts.

Table 5. Criteria/Standard of Environmental Quality and Natural Environment

Criteria/Standards	Philippine	International
Ambient air quality	National Ambient Air Quality Guideline Values, "Implementing Rules and Regulations of the Philippine Clean Air Act of 1999"	N/A
Noise	The National Pollution Control Commission (NPCC) Memorandum Circular No. 002 Series of 1980, Section 78- Ambient Noise Quality and Emission Standards for Noise	N/A
Vibration	N/A	Technology and Laws Regulation for Pollution Control, 2000", Japan Environmental Management Association for Industry
Surface Water Quality	DENR Administrative Order (DAO) No. 2016-08: Water Quality Guidelines and General Effluent Standards of 2016	N/A
Groundwater Quality	Philippine National Standards for Drinking Water 2007	N/A
Flora and Fauna	DAO No. 2004-15, Establishing the National List of Threatened Philippine Plants and Their Categories, and the List of Other Wildlife Species.	International Union for the Conservation of Nature and Natural Resources (IUCN) Red List

The severity of the identified impacts was assessed and rated according to the following:

Table 6. Impact Assessment Criteria

Assessment	Criteria
High Adverse	Impact is a major problem. An accepted limit or standard may be exceeded or large magnitude impacts occur to highly valued/ sensitive receptors. Extensive disturbance to current resources resulting in some minor human health effects upon nearby residents and businesses. Considerable permanent adverse disturbance of ecology due to contamination over a local scale. Mitigation measures and detailed design work are unlikely to remove all of the significant

Assessment	Criteria
	effects.
Moderate Adverse	Adverse change resulting in some loss or permanent lowering of resources, though no impact upon human health. Loss and permanent damage to ecology on a local scale. Some recovery is anticipated following completion of the works concerned. Mitigation measures are anticipated to alleviate close to all impacts.
Low Adverse	An effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards. Limited or temporary effects resulting in low levels of disturbance or loss to local resources or ecology. No impact upon human health. Close to full recovery is anticipated following completion of the works concerned. Mitigation measures are anticipated to alleviate close to all impacts.
Negligible	The receiving environment will not be affected in any way by a particular activity. No appreciable impacts upon local resources, human health or ecology. Effects are within normal bounds of variation.
Beneficial	Impact provides major improvement to the existing environment or major enhancement to the current condition. These can include measures to improve social values, resources, ecological health and long-term protection of ecological functions.

1.5. PUBLIC PARTICIPATION

1.5.1. Public Consultation for EIA

The pre-scoping or the IEC meetings with LGUs, which have jurisdiction over the project area, were conducted to formally introduce the MMSP to the concerned LGUs in preparation for the public consultation meetings, EIA surveys and socio-economic surveys that will be conducted as part of the EIA Study. The schedule and participants of the IEC meetings are summarized in Table 7.

Table 7. Schedule of IEC Meetings with LGUs

Date	LGU	Participants
December 7, 2016	Quezon City	City Mayor, City Planning Office, Engineering Department, DOTr, JICA Study Team (JST), DTCI
December 14, 2016	Caloocan City	City Mayor, Mayor's Office, City Planning Office, City Engineering Department, Brgy. 116, UPAO, DOTr, JST, DTCI
December 16, 2016 (morning)	Valenzuela City	City Mayor, Chief of Staff-Office of the Mayor, Brgy. Ugong, Housing and Resettlement Office, DOTr, JST, DTCI
December 16, 2016	Taguig City	Office of the City Administration, City Engineering

Date	LGU	Participants
(afternoon)		Office, DOTr, JST, DTCI
January 10, 2017	Makati City	City Administrator, City Legal Officer, DOTr, JST, DTCI
January 18, 2017	Pasig City	City Mayor, Transport Consultant, CENRO, TPMO, TED, DOTr, JST, DTCI
March 13, 2017	Parañaque City	City Mayor, City Assessor, CPDC, Brgy. San Martin de Porres, DOTr, JST, DTCI, Ecosys Corp.

The stakeholders' consultation meetings for environmental consideration and public scoping were conducted last March 9 to April 27, 2017in the six (6) affected cities. Table 8 shows the schedule and number of participants of the said meetings.

Table 8. Schedule of the Schedule of Stakeholders' Consultation Meetings for Environmental Consideration and Public Scoping

Date	LGU	No. of Participants
March 9, 2017	Makati City	20
March 16, 2017	Taguig City	25
March 20, 2017	Pasig City	32
March 21, 2017	Quezon City (Batch 1)	26
March 22, 2017	Quezon City (Batch 2)	49
April 26, 2017	Paranaque City	24
April 27, 2017	Valenzuela City	27

1.5.2. Public Consultation for RAP

DOTr, through the RAP consultants, has been holding stakeholder consultation meetings and public consultation meetingsin order to ensure public involvement through the process of resettlement planning. In addition, focus group discussions (FGD) were also held for the vulnerable groups or persons, such as women, elders and the poor segment of people. Minutes of the meetings are presented in Appendix B.

(1) First Round of the Public Consultation Meetings (PCM)

Public consultations have been held in each LGU as shown in Table 9. In the PCM, the outline of the MMSP projects, schedule for census and tagging, and the cut-off dates were announced.

Table 9. Outline of the First Round of Public Consultations

LGUs	Venue	Date	Participants	No. of Participants
Makati City	17/F Training Room, Building 1, Makati City Hall	18-Apr-2017	PAPs, LGU, DOTr	

LGUs	Venue	Date	Participants	No. of Participants
Pasig City	Legislative Session Hall, Pasig City Hall	18-Apr-2017	LGU Pasig,Brgy. Kapitolyo, Brgy. San Antonio, DOTr, JST, Ortigas & Co., OHI	20
Quezon City (Group A)	2nd Floor, DFA Conference Room, Civic Center Building C, Quezon City Hall	25-Apr-2017	LGU Quezon City,Brgy. Talipapa, Brgy. Tandang Sora, Brgy. Bagong Pagasa, Brgy. Pinyahan, Brgy. Bagumbuhay, Brgy. St. Ignatius, DOTr, JST, Residents, Lot owners	23
Quezon City (Group B)		26-Apr-2017		23
Valenzuela City	2nd Floor, Valenzuela Town Center, Valenzuela Town Hall A, Valenzuela City Hall	26-Apr-2017	LGU Valenzuela, Brgy. Ugong, DOTr, JST, Residents, Lot owners	98
Paranaque City	2nd Floor, Session Hall, Brgy. Hall of San Martin De Porres	27-Apr-2017	LGU Paranaque, Brgy. San Martin de Porres, Brgy. Merville, DOTr, JST, DMCI Raya, Green Cross, Inc, United Hills Village, PAPs	28
Taguig City	People's Hall, Taguig City Hall Satellite Office, 9th Floor, SM Aura	2-May-2017	LGU Taguig, Brgy. Pinagsama, Brgy. Ususan, DOTr, JST, BCDA	12

Source: JICA Study Team

(2) Follow-up Meeting at Barangay Level

Having considered the low attendance of the first round of PCM at some LGUs, follow-up meeting was organized at barangay level at the following schedule shown below.

Table 10. Schedule of the Follow-up Meeting at Barangay Level

LGUs	Venue	Date	Stations
Quezon City	Barangay Hall of Talipapa	15-May-2017	Quirino Highway

	Barangay Hall of Tandang Sora	15-May-2017	Tandang Sora
	Barangay Hall of Pinyahan	18-May-2017	East Avenue
	Barangay Hall of Bagumbuhay	18-May-2017	Anonas
	Barangay Hall of Blueridge A	19-May-2017	Katipunan
Pasig	Barangay Hall of San Antonio	24-May-2017	Ortigas South Ortigas North

Source: JICA Study Team

(3) Second Round of the Public Consultation Meetings (PCM)

Table 11. Schedule of Second Round of Public Consultations

LGUs and Barangay	Venue	Date	Stations
Quezon City Barangay: Talipapa, Tandang Sora, Bagong Pag-asa	Barangay Hall of Talipapa,	15-May-2017	Mindanao-Quirino, Tandang Sora, North Avenue and Quezon Avenue Mindanao-Quirino
Quezon City Barangay: Pinyahan, Bagumbuhay	Barangay Hall of Bagumbuhay,	5-Jun-2017	East Avenue and Anonas
Quezon City Barangay: Blueridge, Bayanihan, St. Ignatius	Barangay Hall of St. Ignatius,	6-Jun-2017	Katipunan
Pasig City Barangay: San Antonio, Ugong, Oranbo, Kapitolyo	Barangay Hall of San Antonio,	7-Jun-2017	Ortigas South Ortigas North
Makati City Barangay: West Rembo	Barangay Hall of West Rembo	7-Jun-2017	Underground - No station
Paranaque City Barangay: San Martin De Porres, Merville	Barangay Hall of San Martin De Porres	8-Jun-2017	FTI
Valanzuela City Barangay: Ugong	Barangay Hall of Ugong	9-Jun-2017	Depot

Source: JICA Study Team

1.5.3. Public Hearing

After submission of the draft Environmental Impact Statement (EIS) Report to EMB-NCR, the full EIS Report, together with a laymanized Executive Summary for the Public (ESP) both in English and Filipino versions were made available to the public last August 18, 2017 through the EMB-DENR website at www.emb.gov.ph. Notice of Public Hearing from the EMB-DENR was published in two national broadsheets – Philippine Daily Inquirer and The Philippine Star, last August 21 and 28, 2017, respectively. Likewise, the notice was posted in bulletin boards at City Halls and barangays within the DIA and IIAs. The list of stakeholders previously identified during the initial consultation meetings were updated based on the delineation of DIAs and IIAs and based on the socio-ecoomic surveys being conducted in concurrence with the EIA study. Letters of invitation to attend the Public Hearing and copies of the ESP were sent to the identified stakeholders. Public hearings were conducted to achieve efficient exchange and views among DOTr, EMB-NCR, relevant agencies, LGUs and other stakeholders on the environmental impacts of the proposed project. Public hearings were conducted at the following schedule:

Table 12. Schedule of Public Hearing

Date	Venue	Stakeholders invited	No. of Participants
5-Sept-2017	10th Flr. Kalayaan Hall, SM Aura Office Tower, Taguig City	Stakeholders from Pasig, Makati, Taguig and Parañaque Cities	120
6-Sept-2017	3rd Flr., EPWMD Conference Room, Quezon City Hall	Stakeholders from Quezon City	85
7-Sept-2017	Roliing Hills Resort, Brgy. Ugong, Valenzuela City	Stakeholders from Valenzuela City	203

Stakeholder groups and representing individuals who were invited and participated in the public hearing are shown in Table 13. For Valenzuela City, Notice of Public Hearing was distributed to the affected business/lot owners and residents through theassistance from Barangay Ugong.

Table 13. List of Stakeholder Invited and Participated in the Public Hearing for MMSP

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Vizminda A. Osorio	Regional Director	Environmental Management Bureau-NCR	Government	✔	✔
Danilo Delapuz Lim	Chairman	Metro Manila Development Authority (MMDA)	Government	✔	✔
Terry L. Ridon	Chairperson	The Presidential Commission for the Urban Poor	Government	✔	✔
Maria Catalina Cabral	Undersecretary for Planning and PPP	Department of Public Works and Highways - Planning Services	Government	✔	
Melvin Navarro	Regional Director	Department of Public Works and Highways - NCR	Government	✔	✔
		Department of Public Works and Highways - Metro Manila 3 District Engineering Office	Government	✔	✔
Renato Solidum, Jr.	Director	Philippine Institute of Volcanology and Seismology	Government	✔	✔
Ray Espinosa	Chief Corporate Services Officer	Philippine Long Distance Company	Public Utility	x	
Antonio La Vina	Executive Director	Manila Observatory (KLIMA)	NGO	✔	
Bonar Laureto	Executive Director	Philippine Business for the Environment	NGO	✔	
Reynaldo Antonio Laguda	Executive Director	Philippine Business for Sustainable Development	NGO	✔	
Quezon City					
Herbert Bautista	City Mayor	City of Quezon	LGU Quezon City	✔	✔
Aldrin Cuna	City Administrator	City Administration Department	LGU Quezon City	✔	✔
Joselito Cabungcal	Head	Engineering Department	LGU Quezon City	✔	✔

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Frederika C. Rentoy	Head	Environmental Protection and Waste Management Department	LGU Quezon City	✔	✔
Ramon Asprer	Head	Housing and Community and Resettlement Department (HCDRD)	LGU Quezon City	✔	✔
Alfredo Roxas	Brgy. Captain	Brgy. Kaligayahan	LGU Quezon City	x	
Hector B. Geronimo	Brgy. Captain	Brgy. Tandang Sora	LGU Quezon City	✔	
Rodolfo S. Palma	Brgy. Captain	Brgy. Bagong Pag-asa	LGU Quezon City	✔	
Carlos D. Apo	Brgy. Captain	Brgy. Sauyo	LGU Quezon City	✔	✔
Fernando Asia, Jr.	Brgy. Captain	Brgy. Malaya	LGU Quezon City	✔	
Annabella I. Curatcho	Brgy. Captain	Sikatuna Village	LGU Quezon City	✔	✔
Larry Handayan	Brgy. Captain	Brgy. South Triangle	LGU Quezon City	✔	
Richard Ambita	Brgy. Captain	Brgy. Bagbag	LGU Quezon City	✔	✔
Ursula Juan	Brgy. Captain	Brgy. Talipapa	LGU Quezon City	✔	✔
Jose Visaya	Brgy. Captain	Brgy. Novaliches Proper	LGU Quezon City	x	
Vicente Honorio Llamas	Brgy. Captain	Brgy. Project 6	LGU Quezon City	✔	
Gabriel C. Legaspi	Brgy. Captain	Brgy. Blue Ridge A	LGU Quezon City	✔	✔
Noel V. Lopez	Brgy. Captain	Brgy. West Triangle	LGU Quezon City	✔	
Zaldy Nepomuceno	Brgy. Captain	Brgy. Sto.Cristo	LGU Quezon City	✔	
Victor Ferrer, Jr.	Brgy. Captain	Brgy. Bahay Toro	LGU Quezon City	x	
Jesus Lipnica, Jr.	Brgy. Captain	Brgy. Pinyahan	LGU Quezon City	✔	
Dominador L. Soliven,	Brgy. Captain	Brgy. East Kamias	LGU Quezon City	✔	
Noel R. Agdeppa	Brgy. Captain	Brgy. Quirino 2A	LGU Quezon City	✔	
Ma. Victoria V. Padolina	Brgy. Captain	Brgy. Quirino 3A	LGU Quezon City	✔	✔
Raulito Datiles	Brgy. Captain	Brgy. Bagumbuhay	LGU Quezon City	✔	
Alejandro H. Cuizon	Brgy. Captain	Brgy. Milagrosa	LGU Quezon City	✔	
Edwin Tansingco	Brgy. Captain	Brgy. St. Ignatius	LGU Quezon City	✔	
Teresita Iguico	Brgy. Captain	Brgy. White Plains	LGU Quezon City	✔	
Zarina Yasmine Xenelle W. Jorge	Brgy. Captain	Brgy. Ugong Norte	LGU Quezon City	✔	✔

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Simplicio EJ. Hermogenes	Brgy. Captain	Brgy. Philam	LGU Quezon City	✔	
Dominador M. Chiong, Jr.	Director	Veterans Memorial Medical Center	Institution - DIA	✔	✔
Edwin Leo T. Torrelavega	Commanding General	Armed Forces of the Philippines (AFP) Health Service Command	Institution - DIA	✔	
Rodaliza E. Lanctize	PEU	Armed Forces of the Philippines (AFP) Health Service Command	Institution - DIA	✔	
James Kenley M. Torres	Executive Vice President	St. James College of Quezon City	Institution - IIA	✔	✔
Cynthia Lorenzo	President	Landcom Village II Homeowners Association	Residents - IIA	✔	
Juan A. Lagunzad	President	Pacific Global Medical Center	Institution - DIA	✔	✔
Catherine Jane T. Ng	General Manager	Tony's Bar and Grill	Business - DIA	✔	✔
Jose Rodrigo C. Lozano	Complex Manager, Property Management	Trinoma	Business - DIA	✔	represented by ALI
Ronna Cabalfin	Associate Business Development Manager	Ayala Land, Inc.	Business - DIA,IIA	✔	✔
John Paul M. Fernandez	Project-in-charge	Vertis North - Avida Vita Towers	Business - DIA,IIA	✔	represented by ALI
Engr. Ronald Responde	Asst. Property Manager (Operations)	Eton Centris	Business - IIA	✔	
Teresita Agda	President	Philippine Medical Women's Association	PO - IIA	✔	
Jasmin Torres	Property Manager	Anonas LRT City Center	Business - IIA	✔	
Richard Lazaro	Property Management	World Citi Medical Center	Institution - IIA	✔	
Cristine Pabillaran	Dining Supervisor	Balay Ligaya Restaurant	Business - DIA	✔	✔
Ramon N. Eloriaga	Parish Priest	St. Joseph Parish Shrine	Institution - IIA	✔	
Janine Tomara	Representative	Brgy.Bagumbuhay	Residents - DIA	✔	
Flordeliza Pantig	President	Brgy.Bagumbuhay	Residents - DIA	✔	
Francisco Arellano	Head of Corporate Quality, Environment,	Maynilad Water Services, Inc.	Public Utility	✔	✔

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
	Safety and Health				
Marc Tom Mulingbayan	Head, Sustainability Dept.	Manila Water Company, Inc.	Public Utility	✔	✔
John Mark Bordeos	Manager	Shell Gas Station	Business - DIA	✔	
Maria Nelia Bongalbal	Business Owner	Brgy. Blue Ridge A	Residents - DIA	x	
Cherrie Paterno	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	x	
Jacquelene Manalantas	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	✔	✔
Zarah Jane Marasigan	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	✔	✔
Ces Muceros	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	✔	✔
Gilbert Bernardo	Manager	Honda	Business - DIA	x	
Manuel Panuelas			Residents - DIA	x	
Tony Chua	Lot Owner	CHP Marketing Corp.	Business - DIA	✔	✔
Jowell Chua	Lot Owner	Unioil	Business - DIA	✔	
Gilberta Bascara	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	✔	
Lydia Malones	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	x	
Rolando Magsino	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	✔	
Herminio Alminar	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	✔	✔
Luis Almazen	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	✔	✔
Rosita Bonifacio	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	x	
Peter Tansiyok	Lot Owner	Brgy. St. Ignatius	Residents - DIA	x	
Gerry Crudo	Representative	Primo's Burger, Brgy. St. Ignatius	Business - IIA	x	
	Students	UP Diliman	Academe		✔
Rommel Del Mundo	Office of Administrative Services	Asian Development Bank	Institution		✔
RC G. Cesar	Representative	Green Convergence	NGO		✔
Pasig City					
Bobby Eusebio	Mayor	City of Pasig	LGU Pasig	✔	✔
Alberto Dulay	Head	Traffic and Parking Management Office	LGU Pasig	✔	✔

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Lydia Gutana	Head	Traffic and Engineering Department	LGU Pasig	✔	✔
Engr. Hermogenes N. Lerio		City Engineer's Office	LGU Pasig	✔	
Racquel A. Naciongayo		City Environment and Natural Resources Office	LGU Pasig	✔	✔
Engracio E. Santiago	Barangay Chairman	Brgy. Ugong	LGU Pasig	✔	✔
Noel R. Pajara	Barangay Chairman	Brgy. Kapitolyo	LGU Pasig	✔	✔
Vicente V. Javier, Jr.	Barangay Chairman	Brgy. Oranbo	LGU Pasig	✔	
Joselito dela Merced	Barangay Chairman	Brgy. San Antonio	LGU Pasig	✔	
Malou B. Reyes	General Manager	Ortigas Center Association Inc.	Business Organization	✔	✔
Geralyn Solida	Head, External Affairs	Manila Electric Company (MERALCO)	Private Utiity	✔	✔
Ramon Sumulong	Head, Property Management Shopping Centers Division	OCLP Holdings, Inc.	Business - DIA	✔	✔
Cris Arpon		Iriz One Propertis, Inc.	Business - IIA	✔	
Keith Villareal	Property manager	Isquare Building	Business - IIA	✔	
Oliver Joseph C. Uy	Proprietor	Green Peace Emission	Business - IIA	✔	✔
Cherry Arganda	Finance Director	Republic Apparel Retailers	Business - IIA	✔	
Joel Virgino	HR Manager	Valuecare Health Systems	Business - IIA	✔	✔
Danilo Santos	President	Ardan Bldg. / San Aura Properties	Business - DIA	✔	✔
Nelia Chipeco	Chairman	Chipeco Bldg.	Business - DIA	✔	
Edna San Buenaventura	Chairman	San Buena Bldg.	Business - DIA	✔	✔
Lawrence A. Paray	Sr. Architect	OCLP Holdings Inc.	Business - DIA	✔	✔
Jeremy Sy	Lot owner		Business - IIA	✔	✔
Makati City					
Abby Binay	Mayor	City of Makati LGU	LGU Makati City	✔	✔

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Atty. Claro Certeza	Makati City Administrator	City Administration Dept.	LGU Makati City	✔	✔
Engr. Leopoldo V. Parumog		Department of Environmental Services (DES)	LGU Makati City	✔	✔
Engr. Elmer V. Acuesta		Department of Engineering and Public Works (DEPW)	LGU Makati City	✔	✔
Engr. Merlina G. Panganiban		Urban Dev. Dept Makati City	LGU Makati City	✔	
Mr. Ryan F. Barcelo		Makati Social Welfare Department (MSWD)	LGU Makati City	✔	
Judith B. Celos	Barangay Captain	Barangay West Rembo	LGU Makati City	✔	
Jeline M. Olfato	Barangay Captain	Barangay Pembo	LGU Makati City	✔	✔
Arnold J. Cruz	Barangay Captain	Barangay Rizal	LGU Makati City	✔	
Tomas B. Lopez, Jr.	President	University of Makati	LGU Makati City	✔	
Martin Millar		Villa Kalayaan Homeowners Association	Residents	x	
Distributed through the assistance of Barangay West Rembo					
Alfredo Penaflorida		157 Teachers Compound, West Rembo, Makati City	Residents	✔	✔
Robin delos Santos		158 Teachers Compound, West Rembo, Makati City	Residents	✔	
Lucita Fojas		158 Teachers Compound, West Rembo, Makati City	Residents	✔	
Ericsson Fermil		#84 Blk 4 West Rembo, Makati City	Residents	✔	
Roberto B. Tabigne		108 Teachers Compound	Residents	✔	
Porferio Benig Sr.		108 Blk 4 West Rembo, Makati City	Residents	✔	✔
Federico P. Cueva		109 Blk 4 Ext. West Rembo, Makati City	Residents	✔	✔
Yangler Calimag		Zero Block Ext., West Rembo, Makati	Residents	✔	✔

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
		City			
Yolanda Reginaldo		110 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	✔
Juanito Rosario		111 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	
Sergio V. Magaro		112 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	✔
Felisa Singayan		113 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	✔
Rodolfo Madrid		114 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	✔
Renato Reyes		116 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	
Emma valenzuela		117 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	
Allson Alejandro		118 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	✔	✔
Maria Paz Yanga		156 Teachers Compound, West Rembo, Makati City	Residents		✔
Evelyn C Amurten		160 Teachers Compound, West Rembo, Makati City	Residents		✔
Taguig City					
Lani Cayetano	Mayor	City of Taguig	LGU Taguig	✔	✔
Emiluisa C. Perano	Officer-In-Charge	Mayor 's Office	LGU Taguig	✔	
Agapito M. Cruz	OIC	UPAO - Taguig	LGU Taguig	✔	✔
Allan E. Oliman	Barangay Captain	Barangay Fort Bonifacio	LGU Taguig	✔	✔
Nicky Supan	Barangay Captain	Barangay Western Bicutan	LGU Taguig	✔	✔
Marilyn F. Marcelino	Barangay Captain	Barangay Ususan	LGU Taguig	✔	✔
Ma. Victoria M. Balidoy	Barangay Captain	Barangay Pinagsama	LGU Taguig	✔	✔

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Junn Magno	Officer in Charge	Philippine National Railways	Government	✔	
Rodney Jay E. Asinas	Urban & Transport Planner	Ayala Land, Inc.	Business	✔	✔
Edwin Villanueva	Property Manager	Market Market	Business - DIA	✔	✔
Jaime Francisco Galvez	General Manager	Bonifacio Estate Service Corp.	Business	✔	✔
Manuel Blas	Head, Commercial Operations	Fort Bonifacio Development Corporation	Business	✔	✔
Hon. Vivencio Dizon	President and CEO	Bases Conversion and Development Authority	Government	✔	
Parañaque City					
Edwin Olivarez	City Mayor	City of Paranaque	LGU Paranaque	✔	✔
Fernando Soriano	City Administrator	City Administration Dept.	LGU Paranaque	✔	
Concepcion N. Vergoza	Engineering	Paranaque City Engineering Dept.	LGU Paranaque	✔	
Bernie Amurao	Head	City Environment and Natural Resources Office (CENRO)	LGU Paranaque	✔	✔
Francisco V. Agamata	Engr. IV	Paranaque City Engineering Department	LGU Paranaque	✔	
Imelda Villaruel	Officer-in-charge	City Social Welfare and Development Office	LGU Paranaque	✔	
Antonio L. Lucenas		City Planning and Development Coordinator's Office	LGU Paranaque	✔	✔
Alicia Benzon	Barangay Captain	Brgy. Merville	LGU Paranaque	✔	
Michael Thor C. Singson	Barangay Captain	Brgy. San Martin de Porres	LGU Paranaque	✔	✔
Johnny Chung	Asst. Department Head	La Suerte	Business - DIA	✔	
Mavic Oduja	Administrative Head	Raya Garden Condominium	Business - DIA	✔	✔
Lowell Frederick A. Madrileno	Counsel	Pusco Investment Corporation		✔	
Riofel Nery			Business - DIA	x	
Carmelita M. Ramos	Manager	Ang Bigas Inc.	Business - DIA	✔	

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Nelson C. Alastoy	Pastor	United Hills Village/Church of the Nazarene	Institutional - DIA	✔	✔
Zenaida L. Angeles	Representative	United Hills Village	Residents	✔	
Ben Dominic R. Yap	Legal Counsel	Green Cross Inc.	Business - DIA	✔	✔
Joel Laurente	President	United Hills Association	Residents - DIA	✔	
Valenzuela City					
Rex Gatchalian	Mayor	City of Valenzuela	Government	✔	✔
Alan Roullo Yap	City Administrator	City Administration Office	Government	✔	
Josefina Acurantes	Head	City Planning and Development Office	Government	✔	✔
Elenita Reyes	Head	Housing and Resettlement Office	Government	✔	
Rommel l. Pondevida	Head	Environment and Natural Resources Office	Government	✔	✔
Fortune Angeles	Project Evaluation Officer	Valenzuela City	Government	✔	
Eduardo Nazar	Barangay Captain	Barangay Ugong	Government	✔	✔
Ricardo Yu	President	Valenzuela Chamber of Commerce and Industry	Business Organization	✔	✔
Jimmy C. Chua	President	Hyundai Forklift PowerlifterPhils.	Business	✔	✔
Edwin Francisco	Resort Manager	Rolling Hills Resort	Business	✔	✔
		Barangay Ugong	Business/ Lot owners/ Residents	(~250)	(175 residents, 5 commercial/ industrial)

APPENDIX B

Documentation of the Stakeholders Meetings

Appendix B.1: Documentation of the IEC Meetings

Appendix B.2: Documentation of the Stakeholders Consultation Meetings and Public Scoping

Appendix B.3: Documentation of RAP Public Scoping Meetings

Appendix B.4: Documentation of the Public Hearing

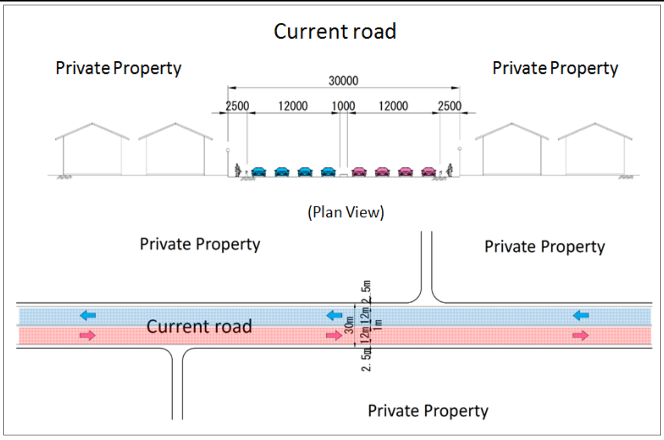
APPENDIX C

Maps of the MMSP Alignment

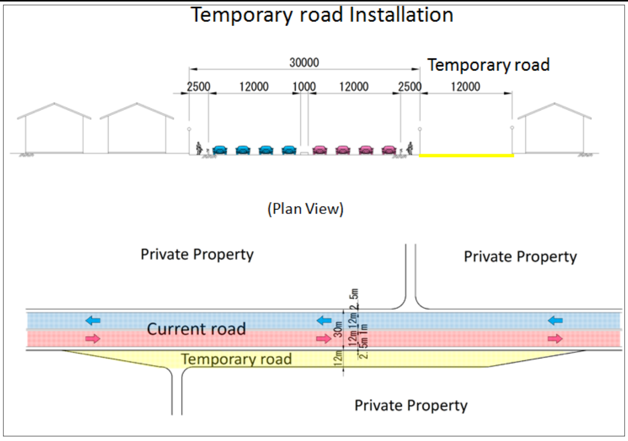
APPENDIX D

Proposed Excavation Method

PROPOSED EXCAVATION METHOD TO ENSURE TRAFFIC FLOW DURING CONSTRUCTION



Step 1



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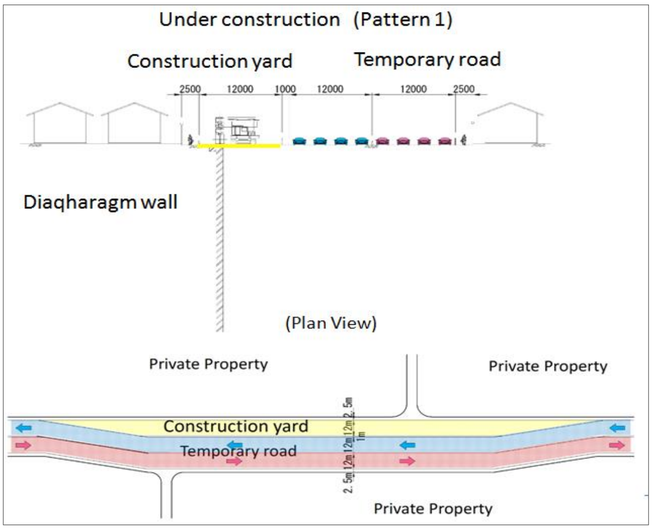

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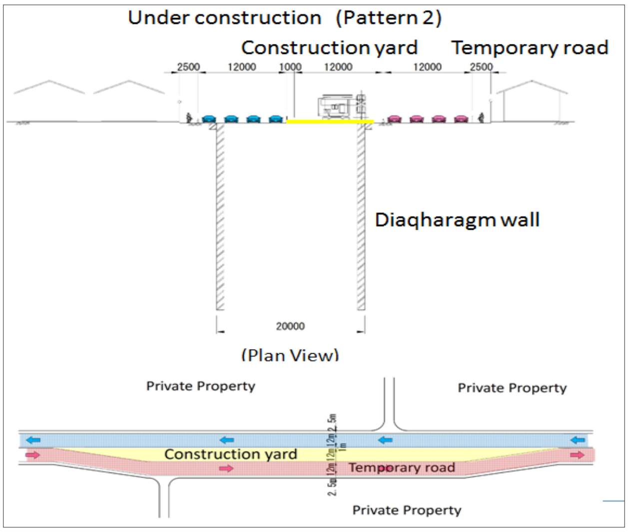

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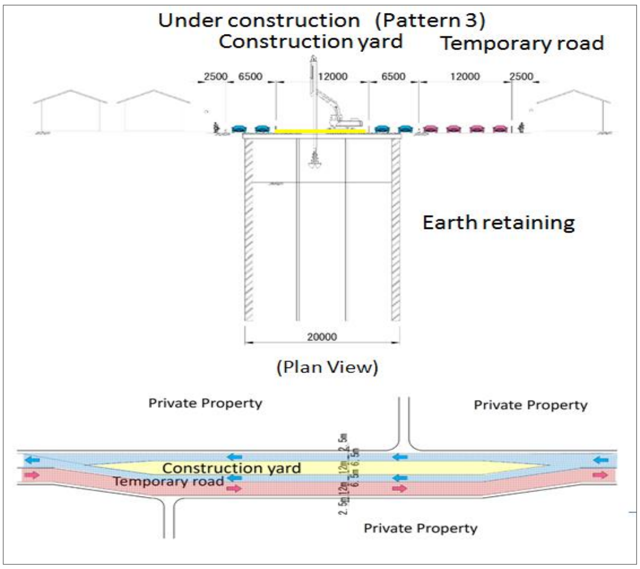
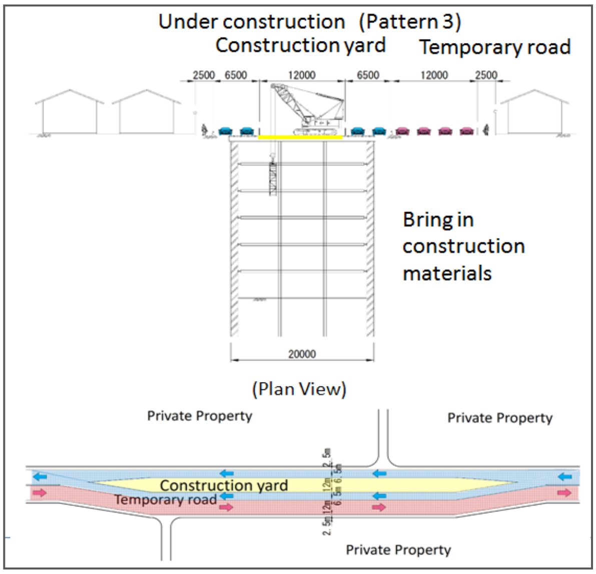


Step 5



Step 6

APPENDIX E

Result of Flora Survey

Appendix E-1.

Census data for trees and other arborescent taxa falling within the proposed stations of the Metro Manila Subway Project

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pterocarpus indicus	31.2	9		Kalayaan
Pterocarpus indicus	34.6	10		Kalayaan
Pterocarpus indicus	23.2	10		Kalayaan
Pterocarpus indicus	28.3	10		Kalayaan
Pterocarpus indicus	18.7	9		Kalayaan
Pterocarpus indicus	25.5	8		Kalayaan
Pterocarpus indicus	17.1	9		Kalayaan
Pterocarpus indicus	26.9	10		Kalayaan
Pterocarpus indicus	23.7	11		Kalayaan
Pterocarpus indicus	23.5	11		Kalayaan
Pterocarpus indicus	11.7	6	Fork	Kalayaan
Pterocarpus indicus	10.2	6	Fork	Kalayaan
Pterocarpus indicus	18.9	7		Kalayaan
Michelia champaca	11.0	6		Kalayaan
Michelia champaca	11.5	7		Kalayaan
Michelia champaca	8.3	3		Kalayaan
Michelia champaca	8.4	6		Kalayaan
Michelia champaca	8.9	6		Kalayaan
Michelia champaca	8.6	7		Kalayaan
Michelia champaca	7.3	7		Kalayaan
Michelia champaca	10.7	5		Kalayaan
Michelia champaca	8.4	6		Kalayaan
Michelia champaca	10.5	3		Kalayaan
Michelia champaca	10.2	4		Kalayaan
Pterocarpus indicus	14.6	9		Kalayaan
Pterocarpus indicus	20.1	10		Kalayaan
Pterocarpus indicus	19.8	10		Kalayaan
Pterocarpus indicus	20.4	9		Kalayaan
Pterocarpus indicus	17.7	9		Kalayaan
Pterocarpus indicus	18.2	9		Kalayaan
Pterocarpus indicus	25.9	8		Kalayaan
Pterocarpus indicus	17.8	10		Kalayaan
Pterocarpus indicus	17.4	8		Kalayaan
Pterocarpus indicus	16.0	9		Kalayaan
Pterocarpus indicus	22.1	10		Kalayaan
Pterocarpus indicus	17.1	6		Kalayaan
Pterocarpus indicus	13.5	6		Kalayaan
Pterocarpus indicus	24.8	12		Kalayaan
Pterocarpus indicus	23.9	10		Kalayaan

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pterocarpus indicus	20.0	10		Kalayaan
Pterocarpus indicus	25.0	12		Kalayaan
Pterocarpus indicus	16.9	9		Kalayaan
Pterocarpus indicus	13.6	5		Kalayaan
Pterocarpus indicus	18.5	10		Kalayaan
Roystonea regia	30.6	5		Kalayaan
Acacia auriculiformis	18.2	7		Kalayaan
Roystonea regia	26.6	5		Kalayaan
Roystonea regia	22.9	5		Kalayaan
Wodyetia bifurcata	23.6	7		Kalayaan
Wodyetia bifurcata	25.0	7		Kalayaan
Wodyetia bifurcata	22.3	7		Kalayaan
Wodyetia bifurcata	20.1	7		Kalayaan
Roystonea regia	21.2	4		Kalayaan
Chrysophyllum cainito	42	13		Anonas
Pachira aquatica	10	8		Anonas
Mangifera indica	36	10		Anonas
Moringa oleifera	10	5		Anonas
Averrhoa bilimbi	10	8		Anonas
Persea americana	13	7		Anonas
Gmelina arborea	44.6	21		East Ave.
Gmelina arborea	45.2	20		East Ave.
Cocos nucifera	33.9	16		East Ave.
Swietenia macrophylla	14.8	12		East Ave.
Cocos nucifera	29.6	16		East Ave.
Gmelina arborea	45.7	22		East Ave.
Cocos nucifera	33.8	24		East Ave.
Cocos nucifera	32.3	12		East Ave.
Toona calantas	14.8	12		East Ave.
Gmelina arborea	25	10		East Ave.
Gmelina arborea	15	9		East Ave.
Cocos nucifera	34.1	17		East Ave.
Millettia pinnata	19.1	10		East Ave.
Cocos nucifera	28.0	13		East Ave.
Eucalyptus tereticornis	8.9	6		East Ave.
Swietenia macrophylla	15.3	12		East Ave.
Swietenia macrophylla	15.4	12		East Ave.
Swietenia macrophylla	6.0	7		East Ave.
Swietenia macrophylla	11.5	11		East Ave.
Swietenia macrophylla	14.3	10		East Ave.
Swietenia macrophylla	15.4	12		East Ave.
Swietenia macrophylla	11.6	8		East Ave.
Swietenia macrophylla	11.1	9		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Swietenia macrophylla	16.2	11		East Ave.
Cocos nucifera	34.3	20		East Ave.
Swietenia macrophylla	14.8	10		East Ave.
Diospyros sp.	70.1	17		East Ave.
Cocos nucifera	32.5	19		East Ave.
Citrus "dalandan"	7.3	5		East Ave.
Citrus "dalandan"	5.3	5		East Ave.
Cocos nucifera	29.9	17		East Ave.
Pterocarpus indicus	64.8	15		East Ave.
Cocos nucifera	34.2	18		East Ave.
Cocos nucifera	29.5	21		East Ave.
Cocos nucifera	25.8	16		East Ave.
Pterocarpus indicus	72.3	16		East Ave.
Pterocarpus indicus	83.4	17		East Ave.
Swietenia macrophylla	5.2	5		East Ave.
Albizia saman	76.4	29		East Ave.
Swietenia macrophylla	9.9	9		East Ave.
Eucalyptus tereticornis	9.9	13		East Ave.
Swietenia macrophylla	11.1	10		East Ave.
Millettia pinnata	9.4	9		East Ave.
Swietenia macrophylla	11.7	6		East Ave.
Cocos nucifera	24.2	7		East Ave.
Swietenia macrophylla	8.3	8		East Ave.
Swietenia macrophylla	16.6	10		East Ave.
Swietenia macrophylla	15.5	9		East Ave.
Swietenia macrophylla	18.7	10		East Ave.
Eucalyptus tereticornis	21.5	11		East Ave.
Swietenia macrophylla	15.9	10		East Ave.
Eucalyptus tereticornis	19.3	12		East Ave.
Gmelina arborea	20.7	8		East Ave.
Swietenia macrophylla	6.1	6		East Ave.
Cocos nucifera	35.4	16		East Ave.
Gmelina arborea	33.8	13		East Ave.
Pterocarpus indicus	63.7	14		East Ave.
Cocos nucifera	37.7	17		East Ave.
Pterocarpus indicus	39.5	13		East Ave.
Cocos nucifera	39.8	22		East Ave.
Pterocarpus indicus	54.1	14		East Ave.
Cocos nucifera	34.6	16		East Ave.
Mangifera indica	40	8		East Ave.
Polyalthia longifolia	10.0	7		East Ave.
Pterocarpus indicus	80.6	12		East Ave.
Polyalthia longifolia	36.5	12		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Cocos nucifera	26.8	10		East Ave.
Mangifera indica	74.5	10		East Ave.
Ficus religiosa	12.1	6		East Ave.
Eucalyptus tereticornis	59.9	12		East Ave.
Dipterocarpus blancoi	44.4	12		East Ave.
Swietenia macrophylla	12.9	7		East Ave.
Swietenia macrophylla	12.9	7		East Ave.
Spathodea campanulata	60	13		East Ave.
Swietenia macrophylla	30.3	10		East Ave.
Gmelina arborea	35.8	10		East Ave.
Swietenia macrophylla	59.6	13		East Ave.
Swietenia macrophylla	44.1	13		East Ave.
Cocos nucifera	34.9	10		East Ave.
Gmelina arborea	36.0	9		East Ave.
Swietenia macrophylla	20.4	6		East Ave.
Cocos nucifera	29.5	10		East Ave.
Ficus religiosa	43.9	7		East Ave.
Swietenia macrophylla	15.4	6		East Ave.
Cocos nucifera	38.9	16		East Ave.
Pterocarpus indicus	27.5	13		East Ave.
Cocos nucifera	35.4	16		East Ave.
Gmelina arborea	45.2	9		East Ave.
Cocos nucifera	25.0	12		East Ave.
Swietenia macrophylla	61.1	15		East Ave.
Pterocarpus indicus	22.3	10		East Ave.
Swietenia macrophylla	21.6	11		East Ave.
Gmelina arborea	19.1	15		East Ave.
Cocos nucifera	36.1	15		East Ave.
Pterocarpus indicus	17.5	10		East Ave.
Pterocarpus indicus	29.9	10		East Ave.
Calophyllum inophyllum	31.2	7		Bonifacio Global City
Calophyllum inophyllum	25.3	8		Bonifacio Global City
Calophyllum inophyllum	26.4	8		Bonifacio Global City
Calophyllum inophyllum	18.9	7		Bonifacio Global City
Calophyllum inophyllum	31.7	8		Bonifacio Global City
Calophyllum inophyllum	33.8	9		Bonifacio Global City
Calophyllum inophyllum	29.9	9		Bonifacio Global City
Calophyllum inophyllum	29.3	9		Bonifacio Global City
Calophyllum inophyllum	31.1	11		Bonifacio Global City
Calophyllum inophyllum	28.7	10		Bonifacio Global City
Calophyllum inophyllum	35.7	9		Bonifacio Global City
Calophyllum inophyllum	25.9	9		Bonifacio Global City
Calophyllum inophyllum	27.2	10		Bonifacio Global City

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Calophyllum inophyllum	24.0	9		Bonifacio Global City
Calophyllum inophyllum	23.9	7		Bonifacio Global City
Calophyllum inophyllum	21.6	7		Bonifacio Global City
Calophyllum inophyllum	30.8	8		Bonifacio Global City
Calophyllum inophyllum	29.3	8		Bonifacio Global City
Calophyllum inophyllum	23.0	9		Bonifacio Global City
Calophyllum inophyllum	37.2	8		Bonifacio Global City
Calophyllum inophyllum	29.0	10		Bonifacio Global City
Calophyllum inophyllum	28.7	9		Bonifacio Global City
Cocos nucifera	29.6	9		Tandang Sora
Cocos nucifera	28.6	9		Tandang Sora
Psidium guajava	5.9	4		Tandang Sora
Cocos nucifera	25.5	8		Tandang Sora
Mangifera indica	41.7	8		Tandang Sora
Cocos nucifera	28.2	8		Tandang Sora
Cocos nucifera	27.3	7		Tandang Sora
Cocos nucifera	27.4	9		Tandang Sora
Mangifera indica	36.9	8		Tandang Sora
Cocos nucifera	31.4	7		Tandang Sora
Mangifera indica	40.6	6		Tandang Sora
Mangifera indica	44.3	7		Tandang Sora
Dimocarpus longan	26.1	6		Tandang Sora
Dimocarpus longan	22.1	7		Tandang Sora
Dimocarpus longan	22.6	9		Tandang Sora
Dimocarpus longan	24.8	9		Tandang Sora
Pterocarpus indicus	46.2	10		East Ave.
Sandoricum koetjape	44.9	19		East Ave.
Vitex parviflora	43.1	18		East Ave.
Vitex parviflora	41.1	18		East Ave.
Vitex parviflora	24.8	18		East Ave.
Delonix regia	71.3	22		East Ave.
Pterocarpus indicus	24.3	19		East Ave.
Pterocarpus indicus	36.5	14		East Ave.
Moringa oleifera	10	6		East Ave.
Cocos nucifera	26.8	10		East Ave.
Sandoricum koetjape	32.0	14		East Ave.
Sandoricum koetjape	19.1	13		East Ave.
Mangifera indica	41.5	13		East Ave.
Mangifera indica	30.6	12		East Ave.
Mangifera indica	37.6	15		East Ave.
Cocos nucifera	35.2	12		East Ave.
Plumeria acuminata	64.0	12		East Ave.
Chrysophyllum cainito	73.6	14		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Mangifera indica	40.1	13		East Ave.
Mangifera indica	40.1	14		East Ave.
Pouteria campechiana	11.1	5		East Ave.
Adenanthera pavonina	41.9	7		Ortigas South
Ficus religiosa	25.5	9		Ortigas South
Polyalthia longifolia	11.5	5		Ortigas South
Cocos nucifera	25	7		Ortigas South
Ficus religiosa	2.5	2.5		Ortigas South
Pterocarpus indicus	27.4	9		Ortigas South
Mangifera indica	14.3	12		Ortigas South
Mangifera indica	15.9	12		Ortigas South
Mangifera indica	19.1	12		Ortigas South
Syzygium cumini	11.1	8		Ortigas South
Pterocarpus indicus	26.1	9		Ortigas South
Polyalthia longifolia	13.8	5		Ortigas South
Pterocarpus indicus	21.0	7		Ortigas South
Pterocarpus indicus	43.8	9		Ortigas South
Polyalthia longifolia	7.4	5		Ortigas South
Polyalthia longifolia	6.9	5		Ortigas South
Polyalthia longifolia	11.5	5		Ortigas South
Ficus religiosa	2.5	2		Ortigas South
Pterocarpus indicus	86.6	16		Ortigas South
Sandoricum koetjape	26.1	6		Ortigas South
Pterocarpus indicus	29.7	9		Ortigas South
Adonidia merrillii	16.2	5		Ortigas South
Cassia fistula	22.0	5		Ortigas South
Ceiba pentandra	32.5	5		Ortigas South
Moringa oleifera	10	4		Ortigas South
Cocos nucifera	8.6	8		Ortigas South
Pterocarpus indicus	35.0	8		Ortigas South
Trema orientalis	40	10		Ortigas South
Adonidia merrillii	11.2	5		Ortigas South
Adonidia merrillii	10.7	5		Ortigas South
Adonidia merrillii	9.1	4		Ortigas South
Adonidia merrillii	9.0	5		Ortigas South
Adonidia merrillii	12.1	5		Ortigas South
Adonidia merrillii	10.8	5		Ortigas South
Adonidia merrillii	10.8	5		Ortigas South
Adonidia merrillii	14.7	6		Ortigas South
Adonidia merrillii	10.7	6		Ortigas South
Adonidia merrillii	11.6	5		Ortigas South
Adonidia merrillii	11.0	6		Ortigas South
Adonidia merrillii	11.7	5		Ortigas South

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Adonidia merrillii	8.3	4		Ortigas South
Pterocarpus indicus	36.7	10		Ortigas South
Swietenia macrophylla	14.7	16		Ortigas South
Swietenia macrophylla	14.1	6		Ortigas South
Pterocarpus indicus	37.6	10		Ortigas South
Swietenia macrophylla	13.6	6		Ortigas South
Swietenia macrophylla	38.1	11		FTI
Vitex parviflora	9.7	6		FTI
Vitex parviflora	6.5	7		FTI
Swietenia macrophylla	28.7	12		FTI
Swietenia macrophylla	40.5	12		FTI
Vitex parviflora	8.8	6		FTI
Vitex parviflora	5.3	5		FTI
Vitex parviflora	11.1	7		FTI
Swietenia macrophylla	6.6	6		FTI
Jatropha gossypifolia	7.3	3		FTI
Jatropha gossypifolia	7.3	3		FTI
Swietenia macrophylla	37.1	11		FTI
Vitex parviflora	4.7	3		FTI
Pterocarpus indicus	43.9	19	Fork	FTI
Pterocarpus indicus	66.2	19	Fork	FTI
Swietenia macrophylla	26.6	14		FTI
Jatropha integerrima	6.7	2	Fork	FTI
Jatropha integerrima	4.5	2	Fork	FTI
Swietenia macrophylla	25.5	12		FTI
Swietenia macrophylla	31.1	12		FTI
Swietenia macrophylla	29.5	11		FTI
Swietenia macrophylla	43.6	13		FTI
Swietenia macrophylla	30.3	13		FTI
Syzygium cumini	30.0	7		FTI
Syzygium cumini	27.9	7		FTI
Swietenia macrophylla	42.4	13		FTI
Pterocarpus indicus	24.3	9		FTI
Pterocarpus indicus	38.3	11		FTI
Swietenia macrophylla	38.9	15		FTI
Jatropha integerrima	10.4	5.5		FTI
Vitex parviflora	3.7	4		FTI
Swietenia macrophylla	37.4	12		FTI
Swietenia macrophylla	26.1	10		FTI
Alstonia macrophylla	5.6	5		FTI
Vitex parviflora	10.6	8		FTI
Vitex parviflora	8.0	6		FTI
Pithecellobium dulce	17.8	6		FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pithecellobium dulce	31.2	8		FTI
Pterocarpus indicus	27.5	12		FTI
Pterocarpus indicus	22.8	10		FTI
Pterocarpus indicus	60.2	11		FTI
Pithecellobium dulce	18.7	7		FTI
Syzygium cumini	38.1	11		FTI
Syzygium cumini	43.5	7		FTI
Syzygium cumini	28.5	5		FTI
Vitex parviflora	9.2	5		FTI
Vitex parviflora	7.7	5		FTI
Pterocarpus indicus	10.9	4		FTI
Terminalia catappa	4.8	3		FTI
Pterocarpus indicus	38.2	9		FTI
Plumeria acuminata	14.6	6	Fork	FTI
Plumeria acuminata	19.7	6	Fork	FTI
Pterocarpus indicus	13.9	8		FTI
Pterocarpus indicus	46.9	17		FTI
Pterocarpus indicus	10.4	5		FTI
Pterocarpus indicus	32.8	15	Fork	FTI
Pterocarpus indicus	34.1	15	Fork	FTI
Terminalia catappa	5.8	4.5		FTI
Terminalia catappa	5.7	5		FTI
Syzygium cumini	32.8	11		FTI
Syzygium cumini	32.9	12		FTI
Pterocarpus indicus	33.1	13	Fork	FTI
Pterocarpus indicus	17.7	13	Fork	FTI
Pterocarpus indicus	24.2	13	Fork	FTI
Syzygium cumini	25.3	10		FTI
Mangifera indica	6.1	4		FTI
Pterocarpus indicus	42.4	14		FTI
Mangifera indica	14.4	8		FTI
Pterocarpus indicus	27.5	10	Fork	FTI
Pterocarpus indicus	36.1	10	Fork	FTI
Pterocarpus indicus	38.2	14		FTI
Pterocarpus indicus	26.7	12		FTI
Pterocarpus indicus	37.8	14		FTI
Pterocarpus indicus	33.6	11	Fork	FTI
Pterocarpus indicus	44.3	11	Fork	FTI
Mangifera indica	6.1	4		FTI
Artocarpus heterophyllus	7.5	3		FTI
Artocarpus heterophyllus	9.1	3		FTI
Pterocarpus indicus	33.1	6		FTI
Pterocarpus indicus	31.8	6		FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pterocarpus indicus	4.6	4.5		FTI
Pterocarpus indicus	43.9	12		FTI
Pterocarpus indicus	30.3	15		FTI
Pterocarpus indicus	26.1	13		FTI
Pterocarpus indicus	37.6	15		FTI
Polyalthia longifolia	26.0	12		FTI
Polyalthia longifolia	21.7	10		FTI
Morinda citrifolia	11.6	8	Fork	FTI
Morinda citrifolia	9.9	8	Fork	FTI
Polyalthia longifolia	22.5	7	Fork	FTI
Polyalthia longifolia	31.2	7	Fork	FTI
Pterocarpus indicus	19.9	12		FTI
Adonidia merrillii	10.8	6		FTI
Adonidia merrillii	15.9	6		FTI
Swietenia macrophylla	32.6	8		FTI
Adonidia merrillii	15.8	4		FTI
Adonidia merrillii	14.1	4		FTI
Adonidia merrillii	14.0	4.5		FTI
Mangifera indica	35.4	7	Fork	FTI
Mangifera indica	31.0	7	Fork	FTI
Swietenia macrophylla	7.0	6		FTI
Adonidia merrillii	13.7	4.5		FTI
Artocarpus heterophyllus	10.8	4		FTI
Leucaena leucocephala	12.7	8		FTI
Adonidia merrillii	14.3	3.5		FTI
Swietenia macrophylla	10.1	4		FTI
Pterocarpus indicus	14.3	6		FTI
Pterocarpus indicus	42.8	12		FTI
Pterocarpus indicus	26.8	12		FTI
Mangifera indica	10.4	5		FTI
Adonidia merrillii	14.5	4.5		FTI
Adonidia merrillii	14.3	4.5		FTI
Roystonea regia	35.7	7		Ortigas North
Pterocarpus indicus	36.0	9		Ortigas North
Pterocarpus indicus	33.8	7		Ortigas North
Wodyetia bifurcata	24.8	4		Ortigas North
Muntingia calabura	4.8	5		Ortigas North
Muntingia calabura	4.8	5		Ortigas North
Wodyetia bifurcata	22.1	5		Ortigas North
Wodyetia bifurcata	25.6	5		Ortigas North
Wodyetia bifurcata	22.9	4		Ortigas North
Wodyetia bifurcata	22.5	4		Ortigas North
Wodyetia bifurcata	21.7	5		Ortigas North

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Wodyetia bifurcata	22.3	5		Ortigas North
Calophyllum inophyllum	23.6	7		Bonifacio Global City
Calophyllum inophyllum	27.1	9		Bonifacio Global City
Calophyllum inophyllum	21.5	8		Bonifacio Global City
Calophyllum inophyllum	22.3	7		Bonifacio Global City
Calophyllum inophyllum	22.2	7		Bonifacio Global City
Calophyllum inophyllum	36.0	7		Bonifacio Global City
Calophyllum inophyllum	22.5	6	Fork	Bonifacio Global City
Calophyllum inophyllum	22.2	6	Fork	Bonifacio Global City
Calophyllum inophyllum	22.7	5		Bonifacio Global City
Calophyllum inophyllum	22.1	6		Bonifacio Global City
Calophyllum inophyllum	27.9	9		Bonifacio Global City
Pterocarpus indicus	23.6	8	Fork	FTI
Pterocarpus indicus	21.3	8	Fork	FTI
Vitex parviflora	15.8	10		FTI
Pterocarpus indicus	28.5	12		FTI
Syzygium cumini	31.4	7	Fork	FTI
Syzygium cumini	27.8	7	Fork	FTI
Tabebuia pallida	14.2	6	Fork	FTI
Tabebuia pallida	13.6	6	Fork	FTI
Syzygium cumini	19.3	8	Fork	FTI
Syzygium cumini	36.7	8	Fork	FTI
Swietenia macrophylla	27.4	9		FTI
Swietenia macrophylla	25.2	12		FTI
Swietenia macrophylla	41.1	14		FTI
Swietenia macrophylla	6.5	6		FTI
Swietenia macrophylla	6.7	7		FTI
Swietenia macrophylla	7.0	7		FTI
Swietenia macrophylla	5.6	8		FTI
Swietenia macrophylla	24.5	12		FTI
Swietenia macrophylla	26.8	13		FTI
Swietenia macrophylla	31.4	9		FTI
Syzygium cumini	8.2	5		FTI
Swietenia macrophylla	52.5	14		FTI
Syzygium cumini	28.5	14	Fork	FTI
Syzygium cumini	43.3	16	Fork	FTI
Syzygium cumini	34.2	14		FTI
Syzygium cumini	32.9	14		FTI
Artocarpus heterophyllus	29.3	7		FTI
Artocarpus heterophyllus	27.7	7		FTI
Jatropha integerrima	13.2	4	Fork	FTI
Jatropha integerrima	7.3	4	Fork	FTI
Jatropha integerrima	8.6	4	Fork	FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Jatropha integerrima	10.7	4	Fork	FTI
Vitex parviflora	10.2	9		FTI
Vitex parviflora	9.6	10	Fork	FTI
Vitex parviflora	9.6	10	Fork	FTI
Vitex parviflora	10.8	9	Fork	FTI
Vitex parviflora	12.6	9	Fork	FTI
Vitex parviflora	5.5	7		FTI
Lagerstroemia speciosa	3.2	3		FTI
Swietenia macrophylla	36.7	8		FTI
Vitex parviflora	5.6	5	Fork	FTI
Vitex parviflora	6.0	5	Fork	FTI
Swietenia macrophylla	17.7	8		Ortigas South
Swietenia macrophylla	19.7	10		Ortigas South
Acacia auriculiformis	5.9	3.5		Ortigas South
Swietenia macrophylla	13.5	9		Ortigas South
Swietenia macrophylla	19.9	10		Ortigas South
Ficus septica	8.0	5	Fork	Ortigas South
Ficus septica	4.3	5	Fork	Ortigas South
Swietenia macrophylla	21.7	6		Ortigas South
Swietenia macrophylla	23.7	6		Ortigas South
Swietenia macrophylla	11.1	5		Ortigas South
Swietenia macrophylla	22.5	6		Ortigas South
Ficus sp.	6.4	4		Ortigas South
Swietenia macrophylla	9.1	5		Ortigas South
Plumeria acuminata	27.5	5		Ortigas South
Pterocarpus indicus	14	5	Fork	Ortigas South
Pterocarpus indicus	12	5	Fork	Ortigas South
Pterocarpus indicus	14	5	Fork	Ortigas South
Swietenia macrophylla	19.9	7		Ortigas South
Swietenia macrophylla	18.9	7		Ortigas South
Swietenia macrophylla	17.7	8		Ortigas South
Swietenia macrophylla	20.1	8		Ortigas South
Swietenia macrophylla	20.1	8		Ortigas South
Swietenia macrophylla	21.7	9		Ortigas South
Swietenia macrophylla	21.4	9		Ortigas South
Swietenia macrophylla	24.6	9		Ortigas South
Swietenia macrophylla	22.1	9		Ortigas South
Swietenia macrophylla	26.2	10		Ortigas South
Swietenia macrophylla	19.4	10		Ortigas South
Swietenia macrophylla	21.5	10		Ortigas South
Roystonea regia	43.5	14		Ortigas South
Roystonea regia	38.2	14		Ortigas South
Calophyllum inophyllum	22.6	5		Bonifacio Global City

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Calophyllum inophyllum	22.5	6		Bonifacio Global City
Calophyllum inophyllum	21.7	6		Bonifacio Global City
Calophyllum inophyllum	21.6	7		Bonifacio Global City
Calophyllum inophyllum	25.2	6.5		Bonifacio Global City
Calophyllum inophyllum	18.9	6		Bonifacio Global City
Calophyllum inophyllum	18.5	7		Bonifacio Global City
Calophyllum inophyllum	16.1	7		Bonifacio Global City
Calophyllum inophyllum	18.0	6		Bonifacio Global City
Calophyllum inophyllum	20.6	7		Bonifacio Global City
Calophyllum inophyllum	18.5	7		Bonifacio Global City
Calophyllum inophyllum	11.5	5		Bonifacio Global City
Calophyllum inophyllum	24.7	6		Bonifacio Global City
Calophyllum inophyllum	24.6	6.5		Bonifacio Global City
Calophyllum inophyllum	35.8	6		Bonifacio Global City
Calophyllum inophyllum	18.5	6		Bonifacio Global City
Calophyllum inophyllum	20.2	6		Bonifacio Global City
Calophyllum inophyllum	12.3	5		Bonifacio Global City
Calophyllum inophyllum	23.6	5		Bonifacio Global City
Calophyllum inophyllum	25.2	7		Bonifacio Global City
Calophyllum inophyllum	20.5	7		Bonifacio Global City
Calophyllum inophyllum	19.1	7		Bonifacio Global City
Calophyllum inophyllum	16.9	7		Bonifacio Global City
Calophyllum inophyllum	23.9	11		Bonifacio Global City
Calophyllum inophyllum	18.8	9		Bonifacio Global City
Calophyllum inophyllum	23.5	9		Bonifacio Global City
Calophyllum inophyllum	24.4	7		Bonifacio Global City
Calophyllum inophyllum	25.8	6		Bonifacio Global City
Calophyllum inophyllum	21.8	6		Bonifacio Global City
Calophyllum inophyllum	25.2	7		Bonifacio Global City
Calophyllum inophyllum	26.8	8		Bonifacio Global City
Calophyllum inophyllum	26.0	8		Bonifacio Global City
Calophyllum inophyllum	19.3	7		Bonifacio Global City
Calophyllum inophyllum	26.7	8		Bonifacio Global City
Calophyllum inophyllum	18.5	6		Bonifacio Global City
Calophyllum inophyllum	22.4	7		Bonifacio Global City
Calophyllum inophyllum	20.7	7		Bonifacio Global City
Calophyllum inophyllum	15.8	6		Bonifacio Global City
Calophyllum inophyllum	16.7	7		Bonifacio Global City
Calophyllum inophyllum	19.3	5		Bonifacio Global City
Calophyllum inophyllum	14.8	5		Bonifacio Global City
Calophyllum inophyllum	19.1	7		Bonifacio Global City
Calophyllum inophyllum	21.2	8		Bonifacio Global City
Mangifera indica	30	7		Ortigas North

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Roystonea regia	35.7	8		Ortigas North
Roystonea regia	36.0	8		Ortigas North
Eucalyptus tereticornis	15	7		Ortigas North
Eucalyptus tereticornis	14	7		Ortigas North
Acacia auriculiformis	15	7		Ortigas North
Lagerstroemia speciosa	13	2		Ortigas North
Acacia auriculiformis	3.8	5		Ortigas North
Leucaena leucocephala	12	6		Ortigas North
Lagerstroemia speciosa	13	2.5		Ortigas North
Roystonea regia	39.5	7		Ortigas North
Lagerstroemia speciosa	12	2.25		Ortigas North
Leucaena leucocephala	13	4		Ortigas North
Acacia auriculiformis	8	2.25		Ortigas North
Acacia auriculiformis	7	2		Ortigas North
Lagerstroemia speciosa	7	1.5		Ortigas North
Acacia auriculiformis	13	4.5		Ortigas North
Acacia auriculiformis	2.5	3		Ortigas North
Leucaena leucocephala	10	4.5		Ortigas North
Eucalyptus tereticornis	10	7		Ortigas North
Elaeis guineensis	25	4		Ortigas North
Acacia auriculiformis	10	4.5		Ortigas North
Acacia auriculiformis	6	2		Ortigas North
Roystonea regia	34.5	12		Ortigas North
Roystonea regia	32.9	9		Ortigas North
Roystonea regia	29.6	12		Ortigas North
Roystonea regia	39.5	9		Ortigas North
Roystonea regia	34.7	9		Ortigas North
Roystonea regia	35.0	9		Ortigas North
Roystonea regia	37.9	10		Ortigas North
Acacia auriculiformis	9.6	6		Ortigas North
Eucalyptus tereticornis	26.8	8		Ortigas North
Roystonea regia	37.6	10		Ortigas North
Roystonea regia	38.2	10		Ortigas North
Terminalia catappa	4.5	3		Ortigas North
Ficus septica	3.2	3		Ortigas North
Ficus septica	3.2	2.5		Ortigas North
Pithecellobium dulce	4.5	2	Fork	Ortigas North
Pithecellobium dulce	3.8	2	Fork	Ortigas North
Pithecellobium dulce	3.2	2	Fork	Ortigas North
Roystonea regia	37.6	8		Ortigas North
Adonidia merrillii	0.0	4		Ortigas North
Roystonea regia	38.2	8		Ortigas North
Swietenia macrophylla	58.6	16		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Cocos nucifera	25.5	13		East Ave.
Pterocarpus indicus	14.5	10		East Ave.
Pterocarpus indicus	44.3	14		East Ave.
Mangifera indica	41.5	15		East Ave.
Delonix regia	70.2	19		East Ave.
Cocos nucifera	33.9	21		East Ave.
Delonix regia	74.2	18		East Ave.
Cocos nucifera	37.6	22		East Ave.
Cocos nucifera	38.2	15		East Ave.
Mangifera indica	47.8	16		East Ave.
Cocos nucifera	42.0	20		East Ave.
Cocos nucifera	32.8	16		East Ave.
Delonix regia	69.7	18		East Ave.
Albizia saman	64.0	18		East Ave.
Sandoricum koetjape	47.3	11		East Ave.
Cocos nucifera	36.9	12		East Ave.
Swietenia macrophylla	17.4	12		East Ave.
Cocos nucifera	39.0	14		East Ave.
Toona calantas	75.2	15		East Ave.
Albizia saman	68.8	25		East Ave.
Delonix regia	73.6	26		East Ave.
Cocos nucifera	32.5	16		East Ave.
Cocos nucifera	38.5	15		East Ave.
Swietenia macrophylla	77.7	20		East Ave.
Swietenia macrophylla	55.6	18		East Ave.
Swietenia macrophylla	18.8	14		East Ave.
Mangifera indica	31.9	12		East Ave.
Swietenia macrophylla	52.2	18		East Ave.
Swietenia macrophylla	17.2	12		East Ave.
Swietenia macrophylla	16.6	12		East Ave.
Swietenia macrophylla	52.9	12		East Ave.
Swietenia macrophylla	59.1	19		East Ave.
Pterocarpus indicus	31.5	12		Kalayaan
Pterocarpus indicus	23.9	8		Kalayaan
Pterocarpus indicus	22.3	9		Kalayaan
Pterocarpus indicus	21.8	7		Kalayaan
Pterocarpus indicus	38.4	15		Kalayaan
Pterocarpus indicus	18.1	8		Kalayaan
Pterocarpus indicus	17.9	9		Kalayaan
Pterocarpus indicus	10.9	6		Kalayaan
Pterocarpus indicus	12.2	5		Kalayaan
Pterocarpus indicus	16.1	5		Kalayaan
Pterocarpus indicus	9.8	5		Kalayaan

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Calophyllum inophyllum	36.6	13		Bonifacio Global City
Calophyllum inophyllum	27.5	9		Bonifacio Global City
Calophyllum inophyllum	19.4	7		Bonifacio Global City
Calophyllum inophyllum	19.3	5		Bonifacio Global City
Calophyllum inophyllum	26.0	8		Bonifacio Global City
Calophyllum inophyllum	28.7	7		Bonifacio Global City
Calophyllum inophyllum	32.9	9		Bonifacio Global City
Moringa oleifera	14	4		FTI
Moringa oleifera	12	5		FTI
Pouteria campechiana	25	8		FTI
Pouteria campechiana	40	14		FTI
Wodyetia bifurcata	10.4	4		FTI
Wodyetia bifurcata	13.1	5		FTI
Vitex parviflora	72.0	8		FTI
Swietenia macrophylla	29.8	10		FTI
Pterocarpus indicus	27.9	8		FTI
Adonidia merrillii	20	7		FTI
Adonidia merrillii	3.8	5		FTI
Pterocarpus indicus	101.0	12		FTI
Adonidia merrillii	14.2	5		FTI
Swietenia macrophylla	35.5	13		FTI
Swietenia macrophylla	33.0	13		FTI
Pterocarpus indicus	35.8	13		FTI
Swietenia macrophylla	36.5	14		FTI
Pterocarpus indicus	46.2	11		FTI
Swietenia macrophylla	10.8	6		FTI
Annona squamosa	15	4		FTI
Chrysophyllum cainito	45	10		FTI
Mangifera indica	60	10		FTI
Adonidia merrillii	46	4.5		FTI
Mangifera indica	40	7		FTI
Moringa oleifera	15	7		FTI
Pterocarpus indicus	102.2	14		FTI
Pterocarpus indicus	105.1	14		FTI
Pterocarpus indicus	41.9	12		FTI
Ficus concinna	45	10		FTI
Adonidia merrillii	102.9	4		FTI
Wodyetia bifurcata	15	4		FTI
Wodyetia bifurcata	16	4		FTI
Wodyetia bifurcata	19	4		FTI
Cocos nucifera	34	4		FTI
Moringa oleifera	15	4		FTI
Pterocarpus indicus	42	9		FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Adonidia merrillii	15	7		FTI
Plumeria acuminata	14.3	7		Katipunan
Phoenix roebelenii	15	3		Katipunan
Psidium guajava	3.2	4		Katipunan
Adonidia merrillii	15	6		Katipunan
Wodyetia bifurcata	36	7		Katipunan
Wodyetia bifurcata	40	7		Katipunan
Tamarindus indica	37.3	12		Katipunan
Syzygium samarangense	10.8	8		Katipunan
Cocos nucifera	34	6		Katipunan
Mangifera indica	45	8		Katipunan
Mangifera indica	43	8		Katipunan
Pisonia alba	48	7		Katipunan
Dracaena fragrans	12	4		Katipunan
Dracaena fragrans	11	4		Katipunan
Dracaena fragrans	10	4		Katipunan
Polyalthia longifolia	15	10		Katipunan
Polyalthia longifolia	18	10		Katipunan
Polyalthia longifolia	19	10		Katipunan
Gmelina arborea	4.8	4		Katipunan
Adonidia merrillii	14.7	4		Katipunan
Adonidia merrillii	15.4	4		Katipunan
Adonidia merrillii	12.5	4		Katipunan
Adonidia merrillii	9.3	4		Katipunan
Nephelium lappaceum	2.5	3		Katipunan
Thevetia peruviana	3.2	4		Katipunan
Chrysophyllum cainito	15	5		Katipunan
Adonidia merrillii	13.4	4		Katipunan
Adonidia merrillii	14.5	4		Katipunan
Adonidia merrillii	14.3	4		Katipunan
Adonidia merrillii	15.8	5		Katipunan
Adonidia merrillii	15	9		Katipunan
Ravenala madagascariensis	19.6	5		Quezon Ave.
Ravenala madagascariensis	23.7	7		Quezon Ave.
Ravenala madagascariensis	20.9	5		Quezon Ave.
Ravenala madagascariensis	22.4	5		Quezon Ave.
Ravenala madagascariensis	23.0	6		Quezon Ave.
Ravenala madagascariensis	20.7	5		Quezon Ave.
Ravenala madagascariensis	22.6	7		Quezon Ave.
Ravenala madagascariensis	27.0	8		Quezon Ave.
Ravenala madagascariensis	25.5	8		Quezon Ave.
Ravenala madagascariensis	25.8	6		Quezon Ave.
Ravenala madagascariensis	26.1	7		Quezon Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Ficus septica	4.8	4		Quezon Ave.
Pterocarpus indicus	25.8	8		Quezon Ave.
Pterocarpus indicus	13.4	6		Quezon Ave.
Pterocarpus indicus	12.1	5		Quezon Ave.
Mangifera indica	45	6		Quezon Ave.
Trema orientalis	15	7		Quezon Ave.
Ceiba pentandra	2.5	3		Quezon Ave.
Swietenia macrophylla	9.1	7		Quezon Ave.
Swietenia macrophylla	10.4	7		Quezon Ave.
Murraya paniculata	3.7	2		Quezon Ave.
Murraya paniculata	10.4	7		Quezon Ave.
Murraya paniculata	2.5	2		Quezon Ave.
Murraya paniculata	2.9	2		Quezon Ave.
Murraya paniculata	3.2	2		Quezon Ave.
Artocarpus heterophyllus	16.1	5		Quezon Ave.
Ficus benjamina	10.4	6		Quezon Ave.
Ficus benjamina	9.7	5		Quezon Ave.
Ficus benjamina	9.9	5		Quezon Ave.
Senna spectabilis	4.1	5		Quezon Ave.
Moringa oleifera	13.4	4		Quezon Ave.
Pterocarpus indicus	11.1	5		Quezon Ave.
syzygium cumini	51.0	6		North Ave.
Artocarpus heterophyllus	33.9	7		North Ave.
Tabernaemontana pandacaqui	9.3	5		North Ave.
Tabernaemontana pandacaqui	7.4	5		North Ave.
Ficus septica	10.5	5		North Ave.
Ficus septica	19.6	5		North Ave.
Caesalpinia pulcherrima	14	5		North Ave.
Sandoricum koetjape	21.2	7		North Ave.
Sandoricum koetjape	23.4	7		North Ave.
Leucaena leucocephala	15	5		North Ave.
Leucaena leucocephala	30	5		North Ave.
Ceiba pentandra	43.2	5		North Ave.
Cassia fistula	5	5		North Ave.
Mangifera indica	4.8	3		North Ave.
Mangifera indica	12	3		North Ave.
Pterocarpus indicus	80	8		North Ave.
Sandoricum koetjape	14	3.5		North Ave.
Cocos nucifera	31	8		North Ave.
Acacia mangium	30	6		North Ave.
Cocos nucifera	34	7		North Ave.
Muntingia calabura	10.4	4		Mindanao Ave.
Muntingia calabura	11.3	4		Mindanao Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Mangifera indica	31.8	7		Mindanao Ave.
Azadirachta indica	31.2	6		Mindanao Ave.
Azadirachta indica	31.8	6		Mindanao Ave.
Mangifera indica	41	6		Mindanao Ave.
Pouteria campechiana	45	4		Mindanao Ave.
Leucaena leucocephala	26	4		Mindanao Ave.
Averrhoa bilimbi	10	3		Mindanao Ave.
Adonidia merrillii	4.8	2		Mindanao Ave.
Ficus benjamina	9.6	5		Mindanao Ave.
syzygium cumini	32.3	7		Mindanao Ave.
Sandoricum koetjape	9.6	5		Mindanao Ave.
Muntingia calabura	3.2	3.5		Mindanao Ave.
Chrysophyllum cainito	10	5		Mindanao Ave.
Mangifera indica	35	7		Mindanao Ave.
Wodyetia bifurcata	10	3		Mindanao Ave.
Wodyetia bifurcata	10.5	3		Mindanao Ave.
Wodyetia bifurcata	10	3		Mindanao Ave.
Mangifera indica	45	9		Mindanao Ave.
syzygium cumini	47	7		Mindanao Ave.
Wodyetia bifurcata	15	6		Mindanao Ave.
Terminalia catappa	30	9		Mindanao Ave.
Terminalia catappa	20	7		Mindanao Ave.
Mangifera indica	2.5	4		Mindanao Ave.
Moringa oleifera	40	7		Mindanao Ave.
Moringa oleifera	15	7		Mindanao Ave.
Melanolepis multiglandulosa	8	4		Mindanao Ave.
Melanolepis multiglandulosa	10	4		Mindanao Ave.
Roystonea regia	20	5		Mindanao Ave.
Melanolepis multiglandulosa	3.8	5		Mindanao Ave.
Adonidia merrillii	15	3		Mindanao Ave.
Adonidia merrillii	20	4		Mindanao Ave.
Adonidia merrillii	8.3	4		Mindanao Ave.
Adonidia merrillii	15	3		Mindanao Ave.
Adonidia merrillii	14	2		Mindanao Ave.
Leucaena leucocephala	4.8	3		FTI
Trema orientalis	4.8	4		FTI
Cocos nucifera	26.0	8		FTI
Cocos nucifera	23.0	9		FTI
Ficus benjamina	50	6		FTI
Ficus benjamina	53	7		FTI

Appendix E-2.
Checklist of Species recorded from Metro Manila Subway Project, Family, local names and uses

FAMILY	SPECIES	COMMON NAME	USES
ACANTHACEAE	*Asystasia gangetica (L.) T Anders.*	zamboangenita (Tag.)	ornamental
ACANTHACEAE	*Ruellia tuberosa L.*	meadow wood (Engl.)	ornamental
ACANTHACEAE	*Sanchezia speciosa J. Leon*	sanchezia (Engl.)	ornamental
AGAVACEAE	*Agave tequilana F. A. C. Weber*	blue agave (Engl.)	ornamental
ALOACEAE	*Aloe vera (L.) Buerm f.*	sabila (Tag.)	medicinal, ornamental
AMARANTHACEAE	*Amaranthus spinosus L.*	kolitis (Tag.)	edible leaves, medicinal
AMARANTHACEAE	*Alternathera sessilis (L) DC*	butones-butonesan (Tag.)	edible leaves, medicinal
AMARANTHACEAE	*Celosia argentea L.*	silver cockscomb (Engl.)	ornamental, edible leaves
AMARYLLIDACEAE	*Crinum amabile Donn.*	spider lily (Engl.)	ornamental
AMARYLLIDACEAE	*Crinum asiaticum L.*	bakong (Tag.)	ornamental
ANACARDIACEAE	*Mangifera indica L.*	mangga (Ig., Ilk.,Tag.)	edible fruit, medicinal
ANNONACEAE	*Annona squamosa L.*	ates (Fil.)	edible fruit
ANNONACEAE	*Polyalthia longifolia Benth. & Hook f.*	India lanutan (Fil.)	ornamental
ANNONACEAE	*Annona muricata L.*	Guyabano (Tag.)	fruit edible
APOCYNACEAE	*Wrightia pubescens R. Br. ssp. laniti*	laniti (Tag.)	wood used for carving
APOCYNACEAE	*Catharansus roseus (L.) G. Don*	tsitsirika (Tag.)	ornamental, medicinal
APOCYNACEAE	*Plumeria acuminata Ait.*	kalachuche (Aztec-Fil)	ornamental, medicinal
APOCYNACEAE	*Wrightia religiosa Teijs. & Binn.*	sacred buddhist (Engl.)	ornamental
APOCYNACEAE	*Thevetia peruviana (Pers.) K. Schum.*	campanilla (Sp.)	ornamental
APOCYNACEAE	*Alstonia macrophylla Wall. ex G. Don*	batino (Tag.)	wood for construction
APOCYNACEAE	*Tabernaemontana pandacaqui Poir.*	pandakaki (Tag.)	ornamental, medicinal

FAMILY	SPECIES	COMMON NAME	USES
ARACEAE	*Zamioculcas zamiifolia (Lodd.) Engl.*	arum fern (Engl.)	ornamental
ARACEAE	*Dieffenbachia amoena Bull.*	dumb cane (Engl.)	ornamental
ARACEAE	*Colocasia esculenta (L.) Schott.*	gabi (Tag.)	edible corns
ARACEAE	*Homalomena rubescens (Roxb.) Kunth.*		ornamental, medicinal
ARACEAE	*Xanthosoma sagittifolium (L.) Schott.*		ornamental
ARALIACEAE	*Polyscias fruticosa (L.) Harms*	parsley panax (Engl.)	ornamental
ARALIACEAE	*Schefflera odorata L.*	galamayamo (Tag.)	ornamental, medicinal
ARALIACEAE	*Polyscias guilfoylei (Bull.) L. H. Bailey*	papua (Engl.)	ornamental
ARECACEAE	*Wodyetia bifurcata A. K. Irvine*	Foxtail palm (Engl.)	ornamental, landscaping
ARECACEAE	*Cocos nucifera L.*	niyog (Tag.)	fruit edible, medicinal
ARECACEAE	*Caryota cumingii Lodd. ex C. Martius*	takipan (Tag.)	palm pith edible, ornamental
ARECACEAE	*Adonidia merrillii (Becc.) Becc.*	bunga de jolo (Tag.)	ornamental
ARECACEAE	*Dypsis lutescens (H. Wendl.) Beentje & Dransf.*	butterfly palm (Engl.)	ornamental
ARECACEAE	*Arenga pinnata (Wurmb.) Merr*	kaong (Tag.)	fruit edible, ornamental
ARECACEAE	*Rhapis excelsa (Thunb) A. Henry*	lady palm	ornamental
ARECACEAE	*Roystonea regia (HBK) O. F. Cook*	royal palm (Engl.)	ornamental
ARECACEAE	*Elaeis guineensis Jaca.*	red palm (Engl.)	ornamental
ARECACEAE	*Hyophorbe lagenicaulis (L. H. Bailey) H. E. Moore*	champagne palm (Engl.)	ornamental
ARECACEAE	*Ptychosperma macarthurii (H. Wendl.) Nichols*	McArthur palm (Engl.)	ornamental
ARECACEAE	*Cyrtostachys renda Bl.*	red palm (Engl.)	ornamental
ARECACEAE	*Phoenix roebelenii O'Brien*	pygmy date palm (Engl.)	ornamental
ASPARAGACEAE	*Sanseveria trifasciata Prain*	buntot tigre (Tag.)	ornamental, medicinal
ASPARAGACEAE	*Dracaena angustifolia Roxb.*	malasambal (Tag.)	ornamental

FAMILY	SPECIES	COMMON NAME	USES
ASPARAGACEAE	*Dracaena surculosa Lindl.*	spotted dracaena (Engl.)	ornamental
ASPARAGACEAE	*Cordyline fruticosa (L.) A. Cher.*	tungkod pari (Tag.)	ornamental
ASPARAGACEAE	*Dracaena fragrans (L.) Ker. Gawl.*	fortune plant (Engl.)	ornamental
ASPARAGACEAE	*Asparagus densiflorus L.*	foxtail asparagus (Engl.)	ornamental
ASTERACEAE	*Pseudoelephantopus spicatus (Juss.) Robr.*	dilang baka (Tag.)	medicinal
ASTERACEAE	*Chromolaena odorata (L.) R. King & H. Robinson*	hagonoy (Tag.)	medicinal
ASTERACEAE	*Mikania cordata (Burm.) Bl. Robinson.*	ooka (Tag.)	medicinal
ASTERACEAE	*Tridax procumbens L.*	tridax daisy (Engl.)	medicinal
ASTERACEAE	*Bidens pilosus L.*	buburtak (Tag.)	medicinal
ASTERACEAE	*Blumea balsamifera (L.) DC*	sambong (Tag.)	medicinal
ASTERACEAE	*Cyanthillium cinereum (L.) H. Robinson*	agas-moro (Tag.)	medicinal
ASTERACEAE	*Sphagneticola trilobata (L.) Pruski*	wedelia (Engl.)	ornamental
ASTERACEAE	*Conyza sumatrensis (Retz.) Walker*	atipukpuk (Tag.)	medicinal
ASTERACEAE	*Artemisia scoparia Waldst. & Kit*	wormwood (Engl.)	ornamental, medicinal
BASELLACEAE	*Basella alba L.*	alugbati (Tag.)	leaves edible
BIGNONIACEAE	*Spondias purpurea L.*	siniguelas (Sp., Fil.)	edible fruit
BIGNONIACEAE	*Tabebuia pallida (Lindl.) Miers*	cuban pink trumpet	ornamental
BIGNONIACEAE	*Spathodea campanulata Beauv.*	African Tulip (Engl.)	ornamental
BORAGINACEAE	*Heliotropium indicum L.*	tropa ng elepante (Tag.)	medicinal
BORAGINACEAE	*Ehretia microphylla Lam.*	tsaang gubat (Tag.)	medicinal
CACTACEAE	*Pereskia aculeata Mill.*	barbados gooseberry (Engl.)	fruit edible, ornamental
CALOPHYLLACEAE	*Calophyllum inophyllum L.*	palo maria (Tag.)	wood for construction, ornamental
CANNACEAE	*Canna indica L.*	bandera espanola (Sp.)	ornamental, medicinal

FAMILY	SPECIES	COMMON NAME	USES
CANNACEAE	*Trema orientalis (L.) Blume*	anabiong (Tag.)	firewood
CAPPARIDACEAE	*Cleome rutidosperma DC*	seru-walai (Tag.)	medicinal
CARICACEAE	*Carica papaya L.*	papaya (Tag.)	edible fruit
COMBRETACEAE	*Bucida molineti*	Dwarf Geometry tree (Engl.)	ornamental, landscaping
COMBRETACEAE	*Terminalia catappa L.*	talisai (Bag., Bik., Bis.,Pamp. Sbl.)	edible fruit kernel
COMBRETACEAE	*Quisqualis indica L.*	niyog-niyogan (Tag.)	ornamental, seeds anthelmintic
COMMELINACEAE	*Tradescantia spathacea Sw.*	rhoeo (Engl.)	ornamental, medicinal
COMMELINACEAE	*Commelina diffusa*	alikbangon (Tag.)	medicinal
CONVOLVULACEAE	*Ipomoea batatas (L.) Lamk.*	kamote (Tag.)	edible tuber & leaves
CONVOLVULACEAE	*Merremia sp.*		
CUCURBITACEAE	*Coccinia grandis (L.) Voigt.*	scarlet gourd (Engl.)	medicinal
CYPERACEAE	*Cyperus kyllingia Endl.*		medicinal
DIOSCOREACEAE	*Dioscorea esculenta (Lour.) Burkill*	tugi (Tag.)	tubers edible
EBENACEAE	*Diospyros blancoi A DC*	mabolo (Tag.)	wood for furniture, fruit edible
EUPHORBIACEAE	*Croton tiglium L.*	tuba (Tag.)	botanical pesticide
EUPHORBIACEAE	*Melanolepis multiglandulosa (Reinw. ex Blume) Rohb. f. & Zoll.*	alim (Tag.)	medicinal
EUPHORBIACEAE	*Excoecaria cochinchinensis*	variegated blindness tree (Engl.)	ornamental
EUPHORBIACEAE	*Euphorbia tirucalli L.*	milk bush (Engl.)	ornamental, medicinal
EUPHORBIACEAE	*Manihot esculenta Crantz.*	cassava (Engl.)	edible tuber
EUPHORBIACEAE	*Euphorbia hirta L.*	tawa-tawa (Tag.)	medicinal
EUPHORBIACEAE	*Jatropha curcas L.*	tubang bakod (Fil.)	boundary plantings, biodiesel
EUPHORBIACEAE	*Jatropha integerrima Jacq.*	peregrina (Sp.)	ornamental

FAMILY	SPECIES	COMMON NAME	USES
EUPHORBIACEAE	*Jatropha curcas L.*	tubang-bakod (Fil.)	boundary plantings, biodiesel
EUPHORBIACEAE	*Pedilanthus tithymaloides (L.) Poit.*	luhang dalaga (Tag.)	ornamental
EUPHORBIACEAE	*Euphorbia milii Desmoul*	crown of thorns (Engl.)	ornamental
EUPHORBIACEAE	*Macaranga tanarius (L.) Muell-Arg.*	binunga (Tag.)	pioneer tree for ecological restoration
EUPHORBIACEAE	*Jatropha gossypifolia L.*	tubang morado (Tag.)	ornamental
FABACEAE	*Senna alata (L.) Roxb.*	akapulko (Tag.)	medicinal
FABACEAE	*Albizia saman F. Muell.*	akasya (Tag.)	timber, wood carving
FABACEAE	*Gliricidia sepium (Jacq.) Kunthe ex Steud.*	madre-cacao (Sp.)	firewood, charcoal
FABACEAE	*Leucaena leucocephala (Lam.) de Wit*	Ipil-ipil (Tag.)	fodder, charcoal
FABACEAE	*Bauhinia purpurea L.*	fringon -morado (Sp.)	charcoal
FABACEAE	*Tamarindus indica L.*	sampalok (C. Bis., Pamp., Tag.)	medicinal, fruit edible
FABACEAE	*Caesalpinia pulcherrima (L.) Sw.*	caballero (Tag.)	ornamental
FABACEAE	*Centrosema pubescens Benth.*	pukinggan (Tag.)	fodder
FABACEAE	*Pterocarpus indicus Willd.*	narra (most dialects)	timber, ornamental
FABACEAE	*Sesbania grandiflora (L.) Pers.*	katuray (Tag.)	edible flowers
FABACEAE	*Cassia fistula L.*	tropical golden shower (Engl.)	ornamental, medicinal
FABACEAE	*Acacia auriculiformis A. Cunn. ex Benth.*	auri (Tag.)	wood for light construction
FABACEAE	*Pithecellobium dulce (Roxb.) Benth.*	kamachile (Tag.)	edible fruit, wood for light construction
FABACEAE	*Delonix regia (Boj. ex Hook.) Raf.*	fire tree (Engl.)	ornamental
FABACEAE	*Millettia pinnata (L.) Panighari*	bani (Tag.)	medicinal, ornamental
FABACEAE	*Vigna unguiculata (L.) Walp.*	sitao (Tag.)	pods eaten as vegetable
FABACEAE	*Senna spectabilis (DC.) Irwin & Barneby*		ornamental

FAMILY	SPECIES	COMMON NAME	USES
FABACEAE	*Acacia mangium Willd.*	mangium (Tag.)	timber for light construction
LAMIACEAE	*Premna odorata*	alagau (Bik., P.Bis., Tag., Bis.)	medicinal
LAMIACEAE	*Coleus amboinicus Lour.*	oregano (Tag.)	medicinal
LAMIACEAE	*Coleus blumei Benth.*	mayana (Tag.)	ornamental, medicinal
LAMIACEAE	*Vitex parviflora Juss.*	molave(Bik., Bis., Ilk. Lam., Sbl. Tag.)	timber, furniture
LAMIACEAE	*Duranta repens L.*	pigeon berry (Engl.)	ornamental
LAMIACEAE	*Gmelina arborea Roxb.*	yemane (Tag.)	wood for furniture
LAMIACEAE	*Orthosiphon aristatus (Bl.) Mig.*	balbas pusa (Tag.)	medicinal, ornamental
LAURACEAE	*Persea americana Mill.*	avocado (Engl. Sp.)	fruit edible
LYTHRACEAE	*Lagerstroemia speciosa (L.) Pers.*	banaba (Tag.)	medicinal, ornamental
MAGNOLIACEAE	*Michelia champaca L.*	tsampaka (Tag.)	ornamental, fragrant flowers for perfume production
MALPHIGIACEAE	*Tristellateia australasiae A. Rich*	binusisi (Tag.)	ornamental
MALPHIGIACEAE	*Malpighia coccigera L.*	miniature holly (Engl.)	ornamental
MALVACEAE	*Ceiba pentandra (L.) Gaertn.*	kapok (Bis., Jav., Sul., Tag.)	seedpod, fiber stuffing for pillow
MALVACEAE	*Pterospermum diversifolium Blume*	Bayok (Nik., Mag., P.Bis., Tag.)	charcoal, firewood
MALVACEAE	*Pachira aquatica Aubl.*	guiana chestnut (Engl.)	ornamental
MALVACEAE	*Abelmoschus esculentus*	okra (Tag.)	fruit edible
MALVACEAE	*Sida acuta Burm. f.*	waliswalisan (Tag.)	medicinal
MALVACEAE	*Theobroma cacao L.*	cacao (Sp., Tag.)	seeds made into chocolate
MALVACEAE	*Hibiscus rosa sinensis L.*	gumamela (Bis., Pa,mp. Tag.)	ornamental, medicinal
MALVACEAE	*Malvastrum coromandelianum (L.) Garcke*		medicinal
MARANTACEAE	*Calathea makoyana E. Morr.*	peacock plant (Engl.)	ornamental
MELIACEAE	*Sandoricum koetjape (Burm. f.) Merr.*	santol (most dialects)	edible fruit, wood for carving

FAMILY	SPECIES	COMMON NAME	USES
MELIACEAE	*Swietenia macrophylla King*	large leaved mahogany (Engl.)	timber, high grade furniture
MELIACEAE	*Melia azedarach L.*	paraiso (Sp.)	ornamental, medicinal
MELIACEAE	*Azadirachta indica A. Juss.*	neem tree (Tag.)	ornamental, botanical pesticide
MELIACEAE	*Toona calantas Merr. & Rolfe*	kalantas (Tag.)	wood for cigar boxes, furniture
MOLLUGINACEAE	*Mollugo pentaphylla L.*		medicinal
MORACEAE	*Ficus septica Burm. f.*	hauili (Neg., Tag.)	medicinal
MORACEAE	*Ficus sp.*		
MORACEAE	*Ficus benjamina L.*	salisi (Is. Sab.)	ornamental
MORACEAE	*Streblus asper Lour.*	kalios (Ibn., Tag.)	edible fruit, timber
MORACEAE	*Artocarpus blancoi (Elm.) Merr.*	antipolo (Tag.)	edible fruit, wood for carving
MORACEAE	*Ficus nota (Blanco) Merr.*	tibig (Ilk., Tag.)	fruit eaten by bats
MORACEAE	*Ficus ulmifolia Lam.*	Is-is (Neg., P. Bis., Tag.)	leaves used as sandpaper
MORACEAE	*Ficus religiosa L.*	bo tree (Singh Engl.)	
MORACEAE	*Artocarpus heterophyllus Lam.*	nangka (Bis., Ibn., Sul.,Tag.)	edible fruit, wood for musical instruments
MORACEAE	*Ficus pumila L.*	creeping fig (Engl.)	ornamental
MORACEAE	*Ficus concinna Mia.*	malasapla (Ilk.)	medicinal
MORACEAE	*Ficus calophylla Blume*	basala (Tag.)	medicinal, ornamental
MORACEAE	*Broussonetia luzonica (Blanco) Bureau*	himbabao (Tag.)	male inflorescence edible
MORINGACEAE	*Moringa oleifera Lam.*	malunggai (Sanskr. Fil.)	edible leaves, medicinal
MUNTINGIACEAE	*Muntingia calabura L.*	datiles(Bik., Tag.)	edible fruit
MUSACEAE	*Musa x paradisiaca*	saging (Tag.)	edible fruit
MYRTACEAE	*Syzygium samarangense (Blume) Merr. & Perry*	makopa (Bik., Tag.)	edible fruit
MYRTACEAE	*Psidium guajava L.*	bayabas (Bik., Bis., Ibn., Sp. Fil.)	edible fruit, medicinal

FAMILY	SPECIES	COMMON NAME	USES
MYRTACEAE	*Syzygium cumini (L.) Skeels*	duhat (P. Bis., Tag.)	edible fruit, medicinal
MYRTACEAE	*Eugenia sp.*		ornamental
MYRTACEAE	*Eucalyptus deglupta Blume*	bagras (Mbo.)	timber
MYRTACEAE	*Eucalyptus tereticornis Sm.*	gray gum (Engl.)	ornamental, wood for light construction
NYCTAGINACEAE	*Pisonia alba Span.*	maluko (Tag.)	edible leaves, ornamental
NYCTAGINACEAE	*Bougainvillea spectabilis Willd*	bougainvillea (Engl.)	ornamental
NYCTAGINACEAE	*Mirabilis jalappa L.*	four o clock (Engl.)	ornamental, medicinal
OLEACEAE	*Jasminum sambac (L.) Ait.*	sampaguita (Tag.)	ornamental
ORCHIDACEAE	*Dendrobium aphyllum*		ornamental
OXALIDACEAE	*Averrhoa bilimbi L.*	kamias (Tag.)	edible fruit
PANDANACEAE	*Pandanus amaryllifolius Roxb.*	pandan mabango (Tag.)	medicinal
PASSIFLORACEAE	*Passiflora foetida L.*	pasyonaryong mabaho (Tag.)	fruit edible
PHYLLANTHACEAE	*Phyllanthus urinaria L.*	sampaluk-sampalukan	medicinal
PHYLLANTHACEAE	*Cicca acida (L.) Merr.*	Iba (Pamp., P.Bis., Sul., Tag.)	fruit edible, medicinal
PHYLLANTHACEAE	*Phyllanthus niruri*		medicinal
PHYLLANTHACEAE	*Phyllanthus myrtifolius Moon.*		ornamental
PHYLLANTHACEAE	*Sauropus androgynus (L.) Merr.*	Chinese malunggai (Tag.)	leaves edible
PHYTOLACCACEAE	*Rivina humilis L.*		ornamental
PIPERACEAE	*Peperomia pellucida Kunth.*	pansit-pansitan (Tag.)	medicinal
POACEAE	*Saccharum spontaneum L.*	talahib (Tag.)	fodder
POACEAE	*Bambusa blumeana Schultes f.*	kawayang tinik (Tag.)	culms for construction
POACEAE	*Cyrtococcum accressens (trin) Stapf.*		fodder
POACEAE	*Cenchrus echinatus L.*	spiny sandbar (Engl.)	fodder
POACEAE	*Eleusine indica (L.) Gaertn.*	paragis (Tag.)	fodder, medicinal

FAMILY	SPECIES	COMMON NAME	USES
POACEAE	*Axonopus compressus (Sw.) P. Beaur*	carabao grass (Engl.)	fodder, medicinal
POACEAE	*Chloris gayana Kunth*	Rhodes grass (Engl.)	fodder
POACEAE	*Pennisetum polystachion (L.) Schultes*	buntot pusa (Tag.)	fodder
POACEAE	*Panicum maximum Jacq.*	Guinea grass (Engl.)	fodder
POACEAE	*Bambusa multiplex (Lour.) Raensch. ex Schult.*	hedge bamboo (Engl.)	ornamental
POACEAE	*Cymbopogon citratus (DC) Stapf.*	tanglad (Tag.)	medicinal, leaves distilled for essential oil
POACEAE	*Dactyloctenium aegyptium (L.) Willd.*	krus-krusan (Tag.)	medicinal, fodder grass
POACEAE	*Pennisetum purpureum Schumach.*	napier (Engl.)	fodder grass
POACEAE	*Mnesithea cochinchinensis*		fodder grass
POLYGONACEAE	*Antigonon leptopus Hook. & Arn.*	cadena de amor (Sp.)	ornamental
POLYPODIACEAE	*Drynaria quercifolia (L.) J. Sm.*	kabkabin (Tag.)	ornamental
PORTULACACEAE	*Portulaca quadrifida L.*	gulasiman (Tag.)	medicinal
PORTULACACEAE	*Portulaca oleracea L.*	kolasiman (Tag.)	medicinal
PTERIDACEAE	*Pteris ensiformis Burm. F.*	sword brake fern (Engl.)	medicinal
PTERIDACEAE	*Adiantum philippense L.*	kaikai (Tag.)	medicinal, ornamental
ROSACEAE	*Rosa cv.*	rose (Engl.)	ornamental
RUBIACEAE	*Morinda citrifolia L.*	bangkoro (C. BisMag. Tag.)	medicinal
RUBIACEAE	*Ixora chinensis Lam.*	santan (Tag.)	ornamental
RUBIACEAE	*Nauclea orientalis L.*	bangkal (Bis., Ilk., Mag, Mbo. Tag.)	timber, charcoal
RUBIACEAE	*Gardenia jasminoides (L.) Ellis*	rosal (Tag.)	ornamental
RUBIACEAE	*Coffea robusta L. Lindl. ex de Wildem*	robusta (Tag.)	seeds roasted into coffee
RUBIACEAE	*Mussaenda "Doña Aurora"*	Doña Aurora (Tag.)	ornamental
RUTACEAE	*Citrus x microcarpa Bunge*	kalamansi (Tag.)	fruit edible, medicinal
RUTACEAE	*Murraya paniculata (L.) Jack.*	kamuning (Tag.)	ornamental

FAMILY	SPECIES	COMMON NAME	USES
RUTACEAE	*Citrus x aurantium L.*	kahel (Sp. Fil.)	fruit edible
SAPINDACEAE	*Dimocarpus longan Lour.*	longan (Engl.)	fruit edible
SAPINDACEAE	*Nephelium lappaceum L.*	rambutan (Tag.)	fruit edible
SAPOTACEAE	*Chrysophyllum cainito L.*	star apple(Engl.) caimito Sp.)	edible fruit, timber
SAPOTACEAE	*Manilkara sapota L.*	chico (sp. Mex.)	fruit edible
SAPOTACEAE	*Pouteria campechiana (HBK.) Bachni*	tiesa (Engl.)	fruit edible
SCROPHULARIACEAE	*Scoparia dulcis L.*	saang-kabayo (Tag.)	medicinal
SCROPHULARIACEAE	*Leucophyllum frutescens Berland. I. M. Johnst.*	Mexican sage (Engl.)	ornamental
SOLANACEAE	*Capsicum frutescens L.*	siling labuyo (Tag.)	fruit edible, spice
SOLANACEAE	*Solanum lycopersicum L.*	kamatis (Tag.)	fruit edible
SOLANAEAE	*Solanum torvum Sw.*	prickly nightshade (Engl.)	medicinal
STRELITZIACEAE	*Ravenala madagascariensis Sonn.*	travellers tree (Engl.)	ornamental
TURNERACEAE	*Turnera subulata Sm.*	white buttercup (Engl.)	ornamental
VITACEAE	*Cissus nodosa Blume*	grape ivy (Engl.)	ornamental

Appendix E-3.

Checklist, endemicity, growth form and distribution of plant Species recorded from Metro Manila Subway Project

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ACANTHACEAE	*Asystasia gangetica (L.) T Anders.*	NE	HERB	x													
ACANTHACEAE	*Ruellia tuberosa L.*	EXOTIC	HERB	x							x						
ACANTHACEAE	*Sanchezia speciosa J. Leon*	EXOTIC	SHRUB	x									x				
AGAVACEAE	*Agave tequilana F. A. C. Weber*	EXOTIC	HERB			x					x		x			x	
ALOACEAE	*Aloe vera (L.) Buerm f.*	EXOTIC	HERB	x													
AMARANTHACEAE	*Amaranthus spinosus L.*	EXOTIC	HERB	x	x	x					x						x
AMARANTHACEAE	*Alternathera sessilis (L) DC*	EXOTIC	HERB	x													
AMARANTHACEAE	*Celosia argentea L.*	EXOTIC	HERB	x													
AMARYLLIDACEAE	*Crinum amabile Donn.*	EXOTIC	HERB			x							x				
AMARYLLIDACEAE	*Crinum asiaticum L.*	NE	HERB							x							
ANACARDIACEAE	*Mangifera indica L.*	EXOTIC	TREE		x	x	x	x	x	x	x	x	x			x	x
ANNONACEAE	*Annona squamosa L.*	EXOTIC	TREE	x												x	x
ANNONACEAE	*Polyalthia longifolia Benth. & Hook f.*	EXOTIC	TREE	x					x		x		x				x
ANNONACEAE	*Annona muricata L.*	EXOTIC	TREE						x								

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
APOCYNACEAE	*Wrightia pubescens R. Br. ssp. laniti*	NE	TREE	x												x	
APOCYNACEAE	*Catharansus roseus (L.) G. Don*	EXOTIC	SHRUB	x						x							
APOCYNACEAE	*Plumeria acuminata Ait.*	EXOTIC	TREE	x					x		x		x				x
APOCYNACEAE	*Wrightia religiosa Teijs. & Binn.*	EXOTIC	TREE								x					x	x
APOCYNACEAE	*Thevetia peruviana (Pers.) K. Schum.*	EXOTIC	TREE								x						x
APOCYNACEAE	*Alstonia macrophylla Wall. ex G. Don*	NE	TREE														x
APOCYNACEAE	*Tabernaemontana pandacaqui Poir.*	NE	TREE				x										
ARACEAE	*Zamioculcas zamiifolia (Lodd.) Engl.*	EXOTIC	HERB	x			x			x							
ARACEAE	*Dieffenbachia amoena Bull.*	EXOTIC	HERB	x					x		x						
ARACEAE	*Colocasia esculenta (L.) Schott.*	NE	HERB						x								
ARACEAE	*Homalomena rubescens (Roxb.) Kunth.*	NE	HERB							x							
ARACEAE	*Xanthosoma sagittifolium (L.) Schott.*	NE	HERB						x								
ARALIACEAE	*Polyscias fruticosa (L.) Harms*	EXOTIC	SHRUB	x													
ARALIACEAE	*Schefflera odorata L.*	EXOTIC	SHRUB	x			x										

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ARALIACEAE	*Polyscias guilfoylei (Bull.) L. H. Bailey*	EXOTIC	SHRUB		x	x	x			x	x		x				
ARECACEAE	*Wodyetia bifurcata A. K. Irvine*	EXOTIC	PALM	x	x						x	x		x		x	
ARECACEAE	*Cocos nucifera L.*	NE	PALM	x		x	x		x		x		x			x	x
ARECACEAE	*Caryota cumingii Lodd. ex C. Martius*	PE	PALM	x													
ARECACEAE	*Adonidia merrillii (Becc.) Becc.*	NE	PALM	x	x						x	x	x			x	x
ARECACEAE	*Dypsis lutescens (H. Wendl.) Beentje & Dransf.*	EXOTIC	PALM	x			x										
ARECACEAE	*Arenga pinnata (Wurmb.) Merr*	NE	PALM	x													
ARECACEAE	*Rhapis excelsa (Thunb) A. Henry*	EXOTIC	PALM				x				x						x
ARECACEAE	*Roystonea regia (HBK) O. F. Cook*	EXOTIC	PALM		x							x	x	x			
ARECACEAE	*Elaeis guineensis Jaca.*	EXOTIC	PALM									x					
ARECACEAE	*Hyophorbe lagenicaulis (L. H. Bailey) H. E. Moore*	EXOTIC	PALM														x
ARECACEAE	*Ptychosperma macarthurii (H. Wendl.) Nichols*	EXOTIC	PALM		x						x		x				x
ARECACEAE	*Cyrtostachys renda Bl.*	EXOTIC	PALM										x				
ARECACEAE	*Phoenix roebelenii O'Brien*	EXOTIC	PALM								x						

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ASAPARAGACEAE	*Sanseveria trifasciata Prain*	EXOTIC	HERB	x		x	x			x							x
ASPARAGACEAE	*Dracaena angustifolia Roxb.*	NE	SHRUB	x		x											
ASPARAGACEAE	*Dracaena surculosa Lindl.*	EXOTIC	SHRUB	x							x		x				
ASPARAGACEAE	*Cordyline fruticosa (L.) A. Cher.*	EXOTIC	SHRUB	x		x	x		x	x							x
ASPARAGACEAE	*Dracaena fragrans (L.) Ker. Gawl.*	EXOTIC	TREE	x	x					x	x		x				
ASPARAGACEAE	*Asparagus densiflorus L.*	EXOTIC	HERB	x													
ASTERACEAE	*Pseudoelephantopus spicatus (Juss.) Robr.*	EXOTIC	HERB	x													
ASTERACEAE	*Chromolaena odorata (L.) R. King & H. Robinson*	EXOTIC	SHRUB	x				x									
ASTERACEAE	*Mikania cordata (Burm.) Bl. Robinson.*	EXOTIC	CLIMBER	x													
ASTERACEAE	*Tridax procumbens L.*	EXOTIC	HERB	x	x			x			x		x			x	x
ASTERACEAE	*Bidens pilosus L.*	EXOTIC	HERB	x													
ASTERACEAE	*Blumea balsamifera (L.) DC*	NE	SHRUB	x	x				x								
ASTERACEAE	*Cyanthillium cinereum (L.) H. Robinson*	EXOTIC	HERB	x	x				x							x	
ASTERACEAE	*Sphagneticola trilobata (L.) Pruski*	EXOTIC	HERB														x

FAMILY	**Appendix E-3** SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ASTERACEAE	*Conyza sumatrensis (Retz.) Walker*	EXOTIC	HERB						x								
ASTERACEAE	*Artemisia scoparia Waldst. & Kit*	EXOTIC	SHRUB				x				x						
BASELLACEAE	*Basella alba L.*	EXOTIC	CLIMBER	x							x		x				
BIGNONIACEAE	*Spondias purpurea L.*	EXOTIC	TREE	x													
BIGNONIACEAE	*Tabebuia pallida (Lindl.) Miers*	EXOTIC	TREE	x					x							x	x
BIGNONIACEAE	*Spathodea campanulata Beauv.*	EXOTIC	TREE													x	
BORAGINACEAE	*Heliotropium indicum L.*	EXOTIC	HERB	x													
BORAGINACEAE	*Ehretia microphylla Lam.*	NE	SHRUB	x		x							x			x	
CACTACEAE	*Pereskia aculeata Mill.*	EXOTIC	CLIMBER					x									
CALOPHYLLACEAE	*Calophyllum inophyllum L.*	NE	TREE						x						x		
CANNACEAE	*Canna indica L.*	EXOTIC	HERB	x									x				x
CANNACEAE	*Trema orientalis (L.) Blume*	NE	TREE					x					x				x
CAPPARIDACEAE	*Cleome rutidosperma DC*	EXOTIC	HERB	x	x								x				
CARICACEAE	*Carica papaya L.*	EXOTIC	HERB	x					x				x			x	x
COMBRETACEAE	*Bucida molinethi*	EXOTIC	TREE	x		x											
COMBRETACEAE	*Terminalia catappa L.*	NE	TREE	x	x							x	x			x	x

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
COMBRETACEAE	*Quisqualis indica L.*	NE	CLIMBER					x									
COMMELINACEAE	*Tradescantia spathacea Sw.*	EXOTIC	HERB	x	x		x										
COMMELINACEAE	*Commelina diffusa*	NE	HERB	x	x			x	x								
CONVOLVULACEAE	*Ipomoea batatas (L.) Lamk.*	EXOTIC	CLIMBER	x	x		x				x						
CONVOLVULACEAE	*Merremia sp.*	EXOTIC	CLIMBER	x			x										
CUCURBITACEAE	*Coccinia grandis (L.) Voigt.*	EXOTIC	CLIMBER	x	x			x									
CYPERACEAE	*Cyperus kyllingia Endl.*	NE					x										
DIOSCOREACEAE	*Dioscorea esculenta (Lour.) Burkill*	NE	CLIMBER										x				
EBENACEAE	*Diospyros blancoi A DC*		TREE						x								
EUPHORBIACEAE	*Croton tiglium L.*	NE	SHRUB	x													
EUPHORBIACEAE	*Melanolepis multiglandulosa (Reinw. ex Blume) Rohb. f. & Zoll.*	NE	TREE	x	x												
EUPHORBIACEAE	*Excoecaria cochinchinensis*	EXOTIC	SHRUB	x	x		x						x				
EUPHORBIACEAE	*Euphorbia tirucalli L.*	EXOTIC	SHRUB	x						x							
EUPHORBIACEAE	*Manihot esculenta Crantz.*	EXOTIC	SHRUB	x													
EUPHORBIACEAE	*Euphorbia hirta L.*	EXOTIC	HERB	x	x								x				
EUPHORBIACEAE	*Jatropha curcas L.*	EXOTIC	TREE	x													

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
EUPHORBIACEAE	*Jatropha integerrima Jacq.*	EXOTIC	SHRUB	x												x	x
EUPHORBIACEAE	*Jatropha curcas L.*	EXOTIC	TREE													x	x
EUPHORBIACEAE	*Pedilanthus tithymaloides (L.) Poit.*	EXOTIC	SHRUB							x			x			x	
EUPHORBIACEAE	*Euphorbia milii Desmoul*	EXOTIC	SHRUB														x
EUPHORBIACEAE	*Macaranga tanarius (L.) Muell-Arg.*	NE	TREE					x									
EUPHORBIACEAE	*Jatropha gossypifolia L.*	EXOTIC	SHRUB								x						
FABACEAE	*Senna alata (L.) Roxb.*	EXOTIC	SHRUB	x							x						
FABACEAE	*Albizia saman F. Muell.*	EXOTIC	TREE	x		x			x								
FABACEAE	*Gliricidia sepium (Jacq.) Kunthe ex Steud.*	EXOTIC	TREE	x													
FABACEAE	*Leucaena leucocephala (Lam.) de Wit*	EXOTIC	TREE	x	x	x	x		x							x	x
FABACEAE	*Bauhinia purpurea L.*	EXOTIC	TREE	x													
FABACEAE	*Tamarindus indica L.*	EXOTIC	TREE	x							x					x	
FABACEAE	*Caesalpinia pulcherrima (L.) Sw.*	EXOTIC	SHRUB	x			x										
FABACEAE	*Centrosema pubescens Benth.*	EXOTIC	CLIMBER	x					x								
FABACEAE	*Pterocarpus indicus Willd.*	NE	TREE	x		x	x	x	x				x	x		x	x

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
FABACEAE	*Sesbania grandiflora (L.) Pers.*	EXOTIC	TREE													x	
FABACEAE	*Cassia fistula L.*	EXOTIC	TREE			x	x						x				
FABACEAE	*Acacia auriculiformis A. Cunn. ex Benth.*	EXOTIC	TREE									x	x				
FABACEAE	*Pithecellobium dulce (Roxb.) Benth.*	EXOTIC	TREE									x					x
FABACEAE	*Delonix regia (Boj. ex Hook.) Raf.*	EXOTIC	TREE						x								
FABACEAE	*Millettia pinnata (L.) Panighari*	NE	TREE						x								
FABACEAE	*Vigna unguiculata (L.) Walp.*	EXOTIC	CLIMBER						x								
FABACEAE	*Senna spectabilis (DC.) Irwin & Barneby*	EXOTIC	TREE					x									
FABACEAE	*Acacia mangium Willd.*	EXOTIC	TREE				x										
LAMIACEAE	*Premna odorata*	NE	TREE	x													
LAMIACEAE	*Coleus amboinicus Lour.*	EXOTIC	HERB	x			x										
LAMIACEAE	*Coleus blumei Benth.*	EXOTIC	HERB	x													
LAMIACEAE	*Vitex parviflora Juss.*	NE	TREE	x					x							x	x
LAMIACEAE	*Duranta repens L.*	EXOTIC	SHRUB								x		x			x	x
LAMIACEAE	*Gmelina arborea Roxb.*	EXOTIC	TREE						x								

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
LAMIACEAE	*Orthosiphon aristatus (Bl.) Mig.*	EXOTIC	HERB							x							
LAURACEAE	*Persea americana Mill.*	EXOTIC	TREE	x						x	x						
LYTHRACEAE	*Lagerstroemia speciosa (L.) Pers.*	NE	TREE									x					
MAGNOLIACEAE	*Michelia champaca L.*	EXOTIC	TREE											x			
MALPHIGIACEAE	*Tristellateia australasiae A. Rich*	NE	CLIMBER	x													
MALPHIGIACEAE	*Malpighia coccigera L.*	EXOTIC	SHRUB			x					x						x
MALVACEAE	*Ceiba pentandra (L.) Gaertn.*	EXOTIC	TREE	x			x	x					x			x	
MALVACEAE	*Pterospermum diversifolium Blume*	NE	TREE	x													
MALVACEAE	*Pachira aquatica Aubl.*	EXOTIC	TREE	x						x	x						
MALVACEAE	*Abelmoschus esculentus*	EXOTIC	SHRUB	x													x
MALVACEAE	*Sida acuta Burm. f.*	EXOTIC	SHRUB	x													
MALVACEAE	*Theobroma cacao L.*	EXOTIC	TREE													x	
MALVACEAE	*Hibiscus rosa sinensis L.*	EXOTIC	TREE													x	x
MALVACEAE	*Malvastrum coromandelianum (L.) Garcke*	EXOTIC	HERB						x								
MARANTACEAE	*Calathea makoyana E. Morr.*	EXOTIC	HERB													x	

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
MELIACEAE	*Sandoricum koetjape (Burm. f.) Merr.*	NE	TREE	x	x		x		x				x			x	
MELIACEAE	*Swietenia macrophylla King*	EXOTIC	TREE	x				x	x				x			x	x
MELIACEAE	*Melia azedarach L.*	NE	TREE	x	x											x	
MELIACEAE	*Azadirachta indica A. Juss.*	EXOTIC	TREE		x											x	x
MELIACEAE	*Toona calantas Merr. & Rolfe*		TREE						x								
MOLLUGINACEAE	*Mollugo pentaphylla L.*	NE	HERB								x						
MORACEAE	*Ficus septica Burm. f.*	NE	TREE	x	x		x	x	x	x	x	x	x			x	
MORACEAE	*Ficus sp.*		TREE	x													
MORACEAE	*Ficus benjamina L.*	NE	TREE	x	x	x		x	x		x					x	x
MORACEAE	*Streblus asper Lour.*	NE	TREE	x													
MORACEAE	*Artocarpus blancoi (Elm.) Merr.*	PE	TREE	x													
MORACEAE	*Ficus nota (Blanco) Merr.*	NE	TREE	x													
MORACEAE	*Ficus ulmifolia Lam.*	PE	TREE		x											x	
MORACEAE	*Ficus religiosa L.*	EXOTIC	TREE						x				x			x	x
MORACEAE	*Artocarpus heterophyllus Lam.*	EXOTIC	TREE				x	x								x	x
MORACEAE	*Ficus pumila L.*	EXOTIC	CLIMBER								x						x
MORACEAE	*Ficus concinna Mia.*	NE	TREE		x												x

FAMILY	**Appendix E-3** SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
MORACEAE	*Ficus calophylla Blume*	EXOTIC	TREE										x				
MORACEAE	*Broussonetia luzonica (Blanco) Bureau*	EXOTIC	TREE										x				
MORINGACEAE	*Moringa oleifera Lam.*	EXOTIC	TREE	x	x		x	x	x	x		x	x				x
MUNTINGIACEAE	*Muntingia calabura L.*	EXOTIC	TREE	x	x			x				x				x	
MUSACEAE	*Musa x paradisiaca*	EXOTIC	HERB	x				x	x	x						x	x
MYRTACEAE	*Syzygium samarangense (Blume) Merr. & Perry*	NE	TREE	x							x						
MYRTACEAE	*Psidium guajava L.*	EXOTIC	TREE	x	x	x					x		x				x
MYRTACEAE	*Syzygium cumini (L.) Skeels*	NE	TREE	x	x		x						x			x	x
MYRTACEAE	*Eugenia sp.*		TREE													x	
MYRTACEAE	*Eucalyptus deglupta Blume*	NE				x											
MYRTACEAE	*Eucalyptus tereticornis Sm.*	EXOTIC	TREE									x					
NYCTAGINACEAE	*Pisonia alba Span.*	EXOTIC	TREE	x							x						
NYCTAGINACEAE	*Bougainvillea spectabilis Willd*	EXOTIC	SHRUB	x	x	x	x		x			x	x				x
NYCTAGINACEAE	*Mirabilis jalappa L.*	EXOTIC	SHRUB		x												
OLEACEAE	*Jasminum sambac (L.) Ait.*	EXOTIC	CLIMBER	x						x							
ORCHIDACEAE	*Dendrobium aphyllum*	NE	ORCHID							x							

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
OXALIDACEAE	*Averrhoa bilimbi L.*	EXOTIC	TREE	x	x					x							
PANDANACEAE	*Pandanus amaryllifolius Roxb.*	EXOTIC	PANDAN						x								
PASSIFLORACEAE	*Passiflora foetida L.*	EXOTIC	CLIMBER									x					
PHYLLANTHACEAE	*Phyllanthus urinaria L.*	NE	HERB	x							x		x				
PHYLLANTHACEAE	*Cicca acida (L.) Merr.*	EXOTIC	TREE													x	
PHYLLANTHACEAE	*Phyllanthus niruri*	NE	HERB		x											x	x
PHYLLANTHACEAE	*Phyllanthus myrtifolius Moon.*	EXOTIC	SHRUB												x		
PHYLLANTHACEAE	*Sauropus androgynus (L.) Merr.*	NE	SHRUB					x									
PHYTOLACCACEAE	*Rivina humilis L.*	EXOTIC	HERB					x	x								
PIPERACEAE	*Peperomia pellucida Kunth.*	NE	HERB														x
POACEAE	*Saccharum spontaneum L.*	NE	GRASS	x													
POACEAE	*Bambusa blumeana Schultes f.*	EXOTIC	BAMBOO	x													
POACEAE	*Cyrtococcum accressens (trin) Stapf.*	EXOTIC	GRASS	x				x					x				
POACEAE	*Cenchrus echinatus L.*	NE	GRASS	x	x						x					x	x
POACEAE	*Phyllanthus myrtifolius (L.) Gaertn.*	NE	GRASS	x		x		x	x		x						x
POACEAE	*Axonopus compressus (Sw.) P. Beaur*	NE	GRASS	x					x	x							

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
POACEAE	*Chloris gayana Kunth*	EXOTIC	GRASS	x	x											x	x
POACEAE	*Pennisetum polystachion (L.) Schultes*	EXOTIC	GRASS	x													
POACEAE	*Panicum maximum Jacq.*	EXOTIC	GRASS	x													
POACEAE	*Bambusa multiplex (Lour.) Raensch. ex Schult.*	EXOTIC	BAMBOO								x					x	
POACEAE	*Cymbopogon citratus (DC) Stapf.*	EXOTIC	GRASS						x								
POACEAE	*Dactyloctenium aegyptium (L.) Willd.*	NE	GRASS						x								
POACEAE	*Pennisetum purpureum Schumach.*	EXOTIC	GRASS					x									
POACEAE	*Mnesithea cochinchinensis*	NE	GRASS					x									
POLYGONACEAE	*Antigonon leptopus Hook. & Arn.*	EXOTIC	CLIMBER													x	
POLYPODIACEAE	*Drynaria quercifolia (L.) J. Sm.*	NE	FERN	x					x								
PORTULACACEAE	*Portulaca quadrifida L.*	NE	HERB	x	x												
PORTULACACEAE	*Portulaca oleracea L.*	NE	HERB	x									x				x
PTERIDACEAE	*Pteris ensiformis Burm. F.*	NE	FERN	x													
PTERIDACEAE	*Adiantum philippense L.*	NE	FERN						x								

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ROSACEAE	*Rosa cv.*	EXOTIC	SHRUB	x													
RUBIACEAE	*Morinda citrifolia L.*	NE	TREE	x													x
RUBIACEAE	*Ixora chinensis Lam.*	EXOTIC	SHRUB	x	x						x	x					x
RUBIACEAE	*Nauclea orientalis L.*	NE	TREE	x													
RUBIACEAE	*Gardenia jasminoides (L.) Ellis*	EXOTIC	SHRUB											x			
RUBIACEAE	*Coffea robusta L. Lindl. ex de Wildem*	EXOTIC	TREE						x								
RUBIACEAE	*Mussaenda "Doña Aurora"*	EXOTIC	SHRUB							x							
RUTACEAE	*Citrus x microcarpa Bunge*	EXOTIC	TREE	x						x							
RUTACEAE	*Murraya paniculata (L.) Jack.*	NE	SHRUB	x	x			x			x	x	x			x	
RUTACEAE	*Citrus x aurantium L.*	EXOTIC	TREE						x							x	
SAPINDACEAE	*Dimocarpus longan Lour.*	EXOTIC	TREE														x
SAPINDACEAE	*Nephelium lappaceum L.*	EXOTIC	TREE								x						
SAPOTACEAE	*Chrysophyllum cainito L.*	EXOTIC	TREE	x					x	x	x						
SAPOTACEAE	*Manilkara sapota L.*	EXOTIC	TREE	x													
SAPOTACEAE	*Pouteria campechiana (HBK.) Bachni*	EXOTIC	TREE		x				x								x
SCROPHULARIACEAE	*Scoparia dulcis L.*	EXOTIC	HERB	x													

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
SCROPHULARIACEAE	*Leucophyllum frutescens Berland. I. M. Johnst.*	EXOTIC	SHRUB		x											x	
SOLANACEAE	*Capsicum frutescens L.*	EXOTIC	SHRUB	x													
SOLANACEAE	*Solanum lycopersicum L.*	EXOTIC	HERB	x													
SOLANAEAE	*Solanum torvum Sw.*	EXOTIC	SHRUB	x				x									
STRELITZIACEAE	*Ravenala madagascariensis Sonn.*	EXOTIC	TREE					x									
TURNERACEAE	*Turnera subulata Sm.*	EXOTIC	SHRUB			x											
VITACEAE	*Cissus nodosa Blume*	EXOTIC	VINE	x	x							x					x

Note: The “x” mark indicates presence. Legend: Exotic-Introduced to the Philippines, PE-Philippine Endemic, NE-Indigenous but non endemic

Appendix E-4. Coordinates of Threatened Species

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°40.722'	121°01.925'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.719'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.716'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.712'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.709'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.704'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.702'	121°01.926'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.699'	121°01.926'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.696'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.690'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.686'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.679'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.675'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.668'	121°01.930'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.663'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.641'	121°01.927'	Tandang Sora Ave. Station
Wrightia pubescens R. Br. Ssp. laniti	14°41.642'	121°01.347'	Valenzuela Depot
Adonidia merrillii (Becc.) Becc.	14°41.642'	121°01.347'	Valenzuela Depot
Adonidia merrillii (Becc.) Becc.	14°41.824'	121°01.217'	Valenzuela Depot
Vitex parviflora Juss.	14°41.735'	121°01.329'	Valenzuela Depot
Drynaria quercifolia	14°41.831'	121°01.198'	Valenzuela Depot
Artocarpus blancoi (Elm.) Merr.	14°41.798'	121°01.329'	Valenzuela Depot
Pterocarpus indicus Willd.	14°42.444'	121°00.094'	Valenzuela Depot
Pterocarpus indicus Willd.	14°31.139'	121°03.141'	Cayetano Blvd. Station
Vitex parviflora Juss.	14°31.678'	121°03.405'	Cayetano Blvd. Station
Adonidia merrillii (Becc.) Becc.	14°31.669'	121°03.402'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.656'	121°03.397'	Cayetano Blvd. Station
Ficus ulmifolia Lam.	14°31.687'	121°03.432'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.651'	121°03.388'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.648'	121°03.387'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.644'	121°03.387'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.636'	121°03.385'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°30.445'	121°02.118'	FTI Station
Pterocarpus indicus Willd.	14°30.455'	121°02.113'	FTI Station
Pterocarpus indicus Willd.	14°30.458'	121°02.112'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.429'	121°02.145'	FTI Station
Pterocarpus indicus Willd.	14°30.425'	121°02.152'	FTI Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°30.434'	121°02.146'	FTI Station
Pterocarpus indicus Willd.	14°30.346'	121°02.171'	FTI Station
Pterocarpus indicus Willd.	14°30.347'	121°02.173'	FTI Station
Pterocarpus indicus Willd.	14°30.349'	121°02.177'	FTI Station
Pterocarpus indicus Willd.	14°30.352'	121°02.165'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.390'	121°02.152'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.390'	121°02.149'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.387'	121°02.145'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.386'	121°02.147'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.387'	121°02.146'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.381'	121°02.246'	FTI Station
Pterocarpus indicus Willd.	14°30.383'	121°02.154'	FTI Station
Pterocarpus indicus Willd.	14°30.380'	121°02.154'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.381'	121°02.152'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.382'	121°02.150'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.373'	121°02.153'	FTI Station
Pterocarpus indicus Willd.	14°30.320'	121°02.189'	FTI Station
Pterocarpus indicus Willd.	14°30.321'	121°02.192'	FTI Station
Pterocarpus indicus Willd.	14°30.322'	121°02.194'	FTI Station
Vitex parviflora Juss.	14°30.304'	121°02.202'	FTI Station
Pterocarpus indicus Willd.	14°30.322'	121°02.185'	FTI Station
Pterocarpus indicus Willd.	14°30.344'	121°02.169'	FTI Station
Pterocarpus indicus Willd.	14°30.348'	121°02.168'	FTI Station
Pterocarpus indicus Willd.	14°30.350'	121°02.167'	FTI Station
Pterocarpus indicus Willd.	14°30.349'	121°02.172'	FTI Station
Pterocarpus indicus Willd.	14°30.332'	121°02.187'	FTI Station
Pterocarpus indicus Willd.	14°30.334'	121°02.181'	FTI Station
Pterocarpus indicus Willd.	14°30.339'	121°02.170'	FTI Station
Pterocarpus indicus Willd.	14°30.340'	121°02.168'	FTI Station
Pterocarpus indicus Willd.	14°30.342'	121°02.177'	FTI Station
Pterocarpus indicus Willd.	14°30.340'	121°02.171'	FTI Station
Pterocarpus indicus Willd.	14°30.328'	121°02.178'	FTI Station
Pterocarpus indicus Willd.	14°30.327'	121°02.178'	FTI Station
Pterocarpus indicus Willd.	14°30.336'	121°02.174'	FTI Station
Vitex parviflora Juss.	14°30.299'	121°02.195'	FTI Station
Vitex parviflora Juss.	14°30.298'	121°02.196'	FTI Station
Vitex parviflora Juss.	14°30.299'	121°02.197'	FTI Station
Vitex parviflora Juss.	14°30.298'	121°02.200'	FTI Station
Vitex parviflora Juss.	14°30.301'	121°02.192'	FTI Station
Vitex parviflora Juss.	14°30.301'	121°02.197'	FTI Station
Vitex parviflora Juss.	14°30.300'	121°02.194'	FTI Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Vitex parviflora Juss.	14°30.303'	121°02.195'	FTI Station
Vitex parviflora Juss.	14°30.304'	121°02.196'	FTI Station
Vitex parviflora Juss.	14°30.282'	121°02.205'	FTI Station
Pterocarpus indicus Willd.	14°30.282'	121°02.204'	FTI Station
Pterocarpus indicus Willd.	14°30.313'	121°02.187'	FTI Station
Pterocarpus indicus Willd.	14°30.317'	121°02.186'	FTI Station
Vitex parviflora Juss.	14°30.292'	121°02.197'	FTI Station
Alstonia macrophylla Wall. ex D.C.	14°30.296'	121°02.196'	FTI Station
Vitex parviflora Juss.	14°30.297'	121°02.197'	FTI Station
Vitex parviflora Juss.	14°30.298'	121°02.198'	FTI Station
Vitex parviflora Juss.	14°30.263'	121°02.215'	FTI Station
Pterocarpus indicus Willd.	14°30.264'	121°02.213'	FTI Station
Pterocarpus indicus Willd.	14°30.263'	121°02.215'	FTI Station
Pterocarpus indicus Willd.	14°30.304'	121°02.222'	FTI Station
Pterocarpus indicus Willd.	14°30.209'	121°02.241'	FTI Station
Pterocarpus indicus Willd.	14°30.214'	121°02.237'	FTI Station
Pterocarpus indicus Willd.	14°30.221'	121°02.235'	FTI Station
Pterocarpus indicus Willd.	14°30.293'	121°02.216	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.132'	121°02.290'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.139'	121°02.290'	FTI Station
Pterocarpus indicus Willd.	14°30.185'	121°02.263'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.189'	121°02.254'	FTI Station
Vitex parviflora Juss.	14°30.288'	121°02.220'	FTI Station
Pterocarpus indicus Willd.	14°30.292'	121°02.217'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.096'	121°02.304'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.097'	121°02.299'	FTI Station
Pterocarpus indicus Willd.	14°30.110'	121°02.295'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.111'	121°02.295'	FTI Station
Vitex parviflora Juss.	14°30.288'	121°02.220'	FTI Station
Pterocarpus indicus Willd.	14°33.609'	121°03.408'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.612'	121°03.405'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.623'	121°03.393'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.626'	121°03.396'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.617'	121°03.371'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.617'	121°03.375'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.623'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.626'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.626'	121°03.380'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.631'	121°03.382'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.507'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.620'	121°03.376'	Kalayaan Ave. Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°33.590'	121°03.394'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.584'	121°03.392'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.579'	121°03.387'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.572'	121°03.389'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.562'	121°03.384'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.609'	121°03.349'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.543'	121°03.392'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.541'	121°03.386'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.521'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.522'	121°03.366'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.520'	121°03.366'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.565'	121°03.379'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.558'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.577'	121°03.369'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.578'	121°03.362'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.586'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.592'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.603'	121°03.347'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.509'	121°03.354'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.522'	121°03.358'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.522'	121°03.356'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.525'	121°03.362'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.533'	121°03.359'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.535'	121°03.367'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.535'	121°03.371'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.540'	121°03.360'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.566'	121°03.365'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.564'	121°03.372'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.561'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°38.238'	121°02.921'	East Ave. Station
Pterocarpus indicus Willd.	14°38.211'	121°03.079'	East Ave. Station
Pterocarpus indicus Willd.	14°38.206'	121°03.096'	East Ave. Station
Pterocarpus indicus Willd.	14°38.207'	121°03.105'	East Ave. Station
Pterocarpus indicus Willd.	14°38.201'	121°03.111'	East Ave. Station
Pterocarpus indicus Willd.	14°38.200'	121°03.125'	East Ave. Station
Pterocarpus indicus Willd.	14°38.198'	121°03.135'	East Ave. Station
Pterocarpus indicus Willd.	14°38.238'	121°02.921'	East Ave. Station
Pterocarpus indicus Willd.	14°38.188'	121°03.192'	East Ave. Station
Pterocarpus indicus Willd.	14°38.189'	121°03.194'	East Ave. Station
Toona calantas Merr. & Rolfe	14°38.204'	121°03.143'	East Ave. Station
Drynaria quercifolia	14°38.204'	121°03.143'	East Ave. Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°38.183'	121°03.176'	East Ave. Station
Pterocarpus indicus Willd.	14°38.167'	121°03.255'	East Ave. Station
Vitex parviflora Juss.	14°38.165'	121°03.251'	East Ave. Station
Vitex parviflora Juss.	14°38.181'	121°03.178'	East Ave. Station
Pterocarpus indicus Willd.	14°38.181'	121°03.185'	East Ave. Station
Calophyllum inophyllum L.	14°33.132'	121°03.340'	BGC Station
Calophyllum inophyllum L.	14°33.124'	121°03.338'	BGC Station
Calophyllum inophyllum L.	14°33.127'	121°03.344'	BGC Station
Calophyllum inophyllum L.	14°33.113'	121°03.339'	BGC Station
Calophyllum inophyllum L.	14°33.121'	121°03.334'	BGC Station
Calophyllum inophyllum L.	14°33.014'	121°03.299'	BGC Station
Calophyllum inophyllum L.	14°33.016'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°33.018'	121°03.298'	BGC Station
Calophyllum inophyllum L.	14°33.057'	121°03.299'	BGC Station
Calophyllum inophyllum L.	14°33.030'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°33.029'	121°03.300'	BGC Station
Calophyllum inophyllum L.	14°33.050'	121°03.320'	BGC Station
Calophyllum inophyllum L.	14°33.005'	121°03.331'	BGC Station
Calophyllum inophyllum L.	14°33.060'	121°03.331'	BGC Station
Calophyllum inophyllum L.	14°33.074'	121°03.332'	BGC Station
Calophyllum inophyllum L.	14°33.082'	121°03.333'	BGC Station
Calophyllum inophyllum L.	14°33.073'	121°03.328'	BGC Station
Calophyllum inophyllum L.	14°33.076'	121°03.350'	BGC Station
Calophyllum inophyllum L.	14°33.060'	121°03.354'	BGC Station
Calophyllum inophyllum L.	14°33.046'	121°03.361'	BGC Station
Calophyllum inophyllum L.	14°33.052'	121°03.339'	BGC Station
Calophyllum inophyllum L.	14°33.012'	121°03.320'	BGC Station
Calophyllum inophyllum L.	14°33.013'	121°03.304'	BGC Station
Calophyllum inophyllum L.	14°33.017'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°33.018'	121°03.301'	BGC Station
Calophyllum inophyllum L.	14°33.024'	121°03.306'	BGC Station
Calophyllum inophyllum L.	14°33.015'	121°03.302'	BGC Station
Calophyllum inophyllum L.	14°33.059'	121°03.333'	BGC Station
Calophyllum inophyllum L.	14°33.048'	121°03.330'	BGC Station
Calophyllum inophyllum L.	14°33.047'	121°03.335'	BGC Station
Calophyllum inophyllum L.	14°33.040'	121°03.322'	BGC Station
Calophyllum inophyllum L.	14°33.036'	121°03.322'	BGC Station
Calophyllum inophyllum L.	14°33.024'	121°03.314'	BGC Station
Calophyllum inophyllum L.	14°32.986'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°32.992'	121°03.306'	BGC Station
Calophyllum inophyllum L.	14°32.995'	121°03.292'	BGC Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Calophyllum inophyllum L.	14°32.995'	121°03.292'	BGC Station
Calophyllum inophyllum L.	14°33.011'	121°03.303'	BGC Station
Calophyllum inophyllum L.	14°33.006'	121°03.320'	BGC Station
Calophyllum inophyllum L.	14°33.001'	121°03.322'	BGC Station
Calophyllum inophyllum L.	14°32.997'	121°03.318'	BGC Station
Calophyllum inophyllum L.	14°32.993'	121°03.308'	BGC Station
Calophyllum inophyllum L.	14°32.989'	121°03.310'	BGC Station
Calophyllum inophyllum L.	14°33.090'	121°03.315'	BGC Station
Calophyllum inophyllum L.	14°33.093'	121°03.337'	BGC Station
Calophyllum inophyllum L.	14°33.094'	121°03.343'	BGC Station
Calophyllum inophyllum L.	14°33.089'	121°03.341'	BGC Station
Calophyllum inophyllum L.	14°33.094'	121°03.336'	BGC Station
Calophyllum inophyllum L.	14°33.100'	121°03.341'	BGC Station
Calophyllum inophyllum L.	14°32.940'	121°03.277'	BGC Station
Calophyllum inophyllum L.	14°32.932'	121°03.280'	BGC Station
Calophyllum inophyllum L.	14°32.928'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.922'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.914'	121°03.271'	BGC Station
Calophyllum inophyllum L.	14°32.912'	121°03.270'	BGC Station
Calophyllum inophyllum L.	14°32.910'	121°03.272	BGC Station
Calophyllum inophyllum L.	14°32.906'	121°03.260'	BGC Station
Calophyllum inophyllum L.	14°32.902'	121°03.270'	BGC Station
Calophyllum inophyllum L.	14°32.894'	121°03.266'	BGC Station
Calophyllum inophyllum L.	14°32.892'	121°03.265'	BGC Station
Calophyllum inophyllum L.	14°32.892'	121°03.261'	BGC Station
Calophyllum inophyllum L.	14°32.881'	121°03.259'	BGC Station
Calophyllum inophyllum L.	14°32.876'	121°03.256'	BGC Station
Calophyllum inophyllum L.	14°32.870'	121°03.255'	BGC Station
Calophyllum inophyllum L.	14°32.861'	121°03.257'	BGC Station
Calophyllum inophyllum L.	14°32.859'	121°03.256'	BGC Station
Calophyllum inophyllum L.	14°32.857'	121°03.267'	BGC Station
Calophyllum inophyllum L.	14°32.861'	121°03.263'	BGC Station
Calophyllum inophyllum L.	14°32.866'	121°03.266'	BGC Station
Calophyllum inophyllum L.	14°32.870'	121°03.269'	BGC Station
Calophyllum inophyllum L.	14°32.875'	121°03.270'	BGC Station
Calophyllum inophyllum L.	14°32.880'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.879'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.883'	121°03.272'	BGC Station
Calophyllum inophyllum L.	14°32.887'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.892'	121°03.276'	BGC Station
Calophyllum inophyllum L.	14°32.894'	121°03.270'	BGC Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Calophyllum inophyllum L.	14°32.899'	121°03.279'	BGC Station
Calophyllum inophyllum L.	14°32.915'	121°03.279'	BGC Station
Calophyllum inophyllum L.	14°32.918'	121°03.287'	BGC Station
Calophyllum inophyllum L.	14°32.925'	121°03.285'	BGC Station
Calophyllum inophyllum L.	14°32.930'	121°03.279'	BGC Station
Adonidia merrillii (Becc.) Becc.	14°36.859'	121°04.242'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.910'	121°04.290'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.912'	121°04.243'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.913'	121°04.244'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.963'	121°04.253'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°37.038'	121°04.290'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.914'	121°04.243'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.915'	121°04.242'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.915'	121°04.244'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.916'	121°04.247'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°37.059'	121°04.256'	Katipunan Ave. Station
Pterocarpus indicus Willd.	14°38.192'	121°03.125'	East Ave. Station
Pterocarpus indicus Willd.	14°38.195'	121°03.118'	East Ave. Station
Pterocarpus indicus Willd.	14°38.192'	121°03.122'	East Ave. Station
Calophyllum inophyllum L.	14°38.809'	121°03.083'	East Ave. Station
Pterocarpus indicus Willd.	14°38.754'	121°02.229'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°38.743'	121°02.213'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°38.735'	121°02.216'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°38.709'	121°02.233'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°39.274'	121°02.129'	North Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.407'	121°01.680'	Mindanao Ave. Station
Ficus ulmifolia Lam.	14°41.288'	121°01.815'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.385'	121°01.705'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.387'	121°01.698'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.388'	121°01.598'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.394'	121°01.692'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.398'	121°01.687'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.401'	121°01.685'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.404'	121°01.680'	Mindanao Ave. Station
Pterocarpus indicus Willd.	14°34.528'	121°03.659'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.530'	121°03.677'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.592'	121°03.742'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.590'	121°03.736'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.542'	121°03.701'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.551'	121°03.706'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.555'	121°03.722'	Ortigas South Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.712'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.710'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.549'	121°03.719'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.556'	121°03.719'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.556'	121°03.719'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.557'	121°03.724'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.559'	121°03.718'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.722'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.717'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.555'	121°03.717'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.558'	121°03.715'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.552'	121°03.713'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.600'	121°03.750'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.567'	121°03.726'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.493'	121°03.678'	Ortigas South Station

Appendix E-5:
In Situ Photos of Plants

laniti (*Wrightia pubescens ssp. laniti*)

Manila palm *(Adonidia merrillii*)

[redacted]

[redacted]

Identified Threatened Plants in Valenzuela Depot Site

kalantas (*Toona calantas)*

kabkabin (*Drynaria quercifolia)*

Identified Threatened Plants in East Ave. station location

Palo Maria (*Calophyllum inophyllum)*at the BGC station location

Identified Threatened Plants in Cayetano Blvd. station location

Center Island at FTI station location

APPENDIX F

Methodology for Estimating Carbon Stocks and Sequestration

CARBON STOCKS AND SEQUESTRATION

The amount of carbon stocks and carbon sequestration of the flora in the area to be displaced by the MMSP were estimated using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for Settlements (Chapter 8) under the Land Use, Land Use Change and Forestry (LULUCF). Based on the guidelines the settlements category refers to “all classes of urban formation that have been in use as settlements since the last time data were recorded”. It consists of areas that are functionally or administratively associated with public or private land in cities, villages, or other settlement types.

The carbon stocks or the amount of carbon present in the woody plants were determined using the Tier 2b of the guidelines or the individual plant growth method. In this method, the amount of biomass material is calculated using the biomass estimation allometric equation published by Chave et al. (2014) as follows:

$$Y = 0.0673 \times (\rho D^2 H)^{0.976}$$

Where: Y = tree biomass in kg
ρ = wood density in grams per cubic centimetre (g/cc)
D = Diameter at breast height in centimetre (cm)
H = height in meters (m)

The diameter at breast height and the height of the floras where individually measured during the inventory. The wood density for each species identified was obtained from an online database (http://db.worldagroforestry.org/). For species not included in the database, a value of 0.45 was used which is within the range of wood density of floras in the Philippines.

The amount of carbon in the biomass is assumed at 0.45 or 45% of the biomass which is the default value for the Philippines (Lasco & Puhlin, 2000). The value of carbon stocks in terms of Carbon Dioxide is obtained by multiplying the carbon content of the biomass by 3.6663. In summary the total above soil carbon stock from the biomass inventory was calculated using the following formula.

The annual carbon sequestration of the plants and trees can be estimated from the annual growth rate of each species. However, due to absence of information, the annual carbon sequestration was calculated by dividing the carbon stock by the estimated age of tree. In summary, the annual carbon sequestration in terms of kilogram CO_2 was determined using the following formula.

$$\sum \frac{1.6498 Y_i}{T_i}$$

Where: Y_i = the biomass material of each species in kilograms
T_i = the estimated age of each plant in years.

APPENDIX G

Water Bodies Along the MMSP Alignment

APPENDIX H

Results of Air, Noise and Water Survey

Appendix H.1: Air and Noise

Appendix H.2: Surface Water and Groundwater

APPENDIX I

Documentation of surveys and sampling activities

APPENDIX J

Prediction and Assessment of Noise and Vibration Levels

PREDICTION AND ASSESSMENT OF NOISE AND VIBRATION LEVELS

A. Noise Levels during the Construction Phase

Noise level will definitely increase because of construction activities. Most of the noisewill becontributed by operation of heavy equipment and machineries, the generator set, and vehicles coming inand out of the Project site.

Prediction method:

The prediction model developed in "Prediction model for construction noise (ASJ CN-Model 2007) by The Acoustical Society of Japan" is applied.

Prediction model:

The noise levels at prediction points are calculated by the following formulas:

$$L_A = 10 \log_{10} \Sigma 10^{L_{A,i}/10}$$
$$L_{A,i} = L_{WA,i} - 10 \log (Q/4\pi r^2) = L_{WA,i} - 20 \log r - 8$$

Where, L_A: Composite noise level of construction units at predictionpoint (dB)
r: Distance between noise source and prediction point(m)
Q: Constant on sound radiation (in case of hemisphere radiation: =2)
$L_{A,i}$: Effective noise level of individual noise source i (construction unit i)at perdition point (dB)
$L_{WA,i}$: Effective A-weighted sound power level of construction unit i(dB)

Effective A-weighted sound power level of construction unit:

Construction units that have potentially high noise levels were selected as the prediction targets.

Construction Activities	**Effective A-weighted Sound Power Level**
Pilling works*	106 dB
Skeleton construction works*	105 dB
Excavating works	110 dB

* Construction works at the stations
** Vertical shaft construction works of tunnel

Location of noise source and prediction point:

The noise emission source (construction machinery) is assumed to be set on 5 m (minimum radius of construction machinery) point from the edge of the construction limit, where the highest impact of noise is predicted. The height of the noise emission source is assumed to be set 1.5 m that is a general height of driving of construction machinery. The prediction point is assumed to be set on the edge of the construction limit, and the height is set 1.2m.

B. Vibration Levels during the Construction Phase

Operation of construction machinery, such as pile driver and rock drilling, causes ground vibrations. Because ground vibrations from construction activities spread through the ground and diminish in strength with distance, these do not often reach the levels that can damage structures, but can achieve the audible and sensing ranges for humans very near the construction site.

Prediction method:

The prediction model developed in "Environmental Impact Assessment Technique for Road Project (2012) by National Institute for Land and Infrastructure Management, Japan" is applied.

Prediction model:

The vibration levels at prediction points are calculated by the following formulas:

$L = 20 \log_{10} (a_w/a_0)$
V: Vibration level (dB)
a_w: Frequency weighted acceleration reflecting human perception(m/s^2)
a_0: Standard acceleration $=10^{-5}$ (m/s^2)

$V_A = 10 \log_{10} \Sigma 10^{Vr,i/10}$
$Vr = Vr_0 - 15 \log_{10} (r/r_0) - 8.68\, \alpha\, (r - r_0)$
Where, V_A: Composite vibration level of construction units at prediction point (dB)
$V_{r,i}$: Vibration level of individual vibration source i (construction unit i) at perdition point (dB)
V_r: Vibration level at prediction point (dB)
V_0: Vibration level at reference point (dB)
r: Distance from a vibration source (construction machinery) to prediction point (m)
r_0: Distance of reference point (= 5m)
α: Internal damping ratio

Vibration level of construction unit at reference point:

Construction units that have potentially high vibration levels were selected as the prediction targets.

Construction unit	Vibration level at reference point	Internal damping ratio
Excavation works	63 dB	0.001
Refilling works (Earthwork)	63 dB	0.01

Note:
Construction works of station: Excavation works and refilling works
Vertical shaft construction works of tunnel: Excavating works

Location of vibration source and prediction point:

The vibration emission source (construction works) is assumed to be set on 5 m (minimum radius of construction machinery) point from the edge of the construction limit, where the highest impact of noise is predicted. The prediction point is assumed to be set on the edge of the construction limit (borderline) and 5 m outer point from the borderline.

C. Vibration Levels during the Operation Phase

Prediction method:

The prediction model developed in "Teito Rapid Transit Authority, Japan" is applied.

Prediction model:

The vibration levels at prediction points are calculated by the following formulas.

$L = 20 \log_{10} (a_w/a_0)$
V: Vibration level (dB)
a_w: Frequency weighted acceleration reflecting human perception(m/s2)
a_0: Standard acceleration $=10^{-5}$ (m/s^2)

$VA = K - 20\log_{10} (X/15) - 24\log_{10} (Y/20) + 20\log_{10} (Z/40)$
Where, VA: Vibration level of at predictionpoint (dB)
K: Standard value of resilient tie in single shield tunnel (41)
X: Distance from subway tunnel to prediction point (m)
Y: Unit wait of subway tunnel (16 t/m)
Z: Running speed of train (70 km/h)

Location of prediction point:

The prediction points are set on 10, 20 and 30 m point from the subway tunnel.

APPENDIX K

Environmental Risk Assessment Matrix

ENVIRONMENTAL RISK ASSESSMENT RATING FOR MMSP

POSSIBLE HAZARDS	SEVERITY				PROBABILITY	RELATIVE RISK
	People	Financial	Public	Environment		
Construction related accidents	3	2	1	1	3	21
Toxic chemicals	1	1	1	2	2	10
Fire	4	4	2	4	2	28
Rail system failure	3	3	2	1	3	27
Structural failure	4	4	2	1	3	33
Terrorism attacks	4	4	4	4	2	32
Security and violence incidents	2	1	1	1	4	20
Transmission of infectious diseases	2	1	1	1	2	10

Risk Legend:

- Low: 1 - 15
- Medium: 16 -30
- High: 31 -50
- Very High: 51-80

APPENDIX L

Project Environmental Monitoring And Audit Prioritization Scheme (PEMAPS) Questionnaire

ROWA, Resettlement, Environment, and Livelihood Updates

As of July 25, 2019

I. RIGHT-OF-WAY ACQUISITION (ROWA)

Affected Lots and Structures

Section	Parcels of Land	Landowners	Structures
Depot	404	276	639
Quirino Highway	30	20	25
Tandang Sora	54	40	45
North Avenue	2	2	5
TOTAL	**490**	**338**	**714**

Major ROWA activities

Activity	Target Timeline
Stakeholder Consultation Meeting for affected Land Owners for the submission of the Owner's Copy of Title and signing of revised DOAS	July 29, 2019
Preparation of Letter Offers and Deed of Sale (DOS/DOAS) ➢ Depot ➢ PO stations	 May-June July
Distribution of Letter Offers and DOS/DOAS ➢ Depot ➢ PO Stations	 June-July August
Conduct of DMS for North Avenue: Veterans Memorial Medical Center	August 5-9, 2019
Completion of documents for submission to Finance and Management for processing of payments ➢ Batch 1: Vacant lots in the Ugong Depot	August-September

II. RESETTLEMENT

Summary of PAPs for relocation and rental assistance

	No. of PAPs
For Relocation	183
For Rental Assistance	328
TOTAL	**511**

Major Resettlement activities

Activity	Target timeline
RAP Implementation Management Committee Establishment	First week of August
Informal Settler Families (ISFs) Application for Relocation	
➢ Coordination meeting with National Housing Authority (NHA) and Housing and Resettlement Office re: workplan for the upcoming activities	August 5

Activity	Target timeline
➢ NHA- Tagging and Census Validation (TCV) or Verification	August 13-16, 2019
➢ NHA Approved Master List	September
Preparation of ISFs for relocation	
➢ NHA and LGU Unit Allocation/Lot Raffle	August
➢ PAFs Orientation on actual transfer, schedule, system and process.	August
Distribution of Other Entitlements	September
Actual Relocation	September
Post-relocation monitoring and assistance	October

III. LIVELIHOOD

Major Livelihood Restoration Activities

Activity	Target Timeline
Data completion and categorization through validation for Livelihood Restoration	August
Development of Livelihood and Income Restoration Program menu	
▪ Exploratory meeting with livelihood and relevant offices/institutions for available skills training/ job placement/ business financing services	August
▪ Exploratory meeting with LGU/RIMC, and the JV? For hiring of affected PAPs during construction	August
Processing of temporary closure of businesses or transfer of businesses	August
Completion of requirements for the processing of entitlements	August
Distribution of Entitlements	September onwards
Conduct of trainings and other livelihood programs available for businesses and affected employees	4^{th} quarter 2019 onwards
Conduct of job fair (hiring of skilled workers for construction related jobs)	4^{th} quarter 2019
Processing of RFOs; assistance in seeking capitalization for micro-businesses	4^{th} quarter 2019 onwards
Monitoring of PAPs and businesses	2020

ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR METRO MANILA SUBWAY PROJECT (MMSP) (Phase 1)

VOLUME II

APPENDICES

SEPTEMBER 2017

DEPARTMENT OF TRANSPORTATION (DOTr)

Table of Contents

APPENDIX A

Documentation of the EIA Process

1. DESCRIPTION OF THE PROJECT'S EIA PROCESS

1.1. TERMS OF REFERENCE OF THE EIA STUDY

The Environmental Impact Assessment (EIA) Study was commissioned by Oriental Consultants Global Co., Ltd. (OCG) through Japan International Cooperation Agency (JICA) and in coordination with the Department of Transportation (DOTr). The scope of the study covers the Central Zone of the Metro Manila Subway Project, which starts at Mindanao Avenue-Quirino Highway in Quezon City and ends in FTI, Taguig City and a portion in Brgy. San Martin de Porres in Paranaque City.

The Study consists of the following components:

1) To collect the baseline information and carry out the field surveys on the project affected area;
2) To identify potential project impacts on natural and social environment, and predict and assess the impacts;
3) To draw up the mitigation measures and monitoring plans;
4) To prepare the materials for, facilitate and assist OCG and DOTr on stakeholder meetings such as Information, Education and Communication (IEC) for local government units (LGUs), and public consultation meetings, in coordination with DOTr and OCG;
5) To prepare the Environmental Impact Statement (EIS) report;
6) To prepare required documents for the application of Environmental Compliance Certificate (ECC); and,
7) To assist DOTr to secure ECC.

1.2. THE EIA TEAM

Delta Tierra Consultants, Inc. is a private consulting firm that provides environmental, energy and sustainability solutions to various industry sectors and public and private institutions. Table shows the EIA Team for the subway project.

Table 1. EIA Team for the Metro Manila Subway Project

Name	Position	Qualifications
Engr. Angelica A. Celicious	Team Leader / Environmental Specialist	M.S. Environmental Engineering (EnE);B.S. Chemical Engineering (ChE)
Ms. Charlotte Jennifer M. Calonge	Environmental & Social Safeguards Specialist	M.S. Environmental Science; B.S. Chemistry
Mr. James Allan P. Reyes	Geologist	B.S. Geology
Engr. Marianito T. Margarito	Air and Noise Quality Expert	M.S. Environmental Engineering (EnE); B.S. Chemical Engineering (ChE)
Mr. Ulysses F. Ferreras	Biology Expert	M.A. Environmental Management (with units); B.S. Biology; B.S. Agricultural Technology
Ms. Milagros S. Antofina	EIA Technical Assistant	B.S. Chemistry

1.3. EIA STUDY SCHEDULE

Table 2 presents the completed activities for the EIA study.

Table 2. Completed Activities of the EIA Study

Activity	Areas Covered	Dates Covered
The Land		
Site survey	The entire MMSP alignment including the proposed depot site in Brgy. Ugong, Valenzuela	January to July 2017
Landscape	Depot site in Brgy. Ugong, Valenzuela	May 5, 2017
Flora survey	Depot site in Brgy. Ugong, Valenzuela and all proposed stations	April 28, July 5-18
Ground Vibration measurements	Along the MMSP alignment in the following areas: • Rolling Hills Resort, Brgy. Ugong, Valenzuela City • Landcom Village II, Tandang Sora, Quezon City • Trinoma Parking Lot, Mindanao Ave., Quezon City • Centris Walk, Quezon Ave., Quezon City • World Citi Medical Center Parking Lot, Aurora Boulevard, Quezon City • Brgy. Blue Ridge A, Project 4, Quezon City • Estancia Mall Parking Lot, Capitol Commons, Meralco, Ave., Pasig City • BCDA Field Office – Pamayanang Diego Silang, Cayetano Boulevard • FTI – PNR Station, Taguig City	March 27 – May 4, 2017
The Water		
Surface water quality sampling	At the rivers along the MMSP alignment in the following areas: • Tullahan River (along Mindanao Avenue) • San Juan River (along Mindanao Avenue, Quezon City) • Pasig River, Makati City	March 1, 2017
The Air / Noise		
Ambient air quality sampling	Along the MMSP alignment in the following areas: • Rolling Hills Resort, Brgy. Ugong, Valenzuela City (dry season) • Hyundai Powerlifter Phils., Inc.,	Dry season (March 27 – May 3, 2017) and Wet season (July 10 – 27, 2017)

Activity	Areas Covered	Dates Covered
	Mindanao Avenue, Valenzuela City (wet season) • Pacific Global Medical Center, Mindanao Avenue, Quezon City (wet season) • Landcom Village II, Tandang Sora, Quezon City (wet season) • Trinoma Parking Lot, Mindanao Ave., Quezon City (wet and dry seasons) • Avida Tower I, EDSA, Quezon City (wet season) • AFP Medical Center, V.Luna St., Diliman, Quezon City (wet season) • Brgy. Blue Ridge A, Project 4, Quezon City (wet season) • MMDA Compound, Julia Vargas Ave., Ortigas, Pasig City (wet and dry seasons) • Estancia Mall Parking Lot, Capitol Commons, Meralco, Ave., Pasig City (wet season) • World Citi Medical Center Parking Lot, Aurora Boulevard, Quezon City (wet and dry seasons) • Market Market Parking Lot, BGC, Taguig City (wet and dry seasons) • BGC Parking lot 11th St. cor. 38th St. (wet season) • FTI – PNR Station, Taguig City (wet and dry seasons)	
Noise measurements	Along the MMSP alignment in the following areas: • Rolling Hills Resort, Brgy. Ugong, Valenzuela City • Landcom Village II, Tandang Sora, Quezon City • Trinoma Parking Lot, Mindanao Ave., Quezon City • Centris Walk, Quezon Ave., Quezon City • World Citi Medical Center Parking Lot, Aurora Boulevard, Quezon City • Brgy. Blue Ridge A, Project 4, Quezon	March 27 – May 4, 2017 and July 10 – 27, 2017

Activity	Areas Covered	Dates Covered
	City • Estancia Mall Parking Lot, Capitol Commons, Meralco, Ave., Pasig City • BCDA Office, Cayetano Blvd • FTI – PNR Station, Taguig City	
The People		
IEC meetings with the LGUs	For pre-scoping activity	December 6 – March 18, 2017
Stakeholders Meeting and Public Consultation	For Public Scoping	March 9 – April 27, 2017
Historical/Cultural Heritage	BGC, Taguig City	May 18, 2017

1.4. EIA METHODOLOGY

The EIA was carried out following Terms of Reference (TOR) agreed with the JICA Study Team. The EIA process was also guided by the DENR Administrative Order No. 30 of 2003 or the Implementing Rules and Regulations of Presidential Decree No. 1586, Establishing the Philippine Environmental Impact Statement System.

1.4.1. Secondary Data Gathered and Sources

The secondary data and information on the baseline environmental conditions for land, water, air, and people of the cities along the MMSP alignment and proposed depot location from Valenzuela City to Taguig City are collected from various sources, mainly from relevant government organizations and academic institutions. Other secondary information was sourced from published documents and literatures from previous studies conducted, and from the internet. Project component and description, and other relevant data on the details of the MMSP were provided by DOTr and the JICA Study Team. Table 3 shows the sources of information collected for this study.

Table 3. Information Collected and Sources of Information

Data/Information Collected	Source
Project description, which includes the background of the project, scope of the alignment including maps and basic design of stations	DOTr, JICA Study Team
Pre-feasibility study of MMSP	JICA Study Team
Comprehensive Land Use Plan (CLUP) of the 7 cities affected by the alignment	City Planning Department of the 7 affected cities
Geohazard Maps, Earthquake hazards and risk assessment	Mines and Geosciences Bureau (MGB), Philippine Institute of Volcanology and Seismology (PHIVOLCS)
Flood hazard maps and landslide-related information	The University of the Philippines Nationwide Operational Assessment of Hazards (UP NOAH)/ Department of Science and

Data/Information Collected	Source
	Technology (DOST) PROJECT NOAH
Groundwater data	National Water and Resource Board (NWRB) Local Water Utilities Administration (LWUA)
Climatological and climate change trends and projections	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA), Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)
National Air Quality Status	Department of Environment and Natural Resources (DENR)
Census and Population Data	National Statistics Office (NSO)
Traffic Data	Land Transportation Office
Information on the Fort Bonifacio War Memorial Tunnel traversing Bonifacio Global City, Taguig City and Brgy. Pembo in Makati City	Bases and Conversion Development Authority (BCDA)

1.4.2. Primary/Baseline Data

Primary data were obtained through ocular site inspection along the MMSP alignment to validate the secondary data and evaluate the existing environmental conditions. Field surveys and sampling/measurements at pre-identified locations were also conducted as shown in Table 2.Methodologies used for the sampling, measurement and analysis are summarized in Table 4.

Table 4. Methodologies for sampling and analysis

Parameter	Sampling Method	Method of Analysis
Surface water quality		
Color	Grab sampling	SMEWW Method 2120B - Visual Comparison
Water Temperature		SMEW Method 2550 - Thermometry
pH		SMEWW Method 4500H$^+$ - Electrometric Method
Dissolved oxygen (DO)		SMEWW Method 4500OC - Azide Modification
Biochemical Oxygen Demand (BOD)		SMEWW Method 5210B - Azide Modification
Total Suspended Solid (TSS)		SMEWW Method 2540D - Gravimetry
Surfactants (MBAS)		SMEWW Method 5540C - Colorimetry
Oil/Grease (Petroleum Ether Extracts)		EPA Method 413.1 - Pet Ether Extraction
Nitrate as Nitrogen		EPA Method 352.1 - Brucine Method
Phosphate as Phosphorus		SMEWW Method 4500PD - Stannous Chloride
Phenolic Substances as		SMEWW Method 5530C - Chloroform

Parameter	Sampling Method	Method of Analysis
Phenols		extraction
Total Coliforms or Fecal Coliforms		SMEWW Method 9221B&E
Chloride as Cl		SMEWW Method 4500ClB – Argentometry
Copper (dissolved copper)		EPA SW846 Method 7210 - Flame AAS
Arsenic		SMEWW Method 3500As – Colorimetry
Cadmium		EPA SW846 Method 7130 - Flame AAS
Chromium (hexavalent)		SMEWW Method 3500CrB – Colorimetry
Cyanide		ISE
Lead		EPA SW846 Method 7420 - Flame AAS
Total Mercury		EPA SW846 Method 7470A - Cold Vapor AAS
Organophosphates		EPA 8141A
Groundwater quality		
Color		SMEWW Method 2120B - Visual Comparison
Water Temperature		SMEW Method 2550 - Thermometry
pH		SMEWW Method 4500H^+ - Electrometric Method
Electric Conductivity		SMEWW Method 2510 - Conductimetric
Sodium (Na^+)		EPA SW846 Method 7770 - Flame AAS
Potassium (K^+)		EPA SW846 Method 7610 - Flame AAS
Calcium (Ca^+)		SMEWW Method 2340C - Titrimetry
Magnesium (Mg^+)		Flame AAS
Bicarbonate (HCO^{3-})		SMEWW Method 2320B - Titrimetry
Chloride (Cl^-)		SMEWW Method 4500ClB - Argentometry
Sulfate (SO_4^{2-})	Collected groundwater samples from deep well pumps	SMEWW Method 4500SO_4^{2-} - Turbidimetric
Nitrate (NO_3^-)		SMEWW Method 4500NO_3^-E - Cadmium Reduction
Arsenic		EPA SW846 Method 7061 - AAS Hydride
Cadmium		EPA SW846 Method 7130 - Flame AAS
Chromium (hexavalent)		SMEWW Method 3500CrB - Colorimetry
Cyanide		ISE
Lead		GFAAS
Total Mercury		EPA SW846 Method 7470A - Cold Vapor AAS
Total Coliforms or Fecal Coliforms		SMEWW Method 9221B&E

Parameter	Sampling Method	Method of Analysis
Ambient air quality		
Total Suspended Particulates (TSP)	High volume sampler, 24 hours sampling	Gravimetry
Particulates (PM10)	High Volume Sampler with 10 micron particle-size inlet, 24 hours sampling	Gravimetry
Nitrogen Oxides (NO_2)	Gas Bubbler, 24 hours sampling	Gravimetry
Sulphur Oxides (SO_2)		Griess Saltzman Reaction
Carbon Monoxide (CO)	1 hour continuous real time sampling / measurement	Pararosaniline
Ozone (O_3)	High volume sampler, 24 hours sampling	Direct Read out analyzer
Lead (Pb)	High Volume Sampler with 10 micron particle-size inlet, 24 hours sampling	Neutral Buffered Pottasium Iodide (NBKI) - Colorimetry
Noise and vibration		
Noise	Noise meter, 24 hours monitoring	Direct read out
Vibration	Geode seismic recorders and Accelerographs; Ground vibration monitoring for periods of up to 30 seconds every 10 minutes over 24 hrs	Spectral analysis using Fourier transform
Flora		
Vegetation survey	Walkthrough, visual observation, measurement of tree diameter and height	Analysis of taxa counts, endemicity and identification of threatened plants

1.4.3. Identification, Prediction and Assessment of Impacts

Potential impacts were identified based on description of project activities, its environmental aspects, and the existing condition of the environment or receptors that are susceptible to impacts. The identified impacts were evaluated in terms of the effects that will be encountered by the receptors, both the environment and people.

In reference to the established baseline environmental conditions, predicted and forecasted impacts will be evaluated against the Philippine standards, and in the absence of such, will be evaluated against international standards. Table 5 presents the reference criteria/standards of environmental quality and natural environment used for evaluating the identified impacts.

Table 5. Criteria/Standard of Environmental Quality and Natural Environment

Criteria/Standards	Philippine	International
Ambient air quality	National Ambient Air Quality Guideline Values, "Implementing Rules and Regulations of the Philippine Clean Air Act of 1999"	N/A
Noise	The National Pollution Control Commission (NPCC) Memorandum Circular No. 002 Series of 1980, Section 78- Ambient Noise Quality and Emission Standards for Noise	N/A
Vibration	N/A	Technology and Laws Regulation for Pollution Control, 2000", Japan Environmental Management Association for Industry
Surface Water Quality	DENR Administrative Order (DAO) No. 2016-08: Water Quality Guidelines and General Effluent Standards of 2016	N/A
Groundwater Quality	Philippine National Standards for Drinking Water 2007	N/A
Flora and Fauna	DAO No. 2004-15, Establishing the National List of Threatened Philippine Plants and Their Categories, and the List of Other Wildlife Species.	International Union for the Conservation of Nature and Natural Resources (IUCN) Red List

The severity of the identified impacts was assessed and rated according to the following:

Table 6. Impact Assessment Criteria

Assessment	Criteria
High Adverse	Impact is a major problem. An accepted limit or standard may be exceeded or large magnitude impacts occur to highly valued/ sensitive receptors. Extensive disturbance to current resources resulting in some minor human health effects upon nearby residents and businesses. Considerable permanent adverse disturbance of ecology due to contamination over a local scale. Mitigation measures and detailed design work are unlikely to remove all of the significant

Assessment	Criteria
	effects.
Moderate Adverse	Adverse change resulting in some loss or permanent lowering of resources, though no impact upon human health. Loss and permanent damage to ecology on a local scale. Some recovery is anticipated following completion of the works concerned. Mitigation measures are anticipated to alleviate close to all impacts.
Low Adverse	An effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards. Limited or temporary effects resulting in low levels of disturbance or loss to local resources or ecology. No impact upon human health. Close to full recovery is anticipated following completion of the works concerned. Mitigation measures are anticipated to alleviate close to all impacts.
Negligible	The receiving environment will not be affected in any way by a particular activity. No appreciable impacts upon local resources, human health or ecology. Effects are within normal bounds of variation.
Beneficial	Impact provides major improvement to the existing environment or major enhancement to the current condition. These can include measures to improve social values, resources, ecological health and long-term protection of ecological functions.

1.5. PUBLIC PARTICIPATION

1.5.1. Public Consultation for EIA

The pre-scoping or the IEC meetings with LGUs, which have jurisdiction over the project area, were conducted to formally introduce the MMSP to the concerned LGUs in preparation for the public consultation meetings, EIA surveys and socio-economic surveys that will be conducted as part of the EIA Study. The schedule and participants of the IEC meetings are summarized in Table 7.

Table 7. Schedule of IEC Meetings with LGUs

Date	LGU	Participants
December 7, 2016	Quezon City	City Mayor, City Planning Office, Engineering Department, DOTr, JICA Study Team (JST), DTCI
December 14, 2016	Caloocan City	City Mayor, Mayor's Office, City Planning Office, City Engineering Department, Brgy. 116, UPAO, DOTr, JST, DTCI
December 16, 2016 (morning)	Valenzuela City	City Mayor, Chief of Staff-Office of the Mayor, Brgy. Ugong, Housing and Resettlement Office, DOTr, JST, DTCI
December 16, 2016	Taguig City	Office of the City Administration, City Engineering

Date	LGU	Participants
(afternoon)		Office, DOTr, JST, DTCI
January 10, 2017	Makati City	City Administrator, City Legal Officer, DOTr, JST, DTCI
January 18, 2017	Pasig City	City Mayor, Transport Consultant, CENRO, TPMO, TED, DOTr, JST, DTCI
March 13, 2017	Parañaque City	City Mayor, City Assessor, CPDC, Brgy. San Martin de Porres, DOTr, JST, DTCI, Ecosys Corp.

The stakeholders' consultation meetings for environmental consideration and public scoping were conducted last March 9 to April 27, 2017in the six (6) affected cities. Table 8 shows the schedule and number of participants of the said meetings.

Table 8. Schedule of the Schedule of Stakeholders' Consultation Meetings for Environmental Consideration and Public Scoping

Date	LGU	No. of Participants
March 9, 2017	Makati City	20
March 16, 2017	Taguig City	25
March 20, 2017	Pasig City	32
March 21, 2017	Quezon City (Batch 1)	26
March 22, 2017	Quezon City (Batch 2)	49
April 26, 2017	Paranaque City	24
April 27, 2017	Valenzuela City	27

1.5.2. Public Consultation for RAP

DOTr, through the RAP consultants, has been holding stakeholder consultation meetings and public consultation meetingsin order to ensure public involvement through the process of resettlement planning. In addition, focus group discussions (FGD) were also held for the vulnerable groups or persons, such as women, elders and the poor segment of people. Minutes of the meetings are presented in Appendix B.

(1) First Round of the Public Consultation Meetings (PCM)

Public consultations have been held in each LGU as shown in Table 9. In the PCM, the outline of the MMSP projects, schedule for census and tagging, and the cut-off dates were announced.

Table 9. Outline of the First Round of Public Consultations

LGUs	Venue	Date	Participants	No. of Participants
Makati City	17/F Training Room, Building 1, Makati City Hall	18-Apr-2017	PAPs, LGU, DOTr	

LGUs	Venue	Date	Participants	No. of Participants
Pasig City	Legislative Session Hall, Pasig City Hall	18-Apr-2017	LGU Pasig,Brgy. Kapitolyo, Brgy. San Antonio, DOTr, JST, Ortigas & Co., OHI	20
Quezon City (Group A)	2nd Floor, DFA Conference Room, Civic Center Building C, Quezon City Hall	25-Apr-2017	LGU Quezon City,Brgy. Talipapa, Brgy. Tandang Sora, Brgy. Bagong Pagasa, Brgy. Pinyahan, Brgy. Bagumbuhay, Brgy. St. Ignatius, DOTr, JST, Residents, Lot owners	23
Quezon City (Group B)		26-Apr-2017		23
Valenzuela City	2nd Floor, Valenzuela Town Center, Valenzuela Town Hall A, Valenzuela City Hall	26-Apr-2017	LGU Valenzuela, Brgy. Ugong, DOTr, JST, Residents, Lot owners	98
Paranaque City	2nd Floor, Session Hall, Brgy. Hall of San Martin De Porres	27-Apr-2017	LGU Paranaque, Brgy. San Martin de Porres, Brgy. Merville, DOTr, JST, DMCI Raya, Green Cross, Inc, United Hills Village, PAPs	28
Taguig City	People's Hall, Taguig City Hall Satellite Office, 9th Floor, SM Aura,	2-May-2017	LGU Taguig, Brgy. Pinagsama, Brgy. Ususan, DOTr, JST, BCDA	12

Source: JICA Study Team

(2) Follow-up Meeting at Barangay Level

Having considered the low attendance of the first round of PCM at some LGUs, follow-up meeting was organized at barangay level at the following schedule shown below.

Table 10. Schedule of the Follow-up Meeting at Barangay Level

LGUs	Venue	Date	Stations
Quezon City	Barangay Hall of Talipapa	15-May-2017	Quirino Highway

	Barangay Hall of Tandang Sora	15-May-2017	Tandang Sora
	Barangay Hall of Pinyahan	18-May-2017	East Avenue
	Barangay Hall of Bagumbuhay	18-May-2017	Anonas
	Barangay Hall of Blueridge A	19-May-2017	Katipunan
Pasig	Barangay Hall of San Antonio	24-May-2017	Ortigas South Ortigas North

Source: JICA Study Team

(3) Second Round of the Public Consultation Meetings (PCM)

Table 11. Schedule of Second Round of Public Consultations

LGUs and Barangay	Venue	Date	Stations
Quezon City Barangay: Talipapa, Tandang Sora, Bagong Pag-asa	Barangay Hall of Talipapa,	15-May-2017	Mindanao-Quirino, Tandang Sora, North Avenue and Quezon Avenue Mindanao-Quirino
Quezon City Barangay: Pinyahan, Bagumbuhay	Barangay Hall of Bagumbuhay,	5-Jun-2017	East Avenue and Anonas
Quezon City Barangay: Blueridge, Bayanihan, St. Ignatius	Barangay Hall of St. Ignatius,	6-Jun-2017	Katipunan
Pasig City Barangay: San Antonio, Ugong, Oranbo, Kapitolyo	Barangay Hall of San Antonio,	7-Jun-2017	Ortigas South Ortigas North
Makati City Barangay: West Rembo	Barangay Hall of West Rembo	7-Jun-2017	Underground - No station
Paranaque City Barangay: San Martin De Porres, Merville	Barangay Hall of San Martin De Porres	8-Jun-2017	FTI
Valanzuela City Barangay: Ugong	Barangay Hall of Ugong	9-Jun-2017	Depot

Source: JICA Study Team

1.5.3. Public Hearing

After submission of the draft Environmental Impact Statement (EIS) Report to EMB-NCR, the full EIS Report, together with a laymanized Executive Summary for the Public (ESP) both in English and Filipino versions were made available to the public last August 18, 2017 through the EMB-DENR website at www.emb.gov.ph. Notice of Public Hearing from the EMB-DENR was published in two national broadsheets – Philippine Daily Inquirer and The Philippine Star, last August 21 and 28, 2017, respectively. Likewise, the notice was posted in bulletin boards at City Halls and barangays within the DIA and IIAs. The list of stakeholders previously identified during the initial consultation meetings were updated based on the delineation of DIAs and IIAs and based on the socio-ecoomic surveys being conducted in concurrence with the EIA study. Letters of invitation to attend the Public Hearing and copies of the ESP were sent to the identified stakeholders. Public hearings were conducted to achieve efficient exchange and views among DOTr, EMB-NCR, relevant agencies, LGUs and other stakeholders on the environmental impacts of the proposed project. Public hearings were conducted at the following schedule:

Table 12. Schedule of Public Hearing

Date	Venue	Stakeholders invited	No. of Participants
5-Sept-2017	10th Flr. Kalayaan Hall, SM Aura Office Tower, Taguig City	Stakeholders from Pasig, Makati, Taguig and Parañaque Cities	120
6-Sept-2017	3rd Flr., EPWMD Conference Room, Quezon City Hall	Stakeholders from Quezon City	85
7-Sept-2017	Roliing Hills Resort, Brgy. Ugong, Valenzuela City	Stakeholders from Valenzuela City	203

Stakeholder groups and representing individuals who were invited and participated in the public hearing are shown in Table 13. For Valenzuela City, Notice of Public Hearing was distributed to the affected business/lot owners and residents through theassistance from Barangay Ugong.

Table 13. List of Stakeholder Invited and Participated in the Public Hearing for MMSP

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Vizminda A. Osorio	Regional Director	Environmental Management Bureau-NCR	Government	D	D
Danilo Delapuz Lim	Chairman	Metro Manila Development Authority (MMDA)	Government	D	D
Terry L. Ridon	Chairperson	The Presidential Commission for the Urban Poor	Government	D	D
Maria Catalina Cabral	Undersecretary for Planning and PPP	Department of Public Works and Highways - Planning Services	Government	D	
Melvin Navarro	Regional Director	Department of Public Works and Highways - NCR	Government	D	D
		Department of Public Works and Highways - Metro Manila 3 District Engineering Office	Government	D	D
Renato Solidum, Jr.	Director	Philippine Institute of Volcanology and Seismology	Government	D	D
Ray Espinosa	Chief Corporate Services Officer	Philippine Long Distance Company	Public Utility	x	
Antonio La Vina	Executive Director	Manila Observatory (KLIMA)	NGO	D	
Bonar Laureto	Executive Director	Philippine Business for the Environment	NGO	D	
Reynaldo Antonio Laguda	Executive Director	Philippine Business for Sustainable Development	NGO	D	
Quezon City					
Herbert Bautista	City Mayor	City of Quezon	LGU Quezon City	D	D
Aldrin Cuna	City Administrator	City Administration Department	LGU Quezon City	D	D
Joselito Cabungcal	Head	Engineering Department	LGU Quezon City	D	D

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Frederika C. Rentoy	Head	Environmental Protection and Waste Management Department	LGU Quezon City	D	D
Ramon Asprer	Head	Housing and Community and Resettlement Department (HCDRD)	LGU Quezon City	D	D
Alfredo Roxas	Brgy. Captain	Brgy. Kaligayahan	LGU Quezon City	x	
Hector B. Geronimo	Brgy. Captain	Brgy. Tandang Sora	LGU Quezon City	D	
Rodolfo S. Palma	Brgy. Captain	Brgy. Bagong Pag-asa	LGU Quezon City	D	
Carlos D. Apo	Brgy. Captain	Brgy. Sauyo	LGU Quezon City	D	D
Fernando Asia, Jr.	Brgy. Captain	Brgy. Malaya	LGU Quezon City	D	
Annabella I. Curatcho	Brgy. Captain	Sikatuna Village	LGU Quezon City	D	D
Larry Handayan	Brgy. Captain	Brgy. South Triangle	LGU Quezon City	D	
Richard Ambita	Brgy. Captain	Brgy. Bagbag	LGU Quezon City	D	D
Ursula Juan	Brgy. Captain	Brgy. Talipapa	LGU Quezon City	D	D
Jose Visaya	Brgy. Captain	Brgy. Novaliches Proper	LGU Quezon City	x	
Vicente Honorio Llamas	Brgy. Captain	Brgy. Project 6	LGU Quezon City	D	
Gabriel C. Legaspi	Brgy. Captain	Brgy. Blue Ridge A	LGU Quezon City	D	D
Noel V. Lopez	Brgy. Captain	Brgy. West Triangle	LGU Quezon City	D	
Zaldy Nepomuceno	Brgy. Captain	Brgy. Sto.Cristo	LGU Quezon City	D	
Victor Ferrer, Jr.	Brgy. Captain	Brgy. Bahay Toro	LGU Quezon City	x	
Jesus Lipnica, Jr.	Brgy. Captain	Brgy. Pinyahan	LGU Quezon City	D	
Dominador L. Soliven,	Brgy. Captain	Brgy. East Kamias	LGU Quezon City	D	
Noel R. Agdeppa	Brgy. Captain	Brgy. Quirino 2A	LGU Quezon City	D	
Ma. Victoria V. Padolina	Brgy. Captain	Brgy. Quirino 3A	LGU Quezon City	D	D
Raulito Datiles	Brgy. Captain	Brgy. Bagumbuhay	LGU Quezon City	D	
Alejandro H. Cuizon	Brgy. Captain	Brgy. Milagrosa	LGU Quezon City	D	
Edwin Tansingco	Brgy. Captain	Brgy. St. Ignatius	LGU Quezon City	D	
Teresita Iguico	Brgy. Captain	Brgy. White Plains	LGU Quezon City	D	
Zarina Yasmine Xenelle W. Jorge	Brgy. Captain	Brgy. Ugong Norte	LGU Quezon City	D	D

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Simplicio EJ. Hermogenes	Brgy. Captain	Brgy. Philam	LGU Quezon City	D	
Dominador M. Chiong, Jr.	Director	Veterans Memorial Medical Center	Institution - DIA	D	D
Edwin Leo T. Torrelavega	Commanding General	Armed Forces of the Philippines (AFP) Health Service Command	Institution - DIA	D	
Rodaliza E. Lanctize	PEU	Armed Forces of the Philippines (AFP) Health Service Command	Institution - DIA	D	
James Kenley M. Torres	Executive Vice President	St. James College of Quezon City	Institution - IIA	D	D
Cynthia Lorenzo	President	Landcom Village II Homeowners Association	Residents - IIA	D	
Juan A. Lagunzad	President	Pacific Global Medical Center	Institution - DIA	D	D
Catherine Jane T. Ng	General Manager	Tony's Bar and Grill	Business - DIA	D	D
Jose Rodrigo C. Lozano	Complex Manager, Property Management	Trinoma	Business - DIA	D	represented by ALI
Ronna Cabalfin	Associate Business Development Manager	Ayala Land, Inc.	Business - DIA,IIA	D	D
John Paul M. Fernandez	Project-in-charge	Vertis North - Avida Vita Towers	Business - DIA,IIA	D	represented by ALI
Engr. Ronald Responde	Asst. Property Manager (Operations)	Eton Centris	Business - IIA	D	
Teresita Agda	President	Philippine Medical Women's Association	PO - IIA	D	
Jasmin Torres	Property Manager	Anonas LRT City Center	Business - IIA	D	
Richard Lazaro	Property Management	World Citi Medical Center	Institution - IIA	D	
Cristine Pabillaran	Dining Supervisor	Balay Ligaya Restaurant	Business - DIA	D	D
Ramon N. Eloriaga	Parish Priest	St. Joseph Parish Shrine	Institution - IIA	D	
Janine Tomara	Representative	Brgy.Bagumbuhay	Residents - DIA	D	
Flordeliza Pantig	President	Brgy.Bagumbuhay	Residents - DIA	D	
Francisco Arellano	Head of Corporate Quality, Environment,	Maynilad Water Services, Inc.	Public Utility	D	D

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
	Safety and Health				
Marc Tom Mulingbayan	Head, Sustainability Dept.	Manila Water Company, Inc.	Public Utility	D	D
John Mark Bordeos	Manager	Shell Gas Station	Business - DIA	D	
Maria Nelia Bongalbal	Business Owner	Brgy. Blue Ridge A	Residents - DIA	x	
Cherrie Paterno	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	x	
Jacquelene Manalantas	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	D	D
Zarah Jane Marasigan	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	D	D
Ces Muceros	Lot Owner	Brgy. Blue Ridge A	Residents - DIA	D	D
Gilbert Bernardo	Manager	Honda	Business - DIA	x	
Manuel Panuelas			Residents - DIA	x	
Tony Chua	Lot Owner	CHP Marketing Corp.	Business - DIA	D	D
Jowell Chua	Lot Owner	Unioil	Business - DIA	D	
Gilberta Bascara	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	D	
Lydia Malones	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	x	
Rolando Magsino	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	D	
Herminio Alminar	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	D	D
Luis Almazen	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	D	D
Rosita Bonifacio	Lot Owner	Brgy. Pinyahan, Q.C.	Residents - DIA	x	
Peter Tansiyok	Lot Owner	Brgy. St. Ignatius	Residents - DIA	x	
Gerry Crudo	Representative	Primo's Burger, Brgy. St. Ignatius	Business - IIA	x	
	Students	UP Diliman	Academe		D
Rommel Del Mundo	Office of Administrative Services	Asian Development Bank	Institution		D
RC G. Cesar	Representative	Green Convergence	NGO		D
Pasig City					
Bobby Eusebio	Mayor	City of Pasig	LGU Pasig	D	D
Alberto Dulay	Head	Traffic and Parking Management Office	LGU Pasig	D	D

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Lydia Gutana	Head	Traffic and Engineering Department	LGU Pasig	D	D
Engr. Hermogenes N. Lerio		City Engineer's Office	LGU Pasig	D	
Racquel A. Naciongayo		City Environment and Natural Resources Office	LGU Pasig	D	D
Engracio E. Santiago	Barangay Chairman	Brgy. Ugong	LGU Pasig	D	D
Noel R. Pajara	Barangay Chairman	Brgy. Kapitolyo	LGU Pasig	D	D
Vicente V. Javier, Jr.	Barangay Chairman	Brgy. Oranbo	LGU Pasig	D	
Joselito dela Merced	Barangay Chairman	Brgy. San Antonio	LGU Pasig	D	
Malou B. Reyes	General Manager	Ortigas Center Association Inc.	Business Organization	D	D
Geralyn Solida	Head, External Affairs	Manila Electric Company (MERALCO)	Private Utiity	D	D
Ramon Sumulong	Head, Property Management Shopping Centers Division	OCLP Holdings, Inc.	Business - DIA	D	D
Cris Arpon		Iriz One Propertis, Inc.	Business - IIA	D	
Keith Villareal	Property manager	Isquare Building	Business - IIA	D	
Oliver Joseph C. Uy	Proprietor	Green Peace Emission	Business - IIA	D	D
Cherry Arganda	Finance Director	Republic Apparel Retailers	Business - IIA	D	
Joel Virgino	HR Manager	Valuecare Health Systems	Business - IIA	D	D
Danilo Santos	President	Ardan Bldg. / San Aura Properties	Business - DIA	D	D
Nelia Chipeco	Chairman	Chipeco Bldg.	Business - DIA	D	
Edna San Buenaventura	Chairman	San Buena Bldg.	Business - DIA	D	D
Lawrence A. Paray	Sr. Architect	OCLP Holdings Inc.	Business - DIA	D	D
Jeremy Sy	Lot owner		Business - IIA	D	D
Makati City					
Abby Binay	Mayor	City of Makati LGU	LGU Makati City	D	D

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Atty. Claro Certeza	Makati City Administrator	City Administration Dept.	LGU Makati City	D	D
Engr. Leopoldo V. Parumog		Department of Environmental Services (DES)	LGU Makati City	D	D
Engr. Elmer V. Acuesta		Department of Engineering and Public Works (DEPW)	LGU Makati City	D	D
Engr. Merlina G. Panganiban		Urban Dev. Dept Makati City	LGU Makati City	D	
Mr. Ryan F. Barcelo		Makati Social Welfare Department (MSWD)	LGU Makati City	D	
Judith B. Celos	Barangay Captain	Barangay West Rembo	LGU Makati City	D	
Jeline M. Olfato	Barangay Captain	Barangay Pembo	LGU Makati City	D	D
Arnold J. Cruz	Barangay Captain	Barangay Rizal	LGU Makati City	D	
Tomas B. Lopez, Jr.	President	University of Makati	LGU Makati City	D	
Martin Millar		Villa Kalayaan Homeowners Association	Residents	x	
Distributed through the assistance of Barangay West Rembo					
Alfredo Penaflorida		157 Teachers Compound, West Rembo, Makati City	Residents	D	D
Robin delos Santos		158 Teachers Compound, West Rembo, Makati City	Residents	D	
Lucita Fojas		158 Teachers Compound, West Rembo, Makati City	Residents	D	
Ericsson Fermil		#84 Blk 4 West Rembo, Makati City	Residents	D	
Roberto B. Tabigne		108 Teachers Compound	Residents	D	
Porferio Benig Sr.		108 Blk 4 West Rembo, Makati City	Residents	D	D
Federico P. Cueva		109 Blk 4 Ext. West Rembo, Makati City	Residents	D	D
Yangler Calimag		Zero Block Ext., West Rembo, Makati	Residents	D	D

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
		City			
Yolanda Reginaldo		110 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	D
Juanito Rosario		111 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	
Sergio V. Magaro		112 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	D
Felisa Singayan		113 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	D
Rodolfo Madrid		114 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	D
Renato Reyes		116 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	
Emma valenzuela		117 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	
Allson Alejandro		118 Zero St. Blk 4 Ext. West Rembo, Makati City	Residents	D	D
Maria Paz Yanga		156 Teachers Compound, West Rembo, Makati City	Residents		D
Evelyn C Amurten		160 Teachers Compound, West Rembo, Makati City	Residents		D
Taguig City					
Lani Cayetano	Mayor	City of Taguig	LGU Taguig	D	D
Emiluisa C. Perano	Officer-In-Charge	Mayor 's Office	LGU Taguig	D	
Agapito M. Cruz	OIC	UPAO - Taguig	LGU Taguig	D	D
Allan E. Oliman	Barangay Captain	Barangay Fort Bonifacio	LGU Taguig	D	D
Nicky Supan	Barangay Captain	Barangay Western Bicutan	LGU Taguig	D	D
Marilyn F. Marcelino	Barangay Captain	Barangay Ususan	LGU Taguig	D	D
Ma. Victoria M. Balidoy	Barangay Captain	Barangay Pinagsama	LGU Taguig	D	D

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Junn Magno	Officer in Charge	Philippine National Railways	Government	D	
Rodney Jay E. Asinas	Urban & Transport Planner	Ayala Land, Inc.	Business	D	D
Edwin Villanueva	Property Manager	Market Market	Business - DIA	D	D
Jaime Francisco Galvez	General Manager	Bonifacio Estate Service Corp.	Business	D	D
Manuel Blas	Head, Commercial Operations	Fort Bonifacio Development Corporation	Business	D	D
Hon. Vivencio Dizon	President and CEO	Bases Conversion and Development Authority	Government	D	
Parañaque City					
Edwin Olivarez	City Mayor	City of Paranaque	LGU Paranaque	D	D
Fernando Soriano	City Administrator	City Administration Dept.	LGU Paranaque	D	
Concepcion N. Vergoza	Engineering	Paranaque City Engineering Dept.	LGU Paranaque	D	
Bernie Amurao	Head	City Environment and Natural Resources Office (CENRO)	LGU Paranaque	D	D
Francisco V. Agamata	Engr. IV	Paranaque City Engineering Department	LGU Paranaque	D	
Imelda Villaruel	Officer-in-charge	City Social Welfare and Development Office	LGU Paranaque	D	
Antonio L. Lucenas		City Planning and Development Coordinator's Office	LGU Paranaque	D	D
Alicia Benzon	Barangay Captain	Brgy. Merville	LGU Paranaque	D	
Michael Thor C. Singson	Barangay Captain	Brgy. San Martin de Porres	LGU Paranaque	D	D
Johnny Chung	Asst. Department Head	La Suerte	Business - DIA	D	
Mavic Oduja	Administrative Head	Raya Garden Condominium	Business - DIA	D	D
Lowell Frederick A. Madrileno	Counsel	Pusco Investment Corporation		D	
Riofel Nery			Business - DIA	x	
Carmelita M. Ramos	Manager	Ang Bigas Inc.	Business - DIA	D	

Name	Designation	Organization	Sector	Invitation sent and received	Represented in Public Hearing
Nelson C. Alastoy	Pastor	United Hills Village/Church of the Nazarene	Institutional - DIA	D	D
Zenaida L. Angeles	Representative	United Hills Village	Residents	D	
Ben Dominic R. Yap	Legal Counsel	Green Cross Inc.	Business - DIA	D	D
Joel Laurente	President	United Hills Association	Residents - DIA	D	
Valenzuela City					
Rex Gatchalian	Mayor	City of Valenzuela	Government	D	D
Alan Roullo Yap	City Administrator	City Administration Office	Government	D	
Josefina Acurantes	Head	City Planning and Development Office	Government	D	D
Elenita Reyes	Head	Housing and Resettlement Office	Government	D	
Rommel l. Pondevida	Head	Environment and Natural Resources Office	Government	D	D
Fortune Angeles	Project Evaluation Officer	Valenzuela City	Government	D	
Eduardo Nazar	Barangay Captain	Barangay Ugong	Government	D	D
Ricardo Yu	President	Valenzuela Chamber of Commerce and Industry	Business Organization	D	D
Jimmy C. Chua	President	Hyundai Forklift PowerlifterPhils.	Business	D	D
Edwin Francisco	Resort Manager	Rolling Hills Resort	Business	D	D
		Barangay Ugong	Business/ Lot owners/ Residents	(~250)	(175 residents, 5 commercial/ industrial)

APPENDIX B

Documentation of the Stakeholders Meetings

Appendix B.1: Documentation of the IEC Meetings

Appendix B.2: Documentation of the Stakeholders Consultation Meetings and Public Scoping

Appendix B.3: Documentation of RAP Public Scoping Meetings

Appendix B.4: Documentation of the Public Hearing

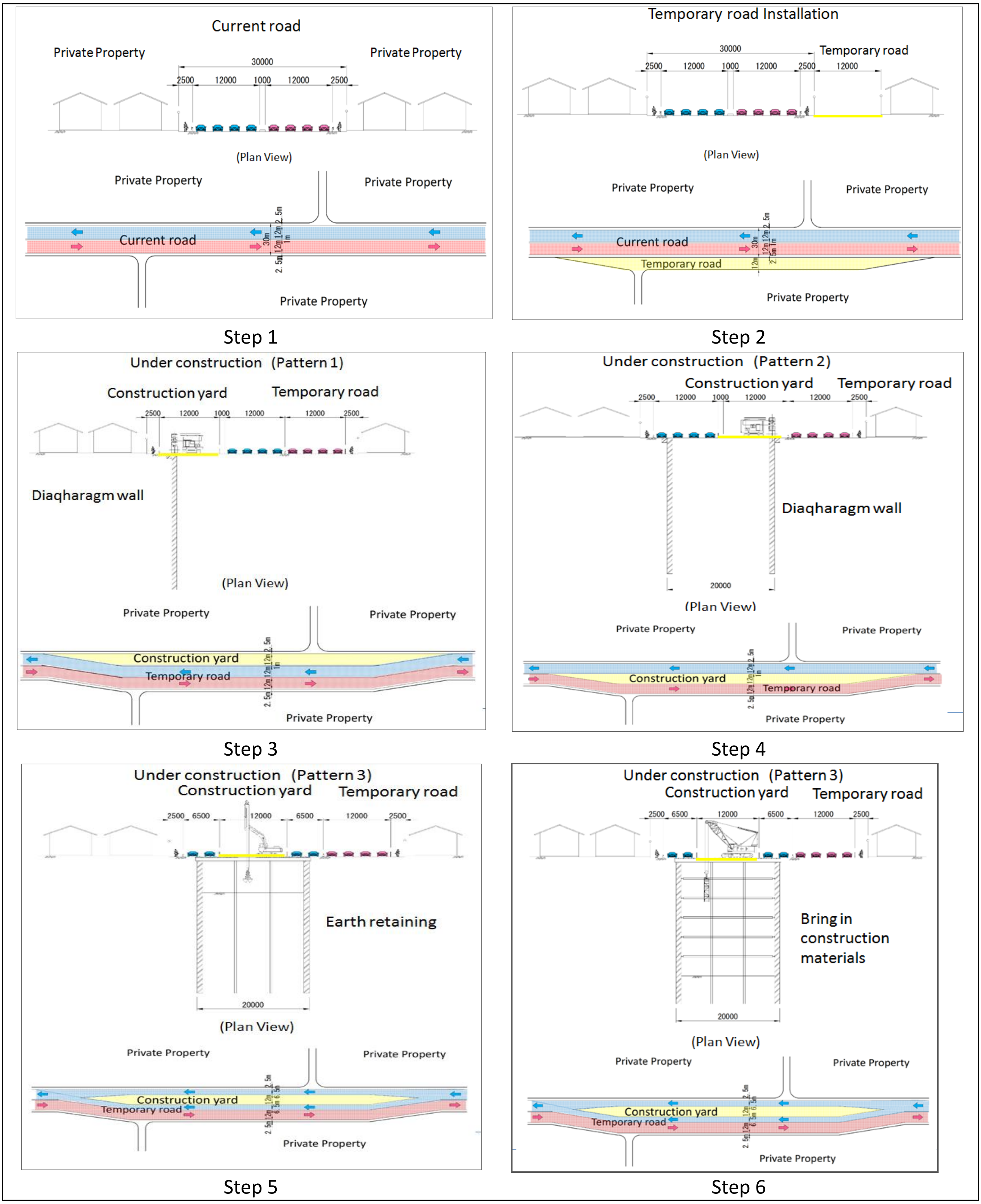
APPENDIX C

Maps of the MMSP Alignment

APPENDIX D

Proposed Excavation Method

PROPOSED EXCAVATION METHOD TO ENSURE TRAFFIC FLOW DURING CONSTRUCTION



APPENDIX E

Result of Flora Survey

Appendix E-1.

Census data for trees and other arborescent taxa falling within the proposed stations of the Metro Manila Subway Project

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pterocarpus indicus	31.2	9		Kalayaan
Pterocarpus indicus	34.6	10		Kalayaan
Pterocarpus indicus	23.2	10		Kalayaan
Pterocarpus indicus	28.3	10		Kalayaan
Pterocarpus indicus	18.7	9		Kalayaan
Pterocarpus indicus	25.5	8		Kalayaan
Pterocarpus indicus	17.1	9		Kalayaan
Pterocarpus indicus	26.9	10		Kalayaan
Pterocarpus indicus	23.7	11		Kalayaan
Pterocarpus indicus	23.5	11		Kalayaan
Pterocarpus indicus	11.7	6	Fork	Kalayaan
Pterocarpus indicus	10.2	6	Fork	Kalayaan
Pterocarpus indicus	18.9	7		Kalayaan
Michelia champaca	11.0	6		Kalayaan
Michelia champaca	11.5	7		Kalayaan
Michelia champaca	8.3	3		Kalayaan
Michelia champaca	8.4	6		Kalayaan
Michelia champaca	8.9	6		Kalayaan
Michelia champaca	8.6	7		Kalayaan
Michelia champaca	7.3	7		Kalayaan
Michelia champaca	10.7	5		Kalayaan
Michelia champaca	8.4	6		Kalayaan
Michelia champaca	10.5	3		Kalayaan
Michelia champaca	10.2	4		Kalayaan
Pterocarpus indicus	14.6	9		Kalayaan
Pterocarpus indicus	20.1	10		Kalayaan
Pterocarpus indicus	19.8	10		Kalayaan
Pterocarpus indicus	20.4	9		Kalayaan
Pterocarpus indicus	17.7	9		Kalayaan
Pterocarpus indicus	18.2	9		Kalayaan
Pterocarpus indicus	25.9	8		Kalayaan
Pterocarpus indicus	17.8	10		Kalayaan
Pterocarpus indicus	17.4	8		Kalayaan
Pterocarpus indicus	16.0	9		Kalayaan
Pterocarpus indicus	22.1	10		Kalayaan
Pterocarpus indicus	17.1	6		Kalayaan
Pterocarpus indicus	13.5	6		Kalayaan
Pterocarpus indicus	24.8	12		Kalayaan
Pterocarpus indicus	23.9	10		Kalayaan

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pterocarpus indicus	20.0	10		Kalayaan
Pterocarpus indicus	25.0	12		Kalayaan
Pterocarpus indicus	16.9	9		Kalayaan
Pterocarpus indicus	13.6	5		Kalayaan
Pterocarpus indicus	18.5	10		Kalayaan
Roystonea regia	30.6	5		Kalayaan
Acacia auriculiformis	18.2	7		Kalayaan
Roystonea regia	26.6	5		Kalayaan
Roystonea regia	22.9	5		Kalayaan
Wodyetia bifurcata	23.6	7		Kalayaan
Wodyetia bifurcata	25.0	7		Kalayaan
Wodyetia bifurcata	22.3	7		Kalayaan
Wodyetia bifurcata	20.1	7		Kalayaan
Roystonea regia	21.2	4		Kalayaan
Chrysophyllum cainito	42	13		Anonas
Pachira aquatica	10	8		Anonas
Mangifera indica	36	10		Anonas
Moringa oleifera	10	5		Anonas
Averrhoa bilimbi	10	8		Anonas
Persea americana	13	7		Anonas
Gmelina arborea	44.6	21		East Ave.
Gmelina arborea	45.2	20		East Ave.
Cocos nucifera	33.9	16		East Ave.
Swietenia macrophylla	14.8	12		East Ave.
Cocos nucifera	29.6	16		East Ave.
Gmelina arborea	45.7	22		East Ave.
Cocos nucifera	33.8	24		East Ave.
Cocos nucifera	32.3	12		East Ave.
Toona calantas	14.8	12		East Ave.
Gmelina arborea	25	10		East Ave.
Gmelina arborea	15	9		East Ave.
Cocos nucifera	34.1	17		East Ave.
Millettia pinnata	19.1	10		East Ave.
Cocos nucifera	28.0	13		East Ave.
Eucalyptus tereticornis	8.9	6		East Ave.
Swietenia macrophylla	15.3	12		East Ave.
Swietenia macrophylla	15.4	12		East Ave.
Swietenia macrophylla	6.0	7		East Ave.
Swietenia macrophylla	11.5	11		East Ave.
Swietenia macrophylla	14.3	10		East Ave.
Swietenia macrophylla	15.4	12		East Ave.
Swietenia macrophylla	11.6	8		East Ave.
Swietenia macrophylla	11.1	9		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Swietenia macrophylla	16.2	11		East Ave.
Cocos nucifera	34.3	20		East Ave.
Swietenia macrophylla	14.8	10		East Ave.
Diospyros sp.	70.1	17		East Ave.
Cocos nucifera	32.5	19		East Ave.
Citrus "dalandan"	7.3	5		East Ave.
Citrus "dalandan"	5.3	5		East Ave.
Cocos nucifera	29.9	17		East Ave.
Pterocarpus indicus	64.8	15		East Ave.
Cocos nucifera	34.2	18		East Ave.
Cocos nucifera	29.5	21		East Ave.
Cocos nucifera	25.8	16		East Ave.
Pterocarpus indicus	72.3	16		East Ave.
Pterocarpus indicus	83.4	17		East Ave.
Swietenia macrophylla	5.2	5		East Ave.
Albizia saman	76.4	29		East Ave.
Swietenia macrophylla	9.9	9		East Ave.
Eucalyptus tereticornis	9.9	13		East Ave.
Swietenia macrophylla	11.1	10		East Ave.
Millettia pinnata	9.4	9		East Ave.
Swietenia macrophylla	11.7	6		East Ave.
Cocos nucifera	24.2	7		East Ave.
Swietenia macrophylla	8.3	8		East Ave.
Swietenia macrophylla	16.6	10		East Ave.
Swietenia macrophylla	15.5	9		East Ave.
Swietenia macrophylla	18.7	10		East Ave.
Eucalyptus tereticornis	21.5	11		East Ave.
Swietenia macrophylla	15.9	10		East Ave.
Eucalyptus tereticornis	19.3	12		East Ave.
Gmelina arborea	20.7	8		East Ave.
Swietenia macrophylla	6.1	6		East Ave.
Cocos nucifera	35.4	16		East Ave.
Gmelina arborea	33.8	13		East Ave.
Pterocarpus indicus	63.7	14		East Ave.
Cocos nucifera	37.7	17		East Ave.
Pterocarpus indicus	39.5	13		East Ave.
Cocos nucifera	39.8	22		East Ave.
Pterocarpus indicus	54.1	14		East Ave.
Cocos nucifera	34.6	16		East Ave.
Mangifera indica	40	8		East Ave.
Polyalthia longifolia	10.0	7		East Ave.
Pterocarpus indicus	80.6	12		East Ave.
Polyalthia longifolia	36.5	12		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Cocos nucifera	26.8	10		East Ave.
Mangifera indica	74.5	10		East Ave.
Ficus religiosa	12.1	6		East Ave.
Eucalyptus tereticornis	59.9	12		East Ave.
Dipterocarpus blancoi	44.4	12		East Ave.
Swietenia macrophylla	12.9	7		East Ave.
Swietenia macrophylla	12.9	7		East Ave.
Spathodea campanulata	60	13		East Ave.
Swietenia macrophylla	30.3	10		East Ave.
Gmelina arborea	35.8	10		East Ave.
Swietenia macrophylla	59.6	13		East Ave.
Swietenia macrophylla	44.1	13		East Ave.
Cocos nucifera	34.9	10		East Ave.
Gmelina arborea	36.0	9		East Ave.
Swietenia macrophylla	20.4	6		East Ave.
Cocos nucifera	29.5	10		East Ave.
Ficus religiosa	43.9	7		East Ave.
Swietenia macrophylla	15.4	6		East Ave.
Cocos nucifera	38.9	16		East Ave.
Pterocarpus indicus	27.5	13		East Ave.
Cocos nucifera	35.4	16		East Ave.
Gmelina arborea	45.2	9		East Ave.
Cocos nucifera	25.0	12		East Ave.
Swietenia macrophylla	61.1	15		East Ave.
Pterocarpus indicus	22.3	10		East Ave.
Swietenia macrophylla	21.6	11		East Ave.
Gmelina arborea	19.1	15		East Ave.
Cocos nucifera	36.1	15		East Ave.
Pterocarpus indicus	17.5	10		East Ave.
Pterocarpus indicus	29.9	10		East Ave.
Calophyllum inophyllum	31.2	7		Bonifacio Global City
Calophyllum inophyllum	25.3	8		Bonifacio Global City
Calophyllum inophyllum	26.4	8		Bonifacio Global City
Calophyllum inophyllum	18.9	7		Bonifacio Global City
Calophyllum inophyllum	31.7	8		Bonifacio Global City
Calophyllum inophyllum	33.8	9		Bonifacio Global City
Calophyllum inophyllum	29.9	9		Bonifacio Global City
Calophyllum inophyllum	29.3	9		Bonifacio Global City
Calophyllum inophyllum	31.1	11		Bonifacio Global City
Calophyllum inophyllum	28.7	10		Bonifacio Global City
Calophyllum inophyllum	35.7	9		Bonifacio Global City
Calophyllum inophyllum	25.9	9		Bonifacio Global City
Calophyllum inophyllum	27.2	10		Bonifacio Global City

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Calophyllum inophyllum	24.0	9		Bonifacio Global City
Calophyllum inophyllum	23.9	7		Bonifacio Global City
Calophyllum inophyllum	21.6	7		Bonifacio Global City
Calophyllum inophyllum	30.8	8		Bonifacio Global City
Calophyllum inophyllum	29.3	8		Bonifacio Global City
Calophyllum inophyllum	23.0	9		Bonifacio Global City
Calophyllum inophyllum	37.2	8		Bonifacio Global City
Calophyllum inophyllum	29.0	10		Bonifacio Global City
Calophyllum inophyllum	28.7	9		Bonifacio Global City
Cocos nucifera	29.6	9		Tandang Sora
Cocos nucifera	28.6	9		Tandang Sora
Psidium guajava	5.9	4		Tandang Sora
Cocos nucifera	25.5	8		Tandang Sora
Mangifera indica	41.7	8		Tandang Sora
Cocos nucifera	28.2	8		Tandang Sora
Cocos nucifera	27.3	7		Tandang Sora
Cocos nucifera	27.4	9		Tandang Sora
Mangifera indica	36.9	8		Tandang Sora
Cocos nucifera	31.4	7		Tandang Sora
Mangifera indica	40.6	6		Tandang Sora
Mangifera indica	44.3	7		Tandang Sora
Dimocarpus longan	26.1	6		Tandang Sora
Dimocarpus longan	22.1	7		Tandang Sora
Dimocarpus longan	22.6	9		Tandang Sora
Dimocarpus longan	24.8	9		Tandang Sora
Pterocarpus indicus	46.2	10		East Ave.
Sandoricum koetjape	44.9	19		East Ave.
Vitex parviflora	43.1	18		East Ave.
Vitex parviflora	41.1	18		East Ave.
Vitex parviflora	24.8	18		East Ave.
Delonix regia	71.3	22		East Ave.
Pterocarpus indicus	24.3	19		East Ave.
Pterocarpus indicus	36.5	14		East Ave.
Moringa oleifera	10	6		East Ave.
Cocos nucifera	26.8	10		East Ave.
Sandoricum koetjape	32.0	14		East Ave.
Sandoricum koetjape	19.1	13		East Ave.
Mangifera indica	41.5	13		East Ave.
Mangifera indica	30.6	12		East Ave.
Mangifera indica	37.6	15		East Ave.
Cocos nucifera	35.2	12		East Ave.
Plumeria acuminata	64.0	12		East Ave.
Chrysophyllum cainito	73.6	14		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Mangifera indica	40.1	13		East Ave.
Mangifera indica	40.1	14		East Ave.
Pouteria campechiana	11.1	5		East Ave.
Adenanthera pavonina	41.9	7		Ortigas South
Ficus religiosa	25.5	9		Ortigas South
Polyalthia longifolia	11.5	5		Ortigas South
Cocos nucifera	25	7		Ortigas South
Ficus religiosa	2.5	2.5		Ortigas South
Pterocarpus indicus	27.4	9		Ortigas South
Mangifera indica	14.3	12		Ortigas South
Mangifera indica	15.9	12		Ortigas South
Mangifera indica	19.1	12		Ortigas South
Syzygium cumini	11.1	8		Ortigas South
Pterocarpus indicus	26.1	9		Ortigas South
Polyalthia longifolia	13.8	5		Ortigas South
Pterocarpus indicus	21.0	7		Ortigas South
Pterocarpus indicus	43.8	9		Ortigas South
Polyalthia longifolia	7.4	5		Ortigas South
Polyalthia longifolia	6.9	5		Ortigas South
Polyalthia longifolia	11.5	5		Ortigas South
Ficus religiosa	2.5	2		Ortigas South
Pterocarpus indicus	86.6	16		Ortigas South
Sandoricum koetjape	26.1	6		Ortigas South
Pterocarpus indicus	29.7	9		Ortigas South
Adonidia merrillii	16.2	5		Ortigas South
Cassia fistula	22.0	5		Ortigas South
Ceiba pentandra	32.5	5		Ortigas South
Moringa oleifera	10	4		Ortigas South
Cocos nucifera	8.6	8		Ortigas South
Pterocarpus indicus	35.0	8		Ortigas South
Trema orientalis	40	10		Ortigas South
Adonidia merrillii	11.2	5		Ortigas South
Adonidia merrillii	10.7	5		Ortigas South
Adonidia merrillii	9.1	4		Ortigas South
Adonidia merrillii	9.0	5		Ortigas South
Adonidia merrillii	12.1	5		Ortigas South
Adonidia merrillii	10.8	5		Ortigas South
Adonidia merrillii	10.8	5		Ortigas South
Adonidia merrillii	14.7	6		Ortigas South
Adonidia merrillii	10.7	6		Ortigas South
Adonidia merrillii	11.6	5		Ortigas South
Adonidia merrillii	11.0	6		Ortigas South
Adonidia merrillii	11.7	5		Ortigas South

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Adonidia merrillii	8.3	4		Ortigas South
Pterocarpus indicus	36.7	10		Ortigas South
Swietenia macrophylla	14.7	16		Ortigas South
Swietenia macrophylla	14.1	6		Ortigas South
Pterocarpus indicus	37.6	10		Ortigas South
Swietenia macrophylla	13.6	6		Ortigas South
Swietenia macrophylla	38.1	11		FTI
Vitex parviflora	9.7	6		FTI
Vitex parviflora	6.5	7		FTI
Swietenia macrophylla	28.7	12		FTI
Swietenia macrophylla	40.5	12		FTI
Vitex parviflora	8.8	6		FTI
Vitex parviflora	5.3	5		FTI
Vitex parviflora	11.1	7		FTI
Swietenia macrophylla	6.6	6		FTI
Jatropha gossypifolia	7.3	3		FTI
Jatropha gossypifolia	7.3	3		FTI
Swietenia macrophylla	37.1	11		FTI
Vitex parviflora	4.7	3		FTI
Pterocarpus indicus	43.9	19	Fork	FTI
Pterocarpus indicus	66.2	19	Fork	FTI
Swietenia macrophylla	26.6	14		FTI
Jatropha integerrima	6.7	2	Fork	FTI
Jatropha integerrima	4.5	2	Fork	FTI
Swietenia macrophylla	25.5	12		FTI
Swietenia macrophylla	31.1	12		FTI
Swietenia macrophylla	29.5	11		FTI
Swietenia macrophylla	43.6	13		FTI
Swietenia macrophylla	30.3	13		FTI
Syzygium cumini	30.0	7		FTI
Syzygium cumini	27.9	7		FTI
Swietenia macrophylla	42.4	13		FTI
Pterocarpus indicus	24.3	9		FTI
Pterocarpus indicus	38.3	11		FTI
Swietenia macrophylla	38.9	15		FTI
Jatropha integerrima	10.4	5.5		FTI
Vitex parviflora	3.7	4		FTI
Swietenia macrophylla	37.4	12		FTI
Swietenia macrophylla	26.1	10		FTI
Alstonia macrophylla	5.6	5		FTI
Vitex parviflora	10.6	8		FTI
Vitex parviflora	8.0	6		FTI
Pithecellobium dulce	17.8	6		FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pithecellobium dulce	31.2	8		FTI
Pterocarpus indicus	27.5	12		FTI
Pterocarpus indicus	22.8	10		FTI
Pterocarpus indicus	60.2	11		FTI
Pithecellobium dulce	18.7	7		FTI
Syzygium cumini	38.1	11		FTI
Syzygium cumini	43.5	7		FTI
Syzygium cumini	28.5	5		FTI
Vitex parviflora	9.2	5		FTI
Vitex parviflora	7.7	5		FTI
Pterocarpus indicus	10.9	4		FTI
Terminalia catappa	4.8	3		FTI
Pterocarpus indicus	38.2	9		FTI
Plumeria acuminata	14.6	6	Fork	FTI
Plumeria acuminata	19.7	6	Fork	FTI
Pterocarpus indicus	13.9	8		FTI
Pterocarpus indicus	46.9	17		FTI
Pterocarpus indicus	10.4	5		FTI
Pterocarpus indicus	32.8	15	Fork	FTI
Pterocarpus indicus	34.1	15	Fork	FTI
Terminalia catappa	5.8	4.5		FTI
Terminalia catappa	5.7	5		FTI
Syzygium cumini	32.8	11		FTI
Syzygium cumini	32.9	12		FTI
Pterocarpus indicus	33.1	13	Fork	FTI
Pterocarpus indicus	17.7	13	Fork	FTI
Pterocarpus indicus	24.2	13	Fork	FTI
Syzygium cumini	25.3	10		FTI
Mangifera indica	6.1	4		FTI
Pterocarpus indicus	42.4	14		FTI
Mangifera indica	14.4	8		FTI
Pterocarpus indicus	27.5	10	Fork	FTI
Pterocarpus indicus	36.1	10	Fork	FTI
Pterocarpus indicus	38.2	14		FTI
Pterocarpus indicus	26.7	12		FTI
Pterocarpus indicus	37.8	14		FTI
Pterocarpus indicus	33.6	11	Fork	FTI
Pterocarpus indicus	44.3	11	Fork	FTI
Mangifera indica	6.1	4		FTI
Artocarpus heterophyllus	7.5	3		FTI
Artocarpus heterophyllus	9.1	3		FTI
Pterocarpus indicus	33.1	6		FTI
Pterocarpus indicus	31.8	6		FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Pterocarpus indicus	4.6	4.5		FTI
Pterocarpus indicus	43.9	12		FTI
Pterocarpus indicus	30.3	15		FTI
Pterocarpus indicus	26.1	13		FTI
Pterocarpus indicus	37.6	15		FTI
Polyalthia longifolia	26.0	12		FTI
Polyalthia longifolia	21.7	10		FTI
Morinda citrifolia	11.6	8	Fork	FTI
Morinda citrifolia	9.9	8	Fork	FTI
Polyalthia longifolia	22.5	7	Fork	FTI
Polyalthia longifolia	31.2	7	Fork	FTI
Pterocarpus indicus	19.9	12		FTI
Adonidia merrillii	10.8	6		FTI
Adonidia merrillii	15.9	6		FTI
Swietenia macrophylla	32.6	8		FTI
Adonidia merrillii	15.8	4		FTI
Adonidia merrillii	14.1	4		FTI
Adonidia merrillii	14.0	4.5		FTI
Mangifera indica	35.4	7	Fork	FTI
Mangifera indica	31.0	7	Fork	FTI
Swietenia macrophylla	7.0	6		FTI
Adonidia merrillii	13.7	4.5		FTI
Artocarpus heterophyllus	10.8	4		FTI
Leucaena leucocephala	12.7	8		FTI
Adonidia merrillii	14.3	3.5		FTI
Swietenia macrophylla	10.1	4		FTI
Pterocarpus indicus	14.3	6		FTI
Pterocarpus indicus	42.8	12		FTI
Pterocarpus indicus	26.8	12		FTI
Mangifera indica	10.4	5		FTI
Adonidia merrillii	14.5	4.5		FTI
Adonidia merrillii	14.3	4.5		FTI
Roystonea regia	35.7	7		Ortigas North
Pterocarpus indicus	36.0	9		Ortigas North
Pterocarpus indicus	33.8	7		Ortigas North
Wodyetia bifurcata	24.8	4		Ortigas North
Muntingia calabura	4.8	5		Ortigas North
Muntingia calabura	4.8	5		Ortigas North
Wodyetia bifurcata	22.1	5		Ortigas North
Wodyetia bifurcata	25.6	5		Ortigas North
Wodyetia bifurcata	22.9	4		Ortigas North
Wodyetia bifurcata	22.5	4		Ortigas North
Wodyetia bifurcata	21.7	5		Ortigas North

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Wodyetia bifurcata	22.3	5		Ortigas North
Calophyllum inophyllum	23.6	7		Bonifacio Global City
Calophyllum inophyllum	27.1	9		Bonifacio Global City
Calophyllum inophyllum	21.5	8		Bonifacio Global City
Calophyllum inophyllum	22.3	7		Bonifacio Global City
Calophyllum inophyllum	22.2	7		Bonifacio Global City
Calophyllum inophyllum	36.0	7		Bonifacio Global City
Calophyllum inophyllum	22.5	6	Fork	Bonifacio Global City
Calophyllum inophyllum	22.2	6	Fork	Bonifacio Global City
Calophyllum inophyllum	22.7	5		Bonifacio Global City
Calophyllum inophyllum	22.1	6		Bonifacio Global City
Calophyllum inophyllum	27.9	9		Bonifacio Global City
Pterocarpus indicus	23.6	8	Fork	FTI
Pterocarpus indicus	21.3	8	Fork	FTI
Vitex parviflora	15.8	10		FTI
Pterocarpus indicus	28.5	12		FTI
Syzygium cumini	31.4	7	Fork	FTI
Syzygium cumini	27.8	7	Fork	FTI
Tabebuia pallida	14.2	6	Fork	FTI
Tabebuia pallida	13.6	6	Fork	FTI
Syzygium cumini	19.3	8	Fork	FTI
Syzygium cumini	36.7	8	Fork	FTI
Swietenia macrophylla	27.4	9		FTI
Swietenia macrophylla	25.2	12		FTI
Swietenia macrophylla	41.1	14		FTI
Swietenia macrophylla	6.5	6		FTI
Swietenia macrophylla	6.7	7		FTI
Swietenia macrophylla	7.0	7		FTI
Swietenia macrophylla	5.6	8		FTI
Swietenia macrophylla	24.5	12		FTI
Swietenia macrophylla	26.8	13		FTI
Swietenia macrophylla	31.4	9		FTI
Syzygium cumini	8.2	5		FTI
Swietenia macrophylla	52.5	14		FTI
Syzygium cumini	28.5	14	Fork	FTI
Syzygium cumini	43.3	16	Fork	FTI
Syzygium cumini	34.2	14		FTI
Syzygium cumini	32.9	14		FTI
Artocarpus heterophyllus	29.3	7		FTI
Artocarpus heterophyllus	27.7	7		FTI
Jatropha integerrima	13.2	4	Fork	FTI
Jatropha integerrima	7.3	4	Fork	FTI
Jatropha integerrima	8.6	4	Fork	FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Jatropha integerrima	10.7	4	Fork	FTI
Vitex parviflora	10.2	9		FTI
Vitex parviflora	9.6	10	Fork	FTI
Vitex parviflora	9.6	10	Fork	FTI
Vitex parviflora	10.8	9	Fork	FTI
Vitex parviflora	12.6	9	Fork	FTI
Vitex parviflora	5.5	7		FTI
Lagerstroemia speciosa	3.2	3		FTI
Swietenia macrophylla	36.7	8		FTI
Vitex parviflora	5.6	5	Fork	FTI
Vitex parviflora	6.0	5	Fork	FTI
Swietenia macrophylla	17.7	8		Ortigas South
Swietenia macrophylla	19.7	10		Ortigas South
Acacia auriculiformis	5.9	3.5		Ortigas South
Swietenia macrophylla	13.5	9		Ortigas South
Swietenia macrophylla	19.9	10		Ortigas South
Ficus septica	8.0	5	Fork	Ortigas South
Ficus septica	4.3	5	Fork	Ortigas South
Swietenia macrophylla	21.7	6		Ortigas South
Swietenia macrophylla	23.7	6		Ortigas South
Swietenia macrophylla	11.1	5		Ortigas South
Swietenia macrophylla	22.5	6		Ortigas South
Ficus sp.	6.4	4		Ortigas South
Swietenia macrophylla	9.1	5		Ortigas South
Plumeria acuminata	27.5	5		Ortigas South
Pterocarpus indicus	14	5	Fork	Ortigas South
Pterocarpus indicus	12	5	Fork	Ortigas South
Pterocarpus indicus	14	5	Fork	Ortigas South
Swietenia macrophylla	19.9	7		Ortigas South
Swietenia macrophylla	18.9	7		Ortigas South
Swietenia macrophylla	17.7	8		Ortigas South
Swietenia macrophylla	20.1	8		Ortigas South
Swietenia macrophylla	20.1	8		Ortigas South
Swietenia macrophylla	21.7	9		Ortigas South
Swietenia macrophylla	21.4	9		Ortigas South
Swietenia macrophylla	24.6	9		Ortigas South
Swietenia macrophylla	22.1	9		Ortigas South
Swietenia macrophylla	26.2	10		Ortigas South
Swietenia macrophylla	19.4	10		Ortigas South
Swietenia macrophylla	21.5	10		Ortigas South
Roystonea regia	43.5	14		Ortigas South
Roystonea regia	38.2	14		Ortigas South
Calophyllum inophyllum	22.6	5		Bonifacio Global City

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Calophyllum inophyllum	22.5	6		Bonifacio Global City
Calophyllum inophyllum	21.7	6		Bonifacio Global City
Calophyllum inophyllum	21.6	7		Bonifacio Global City
Calophyllum inophyllum	25.2	6.5		Bonifacio Global City
Calophyllum inophyllum	18.9	6		Bonifacio Global City
Calophyllum inophyllum	18.5	7		Bonifacio Global City
Calophyllum inophyllum	16.1	7		Bonifacio Global City
Calophyllum inophyllum	18.0	6		Bonifacio Global City
Calophyllum inophyllum	20.6	7		Bonifacio Global City
Calophyllum inophyllum	18.5	7		Bonifacio Global City
Calophyllum inophyllum	11.5	5		Bonifacio Global City
Calophyllum inophyllum	24.7	6		Bonifacio Global City
Calophyllum inophyllum	24.6	6.5		Bonifacio Global City
Calophyllum inophyllum	35.8	6		Bonifacio Global City
Calophyllum inophyllum	18.5	6		Bonifacio Global City
Calophyllum inophyllum	20.2	6		Bonifacio Global City
Calophyllum inophyllum	12.3	5		Bonifacio Global City
Calophyllum inophyllum	23.6	5		Bonifacio Global City
Calophyllum inophyllum	25.2	7		Bonifacio Global City
Calophyllum inophyllum	20.5	7		Bonifacio Global City
Calophyllum inophyllum	19.1	7		Bonifacio Global City
Calophyllum inophyllum	16.9	7		Bonifacio Global City
Calophyllum inophyllum	23.9	11		Bonifacio Global City
Calophyllum inophyllum	18.8	9		Bonifacio Global City
Calophyllum inophyllum	23.5	9		Bonifacio Global City
Calophyllum inophyllum	24.4	7		Bonifacio Global City
Calophyllum inophyllum	25.8	6		Bonifacio Global City
Calophyllum inophyllum	21.8	6		Bonifacio Global City
Calophyllum inophyllum	25.2	7		Bonifacio Global City
Calophyllum inophyllum	26.8	8		Bonifacio Global City
Calophyllum inophyllum	26.0	8		Bonifacio Global City
Calophyllum inophyllum	19.3	7		Bonifacio Global City
Calophyllum inophyllum	26.7	8		Bonifacio Global City
Calophyllum inophyllum	18.5	6		Bonifacio Global City
Calophyllum inophyllum	22.4	7		Bonifacio Global City
Calophyllum inophyllum	20.7	7		Bonifacio Global City
Calophyllum inophyllum	15.8	6		Bonifacio Global City
Calophyllum inophyllum	16.7	7		Bonifacio Global City
Calophyllum inophyllum	19.3	5		Bonifacio Global City
Calophyllum inophyllum	14.8	5		Bonifacio Global City
Calophyllum inophyllum	19.1	7		Bonifacio Global City
Calophyllum inophyllum	21.2	8		Bonifacio Global City
Mangifera indica	30	7		Ortigas North

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Roystonea regia	35.7	8		Ortigas North
Roystonea regia	36.0	8		Ortigas North
Eucalyptus tereticornis	15	7		Ortigas North
Eucalyptus tereticornis	14	7		Ortigas North
Acacia auriculiformis	15	7		Ortigas North
Lagerstroemia speciosa	13	2		Ortigas North
Acacia auriculiformis	3.8	5		Ortigas North
Leucaena leucocephala	12	6		Ortigas North
Lagerstroemia speciosa	13	2.5		Ortigas North
Roystonea regia	39.5	7		Ortigas North
Lagerstroemia speciosa	12	2.25		Ortigas North
Leucaena leucocephala	13	4		Ortigas North
Acacia auriculiformis	8	2.25		Ortigas North
Acacia auriculiformis	7	2		Ortigas North
Lagerstroemia speciosa	7	1.5		Ortigas North
Acacia auriculiformis	13	4.5		Ortigas North
Acacia auriculiformis	2.5	3		Ortigas North
Leucaena leucocephala	10	4.5		Ortigas North
Eucalyptus tereticornis	10	7		Ortigas North
Elaeis guineensis	25	4		Ortigas North
Acacia auriculiformis	10	4.5		Ortigas North
Acacia auriculiformis	6	2		Ortigas North
Roystonea regia	34.5	12		Ortigas North
Roystonea regia	32.9	9		Ortigas North
Roystonea regia	29.6	12		Ortigas North
Roystonea regia	39.5	9		Ortigas North
Roystonea regia	34.7	9		Ortigas North
Roystonea regia	35.0	9		Ortigas North
Roystonea regia	37.9	10		Ortigas North
Acacia auriculiformis	9.6	6		Ortigas North
Eucalyptus tereticornis	26.8	8		Ortigas North
Roystonea regia	37.6	10		Ortigas North
Roystonea regia	38.2	10		Ortigas North
Terminalia catappa	4.5	3		Ortigas North
Ficus septica	3.2	3		Ortigas North
Ficus septica	3.2	2.5		Ortigas North
Pithecellobium dulce	4.5	2	Fork	Ortigas North
Pithecellobium dulce	3.8	2	Fork	Ortigas North
Pithecellobium dulce	3.2	2	Fork	Ortigas North
Roystonea regia	37.6	8		Ortigas North
Adonidia merrillii	0.0	4		Ortigas North
Roystonea regia	38.2	8		Ortigas North
Swietenia macrophylla	58.6	16		East Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Cocos nucifera	25.5	13		East Ave.
Pterocarpus indicus	14.5	10		East Ave.
Pterocarpus indicus	44.3	14		East Ave.
Mangifera indica	41.5	15		East Ave.
Delonix regia	70.2	19		East Ave.
Cocos nucifera	33.9	21		East Ave.
Delonix regia	74.2	18		East Ave.
Cocos nucifera	37.6	22		East Ave.
Cocos nucifera	38.2	15		East Ave.
Mangifera indica	47.8	16		East Ave.
Cocos nucifera	42.0	20		East Ave.
Cocos nucifera	32.8	16		East Ave.
Delonix regia	69.7	18		East Ave.
Albizia saman	64.0	18		East Ave.
Sandoricum koetjape	47.3	11		East Ave.
Cocos nucifera	36.9	12		East Ave.
Swietenia macrophylla	17.4	12		East Ave.
Cocos nucifera	39.0	14		East Ave.
Toona calantas	75.2	15		East Ave.
Albizia saman	68.8	25		East Ave.
Delonix regia	73.6	26		East Ave.
Cocos nucifera	32.5	16		East Ave.
Cocos nucifera	38.5	15		East Ave.
Swietenia macrophylla	77.7	20		East Ave.
Swietenia macrophylla	55.6	18		East Ave.
Swietenia macrophylla	18.8	14		East Ave.
Mangifera indica	31.9	12		East Ave.
Swietenia macrophylla	52.2	18		East Ave.
Swietenia macrophylla	17.2	12		East Ave.
Swietenia macrophylla	16.6	12		East Ave.
Swietenia macrophylla	52.9	12		East Ave.
Swietenia macrophylla	59.1	19		East Ave.
Pterocarpus indicus	31.5	12		Kalayaan
Pterocarpus indicus	23.9	8		Kalayaan
Pterocarpus indicus	22.3	9		Kalayaan
Pterocarpus indicus	21.8	7		Kalayaan
Pterocarpus indicus	38.4	15		Kalayaan
Pterocarpus indicus	18.1	8		Kalayaan
Pterocarpus indicus	17.9	9		Kalayaan
Pterocarpus indicus	10.9	6		Kalayaan
Pterocarpus indicus	12.2	5		Kalayaan
Pterocarpus indicus	16.1	5		Kalayaan
Pterocarpus indicus	9.8	5		Kalayaan

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Calophyllum inophyllum	36.6	13		Bonifacio Global City
Calophyllum inophyllum	27.5	9		Bonifacio Global City
Calophyllum inophyllum	19.4	7		Bonifacio Global City
Calophyllum inophyllum	19.3	5		Bonifacio Global City
Calophyllum inophyllum	26.0	8		Bonifacio Global City
Calophyllum inophyllum	28.7	7		Bonifacio Global City
Calophyllum inophyllum	32.9	9		Bonifacio Global City
Moringa oleifera	14	4		FTI
Moringa oleifera	12	5		FTI
Pouteria campechiana	25	8		FTI
Pouteria campechiana	40	14		FTI
Wodyetia bifurcata	10.4	4		FTI
Wodyetia bifurcata	13.1	5		FTI
Vitex parviflora	72.0	8		FTI
Swietenia macrophylla	29.8	10		FTI
Pterocarpus indicus	27.9	8		FTI
Adonidia merrillii	20	7		FTI
Adonidia merrillii	3.8	5		FTI
Pterocarpus indicus	101.0	12		FTI
Adonidia merrillii	14.2	5		FTI
Swietenia macrophylla	35.5	13		FTI
Swietenia macrophylla	33.0	13		FTI
Pterocarpus indicus	35.8	13		FTI
Swietenia macrophylla	36.5	14		FTI
Pterocarpus indicus	46.2	11		FTI
Swietenia macrophylla	10.8	6		FTI
Annona squamosa	15	4		FTI
Chrysophyllum cainito	45	10		FTI
Mangifera indica	60	10		FTI
Adonidia merrillii	46	4.5		FTI
Mangifera indica	40	7		FTI
Moringa oleifera	15	7		FTI
Pterocarpus indicus	102.2	14		FTI
Pterocarpus indicus	105.1	14		FTI
Pterocarpus indicus	41.9	12		FTI
Ficus concinna	45	10		FTI
Adonidia merrillii	102.9	4		FTI
Wodyetia bifurcata	15	4		FTI
Wodyetia bifurcata	16	4		FTI
Wodyetia bifurcata	19	4		FTI
Cocos nucifera	34	4		FTI
Moringa oleifera	15	4		FTI
Pterocarpus indicus	42	9		FTI

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Adonidia merrillii	15	7		FTI
Plumeria acuminata	14.3	7		Katipunan
Phoenix roebelenii	15	3		Katipunan
Psidium guajava	3.2	4		Katipunan
Adonidia merrillii	15	6		Katipunan
Wodyetia bifurcata	36	7		Katipunan
Wodyetia bifurcata	40	7		Katipunan
Tamarindus indica	37.3	12		Katipunan
Syzygium samarangense	10.8	8		Katipunan
Cocos nucifera	34	6		Katipunan
Mangifera indica	45	8		Katipunan
Mangifera indica	43	8		Katipunan
Pisonia alba	48	7		Katipunan
Dracaena fragrans	12	4		Katipunan
Dracaena fragrans	11	4		Katipunan
Dracaena fragrans	10	4		Katipunan
Polyalthia longifolia	15	10		Katipunan
Polyalthia longifolia	18	10		Katipunan
Polyalthia longifolia	19	10		Katipunan
Gmelina arborea	4.8	4		Katipunan
Adonidia merrillii	14.7	4		Katipunan
Adonidia merrillii	15.4	4		Katipunan
Adonidia merrillii	12.5	4		Katipunan
Adonidia merrillii	9.3	4		Katipunan
Nephelium lappaceum	2.5	3		Katipunan
Thevetia peruviana	3.2	4		Katipunan
Chrysophyllum cainito	15	5		Katipunan
Adonidia merrillii	13.4	4		Katipunan
Adonidia merrillii	14.5	4		Katipunan
Adonidia merrillii	14.3	4		Katipunan
Adonidia merrillii	15.8	5		Katipunan
Adonidia merrillii	15	9		Katipunan
Ravenala madagascariensis	19.6	5		Quezon Ave.
Ravenala madagascariensis	23.7	7		Quezon Ave.
Ravenala madagascariensis	20.9	5		Quezon Ave.
Ravenala madagascariensis	22.4	5		Quezon Ave.
Ravenala madagascariensis	23.0	6		Quezon Ave.
Ravenala madagascariensis	20.7	5		Quezon Ave.
Ravenala madagascariensis	22.6	7		Quezon Ave.
Ravenala madagascariensis	27.0	8		Quezon Ave.
Ravenala madagascariensis	25.5	8		Quezon Ave.
Ravenala madagascariensis	25.8	6		Quezon Ave.
Ravenala madagascariensis	26.1	7		Quezon Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Ficus septica	4.8	4		Quezon Ave.
Pterocarpus indicus	25.8	8		Quezon Ave.
Pterocarpus indicus	13.4	6		Quezon Ave.
Pterocarpus indicus	12.1	5		Quezon Ave.
Mangifera indica	45	6		Quezon Ave.
Trema orientalis	15	7		Quezon Ave.
Ceiba pentandra	2.5	3		Quezon Ave.
Swietenia macrophylla	9.1	7		Quezon Ave.
Swietenia macrophylla	10.4	7		Quezon Ave.
Murraya paniculata	3.7	2		Quezon Ave.
Murraya paniculata	10.4	7		Quezon Ave.
Murraya paniculata	2.5	2		Quezon Ave.
Murraya paniculata	2.9	2		Quezon Ave.
Murraya paniculata	3.2	2		Quezon Ave.
Artocarpus heterophyllus	16.1	5		Quezon Ave.
Ficus benjamina	10.4	6		Quezon Ave.
Ficus benjamina	9.7	5		Quezon Ave.
Ficus benjamina	9.9	5		Quezon Ave.
Senna spectabilis	4.1	5		Quezon Ave.
Moringa oleifera	13.4	4		Quezon Ave.
Pterocarpus indicus	11.1	5		Quezon Ave.
syzygium cumini	51.0	6		North Ave.
Artocarpus heterophyllus	33.9	7		North Ave.
Tabernaemontana pandacaqui	9.3	5		North Ave.
Tabernaemontana pandacaqui	7.4	5		North Ave.
Ficus septica	10.5	5		North Ave.
Ficus septica	19.6	5		North Ave.
Caesalpinia pulcherrima	14	5		North Ave.
Sandoricum koetjape	21.2	7		North Ave.
Sandoricum koetjape	23.4	7		North Ave.
Leucaena leucocephala	15	5		North Ave.
Leucaena leucocephala	30	5		North Ave.
Ceiba pentandra	43.2	5		North Ave.
Cassia fistula	5	5		North Ave.
Mangifera indica	4.8	3		North Ave.
Mangifera indica	12	3		North Ave.
Pterocarpus indicus	80	8		North Ave.
Sandoricum koetjape	14	3.5		North Ave.
Cocos nucifera	31	8		North Ave.
Acacia mangium	30	6		North Ave.
Cocos nucifera	34	7		North Ave.
Muntingia calabura	10.4	4		Mindanao Ave.
Muntingia calabura	11.3	4		Mindanao Ave.

SPECIES	DBH	HEIGHT	NOTES	LOCATION
Mangifera indica	31.8	7		Mindanao Ave.
Azadirachta indica	31.2	6		Mindanao Ave.
Azadirachta indica	31.8	6		Mindanao Ave.
Mangifera indica	41	6		Mindanao Ave.
Pouteria campechiana	45	4		Mindanao Ave.
Leucaena leucocephala	26	4		Mindanao Ave.
Averrhoa bilimbi	10	3		Mindanao Ave.
Adonidia merrillii	4.8	2		Mindanao Ave.
Ficus benjamina	9.6	5		Mindanao Ave.
syzygium cumini	32.3	7		Mindanao Ave.
Sandoricum koetjape	9.6	5		Mindanao Ave.
Muntingia calabura	3.2	3.5		Mindanao Ave.
Chrysophyllum cainito	10	5		Mindanao Ave.
Mangifera indica	35	7		Mindanao Ave.
Wodyetia bifurcata	10	3		Mindanao Ave.
Wodyetia bifurcata	10.5	3		Mindanao Ave.
Wodyetia bifurcata	10	3		Mindanao Ave.
Mangifera indica	45	9		Mindanao Ave.
syzygium cumini	47	7		Mindanao Ave.
Wodyetia bifurcata	15	6		Mindanao Ave.
Terminalia catappa	30	9		Mindanao Ave.
Terminalia catappa	20	7		Mindanao Ave.
Mangifera indica	2.5	4		Mindanao Ave.
Moringa oleifera	40	7		Mindanao Ave.
Moringa oleifera	15	7		Mindanao Ave.
Melanolepis multiglandulosa	8	4		Mindanao Ave.
Melanolepis multiglandulosa	10	4		Mindanao Ave.
Roystonea regia	20	5		Mindanao Ave.
Melanolepis multiglandulosa	3.8	5		Mindanao Ave.
Adonidia merrillii	15	3		Mindanao Ave.
Adonidia merrillii	20	4		Mindanao Ave.
Adonidia merrillii	8.3	4		Mindanao Ave.
Adonidia merrillii	15	3		Mindanao Ave.
Adonidia merrillii	14	2		Mindanao Ave.
Leucaena leucocephala	4.8	3		FTI
Trema orientalis	4.8	4		FTI
Cocos nucifera	26.0	8		FTI
Cocos nucifera	23.0	9		FTI
Ficus benjamina	50	6		FTI
Ficus benjamina	53	7		FTI

Appendix E-2.

Checklist of Species recorded from Metro Manila Subway Project, Family, local names and uses

FAMILY	SPECIES	COMMON NAME	USES
ACANTHACEAE	*Asystasia gangetica (L.) T Anders.*	zamboangenita (Tag.)	ornamental
ACANTHACEAE	*Ruellia tuberosa L.*	meadow wood (Engl.)	ornamental
ACANTHACEAE	*Sanchezia speciosa J. Leon*	sanchezia (Engl.)	ornamental
AGAVACEAE	*Agave tequilana F. A. C. Weber*	blue agave (Engl.)	ornamental
ALOACEAE	*Aloe vera (L.) Buerm f.*	sabila (Tag.)	medicinal, ornamental
AMARANTHACEAE	*Amaranthus spinosus L.*	kolitis (Tag.)	edible leaves, medicinal
AMARANTHACEAE	*Alternathera sessilis (L) DC*	butones-butonesan (Tag.)	edible leaves, medicinal
AMARANTHACEAE	*Celosia argentea L.*	silver cockscomb (Engl.)	ornamental, edible leaves
AMARYLLIDACEAE	*Crinum amabile Donn.*	spider lily (Engl.)	ornamental
AMARYLLIDACEAE	*Crinum asiaticum L.*	bakong (Tag.)	ornamental
ANACARDIACEAE	*Mangifera indica L.*	mangga (Ig., Ilk.,Tag.)	edible fruit, medicinal
ANNONACEAE	*Annona squamosa L.*	ates (Fil.)	edible fruit
ANNONACEAE	*Polyalthia longifolia Benth. & Hook f.*	India lanutan (Fil.)	ornamental
ANNONACEAE	*Annona muricata L.*	Guyabano (Tag.)	fruit edible
APOCYNACEAE	*Wrightia pubescens R. Br. ssp. laniti*	laniti (Tag.)	wood used for carving
APOCYNACEAE	*Catharansus roseus (L.) G. Don*	tsitsirika (Tag.)	ornamental, medicinal
APOCYNACEAE	*Plumeria acuminata Ait.*	kalachuche (Aztec-Fil)	ornamental, medicinal
APOCYNACEAE	*Wrightia religiosa Teijs. & Binn.*	sacred buddhist (Engl.)	ornamental
APOCYNACEAE	*Thevetia peruviana (Pers.) K. Schum.*	campanilla (Sp.)	ornamental
APOCYNACEAE	*Alstonia macrophylla Wall. ex G. Don*	batino (Tag.)	wood for construction
APOCYNACEAE	*Tabernaemontana pandacaqui Poir.*	pandakaki (Tag.)	ornamental, medicinal

FAMILY	SPECIES	COMMON NAME	USES
ARACEAE	*Zamioculcas zamiifolia (Lodd.) Engl.*	arum fern (Engl.)	ornamental
ARACEAE	*Dieffenbachia amoena Bull.*	dumb cane (Engl.)	ornamental
ARACEAE	*Colocasia esculenta (L.) Schott.*	gabi (Tag.)	edible corns
ARACEAE	*Homalomena rubescens (Roxb.) Kunth.*		ornamental, medicinal
ARACEAE	*Xanthosoma sagittifolium (L.) Schott.*		ornamental
ARALIACEAE	*Polyscias fruticosa (L.) Harms*	parsley panax (Engl.)	ornamental
ARALIACEAE	*Schefflera odorata L.*	galamayamo (Tag.)	ornamental, medicinal
ARALIACEAE	*Polyscias guilfoylei (Bull.) L. H. Bailey*	papua (Engl.)	ornamental
ARECACEAE	*Wodyetia bifurcata A. K. Irvine*	Foxtail palm (Engl.)	ornamental, landscaping
ARECACEAE	*Cocos nucifera L.*	niyog (Tag.)	fruit edible, medicinal
ARECACEAE	*Caryota cumingii Lodd. ex C. Martius*	takipan (Tag.)	palm pith edible, ornamental
ARECACEAE	*Adonidia merrillii (Becc.) Becc.*	bunga de jolo (Tag.)	ornamental
ARECACEAE	*Dypsis lutescens (H. Wendl.) Beentje & Dransf.*	butterfly palm (Engl.)	ornamental
ARECACEAE	*Arenga pinnata (Wurmb.) Merr*	kaong (Tag.)	fruit edible, ornamental
ARECACEAE	*Rhapis excelsa (Thunb) A. Henry*	lady palm	ornamental
ARECACEAE	*Roystonea regia (HBK) O. F. Cook*	royal palm (Engl.)	ornamental
ARECACEAE	*Elaeis guineensis Jaca.*	red palm (Engl.)	ornamental
ARECACEAE	*Hyophorbe lagenicaulis (L. H. Bailey) H. E. Moore*	champagne palm (Engl.)	ornamental
ARECACEAE	*Ptychosperma macarthurii (H. Wendl.) Nichols*	McArthur palm (Engl.)	ornamental
ARECACEAE	*Cyrtostachys renda Bl.*	red palm (Engl.)	ornamental
ARECACEAE	*Phoenix roebelenii O'Brien*	pygmy date palm (Engl.)	ornamental
ASPARAGACEAE	*Sanseveria trifasciata Prain*	buntot tigre (Tag.)	ornamental, medicinal
ASPARAGACEAE	*Dracaena angustifolia Roxb.*	malasambal (Tag.)	ornamental

FAMILY	SPECIES	COMMON NAME	USES
ASPARAGACEAE	*Dracaena surculosa Lindl.*	spotted dracaena (Engl.)	ornamental
ASPARAGACEAE	*Cordyline fruticosa (L.) A. Cher.*	tungkod pari (Tag.)	ornamental
ASPARAGACEAE	*Dracaena fragrans (L.) Ker. Gawl.*	fortune plant (Engl.)	ornamental
ASPARAGACEAE	*Asparagus densiflorus L.*	foxtail asparagus (Engl.)	ornamental
ASTERACEAE	*Pseudoelephantopus spicatus (Juss.) Robr.*	dilang baka (Tag.)	medicinal
ASTERACEAE	*Chromolaena odorata (L.) R. King & H. Robinson*	hagonoy (Tag.)	medicinal
ASTERACEAE	*Mikania cordata (Burm.) Bl. Robinson.*	ooka (Tag.)	medicinal
ASTERACEAE	*Tridax procumbens L.*	tridax daisy (Engl.)	medicinal
ASTERACEAE	*Bidens pilosus L.*	buburtak (Tag.)	medicinal
ASTERACEAE	*Blumea balsamifera (L.) DC*	sambong (Tag.)	medicinal
ASTERACEAE	*Cyanthillium cinereum (L.) H. Robinson*	agas-moro (Tag.)	medicinal
ASTERACEAE	*Sphagneticola trilobata (L.) Pruski*	wedelia (Engl.)	ornamental
ASTERACEAE	*Conyza sumatrensis (Retz.) Walker*	atipukpuk (Tag.)	medicinal
ASTERACEAE	*Artemisia scoparia Waldst. & Kit*	wormwood (Engl.)	ornamental, medicinal
BASELLACEAE	*Basella alba L.*	alugbati (Tag.)	leaves edible
BIGNONIACEAE	*Spondias purpurea L.*	siniguelas (Sp., Fil.)	edible fruit
BIGNONIACEAE	*Tabebuia pallida (Lindl.) Miers*	cuban pink trumpet	ornamental
BIGNONIACEAE	*Spathodea campanulata Beauv.*	African Tulip (Engl.)	ornamental
BORAGINACEAE	*Heliotropium indicum L.*	tropa ng elepante (Tag.)	medicinal
BORAGINACEAE	*Ehretia microphylla Lam.*	tsaang gubat (Tag.)	medicinal
CACTACEAE	*Pereskia aculeata Mill.*	barbados gooseberry (Engl.)	fruit edible, ornamental
CALOPHYLLACEAE	*Calophyllum inophyllum L.*	palo maria (Tag.)	wood for construction, ornamental
CANNACEAE	*Canna indica L.*	bandera espanola (Sp.)	ornamental, medicinal

FAMILY	SPECIES	COMMON NAME	USES
CANNACEAE	*Trema orientalis (L.) Blume*	anabiong (Tag.)	firewood
CAPPARIDACEAE	*Cleome rutidosperma DC*	seru-walai (Tag.)	medicinal
CARICACEAE	*Carica papaya L.*	papaya (Tag.)	edible fruit
COMBRETACEAE	*Bucida molineti*	Dwarf Geometry tree (Engl.)	ornamental, landscaping
COMBRETACEAE	*Terminalia catappa L.*	talisai (Bag., Bik., Bis.,Pamp. Sbl.)	edible fruit kernel
COMBRETACEAE	*Quisqualis indica L.*	niyog-niyogan (Tag.)	ornamental, seeds anthelmintic
COMMELINACEAE	*Tradescantia spathacea Sw.*	rhoeo (Engl.)	ornamental, medicinal
COMMELINACEAE	*Commelina diffusa*	alikbangon (Tag.)	medicinal
CONVOLVULACEAE	*Ipomoea batatas (L.) Lamk.*	kamote (Tag.)	edible tuber & leaves
CONVOLVULACEAE	*Merremia sp.*		
CUCURBITACEAE	*Coccinia grandis (L.) Voigt.*	scarlet gourd (Engl.)	medicinal
CYPERACEAE	*Cyperus kyllingia Endl.*		medicinal
DIOSCOREACEAE	*Dioscorea esculenta (Lour.) Burkill*	tugi (Tag.)	tubers edible
EBENACEAE	*Diospyros blancoi A DC*	mabolo (Tag.)	wood for furniture, fruit edible
EUPHORBIACEAE	*Croton tiglium L.*	tuba (Tag.)	botanical pesticide
EUPHORBIACEAE	*Melanolepis multiglandulosa (Reinw. ex Blume) Rohb. f. & Zoll.*	alim (Tag.)	medicinal
EUPHORBIACEAE	*Excoecaria cochinchinensis*	variegated blindness tree (Engl.)	ornamental
EUPHORBIACEAE	*Euphorbia tirucalli L.*	milk bush (Engl.)	ornamental, medicinal
EUPHORBIACEAE	*Manihot esculenta Crantz.*	cassava (Engl.)	edible tuber
EUPHORBIACEAE	*Euphorbia hirta L.*	tawa-tawa (Tag.)	medicinal
EUPHORBIACEAE	*Jatropha curcas L.*	tubang bakod (Fil.)	boundary plantings, biodiesel
EUPHORBIACEAE	*Jatropha integerrima Jacq.*	peregrina (Sp.)	ornamental

FAMILY	SPECIES	COMMON NAME	USES
EUPHORBIACEAE	*Jatropha curcas L.*	tubang-bakod (Fil.)	boundary plantings, biodiesel
EUPHORBIACEAE	*Pedilanthus tithymaloides (L.) Poit.*	luhang dalaga (Tag.)	ornamental
EUPHORBIACEAE	*Euphorbia milii Desmoul*	crown of thorns (Engl.)	ornamental
EUPHORBIACEAE	*Macaranga tanarius (L.) Muell-Arg.*	binunga (Tag.)	pioneer tree for ecological restoration
EUPHORBIACEAE	*Jatropha gossypifolia L.*	tubang morado (Tag.)	ornamental
FABACEAE	*Senna alata (L.) Roxb.*	akapulko (Tag.)	medicinal
FABACEAE	*Albizia saman F. Muell.*	akasya (Tag.)	timber, wood carving
FABACEAE	*Gliricidia sepium (Jacq.) Kunthe ex Steud.*	madre-cacao (Sp.)	firewood, charcoal
FABACEAE	*Leucaena leucocephala (Lam.) de Wit*	Ipil-ipil (Tag.)	fodder, charcoal
FABACEAE	*Bauhinia purpurea L.*	fringon -morado (Sp.)	charcoal
FABACEAE	*Tamarindus indica L.*	sampalok (C. Bis., Pamp., Tag.)	medicinal, fruit edible
FABACEAE	*Caesalpinia pulcherrima (L.) Sw.*	caballero (Tag.)	ornamental
FABACEAE	*Centrosema pubescens Benth.*	pukinggan (Tag.)	fodder
FABACEAE	*Pterocarpus indicus Willd.*	narra (most dialects)	timber, ornamental
FABACEAE	*Sesbania grandiflora (L.) Pers.*	katuray (Tag.)	edible flowers
FABACEAE	*Cassia fistula L.*	tropical golden shower (Engl.)	ornamental, medicinal
FABACEAE	*Acacia auriculiformis A. Cunn. ex Benth.*	auri (Tag.)	wood for light construction
FABACEAE	*Pithecellobium dulce (Roxb.) Benth.*	kamachile (Tag.)	edible fruit, wood for light construction
FABACEAE	*Delonix regia (Boj. ex Hook.) Raf.*	fire tree (Engl.)	ornamental
FABACEAE	*Millettia pinnata (L.) Panighari*	bani (Tag.)	medicinal, ornamental
FABACEAE	*Vigna unguiculata (L.) Walp.*	sitao (Tag.)	pods eaten as vegetable
FABACEAE	*Senna spectabilis (DC.) Irwin & Barneby*		ornamental

FAMILY	SPECIES	COMMON NAME	USES
FABACEAE	*Acacia mangium Willd.*	mangium (Tag.)	timber for light construction
LAMIACEAE	*Premna odorata*	alagau (Bik., P.Bis., Tag., Bis.)	medicinal
LAMIACEAE	*Coleus amboinicus Lour.*	oregano (Tag.)	medicinal
LAMIACEAE	*Coleus blumei Benth.*	mayana (Tag.)	ornamental, medicinal
LAMIACEAE	*Vitex parviflora Juss.*	molave(Bik., Bis., Ilk. Lam., Sbl. Tag.)	timber, furniture
LAMIACEAE	*Duranta repens L.*	pigeon berry (Engl.)	ornamental
LAMIACEAE	*Gmelina arborea Roxb.*	yemane (Tag.)	wood for furniture
LAMIACEAE	*Orthosiphon aristatus (Bl.) Mig.*	balbas pusa (Tag.)	medicinal, ornamental
LAURACEAE	*Persea americana Mill.*	avocado (Engl. Sp.)	fruit edible
LYTHRACEAE	*Lagerstroemia speciosa (L.) Pers.*	banaba (Tag.)	medicinal, ornamental
MAGNOLIACEAE	*Michelia champaca L.*	tsampaka (Tag.)	ornamental, fragrant flowers for perfume production
MALPHIGIACEAE	*Tristellateia australasiae A. Rich*	binusisi (Tag.)	ornamental
MALPHIGIACEAE	*Malpighia coccigera L.*	miniature holly (Engl.)	ornamental
MALVACEAE	*Ceiba pentandra (L.) Gaertn.*	kapok (Bis., Jav., Sul., Tag.)	seedpod, fiber stuffing for pillow
MALVACEAE	*Pterospermum diversifolium Blume*	Bayok (Nik., Mag., P.Bis., Tag.)	charcoal, firewood
MALVACEAE	*Pachira aquatica Aubl.*	guiana chestnut (Engl.)	ornamental
MALVACEAE	*Abelmoschus esculentus*	okra (Tag.)	fruit edible
MALVACEAE	*Sida acuta Burm. f.*	waliswalisan (Tag.)	medicinal
MALVACEAE	*Theobroma cacao L.*	cacao (Sp., Tag.)	seeds made into chocolate
MALVACEAE	*Hibiscus rosa sinensis L.*	gumamela (Bis., Pa,mp. Tag.)	ornamental, medicinal
MALVACEAE	*Malvastrum coromandelianum (L.) Garcke*		medicinal
MARANTACEAE	*Calathea makoyana E. Morr.*	peacock plant (Engl.)	ornamental
MELIACEAE	*Sandoricum koetjape (Burm. f.) Merr.*	santol (most dialects)	edible fruit, wood for carving

FAMILY	SPECIES	COMMON NAME	USES
MELIACEAE	*Swietenia macrophylla King*	large leaved mahogany (Engl.)	timber, high grade furniture
MELIACEAE	*Melia azedarach L.*	paraiso (Sp.)	ornamental, medicinal
MELIACEAE	*Azadirachta indica A. Juss.*	neem tree (Tag.)	ornamental, botanical pesticide
MELIACEAE	*Toona calantas Merr. & Rolfe*	kalantas (Tag.)	wood for cigar boxes, furniture
MOLLUGINACEAE	*Mollugo pentaphylla L.*		medicinal
MORACEAE	*Ficus septica Burm. f.*	hauili (Neg., Tag.)	medicinal
MORACEAE	*Ficus sp.*		
MORACEAE	*Ficus benjamina L.*	salisi (Is. Sab.)	ornamental
MORACEAE	*Streblus asper Lour.*	kalios (Ibn., Tag.)	edible fruit, timber
MORACEAE	*Artocarpus blancoi (Elm.) Merr.*	antipolo (Tag.)	edible fruit, wood for carving
MORACEAE	*Ficus nota (Blanco) Merr.*	tibig (Ilk., Tag.)	fruit eaten by bats
MORACEAE	*Ficus ulmifolia Lam.*	Is-is (Neg., P. Bis., Tag.)	leaves used as sandpaper
MORACEAE	*Ficus religiosa L.*	bo tree (Singh Engl.)	
MORACEAE	*Artocarpus heterophyllus Lam.*	nangka (Bis., Ibn., Sul.,Tag.)	edible fruit, wood for musical instruments
MORACEAE	*Ficus pumila L.*	creeping fig (Engl.)	ornamental
MORACEAE	*Ficus concinna Mia.*	malasapla (Ilk.)	medicinal
MORACEAE	*Ficus calophylla Blume*	basala (Tag.)	medicinal, ornamental
MORACEAE	*Broussonetia luzonica (Blanco) Bureau*	himbabao (Tag.)	male inflorescence edible
MORINGACEAE	*Moringa oleifera Lam.*	malunggai (Sanskr. Fil.)	edible leaves, medicinal
MUNTINGIACEAE	*Muntingia calabura L.*	datiles(Bik., Tag.)	edible fruit
MUSACEAE	*Musa x paradisiaca*	saging (Tag.)	edible fruit
MYRTACEAE	*Syzygium samarangense (Blume) Merr. & Perry*	makopa (Bik., Tag.)	edible fruit
MYRTACEAE	*Psidium guajava L.*	bayabas (Bik., Bis., Ibn., Sp. Fil.)	edible fruit, medicinal

FAMILY	SPECIES	COMMON NAME	USES
MYRTACEAE	*Syzygium cumini (L.) Skeels*	duhat (P. Bis., Tag.)	edible fruit, medicinal
MYRTACEAE	*Eugenia sp.*		ornamental
MYRTACEAE	*Eucalyptus deglupta Blume*	bagras (Mbo.)	timber
MYRTACEAE	*Eucalyptus tereticornis Sm.*	gray gum (Engl.)	ornamental, wood for light construction
NYCTAGINACEAE	*Pisonia alba Span.*	maluko (Tag.)	edible leaves, ornamental
NYCTAGINACEAE	*Bougainvillea spectabilis Willd*	bougainvillea (Engl.)	ornamental
NYCTAGINACEAE	*Mirabilis jalappa L.*	four o clock (Engl.)	ornamental, medicinal
OLEACEAE	*Jasminum sambac (L.) Ait.*	sampaguita (Tag.)	ornamental
ORCHIDACEAE	*Dendrobium aphyllum*		ornamental
OXALIDACEAE	*Averrhoa bilimbi L.*	kamias (Tag.)	edible fruit
PANDANACEAE	*Pandanus amaryllifolius Roxb.*	pandan mabango (Tag.)	medicinal
PASSIFLORACEAE	*Passiflora foetida L.*	pasyonaryong mabaho (Tag.)	fruit edible
PHYLLANTHACEAE	*Phyllanthus urinaria L.*	sampaluk-sampalukan	medicinal
PHYLLANTHACEAE	*Cicca acida (L.) Merr.*	Iba (Pamp., P.Bis., Sul., Tag.)	fruit edible, medicinal
PHYLLANTHACEAE	*Phyllanthus niruri*		medicinal
PHYLLANTHACEAE	*Phyllanthus myrtifolius Moon.*		ornamental
PHYLLANTHACEAE	*Sauropus androgynus (L.) Merr.*	Chinese malunggai (Tag.)	leaves edible
PHYTOLACCACEAE	*Rivina humilis L.*		ornamental
PIPERACEAE	*Peperomia pellucida Kunth.*	pansit-pansitan (Tag.)	medicinal
POACEAE	*Saccharum spontaneum L.*	talahib (Tag.)	fodder
POACEAE	*Bambusa blumeana Schultes f.*	kawayang tinik (Tag.)	culms for construction
POACEAE	*Cyrtococcum accressens (trin) Stapf.*		fodder
POACEAE	*Cenchrus echinatus L.*	spiny sandbar (Engl.)	fodder
POACEAE	*Eleusine indica (L.) Gaertn.*	paragis (Tag.)	fodder, medicinal

FAMILY	SPECIES	COMMON NAME	USES
POACEAE	*Axonopus compressus (Sw.) P. Beaur*	carabao grass (Engl.)	fodder, medicinal
POACEAE	*Chloris gayana Kunth*	Rhodes grass (Engl.)	fodder
POACEAE	*Pennisetum polystachion (L.) Schultes*	buntot pusa (Tag.)	fodder
POACEAE	*Panicum maximum Jacq.*	Guinea grass (Engl.)	fodder
POACEAE	*Bambusa multiplex (Lour.) Raensch. ex Schult.*	hedge bamboo (Engl.)	ornamental
POACEAE	*Cymbopogon citratus (DC) Stapf.*	tanglad (Tag.)	medicinal, leaves distilled for essential oil
POACEAE	*Dactyloctenium aegyptium (L.) Willd.*	krus-krusan (Tag.)	medicinal, fodder grass
POACEAE	*Pennisetum purpureum Schumach.*	napier (Engl.)	fodder grass
POACEAE	*Mnesithea cochinchinensis*		fodder grass
POLYGONACEAE	*Antigonon leptopus Hook. & Arn.*	cadena de amor (Sp.)	ornamental
POLYPODIACEAE	*Drynaria quercifolia (L.) J. Sm.*	kabkabin (Tag.)	ornamental
PORTULACACEAE	*Portulaca quadrifida L.*	gulasiman (Tag.)	medicinal
PORTULACACEAE	*Portulaca oleracea L.*	kolasiman (Tag.)	medicinal
PTERIDACEAE	*Pteris ensiformis Burm. F.*	sword brake fern (Engl.)	medicinal
PTERIDACEAE	*Adiantum philippense L.*	kaikai (Tag.)	medicinal, ornamental
ROSACEAE	*Rosa cv.*	rose (Engl.)	ornamental
RUBIACEAE	*Morinda citrifolia L.*	bangkoro (C. BisMag. Tag.)	medicinal
RUBIACEAE	*Ixora chinensis Lam.*	santan (Tag.)	ornamental
RUBIACEAE	*Nauclea orientalis L.*	bangkal (Bis., Ilk., Mag, Mbo. Tag.)	timber, charcoal
RUBIACEAE	*Gardenia jasminoides (L.) Ellis*	rosal (Tag.)	ornamental
RUBIACEAE	*Coffea robusta L. Lindl. ex de Wildem*	robusta (Tag.)	seeds roasted into coffee
RUBIACEAE	*Mussaenda "Doña Aurora"*	Doña Aurora (Tag.)	ornamental
RUTACEAE	*Citrus x microcarpa Bunge*	kalamansi (Tag.)	fruit edible, medicinal
RUTACEAE	*Murraya paniculata (L.) Jack.*	kamuning (Tag.)	ornamental

FAMILY	SPECIES	COMMON NAME	USES
RUTACEAE	*Citrus x aurantium L.*	kahel (Sp. Fil.)	fruit edible
SAPINDACEAE	*Dimocarpus longan Lour.*	longan (Engl.)	fruit edible
SAPINDACEAE	*Nephelium lappaceum L.*	rambutan (Tag.)	fruit edible
SAPOTACEAE	*Chrysophyllum cainito L.*	star apple(Engl.) caimito Sp.)	edible fruit, timber
SAPOTACEAE	*Manilkara sapota L.*	chico (sp. Mex.)	fruit edible
SAPOTACEAE	*Pouteria campechiana (HBK.) Bachni*	tiesa (Engl.)	fruit edible
SCROPHULARIACEAE	*Scoparia dulcis L.*	saang-kabayo (Tag.)	medicinal
SCROPHULARIACEAE	*Leucophyllum frutescens Berland. I. M. Johnst.*	Mexican sage (Engl.)	ornamental
SOLANACEAE	*Capsicum frutescens L.*	siling labuyo (Tag.)	fruit edible, spice
SOLANACEAE	*Solanum lycopersicum L.*	kamatis (Tag.)	fruit edible
SOLANAEAE	*Solanum torvum Sw.*	prickly nightshade (Engl.)	medicinal
STRELITZIACEAE	*Ravenala madagascariensis Sonn.*	travellers tree (Engl.)	ornamental
TURNERACEAE	*Turnera subulata Sm.*	white buttercup (Engl.)	ornamental
VITACEAE	*Cissus nodosa Blume*	grape ivy (Engl.)	ornamental

Appendix E-3.

Checklist, endemicity, growth form and distribution of plant Species recorded from Metro Manila Subway Project

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ACANTHACEAE	*Asystasia gangetica (L.) T Anders.*	NE	HERB	x													
ACANTHACEAE	*Ruellia tuberosa L.*	EXOTIC	HERB	x							x						
ACANTHACEAE	*Sanchezia speciosa J. Leon*	EXOTIC	SHRUB	x									x				
AGAVACEAE	*Agave tequilana F. A. C. Weber*	EXOTIC	HERB			x					x		x			x	
ALOACEAE	*Aloe vera (L.) Buerm f.*	EXOTIC	HERB	x													
AMARANTHACEAE	*Amaranthus spinosus L.*	EXOTIC	HERB	x	x	x					x						x
AMARANTHACEAE	*Alternathera sessilis (L) DC*	EXOTIC	HERB	x													
AMARANTHACEAE	*Celosia argentea L.*	EXOTIC	HERB	x													
AMARYLLIDACEAE	*Crinum amabile Donn.*	EXOTIC	HERB			x							x				
AMARYLLIDACEAE	*Crinum asiaticum L.*	NE	HERB							x							
ANACARDIACEAE	*Mangifera indica L.*	EXOTIC	TREE		x	x	x	x	x	x	x	x	x			x	x
ANNONACEAE	*Annona squamosa L.*	EXOTIC	TREE	x												x	x
ANNONACEAE	*Polyalthia longifolia Benth. & Hook f.*	EXOTIC	TREE	x					x		x		x				x
ANNONACEAE	*Annona muricata L.*	EXOTIC	TREE						x								

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
APOCYNACEAE	*Wrightia pubescens R. Br. ssp. laniti*	NE	TREE	x												x	
APOCYNACEAE	*Catharansus roseus (L.) G. Don*	EXOTIC	SHRUB	x						x							
APOCYNACEAE	*Plumeria acuminata Ait.*	EXOTIC	TREE	x					x		x		x				x
APOCYNACEAE	*Wrightia religiosa Teijs. & Binn.*	EXOTIC	TREE								x					x	x
APOCYNACEAE	*Thevetia peruviana (Pers.) K. Schum.*	EXOTIC	TREE								x						x
APOCYNACEAE	*Alstonia macrophylla Wall. ex G. Don*	NE	TREE														x
APOCYNACEAE	*Tabernaemontana pandacaqui Poir.*	NE	TREE				x										
ARACEAE	*Zamioculcas zamiifolia (Lodd.) Engl.*	EXOTIC	HERB	x			x			x							
ARACEAE	*Dieffenbachia amoena Bull.*	EXOTIC	HERB	x					x		x						
ARACEAE	*Colocasia esculenta (L.) Schott.*	NE	HERB						x								
ARACEAE	*Homalomena rubescens (Roxb.) Kunth.*	NE	HERB							x							
ARACEAE	*Xanthosoma sagittifolium (L.) Schott.*	NE	HERB						x								
ARALIACEAE	*Polyscias fruticosa (L.) Harms*	EXOTIC	SHRUB	x													
ARALIACEAE	*Schefflera odorata L.*	EXOTIC	SHRUB	x			x										

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ARALIACEAE	*Polyscias guilfoylei (Bull.) L. H. Bailey*	EXOTIC	SHRUB		x	x	x			x	x		x				
ARECACEAE	*Wodyetia bifurcata A. K. Irvine*	EXOTIC	PALM	x	x						x	x		x		x	
ARECACEAE	*Cocos nucifera L.*	NE	PALM	x		x	x		x		x		x			x	x
ARECACEAE	*Caryota cumingii Lodd. ex C. Martius*	PE	PALM	x													
ARECACEAE	*Adonidia merrillii (Becc.) Becc.*	NE	PALM	x	x						x	x	x			x	x
ARECACEAE	*Dypsis lutescens (H. Wendl.) Beentje & Dransf.*	EXOTIC	PALM	x			x										
ARECACEAE	*Arenga pinnata (Wurmb.) Merr*	NE	PALM	x													
ARECACEAE	*Rhapis excelsa (Thunb) A. Henry*	EXOTIC	PALM				x				x						x
ARECACEAE	*Roystonea regia (HBK) O. F. Cook*	EXOTIC	PALM		x							x	x	x			
ARECACEAE	*Elaeis guineensis Jaca.*	EXOTIC	PALM									x					
ARECACEAE	*Hyophorbe lagenicaulis (L. H. Bailey) H. E. Moore*	EXOTIC	PALM														x
ARECACEAE	*Ptychosperma macarthurii (H. Wendl.) Nichols*	EXOTIC	PALM		x						x		x				x
ARECACEAE	*Cyrtostachys renda Bl.*	EXOTIC	PALM										x				
ARECACEAE	*Phoenix roebelenii O'Brien*	EXOTIC	PALM								x						

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ASAPARAGACEAE	*Sanseveria trifasciata Prain*	EXOTIC	HERB	x		x	x			x							x
ASPARAGACEAE	*Dracaena angustifolia Roxb.*	NE	SHRUB	x		x											
ASPARAGACEAE	*Dracaena surculosa Lindl.*	EXOTIC	SHRUB	x							x		x				
ASPARAGACEAE	*Cordyline fruticosa (L.) A. Cher.*	EXOTIC	SHRUB	x		x	x		x	x							x
ASPARAGACEAE	*Dracaena fragrans (L.) Ker. Gawl.*	EXOTIC	TREE	x	x					x	x		x				
ASPARAGACEAE	*Asparagus densiflorus L.*	EXOTIC	HERB	x													
ASTERACEAE	*Pseudoelephantopus spicatus (Juss.) Robr.*	EXOTIC	HERB	x													
ASTERACEAE	*Chromolaena odorata (L.) R. King & H. Robinson*	EXOTIC	SHRUB	x				x									
ASTERACEAE	*Mikania cordata (Burm.) Bl. Robinson.*	EXOTIC	CLIMBER	x													
ASTERACEAE	*Tridax procumbens L.*	EXOTIC	HERB	x	x			x			x		x			x	x
ASTERACEAE	*Bidens pilosus L.*	EXOTIC	HERB	x													
ASTERACEAE	*Blumea balsamifera (L.) DC*	NE	SHRUB	x	x				x								
ASTERACEAE	*Cyanthillium cinereum (L.) H. Robinson*	EXOTIC	HERB	x	x				x							x	
ASTERACEAE	*Sphagneticola trilobata (L.) Pruski*	EXOTIC	HERB														x

FAMILY	**Appendix E-3**SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ASTERACEAE	*Conyza sumatrensis (Retz.) Walker*	EXOTIC	HERB						x								
ASTERACEAE	*Artemisia scoparia Waldst. & Kit*	EXOTIC	SHRUB				x				x						
BASELLACEAE	*Basella alba L.*	EXOTIC	CLIMBER	x							x		x				
BIGNONIACEAE	*Spondias purpurea L.*	EXOTIC	TREE	x													
BIGNONIACEAE	*Tabebuia pallida (Lindl.) Miers*	EXOTIC	TREE	x					x							x	x
BIGNONIACEAE	*Spathodea campanulata Beauv.*	EXOTIC	TREE													x	
BORAGINACEAE	*Heliotropium indicum L.*	EXOTIC	HERB	x													
BORAGINACEAE	*Ehretia microphylla Lam.*	NE	SHRUB	x		x							x			x	
CACTACEAE	*Pereskia aculeata Mill.*	EXOTIC	CLIMBER					x									
CALOPHYLLACEAE	*Calophyllum inophyllum L.*	NE	TREE						x						x		
CANNACEAE	*Canna indica L.*	EXOTIC	HERB	x									x				x
CANNACEAE	*Trema orientalis (L.) Blume*	NE	TREE					x					x				x
CAPPARIDACEAE	*Cleome rutidosperma DC*	EXOTIC	HERB	x	x								x				
CARICACEAE	*Carica papaya L.*	EXOTIC	HERB	x					x				x			x	x
COMBRETACEAE	*Bucida molinethi*	EXOTIC	TREE	x		x											
COMBRETACEAE	*Terminalia catappa L.*	NE	TREE	x	x							x	x			x	x

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
COMBRETACEAE	*Quisqualis indica L.*	NE	CLIMBER					x									
COMMELINACEAE	*Tradescantia spathacea Sw.*	EXOTIC	HERB	x	x		x										
COMMELINACEAE	*Commelina diffusa*	NE	HERB	x	x			x	x								
CONVOLVULACEAE	*Ipomoea batatas (L.) Lamk.*	EXOTIC	CLIMBER	x	x		x				x						
CONVOLVULACEAE	*Merremia sp.*	EXOTIC	CLIMBER	x			x										
CUCURBITACEAE	*Coccinia grandis (L.) Voigt.*	EXOTIC	CLIMBER	x	x			x									
CYPERACEAE	*Cyperus kyllingia Endl.*	NE					x										
DIOSCOREACEAE	*Dioscorea esculenta (Lour.) Burkill*	NE	CLIMBER										x				
EBENACEAE	*Diospyros blancoi A DC*		TREE						x								
EUPHORBIACEAE	*Croton tiglium L.*	NE	SHRUB	x													
EUPHORBIACEAE	*Melanolepis multiglandulosa (Reinw. ex Blume) Rohb. f. & Zoll.*	NE	TREE	x	x												
EUPHORBIACEAE	*Excoecaria cochinchinensis*	EXOTIC	SHRUB	x	x		x						x				
EUPHORBIACEAE	*Euphorbia tirucalli L.*	EXOTIC	SHRUB	x						x							
EUPHORBIACEAE	*Manihot esculenta Crantz.*	EXOTIC	SHRUB	x													
EUPHORBIACEAE	*Euphorbia hirta L.*	EXOTIC	HERB	x	x								x				
EUPHORBIACEAE	*Jatropha curcas L.*	EXOTIC	TREE	x													

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
EUPHORBIACEAE	*Jatropha integerrima Jacq.*	EXOTIC	SHRUB	x												x	x
EUPHORBIACEAE	*Jatropha curcas L.*	EXOTIC	TREE													x	x
EUPHORBIACEAE	*Pedilanthus tithymaloides (L.) Poit.*	EXOTIC	SHRUB							x			x			x	
EUPHORBIACEAE	*Euphorbia milii Desmoul*	EXOTIC	SHRUB														x
EUPHORBIACEAE	*Macaranga tanarius (L.) Muell-Arg.*	NE	TREE					x									
EUPHORBIACEAE	*Jatropha gossypifolia L.*	EXOTIC	SHRUB								x						
FABACEAE	*Senna alata (L.) Roxb.*	EXOTIC	SHRUB	x							x						
FABACEAE	*Albizia saman F. Muell.*	EXOTIC	TREE	x		x			x								
FABACEAE	*Gliricidia sepium (Jacq.) Kunthe ex Steud.*	EXOTIC	TREE	x													
FABACEAE	*Leucaena leucocephala (Lam.) de Wit*	EXOTIC	TREE	x	x	x	x		x							x	x
FABACEAE	*Bauhinia purpurea L.*	EXOTIC	TREE	x													
FABACEAE	*Tamarindus indica L.*	EXOTIC	TREE	x							x					x	
FABACEAE	*Caesalpinia pulcherrima (L.) Sw.*	EXOTIC	SHRUB	x			x										
FABACEAE	*Centrosema pubescens Benth.*	EXOTIC	CLIMBER	x					x								
FABACEAE	*Pterocarpus indicus Willd.*	NE	TREE	x		x	x	x	x				x	x		x	x

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
FABACEAE	*Sesbania grandiflora (L.) Pers.*	EXOTIC	TREE													x	
FABACEAE	*Cassia fistula L.*	EXOTIC	TREE			x	x						x				
FABACEAE	*Acacia auriculiformis A. Cunn. ex Benth.*	EXOTIC	TREE									x	x				
FABACEAE	*Pithecellobium dulce (Roxb.) Benth.*	EXOTIC	TREE									x					x
FABACEAE	*Delonix regia (Boj. ex Hook.) Raf.*	EXOTIC	TREE						x								
FABACEAE	*Millettia pinnata (L.) Panighari*	NE	TREE						x								
FABACEAE	*Vigna unguiculata (L.) Walp.*	EXOTIC	CLIMBER						x								
FABACEAE	*Senna spectabilis (DC.) Irwin & Barneby*	EXOTIC	TREE					x									
FABACEAE	*Acacia mangium Willd.*	EXOTIC	TREE				x										
LAMIACEAE	*Premna odorata*	NE	TREE	x													
LAMIACEAE	*Coleus amboinicus Lour.*	EXOTIC	HERB	x			x										
LAMIACEAE	*Coleus blumei Benth.*	EXOTIC	HERB	x													
LAMIACEAE	*Vitex parviflora Juss.*	NE	TREE	x					x							x	x
LAMIACEAE	*Duranta repens L.*	EXOTIC	SHRUB								x		x			x	x
LAMIACEAE	*Gmelina arborea Roxb.*	EXOTIC	TREE						x								

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
LAMIACEAE	*Orthosiphon aristatus (Bl.) Mig.*	EXOTIC	HERB							x							
LAURACEAE	*Persea americana Mill.*	EXOTIC	TREE	x						x	x						
LYTHRACEAE	*Lagerstroemia speciosa (L.) Pers.*	NE	TREE									x					
MAGNOLIACEAE	*Michelia champaca L.*	EXOTIC	TREE											x			
MALPHIGIACEAE	*Tristellateia australasiae A. Rich*	NE	CLIMBER	x													
MALPHIGIACEAE	*Malpighia coccigera L.*	EXOTIC	SHRUB			x					x						x
MALVACEAE	*Ceiba pentandra (L.) Gaertn.*	EXOTIC	TREE	x			x	x					x			x	
MALVACEAE	*Pterospermum diversifolium Blume*	NE	TREE	x													
MALVACEAE	*Pachira aquatica Aubl.*	EXOTIC	TREE	x						x	x						
MALVACEAE	*Abelmoschus esculentus*	EXOTIC	SHRUB	x													x
MALVACEAE	*Sida acuta Burm. f.*	EXOTIC	SHRUB	x													
MALVACEAE	*Theobroma cacao L.*	EXOTIC	TREE													x	
MALVACEAE	*Hibiscus rosa sinensis L.*	EXOTIC	TREE													x	x
MALVACEAE	*Malvastrum coromandelianum (L.) Garcke*	EXOTIC	HERB						x								
MARANTACEAE	*Calathea makoyana E. Morr.*	EXOTIC	HERB													x	

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
MELIACEAE	*Sandoricum koetjape (Burm. f.) Merr.*	NE	TREE	x	x		x		x				x			x	
MELIACEAE	*Swietenia macrophylla King*	EXOTIC	TREE	x				x	x				x			x	x
MELIACEAE	*Melia azedarach L.*	NE	TREE	x	x											x	
MELIACEAE	*Azadirachta indica A. Juss.*	EXOTIC	TREE		x											x	x
MELIACEAE	*Toona calantas Merr. & Rolfe*		TREE						x								
MOLLUGINACEAE	*Mollugo pentaphylla L.*	NE	HERB								x						
MORACEAE	*Ficus septica Burm. f.*	NE	TREE	x	x		x	x	x	x	x	x	x			x	
MORACEAE	*Ficus sp.*		TREE	x													
MORACEAE	*Ficus benjamina L.*	NE	TREE	x	x	x		x	x		x					x	x
MORACEAE	*Streblus asper Lour.*	NE	TREE	x													
MORACEAE	*Artocarpus blancoi (Elm.) Merr.*	PE	TREE	x													
MORACEAE	*Ficus nota (Blanco) Merr.*	NE	TREE	x													
MORACEAE	*Ficus ulmifolia Lam.*	PE	TREE		x											x	
MORACEAE	*Ficus religiosa L.*	EXOTIC	TREE						x				x			x	x
MORACEAE	*Artocarpus heterophyllus Lam.*	EXOTIC	TREE				x	x								x	x
MORACEAE	*Ficus pumila L.*	EXOTIC	CLIMBER								x						x
MORACEAE	*Ficus concinna Mia.*	NE	TREE		x												x

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
MORACEAE	*Ficus calophylla Blume*	EXOTIC	TREE										x				
MORACEAE	*Broussonetia luzonica (Blanco) Bureau*	EXOTIC	TREE										x				
MORINGACEAE	*Moringa oleifera Lam.*	EXOTIC	TREE	x	x		x	x	x	x		x	x				x
MUNTINGIACEAE	*Muntingia calabura L.*	EXOTIC	TREE	x	x			x				x				x	
MUSACEAE	*Musa x paradisiaca*	EXOTIC	HERB	x				x	x	x						x	x
MYRTACEAE	*Syzygium samarangense (Blume) Merr. & Perry*	NE	TREE	x							x						
MYRTACEAE	*Psidium guajava L.*	EXOTIC	TREE	x	x	x					x		x				x
MYRTACEAE	*Syzygium cumini (L.) Skeels*	NE	TREE	x	x		x						x			x	x
MYRTACEAE	*Eugenia sp.*		TREE													x	
MYRTACEAE	*Eucalyptus deglupta Blume*	NE				x											
MYRTACEAE	*Eucalyptus tereticornis Sm.*	EXOTIC	TREE									x					
NYCTAGINACEAE	*Pisonia alba Span.*	EXOTIC	TREE	x							x						
NYCTAGINACEAE	*Bougainvillea spectabilis Willd*	EXOTIC	SHRUB	x	x	x	x		x			x	x				x
NYCTAGINACEAE	*Mirabilis jalappa L.*	EXOTIC	SHRUB		x												
OLEACEAE	*Jasminum sambac (L.) Ait.*	EXOTIC	CLIMBER	x						x							
ORCHIDACEAE	*Dendrobium aphyllum*	NE	ORCHID							x							

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
OXALIDACEAE	*Averrhoa bilimbi L.*	EXOTIC	TREE	x	x					x							
PANDANACEAE	*Pandanus amaryllifolius Roxb.*	EXOTIC	PANDAN						x								
PASSIFLORACEAE	*Passiflora foetida L.*	EXOTIC	CLIMBER									x					
PHYLLANTHACEAE	*Phyllanthus urinaria L.*	NE	HERB	x							x		x				
PHYLLANTHACEAE	*Cicca acida (L.) Merr.*	EXOTIC	TREE													x	
PHYLLANTHACEAE	*Phyllanthus niruri*	NE	HERB		x											x	x
PHYLLANTHACEAE	*Phyllanthus myrtifolius Moon.*	EXOTIC	SHRUB												x		
PHYLLANTHACEAE	*Sauropus androgynus (L.) Merr.*	NE	SHRUB					x									
PHYTOLACCACEAE	*Rivina humilis L.*	EXOTIC	HERB					x	x								
PIPERACEAE	*Peperomia pellucida Kunth.*	NE	HERB														x
POACEAE	*Saccharum spontaneum L.*	NE	GRASS	x													
POACEAE	*Bambusa blumeana Schultes f.*	EXOTIC	BAMBOO	x													
POACEAE	*Cyrtococcum accressens (trin) Stapf.*	EXOTIC	GRASS	x				x					x				
POACEAE	*Cenchrus echinatus L.*	NE	GRASS	x	x						x					x	x
POACEAE	*Phyllanthus myrtifolius (L.) Gaertn.*	NE	GRASS	x		x		x	x		x						x
POACEAE	*Axonopus compressus (Sw.) P. Beaur*	NE	GRASS	x					x	x							

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
POACEAE	*Chloris gayana Kunth*	EXOTIC	GRASS	x	x											x	x
POACEAE	*Pennisetum polystachion (L.) Schultes*	EXOTIC	GRASS	x													
POACEAE	*Panicum maximum Jacq.*	EXOTIC	GRASS	x													
POACEAE	*Bambusa multiplex (Lour.) Raensch. ex Schult.*	EXOTIC	BAMBOO								x					x	
POACEAE	*Cymbopogon citratus (DC) Stapf.*	EXOTIC	GRASS						x								
POACEAE	*Dactyloctenium aegyptium (L.) Willd.*	NE	GRASS						x								
POACEAE	*Pennisetum purpureum Schumach.*	EXOTIC	GRASS					x									
POACEAE	*Mnesithea cochinchinensis*	NE	GRASS					x									
POLYGONACEAE	*Antigonon leptopus Hook. & Arn.*	EXOTIC	CLIMBER													x	
POLYPODIACEAE	*Drynaria quercifolia (L.) J. Sm.*	NE	FERN	x					x								
PORTULACACEAE	*Portulaca quadrifida L.*	NE	HERB	x	x												
PORTULACACEAE	*Portulaca oleracea L.*	NE	HERB	x									x				x
PTERIDACEAE	*Pteris ensiformis Burm. F.*	NE	FERN	x													
PTERIDACEAE	*Adiantum philippense L.*	NE	FERN						x								

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
ROSACEAE	*Rosa cv.*	EXOTIC	SHRUB	x													
RUBIACEAE	*Morinda citrifolia L.*	NE	TREE	x													x
RUBIACEAE	*Ixora chinensis Lam.*	EXOTIC	SHRUB	x	x						x	x					x
RUBIACEAE	*Nauclea orientalis L.*	NE	TREE	x													
RUBIACEAE	*Gardenia jasminoides (L.) Ellis*	EXOTIC	SHRUB											x			
RUBIACEAE	*Coffea robusta L. Lindl. ex de Wildem*	EXOTIC	TREE						x								
RUBIACEAE	*Mussaenda "Doña Aurora"*	EXOTIC	SHRUB							x							
RUTACEAE	*Citrus x microcarpa Bunge*	EXOTIC	TREE	x						x							
RUTACEAE	*Murraya paniculata (L.) Jack.*	NE	SHRUB	x	x			x			x	x	x			x	
RUTACEAE	*Citrus x aurantium L.*	EXOTIC	TREE						x							x	
SAPINDACEAE	*Dimocarpus longan Lour.*	EXOTIC	TREE														x
SAPINDACEAE	*Nephelium lappaceum L.*	EXOTIC	TREE								x						
SAPOTACEAE	*Chrysophyllum cainito L.*	EXOTIC	TREE	x					x	x	x						
SAPOTACEAE	*Manilkara sapota L.*	EXOTIC	TREE	x													
SAPOTACEAE	*Pouteria campechiana (HBK.) Bachni*	EXOTIC	TREE		x				x								x
SCROPHULARIACEAE	*Scoparia dulcis L.*	EXOTIC	HERB	x													

FAMILY	Appendix E-3SPECIES	ENDEMICITY	GROWTH FORM	Valenzuela	Mindanao Ave.	Tandang Sora	North Ave.	Quezon Ave	East Ave	Anonas	Katipunan Ave.	Ortigas North	Ortigas South	Kalayaan Ave.	BGC	Cayetano Blvd.	FTI
SCROPHULARIACEAE	*Leucophyllum frutescens Berland. I. M. Johnst.*	EXOTIC	SHRUB		x											x	
SOLANACEAE	*Capsicum frutescens L.*	EXOTIC	SHRUB	x													
SOLANACEAE	*Solanum lycopersicum L.*	EXOTIC	HERB	x													
SOLANAEAE	*Solanum torvum Sw.*	EXOTIC	SHRUB	x				x									
STRELITZIACEAE	*Ravenala madagascariensis Sonn.*	EXOTIC	TREE					x									
TURNERACEAE	*Turnera subulata Sm.*	EXOTIC	SHRUB			x											
VITACEAE	*Cissus nodosa Blume*	EXOTIC	VINE	x	x							x					x

Note: The "x" mark indicates presence. Legend: Exotic-Introduced to the Philippines, PE-Philippine Endemic, NE-Indigenous but non endemic

Appendix E-4. Coordinates of Threatened Species

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°40.722'	121°01.925'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.719'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.716'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.712'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.709'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.704'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.702'	121°01.926'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.699'	121°01.926'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.696'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.690'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.686'	121°01.928'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.679'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.675'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.668'	121°01.930'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.663'	121°01.927'	Tandang Sora Ave. Station
Pterocarpus indicus Willd.	14°40.641'	121°01.927'	Tandang Sora Ave. Station
Wrightia pubescens R. Br. Ssp. laniti	14°41.642'	121°01.347'	Valenzuela Depot
Adonidia merrillii (Becc.) Becc.	14°41.642'	121°01.347'	Valenzuela Depot
Adonidia merrillii (Becc.) Becc.	14°41.824'	121°01.217'	Valenzuela Depot
Vitex parviflora Juss.	14°41.735'	121°01.329'	Valenzuela Depot
Drynaria quercifolia	14°41.831'	121°01.198'	Valenzuela Depot
Artocarpus blancoi (Elm.) Merr.	14°41.798'	121°01.329'	Valenzuela Depot
Pterocarpus indicus Willd.	14°42.444'	121°00.094'	Valenzuela Depot
Pterocarpus indicus Willd.	14°31.139'	121°03.141'	Cayetano Blvd. Station
Vitex parviflora Juss.	14°31.678'	121°03.405'	Cayetano Blvd. Station
Adonidia merrillii (Becc.) Becc.	14°31.669'	121°03.402'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.656'	121°03.397'	Cayetano Blvd. Station
Ficus ulmifolia Lam.	14°31.687'	121°03.432'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.651'	121°03.388'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.648'	121°03.387'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.644'	121°03.387'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°31.636'	121°03.385'	Cayetano Blvd. Station
Pterocarpus indicus Willd.	14°30.445'	121°02.118'	FTI Station
Pterocarpus indicus Willd.	14°30.455'	121°02.113'	FTI Station
Pterocarpus indicus Willd.	14°30.458'	121°02.112'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.429'	121°02.145'	FTI Station
Pterocarpus indicus Willd.	14°30.425'	121°02.152'	FTI Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°30.434'	121°02.146'	FTI Station
Pterocarpus indicus Willd.	14°30.346'	121°02.171'	FTI Station
Pterocarpus indicus Willd.	14°30.347'	121°02.173'	FTI Station
Pterocarpus indicus Willd.	14°30.349'	121°02.177'	FTI Station
Pterocarpus indicus Willd.	14°30.352'	121°02.165'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.390'	121°02.152'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.390'	121°02.149'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.387'	121°02.145'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.386'	121°02.147'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.387'	121°02.146'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.381'	121°02.246'	FTI Station
Pterocarpus indicus Willd.	14°30.383'	121°02.154'	FTI Station
Pterocarpus indicus Willd.	14°30.380'	121°02.154'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.381'	121°02.152'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.382'	121°02.150'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.373'	121°02.153'	FTI Station
Pterocarpus indicus Willd.	14°30.320'	121°02.189'	FTI Station
Pterocarpus indicus Willd.	14°30.321'	121°02.192'	FTI Station
Pterocarpus indicus Willd.	14°30.322'	121°02.194'	FTI Station
Vitex parviflora Juss.	14°30.304'	121°02.202'	FTI Station
Pterocarpus indicus Willd.	14°30.322'	121°02.185'	FTI Station
Pterocarpus indicus Willd.	14°30.344'	121°02.169'	FTI Station
Pterocarpus indicus Willd.	14°30.348'	121°02.168'	FTI Station
Pterocarpus indicus Willd.	14°30.350'	121°02.167'	FTI Station
Pterocarpus indicus Willd.	14°30.349'	121°02.172'	FTI Station
Pterocarpus indicus Willd.	14°30.332'	121°02.187'	FTI Station
Pterocarpus indicus Willd.	14°30.334'	121°02.181'	FTI Station
Pterocarpus indicus Willd.	14°30.339'	121°02.170'	FTI Station
Pterocarpus indicus Willd.	14°30.340'	121°02.168'	FTI Station
Pterocarpus indicus Willd.	14°30.342'	121°02.177'	FTI Station
Pterocarpus indicus Willd.	14°30.340'	121°02.171'	FTI Station
Pterocarpus indicus Willd.	14°30.328'	121°02.178'	FTI Station
Pterocarpus indicus Willd.	14°30.327'	121°02.178'	FTI Station
Pterocarpus indicus Willd.	14°30.336'	121°02.174'	FTI Station
Vitex parviflora Juss.	14°30.299'	121°02.195'	FTI Station
Vitex parviflora Juss.	14°30.298'	121°02.196'	FTI Station
Vitex parviflora Juss.	14°30.299'	121°02.197'	FTI Station
Vitex parviflora Juss.	14°30.298'	121°02.200'	FTI Station
Vitex parviflora Juss.	14°30.301'	121°02.192'	FTI Station
Vitex parviflora Juss.	14°30.301'	121°02.197'	FTI Station
Vitex parviflora Juss.	14°30.300'	121°02.194'	FTI Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Vitex parviflora Juss.	14°30.303'	121°02.195'	FTI Station
Vitex parviflora Juss.	14°30.304'	121°02.196'	FTI Station
Vitex parviflora Juss.	14°30.282'	121°02.205'	FTI Station
Pterocarpus indicus Willd.	14°30.282'	121°02.204'	FTI Station
Pterocarpus indicus Willd.	14°30.313'	121°02.187'	FTI Station
Pterocarpus indicus Willd.	14°30.317'	121°02.186'	FTI Station
Vitex parviflora Juss.	14°30.292'	121°02.197'	FTI Station
Alstonia macrophylla Wall. ex D.C.	14°30.296'	121°02.196'	FTI Station
Vitex parviflora Juss.	14°30.297'	121°02.197'	FTI Station
Vitex parviflora Juss.	14°30.298'	121°02.198'	FTI Station
Vitex parviflora Juss.	14°30.263'	121°02.215'	FTI Station
Pterocarpus indicus Willd.	14°30.264'	121°02.213'	FTI Station
Pterocarpus indicus Willd.	14°30.263'	121°02.215'	FTI Station
Pterocarpus indicus Willd.	14°30.304'	121°02.222'	FTI Station
Pterocarpus indicus Willd.	14°30.209'	121°02.241'	FTI Station
Pterocarpus indicus Willd.	14°30.214'	121°02.237'	FTI Station
Pterocarpus indicus Willd.	14°30.221'	121°02.235'	FTI Station
Pterocarpus indicus Willd.	14°30.293'	121°02.216	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.132'	121°02.290'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.139'	121°02.290'	FTI Station
Pterocarpus indicus Willd.	14°30.185'	121°02.263'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.189'	121°02.254'	FTI Station
Vitex parviflora Juss.	14°30.288'	121°02.220'	FTI Station
Pterocarpus indicus Willd.	14°30.292'	121°02.217'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.096'	121°02.304'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.097'	121°02.299'	FTI Station
Pterocarpus indicus Willd.	14°30.110'	121°02.295'	FTI Station
Adonidia merrillii (Becc.) Becc.	14°30.111'	121°02.295'	FTI Station
Vitex parviflora Juss.	14°30.288'	121°02.220'	FTI Station
Pterocarpus indicus Willd.	14°33.609'	121°03.408'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.612'	121°03.405'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.623'	121°03.393'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.626'	121°03.396'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.617'	121°03.371'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.617'	121°03.375'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.623'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.626'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.626'	121°03.380'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.631'	121°03.382'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.507'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.620'	121°03.376'	Kalayaan Ave. Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°33.590'	121°03.394'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.584'	121°03.392'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.579'	121°03.387'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.572'	121°03.389'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.562'	121°03.384'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.609'	121°03.349'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.543'	121°03.392'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.541'	121°03.386'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.521'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.522'	121°03.366'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.520'	121°03.366'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.565'	121°03.379'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.558'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.577'	121°03.369'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.578'	121°03.362'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.586'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.592'	121°03.368'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.603'	121°03.347'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.509'	121°03.354'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.522'	121°03.358'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.522'	121°03.356'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.525'	121°03.362'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.533'	121°03.359'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.535'	121°03.367'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.535'	121°03.371'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.540'	121°03.360'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.566'	121°03.365'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.564'	121°03.372'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°33.561'	121°03.376'	Kalayaan Ave. Station
Pterocarpus indicus Willd.	14°38.238'	121°02.921'	East Ave. Station
Pterocarpus indicus Willd.	14°38.211'	121°03.079'	East Ave. Station
Pterocarpus indicus Willd.	14°38.206'	121°03.096'	East Ave. Station
Pterocarpus indicus Willd.	14°38.207'	121°03.105'	East Ave. Station
Pterocarpus indicus Willd.	14°38.201'	121°03.111'	East Ave. Station
Pterocarpus indicus Willd.	14°38.200'	121°03.125'	East Ave. Station
Pterocarpus indicus Willd.	14°38.198'	121°03.135'	East Ave. Station
Pterocarpus indicus Willd.	14°38.238'	121°02.921'	East Ave. Station
Pterocarpus indicus Willd.	14°38.188'	121°03.192'	East Ave. Station
Pterocarpus indicus Willd.	14°38.189'	121°03.194'	East Ave. Station
Toona calantas Merr. & Rolfe	14°38.204'	121°03.143'	East Ave. Station
Drynaria quercifolia	14°38.204'	121°03.143'	East Ave. Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Pterocarpus indicus Willd.	14°38.183'	121°03.176'	East Ave. Station
Pterocarpus indicus Willd.	14°38.167'	121°03.255'	East Ave. Station
Vitex parviflora Juss.	14°38.165'	121°03.251'	East Ave. Station
Vitex parviflora Juss.	14°38.181'	121°03.178'	East Ave. Station
Pterocarpus indicus Willd.	14°38.181'	121°03.185'	East Ave. Station
Calophyllum inophyllum L.	14°33.132'	121°03.340'	BGC Station
Calophyllum inophyllum L.	14°33.124'	121°03.338'	BGC Station
Calophyllum inophyllum L.	14°33.127'	121°03.344'	BGC Station
Calophyllum inophyllum L.	14°33.113'	121°03.339'	BGC Station
Calophyllum inophyllum L.	14°33.121'	121°03.334'	BGC Station
Calophyllum inophyllum L.	14°33.014'	121°03.299'	BGC Station
Calophyllum inophyllum L.	14°33.016'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°33.018'	121°03.298'	BGC Station
Calophyllum inophyllum L.	14°33.057'	121°03.299'	BGC Station
Calophyllum inophyllum L.	14°33.030'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°33.029'	121°03.300'	BGC Station
Calophyllum inophyllum L.	14°33.050'	121°03.320'	BGC Station
Calophyllum inophyllum L.	14°33.005'	121°03.331'	BGC Station
Calophyllum inophyllum L.	14°33.060'	121°03.331'	BGC Station
Calophyllum inophyllum L.	14°33.074'	121°03.332'	BGC Station
Calophyllum inophyllum L.	14°33.082'	121°03.333'	BGC Station
Calophyllum inophyllum L.	14°33.073'	121°03.328'	BGC Station
Calophyllum inophyllum L.	14°33.076'	121°03.350'	BGC Station
Calophyllum inophyllum L.	14°33.060'	121°03.354'	BGC Station
Calophyllum inophyllum L.	14°33.046'	121°03.361'	BGC Station
Calophyllum inophyllum L.	14°33.052'	121°03.339'	BGC Station
Calophyllum inophyllum L.	14°33.012'	121°03.320'	BGC Station
Calophyllum inophyllum L.	14°33.013'	121°03.304'	BGC Station
Calophyllum inophyllum L.	14°33.017'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°33.018'	121°03.301'	BGC Station
Calophyllum inophyllum L.	14°33.024'	121°03.306'	BGC Station
Calophyllum inophyllum L.	14°33.015'	121°03.302'	BGC Station
Calophyllum inophyllum L.	14°33.059'	121°03.333'	BGC Station
Calophyllum inophyllum L.	14°33.048'	121°03.330'	BGC Station
Calophyllum inophyllum L.	14°33.047'	121°03.335'	BGC Station
Calophyllum inophyllum L.	14°33.040'	121°03.322'	BGC Station
Calophyllum inophyllum L.	14°33.036'	121°03.322'	BGC Station
Calophyllum inophyllum L.	14°33.024'	121°03.314'	BGC Station
Calophyllum inophyllum L.	14°32.986'	121°03.307'	BGC Station
Calophyllum inophyllum L.	14°32.992'	121°03.306'	BGC Station
Calophyllum inophyllum L.	14°32.995'	121°03.292'	BGC Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Calophyllum inophyllum L.	14°32.995'	121°03.292'	BGC Station
Calophyllum inophyllum L.	14°33.011'	121°03.303'	BGC Station
Calophyllum inophyllum L.	14°33.006'	121°03.320'	BGC Station
Calophyllum inophyllum L.	14°33.001'	121°03.322'	BGC Station
Calophyllum inophyllum L.	14°32.997'	121°03.318'	BGC Station
Calophyllum inophyllum L.	14°32.993'	121°03.308'	BGC Station
Calophyllum inophyllum L.	14°32.989'	121°03.310'	BGC Station
Calophyllum inophyllum L.	14°33.090'	121°03.315'	BGC Station
Calophyllum inophyllum L.	14°33.093'	121°03.337'	BGC Station
Calophyllum inophyllum L.	14°33.094'	121°03.343'	BGC Station
Calophyllum inophyllum L.	14°33.089'	121°03.341'	BGC Station
Calophyllum inophyllum L.	14°33.094'	121°03.336'	BGC Station
Calophyllum inophyllum L.	14°33.100'	121°03.341'	BGC Station
Calophyllum inophyllum L.	14°32.940'	121°03.277'	BGC Station
Calophyllum inophyllum L.	14°32.932'	121°03.280'	BGC Station
Calophyllum inophyllum L.	14°32.928'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.922'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.914'	121°03.271'	BGC Station
Calophyllum inophyllum L.	14°32.912'	121°03.270'	BGC Station
Calophyllum inophyllum L.	14°32.910'	121°03.272	BGC Station
Calophyllum inophyllum L.	14°32.906'	121°03.260'	BGC Station
Calophyllum inophyllum L.	14°32.902'	121°03.270'	BGC Station
Calophyllum inophyllum L.	14°32.894'	121°03.266'	BGC Station
Calophyllum inophyllum L.	14°32.892'	121°03.265'	BGC Station
Calophyllum inophyllum L.	14°32.892'	121°03.261'	BGC Station
Calophyllum inophyllum L.	14°32.881'	121°03.259'	BGC Station
Calophyllum inophyllum L.	14°32.876'	121°03.256'	BGC Station
Calophyllum inophyllum L.	14°32.870'	121°03.255'	BGC Station
Calophyllum inophyllum L.	14°32.861'	121°03.257'	BGC Station
Calophyllum inophyllum L.	14°32.859'	121°03.256'	BGC Station
Calophyllum inophyllum L.	14°32.857'	121°03.267'	BGC Station
Calophyllum inophyllum L.	14°32.861'	121°03.263'	BGC Station
Calophyllum inophyllum L.	14°32.866'	121°03.266'	BGC Station
Calophyllum inophyllum L.	14°32.870'	121°03.269'	BGC Station
Calophyllum inophyllum L.	14°32.875'	121°03.270'	BGC Station
Calophyllum inophyllum L.	14°32.880'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.879'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.883'	121°03.272'	BGC Station
Calophyllum inophyllum L.	14°32.887'	121°03.273'	BGC Station
Calophyllum inophyllum L.	14°32.892'	121°03.276'	BGC Station
Calophyllum inophyllum L.	14°32.894'	121°03.270'	BGC Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Calophyllum inophyllum L.	14°32.899'	121°03.279'	BGC Station
Calophyllum inophyllum L.	14°32.915'	121°03.279'	BGC Station
Calophyllum inophyllum L.	14°32.918'	121°03.287'	BGC Station
Calophyllum inophyllum L.	14°32.925'	121°03.285'	BGC Station
Calophyllum inophyllum L.	14°32.930'	121°03.279'	BGC Station
Adonidia merrillii (Becc.) Becc.	14°36.859'	121°04.242'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.910'	121°04.290'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.912'	121°04.243'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.913'	121°04.244'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.963'	121°04.253'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°37.038'	121°04.290'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.914'	121°04.243'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.915'	121°04.242'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.915'	121°04.244'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°36.916'	121°04.247'	Katipunan Ave. Station
Adonidia merrillii (Becc.) Becc.	14°37.059'	121°04.256'	Katipunan Ave. Station
Pterocarpus indicus Willd.	14°38.192'	121°03.125'	East Ave. Station
Pterocarpus indicus Willd.	14°38.195'	121°03.118'	East Ave. Station
Pterocarpus indicus Willd.	14°38.192'	121°03.122'	East Ave. Station
Calophyllum inophyllum L.	14°38.809'	121°03.083'	East Ave. Station
Pterocarpus indicus Willd.	14°38.754'	121°02.229'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°38.743'	121°02.213'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°38.735'	121°02.216'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°38.709'	121°02.233'	Quezon Ave. Station
Pterocarpus indicus Willd.	14°39.274'	121°02.129'	North Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.407'	121°01.680'	Mindanao Ave. Station
Ficus ulmifolia Lam.	14°41.288'	121°01.815'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.385'	121°01.705'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.387'	121°01.698'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.388'	121°01.598'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.394'	121°01.692'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.398'	121°01.687'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.401'	121°01.685'	Mindanao Ave. Station
Adonidia merrillii (Becc.) Becc.	14°41.404'	121°01.680'	Mindanao Ave. Station
Pterocarpus indicus Willd.	14°34.528'	121°03.659'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.530'	121°03.677'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.592'	121°03.742'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.590'	121°03.736'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.542'	121°03.701'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.551'	121°03.706'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.555'	121°03.722'	Ortigas South Station

SPECIES	LATITUDE	LONGITUDE	LOCATION
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.712'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.710'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.549'	121°03.719'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.556'	121°03.719'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.556'	121°03.719'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.557'	121°03.724'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.559'	121°03.718'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.722'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.550'	121°03.717'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.555'	121°03.717'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.558'	121°03.715'	Ortigas South Station
Adonidia merrillii (Becc.) Becc.	14°34.552'	121°03.713'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.600'	121°03.750'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.567'	121°03.726'	Ortigas South Station
Pterocarpus indicus Willd.	14°34.493'	121°03.678'	Ortigas South Station

Appendix E-5:
In Situ Photos of Plants

[redacted]

[redacted]

[redacted]

[redacted]

Identified Threatened Plants in Valenzuela Depot Site

[redacted]

Identified Threatened Plants in East Ave. station location

Palo Maria (*Calophyllum inophyllum)*at the BGC station location

Identified Threatened Plants in Cayetano Blvd. station location

Center Island at FTI station location

APPENDIX F

Methodology for Estimating Carb on Stocks and Sequestration

CARBON STOCKS AND SEQUESTRATION

The amount of carbon stocks and carbon sequestration of the flora in the area to be displaced by the MMSP were estimated using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for Settlements (Chapter 8) under the Land Use, Land Use Change and Forestry (LULUCF). Based on the guidelines the settlements category refers to "all classes of urban formation that have been in use as settlements since the last time data were recorded". It consists of areas that are functionally or administratively associated with public or private land in cities, villages, or other settlement types.

The carbon stocks or the amount of carbon present in the woody plants were determined using the Tier 2b of the guidelines or the individual plant growth method. In this method, the amount of biomass material is calculated using the biomass estimation allometric equation published by Chave et al. (2014) as follows:

$$Y = 0.0673 \times (\rho D^2 H)^{0.976}$$

Where: Y = tree biomass in kg

ρ = wood density in grams per cubic centimetre (g/cc)

D = Diameter at breast height in centimetre (cm)

H = height in meters (m)

The diameter at breast height and the height of the floras where individually measured during the inventory. The wood density for each species identified was obtained from an online database (http://db.worldagroforestry.org/). For species not included in the database, a value of 0.45 was used which is within the range of wood density of floras in the Philippines.

The amount of carbon in the biomass is assumed at 0.45 or 45% of the biomass which is the default value for the Philippines (Lasco & Puhlin, 2000). The value of carbon stocks in terms of Carbon Dioxide is obtained by multiplying the carbon content of the biomass by 3.6663. In summary the total above soil carbon stock from the biomass inventory was calculated using the following formula.

The annual carbon sequestration of the plants and trees can be estimated from the annual growth rate of each species. However, due to absence of information, the annual carbon sequestration was calculated by dividing the carbon stock by the estimated age of tree. In summary, the annual carbon sequestration in terms of kilogram CO_2 was determined using the following formula.

[illegible]

Where: Y_i = the biomass material of each species in kilograms

T_i = the estimated age of each plant in years.

APPENDIX G

Water Bodies Along the MMSP Alignment

APPENDIX H

Results of Air, Noise and Water Survey

Appendix H.1: Air and Noise

Appendix H.2: Surface Water and Groundwater

APPENDIX I

Documentation of surveys and sampling activities

APPENDIX J

Prediction and Assessment of Noise and Vibration Levels

PREDICTION AND ASSESSMENT OF NOISE AND VIBRATION LEVELS

A. Noise Levels during the Construction Phase

Noise level will definitely increase because of construction activities. Most of the noisewill becontributed by operation of heavy equipment and machineries, the generator set, and vehicles coming inand out of the Project site.

Prediction method:

The prediction model developed in "Prediction model for construction noise (ASJ CN-Model 2007) by The Acoustical Society of Japan" is applied.

Prediction model:

The noise levels at prediction points are calculated by the following formulas:

$L_A = 10 \log_{10} \Sigma 10^{L_{A,i}/10}$

$L_{A,i} = L_{WA,i} - 10 \log (Q/4\pi r^2) = L_{WA,i} - 20 \log r - 8$

Where,L_A: Composite noise level of construction units at predictionpoint (dB)
r: Distance between noise source and prediction point(m)
Q: Constant on sound radiation (in case of hemisphere radiation: =2)
$L_{A,i}$: Effective noise level of individual noise source i (construction unit i)at perdition point (dB)
$L_{WA,i}$: Effective A-weighted sound power level of construction unit i(dB)

Effective A-weighted sound power level of construction unit:

Construction units that have potentially high noise levels were selected as the prediction targets.

Construction Activities	**Effective A-weighted Sound Power Level**
Pilling works*	106 dB
Skeleton construction works*	105 dB
Excavating works	110 dB

* Construction works at the stations
** Vertical shaft construction works of tunnel

Location of noise source and prediction point:

The noise emission source (construction machinery) is assumed to be set on 5 m (minimum radius of construction machinery) point from the edge of the construction limit, where the highest impact of noise is predicted. The height of the noise emission source is assumed to be set 1.5 m that is a general height of driving of construction machinery. The prediction point is assumed to be set on the edge of the construction limit, and the height is set 1.2m.

B. Vibration Levels during the Construction Phase

Operation of construction machinery, such as pile driver and rock drilling, causes ground vibrations. Because ground vibrations from construction activities spread through the ground and diminish in strength with distance, these do not often reach the levels that can damage structures, but can achieve the audible and sensing ranges for humans very near the construction site.

Prediction method:

The prediction model developed in "Environmental Impact Assessment Technique for Road Project (2012) by National Institute for Land and Infrastructure Management, Japan" is applied.

Prediction model:

The vibration levels at prediction points are calculated by the following formulas:

$L = 20 \log_{10} (a_w/a_0)$
V: Vibration level (dB)
a_w: Frequency weighted acceleration reflecting human perception(m/s^2)
a_0: Standard acceleration $=10^{-5}$ (m/s^2)

$V_A = 10 \log_{10} \Sigma 10^{Vr,i/10}$
$Vr = Vr_0 - 15 \log_{10} (r/r_0) - 8.68\ \alpha\ (r - r_0)$
Where, V_A: Composite vibration level of construction units at prediction point (dB)
$V_{r,i}$: Vibration level of individual vibration source i (construction unit i) at perdition point (dB)
V_r: Vibration level at prediction point (dB)
V_0: Vibration level at reference point (dB)
r: Distance from a vibration source (construction machinery) to prediction point (m)
r_0: Distance of reference point (= 5m)
α: Internal damping ratio

Vibration level of construction unit at reference point:

Construction units that have potentially high vibration levels were selected as the prediction targets.

Construction unit	Vibration level at reference point	Internal damping ratio
Excavation works	63 dB	0.001
Refilling works (Earthwork)	63 dB	0.01

Note:
Construction works of station: Excavation works and refilling works
Vertical shaft construction works of tunnel: Excavating works

Location of vibration source and prediction point:

The vibration emission source (construction works) is assumed to be set on 5 m (minimum radius of construction machinery) point from the edge of the construction limit, where the highest impact of noise is predicted. The prediction point is assumed to be set on the edge of the construction limit (borderline) and 5 m outer point from the borderline.

C. Vibration Levels during the Operation Phase

Prediction method:

The prediction model developed in "Teito Rapid Transit Authority, Japan" is applied.

Prediction model:

The vibration levels at prediction points are calculated by the following formulas.

$L = 20 \log_{10} (a_w/a_0)$
V: Vibration level (dB)
a_w: Frequency weighted acceleration reflecting human perception(m/s2)
a_0: Standard acceleration $=10^{-5}$ (m/s^2)

$VA = K - 20\log_{10} (X/15) - 24\log_{10} (Y/20) + 20\log_{10} (Z/40)$
Where, VA: Vibration level of at predictionpoint (dB)
K: Standard value of resilient tie in single shield tunnel (41)
X: Distance from subway tunnel to prediction point (m)
Y: Unit wait of subway tunnel (16 t/m)
Z: Running speed of train (70 km/h)

Location of prediction point:

The prediction points are set on 10, 20 and 30 m point from the subway tunnel.

APPENDIX K

Environmental Risk Assessment Matrix

ENVIRONMENTAL RISK ASSESSMENT RATING FOR MMSP

POSSIBLE HAZARDS	SEVERITY				PROBABILITY	RELATIVE RISK
	People	Financial	Public	Environment		
Construction related accidents	3	2	1	1	3	21
Toxic chemicals	1	1	1	2	2	10
Fire	4	4	2	4	2	28
Rail system failure	3	3	2	1	3	27
Structural failure	4	4	2	1	3	33
Terrorism attacks	4	4	4	4	2	32
Security and violence incidents	2	1	1	1	4	20
Transmission of infectious diseases	2	1	1	1	2	10

Risk Legend:

- Low: 1 - 15
- Medium: 16 -30
- High: 31 -50
- Very High: 51-80

APPENDIX L

Project Environmental Monitoring And Audit Prioritization Scheme (PEMAPS) Questionnaire

Department of Transportation

Metro Manila Subway Project (MMSP) Phase 1

Project Description for Scoping

JUNE 2019

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Republic of the Philippines
DEPARTMENT OF TRANSPORTATION (DOTr)
RAILWAYS SECTOR

ENVIRONMENTAL MANAGEMENT BUREAU
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06 June 2019

ENGR. METODIO U. TURBELLA
Office of the Director
Environmental and Management Bureau
Department of Environment and Natural Resources
Visayas Avenue, Quezon City

Attention : **ENGR. ESPERANZA SAJUL**
Chief EIA Management Division

Subject : Metro Manila Subway Project (MMSP) – Phase 1
Project Description for Scoping

Dear **Director Turbella:**

This has reference to the ongoing discussion of the DOTr with the Environmental Impact Assessment Management Division (EIAMD) of the DENR regarding the proposed changes to the original project specification of the MMSP that will require a major amendment of **ECC-CO-1708-0017** granted on October 25, 2017. Following are the changes in few sections and extension of the proposed alignment:

1. Realignment from C5 to Bonifacio South Main Boulevard near Lawton Avenue and replacement of the proposed Cayetano Boulevard Station with Lawton East and West Stations in Taguig based on the Environmental Planning Recommendations in the ECC to consider realignment of subway from the West Valley fault;
2. Extension of subway alignment and additional station to NAIA Terminal 3; and
3. Extension of subway alignment to Bicutan for the interoperability with the PNR South Commuter line

In this regard, we are pleased to submit the Project Description for Scoping, for your review and appropriate action.

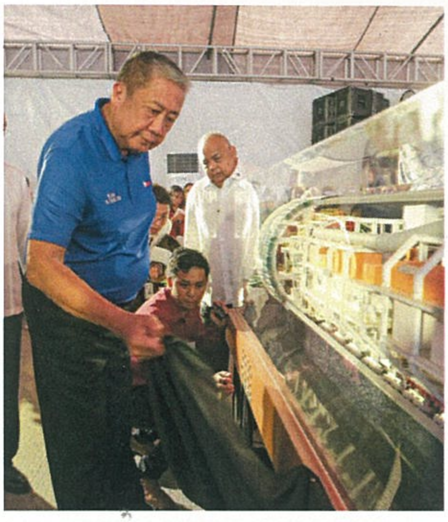
We would be happy to discuss our request with your office, preferably on 13 June 2019, so that we can agree on a way forward. We are looking forward to your favourable response to our request.

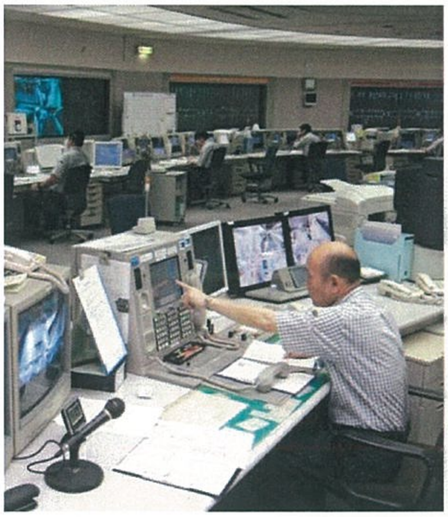
For any clarifications, please do not hesitate to contact Engr. Jim Benidict G. Petate through (0921) 414 6425 / jimpetate.dotr@gmail.com.

Thank you very much.

Sincerely Yours,

TIMOTHY JOHN R. BATAN
Undersecretary for Railways





Department of Transportation

Metro Manila Subway Project (MMSP) Phase 1

Project Description for Scoping

JUNE 2019

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1. Basic project information

Metro Manila Subway Project (MMSP) in the Republic of the Philippines is a railway system project of the Department of Transportation (DOTr), the primary agency responsible for the policy, planning, implementation, promotion, development, and regulation of the country's network of transportation, in partnership with the Japan International Cooperation Agency (JICA). The project aims to construct a subway servicing up to a thousand passengers a day. The underground alignment will traverse seven (7) cities in Metro Manila namely, Quezon, Valenzuela, Makati, Pasig, Taguig, Pasay and Parañaque. On October 25, 2017, the Environmental Compliance Certificate (ECC) for the project was granted (ECC CO 1709-0017), covering the construction and operation of the 13 underground stations with a total length of 28.3 kilometers, which will start in Quirino Highway in Quezon City and end in FTI, Taguig City. The ECC also covers the depot for the trains covering about 31.7 hectares of land in Brgy. Ugong, Valenzuela City.

As the project is currently transitioning from Detailed Engineering Design to Construction phase, there are significant changes and updates in the current project design that will entail the amendment of the ECC. Additional scope and significant changes from the proposed design presented in the 2017 EIS includes the following:

- Realignment from C5 to Bonifacio South Main Boulevard near Lawton Avenue and replacement of the proposed Cayetano Boulevard Station.
- Extension of the alignment and additional station to NAIA Terminal 3 (T3); and
- Extension of the alignment to Bicutan for the interoperability with the PNR South commuter line

Table 1 Project Details

Project Details	Description
Name of the project	Metro Manila Subway Project (MMSP) Phase 1
Location	The proposed route will start from Quirino Highway (Quezon City) to FTI in Paranaque and NAIA Terminal 3 in Pasay
Changes in project design	• Relocation of Cayetano Boulevard Station to Lawton East and West Stations • Extension of the project from FTI station to NAIA Terminal 3 (T3) • Connection of the project from FTI station to PNR Bicutan Station (N2SC) South Commuter Line
Project Type	Underground/subway railway
Components	Underground tunnel, underground stations, depot, and interconnections (i.e. walkway, PUV bays and etc)
Size	Total subway length of 36 kilometers

1.1 Proponent profile

The summary of the proponent's profile is presented in Table 2

Table 2 Proponent profile

Particular	Details
Proponent	Department of Transportation, Republic of the Philippines S. Osmeña Road, Clark Freeport, Mabalacat, Pampanga (632) 790-8300
Authorised signatory	Engr. Mikaela Eloisa D. Mendoza Project Manager
Contact Person	Engr. Jim Benidict G. Petate Email: jimpetate.dotr@gmail.com Contact No.: (0921) 414 6425

2. Project description

2.1 Project location

The proposed railway for the MMSP Phase 1 will be mostly underground, with structures aboveground for the station entrances and exits. The project alignment will pass through Metro Manila and will be connected to the Central Business Districts (CBDs), particularly in Quezon City, Ortigas Center, and Bonifacio Global City. As such, most areas that the railway will traverse are highly developed as urban commercial and residential areas. The proposed depot location is at Brgy. Ugong in Valenzuela City.

As listed in the 2017 EIS, the locations of the project components are presented in Table 3 , as well as the proposed changes subject to ECC amendment.

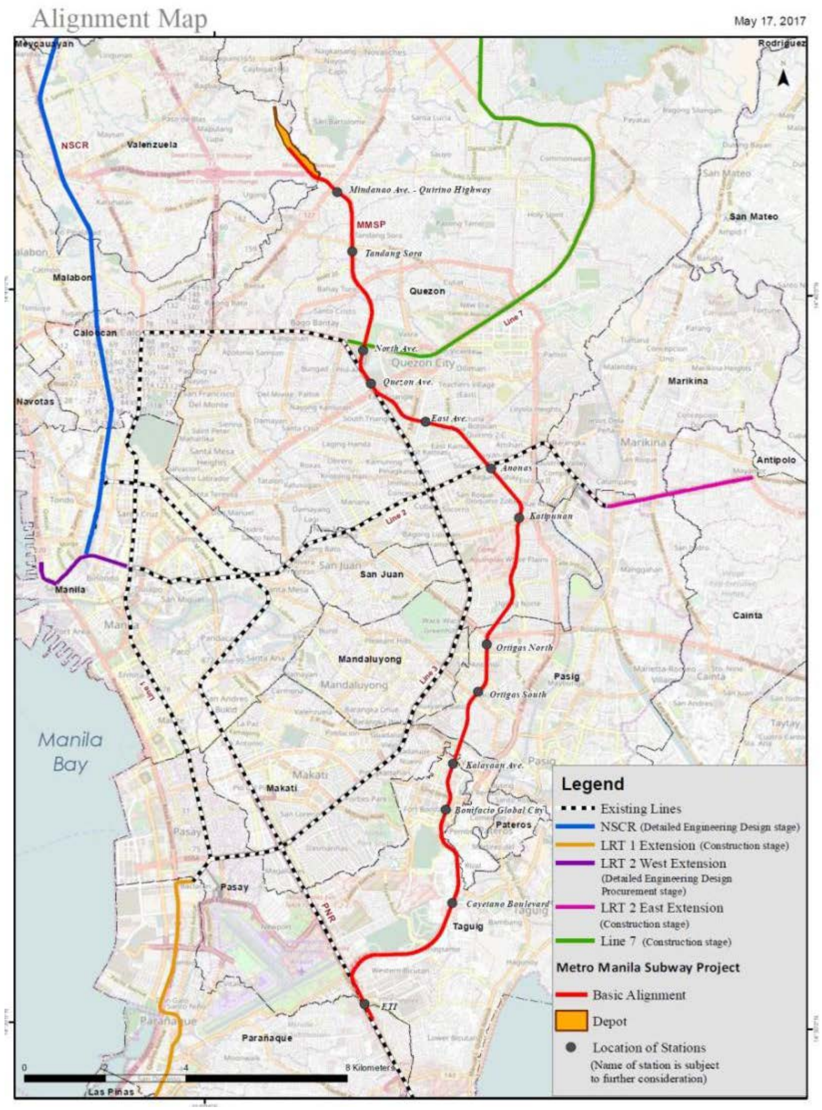
Figure 1 below compares the original alignment and the proposed changes

Table 3 Location of project components

Depot, Stations, Alignment	Structure Location	Barangay
Valenzuela Depot	Aboveground	Brgy. Ugong, Valenzuela City
Alignment from Depot to Quirino Highway Station	Underground	Brgy. Talipapa, Quezon City
Quirino Highway Station	Underground	Brgy. Talipapa, Quezon City
Alignment from Quirino Highway Station to Tandang Sora Station	Underground	Brgy. Tandang Sora, Quezon City
Tandang Sora Station	Underground	Brgy. Tandang Sora, Quezon City
Alignment from Tandang Sora Station to North Ave. Station	Underground	Brgy. Bahay Toro, Quezon City Brgy. Santo Cristo, Quezon City Brgy. BagongPagasa, Quezon City
North Ave. Station	Underground	Brgy. BagongPagasa, Quezon City
Alignment from North Ave. Station to Quezon Ave. Station	Underground	Brgy. BagongPagasa, Quezon City
Quezon Ave. Station	Underground	Brgy. BagongPagasa, Quezon City

Depot, Stations, Alignment	Structure Location	Barangay
Alignment from Quezon Ave. Station to East Ave. Station	Underground	Brgy. Pinyahan, Quezon City
East Ave. Station	Underground	Brgy. Pinyahan, Quezon City
Alignment from East Ave. Station to Anonas Station	Underground	Bgry. Malaya, Quezon City Brgy. Sikatuna Village, Quezon City Brgy. East Kamias, Quezon City Brgy. Quirino 2A, Quezon City Brgy. Quirino 3A, Quezon City
Anonas Station	Underground	Brgy. Bagumbuhay, Quezon City
Alignment from Anonas Station to Katipunan Station	Underground	Brgy. Bagumbuhay, Quezon City Brgy. Milagrosa, Quezon City
Katipunan Station	Underground	Brgy. Blueridge A, Quezon City Brgy. St. Ignatius, Quezon City Brgy. Bayanihan, Quezon City
Alignment from Katipunan Station to Ortigas North Station	Underground	Brgy. White Plains, Quezon City Brgy. Ugong Norte, Quezon City
Ortigas North Station	Underground	Brgy. Ugong, Pasig City
Alignment from Ortigas North Station to Ortigas South Station	Underground	Brgy. Ugong, Pasig City Brgy. Oranbo, Pasig City Brgy. San Antonio, Pasig City
Ortigas South Station	Underground	Brgy. San Antonio, Pasig City Brgy. Oranbo, Pasig City Brgy. Kapitolyo, Pasig City
Alignment from Ortigas South Station to Kalayaan Ave. Station	Underground	Brgy. Kapitolyo, Pasig City Brgy. Pineda, Pasig City Brgy. West Rembo, Makati City
Kalayaan Ave. Station	Underground	Brgy. Fort Bonifacio, Taguig City
Alignment from Kalayaan Ave. Station to Bonifacio Global City Station	Underground	Brgy. Fort Bonifacio, Taguig City
Bonifacio Global City Station	Underground	Brgy. Fort Bonifacio, Taguig City
SECTION OF THE ALIGNMENT WITH CHANGES (as stated in the previous EIS)		
Alignment from Bonifacio Global City Station to Cayetano Boulevard Station	Underground	Brgy. Fort Bonifacio, Taguig City Brgy. Pembo, Makati City Brgy. Rizal, Makati City Brgy. Pinagsama, Taguig City Brgy. Ususan, Taguig City
Cayetano Boulevard Station	Underground	Brgy. Ususan, Taguig City Brgy. Pinagsama, Taguig City
Alignment from Cayetano Boulevard Station to FTI Station	Underground	Brgy. Pinagsama, Taguig City Brgy. Western Bicutan, Taguig City
FTI Station	Underground	Brgy. Western Bicutan, Taguig City
	Service Track	Brgy. San Martin de Porres, Paranaque City Brgy. Merville, Paranaque City
PROPOSED CHANGES (subject to ECC Amendment)		
Alignment from Bonifacio Global City to Lawton East Station	Underground	Brgy. Fort Bonifacio, Taguig City Brgy. Western Bicutan
Lawton East Station	Underground	Brgy. Fort Bonifacio, Taguig City

Depot, Stations, Alignment	Structure Location	Barangay
Alignment from Lawton East Station to Lawton West Station	Underground	Brgy. Fort Bonifacio, Taguig City
Lawton West Station	Underground	Brgy. Fort Bonifacio, Taguig City
Alignment from Lawton West to NAIA Terminal 3	Underground	Brgy. 183, Pasay City
Alignment from Lawton West to FTI Station	Underground	Brgy. Western Bicutan
FTI Station	Underground	Brgy. San Martin de Porres, Paranaque City
	Service Track	Brgy. San Martin de Porres, Paranaque City



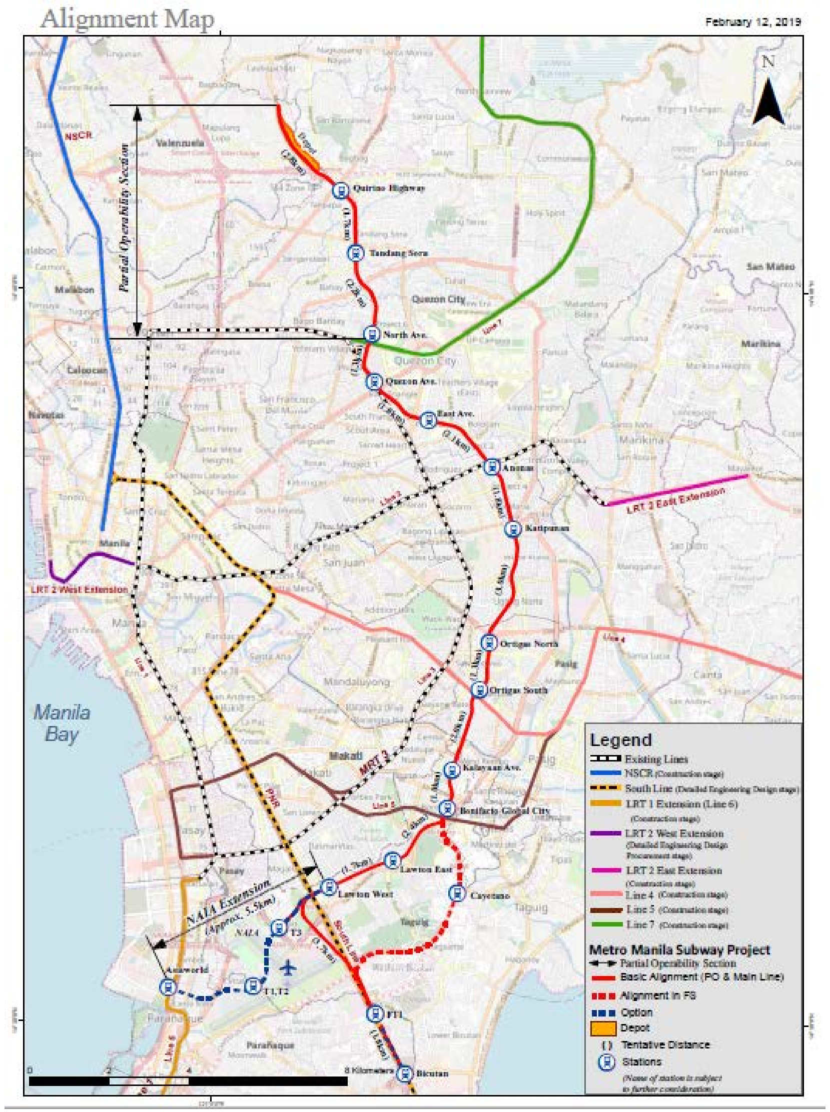


Figure 1 Original vs new alignment

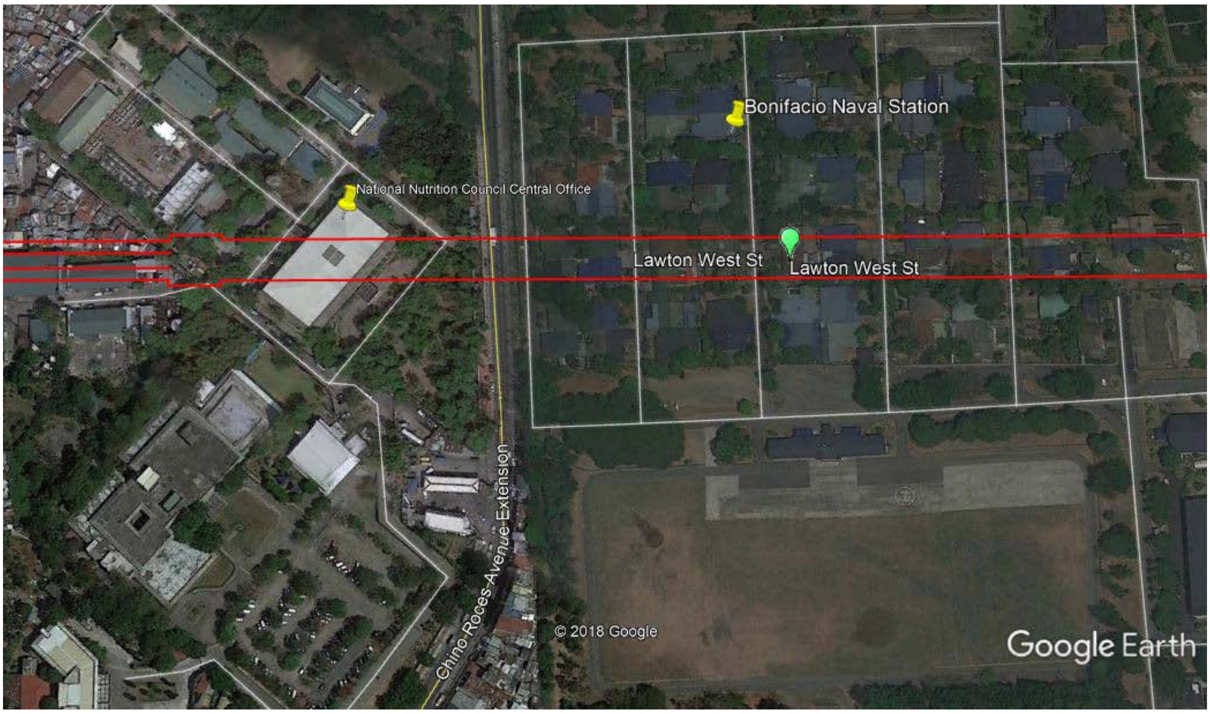


Figure 2 Proposed location of Lawton West Station in Brgy Fort Bonifacio, Taguig City

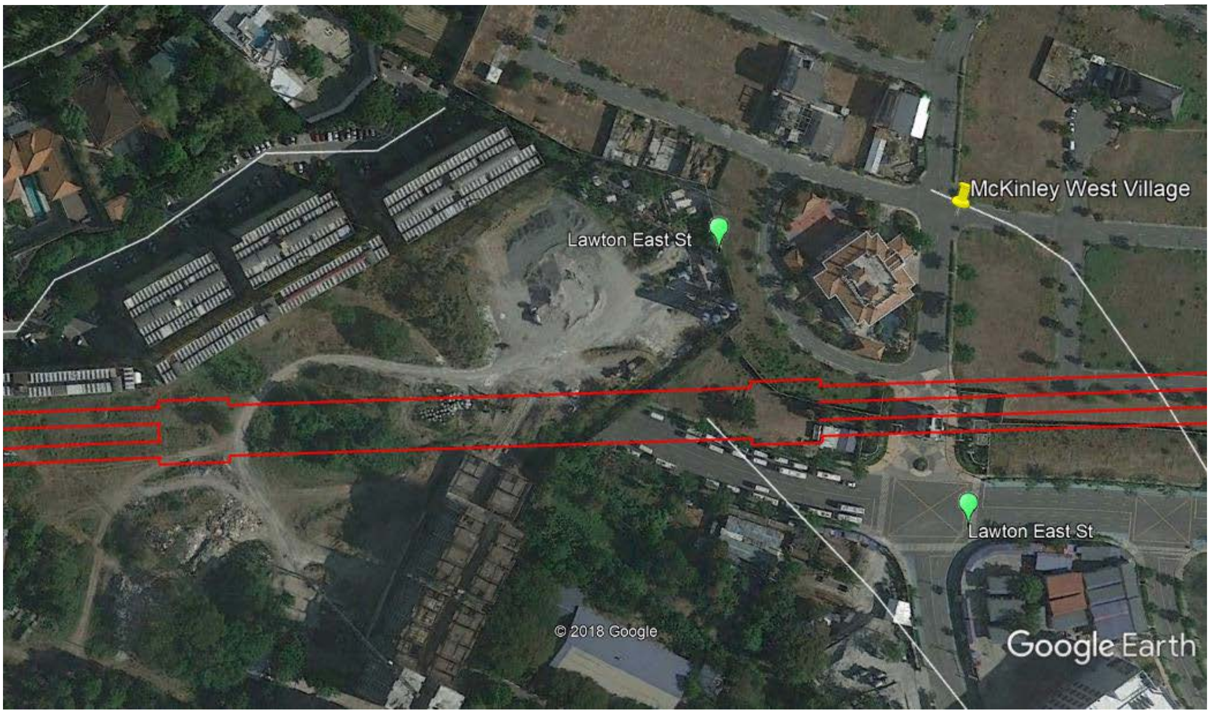


Figure 3 Proposed location of Lawton East Station in Brgy Fort Bonifacio, Taguig City

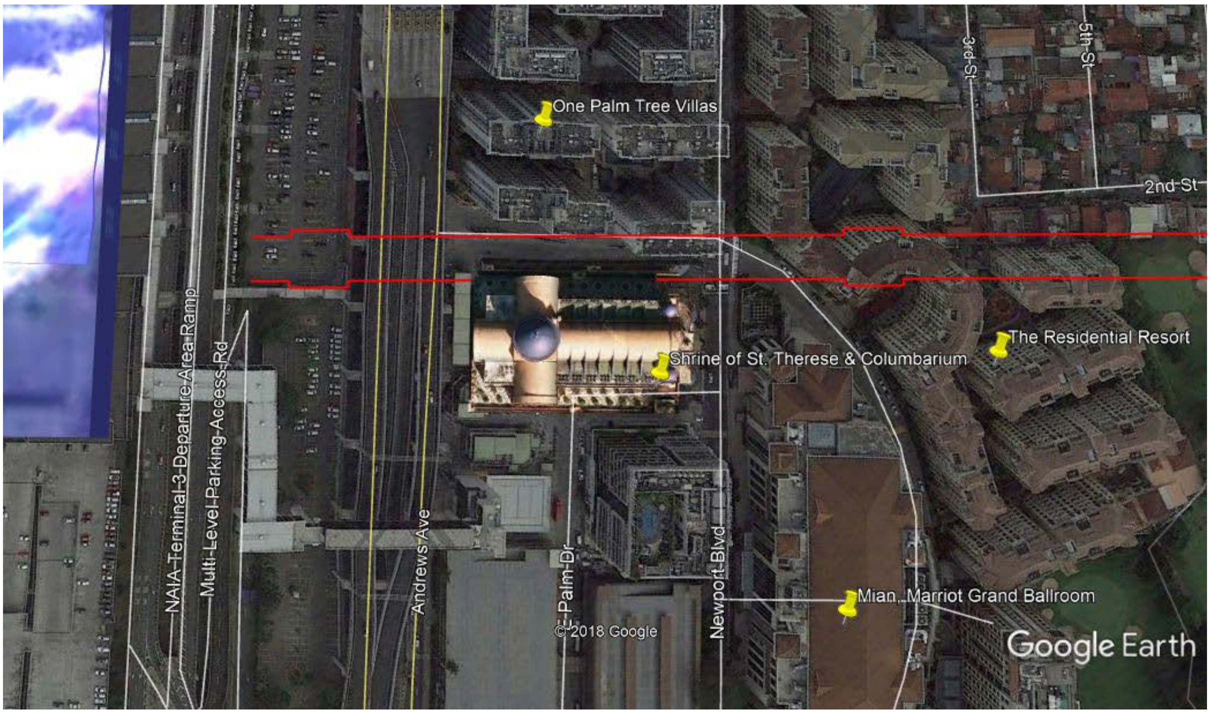


Figure 4 Proposed NAIA T3 Station in Brgy 183, Pasay City

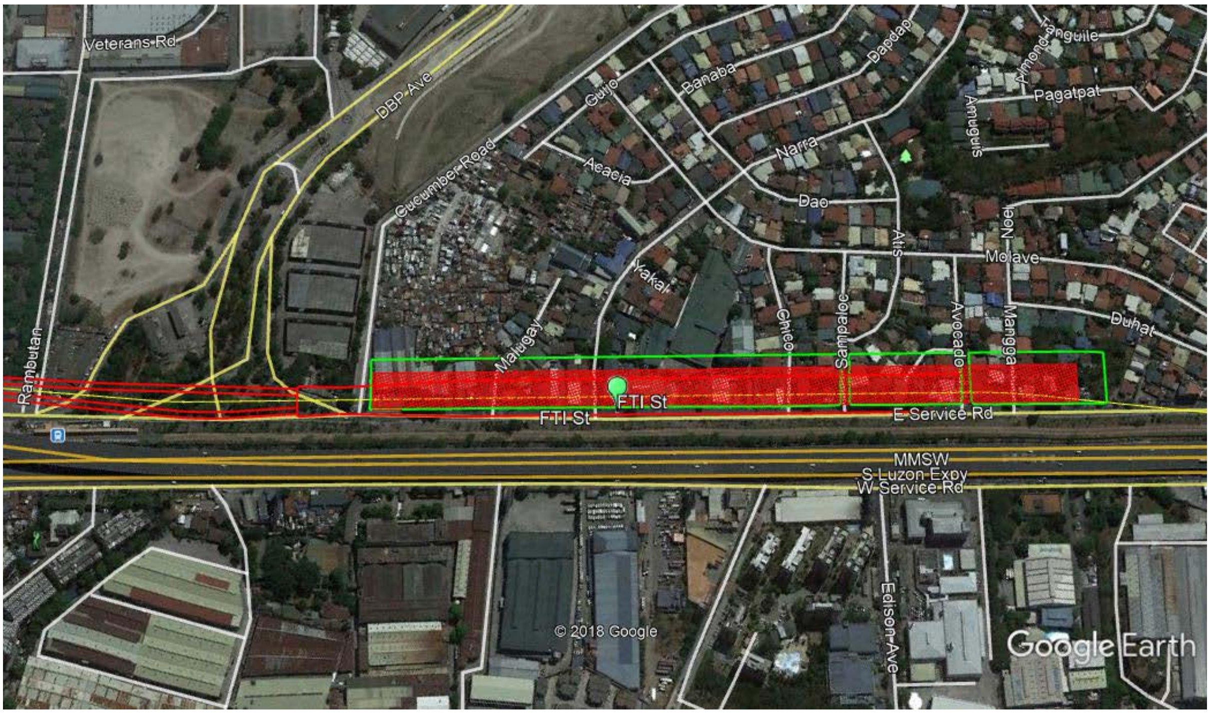


Figure 5 Proposed FTI station and interconnection to PNR in Brgy San Martin de Porres, Paranaque City

2.2 Project rationale

The goals & objectives of the Metro Manila Subway Project is to be able to:

- promote inclusive growth and improve transport systems within and beyond Metro Manila,
- strengthen the hierarchical urban transport network, providing a safe, fast, and reliable railway system that will service up to a thousand passengers a day,
- reduce the traffic congestion in a more environment-friendly way

The new sections aim to provide safer route, increase mobility from major airports, and increase the connectivity of MMSP to other railway projects. Specifically, the rationale for the new sections are described below:

2.2.1 Relocation of Cayetano Boulevard Station to Lawton East and West for safer project route

In the original alignment, one station is proposed to be located in Cayetano Boulevard in Taguig. Upon completion of the EIA, the proposed station was found located parallel to the West Valley Fault (WVF), which is approximately 23 meters west and 41 meters east of different segments of the alignment. As recommended by the DENR, the Cayetano Boulevard Station was removed and the alignment shifted towards Lawton Avenue adjacent to the Manila American Cemetery and Memorial. The change also resulted in considering two stations parallel to Lawton Avenue, referred to as Lawton East and Lawton West station.

2.2.2 Extension of the project from FTI Station to NAIA Terminal 3 (T3) to increase mobility to and from major national airports

As part of the original design, the MMSP is envisioned to be connected to the NAIA Terminal 3. Hence, Lawton East alignment will extend until Barangay 183 in Pasay. One station is proposed to be located along Resorts Drive in the barangay, just beside St Therese Child of Jesus Church.

2.2.3 Connection of the project from FTI Station to PNR Bicutan Station of the N2S-Ex project

To maximize efficiency of the intermodal transport system, several segments are proposed to be connected to other railway networks in Metro Manila. The FTI Station is being planned to be connected to the Philippine National Railway (PNR) system specifically in its Bicutan Station. This plan resulted in further extension of the project area towards the PNR Bicutan Station in Paranaque.

2.3 Project components

For the new section, it will have similar project components as the original alignment. These components were thoroughly described in the 2017 EIS. For the reference of this Project Description for Scoping report, Table 4 presents the list of project components.

Table 4 List of project components

Item	Technical Parameter	Specification		
Train Operation Plant	Maximum Speed	80km/h(Underground section)		
	Gauge	1,435 mm (Standard gauge)		
	Length	Embankment	Elevated	Underground
		1.0km	0.3km	26.7km
	No. of Stations	At Grade	Elevated	Underground
		-	-	13
	Traction Power Supply	Overhead Rigid Conductor System (Main Line) Simple Catenary System (Depot)		
	Standard Passenger Capacity	Seated	Standing (7 Passengers /m^2)	Total
	Lead Car	45	221	266
	Intermediate Car	54	231	285
	Capacity of a Train (8 car train)	Capacity per car	No. of cars	Capacity per train
	Lead Car	266	2	532
	Intermediate Car	285	6	1,710
	Total Passengers	-	8	2,242
	System Operational Specifications	Year		
		2020	2030	
	Traffic Demand (Passengers Per Hour Per Direction: PPHPD)	12,800	19,900	
	Train Composition (cars)	8	8	
	No. of Operated trains	9	12	
	System Capacity (PPHPD)	20,178	26,904	
	Travel Time	Travel Time	Scheduled Speed	
	Express (Quirino Highway – FTI)	31 min 5 sec	48.5 km/h	

Item	Technical Parameter	Specification	
	Local (Quirino Highway–FTI)	42 min 20 sec	35.6 km/h
	Required No. of Trains	Year	
		2020	2030
	Train in Operation	15	20
	Reserved Train	4	4
	Total No. of Train	19	24
	Train Consist	8 cars	8 cars
	Rolling Stock Procurement Plan	Year	
		2020	2030
	No. of Trains to Procure	152 cars (19 x 8-car Train-Sets)	40 cars (5 x 8-car Train-Sets)
Railway Alignment and Structure Plan	Horizontal Curve Radius		
	For Main Line	More than 160m	
	For Stations	More than 400m	
	For Turnout	More than 160m (Main Line) More than 100m (Depot)	
	Transition Curve Length	Maximum out of L1, L2, L3	
		L1=600C	
		L2=7.4CV	
		$L3=6.7C_dV$	
	Length between Transition Curves	More than 20m	
	Maximum Gradient		
	For Main Line	35/1,000	
	For Stations	Level (0), 5/1,000 (absolute maximum) The underground section installs the gradient for a drainage.	
	For Stabling track	Level (0), 5/1,000 (absolute maximum) The underground section installs the gradient for a drainage.	
	For Turnout	Level (0), 25/1,000 (absolute maximum) The underground section installs the gradient for a drainage.	
	Vertical Curve	Radius 3,000m (4,000m where curve radius is less than 800m)	

Item	Technical Parameter	Specification
		Vertical curve is required for more than 10/1,000 of gradient change
	Width of Formation	
	Cut and cover tunnel and U-shaped retaining wall section	More than 2.8m
	Shield tunnel section	The width which can arrange the evacuation passage width of 1 m or more.
	Depot	More than 3.0m
	Other section	More than 3.15m
	Distance between Track Centers	More than 4.0m (Main Line), More than 4.0m (Station), More than 4.0m (Stabling track)
	Width of Structural Gauge	3.4m (Underground),3.8m(others)
	Station Platform	
	Platform Length	210m (For 10 cars train for future)
	Platform Width	10m (Standard, Island platform)
		7.5m (Standard, Separate platform)
System Plan	Train Formation	
	*Tc: Trailer car with driver's cab	4M4T (Tc+M+M+T+T+M+M+Tc)
	*M: Motor car	
	*T: Trailer car	
	Major Dimension	
	Leading Car Length	20,470mm
	Intermediate Car Length	19,500mm
	Body Width	2,950mm
	Passenger Capacity per Train	
	No. of Cars/Train-Sets	8 cars
	Seat	414 passengers
	Standard (4 pax/m^2)	1,466 passengers
	Standing (7 pax/m^2) + Seat	2,242 passengers
	Weight per Train (Tare)	254t
	Body Materials	Aluminum Alloy
	Saloon Design	

Item	Technical Parameter	Specification
	Door Ways	4 doorways each side of a car
	Door Type	Double sliding doors, Pocket Type, 1,300mm width
	Seat Type	Longitudinal seat
	Special Facilities	
	Wheel Chair Space	Equipped
	Baggage Space	Not equipped
	Cab Front End Door	Equipped
	Traffic Performance	
	Acceleration	0.92 m/s^2 (3.3km/h/s)
	Deceleration (Service/Emergency)	Service: 1.17 m/s^2 (4.2km/h/s) Emergency:1.31 m/s^2 (4.7km/h/s)
	Propulsion System	
	Power Collection System	DC 1,500 V Single-arm pantograph (1 unit per motor car) High Voltage Bus Line
	Control System	VVVF inverter with IGBT elements (Option: SiC) 1 set per motor car
	Traction Motor	High Performance Totally Enclosed Induction Motor Gear Ratio : 6.53 (98/15)
	Brake Control System	Electric command electro-pneumatic regenerative brake Anti-Skid Device : Equipped
	Bogies	Bogie with Bolster
	Air Conditioning Equipment	Roof top type (2 units per car)
	Auxiliary Power Supply Equipment	Static Inverter (SIV)
	Passenger Information System	Public address system via loudspeaker Emergency Intercom Visual information system via 17 inches LCD screens
	Electrification System	DC 1500V feeding system
	Transmission Line System of Auxiliary Power for Stations	AC 34.5kV Loop Parallel Power Distribution system

Item	Technical Parameter	Specification		
	Signaling System	CBTC (Automatic Train Protection, Automatic Train Operation, Automatic Train Supervision),Depot signaling (Shunting signal, Track circuit, Computer Based interlocking)		
	Telecommunication System	Multi-Service-Network, Telephone, Digital Radio, Closed-Circuit Television, Passenger information display, Public Address system, Clock, Disaster Prevention System, Facility-SCADA		
	Fare Collection System	Automatic Fare Correction system		
	Track Work			
	Track type	Main line: Ballast-less track, Solid track with resilient sleeper (Main line: underground section) Ballast track (Embankment section and depot)		
	Running Rail	Japanese standard 60kg/m rail or its equivalent		
	Depot (Mindanao Avenue)	Year		
		2025	2045	
	Inspection Track for Daily and Monthly Inspection	3 trains	5 trains	
	Inspection Track after Overhaul and Semi Overhaul	1 train	1 train	
	Track for Occasional Repair	1 train	1 train	
	Assembling and Disassembling Track	2 train	2 train	
	Stabling Track	22	22	
	Washing Track (rolling stock washing plant)	1	1	
	Washing Track (manual washing)	1	2	
	Wheel Re-Profiling Track	1	1	
Operation Plan		Year		
		2025	2030	2035
	No. of Passengers (thousand passengers/day)	365	669	973
		Year		
		2025	2030	2035
	Estimated PPHPD (passenger/hour/direction)	12,556	19,569	26,582

Source: JICA Study Team

2.4 General description of pollution control devices and waste management system

The new sections will employ similar construction methodology and operation phase processes as the original project alignment.

As the project will entail excavation of soil through cut and fill method (for the proposed station) and use of Tunnel Boring Machine (TBM), a large volume of soil is expected to be generated. This also includes concerns on dust and noise generation during construction as well as noise and vibration generation during operation. The project is also foreseen to cause heavy traffic during construction as proposed stations are located along roads.

Spoils/Surplus Soil Management

There are ongoing dialogues with various local government units (LGUs) on the potential uses of surplus soil. These include the use of excavated soils for earth filling works at the depot and stations, backfilling of quarry sites in Rizal Province, reclamation projects and elevation of low-lying areas in Regions III and IV, and other infrastructure projects of the Department of Public Works and Highways (DPWH), DOTr and LGUs within Metro Manila. The following government agencies were also identified as relevant organizations that are potential recipients of surplus soil for their respective projects: Philippine Reclamation Authority (PRA), Mines and Geosciences Bureau (MGB), Provincial Disaster Risk Reduction Management Council (PDRRMC) of Regions III and IV, DPWH and LGUs within the MMSP alignment.

Wastewater Management

During the construction phase, the contractors shall be required to submit a wastewater management plan as requirement for contract bidding and prior to construction works to ensure that proper wastewater management will be considered. The contractors shall provide temporary sanitation facilities such as portable toilets for the construction workers. During the operation phase, sufficient wastewater treatment systems will be installed in the stations and depot facilities.

Solid Waste Management

During the pre-construction and construction phases, the contractor shall be required to prepare and strictly implement a proper construction solid waste management plan including waste due to demolition works. The contractors shall provide garbage bins and implement segregation of wastes. A supervision consultant shall monitor waste management and disposal, and review and evaluate the effectivity of the solid waste management plan regularly to ensure compliance.

During the operation phase, administrators of station and other facilities shall prepare and strictly implement a proper solid waste management plan

Table 5 presents the Impact Management Plan for the project (as presented in the 2017 EIS) with updates on those relevant for the new and additional segments.

Table 5 Impact Management Plan

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
PRE-CONSTRUCTION AND CONSTRUCTION PHASES					
The Land					
Clearing and demolition activities Clearing and demolition of approximately 400 structures (i.e. residential, commercial, mixed) along sections of East Service Road to give way to the proposed road diversion project	Soft ground Soil erosion during clearing of land Soil runoff	• Limit time between pre-construction and construction • Set activities during dry season	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Generation of demolition wastes	Soil contamination and aesthetic impacts	• Recycling of demolition wastes • Use of leftover concrete and metals for suitable alternative projects • Uncontaminated residual wastes will be used as backfilling materials in quarry sites and land reclamation projects	Contractors, with monitoring and supervision by DOTr PMO	Disposal of contaminated soils & wastes is Php 32,000 per 15 m^3 truckload to Clark Landfill	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		• Disposal of contaminated solid wastes through an accredited TSD facility			
Clearing and removal of trees This will include trees that will be potentially removed for the updated MMSP sections: FTI to Bicutan extension and common terminal (~238 trees) NAIA T3 extension Change to Lawton East and West stations (~89 trees)	Potential removal of 767 trees, of which 298 are threatened species, present in the proposed depot and stations Removal or reduction of ecosystem services such as microclimate regulation, flooding, provision of habitat to faunal species and carbon sequestration	• Preparation of a detailed management plan for the removal of trees shall be required from the contractors. • Preparation and implementation of a detailed plan for the transfer/earthballing of matured trees. • A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate. • Replacement and planting of corresponding number of tree seedlings by the proponent • Coordination with concerned agencies or groups for relocation sites of earth-balled trees. A system to	Contractors, with monitoring and supervision by DOTr Environment Unit	Earth-balling ~ Php 30,000 per tree Tree planting cost to be determined based on current prices of seedlings during implementation Other costs: Included in construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		periodically monitor and maintain survival of these species should be set in place to assure high survival rate. • Integration of landscaped green areas (e,g, parks, green roofs and vertical gardens)in the design layout of the proposed depot and stations. • Selection of tree species for green spaces should be biased towards native species to ensure habitat connectivity of local fauna. • Felled trees during the construction phase should not be allowed to degrade under the elements to ensure that the CO_2 trapped in the wood biomass is not released back as GHG. • Leaves and clippings from the felled trees			

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		should be shredded and mulched to ensure that the nutrients stored and captured in the biomass is returned and cycled back to the soil			
Construction site activities	Impairment of visual aesthetics	Use of “green” walls, in the form of green-painted fences, green facades or living walls as construction barriers/fences	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Earthwork activities (tunneling, excavation, backfilling and stockpiling)	Slope failures, landslides and subsidence due to cutting and filling Soft ground Soil erosion and siltation along the rivers and creeks Soil runoff Alteration in topography due to excavations of earth and stockpiling	Reinforced or proper cut slope techniques are to be used Good housekeeping Proper waste and drilled earth materials disposal Construction of a good drainage system	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
Leaks and accidental spills on soil	Soil contamination	Require contractors to: Implement proper handling and management of chemicals Practice good housekeeping at construction sites Establish and implement an emergency and contingency plan in case of spills as well as health and safety management plan Store bulk chemicals, such as fuel, lubricants and other chemicals, in an impermeable area and with appropriate secondary containment and, Comply with environmental permitting requirements for the storage, transport, treatment and handling of hazardous substances and wastes.	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Damage of subsurface structures during drilling and excavation activities	Soil contamination	• Cautious drilling along other artificial subsurface structures; Design adjustments or modification of already present structures	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
Generation of excavated soil (approximately 4.4M m^3) from excavation/ tunneling Additional excavated soil from updated sections.	Traffic congestion and damage of roadways along the route to disposal site Increased siltation of water bodies Aesthetic impacts Soil contamination	• Used of surplus soil as backfilling in: (1) quarry sites in the province of Rizal; (2) projects of Provincial Risk Reduction Management Council (PDRRMC) in Regions III and IV; and (3) projects of Department of Public Works and Highway (DPWH). Permits for transporting of excavated soil will be obtained from the LGUs. • Proper scheduling of excavation works, and coordination with surplus soil recipients to ensure immediate hauling of surplus soil • Develop and implement Traffic Management Plan	Contractors/ subcontractors, with monitoring and supervision by DOTr Environment Unit	Approximately Php 3.5 billion pesos for the 4.4M m^3 excavated soil Disposal/transport to recipient sites of surplus soil is Php 32,000 per 15 m^3 truckload	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		• Road maintenance by the contractors • Periodic analysis of heavy metal levels shall be conducted. If considerable high level of heavy metal is identified, proper management and disposal to an accredited TSD facility shall be implemented.			
Transport of construction materials	Traffic congestion and damage of roadways along the route to disposal site	• Proper scheduling of the delivery of construction supplies and materials • Develop and implement Traffic Management Plan • Road maintenance by the contractors	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Generation of solid wastes from the construction workforce	Land and water contamination Aesthetic impacts Spread of diseases	• Submission and implementation of Solid Waste Management Plan as part of	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		contractors' engagement • Placement of waste bins to avoid dispersal of litter and regular site maintenance duties • Regular collection, transportation and disposal of wastes to minimize the attraction of vermin, insects and pests			
Liquefaction	Damage to underground structures and overlying structures (in depot and stations) in the event of an earthquake Loss of soil strength, settlement of soil, lateral spreading, bearing failures, floatation of embedded structures	• Constructing subways structures at deep underground • Chemical liquid injection for soil strength improvement • Observe 20 meters buffer zone from body of water (surface and subsurface) • Conduct a borehole log of Pasig riverbed to identify how thick is the	Contractors Proponent	Included in the construction cost Included in cost of DED	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangement s
		soft sediments and other sedimentary beds			
Ground shaking	Damage to components of the construction work	• Construction of shield tunnels as a protective and support structure during tunnel excavation • Reinforcement of the surface structures to be constructed for the station to ensure safety and continued use • Adopt a seismic design during the detailed engineering phase of the subway project • Conduct earthquake drills	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Ground rupture New stations are proposed (i.e. Lawton East and West) as consideration to the	Damage to components of the construction work	• Conduct inclined drilling survey of the subsurface condition of the area surrounding not only the Cayetano Boulevard Station but also the sections of the	Proponent/ JICA Study Team	Included in cost of DED	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
recommendation to realign Cayetano station away from fault line.		proposed alignment located nearby the fault traces, in consultation with PHIVOLCS • Strongly consider realignment of the subway in Cayetano Blvd. Station, away from the fault			
The Water					
Clearing and excavation activities No waterbody in the proposed updated sections of the MMSP.	Increase in suspended sediments in the receiving water	• Conduct demolition and excavation activities during the summer, as much as possible. • Protect demolition and excavated materials from the rain by roofing it and redirecting rainwater to a catchment basin or the nearest drainage system • Proper wastewater treatment plans by the	Contractors Proponent	Potable water quality meter: Php 200,500 Others: Included in construction and maintenance costs	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		contractor prior to construction works. • Debris/soil and other excavated materials shall be hauled out from the site immediately and disposed by accredited waste handlers. • Treatment of turbid water caused by excavation works before discharge • Chemical injection method shall be implemented in appropriate ways under sufficient groundwater monitoring systems. • Monitor and control waste water in construction sites.			
Clearing of trees and conversion into construction yards	Erosion and siltation in surface water bodies	• Use permeable pavements after construction works while converting	Contractors Proponent	Included in construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		construction yards into walkways or bike lanes or open spaces.			
Clearing and excavation activities *No natural waterbodies will be traversed by the updated sections	Flooding and inundation due to clogged waterways	• Proper disposal of demolition debris and construction spoils by the contractor • Implementation of erosion control measures before major earthmoving works begin	Contractors Proponent	Included in construction and maintenance costs	Bid Documents / Contract Agreement
Excavation works	Lowering of groundwater level due to inflow of groundwater into underground tunnel	• Conduct more detailed geological and groundwater level surveys in detailed design stage • Consider proper construction plans on the basis of the survey results. • Adoption of the shield tunneling method will reduce possibility of	Contractors Proponent	Included in construction and maintenance costs	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		groundwater inflow into the tunnel structures			
The Air					
Generation of dusts and PM from earthmoving, demolition and stockpiling	Temporary increase of air pollutant emissions, specifically TSP and PM	• Regular wetting of ground soil in the construction site • Construction sites must be fenced for safety and security reasons • Hauling trucks for excavated soil must be covered during travel	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Emission from vehicles and gensets	Temporary increase of air pollutant emissions (NOx, SOx, CO and HC)	• Regular preventive maintenance of heavy equipment and service vehicle	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Movement and operation of construction machinery	Increase noise level and ground vibration during construction	• Select equipment with lower sound power levels • Installation of mufflers on engine exhausts	Contractors Proponent	Included in the construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		and compressor components • Installation of noise suppressors and vibration isolation to construction/mechanical equipment. • Regular maintenance of heavy equipment, machineries and support vehicles • Installation of temporary noise barriers such as galvanized iron shields • Use of Personal Protection Equipment (PPE) • Relocating noise sources to less sensitive areas • Fencing of the construction site • Scheduling of the high noise generating			

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		activities during daytime. • Use of shield tunneling method construction technique			
The People					
Involuntary Resettlement Construction of updated sections will entail potential displacement of private landowners and business owners (~250 structures)	Displacement of residents, commercial and industrial establishments along the proposed alignment	• Alignment was traced under existing public roads and public properties, as much as possible, to minimize ROW acquisition • RAP was prepared to ensure that affected households and establishments are justly compensated and will have a quality of life equal or better than their current condition.	Proponent	Land acquisition cost: Php ~23,018,765,800 Replacement cost: Php ~11,706,958,350.43	RAP Budget can be adjusted to accommodate changes after DED
Informal settlers	In-migration of informal settlers in ROW lands	• Shorten time between the pre-construction phase and the construction phase as much as possible.	Contractors Proponent	--	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		• Project areas will be fenced for safety and security reasons.			
Displacement of Institutional Facilities	Disruption in the provision of institutional services	• Strongly consider diversion of initially proposed construction yard away from Pacific Global Medical Center in Quezon City and United Hills Church of the Nazarene in Paranaque. • Proper resettlement of identified small religious institution in Valenzuela shall be detailed in the final RAP.	Proponent	Included in DED and RAP costs	RAP Budget can be adjusted to accommodate changes after DED
Service utilities	Service utilities interruption	• Subway will be designed to utilize deep underground space • Coordinate with concerned public utilities such as MERALCO, Maynilad, MWCI and PLDT	Contractors Proponent	Included in construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		during the planning and construction phases • Develop a Utility Management Plan			
Employment/ Livelihood	Temporary disturbance of commercial establishments and small vendors Decline or eventual loss of business in affected areas.	• Construction activities shall be undertaken at the shortest possible time to restore normal business operations immediately. • For business establishments that will be permanently removed, the RAP details a replacement cost for the loss. • Alternative livelihood programs in coordination with the LGUs and other government agencies will be taken in to consideration.	Proponent Affected LGUs	Included in the RAP Budget Cost-sharing with LGUs, GOs and other NGOs	RAP Budget / Financing by LGUs, GO's and other NGOs
	Generation of temporary employment	• Priority for employment will be given to the	Contractors Proponent LGUs	N/A	N/A

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		local residents to help boost economic activity of affected LGUs.			
Traffic condition Diversion of traffic from East Service Road (i.e., Bicutan) during construction	Increase in traffic congestion due to mobilization of workers, heavy equipment and construction materials, transport of demolition debris and excavated soil Threat to availability of health services	• A TMP that details the activities to adequately manage traffic flow will be strictly implemented. • Proper coordination and approval of TMP by MMDA and LGUs concerned. • Implementation of a moving construction yard during different phases of the excavation process to minimize traffic congestion. • Proper scheduling of transport of heavy structures during periods when there are less vehicles on the road	Proponent LGUs MMDA	Included in construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
Health and safety	Increased risk of accidents due to improper work ethics which may threaten health and safety of workers and local residents.	• Provision of appropriate PPEs to all construction workers • The contractor shall be duly trained for the subway construction works • Contractors shall submit an Occupational Health and Safety Management Plan prior to commencement of work. • A medical station within the complex will be provided to safeguard the health of the workers • The project site will be fully fenced and access points will be not be available for the public. • Include safety measures in the design of subway	Contractors Proponent	Included in construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
Communicable and infectious diseases	Spread of communicable and infectious diseases	• Stringent observance of high standards of cleanliness and sanitation at the construction site • Medical certificates will also be requested to ensure workers are fit to work. • Appropriate sanitary facilities shall be provided at all construction sites such as portable toilets and litter bins. • Implementation of an Occupational Health and Safety Management Plan by the contractor.	Contractors Proponent	Included in construction cost	Bid Documents / Contract Agreement
OPERATIONAL PHASE					
The Land					
Leaks and accidental spills of chemicals, especially at the depot area	Soil contamination	• Emergency and contingency plan in	Station administrators and	Included in the operation and maintenance cost	EGF

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		case of spills and health and safety management plan must be in place	maintenance contractor		
Solid waste generation	Land and water contamination Aesthetic impacts Spread of diseases	• Policies on solid waste minimization and solid waste management should be implemented in stations and depot.	Station administrators and maintenance contractor	Included in the operation and maintenance cost	EGF
Geological hazards (liquefaction, Ground shaking/ground rupture)	Damage to underground structures and overlying structures (in depot and stations)	• Regular maintenance checks of structures and tests of safety measures; Earthquake drills and early warning system	Station administrators and maintenance contractor	Included in the operation and maintenance cost	EGF
• The Water					
Domestic wastewater generation	Pollution of receiving water bodies	• Installation of wastewater treatment facility • Administrators of station and other facilities shall maintain water treatment	Station administrators and maintenance contractor	Included in construction and maintenance costs	EGF / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		systems in proper conditions			
Maintenance and repair activities in the depot	Pollution of receiving water body, specifically Tullahan River	• Installation of interceptor tank to remove oil and fuel grease from surface water before discharge. • Installation of controlled perimeter drainage system to ensure catchment of all maintenance runoffs. • Operation of a wastewater treatment facility with oil removal. • Equipment and machinery shall be regularly checked for fuel and oil leaks. • During repair of equipment and machinery, containers/drip trays shall be used to collect leakage.	Station administrators and maintenance contractor	Php 500,000 (construction cost) Php30,000 / quarter (overhead cost)	EGF / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangement s
		• Any spilled or spent oil will be collected, stored properly and disposed by accredited waste haulers.			
Heavy rainfall	Flooding and inundation of subway facilities	Installation of water-shut panels at station entrances Installation of drainage pumping station to pump up inflow water from outside ground level (rain water, etc.) and water from inside the tunnel and send them to the sewer.	Station administrators and maintenance contractor	Included in construction and maintenance costs	EGF / Contract Agreement
Changes in groundwater flow	Ground subsidence due to lowering of groundwater level	Installation of monitoring wells for observation along the subway tunnel and monitor change of the surrounding groundwater levels. If abnormal changes are identified, the administrator shall investigate the causes and implement the proper countermeasures immediately.	Station administrators and maintenance contractor	Included in construction and maintenance costs	EMF / EGF
The Air					
Operation of service vehicles and standby generator set	Air Pollution	Proper preventive maintenance of service vehicles and equipment	Station administrators and	Included in the operation and maintenance cost	EGF / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		Use of cleaner fuel for the generator sets	maintenance contractor		
Increase in air pollutants from increased vehicles along stations	Air Pollution	Management of traffic along stations Use of blowers to dissipate pollutants along terminal	Station administrators and maintenance contractor	Included in the operation and maintenance cost	EGF / Contract Agreement
Generation of low frequency noise from structure-borne noise and ground vibration	May cause mental stress to residence	Installation of noise barrier Long welded rail and expansion joint, damped wheel and resilient tie will be adopted Installation of floating slab trackbed Regular conditioning and maintenance of the trains will be implemented on a regular basis Speed of train will be limited to minimize noise and ground vibration	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
Climate change	Accelerated structural fatigue and materials failure	Proper design in making infrastructure robust or resilient to the effects of climate change should be taken into consideration	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
	Greater demands on the construction, operation and maintenance of flood control and	Improvement of current drainages along the alignment to be resilient to climate change.	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
	drainage structures.				
	Increase GHG emissions due to increased demand for cooling system of passenger cars, building offices and ticket booths	Install reliable and heavy duty air-conditioning (AC) system of railcars that will be purchased and use of centralized AC system for the stations	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
	Indirect impact - Increased vulnerability of passengers to spread of communicable disease via a mass transportation system.	Formulate and implement health and safety protocols for all stations and trains Information, Education and Communication (IEC) materials on proper hygiene in all stations Provisions for use of HEPA (High Efficiency Particulate Air Filter) for the AC/ventilation system.	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
The People					
Employment and livelihood	Enhanced commuters mobility Better physical and psychological state of commuters resulting from shorter and more comfortable travel time	Regular preventive maintenance of the subway system to maintain efficient, reliable and safe subway operation and maintain its economic and social benefits	Proponent Station administrators	Included in maintenance cost	N/A

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
	Employment of skilled personnel to operate and maintain the railway system				
Traffic Condition	Easement of traffic congestion	Regular preventive maintenance of the subway system to maintain efficient, reliable and safe subway operation and maintain its economic and social benefits Consider linkages with LRT, MRT lines, bus and jeepney stations for efficient passenger flow transferring to other modes of transportation	Proponent Station administrators	Included in maintenance cost	N/A
	Increased vehicular flow in areas adjacent to stations	Conversion of construction yards into sidewalks, taxi bays, unloading and loading stations or central stations for public utility vehicles Coordination with MMDA and the LGUs to assign traffic enforcers in critical areas.	Proponent Station administrators	Included in construction and maintenance cost	N/A
Health and safety	Risk of accidents due to improper work ethics	Implementation of an Occupational Health and Safety Management Plan, which includes an Emergency Response	Proponent Station administrators	Included in the health, safety and environmental management plan	EGF / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		Plan, during the operations stage Provision of sanitary facilities or utilities to maintain sanitary and healthy conditions in all stations and in the depot Implement safety measures through engineering design and administrative controls during train operation		and budget of the proponent	

Appendices

Appendix A - (IEC Documentation)

Minutes of Meeting			
Project	The Detailed Design Study for the Metro Manila Subway Project (MMSP)		
Subject	Courtesy Call / IEC meeting with Brgy. Fort Bonifacio Chairman		
Date and Time	May 27, 2019 (2:00 pm)		
Venue	Fort Bonifacio Satellite office, 2nd Fl., Market! Market!, McKinley Parkway, BGC, Taguig City		
Attendees	**Org**	**Name**	
	DOTr	Engr. Jim Benidict Petate	
	Brgy. Fort Bonifacio Office	Hon. Jorge Daniel Bocobo	
	JDT	Mr. Shuntaro Miyoshi	Ms. Shekinah Tibay

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- DOTr and JDT presented the general concepts of the MMSP as well as the changes in the alignment.
- Hon. Jorge Bocobo clarified that the Lawton West station is still inside the jurisdiction of Fort Bonifacio meaning all stations within Taguig City are inside said barangay.
- Upon Engr. Jim's further presentation of the stations, Hon. Bocobo informed DOTr and JDT that McKinley West Village already called the attention of the barangay regarding the alignment.
- Ms. Shekinah Tibay discussed the environmental-related aspect of the presentation.
- DOTr and JDT assured that the changes in the project alignment has been discussed with the City Office of Taguig specifically with its Planning and Development Office.
- Hon. Bocobo asked for the schedule of the start and finish of the construction within Fort Bonifacio which Engr. Jim answered as 2020 or 2021 for the construction and operational by 2025 approximately. He also brought up the possible issue in traffic which the construction may cause. Engr. Jim clarified that for the high-rise building, the Project is doing studies regarding the basement and clearances needed.
- Hon. Bocobo asked regarding the attention raised by McKinley West and as per Engr. Jim, the discussion had with McKinley West is mainly for the geotechnical survey needed.
- Hon. Bocobo shared that he will schedule a meeting with the McKinley West Village to hear their concern.
- DOTr also added that a perception survey will be done inside the barangay which Hon. Bocobo agreed to.

III. ACTION ITEMS

- Continuous coordination for information
- Perception Survey
- Public Scoping

IV. PHOTO DOCUMENTATION

DOTr & JDT presenting the Metro Manila Subway Project as part of its Information & Education Campaign.

V. ATTACHMENT

- Attendance Sheet of the Meeting

The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	IEC/COURTESY CALL W/ BRGY. FORT BONIFACIO, TAGUIG CITY
Date and Time	MAY 27, 2019
Venue	FORT BONIFACIO SATELLITE OFFICE, 2FL. MARKET! MARKET!, McKINLEY PARKWAY, BGC, TAGUIG CITY

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	JIM PETATE	DOTr	0921 414 6425	jimpetate.dotr@gmail.com	
2	Shuntaro Miyoshi	JDT	09770971841	miyoshi@katahira.com	
3	SHEKINAH TIBAY	JDT	0916 607-6428	srtibay@gmail.com	
4	Jorge Daniel Bocobo	PB-Fort Bonifacio	09175637307	jsbocobo@ilovetaguig.ph	
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DOTr: Accepted by JICA Design Team: Accepted by

Minutes of Meeting			
Project	The Detailed Design Study for the Metro Manila Subway Project (MMSP)		
Subject	Courtesy Call / IEC meeting with Brgy. San Martin de Porres Officials		
Date and Time	June 03, 2019 (10:30 am)		
Venue	San Martin de Porres Barangay Hall, East Service Road, Parañaque City		
Attendees	**Org**	**Name**	
	DOTr	For. Beo Raven Bensurto	
	Brgy. San Martin de Porres	Hon. Michael Thor C. Singson	Hon. Myrna De Las Cagigas
		Hon. Thess Castillo	Hon. Carlo C. Millano
		Hon. Ludivina M. Valenciano	Sec. Wenceslao Sarmiento
		Mr. Domingo Obligar	
	JDT	Dr. Pia Madid	Ms. Rachelle Perez (GHD)
		Ms. Bea Alvarez (GHD)	Ms. Maria Luisa Regodon (GHD)
		Ms. Carmela Conanan (GHD)	Mr. Marc Vico Pauig (GHD)
		Ms. Shekinah Tibay	

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- DOTr & JDT presented the general information of the MMSP and the changes in the alignment design of the project.
- Hon. Singson asked why the change in the scope of the station increased greatly which Dr. Madid explained that one reason is the planned interconnection with PNR.
- Hon. Singson stated that as he knows, some areas in the proposed station will be for the construction yards, Dr. Madid confirmed it and added that diversion road will be made.
- Sec. Sarmiento stated that in regards to PNR, what they are informed of is that development will be made in the Bicutan area, which Dr. Madid Confirmed and stated that there will be an interconnection with the subway and the PNR, explaining further, the tracks will not meet but it will be connected in other ways (ex. walkways), the subway track will be in the surface for said Bicutan station.
- Sec. Sarmiento added that the latest information they have from the RAP meeting for the PNR project is that PNR's Bicutan station will cover only 250 linear meters with 60 meters in width, Dr. Madid reminded that these are two separate projects affecting the area which will only be interconnected.
- Makati South Hills was identified by the Barangay Officials to be affected as well based on the presented station area.
- Sec. Sarmiento asked how many meters deep are the tunnels, Dr. Madid replied that it varies but ranges from 7-50 meters deep, shallowing as the tunnel approach the stations.
- The Barangay Officials asked if excavation has started which Dr. Madid replied that none has started yet. The Officials were also aware that the cutterhead of the TBM arrived in the country already.
- The Officials also asked when will the excavation start in Quezon City since they are aware that construction will happen there first, Dr. Madid replied that it is targeted within this year.
- Dr. Madid explained the TBM method of tunneling as shown in the presentation and added that Manila Waters also use smaller TBMs.
- Dr. Madid discussed the environment-related aspect of the presentation and informed the officials also that a perception survey will be done in the possibly affected areas.
- Dr. Madid stated that a public scoping will be scheduled soon.

- The Officials asked if there is a second option for the FTI station area, Dr. Madid replied that as of now, it is still in concept stage but detailed design will follow for these changes in alignment once the loan agreement is signed, but prior to signing, JICA requires for the amended ECC that covers this area.
- The barangay officials requested that a clear measurement of area to be affected should be presented since it seems to affect a lot of private households.
- Hon. Singson clarified which will be the basis of the compensation, For. Bensurto confirmed that it is the current market value.
- An endorsement letter for the survey team to enter the identified possibly-affected villages has been issued by the barangay office.

III. ACTION ITEMS

- Present the exact measurements of the possible affected area for the FTI station to the upcoming IEC meetings
- Continuous coordination
- Public Scoping

IV. PHOTO DOCUMENTATION

DOTr & JDT presenting the Metro Manila Subway Project as part of its Information & Education Campaign.

V. ATTACHMENT

- Attendance Sheet of the Meeting

The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	IEC/ COURTESY CALL WITH BRGY. SAN MARTIN DE PORRES, PARAÑAQUE CITY
Date and Time	JUNE 03, 2019
Venue	SAN MARTIN DE PORRES BARANGAY HALL

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	Beo Bersurto	DOTr / Envi			
2	Rachelle Perez	GHD / IDA			
3	Maria Luisa Regodon	GHD / Envi	09068058218	mcregodon@ghd.com	
4	Bea Alvarez	GHD	09171625664	bmalvarez@ghd.com	
5	Marc Vico A. Pauig	GHD	0927 7146631	marcvico.pauig@ghd.com	
6	Carmela Conanan	GHD		carmela.conanan@ghd.com	
7	SHEKINAH TIBAY	JDT	0916-6076428	srtibay@gmail.com	
8	PIA MADID	JICA DESIGN TEAM	09988665831	cmmadid@ghd.com	
9	MYRNA DE LAS CAGIGAS	Kagawad	09171459618	myrnacagigas1950@gmail.com	
10	MITHOR SIMBSON	BRGY. CAPTAIN	09178190776		
11	THESS I CASTILLO	KAGAWAD	09222173555		
12	DOMINGO OBLIGAR	SMDP EX. O	09152459040		
13	CARLO C. MILLANO	KAGAWAD	09294842980		
14	WENCESLAO O. SARMIENTO	Brgy Sec	09085096348		
15	Ludivina M. Valenciano	Kagawad	0910 7226865		
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Minutes of Meeting			
Project	The Detailed Design Study for the Metro Manila Subway Project (MMSP)		
Subject	Courtesy Call / IEC meeting with Brgy. Western Bicutan Officials/Staff		
Date and Time	May 27, 2019 (11:00 am)		
Venue	Western Bicutan Barangay Hall, Sampaguita, Western Bicutan, Taguig City		
Attendees	**Org**	**Name**	
	DOTr	Engr. Jim Benidict Petate	
	Brgy. Western Bicutan Office	Hon. Perlita Carmen	Sec. AC Serrano
		Admin Angela Occiano	Mr. Ronald Blancaflor
		Ms. Merlinda P.	
	JDT	Mr. Shuntaro Miyoshi	Dr. Pia Madid
		Ms. Shekinah Tibay	

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- DOTr and JDT presented the general information regarding the Project and the changes in the design of the alignment.
- The station locations were discussed.
- Brgy. Western Bicutan Office staff asked regarding vibration and Dr. Madid responded that as per the studies made, there might be vibration during the actual construction but for the operations, it is within the standard.
- Hon. Carmen expressed her support for the project knowing that the Project will follow all due process.
- Staff of Brgy. Western Bicutan asked if connections to commercial buildings like malls are present which DOTr and JDT explained that there are multiple entrances and exits near malls that are considered.
- DOTr and JDT informed Hon. Carmen that further discussions will be made as part of the IEC.

III. ACTION ITEMS

- Continuous coordination of DOTr and JDT to Brgy. Western Bicutan as needed.
- Public Scoping

IV. PHOTO DOCUMENTATION


DOTr & JDT presenting the Metro Manila Subway Project as part of its Information & Education Campaign.

V. ATTACHMENT

- Attendance Sheet of the Meeting

The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	IEC / COURTESY CALL WITH WESTERN BICUTAN BARANGAY OFFICE
Date and Time	MAY 27, 2019
Venue	BRGY. WESTERN BICUTAN BARANGAY HALL

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	JIM PETATE	DOTr	09214146425	jimpetate.dotr@gmail.com	[signature]
2	HON. PERLITA CARMEN	PUNONG BRGY.	-	-	[signature]
3	SEC. AC SERRANO	BRGY. SEC.	09178729100	secretary.westernbicutan@gmail.com	[signature]
4	ADMIN ANGELA OCCIANO	BRGY. ADMIN	09178729809	-	
5	[illegible]	B S F			[signature]
6	RONALD BLANCAFLOR	VIP-DEPUTY	09499014864	rblancaflor56@yahoo.com.ph	[signature]
7	Shuntaro Miyoshi	JDT	09770971851	miyoshi@katahira.com	[signature]
8	SHEKINAH TIBAY	JDT			[signature]
9	PIA MADID	JDT	09988665831	cmmadid@ghd.com	[signature]
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<tr><th colspan="4">Minutes of Meeting</th></tr>
<tr><td>Project</td><td colspan="3">The Detailed Design Study for the Metro Manila Subway Project (MMSP)</td></tr>
<tr><td>Subject</td><td colspan="3">Courtesy Call / IEC meeting with Makati South Hills Homeowners' Association President</td></tr>
<tr><td>Date and Time</td><td colspan="3">June 03, 2019</td></tr>
<tr><td>Venue</td><td colspan="3">Makati South Hills, Parañaque City</td></tr>
<tr><td rowspan="4">Attendees</td><td>Org</td><td colspan="2">Name</td></tr>
<tr><td>DOTr</td><td>For. Beo Raven Bensurto</td><td>Engr. Jim Petate</td></tr>
<tr><td>Makati South Hills Homeowners' Association</td><td>Mr. Robert B. Palisoc</td><td></td></tr>
<tr><td>JDT</td><td>Dr. Pia Madid</td><td>Ms. Shekinah Tibay</td></tr>
</table>

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- DOTr & JDT presented the general information regarding the Project and the changes in the design of the alignment.
- Mr. Palisoc raised the issue on the possible traffic impact since traffic is quite heavy most of the time in their area if there would be alternate roads which Engr. Jim responded that currently there no designs for it yet but definitely there will be.
- Dr. Pia informed that as of now, the FTI station of MMSP is in its concept design phase.
- It was clarified that the cut-and-cover method will be used for the stations and tunnel boring machine for the inter-station.
- Mr. Palisoc showed concern regarding the affected areas in their village and the freedom of the people to voice their concerns which DOTr and JDT assured that there are a lot of consultation that will happen, one included is the public scoping which is part of the EIA process and will be scheduled.
- Mr. Palisoc expressed his willingness to help in the invite of the possible affected people to attend in the said public scoping. He also agreed for the team to conduct the perception survey within the village.

III. ACTION ITEMS

- Continuous coordination
- Public Scoping

IV. PHOTO DOCUMENTATION

DOTr & JDT presenting the Metro Manila Subway Project as part of its Information & Education Campaign.

V. ATTACHMENT

- Attendance Sheet of the Meeting

The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	IEC Meeting with MAKATI SOUTH HILLS
Date and Time	JUNE 3, 2019
Venue	

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	ROBERT B PALISOC	MSHHA - PRES.	09175508444	robert b. palisoc@.mail.com	
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3	SHEKINAH TIBAY	JDT	0916.607.6428	srtibay@gmail.com	
4	BEN BENAVENTE	DOTr / Env			
5	JIM PETATE	DOTr			
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<tr><td>Project</td><td colspan="3">The Detailed Design Study for the Metro Manila Subway Project (MMSP)</td></tr>
<tr><td>Subject</td><td colspan="3">Courtesy Call / IEC with Parañaque City Planning & Development Office</td></tr>
<tr><td>Date and Time</td><td colspan="3">May 23, 2019 (10:00 am)</td></tr>
<tr><td>Venue</td><td colspan="3">Parañaque City Planning & Development Office, Parañaque City Hall, San Antonio Ave., Parañaque City</td></tr>
<tr><td rowspan="6">Attendees</td><td>Org</td><td colspan="2">Name</td></tr>
<tr><td>DOTr</td><td>Engr. Jim Benidict Petate</td><td>For. Beo Raven Bensurto</td></tr>
<tr><td rowspan="3">Parañaque Planning & Dev't Office</td><td>Engr. Benigno I. Rivera</td><td>Engr. Regor Columna</td></tr>
<tr><td>Engr. Amie Dolores Obed</td><td>Engr. Allen Gavilan</td></tr>
<tr><td>Ms. Liana Dizon</td><td></td></tr>
<tr><td>JDT</td><td>Dr. Pia Madid</td><td>Ms. Shekinah Tibay</td></tr>
</table>

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

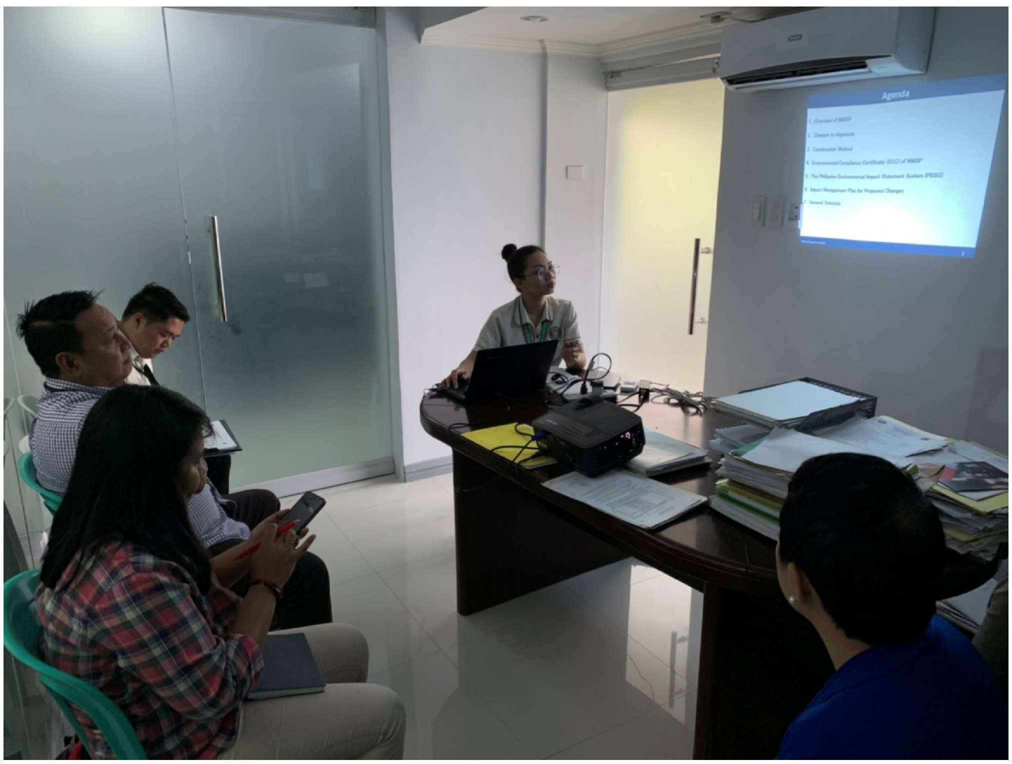
- DOTr & JDT presented the general information regarding the project as well as the changes in the design of the alignment.
- Engr. Rivera clarified if the station still is in Brgy. San Martin De Porres which Dr. Madid confirmed and added that the change in the FTI station is that it expanded.
- Dr. Madid explained that presentations will be done next to the barangay and then to the homeowners' associations which may be affected. Engr. Rivera identified upon seeing the map that it is United Parañaque Subdivision 1.
- Dr. Madid explained that the current design is more sensitive since it is wider than the previous one and may affect around 400 structures in worst case scenario.
- Engr. Rivera identified some structures that will be affected like the Green Cross building and two gasoline stations, school, Barangay hall
- Engr. Rivera asked the extent of the information dissemination regarding the new design which Dr. Madid explained that it just started, first in the LGUs down to the barangay then to the subdivisions.
- According to Engr. Rivera, planning should consider minimal damage since the location is already a built-up area. Dr. Madid responded that in the process, the concerns will be heard.
- Engr. Rivera asked why the project has to take from the private areas when the PNR right-of-way is already taking up 30m and the road have 20 meters, Engr. Jim replied that the PNR's project is separate from the MMSP.
- Engr. Rivera gave emphasis that their main sentiment is that Parañaque City is being used only as a passage way and not benefiting economically from the project but are causing traffic problems.
- Engr. Rivera asked if it is possible to construct without excavating the aboveground, Engr. Petate replied that the NATM can only be used for narrow sections with very delicate excavation process.
- Engr. Petate shared that for FTI Station, around 10m is the depth of the station since the tracks will elevate for the inter-connection with PNR.
- According to Dr. Madid, another concern is the disposal area which has to cater quite a big volume of soil, which is being coordinated with affected LGUs.

- Engr. Petate informed that the clearing for the PO Section may start within the year Engr. Rivera asked if the construction would be by phase, Engr. Jim replied there will be section which will be constructed simultaneously.
- Engr. Rivera asked if there are depressed areas in the project in which Dr. Madid replied that the depot at Brgy. Ugong, Valenzuela is one, but the city has its relocation site.
- Engr. Rivera identified Malugay, Paranaque to have informal settlers.
- Engr. Rivera shared that the Shell gas station took a year to secure its building permit because the residents of UPS 1 is not in favor of it, so it will be a challenge for the project.
- Dr. Madid informed that continuous coordination will be done and that the Project will be presented next to the barangay.

III. ACTION ITEMS

- Continuous coordination
- Public scoping

IV. PHOTO DOCUMENTATION



DOTr & JDT presenting the Metro Manila Subway Project as part of its Information & Education Campaign.

V. ATTACHMENT

- Attendance Sheet of the Meeting

The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	IEC / COURTESY CALL FOR CHANGES IN ALIGNMENT
Date and Time	MAY 23, 2019 (
Venue	PARAÑAQUE CITY PLANNING & DEVELOPMENT OFFICE, CITY HALL, PARAÑAQUE CITY

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	JIM PETATE	DOTr	0921 414 6425	jimpetate.dotr@gmail.com	
2	PIA MADID	JICA DESIGN TEAM	09988[illegible]	cmmadid@gmd.com	
3	Reo Bensurto	DOTr	0905 457 0992	brvbensurto.dotr@gmail.com	
4	ENGR. BENIGNO I RIVERA	HEAD - CPDCO	0920 641 4360	cpdco.pque@ymail.com	
5	ENGR. REGOR LEURIC COLUMNA	PLANNING OFFICER I	09952880156	regorleuric@yahoo.com	
6	Engr Amie Dolores S. Obed	PLANNING OFFICER 3	8254808	amie_obed@yahoo.com	
7	ENGR. ALLEN GAVILAN	PROJ. DEV'T OFFICER 2	8254808	aaagavilan@gmail.com	
8	LIANA DIZON	ADMIN. AIDE VI	09278424217	cpdco.pque@ymail.com	
9	SHEKINAH TIBAY	JDT	0916-607-6428	srtibay@gmail.com	
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Minutes of Meeting			
Project	The Detailed Design Study for the Metro Manila Subway Project (MMSP)		
Subject	Courtesy Call / IEC with Pasay City Planning & Development Office		
Date and Time	May 03, 2019 (10:00 am)		
Venue	Pasay City Planning & Development Office, Pasay City Hall, F.B. Harrison, Pasay CIty		
Attendees	**Org**	**Name**	
	DOTr	Engr. Jim Benidict Petate	For. Beo Raven Bensurto
	Pasay Planning & Dev't Office	Engr. Merlita Lagmay	Engr. Ronald Allan Dela Cruz
		Engr. Achilles Robiso	Engr. Rolando Fajardo
		Engr. Johari Rangires	Engr. Rene Ipac
	JDT	Dr. Pia Madid	Ms. Shekinah Tibay

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- DOTr, led by Forester Beo Bensurto, presented the general concepts of MMSP to representatives of the Pasay City Planning & Development Office and City Engineers Office.
- For. Beo also presented the changes in the alignment. Engr. Jim explained that the former Cayetano Blvd. Station was moved to Lawton area due to its proximity to a faultline.
- Engr. Jim presented the proposed station location of NAIA T3 Station in Pasay City and explained that as of now, it is still under the pre-feasibility study stage therefore there is no definite station location yet.
- As per Engr. Jim, the width of the station is around 10.4m, in response to Engr. Lagmay's question. This is in reference to the station in FTI
- Engr. Rene Ipac of the CPDO expressed interest in the Project having stations connecting all terminals of NAIA, which Engr. Jim responded to that having stations in Terminals 1 & 2 would be part of the Phase-2 stage of the Project which may stretch until Asia World.
- Dr. Pia Madid presented the general overview of the EIA process and informed everyone that DOTr, in assistance of the JDT is currently in the social preparations stage.
- Engr. Lagmay said that it seems like in Pasay, the condominium units are going to be affected and the dust may be a concern. Engr. Lagmay and Dr. Pia agreed that the traffic might be a concern to the stakeholders as well.
- Engr. Lagmay informed DOTr and JDT that some of the condominiums have basements for parking as deep as 6 stories down and should be considered in the design.
- Dr. Pia presented the summary of the Impact Management Plan and gave emphasis that the potential impacts like dust and traffic were considered. Dr. Pia added that with regards to Pasay, there are no informal settlers found in the proposed affected locations; and discussion may be focused on the unit owners of the condominiums in the area.
- Engr. Lagmay shared that the soil profile of the area considered for the T3 station is good for underground works.
- As per Dr. Pia and Engr. Jim, since the NAIA T3 station of the project is still under pre-feasibility study stage, the station location may still change.
- Dr. Pia presented the general timeline of the Project and discussed that the Partial Operability (PO) Section will be operational by 2022, she added that as of now the focus is in Valenzuela City and Quezon City.
- The members of the Pasay LGU expressed their support and hope for the implementation

of the Project.

- Dr. Pia assured that there will be more future coordination with Pasay LGU as the Project progress during the EIA Process.
- Engr. Lagmay informed that the only concerned barangay based on the presented station location is Brgy. 183.

III. ACTION ITEMS

- DOTr & JDT to conduct IEC with the officials of the concerned barangay (Brgy. 183, Pasay City).
- DOTr & JDT to continue coordinating closely with Pasay LGU.

IV. PHOTO DOCUMENTATION

DOTr & JDT presenting the Metro Manila Subway Project to Pasay City Planning & Development Officers and City Engineering Officers as part of the project's Information & Education Campaign.

V. ATTACHMENT

- See attached Attendance Sheet of the Meeting

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<tr><th colspan="4">Minutes of Meeting</th></tr>
<tr><td>Project</td><td colspan="3">The Detailed Design Study for the Metro Manila Subway Project (MMSP)</td></tr>
<tr><td>Subject</td><td colspan="3">Courtesy Call / IEC meeting with United Parañaque Subdivision 1 Homeowners' Association President</td></tr>
<tr><td>Date and Time</td><td colspan="3">June 03, 2019</td></tr>
<tr><td>Venue</td><td colspan="3">UPS 1 Homeowners' Assoc. Office, Parañaque City</td></tr>
<tr><td rowspan="4">Attendees</td><td>Org</td><td colspan="2">Name</td></tr>
<tr><td>DOTr</td><td>For. Beo Raven Bensurto</td><td>Engr. Jim Petate</td></tr>
<tr><td>UPS 1 Homeowners' Association</td><td>Mr. Eugene Babia</td><td></td></tr>
<tr><td>JDT</td><td>Dr. Pia Madid</td><td>Ms. Shekinah Tibay</td></tr>
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I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- DOTr & JDT presented the general information of the Project and the changes in the design of the alignment.
- As per Mr. Babia, it would be better to include the owners of the Green Cross building for the other IEC meetings. He added that in reference to presented map of station, all service roads of United Parañaque Subdivision 1 (UPS 1) will be affected.
- DOTr and JDT explained that an access will be provided for village.
- Mr. Babia added that most of those households that may be affected are the earlier residents who were able to choose the areas near the East Service Road.
- Mr. Babia asked the reason for the expansion of the station area which Dr. Madid responded that one main reason is the planned inter-connection of the subway to the PNR.
- Mr. Babia told the team that if they will be presenting these changes to the residents, they will be bombarded with questions that they are not in the position to answer, Dr. Madid assured him that the Project will soon conduct a public hearing to be able to present the information and hear the concerns of the residents.
- Mr. Babia explained that the residents who may be affected which are planning to do constructions in their houses has to be informed soon since it may not be necessary at this point in time for them to do so.
- Dr. Madid assured that there will be further IEC meetings to come, one is the public scoping.
- According to Mr. Babia, UPS 1 is very much concerned that the Project will be taking up the general frontage of their village, he requested for it to be made to green space after the construction, he emphasized also that this is a very important matter to them. DOTr and JDT responded that one of the existing conditions in the existing ECC tackles the requirement of green/open space.
- Mr. Babia expressed willingness to help in the invitation of their residents who would need to attend the public scoping.

III. ACTION ITEMS

- Continuous Coordination
- Public Scoping (JDT to include current TOD design in the presentation)

IV. PHOTO DOCUMENTATION

DOTr & JDT presenting the Metro Manila Subway Project as part of its Information & Education Campaign.

V. ATTACHMENT

- Attendance Sheet of the Meeting

The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	IEC mtg w/ UPS 1
Date and Time	3 JUNE 2019
Venue	UPS I HOMEOWNERS ASSOC OFFICE

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	PIA MADID	JICA DESIGN TEAM	09988665831	cmmadid@ghd.com	
2	BABIA, Eugene	PRES. UHV I	09178500410		
3	JIM PETATE	PDO	0921 414 6425	jimpetate.dotr@gmail.com	
4	Beo Bensurto	DOTr / Envi			
5	SHEKINAH TIBAY	JDT	0916-607-1A28	srtibay@gmail.com	
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Minutes of Meeting

Project	The Detailed Design Study for the Metro Manila Subway Project (MMSP)		
Subject	Courtesy Call / IEC		
Date and Time	11 April 2019 (2pm – 4pm)		
Venue	Taguig City Planning & Development Office, Taguig City Satellite Office, 10th Fl., SM Aura Tower Bldg., Taguig City		
Attendees	**Org**	**Name**	
	DOTr	Engr. Jim Benidict Petate	For. Beo Raven Bensurto
		Engr. Ada Lechen Gomez	
	Taguig Planning & Dev't Office	Arch. Hilda Candelario	Engr. Gissel Blanco
		Arch. Eric Castro	Engr. Lou Aniceto
	JDT	Dr. Pia Madid	Ms. Shekinah Tibay

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- DOTr, led by Engr. Jim Petate, presented the general concepts of MMSP to Taguig City Planning & Development Officers.
- DOTr also presented the changes in station locations that are within Taguig City. DOTr gave emphasis to the replacement of the originally proposed Cayetano Blvd. Station to the Lawton East & West Stations. Dr. Pia Madid of JDT added that the shifting is also recommended by DENR on the ECC of the project.
- Dr. Madid presented the current Impact Management Plan and according to her, based on desktop analysis, approximately 238 trees may be affected in the FTI-Bicutan interoperability station and approximately 89 trees for the Lawton East & West Stations.
- Dr. Madid added that for the construction of the stations cut-and-fill method will be used meaning there will surely be disturbance aboveground.
- Taguig LGU asked where will the excavated soils be disposed which Engr. Jim of DOTr replied that for the Partial Operability (PO) Section, the LGUs of Quezon City & Valenzuela City expressed their willingness to cater said spoils, he added that there have been discussions with the Taguig LGU and the only spoils Taguig City will cater are those that were excavated within its jurisdiction, although, no further meetings have been held, yet.
- Taguig LGU asked the length of the alignment which will passed through Taguig, according to Engr. Jim approximately 5km long with the Tunnel Boring Machine's (TBM) diameter of ~7m.
- Dr. Madid also reported that for the stations within Taguig City and the rest of the alignment extension, there are no found water bodies.
- Taguig LGU raised that there may be underground tunnels in the proposed alignment locations which Dr. Madid assured that finding said tunnels will also be included in the EIA.
- The Taguig LGU expressed concern regarding the naming of the stations since the proposed FTI station is actually part of Parañaque City already.
- The Taguig LGU clarified that both BGC & Lawton East Stations are within Brgy. Fort Bonifacio and Lawton West Station is within Brgy. Western Bicutan.
- The Taguig LGU requested for a formal report regarding the selection of station locations

in Taguig City as well as a traffic management plan during construction period.

III. ACTION ITEMS

- DOTr & JDT to provide report of the selection of the station locations and traffic management plan during construction to Taguig LGU.
- DOTr to send request letters for courtesy call and IEC endorsed by the LGU to affected barangays in Taguig City.

IV. PHOTO DOCUMENTATION

DOTr & JDT presenting the Metro Manila Subway Project to Taguig City Planning & Development Officers as part of the project's Information & Education Campaign.

V. Others

- Attendance Sheet

The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	COURTESY CALL WITH TAGUIG CITY PLANNING & DEVELOPMENT OFFICE / IEC
Date and Time	APRIL 11, 2019 (2:00 pm)
Venue	10th Fl., SM AURA TOWER, CITY PLANNING & DEV'T OFFICE, TAGUIG CITY

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	JIM PEPATE	DOTr / PDO	0921 414 6976	jimpepate.dotr@gmail.com	
2	Beo Rencurto	DOTr / Envi Officer			
3	ADA LECHEN GOMEZ	DOTr / PDO	09594493936	adagomez.dotr@gmail.com	
4	HILDA CANDELARIO	Planning Dept / ARCH.	09260446311	cpdo@ ~~yahoo~~ gmail.com	
5	GISSEL BLANCO	CPDO / ENGR	09182576216		
6	ERIC CASTRO	CPDO / Arch.	09263902719	cpdotaguigcity@gmail.com	
7	LOU ANICETO	CPDO / ENGR	09479511229	louminho21@gmail.com	
8	SHEKINAH R. TIBAY	JDT	09166076428	srtibay@gmail.com	
9	PIA MADID	JDT	09988665831	cinnadid@ yahoo.com	
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Minutes of Meeting

Project	The Detailed Design Study for the Metro Manila Subway Project (MMSP)	
Subject	Courtesy Call / IEC with Pasay City Planning & Development Office	
Date and Time	May 10, 2019 (10:00 am)	
Venue	Barangay Hall, Barangay 183, Pasay City	
Attendees	**Org**	**Name**
	DOTr	Engr. Jim Benidict Petate
	Barangay 183 Council Members	Kagawad Allan Ibones
		Kagawad Gerald John Sobrevesa
	JDT	Dr. Pia Madid

I. AGENDA

- Information & Education Campaign regarding the changes in alignment of the Metro Manila Subway Project (MMSP) and courtesy call.

II. NOTES

- Engr Jim presented the general overview of the project and its objective. He also presented the proposed route as well as changes in the route as per the project's ECC and changes.
- Engr Jim emphasised that the project alignment and station location is still subject to change depending on the result of the engineering design study.
- Dr. Pia presented the status of the environmental approvals from the DENR on the project, indicating that the project's ECC will require amendment due to changes in the original alignment and the additional project footprint (FTI to T3 and FTI to Bicutan).
- Dr. Pia presented that as per the DENR's EIA process, DOTr is still in its IEC/Social preparation stage and assured that there will be more future coordination with the Barangay officials as the Project progress during the EIA Process.
- Kagawad Sobrevesa raised possible issues that should be looked at during the conduct of the EIA, and these are:
    - Possible effect of the project (during construction) on Sales Avenue which is currently considered a traffic bottleneck in the area.
    - Possible effect on church goers and property owners along Resorts drive due to possible generation of dust, noise and vibration during construction
    - Low lying or flood prone areas near Villamor golf course which could be flooded by 6 to 7 feet.
- Kagawad Ibones expressed confidence in the project that it will obtain the necessary environmental permits from the barangay, if needed. He also reminded DOTr to consult closely with project managers in the area.
- Engr Jim stated that part of the detailed engineering design is to check on the existing structures and seek proper clearance.
- Dr. Pia stated that there will be a public scoping soon and that all project stakeholders in Pasay will be invited to attend. An invitation will be sent to the Barangay Council.
- Meeting was adjourned by 11:00am.

III. ACTION ITEMS

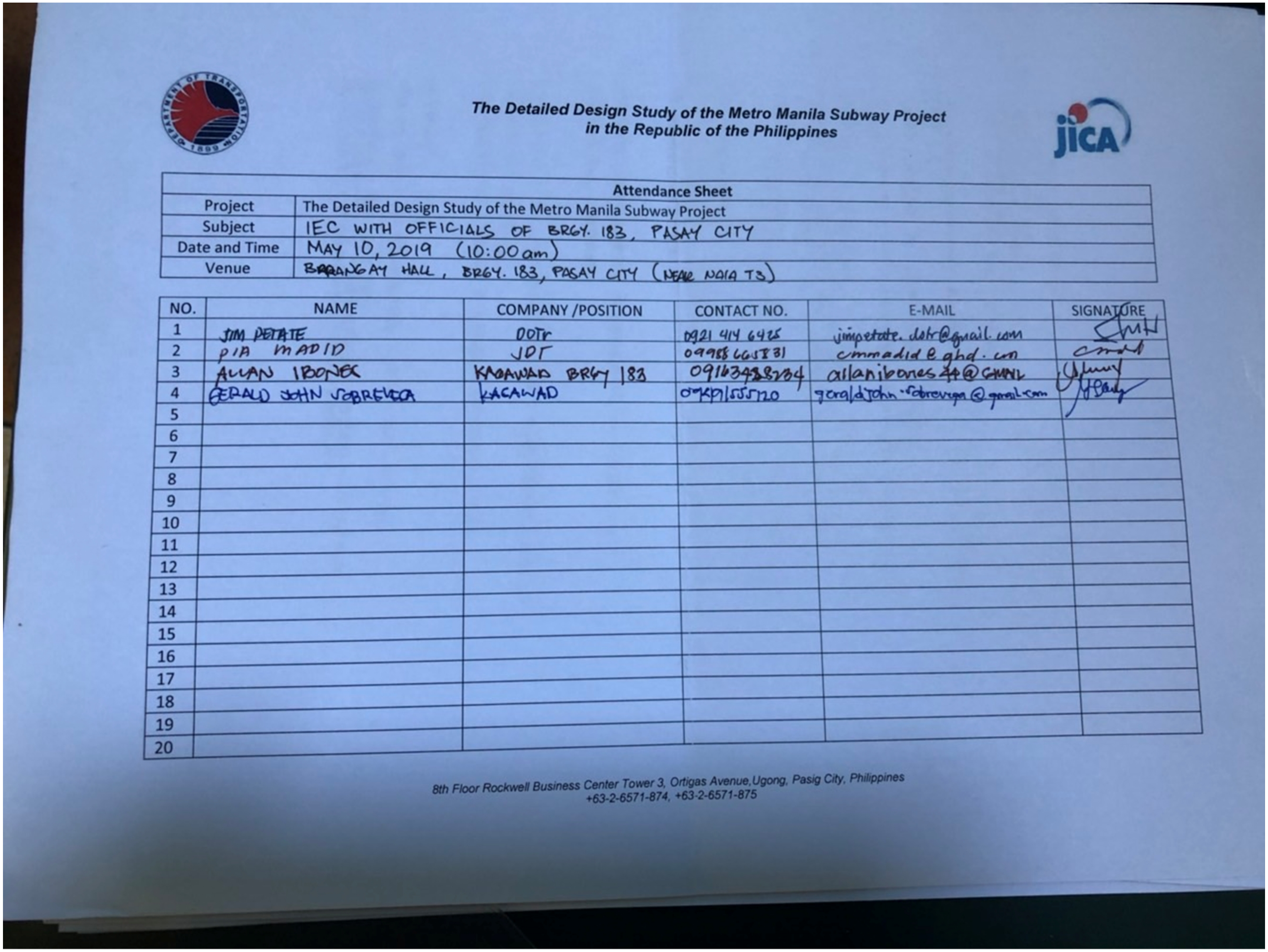
- DOTr & JDT to identify project stakeholders in Pasay for the Public Scoping
- DOTr & JDT to continue coordinating closely with Pasay BLGU.

IV. PHOTO DOCUMENTATION

DOTr & JDT presenting the Metro Manila Subway Project to Barangay Councilors of Barangay 183 in Pasay City as part of the project's Information & Education, Campaign activity.

V. ATTACHMENT

- See attached Attendance Sheet of the Meeting



The Detailed Design Study of the Metro Manila Subway Project
in the Republic of the Philippines

Attendance Sheet	
Project	The Detailed Design Study of the Metro Manila Subway Project
Subject	IEC WITH OFFICIALS OF BRGY. 183, PASAY CITY
Date and Time	MAY 10, 2019 (10:00 am)
Venue	BARANGAY HALL, BRGY. 183, PASAY CITY (NEAR NAIA T3)

NO.	NAME	COMPANY /POSITION	CONTACT NO.	E-MAIL	SIGNATURE
1	JIM PETATE	DOTr	0921 414 6425	jimpetate.dotr@gmail.com	
2	PIA MADID	JDT	09988665831	cmmadid@ghd.com	
3	ALLAN IBONES	KAGAWAD BRGY 183	09163488234	allanibones44@GMAIL	
4	GERALD JOHN SOBREVEGA	KAGAWAD	09171555720	geraldjohn.sobrevega@gmail.com	
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Appendix B - (Perception Survey Results)

Department of Transportation

Metro Manila Subway Project (MMSP) Phase 1

Perception Survey Report

JUNE 2019

Table of contents

Table index

Figure index

Appendices

1. Perception survey

1.1 Introduction

The perception survey is undertaken as part of the information, education and communication (IEC) activities in the early stages of the Environmental Impact Assessment (EIA) process. It is done in accordance with DAO 2017-15 or the guidelines on public participation under the Philippine Environmental Impact Statement (EIS). This initial survey is carried out to assess understanding and knowledge of the community about the project, to measure their level of acceptance, and to note any questions, suggestions and/or opinion that they may have with regard to the project and their perceived impacts.

1.2 Methodology

This perception survey was conducted at three barangays in different cities that will potentially be affected by the project. The survey was done in Barangay 183, Villamor in Pasay City on 30 May, followed by Barangay Fort Bonifacio in Taguig City on 31 May, and Barangay San Martin de Porres (SMDP) in Parañaque City on 03 June 2019. Survey enumerators composed of two Department of Transportation (DOTr), two Jica Design Team (JDT), three OC Global, and four GHD personnel were deployed to perform the survey to approximately 100 households in each barangay. Prior to the initial survey, an orientation was conducted to the enumerators to discuss the objectives of the survey and to run-through the questions in the survey form to increase the quality and accuracy of data collected. After the survey, a debriefing meeting was also conducted to discuss general responses and challenges encountered.

1.3 Results

1.3.1 Barangay 183, Pasay City

The perception survey in Barangay 183, Pasay City was conducted on 30 May 2019 to the directly affect population in the direct impact area. The respondents were constituted of household members, property owners, tenants, and business owners. A total of 98 respondents were surveyed, 53 of which were female (54 %) and 45 were male (46 %).

Project perception and awareness

The respondents' level of awareness on the project were assessed based on key questions regarding the project. Majority of the respondents (54 % or 52 individuals) in Barangay 183 answered that they do not have prior knowledge about the project, while 44 individuals (46 %) responded that they were aware about the project (Figure 1).

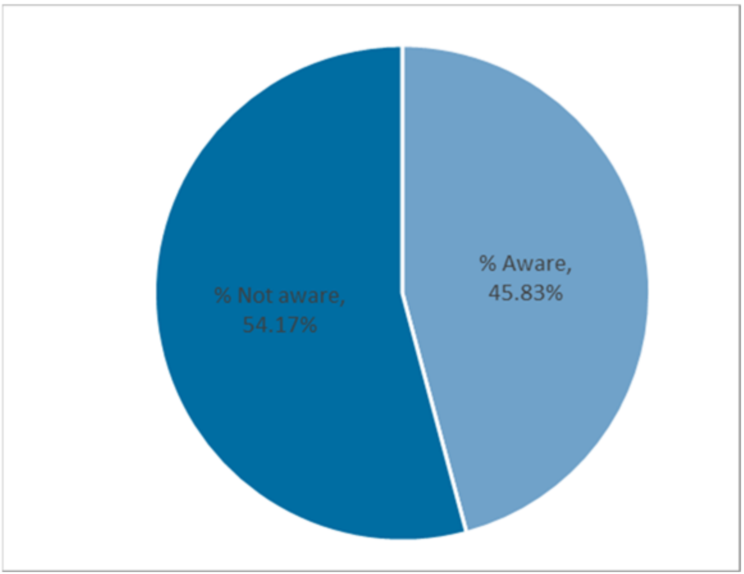

Figure 1 Level of project awareness in Brgy. 183, Pasay City

In general, most of the respondents that were aware of the project gained information through mass media (87 %), particularly from local news networks. Further, some of the respondents that were aware of the project got the information from relatives, friends or neighbours (8 %); from government or barangay officials (3 %) and from previous meetings or consultations through IEC's in the barangay government unit or other stakeholder groups (3 %). Figure 2 presents the distribution of the respondents' source of information about the project.

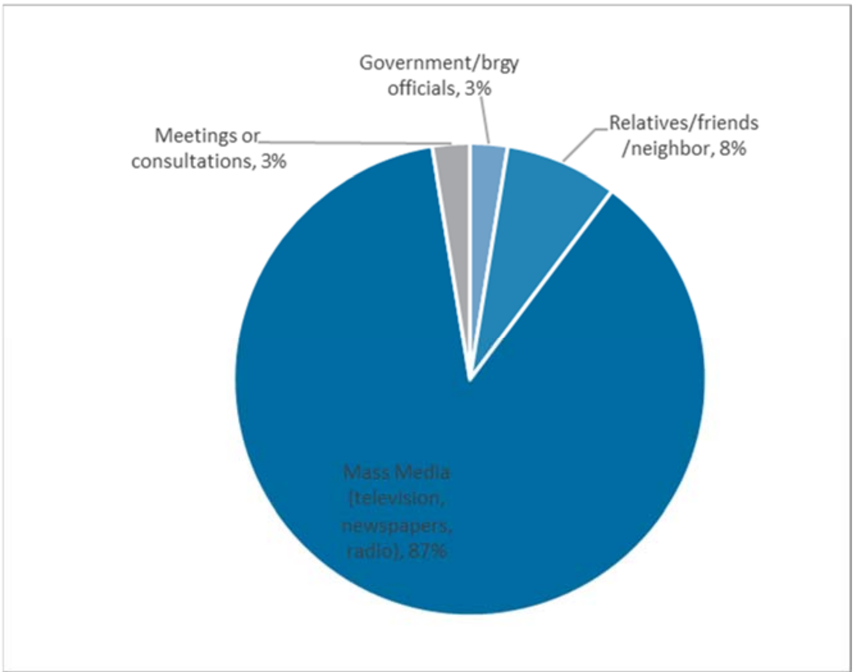

Figure 2 Source of information about the project of the respondents in Barangay 183, Pasay City

The enumerators were also able to gather information on how respondents perceive the effects of the project in the community. In terms of the positive effects, majority of the respondents see that the project will improve mass transportation (36 % or 68 respondents), provide employment opportunities (19 % or 35 respondents) and increase overall development of the barangay (14 % or 26 respondents). Figure 3**Error! Reference source not found.** presents the distribution of positive impacts based on the gathered responses and Table 1 lists the count and percentage of these impacts.

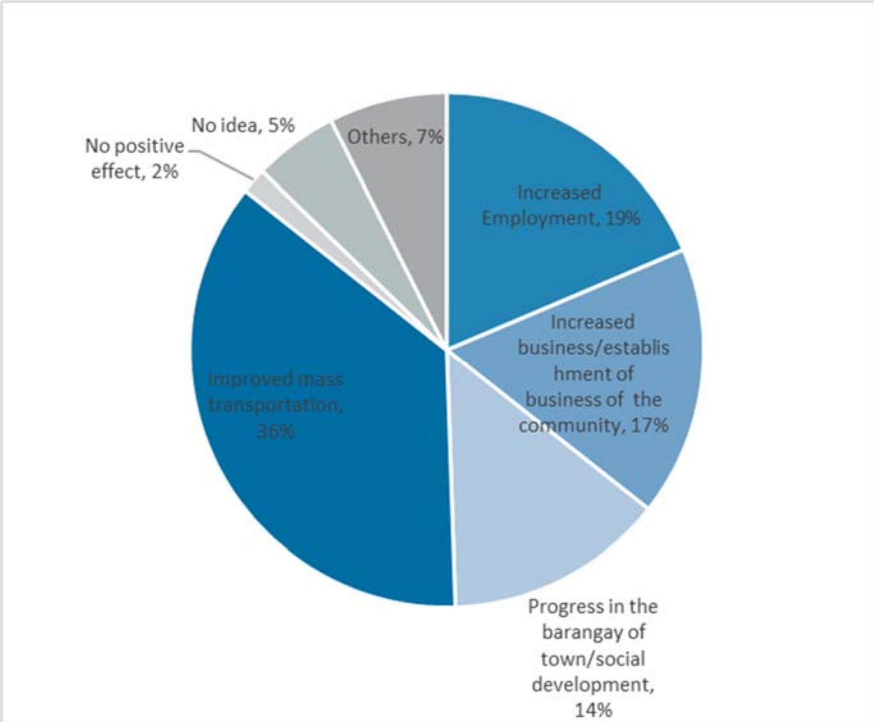

Figure 3 Perceived positive effects of the project from respondents in Barangay 183, Pasay City

Table 1 Perceived positive effects of the project from respondents in Barangay 183, Pasay City

Positive impacts	Percentage	Count*
Increased Employment	19%	35
Increased business/establishment of business of the community	17%	32
Progress in the barangay of town/social development	14%	26
Improved mass transportation	36%	68
No positive effect	2%	3
No idea	5%	10
Others	7%	14
Total		**188**

*Respondents provided multiple responses

On the other hand, the negative effects perceived by the respondents was primarily the loss of properties (18 % or 30 respondents). This was followed by individuals with various responses (18 % or 30 respondents) including concerns on safety such as geohazard risks (sudden ground collapse, sinkhole/ground subsidence, earthquake resiliency), relocation, and flooding. Some respondents were concerned about the safety issues (11% or 19 respondents) and the removal of trees (11 % or 19 respondents) as shown in Figure 4 and listed in Table 2.

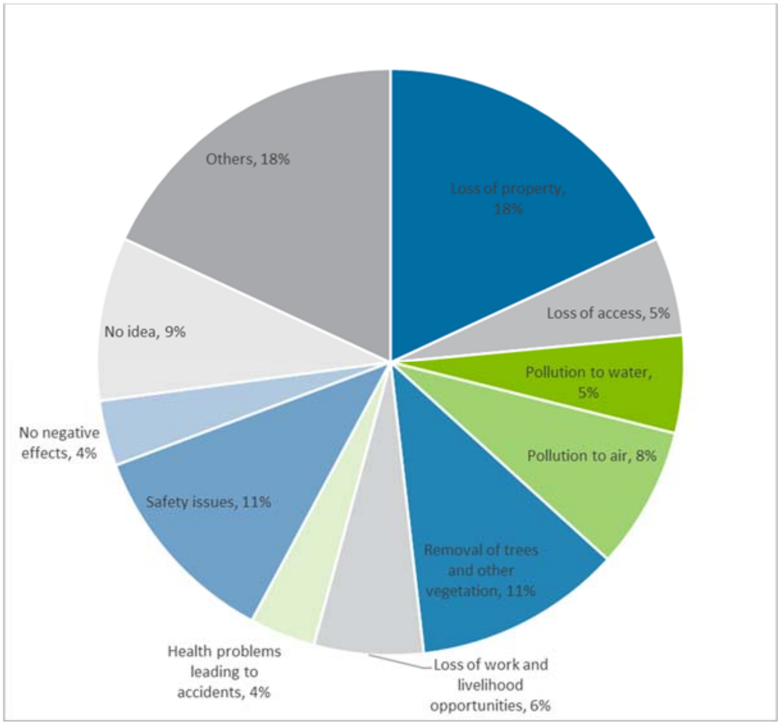

Figure 4 Perceived negative effects of the project by Barangay 183, Pasay City respondents

Table 2 Perceived negative effects of the project by Barangay 183, Pasay City respondents

Brgy. Fort Bonifacio	Count*	Percentage
Loss of property	30	18%
Loss of access	9	5%
Pollution to water	9	5%
Pollution to air	13	8%
Removal of trees and other vegetation	19	11%
Loss of work and livelihood opportunities	10	6%
Health problems leading to accidents	6	4%
Safety issues	19	11%
No negative effects	6	4%
No idea	15	9%
Others	30	18%
Total	**188**	

*Respondents that provided multiple answers

Overall, majority of the respondents in Barangay 183 were in favour of the project (79 %). Respondents that did not express approval of the project (13 %) were probably those that will be directly affected by possible clearing of their existing properties. Further, a small percentage (8 %) did not provide a response or were still undecided (Figure 5).

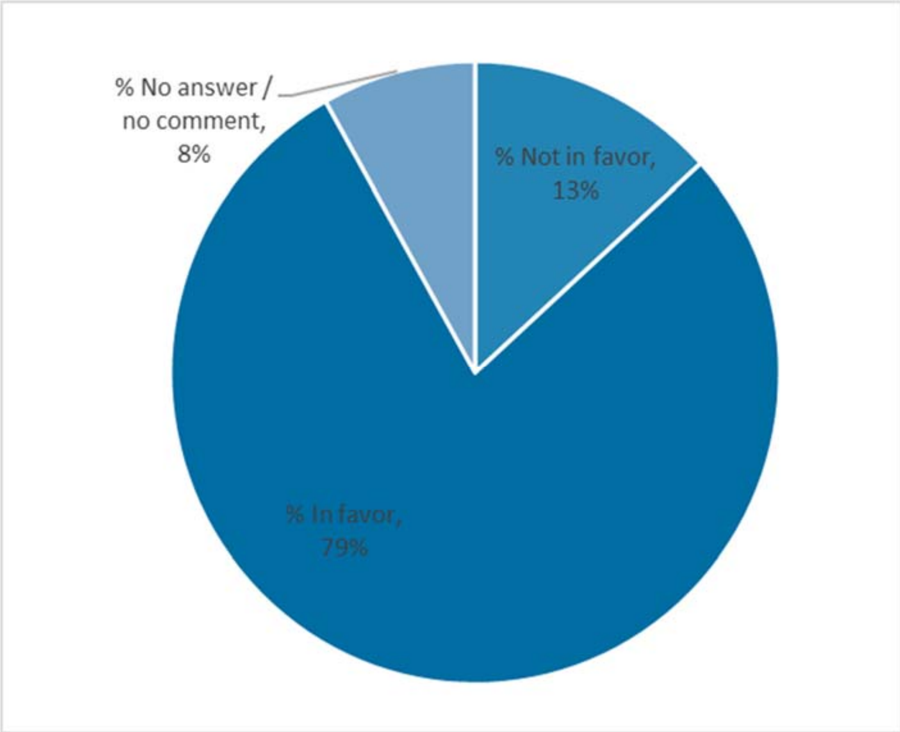

Figure 5 Project acceptance of the respondents in Barangay 183, Pasay City

The perception survey in Barangay Fort Bonifacio, Taguig City was conducted on 31 May 2019. Targeted respondents were office workers near the direct impact areas, vendors, and residents. A total of 100 respondents were interviewed in the barangay, 58 of which were male (58 %) and 42 were female (42 %).

Project perception and awareness

In general, respondents of the barangay were aware about the project (72 %), primarily sourcing the information from mass media (73 %). Others were aware of the project from the government and barangay officials (15 %), while others from relatives, neighbours, and friends (12 %).

Figure 6 shows the distribution of respondents in terms of their awareness on the project, while Figure 7 presents their source of knowledge.

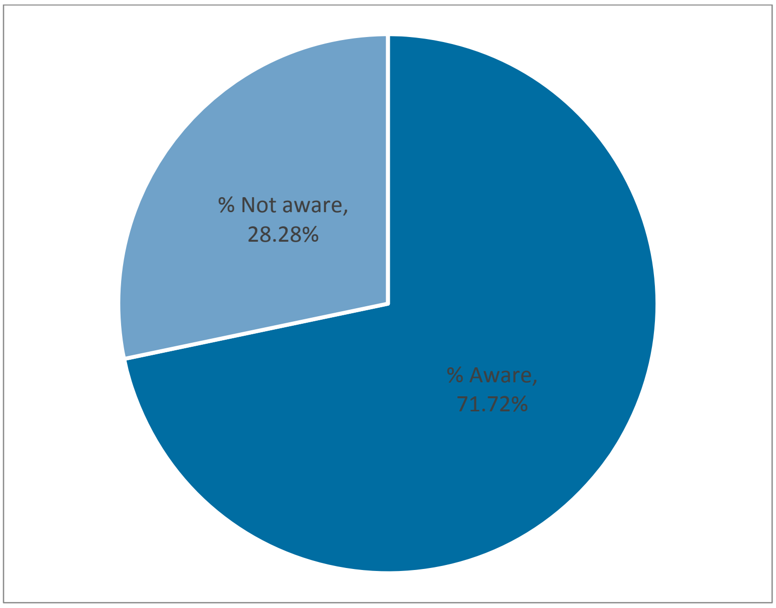

Figure 6 Awareness of the project by respondents in Barangay Fort Bonifacio, Taguig City

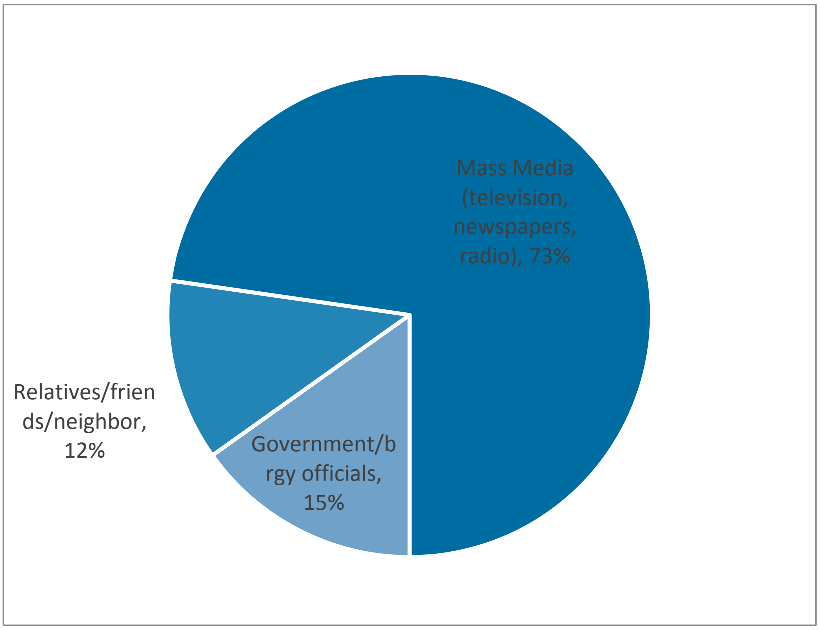

Figure 7 Source of information about the project of the respondents in Barangay Fort Bonifacio, Taguig City

In terms of perceived positive effects, most respondents see that the project will improve mass transportation (37 % or 82 respondents). The perceived effects such as increase in employment or livelihood opportunities (22 %), increase in business in the barangay (21 %), and community progress and social development (19 %) had almost equal percentages of responses. Figure 8 presents the distribution of the perceived positive impacts of the project, while Table 3 lists these impacts and the number of responses per each item.

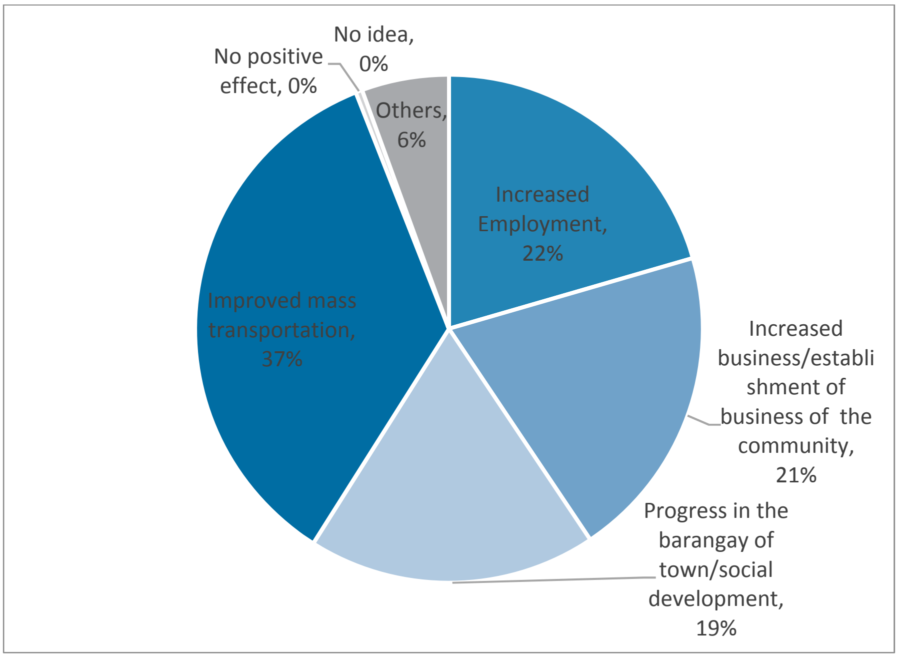

Figure 8 Perceived positive effects of the project from respondents in Barangay Fort Bonifacio, Taguig City

Table 3 Perceived positive effects of the project by Barangay Fort Bonifacio respondents

Positive impacts	Percentage	Count*
Increased Employment	22%	48
Increased business/establishment of business of the community	21%	47
Progress in the barangay of town/social development	19%	43
Improved mass transportation	37%	82
No positive effect	0%	1
No idea	0%	
Others	6%	13
Total		**221**

*Respondents provided multiple answers

Meanwhile, loss of property and removal of trees or other vegetation accounts were perceived as negative effect from most of the respondents at 18 percent for each. This response mainly came from potentially affected residents and office workers of the National Mapping and Resource Information Authority (NAMRIA-DENR). A significant percentage also stated that they are worried about the safety during project construction and operation (12 %). Consequently, some did not believe that the project will have any negative effect (12 %), and a few has no idea of any negative impacts it might cause (5 %). Distribution and percentage count per negative impact is presented in Figure 9 and Table 8, respectively.

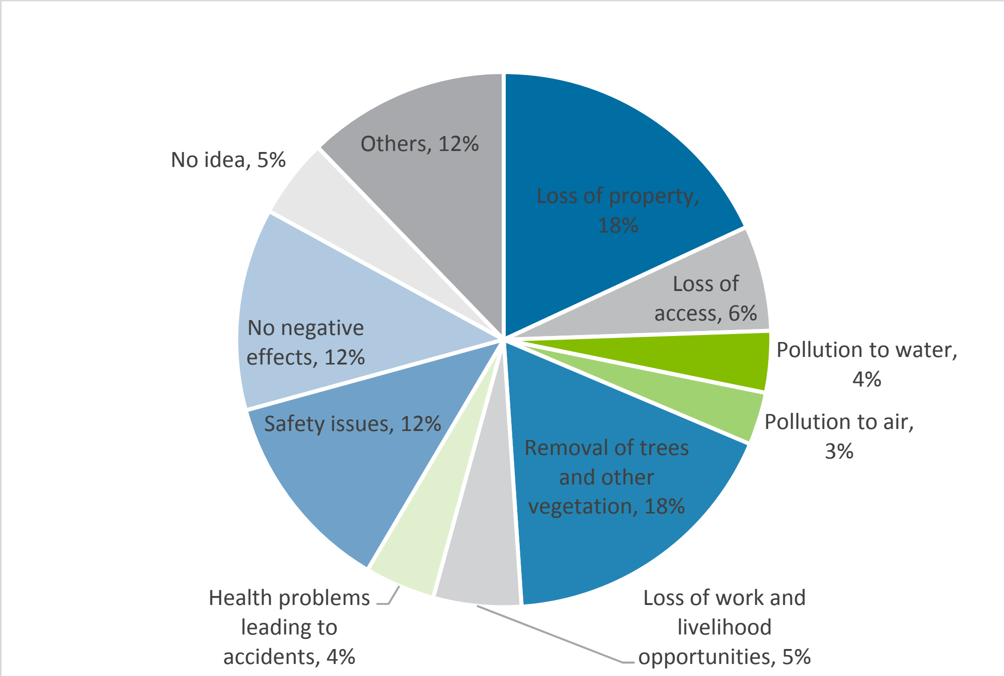

Figure 9 Perceived negative effects of the project from respondents in Barangay Fort Bonifacio, Taguig City

Table 4 Perceived negative effects of the project by Barangay Fort Bonifacio respondents

Brgy. Fort Bonifacio	Count*	Percentage
Loss of property	34	18%
Loss of access	12	6%
Pollution to water	7	4%
Pollution to air	6	3%
Removal of trees and other vegetation	33	18%
Loss of work and livelihood opportunities	10	5%
Health problems leading to accidents	8	4%
Safety issues	23	12%
No negative effects	23	12%
No idea	9	5%
Others	23	12%
Total	**188**	

*Respondents provided multiple answers

Overall, the respondents of the barangay are mostly in favour of the project (96 %). Only four percent responded no to the project (Figure 10). More respondents are in favour of the project from this barangay mainly because there are fewer household and properties that are expected to be cleared compared to the other barangays interviewed during this initial perception survey. However, residents of an affected subdivision had not been interviewed yet, hence, the result of this study must not be viewed as the representation of the entire affected population.

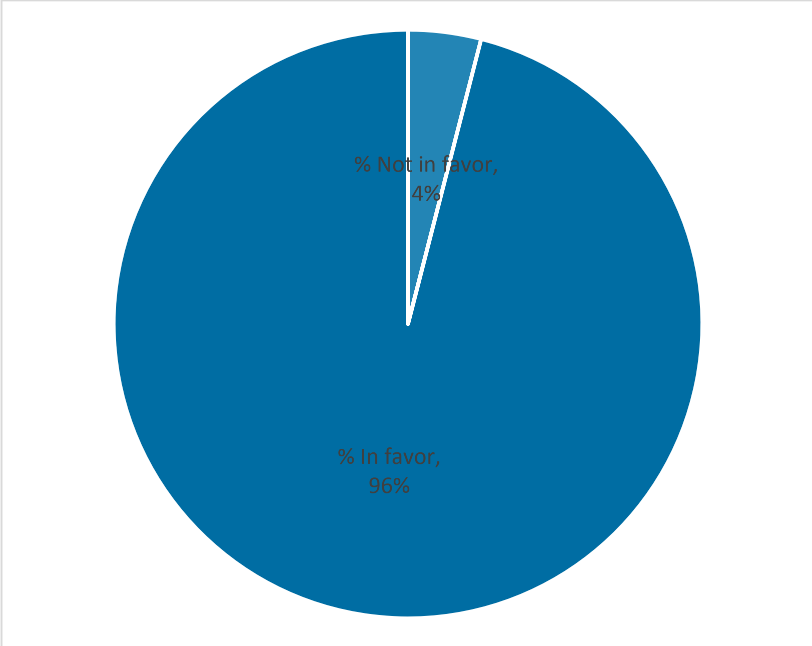

Figure 10 Project acceptance of the respondents in Barangay Fort Bonifacio, Taguig City

1.3.2 Barangay San Martin de Porres, Parañaque City

The enumerators conducted the interview within and around the directly affected area in Barangay San Martin de Porres, Parañaque on 03 July 2019. The respondents were a diverse group of property owners, tenants, business owners and their employees. The survey was conducted upon the IEC to the Barangay Chairman and officials, as well as to the officials of the Homeowners' Association of the affected village.

Project perception and awareness

The awareness of the respondents were assessed based on questions about their depth of knowledge on the project and source of information about the project. Majority of the respondents from SMDP stated that they have prior knowledge about the project (76 %) (Figure 11), with 50 percent of those with prior knowledge stating that mass media such as television, radio, and newspapers was the source of their information. The enumerators also took the opportunity for those who do not have prior knowledge about the project to discuss some project information during the interview. Figure 12 presents the distribution of the source of information of the respondents.

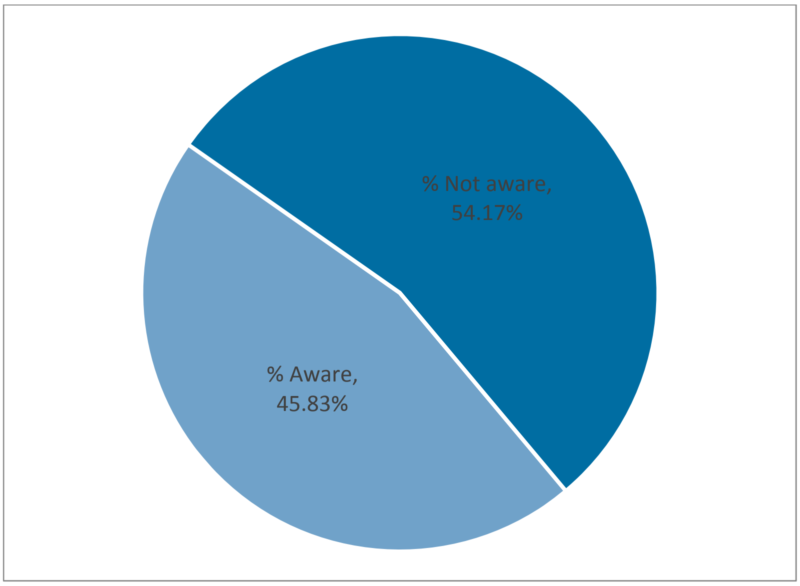

Figure 11 Awareness of the project by respondents in Barangay SMDP, Parañaque City

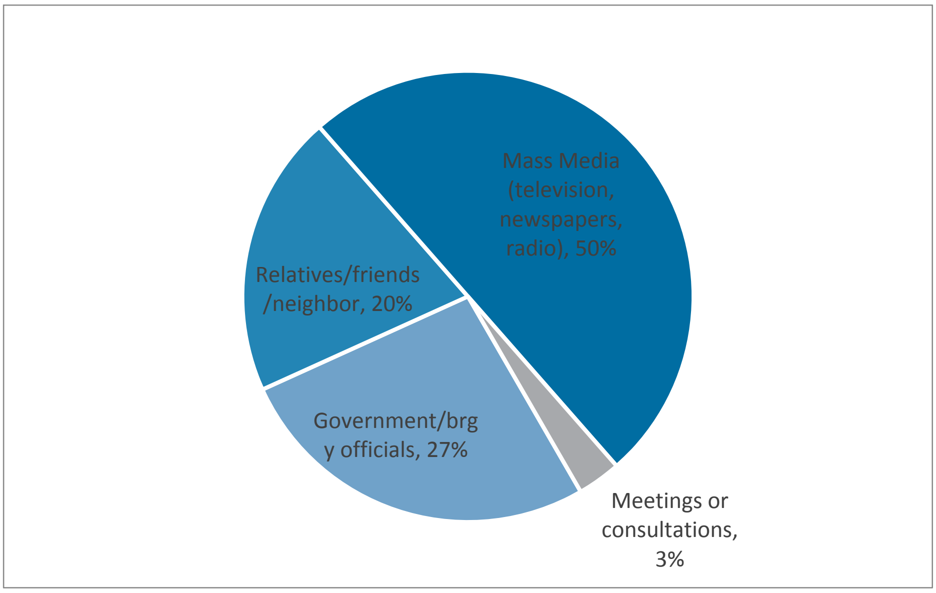

Figure 12 Source of information about the project of the respondents in Barangay SMDP, Parañaque City

The enumerators were also able to gather information on how respondents perceive the effects of the project in the community. Majority believe that the project will improve mass transportation (35 %), while some sees the project as an additional source of livelihood through employment (21 %). Few also stated that increase in business opportunities (18 %) as well as progress, and social development in the barangays (17 %) will be some of the benefits. There were other respondents that either has no idea or does not see any positive effects of the project (2 %). Figure 13 and Table 5 presents the list of positive impacts perceived by the respondents and the percentage for each impact.

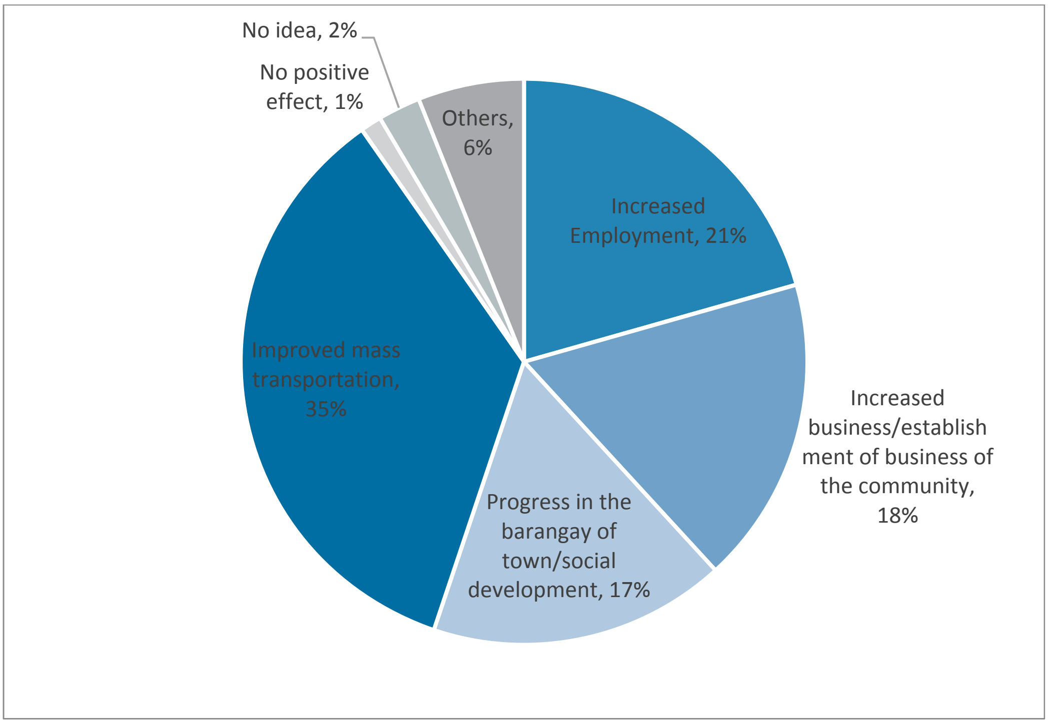

Figure 13 Perceived positive effects of the project from respondents in Barangay SMDP, Parañaque City

Table 5 Perceived positive effects of the project by SMDP respondents

Brgy. San Martin de Porres	Percentage	Count*
Increased Employment	21%	34
Increased business/establishment of business of the community	18%	29
Progress in the barangay of town/social development	17%	28
Improved mass transportation	35%	58
No positive effect	1%	2
No idea	2%	4
Others	6%	10
Total		**165**

*Respondents provided multiple answers

With regard to perception on negative impacts, majority believe that they will lose their property once construction starts (19 %). as well as removal of trees and other vegetation during clearing (12 %), and safety issues (12 %) that may arise both during construction and operation of the subway.

While there were different negative impacts identified, few still did not have any idea (7 %) while other respondents believe that the project would have no negative effect to the community (7 %). Figure 14 and Table 6 presents the perceived negative effects of the project by the respondents in Barangay SMDP.

Table 6 Perceived negative effects of the project by SMDP respondents

Negative effect	Count*	Percentage
Loss of property	99	19%
Loss of access	36	7%
Pollution to water	26	5%
Pollution to air	29	6%
Removal of trees and other vegetation	62	12%
Loss of work and livelihood opportunities	38	7%
Health problems leading to accidents	20	4%
Safety issues	62	12%
No negative effects	37	7%
No idea	37	7%
Others	72	14%
Total	**518**	

* Respondents provided multiple answers

Overall, despite differences in opinion, there was a high acceptance of the project which accounts to 83 percent of the respondents. Sixteen percent were not in favour while one percent provided no answer or was still undecided. Figure 14 presents the acceptance level of the respondents in the barangay.

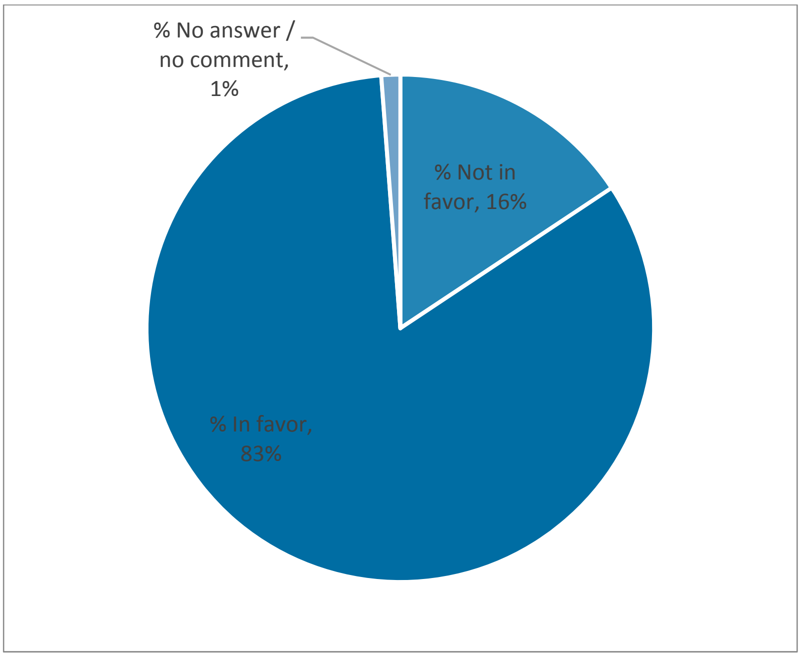

Figure 14 Project acceptance of the respondents in Barangay SMDP, Parañaque City

1.3.3 Summary of the barangays

Basic respondents' profile

There were a total of 281 respondents surveyed in three barangays. Out of the 281, male comprised more than half with 143 respondents (51 %), while female comprised the remaining 138 respondents (49 %). The survey was conducted only to 18 years old and above, with the exception that younger participants can be interviewed only if they were aware or have knowledge of the project. Majority of the respondents (15 % or 44 respondents) were under the age group of 25-29 years old followed by age group 20-24 which accounts to 14 percent (40 respondents). The sex distribution of the participants in the three barangays is presented in Figure 15, while the distribution per age group is presented in a population pyramid in Figure 16.

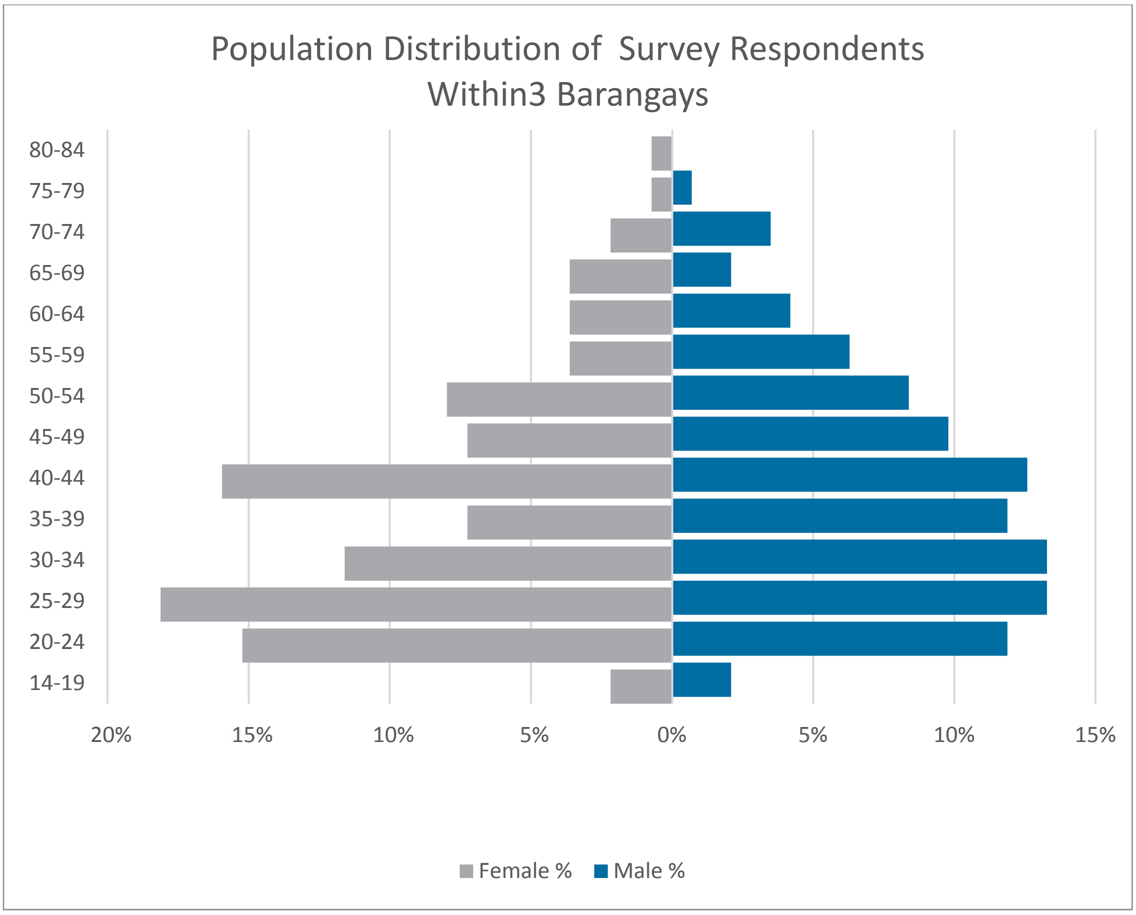

Figure 15 Sex distribution of survey respondents

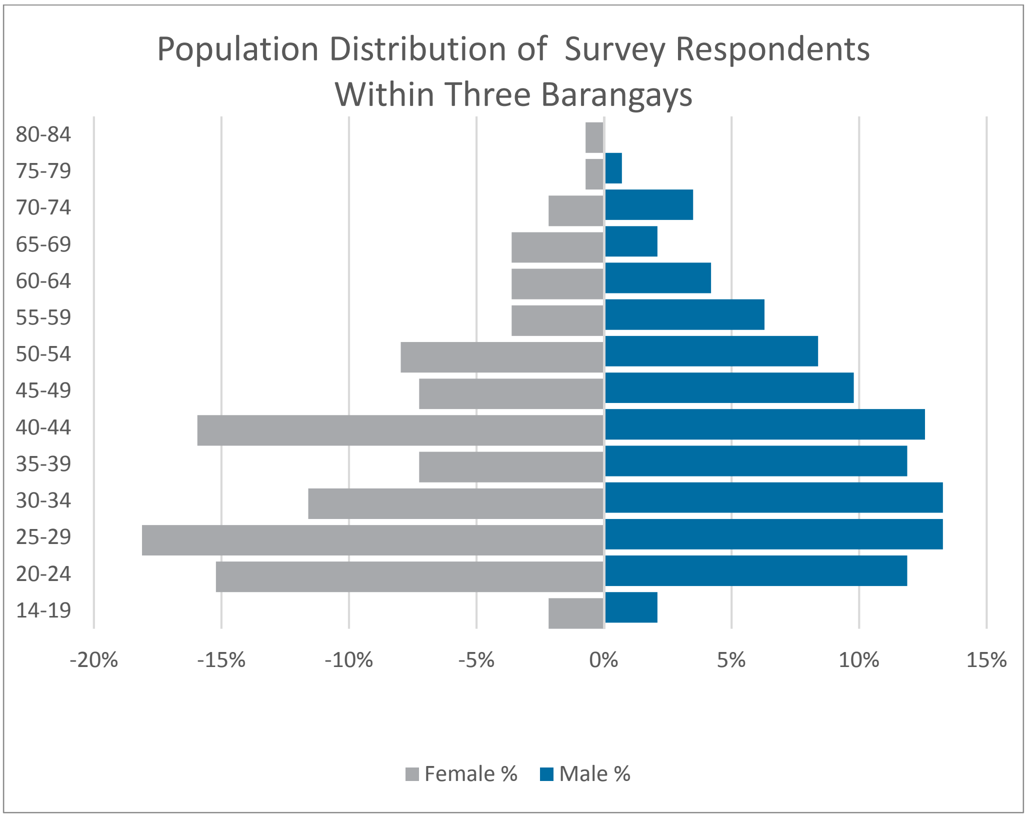

Figure 16 Age distribution of survey respondents

In terms of land tenure, only 271 provided a response and almost half stated that they have been residing in the area for more than 10 years already (49 % or 132 respondents). Others were relatively new to the community and are living only for less than a year (14 % or 38 respondents). In addition, some respondents were residing in the respective barangay for only three to four years (12 % or 33 respondents) or one to two years (10 percent or 27 respondents). Some of these are tenants or those who came to work in the barangay as household or small business helpers. Figure 17 presents the distribution of the respondents based on their length of stay in their respective barangays.

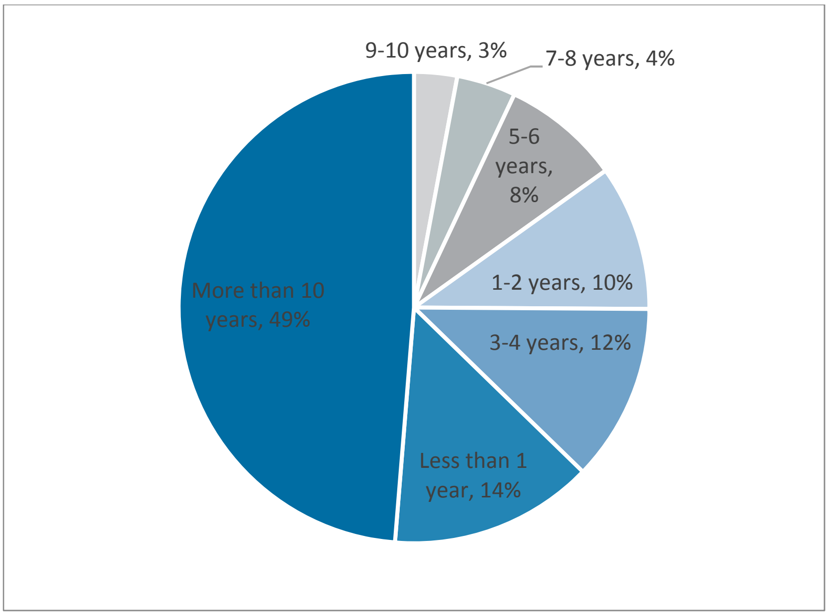

Figure 17 Length of residence

On the employment of the residents, 252 respondents stated that they are currently employed. Majority of them (70 % or 176 respondents) works within the barangay, while the remaining 30 percent (76 respondents) works outside the barangay. The distribution of the workplace location of the respondents is presented in Figure 18.

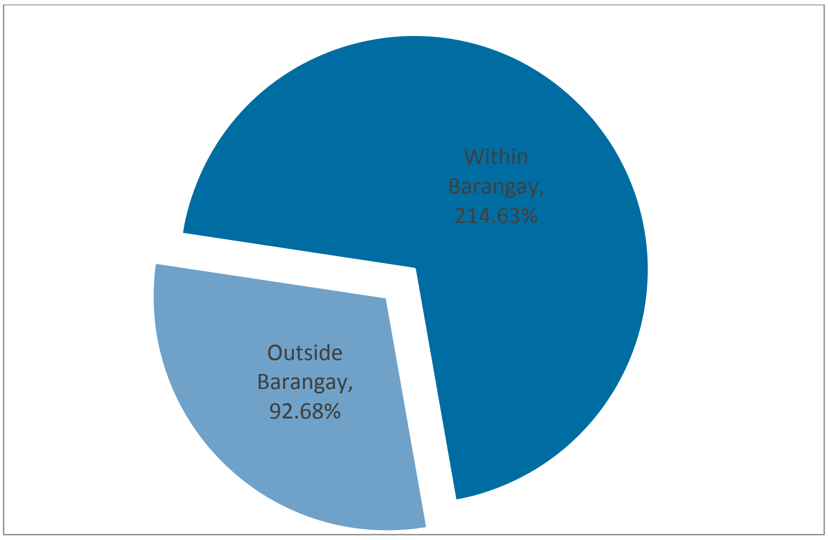

Figure 18 Location of work of the respondents in Barangay SMDP, Parañaque City

Project perception and awareness

The awareness of the respondents were assessed based on questions about their depth of knowledge on the project and source of information. As shown in Figure 19, Most of the respondents (54 %) were aware, while for some who were not (46 %), the enumerators took the interview as an opportunity to discuss and give information on the project. It can be seen in Figure 20 that in all barangays, information was acquired primarily through mass media such as television, newspapers or radio (53 %). Other sources of information were from the government (13 %), or heard from relatives or neighbours (11 %). On the knowledge of the respondents to the additional station in Taguig, Parañaque and Pasay, almost all (81 %) of the respondents did not have any idea on it (Figure 21).

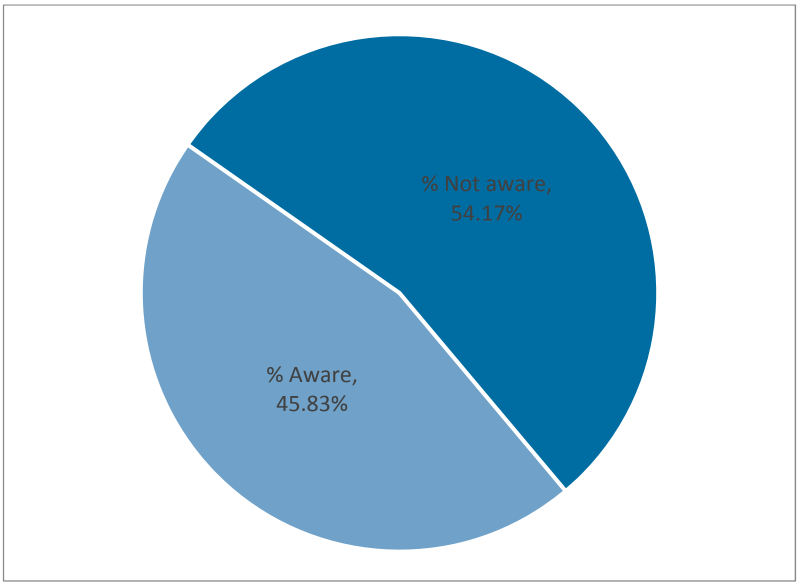

Figure 19 Awareness of the project

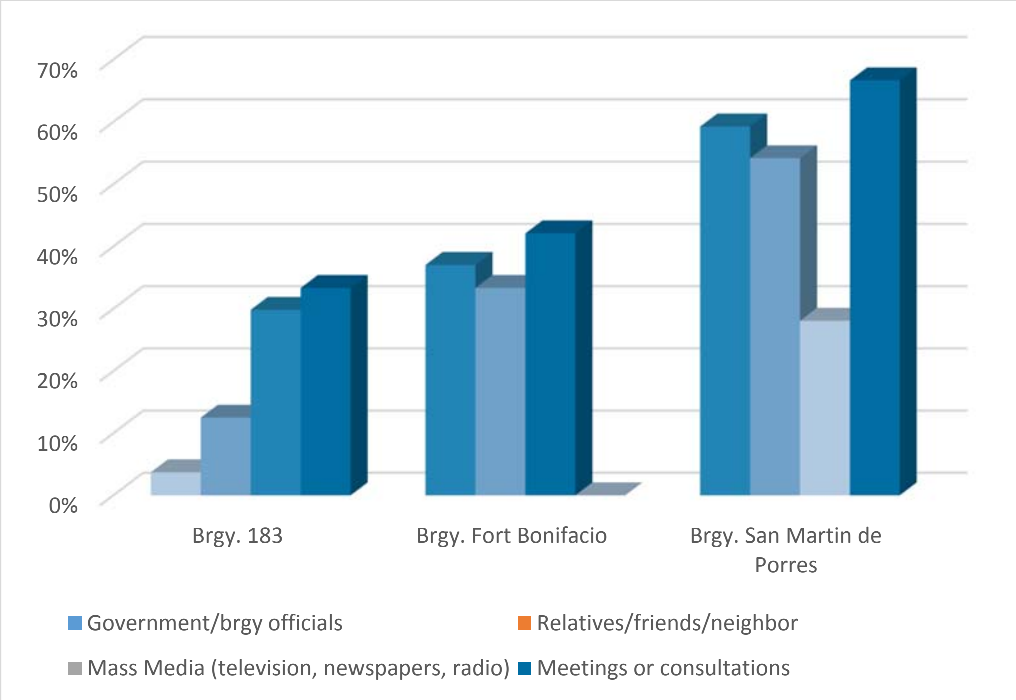

Figure 20 Source of information about the project

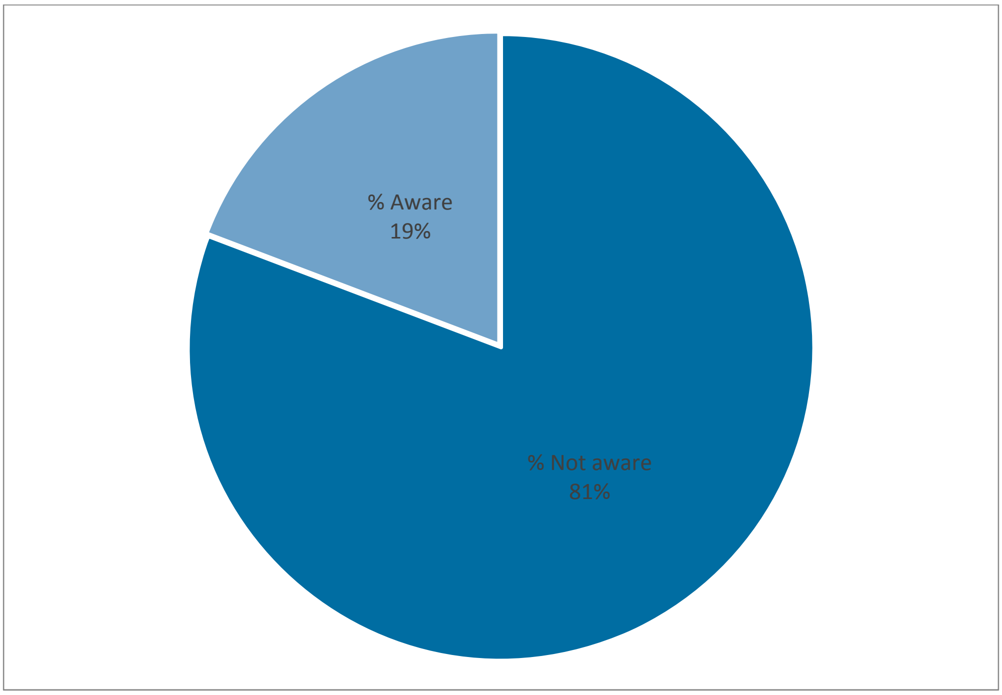

Figure 21 Awareness of residents on the additional stations in Taguig, Parañaque and Pasay

When asked about their satisfaction to the level of information received, more than half stated that they are not satisfied (58 %) and wanted to have additional knowledge about the project. The other 35 percent, meanwhile, was already contented, and the few seven percent either could not decide if they were satisfied or not, or did not respond to the question. Figure 22 shows the distribution of the total satisfaction of respondents in each barangay.

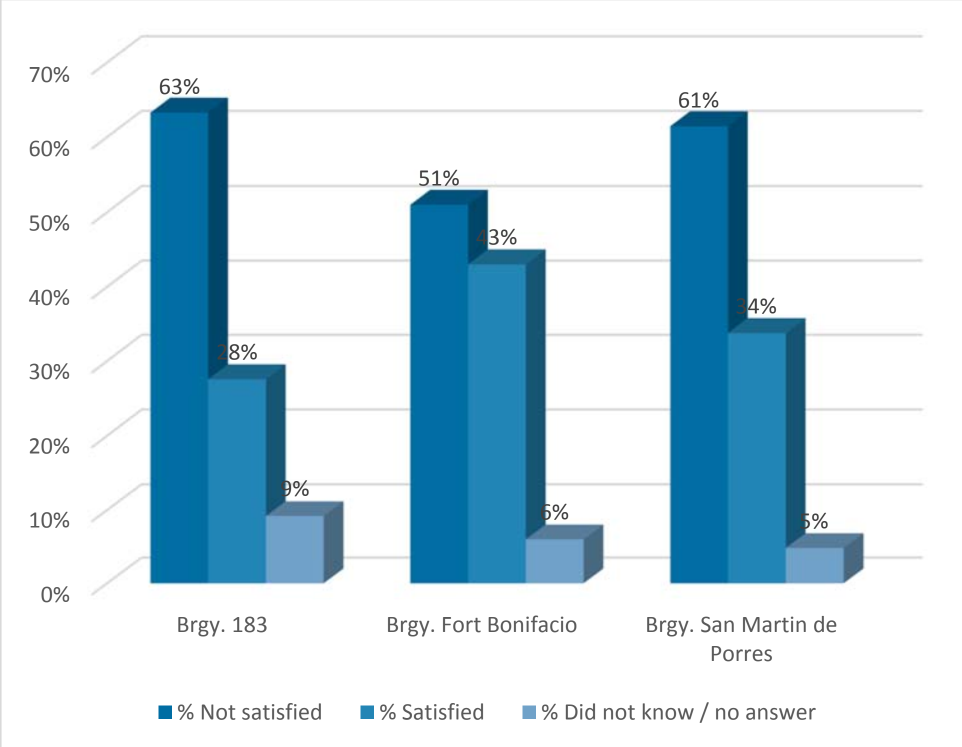

Figure 22 Satisfaction of respondents to the level of information received

In order to determine the perception of the residents on the impacts of the project to the community and environment, the enumerators gave a brief explanation about the general benefits of the project. They had it ranked according to what they think was most important to them, and subsequently identify other impacts. Table 7 presents the perceived positive impacts of the project and its percentage. Most of the respondents from all three barangays believe that the project will improve mass transportation within Metro Manila (35 % or 208 respondents), while others understood that it would increase employment opportunities for the residents (20 % or 117 respondents). Other significant positive impacts identified were establishment of more business within the community (18 %) and social development or progress in the barangay (17 %).

Table 7 Count and percentage of respondents based on their perceived positive impacts of the project

Positive impact	Count*	Percentage
Increased Employment	117	20 %
Increased business/establishment of business of the community	108	18 %
Progress in the barangay of town/social development	97	17 %
Improved mass transportation	208	35 %
No positive effect	6	1 %
No idea	14	2 %
Others (	37	6 %
Total	**587**	

* Respondents provided multiple answers

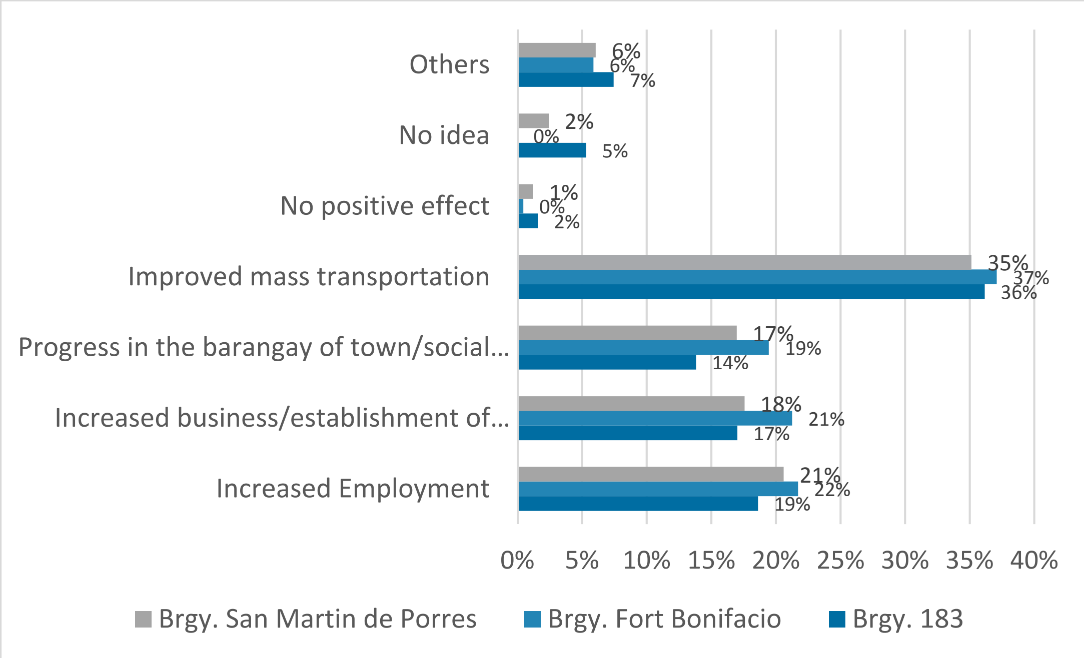

Figure 23 Perceived positive effects of the project from respondents

Aside from the positive impacts, the respondents were also asked to identify the negative effects they think the project would bring about to the environment and community. Among the significantly identified impacts were loss of property (19 %), removal of trees and other vegetation (12 %), and safety issues (12 %). Residents who responded that they would lose their property were those located within the direct impact area based on the conceptual design, which will possibly be cleared for the construction. Majority of them were property owners or small and medium enterprise owners who lease the property (i.e. sari-sari store, canteen, convenience store). In terms of safety issues, some respondents were concerned if transportation underground will be safe since there were concerns about earthquake, particularly "The Big One" in Metro Manila. Figure 24 and Table 8 presents the perceived negative impacts of the project.

Table 8 Count and percentage of respondents based on their perceived negative impacts of the project

Positive impact	Count*	Percentage
Loss of property	99	19%
Loss of access	36	7%
Pollution to water	26	5%
Pollution to air	29	6%
Removal of trees and other vegetation	62	12%
Loss of work and livelihood opportunities	38	7%
Health problems leading to accidents	20	4%
Safety issues	62	12%
No negative effects	37	7%
No idea	37	7%
Others	72	14%
Total	**518**	

* Respondents provided multiple answers

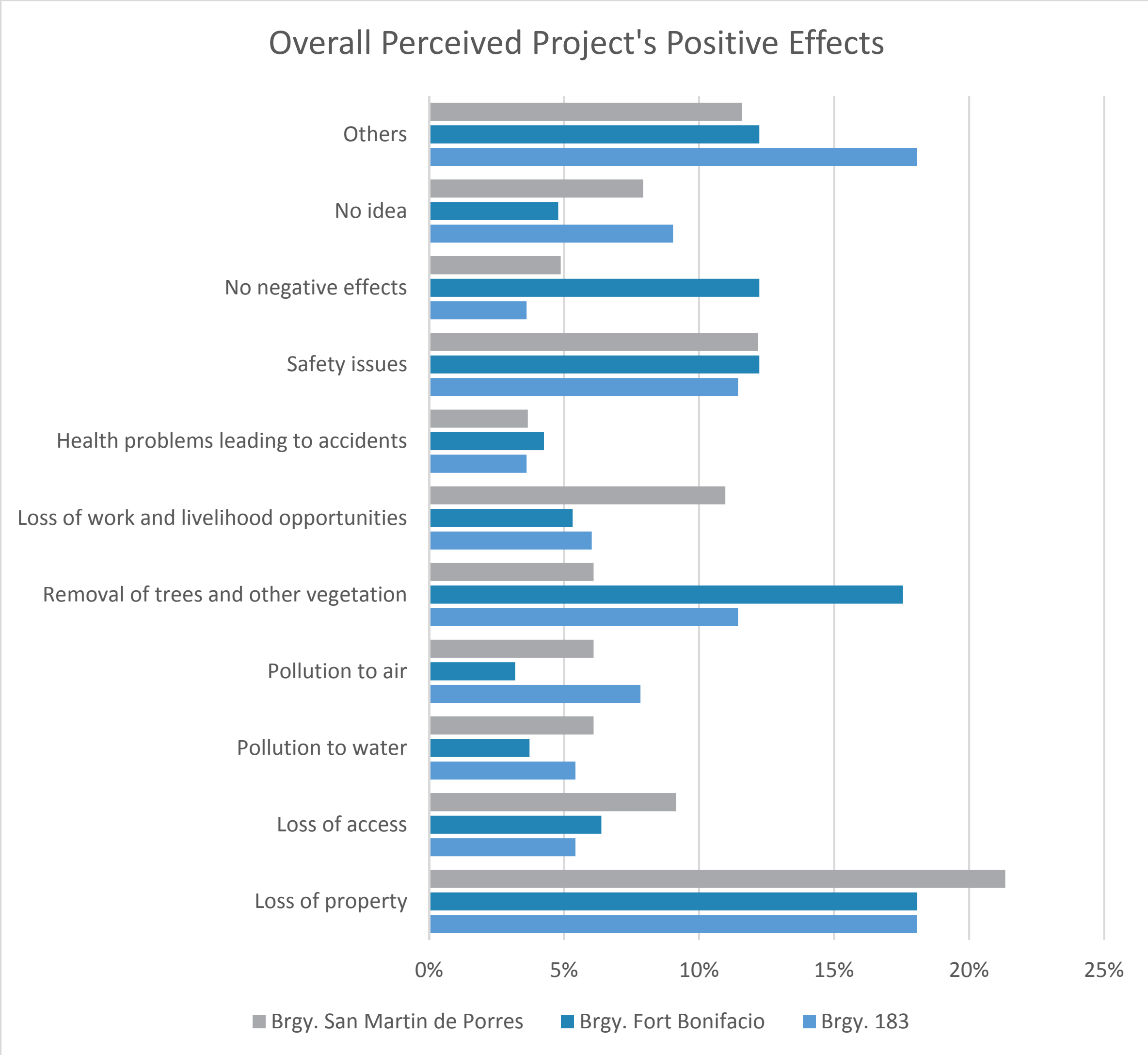

Figure 24 Perceived negative effects of the project

To address these identified negative impacts, the enumerators asked the respondents on how they think it can be mitigated. Several solutions were provided, with the majority of those who responded (12 individuals) stated that the project should avoid areas with numerous trees to prevent removal of trees and vegetation, and replace those trees that will be affected. These responses evidently came from government workers of NAMRIA in Barangay Fort Bonifacio who took in consideration the DENR’s mandates on protection of trees and other natural resources. In addition, 10 of the respondents stated that there should be proper compensation and relocation for those houses and establishments that will be affected by the project. Many from these came from those directly affected whose dwellings and businesses will be possibly cleared for the construction. Other identified mitigation measures are listed in Table 9.

Table 9 Possible mitigation measures for the negative impacts

Mitigation measure	Count*	Percentage
Provision of alternative routes and lessen unnecessary road closure	4	1.9%
Avoid areas with numerous trees and replace affected trees	12	5.8%
Avoid areas with numerous people find alternative areas	1	0.5%
Ensure project transparency to avoid corruption	3	1.5%

Mitigation measure	Count*	Percentage
Proper IEC, coordination and consultation activities with areas to be affected	5	2.4%
Implement earth balling for trees to be affected	1	0.5%
Assurance of the capability of the contractor to implement the project	3	1.5%
Ensure construction materials for the project are of good quality	6	2.9%
Ensure good plans for soil integrity	1	0.5%
Ensure proper compensation and relocation for project affected population	10	4.9%
Ensure good and synergised project planning	6	2.9%
Ensure security and minimise safety risk	6	2.9%
Provision of alternative routes and lessen unnecessary road closure	3	1.5%
Ensure capability of MMSP to geotechnical hazards and flooding	6	2.9%
Full support, cooperation and appreciation of general public for the project	3	1.5%
Ensure MMSP fare affordability	2	1.0%
Ensure regular and effective train maintenance during MMSP operations to avoid existing MRT/LRT problems	2	1.0%
Policy on shifting of business hours	1	0.5%
No idea/no answer	206	100%

Overall, the acceptance in all three barangays is high with 242 respondents (86 %) in favour of the project. Only 30 out of the 242 (11 %) were not in favour, while a minimum of nine respondents (3 %) were still undecided.

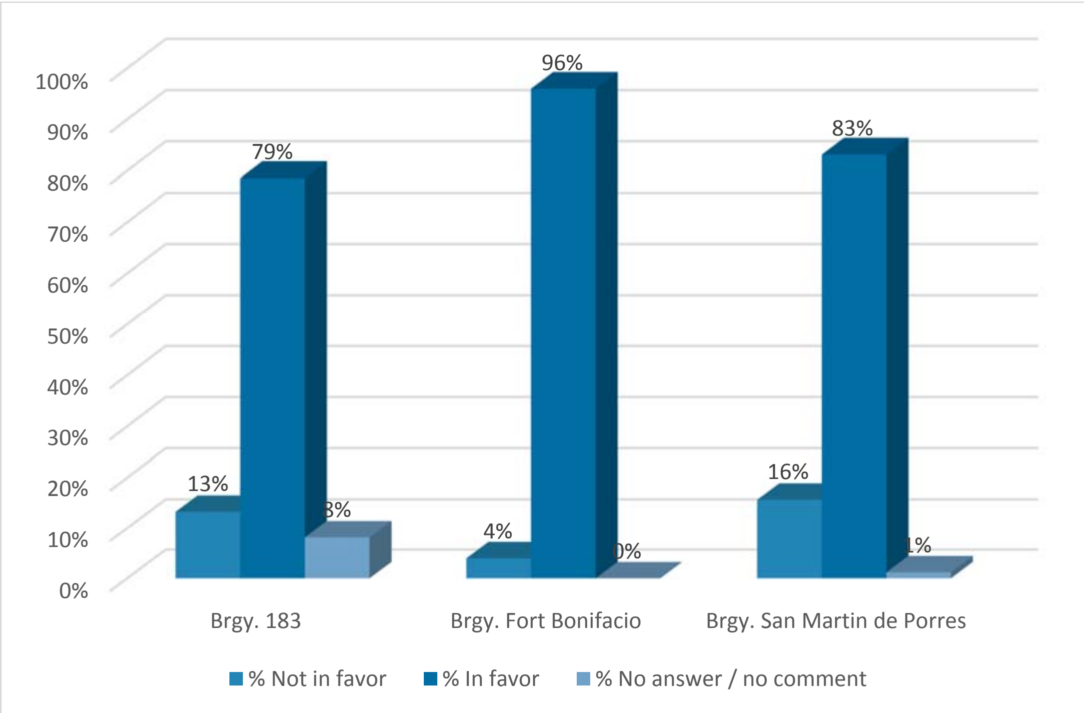

Figure 25 Project acceptance of the respondents in three barangays

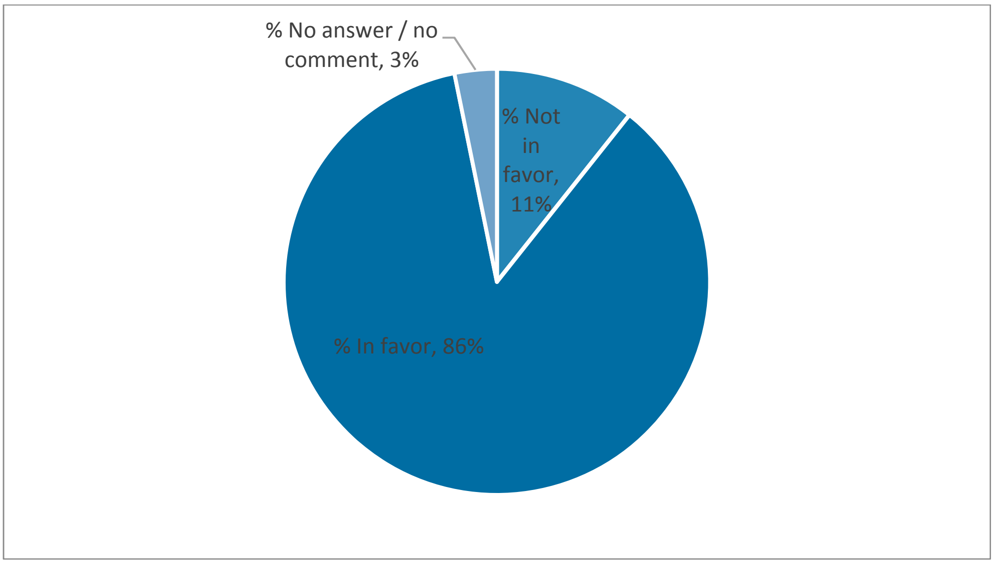

Figure 26 Overall project acceptance of the respondents

Based on the survey results, improved mass transportation for commuter's convenience (20 %), ease up the traffic situation in Metro Manila (18 %), and for the overall development of the country (10 %) were the main reasons why people support and agree to the project. On the other hand, loss of property and relocation issues (15 %) was the only significant reason why people did not express support to the project. The list of these reasons to support and not to support the project is presented in Table 10 and Table 11, respectively.

Table 10 Reasons to support the project

Reasons	Number of response	Percentage
Ease up traffic situation	36	18%
Increased employment and business opportunities	6	3%
Improved mass transport commuter convenience	40	20%
Faster travel time	19	9%
For overall community development	5	2%
For overall development of the country and its economy	21	10%
In favour if no property will be affected	6	3%
No comment / no answer	72	35%
Total	205	100%

Table 11 Reasons not to support the project

Overall	No. of responses	Percentage
Loss of property and relocation issues	14	15 %
Loss of access	5	5 %
Possibility of geohazard risks	2	2 %
Loss of business/livelihood	2	2 %
Noise pollution	1	1 %
No comment / no answer	70	74 %
Total	94	100 %

Survey Code :

Metro Manila Subway Project – ECC Amendment

PERCEPTION SURVEY

Date:

Location (where the interview was conducted):
Purok/Sitio: ____________________
Barangay: ____________________
____
____

Time started: ____________________
Time ended: ____________________
Interviewer's: ____________________
Name & ____________________
Signature ____________________

1. **Respondent's profile/Tungkol sa "Respondent"**

1.1. Name/*Pangalan* (optional)

____

1.2. Address/*Tirahan* (optional)

____

1.3. How long have you been living in your current address/*Gaano katagal na kayong naninirahan dito*?

1 ☐ Less than 1 year
2 ☐ 1-2 years
3 ☐ 3-4 years
4 ☐ 5-6 years
5 ☐ 7-8 years
6 ☐ 9-10 years
7 ☐ More than 10 years

1.4. Age /*Edad* ___________

1.5. Sex/*Kasarian*

1 ☐ Male/***Lalaki*** 2 ☐ Female/***Babae***

1.6. Place of work/*Lugar ng trabaho*

1 ☐ Within Barangay/***Sa loob ng Barangay***
2 ☐ Outside Barangay/***Sa labas ng Barangay***
Where/**Saan**? *(name of barangay, town, province)*

____

2. **Project awareness/*Kaalaman tungkol sa Proyekto***

2.1. **Are you aware of the Metro Manila Subway Project (MMSP)/*Alam niyo ba na may itatayong Metro Manila Subway Project (MMSP)?***

1 ☐ Yes 2 ☐ No

2.2. If yes, where did you get the information (source of information)/Kung oo, *saan galing ang impormasyong ito*?

1 ☐ Government/ barangay officials
2 ☐ Relatives/ friends/ neighbor
3 ☐ Mass media (television, newspapers, radio)
4 ☐ Meetings or consultations (PLEASE SPECIFY)
____
5 ☐ Others (PLEASE SPECIFY)
____

2.3. In your opinion, what is the primary purpose/objective/goal why the Subway Project is going to be implemented/*Sa inyong palagay, ano ang pangunahing layunin/hangarin/dahilan bakit itatayo ang Subway Project*? (Please rank accordingly: 1 to 3, with 1 as the highest)

☐ To reduce the use of personal car within the city
☐ To ease up traffic in Metro Manila
☐ To reduce travel time between cities

☐ Others (PLEASE SPECIFY)

____

____

____

2.4. **Are you aware of the specific proposed locations of the Project components (i.e. stations, underground alignment, depot, etc)/*Alam ba ninyo ang mga lugar kung saan itatayo ang mga iba't ibang bahagi ng MMSP?***

1 ☐ Yes 2 ☐ No

2.5. **If yes, how did you know about the specific proposed locations (source of information)/*Paano ninyo nalaman ang tungkol sa mga ito?***

1 ☐ Government/ barangay officials.
2 ☐ Relatives/ friends/ neighbor
3 ☐ Mass media (television, newspapers, radio)
4 ☐ Meetings or consultation (pls. specify title of meeting consultation and when)
____
5 ☐ Others (pls. specify.) ____

2.6. Are you aware that the MMSP is adding stations in sections of Taguig, Paranaque and Pasay/ *Alam niyo ba na magdadagdag ng mga istasyon sa Taguig, Paranaque at Pasay*?

1 ☐ Yes 2 ☐ No

2.7. **At this time, are you already satisfied with the level of information that you have about the Project/*Sa ngayon, sapat na ba ang mga kaalamang nakuha ninyo tungkol sa Proyekto?***

1 ☐ Yes 2 ☐ No

If No, what information do you hope to know more about/***Kung hindi, ano pang mga impormasyon ang nais niyong malaman? (top 5):***
a.____
b. ____
c. ____
d. ____
e. ____

2.8. In your opinion, what are the positive effects of the Subway Project to the community/*Sa inyong palagay*, a*nu-ano ang mga positibong pakinabang na maibabahagi o maibibigay ng Subway Project sa inyong komunidad?* (Check all possible answers)

1 ☐ Increased employment
2 ☐ Increased business/establishment of business of the community
3 ☐ Progress in barangay or town/social development
4 ☐ Improved mass transportation/***Mas maayos na pampublikong transportasyon***
5 ☐ No positive effect/***Walang positibong epekto***
6 ☐ No idea/***Walang sapat na kaalaman***
7 ☐ Others (PLEASE SPECIFY)
____

2.9. Do you have any recommendations or suggestions to enhance the benefits of the Project/*Meron ba kayong gustong imungkahi upang lalo pang mapabuti o maparami ang mga pakinabang na makukuha sa Proyekto?*

____
____

2.10. **In your opinion, what are the negative effects that the Subway Project will bring?/*Sa inyong palagay, ano ang mga hindi magagandang bagay na maidudulot ng Subway Project?***

1 ☐ Loss of property

2 ☐ Loss of access
3 ☐ Pollution to water
4 ☐ Pollution to air
5 ☐ Removal of trees and other vegetation
6 ☐ Loss of work and livelihood opportunities
7 ☐ Health problems leading to accidents
8 ☐ Safety issues
9 ☐ No negative effect
10 ☐ No idea.
11 ☐ Others (PLEASE SPECIFY)
____

2.11. Can the negative effects be minimized or resolved? How?/*Paano mababawasan o tuluyang maresolba ang mga negatibong epekto* ?

____
____
____

2.12.* Are you in favor of the construction of the sections of the Project in your area/*Sang-ayon po ba kayo na maitayo ang bahagi ng proyekto sa inyong lugar?

[ ] Yes [ ] No

Why do you say so? ***Bakit po***?

____

____

(Mention the respondent's perception of the purpose of the project Question#2.3)

2.13. What do you think would be another alternative/substitute to the Subway Project or other methods so that the same primary purpose/objective/goal in question 2.3 will be achieved/attained?/ *May naiisip pa po ba kayong ibang proyekto maliban sa Subway Project o iba pang mga paraan upang makamtam/matamo ang pangunahing layunin/hangarin/dahilan sa 2.3* (if not Subway, then what project?/kung hindi Subway, anong proyekto?)

____

____

MARAMING SALAMAT PO!

Enumerator Notes, if any:

Appendices

Appendix A - (Photo-documentation)

DOTr's Engr. Jim Benidict Petate (green) during an interview with a resident of Barangay 183, Villamor, Pasay City

For. Beo Raven Bensurto of DOTr (blue) conducting a survey on residents of Barangay 183, Villamor, Pasay City

For. Marc Vico Pauig of GHD (left most) and For. Maria Luisa Regodon of GHD (lower left) conducting interviews to two tricyle drivers at Barangay Fort Bonifacio, Taguig City

For. Bea Roselle Alvarez (GHD) discussing the project to government staff of NAMRIA at the NAMRIA office in Barangay Fort Bonifacio, Taguig City

For. Marc Vico Pauig interviewing one Police officer trainee and two Army officer trainees in Barangay Fort Bonifacio, Taguig City

For. Maria Luisa Regodon (GHD) on interview with a staff of 7-11 convenience store at Barangay San Martin de Porres, Parañaque City

Debriefing meeting of the enumerators at GHD Office in Makati

Appendix B - Perception survey questionnaire

Appendix C - (Public Scoping Document)

Public scoping documents

Proposed invitees for the public scoping

Stakeholder/organisation		Head	Position
DENR-EMB NCR		Jacqueline A. Caancan	Regional Director
LGU Department Heads			
	Office of the Mayor - Taguig	Lino Cayetano	Mayor
	Office of the Mayor - Pasay	Antonino Calixto	Mayor
	Office of the Mayor - Paranaque	Edwin Olivarez	Mayor
	City Planning and Development Office (CPDO) – Paranaque	Engr. Benigno Rivera	CPDO
	City Planning and Development Office (CPDO) – Pasay	Engr. Merlita Lagmay	CPDO
	City Planning and Development Office (CPDO) - Taguig	Arch. Hilda Candelario	CPDO
Stakeholder/organisation		Head	Position
	Megaworld Corporation		Administrator
	Church of St Therese Child of Jesus (Pasay)	Msgr. Albert Sonco	Administrator
	Church of St Nazarene (Paranaque)		Administrator
	United Paranaque Subdivision 1 Homeowners Association	Eugene Babia	President
	Makati South Hills Subdivision	Robert Palisoc	President
	Upper West McKinley Subdivision		Board of Directors
	Airmen Village (Pasay)		Board of Directors
Barangay			
	Barangay San Martin De Porres (Paranaque)	Michael Thor Singson	Barangay Chairman
	Barangay 183 (Pasay)	Ruth Cortez	Barangay Chairman
	Barangay Fort Bonifacio (Taguig)	Jorge Daniel Bacobo	Barangay Chairman
	Barangay Western Bicutan (Taguig)	Perlita Carmen	Barangay Chairman
	Women's Organisation		
	Dr. Arcadio Santos National Highschool	Concepcion C. Bernaldez	Principal
	Farmer's Association		
	Senior Citizen's Association		
	Youth		
	General public		

Draft Invitation letter

Date

Name
Designation
Address

Dear ___________

Subject: Public Scoping for the additional segment of the Metro Manila Subway Project (MMSP)

The Department of Transportation is applying for the amendment of its Environmental Compliance Certificate (ECC) to the Department of Environment and Natural Resources (DENR) Environmental Management Bureau (EMB) – Central Office for the additional segment of the Metro Manila Subway Project in the cities of Taguig, Pasay, and Paranaque.

An Information, Education and Communication (IEC) activity was conducted from the month of April and May 2013, to inform various stakeholder, especially the LGUs and heads of the concerned organisations, about the updates of the project and the upcoming environmental impact assessment (EIA) activities. In line with this proposed development, we would like to invite you to attend the Public Scoping scheduled on **(date)**, **(time)**, and to be held at **(venue)**.

The Public Scoping will be conducted in compliance with the Philippine Environmental Impact Statement System (PEISS) in relation to DOTr's application for the ECC amendment. Representatives from DOTr will present the proposed project components and activities. Project stakeholders within the concerned local communities will be given the opportunity to express freely their issues, concerns or questions about the project in order to identify the most significant issues and impacts of the proposed project that need to be addressed in the EIA for the project.

For more details, you may contact the EMB Central Office at **(contact details)**.

Thank you and we look forward to your presence and participation.

Sincerely yours,

Engr. Esperanza Sajul
Chief, EIAMD
DENR EMB– Central
Office

FOCUS GROUP DISCUSSION/ KEY INFORMANT INTERVIEW

METRO MANILA SUBWAY PROJECT

ATTENDANCE SHEET

	Complete Name	Barangay/Office/Org	Position	Contact number/ E-mail address	Signature
1	DANICA M. SOLIS	AECOM	APM / ENVI. SU.	09175146924 / danielle.solis@aecom.com	
2	Lance Ando	AECOM	Intern	09179626828 / lance.ando@[illegible]	
3	Miko Tendero	AECOM	Intern	0917599 5617	
4	WILLY PACARCA	"	Consultant	0922-824-1571	
5	PO1 DONNIE B LUCHAGAN PN	BNS, PN	Asst. CMAA, SPA, BNS	0995-871-8831	
6	CDR ERIC ANTHONY G DESUASIDO PN	HQ BNS	Deputy Cmdr	09178379466	
7	LCDR RENOIR D HUEVOS PN	BNS, PN	CO, PEU BNS	09184339007	
8	IS1 Rolando S Nieve PN	BNS, PN	ACTING POIC, BNS2	09173288547	
9					
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FOCUS GROUP DISCUSSION/ KEY INFORMANT INTERVIEW
15 July 2019

Barangays San Martin de Porres

- Why the project avoiding the ARCA south which has huge open spaces? Why you keep on pushing it to our area which has lots of properties and residents to be affected? Is it because the government protecting the Ayala (arca south is owned by the Ayala)
- The issue is the land acquisition, of course we are in favor in the subway project but the issue is you were putting it in our area which we will be replace unlike in the arca south or in the government area along bicutan that has a hectares of spaces.
- Most of the residents are already seniors or retirees. ¾ are formal settlers and ¼ are informal settlers.
- Little objection before, but now in the realignment there's a strong objection because, first, what will happen after the construction of subway will the land return to the residents? Secondly, why large amount of land were needed if it is only the station will be constructed? Less opposition will be receive by the project if the land area will return to them after construction instead of putting plaza or make it a commercial area. a
- Another suggestion, in the tenement area in which already beyond in its life capacity, so that is a good opportunity of the government to get it.

Fort Bonifacio

- There were no objections in Fort Bonifacio as they were no high impact in their area. The only possible issues are the amenities and inconvenience.
- Mckinley west was mentioned as they were not cooperating on the project, secretary and kagawad of Fort Bonifacio, confirmed that Mckinley west is very hard to talk to, they are not cooperative even For Bonifacio captain having hard time in communicating with the subdivision, as such the barangay ask for them to put pipe underground but they were not allowed because visually not good.

Bonifacio Naval Station

- BNS have no objection in the project, however, just make sure that relocation site will be provided and the site should replicate the former housing area.
- No problem with construction, but there were some risk with operation such as terrorism in subway to get to base or using of bombs in tunnel.
- There was Technical Working Group (TWG) in which handling the coordination and preparation, BNS will only put into action during the construction.
- Housing units for officers – 30 units were occupied out of 84
- There were 200 houses for officers – 2 families per house.
- Along with the construction of senate building care of BCDA the preparation and construction of the Metro Manila Subway Project.

FOCUS GROUP DISCUSSION/ KEY INFORMANT INTERVIEW

METRO MANILA SUBWAY PROJECT

ATTENDANCE SHEET

	Complete Name	Barangay/Office/Org	Position	Contact number/ E-mail address	Signature
1	DANICA M. SOLIS	AECOM	APM / ENVI SCI.	09175146924	
2	MIGHOR SAMSON	SAN MARTIN DE PORRES	BRGY. CAPTAIN		
3	Teresa Gurrea	Fort Bonifacio	Brgy Secretary		
4	Nick ASYAO	"	BRGY. KAG.	09178741100	
5	Vilma V. Padua	Fort Bonifacio	Brgy Kag	09153039526	
6	Lance Asido	AECOM	Intern	09186268928	
7	Martin Tendero	AECOM	Intern	09175195617	
8					
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Annex ES.1-3

RROW/Lease Agreement

ROWA, Resettlement, Environment, and Livelihood Updates

As of July 25, 2019

I. RIGHT-OF-WAY ACQUISITION (ROWA)

Affected Lots and Structures

Section	Parcels of Land	Landowners	Structures
Depot	404	276	639
Quirino Highway	30	20	25
Tandang Sora	54	40	45
North Avenue	2	2	5
TOTAL	**490**	**338**	**714**

Major ROWA activities

Activity	Target Timeline
Stakeholder Consultation Meeting for affected Land Owners for the submission of the Owner's Copy of Title and signing of revised DOAS	July 29, 2019
Preparation of Letter Offers and Deed of Sale (DOS/DOAS) ➢ Depot ➢ PO stations	 May-June July
Distribution of Letter Offers and DOS/DOAS ➢ Depot ➢ PO Stations	 June-July August
Conduct of DMS for North Avenue: Veterans Memorial Medical Center	August 5-9, 2019
Completion of documents for submission to Finance and Management for processing of payments ➢ Batch 1: Vacant lots in the Ugong Depot	August-September

II. RESETTLEMENT

Summary of PAPs for relocation and rental assistance

	No. of PAPs
For Relocation	183
For Rental Assistance	328
TOTAL	**511**

Major Resettlement activities

Activity	Target timeline
RAP Implementation Management Committee Establishment	First week of August
Informal Settler Families (ISFs) Application for Relocation	
➢ Coordination meeting with National Housing Authority (NHA) and Housing and Resettlement Office re: workplan for the upcoming activities	August 5

Activity	Target timeline
➢ NHA- Tagging and Census Validation (TCV) or Verification	August 13-16, 2019
➢ NHA Approved Master List	September
Preparation of ISFs for relocation	
➢ NHA and LGU Unit Allocation/Lot Raffle	August
➢ PAFs Orientation on actual transfer, schedule, system and process.	August
Distribution of Other Entitlements	September
Actual Relocation	September
Post-relocation monitoring and assistance	October

III. LIVELIHOOD

Major Livelihood Restoration Activities

Activity	Target Timeline
Data completion and categorization through validation for Livelihood Restoration	August
Development of Livelihood and Income Restoration Program menu	
▪ Exploratory meeting with livelihood and relevant offices/institutions for available skills training/ job placement/ business financing services	August
▪ Exploratory meeting with LGU/RIMC, and the JV? For hiring of affected PAPs during construction	August
Processing of temporary closure of businesses or transfer of businesses	August
Completion of requirements for the processing of entitlements	August
Distribution of Entitlements	September onwards
Conduct of trainings and other livelihood programs available for businesses and affected employees	4^{th} quarter 2019 onwards
Conduct of job fair (hiring of skilled workers for construction related jobs)	4^{th} quarter 2019
Processing of RFOs; assistance in seeking capitalization for micro-businesses	4^{th} quarter 2019 onwards
Monitoring of PAPs and businesses	2020

Annex 2.1-1

List of Flora Species Found during the MMSP surveys for the 2017 EIS

Appendix A List of recorded flora species for the surveyed original proposed stations of the Metro Manila Subway Project (EIS 2017)

Family	Species	Common name	Uses
ACANTHACEAE	*Asystasia gangetica*	Zamboangenita (Tag.)	ornamental
ACANTHACEAE	*Ruellia tuberosa*	Meadow wood (Engl.)	ornamental
ACANTHACEAE	*Sanchezia speciosa*	Sanchezia (Engl.)	ornamental
AGAVACEAE	*Agave tequilana*	Blue agave (Engl.)	ornamental
ALOACEAE	*Aloe vera*	Sabila (Tag.)	medicinal, ornamental
AMARANTHACEAE	*Alternathera sessilis*	Butones-butonesan (Tag.)	edible leaves; medicinal
AMARANTHACEAE	*Amaranthus spinosus*	Kolitis (Tag.)	edible leaves; medicinal
AMARANTHACEAE	*Celosia argentea*	Silver cockscomb (Engl.)	ornamental; edible leaves
AMARYLLIDACEAE	*Crinum amabile*	Spider lily (Engl.)	ornamental
AMARYLLIDACEAE	*Crinum asiaticum*	Bakong (Tag.)	ornamental
ANACARDIACEAE	*Mangifera indica*	Mangga (Ig., Ilk., Tag.)	edible fruit; medicinal
ANNONACEAE	*Annona muricata*	Guyabano (Tag.)	fruit edible
ANNONACEAE	*Annona squamosa*	Ates (Fil.)	edible fruit
ANNONACEAE	*Polyalthia longifolia*	India lanutan (Fil.)	ornamental
APOCYNACEAE	*Alstonia macrophylla*	Batino (Tag.)	wood for construction
APOCYNACEAE	*Catharansus roseus*	Tsitsirika (Tag.)	ornamental; medicinal
APOCYNACEAE	*Plumeria acuminata*	Kalachuche (Aztec-Fil)	ornamental; medicinal
APOCYNACEAE	*Tabernaemontana pandacaqui*	Pandakaki (Tag.)	ornamental; medicinal
APOCYNACEAE	*Thevetia peruviana*	Campanilla (Sp.)	ornamental
APOCYNACEAE	*Wrightia pubescens*	Laniti (Tag.)	wood used for carving
APOCYNACEAE	*Wrightia religiosa*	Sacred buddhist (Engl.)	ornamental
ARACEAE	*Colocasia esculenta*	Gabi (Tag.)	edible corns
ARACEAE	*Dieffenbachia amoena*	Dumb cane (Engl.)	ornamental
ARACEAE	*Homalomena rubescens*		ornamental; medicinal
ARACEAE	*Xanthosoma sagittifolium*		ornamental
ARACEAE	*Zamioculcas zamiifolia*	Arum fern (Engl.)	ornamental
ARALIACEAE	*Polyscias fruticosa*	Parsley panax (Engl.)	ornamental
ARALIACEAE	*Polyscias guilfoylei*	Papua (Engl.)	ornamental
ARALIACEAE	*Schefflera odorata*	Galamayamo (Tag.)	ornamental; medicinal
ARECACEAE	*Adonidia merrillii*	Bunga de jolo (Tag.)	ornamental
ARECACEAE	*Arenga pinnata*	Kaong (Tag.)	fruit edible; ornamental
ARECACEAE	*Caryota cumingii*	Takipan (Tag.)	palm pith edible; ornamental
ARECACEAE	*Cocos nucifera*	Niyog (Tag.)	fruit edible; medicinal
ARECACEAE	*Cyrtostachys renda*	Red palm (Engl.)	ornamental
ARECACEAE	*Dypsis lutescens*	Butterfly palm (Engl.)	ornamental
ARECACEAE	*Elaeis guineensis*	Red palm (Engl.)	ornamental
ARECACEAE	*Hyophorbe lagenicaulis*	Champagne palm (Engl.)	ornamental
ARECACEAE	*Phoenix roebelenii*	Pygmy date palm (Engl.)	ornamental
ARECACEAE	*Ptychosperma macarthurii*	McArthur palm (Engl.)	ornamental

Family	Species	Common name	Uses
ARECACEAE	*Rhapis excelsa*	Lady palm	ornamental
ARECACEAE	*Roystonea regia*	Royal palm (Engl.)	ornamental
ARECACEAE	*Wodyetia bifurcata*	Foxtail palm (Engl.)	ornamental; landscaping
ASPARAGACEAE	*Asparagus densiflorus*	Foxtail asparagus (Engl.)	ornamental
ASPARAGACEAE	*Cordyline fruticosa*	Tungkod pari (Tag.)	ornamental
ASPARAGACEAE	*Dracaena angustifolia*	Malasambal (Tag.)	ornamental
ASPARAGACEAE	*Dracaena fragrans*	Fortune plant (Engl.)	ornamental
ASPARAGACEAE	*Dracaena surculosa*	Spotted dracaena (Engl.)	ornamental
ASPARAGACEAE	*Sanseveria trifasciata*	Buntot tigre (Tag.)	ornamental; medicinal
ASTERACEAE	*Artemisia scoparia*	Wormwood (Engl.)	ornamental; medicinal
ASTERACEAE	*Bidens pilosus*	Buburtak (Tag.)	medicinal
ASTERACEAE	*Blumea balsamifera*	Sambong (Tag.)	medicinal
ASTERACEAE	*Chromolaena odorata*	Hagonoy (Tag.)	medicinal
ASTERACEAE	*Conyza sumatrensis*	Atipukpuk (Tag.)	medicinal
ASTERACEAE	*Cyanthillium cinereum*	Agas-moro (Tag.)	medicinal
ASTERACEAE	*Mikania cordata*	Ooko (Tag.)	medicinal
ASTERACEAE	*Pseudoelephantopus spicatus*	Dilang baka (Tag.)	medicinal
ASTERACEAE	*Sphagneticola trilobata*	Wedelia (Engl.)	ornamental
ASTERACEAE	*Tridax procumbens*	Tridax daisy (Engl.)	medicinal
BASELLACEAE	*Basella alba*	Alugbati (Tag.)	leaves edible
BIGNONIACEAE	*Spathodea campanulata*	African Tulip (Engl.)	ornamental
BIGNONIACEAE	*Spondias purpurea*	Siniguelas (Sp., Fil.)	edible fruit
BIGNONIACEAE	*Tabebuia pallida*	Cuban pink trumpet	ornamental
BORAGINACEAE	*Ehretia microphylla*	Tsaang gubat (Tag.)	medicinal
BORAGINACEAE	*Heliotropium indicum*	Tropa ng elepante (Tag.)	medicinal
CACTACEAE	*Pereskia aculeata*	Barbados gooseberry (Engl.)	fruit edible, ornamental
CALOPHYLLACEAE	*Calophyllum inophyllum*	Palo maria (Tag.)	wood for construction; ornamental
CANNACEAE	*Canna indica*	Bandera espanola (Sp.)	ornamental; medicinal
CANNACEAE	*Trema orientalis*	Anabiong (Tag.)	firewood
CAPPARIDACEAE	*Cleome rutidosperma*	Seru-walai (Tag.)	medicinal
CARICACEAE	*Carica papaya*	Papaya (Tag.)	edible fruit
COMBRETACEAE	*Bucida molineti*	Dwarf Geometry tree (Engl.)	ornamental, landscaping
COMBRETACEAE	*Quisqualis indica*	Niyog-niyogan (Tag.)	ornamental; seeds anthelmintic
COMBRETACEAE	*Terminalia catappa*	Talisai (Bag., Bik., Bis.,Pamp.)	edible fruit kernel
COMMELINACEAE	*Commelina diffusa*	Alikbangon (Tag.)	medicinal
COMMELINACEAE	*Tradescantia spathacea*	Rhoeo (Engl.)	ornamental; medicinal
CONVOLVULACEAE	*Ipomoea batatas*	Kamote (Tag.)	edible tuber & leaves
CONVOLVULACEAE	*Merremia sp.*		
CUCURBITACEAE	*Coccinia grandis*	Scarlet gourd (Engl.)	medicinal
CYPERACEAE	*Cyperus kyllingia*		medicinal
DIOSCOREACEAE	*Dioscorea esculenta*	Tugi (Tag.)	tubers edible
EBENACEAE	*Diospyros blancoi*	Mabolo (Tag.)	wood for furniture, fruit edible

Family	Species	Common name	Uses
EUPHORBIACEAE	*Croton tiglium*	Tuba (Tag.)	botanical pesticide
EUPHORBIACEAE	*Euphorbia hirta*	Tawa-tawa (Tag.)	medicinal
EUPHORBIACEAE	*Euphorbia milii*	Crown of thorns (Engl.)	ornamental
EUPHORBIACEAE	*Euphorbia tirucalli*	Milk bush (Engl.)	ornamental; medicinal
EUPHORBIACEAE	*Excoecaria cochinchinensis*	Variegated blindness tree (Engl.)	ornamental
EUPHORBIACEAE	*Jatropha curcas*	Tubang bakod (Fil.)	boundary plantings, biodiesel
EUPHORBIACEAE	*Jatropha gossypifolia*	Tubang morado (Tag.)	ornamental
EUPHORBIACEAE	*Jatropha integerrima*	Peregrina (Sp.)	ornamental
EUPHORBIACEAE	*Macaranga tanarius*	Binunga (Tag.)	pioneer tree for restoration
EUPHORBIACEAE	*Manihot esculenta*	Cassava (Engl.)	edible tuber
EUPHORBIACEAE	*Melanolepis multiglandulosa*	Alim (Tag.)	medicinal
EUPHORBIACEAE	*Pedilanthus tithymaloides*	Luhang dalaga (Tag.)	ornamental
FABACEAE	*Acacia auriculiformis*	Auri (Tag.)	wood for light construction
FABACEAE	*Acacia mangium*	Mangium (Tag.)	timber for light construction
FABACEAE	*Albizia saman*	Akasya (Tag.)	timber; wood carving
FABACEAE	*Bauhinia purpurea*	Fringon -morado (Sp.)	charcoal
FABACEAE	*Caesalpinia pulcherrima*	Caballero (Tag.)	ornamental
FABACEAE	*Cassia fistula*	Tropical golden shower (Engl.)	ornamental; medicinal
FABACEAE	*Centrosema pubescens*	Pukinggan (Tag.)	fodder
FABACEAE	*Delonix regia*	Fire tree (Engl.)	ornamental
FABACEAE	*Gliricidia sepium*	Madre de cacao (Sp.)	firewood, charcoal
FABACEAE	*Leucaena leucocephala*	Ipil-ipil (Tag.)	fodder; charcoal
FABACEAE	*Millettia pinnata*	Bani (Tag.)	medicinal; ornamental
FABACEAE	*Pithecellobium dulce*	Kamachile (Tag.)	edible fruit; wood for construction
FABACEAE	*Pterocarpus indicus*	Narra (most dialects)	timber; ornamental
FABACEAE	*Senna alata*	Akapulko (Tag.)	medicinal
FABACEAE	*Senna spectabilis*		ornamental
FABACEAE	*Sesbania grandiflora*	Katuray (Tag.)	edible flowers
FABACEAE	*Tamarindus indica*	Sampalok (C.., Pamp., Tag.)	medicinal; fruit edible
FABACEAE	*Vigna unguiculata*	Sitao (Tag.)	pods eaten as vegetable
LAMIACEAE	*Coleus amboinicus*	Oregano (Tag.)	medicinal
LAMIACEAE	*Coleus blumei*	Mayana (Tag.)	ornamental; medicinal
LAMIACEAE	*Duranta repens*	Pigeon berry (Engl.)	ornamental
LAMIACEAE	*Gmelina arborea*	Yemane (Tag.)	wood for furniture
LAMIACEAE	*Orthosiphon aristatus*	Balbas pusa (Tag.)	medicinal; ornamental
LAMIACEAE	*Premna odorata*	Alagau (Bik., P.Bis., Tag., Bis.)	medicinal
LAMIACEAE	*Vitex parviflora*	Molave (Bik., Bis., Ilk., Tag.)	timber; furniture
LAURACEAE	*Persea americana*	Avocado (Engl. Sp.)	fruit edible
LYTHRACEAE	*Lagerstroemia speciosa*	Banaba (Tag.)	medicinal; ornamental
MAGNOLIACEAE	*Michelia champaca*	Tsampaka (Tag.)	ornamental; perfume production
MALPHIGIACEAE	*Malpighia coccigera*	Miniature holly (Engl.)	ornamental
MALPHIGIACEAE	*Tristellateia australasiae*	Binusisi (Tag.)	ornamental

Family	Species	Common name	Uses
MALVACEAE	*Abelmoschus esculentus*	Okra (Tag.)	fruit edible
MALVACEAE	*Ceiba pentandra*	Kapok (Bis., Jav., Sul., Tag.)	seedpod, fiber stuffing for pillow
MALVACEAE	*Hibiscus rosa sinensis*	Gumamela (Bis., Pa,mp. Tag.)	ornamental; medicinal
MALVACEAE	*Malvastrum coromandelianum*		medicinal
MALVACEAE	*Pachira aquatica*	Guiana chestnut (Engl.)	ornamental
MALVACEAE	*Pterospermum diversifolium*	Bayok (Nik., Mag., Tag.)	charcoal, firewood
MALVACEAE	*Sida acuta*	Waliswalisan (Tag.)	medicinal
MALVACEAE	*Theobroma cacao*	Cacao (Sp., Tag.)	seeds made into chocolate
MARANTACEAE	*Calathea makoyana*	Peacock plant (Engl.)	ornamental
MELIACEAE	*Azadirachta indica*	Neem tree (Tag.)	ornamental; botanical pesticide
MELIACEAE	*Melia azedarach*	Paraiso (Sp.)	ornamental; medicinal
MELIACEAE	*Sandoricum koetjape*	Santol (Tag.)	edible fruit; wood for carving
MELIACEAE	*Swietenia macrophylla*	Large leaved mahogany (Engl.)	Timber; high grade furniture
MELIACEAE	*Toona calantas*	Kalantas (Tag.)	wood for cigar boxes; furniture
MOLLUGINACEAE	*Mollugo pentaphylla*		medicinal
MORACEAE	*Artocarpus blancoi*	Antipolo (Tag.)	edible fruit; wood for carving
MORACEAE	*Artocarpus heterophyllus*	Nangka (Bis., Ibn., Sul.,Tag.)	edible fruit; wood for musical instruments
MORACEAE	*Broussonetia luzonica*	Himbabao (Tag.)	male inflorescence edible
MORACEAE	*Ficus benjamina*	Salisi (Is. Sab.)	ornamental
MORACEAE	*Ficus calophylla*	Basala (Tag.)	medicinal; ornamental
MORACEAE	*Ficus concinna*	Malasapla (Ilk.)	medicinal
MORACEAE	*Ficus nota*	Tibig (Ilk., Tag.)	fruit eaten by bats
MORACEAE	*Ficus pumila*	Creeping fig (Engl.)	ornamental
MORACEAE	*Ficus religiosa*	Bo tree (Singh Engl.)	
MORACEAE	*Ficus septica*	Hauili (Neg., Tag.)	medicinal
MORACEAE	*Ficus sp.*		
MORACEAE	*Ficus ulmifolia*	Is-is (Neg., P. Bis., Tag.)	leaves used as sandpaper
MORACEAE	*Streblus asper*	Kalios (Ibn., Tag.)	edible fruit; timber
MORINGACEAE	*Moringa oleifera*	Malunggai (Sanskr. Fil.)	edible leaves; medicinal
MUNTINGIACEAE	*Muntingia calabura*	Datiles(Bik., Tag.)	edible fruit
MUSACEAE	*Musa x paradisiaca*	Saging (Tag.)	edible fruit
MYRTACEAE	*Eucalyptus deglupta*	Bagras (Mbo.)	timber
MYRTACEAE	*Eucalyptus tereticornis*	Gray gum (Engl.)	ornamental wood for construction
MYRTACEAE	*Eugenia sp.*		ornamental
MYRTACEAE	*Psidium guajava*	Bayabas (Bik., Bis., Ibn., Sp. Fil.)	edible fruit, medicinal
MYRTACEAE	*Syzygium cumini*	Duhat (P. Bis., Tag.)	edible fruit, medicinal
MYRTACEAE	*Syzygium samarangense*	Makopa (Bik., Tag.)	edible fruit
NYCTAGINACEAE	*Bougainvillea spectabilis*	Bougainvillea (Engl.)	ornamental
NYCTAGINACEAE	*Mirabilis jalappa*	Four o clock (Engl.)	ornamental; medicinal
NYCTAGINACEAE	*Pisonia alba*	Maluko (Tag.)	edible leaves, ornamental
OLEACEAE	*Jasminum sambac*	Sampaguita (Tag.)	ornamental
ORCHIDACEAE	*Dendrobium aphyllum*		ornamental

Family	Species	Common name	Uses
OXALIDACEAE	*Averrhoa bilimbi*	Kamias (Tag.)	edible fruit
PANDANACEAE	*Pandanus amaryllifolius*	Pandan mabango (Tag.)	medicinal
PASSIFLORACEAE	*Passiflora foetida*	Pasyonaryong mabaho (Tag.)	fruit edible
PHYLLANTHACEAE	*Cicca acida*	Iba (Pamp., Sul., Tag.)	fruit edible; medicinal
PHYLLANTHACEAE	*Phyllanthus myrtifolius*		ornamental
PHYLLANTHACEAE	*Phyllanthus niruri*		medicinal
PHYLLANTHACEAE	*Phyllanthus urinaria*	Sampaluk-sampalukan (Tag.)	medicinal
PHYLLANTHACEAE	*Sauropus androgynus*	Chinese malunggai (Tag.)	leaves edible
PHYTOLACCACEAE	*Rivina humilis*		ornamental
PIPERACEAE	*Peperomia pellucida*	Pansit-pansitan (Tag.)	medicinal
POACEAE	*Axonopus compressus*	Carabao grass (Engl.)	fodder; medicinal
POACEAE	*Bambusa blumeana*	Kawayang tinik (Tag.)	culms for construction
POACEAE	*Bambusa multiplex*	Hedge bamboo (Engl.)	ornamental
POACEAE	*Cenchrus echinatus*	Spiny sandbar (Engl.)	fodder
POACEAE	*Chloris gayana*	Rhodes grass (Engl.)	fodder
POACEAE	*Cymbopogon citratus*	Tanglad (Tag.)	medicinal; leaves distilled for essential oils
POACEAE	*Cyrtococcum accressens*		fodder
POACEAE	*Dactyloctenium aegyptium*	Krus-krusan (Tag.)	medicinal; fodder grass
POACEAE	*Eleusine indica*	Paragis (Tag.)	fodder; medicinal
POACEAE	*Mnesithea cochinchinensis*		fodder grass
POACEAE	*Panicum maximum*	Guinea grass (Engl.)	fodder
POACEAE	*Pennisetum polystachion*	Buntot pusa (Tag.)	fodder
POACEAE	*Pennisetum purpureum*	Napier (Engl.)	fodder grass
POACEAE	*Saccharum spontaneum*	Talahib (Tag.)	fodder
POLYGONACEAE	*Antigonon leptopus*	Cadena de amor (Sp.)	ornamental
POLYPODIACEAE	*Drynaria quercifolia*	Kabkabin (Tag.)	ornamental
PORTULACACEAE	*Portulaca oleracea*	Kolasiman (Tag.)	medicinal
PORTULACACEAE	*Portulaca quadrifida*	Gulasiman (Tag.)	medicinal
PTERIDACEAE	*Adiantum philippense*	Kaikai (Tag.)	medicinal; ornamental
PTERIDACEAE	*Pteris ensiformis*	Sword brake fern (Engl.)	medicinal
ROSACEAE	*Rosa cv.*	Rose (Engl.)	ornamental
RUBIACEAE	*Coffea robusta*	Robusta (Tag.)	seeds roasted into coffee
RUBIACEAE	*Gardenia jasminoides*	Rosal (Tag.)	ornamental
RUBIACEAE	*Ixora chinensis*	Santan (Tag.)	ornamental
RUBIACEAE	*Morinda citrifolia*	Bangkoro (C. BisMag. Tag.)	medicinal
RUBIACEAE	*Mussaenda "Doña Aurora"*	Doña Aurora (Tag.)	ornamental
RUBIACEAE	*Nauclea orientalis*	Bangkal (Bis., Ilk., Mbo. Tag.)	timber; charcoal
RUTACEAE	*Citrus x aurantium*	Kahel (Sp. Fil.)	fruit edible
RUTACEAE	*Citrus x microcarpa*	Kalamansi (Tag.)	fruit edible; medicinal
RUTACEAE	*Murraya paniculata*	Kamuning (Tag.)	ornamental
SAPINDACEAE	*Dimocarpus longan*	Longan (Engl.)	fruit edible
SAPINDACEAE	*Nephelium lappaceum*	Rambutan (Tag.)	fruit edible

Family	Species	Common name	Uses
SAPOTACEAE	*Chrysophyllum cainito*	Star apple(Engl.) caimito Sp.)	edible fruit; timber
SAPOTACEAE	*Manilkara sapota*	Chico (sp. Mex.)	fruit edible
SAPOTACEAE	*Pouteria campechiana*	Tiesa (Engl.)	fruit edible
SCROPHULARIACEAE	*Leucophyllum frutescens*	Mexican sage (Engl.)	ornamental
SCROPHULARIACEAE	*Scoparia dulcis*	Saang-kabayo (Tag.)	medicinal
SOLANACEAE	*Capsicum frutescens*	Siling labuyo (Tag.)	fruit edible; spice
SOLANACEAE	*Solanum lycopersicum*	Kamatis (Tag.)	fruit edible
SOLANAEAE	*Solanum torvum*	Prickly nightshade (Engl.)	medicinal
STRELITZIACEAE	*Ravenala madagascariensis*	Travellers tree (Engl.)	ornamental
TURNERACEAE	*Turnera subulata*	White buttercup (Engl.)	ornamental
VITACEAE	*Cissus nodosa*	Grape ivy (Engl.)	ornamental

Annex 2.1-2

List of Flora Species Found Showing Endemicity Status, Growth Form and Respective Distribution during the MMSP surveys for the 2017 EIS

Appendix C List of recorded flora species for the Metro Manila Subway Project with showing endemicity status, growth form, and respective distribution across original proposed stations (EIS 2017)

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
ACANTHACEAE	*Asystasia gangetica*	NE	Herb	x													
ACANTHACEAE	*Ruellia tuberosa*	EX	Herb	x							x						
ACANTHACEAE	*Sanchezia speciosa*	EX	Shrub	x									x				
AGAVACEAE	*Agave tequilana*	EX	Herb			x					x		x			x	
ALOACEAE	*Aloe vera*	EX	Herb	x													
AMARANTHACEAE	*Alternathera sessilis*	EX	Herb	x													
AMARANTHACEAE	*Amaranthus spinosus*	EX	Herb	x	x	x					x						x
AMARANTHACEAE	*Celosia argentea*	EX	Herb	x													
AMARYLLIDACEAE	*Crinum amabile*	EX	Herb			x							x				
AMARYLLIDACEAE	*Crinum asiaticum*	NE	Herb							x							
ANACARDIACEAE	*Mangifera indica*	EX	Tree		x	x	x	x	x	x	x	x	x			x	x
ANNONACEAE	*Annona muricata*	EX	Tree						x								
ANNONACEAE	*Annona squamosa*	EX	Tree	x												x	x
ANNONACEAE	*Polyalthia longifolia*	EX	Tree	x					x		x		x				x
APOCYNACEAE	*Alstonia macrophylla*	NE	Tree														x
APOCYNACEAE	*Catharansus roseus*	EX	Shrub	x						x							
APOCYNACEAE	*Plumeria acuminata*	EX	Tree	x					x		x		x				x
APOCYNACEAE	*Tabernaemontana pandacaqui*	NE	Tree				x										
APOCYNACEAE	*Thevetia peruviana*	EX	Tree								x						x
APOCYNACEAE	*Wrightia pubescens*	NE	Tree	x												x	
APOCYNACEAE	*Wrightia religiosa*	EX	Tree								x					x	x
ARACEAE	*Colocasia esculenta*	NE	Herb						x								
ARACEAE	*Dieffenbachia amoena*	EX	Herb	x					x		x						
ARACEAE	*Homalomena rubescens*	NE	Herb							x							
ARACEAE	*Xanthosoma sagittifolium*	NE	Herb						x								
ARACEAE	*Zamioculcas zamiifolia*	EX	Herb	x			x			x							
ARALIACEAE	*Polyscias fruticosa*	EX	Shrub	x													

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
ARALIACEAE	*Polyscias guilfoylei*	EX	Shrub		x	x	x			x	x		x				
ARALIACEAE	*Schefflera odorata*	EX	Shrub	x			x										
ARECACEAE	*Adonidia merrillii*	NE	Palm	x	x						x	x	x			x	x
ARECACEAE	*Arenga pinnata*	NE	Palm	x													
ARECACEAE	*Caryota cumingii*	PE	Palm	x													
ARECACEAE	*Cocos nucifera*	NE	Palm	x		x	x		x		x		x			x	x
ARECACEAE	*Cyrtostachys renda*	EX	Palm										x				
ARECACEAE	*Dypsis lutescens*	EX	Palm	x			x										
ARECACEAE	*Elaeis guineensis*	EX	Palm									x					
ARECACEAE	*Hyophorbe lagenicaulis*	EX	Palm														x
ARECACEAE	*Phoenix roebelenii*	EX	Palm								x						
ARECACEAE	*Ptychosperma macarthurii*	EX	Palm		x						x		x				x
ARECACEAE	*Rhapis excelsa*	EX	Palm				x				x						x
ARECACEAE	*Roystonea regia*	EX	Palm		x							x	x	x			
ARECACEAE	*Wodyetia bifurcata*	EX	Palm	x	x						x	x		x		x	
ASPARAGACEAE	*Asparagus densiflorus*	EX	Herb	x													
ASPARAGACEAE	*Cordyline fruticosa*	EX	Shrub	x		x	x		x	x							x
ASPARAGACEAE	*Dracaena angustifolia*	NE	Shrub	x		x											
ASPARAGACEAE	*Dracaena fragrans*	EX	Tree	x	x					x	x		x				
ASPARAGACEAE	*Dracaena surculosa*	EX	Shrub	x							x		x				
ASPARAGACEAE	*Sanseveria trifasciata*	EX	Herb	x		x	x			x							x
ASTERACEAE	*Artemisia scoparia*	EX	Shrub				x				x						
ASTERACEAE	*Bidens pilosus*	EX	Herb	x													
ASTERACEAE	*Blumea balsamifera*	NE	Shrub	x	x				x								
ASTERACEAE	*Chromolaena odorata*	EX	Shrub	x				x									
ASTERACEAE	*Conyza sumatrensis*	EX	Herb						x								
ASTERACEAE	*Cyanthillium cinereum*	EX	Herb	x	x				x							x	
ASTERACEAE	*Mikania cordata*	EX	Climber	x													
ASTERACEAE	*Pseudoelephantopus spicatus*	EX	Herb	x													

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
ASTERACEAE	*Sphagneticola trilobata*	EX	Herb														x
ASTERACEAE	*Tridax procumbens*	EX	Herb	x	x			x			x		x			x	x
BASELLACEAE	*Basella alba*	EX	Climber	x							x		x				
BIGNONIACEAE	*Spathodea campanulata*	EX	Tree													x	
BIGNONIACEAE	*Spondias purpurea*	EX	Tree	x													
BIGNONIACEAE	*Tabebuia pallida*	EX	Tree	x					x							x	x
BORAGINACEAE	*Ehretia microphylla*	NE	Shrub	x		x							x			x	
BORAGINACEAE	*Heliotropium indicum*	EX	Herb	x													
CACTACEAE	*Pereskia aculeata*	EX	Climber					x									
CALOPHYLLACEAE	*Calophyllum inophyllum*	NE	Tree						x						x		
CANNACEAE	*Canna indica*	EX	Herb	x									x				x
CANNACEAE	*Trema orientalis*	NE	Tree					x					x				x
CAPPARIDACEAE	*Cleome rutidosperma*	EX	Herb	x	x								x				
CARICACEAE	*Carica papaya*	EX	Herb	x					x				x			x	x
COMBRETACEAE	*Bucida molineti*	EX	Tree	x		x											
COMBRETACEAE	*Quisqualis indica*	NE	Climber					x									
COMBRETACEAE	*Terminalia catappa*	NE	Tree	x	x							x	x			x	x
COMMELINACEAE	*Commelina diffusa*	NE	Herb	x	x			x	x								
COMMELINACEAE	*Tradescantia spathacea*	EX	Herb														
CONVOLVULACEAE	*Ipomoea batatas*	EX	Climber	x	x		x				x						
CONVOLVULACEAE	*Merremia sp.*	EX	Climber	x			x										
CUCURBITACEAE	*Coccinia grandis*	EX	Climber	x	x			x									
CYPERACEAE	*Cyperus kyllingia*	NE	Sedge				x										
DIOSCOREACEAE	*Dioscorea esculenta*	NE	Climber										x				
EBENACEAE	*Diospyros blancoi*	NE	Tree						x								
EUPHORBIACEAE	*Croton tiglium*	NE	Shrub	x													
EUPHORBIACEAE	*Euphorbia hirta*	EX	Herb	x	x								x				
EUPHORBIACEAE	*Euphorbia milii*	EX	Shrub														x
EUPHORBIACEAE	*Euphorbia tirucalli*	EX	Shrub	x						x							

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
EUPHORBIACEAE	*Excoecaria cochinchinensis*	EX	Shrub	x	x		x						x				
EUPHORBIACEAE	*Jatropha curcas*	EX	Tree	x												x	x
EUPHORBIACEAE	*Jatropha gossypifolia*	EX	Shrub								x						
EUPHORBIACEAE	*Jatropha integerrima*	EX	Shrub	x												x	x
EUPHORBIACEAE	*Macaranga tanarius*	NE	Tree					x									
EUPHORBIACEAE	*Manihot esculenta*	EX	Shrub	x													
EUPHORBIACEAE	*Melanolepis multiglandulosa*	NE	Tree	x	x												
EUPHORBIACEAE	*Pedilanthus tithymaloides*	EX	Shrub							x			x			x	
FABACEAE	*Acacia auriculiformis*	EX	Tree									x	x				
FABACEAE	*Acacia mangium*	EX	Tree				x										
FABACEAE	*Albizia saman*	EX	Tree	x		x			x								
FABACEAE	*Bauhinia purpurea*	Ex	Tree	x													
FABACEAE	*Caesalpinia pulcherrima*	EX	Shrub	x			x										
FABACEAE	*Cassia fistula*	EX	Tree			x	x						x				
FABACEAE	*Centrosema pubescens*	EX	Climber	x					x								
FABACEAE	*Delonix regia*	EX	Tree						x								
FABACEAE	*Gliricidia sepium*	EX	Tree	x													
FABACEAE	*Leucaena leucocephala*	EX	Tree	x	x	x	x		x							x	x
FABACEAE	*Millettia pinnata*	NE	Tree						x								
FABACEAE	*Pithecellobium dulce*	EX	Tree									x					
FABACEAE	*Pterocarpus indicus*	NE	Tree	x		x	x	x	x				x	x		x	x
FABACEAE	*Senna alata*	EX	Shrub	x							x						
FABACEAE	*Senna spectabilis*	EX	Tree					x									
FABACEAE	*Sesbania grandiflora*	EX	Tree													x	
FABACEAE	*Tamarindus indica*	EX	Tree	x							x					x	
FABACEAE	*Vigna unguiculata*	EX	Climber						x								
LAMIACEAE	*Coleus amboinicus*	EX	Herb	x			x										
LAMIACEAE	*Coleus blumei*	EX	Herb	x													
LAMIACEAE	*Duranta repens*	EX	Shrub								x		x			x	x

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
LAMIACEAE	*Gmelina arborea*	EX	Tree						x								
LAMIACEAE	*Orthosiphon aristatus*	EX	Herb							x							
LAMIACEAE	*Premna odorata*	NE	Tree	x													
LAMIACEAE	*Vitex parviflora*	NE	Tree	x					x								
LAURACEAE	*Persea americana*	EX	Tree	x						x	x						
LYTHRACEAE	*Lagerstroemia speciosa*	NE	Tree									x					
MAGNOLIACEAE	*Michelia champaca*	EX	Tree											x			
MALPHIGIACEAE	*Malpighia coccigera*	EX	Shrub			x					x						x
MALPHIGIACEAE	*Tristellateia australasiae*	NE	Climber	x													
MALVACEAE	*Abelmoschus esculentus*	EX	Shrub	x													x
MALVACEAE	*Ceiba pentandra*	EX	Tree	x			x	x					x			x	
MALVACEAE	*Hibiscus rosa sinensis*	EX	Tree													x	x
MALVACEAE	*Malvastrum coromandelianum*	EX	Herb						x								
MALVACEAE	*Pachira aquatica*	EX	Tree	x						x	x						
MALVACEAE	*Pterospermum diversifolium*	NE	Tree	x													
MALVACEAE	*Sida acuta*	EX	Shrub	x													
MALVACEAE	*Theobroma cacao*	EX	Tree													x	
MARANTACEAE	*Calathea makoyana*	EX	Herb													x	
MELIACEAE	*Azadirachta indica*	EX	Tree		x											x	x
MELIACEAE	*Melia azedarach*	NE	Tree	x	x											x	
MELIACEAE	*Sandoricum koetjape*	NE	Tree	x	x		x		x				x			x	
MELIACEAE	*Swietenia macrophylla*	EX	Tree	x				x	x				x			x	x
MELIACEAE	*Toona calantas*	NE	Tree						x								
MOLLUGINACEAE	*Mollugo pentaphylla*	NE	Herb								x						
MORACEAE	*Artocarpus blancoi*	PE	Tree	x													
MORACEAE	*Artocarpus heterophyllus*	EX	Tree				x	x								x	x
MORACEAE	*Broussonetia luzonica*	EX	Tree										x				
MORACEAE	*Ficus benjamina*	NE	Tree	x	x	x		x	x		x					x	x
MORACEAE	*Ficus calophylla*	EX	Tree										x				

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
MORACEAE	*Ficus concinna*	NE	Tree		x												x
MORACEAE	*Ficus nota*	NE	Tree	x													
MORACEAE	*Ficus pumila*	EX	Climber								x						x
MORACEAE	*Ficus religiosa*	EX	Tree						x				x			x	x
MORACEAE	*Ficus septica*																
MORACEAE	*Ficus sp.*		Tree	x													
MORACEAE	*Ficus ulmifolia*	PE	Tree		x											x	
MORACEAE	*Streblus asper*	NE	Tree	x													
MORINGACEAE	*Moringa oleifera*	EX	Tree	x	x		x	x	x	x		x	x				x
MUNTINGIACEAE	*Muntingia calabura*	EX	Tree	x	x			x				x				x	
MUSACEAE	*Musa x paradisiaca*	EX	Herb	x				x	x	x						x	x
MYRTACEAE	*Eucalyptus deglupta*	NE	Tree			x											
MYRTACEAE	*Eucalyptus tereticornis*	EX	Tree									x					
MYRTACEAE	*Eugenia sp.*		Tree													x	
MYRTACEAE	*Psidium guajava*	EX	Tree	x	x	x					x		x				x
MYRTACEAE	*Syzygium cumini*	NE	Tree	x	x		x						x			x	x
MYRTACEAE	*Syzygium samarangense*	NE	Tree	x							x						
NYCTAGINACEAE	*Bougainvillea spectabilis*	EX	Shrub	x	x	x	x		x			x	x				x
NYCTAGINACEAE	*Mirabilis jalappa*	EX	Shrub		x												
NYCTAGINACEAE	*Pisonia alba*	EX	Tree	x							x						
OLEACEAE	*Jasminum sambac*	EX	Climber	x						x							
ORCHIDACEAE	*Dendrobium aphyllum*	NE	Orchid							x							
OXALIDACEAE	*Averrhoa bilimbi*	EX	Tree	x	x					x							
PANDANACEAE	*Pandanus amaryllifolius*	EX	Pandan						x								
PASSIFLORACEAE	*Passiflora foetida*	EX	Climber									x					
PHYLLANTHACEAE	*Cicca acida*	EX	Tree													x	
PHYLLANTHACEAE	*Phyllanthus myrtifolius*	EX	Shrub												x		
PHYLLANTHACEAE	*Phyllanthus niruri*	NE	Herb		x											x	x
PHYLLANTHACEAE	*Phyllanthus urinaria*	NE	Herb	x							x		x				

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
PHYLLANTHACEAE	*Sauropus androgynus*	NE	Shrub					x									
PHYTOLACCACEAE	*Rivina humilis*	EX	Herb					x	x								
PIPERACEAE	*Peperomia pellucida*	NE	Herb														x
POACEAE	*Axonopus compressus*	NE	Grass	x					x	x							
POACEAE	*Bambusa blumeana*	EX	Bamboo	x													
POACEAE	*Bambusa multiplex*	EX	Bamboo								x					x	
POACEAE	*Cenchrus echinatus*	NE	Grass	x	x						x					x	x
POACEAE	*Chloris gayana*	EX	Grass	x	x											x	x
POACEAE	*Cymbopogon citratus*	EX	Grass						x								
POACEAE	*Cyrtococcum accressens*	EX	Grass	x				x					x				
POACEAE	*Dactyloctenium aegyptium*	NE	Grass						x								
POACEAE	*Eleusine indica*																
POACEAE	*Mnesithea cochinchinensis*	NE	Grass					x									
POACEAE	*Panicum maximum*	EX	Grass	x													
POACEAE	*Pennisetum polystachion*	EX	Grass	x													
POACEAE	*Pennisetum purpureum*	EX	Grass					x									
POACEAE	*Saccharum spontaneum*	NE	Grass	x													
POLYGONACEAE	*Antigonon leptopus*	EX	Climber													x	
POLYPODIACEAE	*Drynaria quercifolia*	NE	Fern	x					x								
PORTULACACEAE	*Portulaca oleracea*	NE	Herb	x									x				x
PORTULACACEAE	*Portulaca quadrifida*	NE	Herb	x	x												
PTERIDACEAE	*Adiantum philippense*	NE	Fern						x								
PTERIDACEAE	*Pteris ensiformis*	NE	Fern	x													
ROSACEAE	*Rosa cv.*	EX	Shrub	x													
RUBIACEAE	*Coffea robusta*	EX	Tree						x								
RUBIACEAE	*Gardenia jasminoides*	EX	Shrub											x			
RUBIACEAE	*Ixora chinensis*	EX	Shrub	x	x						x	x					x
RUBIACEAE	*Morinda citrifolia*	NE	Tree	x													x
RUBIACEAE	*Mussaenda "Doña Aurora"*	EX	Shrub							x							

Family	Species	Endemicity	Growth From	Proposed Stations													
				01	02	03	04	05	06	07	08	09	10	11	12	13	14
RUBIACEAE	*Nauclea orientalis*	NE	Tree	x													
RUTACEAE	*Citrus x aurantium*	EX	Tree						x							x	
RUTACEAE	*Citrus x microcarpa*	EX	Tree	x						x							
RUTACEAE	*Murraya paniculata*	NE	Shrub	x	x			x			x	x	x			x	
SAPINDACEAE	*Dimocarpus longan*	EX	Tree														x
SAPINDACEAE	*Nephelium lappaceum*	EX	Tree								x						
SAPOTACEAE	*Chrysophyllum cainito*	EX	Tree	x					x	x	x						
SAPOTACEAE	*Manilkara sapota*	EX	Tree	x													
SAPOTACEAE	*Pouteria campechiana*	EX	Tree		x				x								x
SCROPHULARIACEAE	*Leucophyllum frutescens*	EX	Shrub		x											x	
SCROPHULARIACEAE	*Scoparia dulcis*	EX	Herb	x													
SOLANACEAE	*Capsicum frutescens*	EX	Shrub	x													
SOLANACEAE	*Solanum lycopersicum*	EX	Herb	x													
SOLANAEAE	*Solanum torvum*	EX	Shrub	x				x									
STRELITZIACEAE	*Ravenala madagascariensis*	EX	Tree					x									
TURNERACEAE	*Turnera subulata*	EX	Shrub			x											
VITACEAE	*Cissus nodosa*	EX	Vine	x	x							x					x

***01** = Valenzuela Depot; **02** = Quirino Highway Station; **03** = Tandang Sora Avenue Station; **04** = North Avenue Station; **05** = Quezon Avenue Station; **06** = East Avenue Station; **07** = Anonas Station; **08** = Katipunan Avenue Station; **09** = Ortigas North Station; **10** = Ortigas South Station; **11** = Kalayaan Avenue Station; **12** = Bonifacio Global City Station; **13** = Cayetano Boulevard Station; and **14** = FTI Station*

***x** = presence; **EX** = exotic; **NE** = native, non-endemic; **PE** = Philippines endemic*

Annex 2.1-3

List of Flora Species Found during the MMSP surveys for the 2019 ECC Amendment

Appendix B List of recorded flora species for the surveyed additional transects of the Metro Manila Subway Project (2019)

Family	Species	Common name	Uses
ACHARIACEAE	*Hydnocarpus sumatrana*	Bagarbas	medicinal
ANACARDIACEAE	*Mangifera indica*	Mangga	edible fruit; medicinal
ANACARDIACEAE	*Spondias pinnata*	Libas	edible fruit and leaves; medicinal
ANNONACEAE	*Annona muricata*	Guayabano	edible fruit
ANNONACEAE	*Annona squamosa*	Atis	edible fruit
ANNONACEAE	*Polyalthia longifolia*	Indian lanutan	ornamental
APOCYNACEAE	*Plumeria alba*	Kalachuchi puti	edible flowers; ornamental; medicinal
ARAUCARIACEAE	*Araucaria heterophylla*	Araucaria	ornamental
ARECACEAE	*Adonidia merrillii*	Manila Palm	ornamental
ARECACEAE	*Calamus sp.*	Calamus	medicinal
ARECACEAE	*Caryota rumphiana var. philippinensis*	Takipan	edible young shoot bud; ornamental
ARECACEAE	*Cocos nucifera*	Niyog	fruit edible; medicinal
ARECACEAE	*Dypsis lutescens*	Palmera	ornamental
ARECACEAE	*Phoenix sylvestris*	-	edible fruit; medicinal
ARECACEAE	*Ptychosperma macarthurii*	McArthur's palm	ornamental
ARECACEAE	*Roystonea regia*	Royal palm	ornamental
ARECACEAE	*Saribus rotundifolius*	Anahau	leaves used for thatching and food wrapping
ARECACEAE	*Wodyetia bifurcata*	Foxtail palm	ornamental; landscaping
ASPARAGACEAE	*Dracaena fragrans*	Fortune plant	Shrub
ASPARAGACEAE	*Dracaena multiflora*		
ASTERACEAE	*Chromolaena odorata*	Gonoi	medicinal
ASTERACEAE	*Mikania cordata*	Ooko	medicinal
BIGNONIACEAE	*Spathodea campanulata*	African tulip	ornamental
BIGNONIACEAE	*Tabebuia rosea*	Bigoniaceae	medicinal
BOMBACACEAE	*Ceiba pentandra*	American kapok	seedpod, fiber stuffing for pillow
CARICACEAE	*Carica papaya*	Papaya	edible fruit
COMBRETACEAE	*Terminalia catappa*	Talisai	edible fruit kernel
COMBRETACEAE	*Terminalia microcarpa*	Kalumpit	edible fruit; medicinal; agroforestry
COMMELINACEAE	*Murdannia nodiflora*	Alikbangon babae	
EBENACEAE	*Diospyros discolor*	Kamagong	edible fruit; timber
EUPHORBIACEAE	*Jatropha curcas*	Tuba-tuba	boundary plantings, biodiesel
EUPHORBIACEAE	*Macaranga tanarius*	Binunga	pioneer tree for restoration
EUPHORBIACEAE	*Melanolepis multiglandulosa*	Alim	medicinal
FABACEAE	*Albizia saman*	Rain tree	timber; wood carving
FABACEAE	*Arachis pintoi*	Mani-mani	agroforestry
FABACEAE	*Bauhinia malabarica*	Alibangbang	
FABACEAE	*Bauhinia monandra*	Fringon	edible young leaves and seedpods; medicinal
FABACEAE	*Caesalpinia pulcherrima*	Caballero	ornamental
FABACEAE	*Cassia alata*	Akapulko	medicinal; ornamental
FABACEAE	*Cassia fistula*	Golden Shower	ornamental; medicinal

Family	Species	Common name	Uses
FABACEAE	*Cassia javanica*	Anchoan	medicinal
FABACEAE	*Centrosema pubescens*	Pukinggang Baging	fodder
FABACEAE	*Delonix regia*	Fire tree	ornamental
FABACEAE	*Leucaena leucocephala*	Ipil-ipil	fodder; charcoal
FABACEAE	*Peltophorum pterocarpum*	Siar	ornamental; wood used for furniture; fodder
FABACEAE	*Pithecellobium dulce*	Camachile	edible fruit; wood for construction
FABACEAE	*Pterocarpus indicus*	Narra	timber; ornamental
FABACEAE	*Sesbania nudiflora*	Katurai	
FABACEAE	*Tamarindus indica*	Sampalok	medicinal; fruit edible
LAMIACEAE	*Gmelina arborea*	Gmelina	wood used for furniture
LAMIACEAE	*Premna odorata*	Alagau	medicinal
LAMIACEAE	*Vitex negundo*	Lagundi	edible seed; medicinal; agroforestry
LAMIACEAE	*Vitex parviflora*	Molave	timber; furniture
LAURACEAE	*Persea gratissima*	Avocado	edible fruit; ornamental
LECYTHIDACEAE	*Barringtonia asiatica*	Botong	seeds used for fish capture
LYTHRACEAE	*Lagerstroemia speciosa*	Banaba	medicinal; ornamental
MALVACEAE	*Hibiscus rosa-sinensis*	Gumamela	edible flowers; medicinal
MALVACEAE	*Pachira aquatica*	-	ornamental
MELIACEAE	*Azadirachta indica*	Neem tree	ornamental; botanical pesticide
MELIACEAE	*Melia dubia*	Bagalunga	Medicinal; fodder; wood for fuel; pest management
MELIACEAE	*Sandoricum koetjape*	Santol	edible fruit; wood for carving
MELIACEAE	*Swietenia macrophylla*	Mahogany	timber; high grade furniture
MORACEAE	*Artocarpus heterophyllus*	Nangka	edible fruit; wood for musical instruments
MORACEAE	*Broussonetia luzonica*	Himbabao	male inflorescence edible
MORACEAE	*Ficus balete*	Balete	ornamental
MORACEAE	*Ficus concinna*	-	medicinal
MORACEAE	*Ficus elastica*	Indian rubber	ornamental; latex
MORACEAE	*Ficus fistulosa*	-	edible young leaves; medicinal
MORACEAE	*Ficus nota*	Tibig	fruit eaten by bats
MORACEAE	*Ficus pseudopalma*	Niog-niogan	Edible young shoots; medicinal
MORACEAE	*Ficus religiosa*	Bo tree	religion; medicinal
MORACEAE	*Ficus septica*	Hauli	medicinal
MORACEAE	*Ficus ulmifolia*	Is-is	leaves used as sandpaper
MORACEAE	*Morus alba*	Mulberry	
MORACEAE	*Streblus asper*	Kalios	edible fruit; timber
MORINGACEAE	*Moringa oleifera*	Malunggai	edible leaves; medicinal
MUNTINGIACEAE	*Muntingia calabura*	Datiles	edible fruit
MYRTACEAE	*Callistemon citrinus*	Red bottle brush	agriculture
MYRTACEAE	*Eucalyptus camaldulensis*	Austalian Red Gum	horticulture; timber
MYRTACEAE	*Psidium guajava*	Bayabas	edible fruit; medicinal
MYRTACEAE	*Syzygium cuminii*	Duhat	medicinal
MYRTACEAE	*Syzygium samarangense*	Makopa	edible fruit

Family	Species	Common name	Uses
NYCTAGINACEAE	*Bougainvillea spectabilis*	Bougainv illea	ornamental
PHYLLANTHACEAE	*Antidesma bunius*	Bignai	edible fruit and leav es; natural pioneer species
POACEAE	*Eleusine indica*	Paragis	fodder; medicinal
POACEAE	*Saccharum spontaneum*	Tubo	fodder
POACEAE	*Thyrsostachys siamensis*	Pole bamboo	edible y oung shoots; agroforestry
PODOCARPACEAE	*Podocarpus costalis*	Arius	medicinal
RUBIACEAE	*Morinda citrifolia*	Noni	medicinal
RUBIACEAE	*Mussaenda philippica*	Kahoy dalaga	ornamental
RUBIACEAE	*Neolamarckia cadamba*	Kaatoang bangkal	ornamental
RUTACEAE	*Citrofortunella microcarpa*	Kalamansi	edible fruit
RUTACEAE	*Citrus maxima*	Lukban	edible fruit
SAPOTACEAE	*Chrysophyllum cainito*	Caimito	edible fruit; timber
SAPOTACEAE	*Manilkara sapota*	Chico	fruit edible
STERCULIACEAE	*Sterculia foetida*	Kalumpang	oil used for biofuel
STRELIZIACEAE	*Ravenala madagascariensis*	Trav eler's Palm	ornamental
VERBENACEAE	*Lantana camara*	Coronitas	medicinal; ornamental

Annex 2.1-4

List of Flora Species Found Showing Endemicity Status, Growth Form and Respective Distribution during the MMSP surveys for the 2019 ECC Amendment

Appendix D List of recorded flora species for the Metro Manila Subway Project with showing endemicity status, growth form, and respective distribution across additional stations (2019)

Family	Species	Endemicity	Growth From	Additional Stations			
				Transect 1	Transect 2	Transect 3	Transect 4
ACHARIACEAE	*Hydnocarpus sumatrana*	NE	Tree				
ANACARDIACEAE	*Mangifera indica*	EX	Tree	x		x	x
ANACARDIACEAE	*Spondias pinnata*	NE	Tree				x
ANNONACEAE	*Annona muricata*	EX	Tree				x
ANNONACEAE	*Annona squamosa*	EX	Tree	x			x
ANNONACEAE	*Polyalthia longifolia*	EX	Tree	x	x	x	x
APOCYNACEAE	*Plumeria alba*	EX	Shrub				x
ARAUCARIACEAE	*Araucaria heterophylla*	EX	Tree				x
ARECACEAE	*Adonidia merrillii*	NE	Palm	x			
ARECACEAE	*Calamus* sp.		Palm				
ARECACEAE	*Caryota rumphiana var. philippinensis*	NE	Palm			x	
ARECACEAE	*Cocos nucifera*	NE	Palm	x			x
ARECACEAE	*Dypsis lutescens*	EX	Palm				
ARECACEAE	*Phoenix sylvestris*	EX	Palm				
ARECACEAE	*Ptychosperma macarthurii*	EX	Palm				
ARECACEAE	*Roystonea regia*	EX	Palm	x			
ARECACEAE	*Saribus rotundifolius*	NE	Palm	x			
ARECACEAE	*Wodyetia bifurcata*	EX	Palm				x
ASPARAGACEAE	*Dracaena fragrans*	EX	Tree				
ASPARAGACEAE	*Dracaena multiflora*	NE	Palm	x			x
ASTERACEAE	*Chromolaena odorata*	EX	Shrub				
ASTERACEAE	*Mikania cordata*	EX	Climber				
BIGNONIACEAE	*Spathodea campanulata*	EX	Tree	x	x	x	
BIGNONIACEAE	*Tabebuia rosea*	EX	Tree		x		
BOMBACACEAE	*Ceiba pentandra*	EX	Tree	x			

Family	Species	Endemicity	Growth From	Additional Stations			
				Transect 1	Transect 2	Transect 3	Transect 4
CARICACEAE	*Carica papaya*	EX	Herb				
COMBRETACEAE	*Terminalia catappa*	NE	Tree	x	x	x	x
COMBRETACEAE	*Terminalia microcarpa*	NE	Tree			x	
COMMELINACEAE	*Murdannia nodiflora*	NE	Orchid				
EBENACEAE	*Diospyros discolor*	NE	Tree	x		x	x
EUPHORBIACEAE	*Jatropha curcas*	EX	Tree	x			
EUPHORBIACEAE	*Macaranga tanarius*	NE	Tree				
EUPHORBIACEAE	*Melanolepis multiglandulosa*	NE	Tree				
FABACEAE	*Albizia saman*	EX	Tree	x	x	x	x
FABACEAE	*Arachis pintoi*	EX	Herb				
FABACEAE	*Bauhinia malabarica*	NE	Tree		x		
FABACEAE	*Bauhinia monandra*	EX	Tree		x	x	
FABACEAE	*Caesalpinia pulcherrima*	EX	Shrub				
FABACEAE	*Cassia alata*	EX	Shrub			x	
FABACEAE	*Cassia fistula*	EX	Tree				
FABACEAE	*Cassia javanica*	NE	Tree	x			
FABACEAE	*Centrosema pubescens*	EX	Climber				
FABACEAE	*Delonix regia*	EX	Tree	x	x	x	
FABACEAE	*Leucaena leucocephala*	EX	Tree	x		x	
FABACEAE	*Peltophorum pterocarpum*	NE	Tree			x	
FABACEAE	*Pithecellobium dulce*	EX	Tree	x		x	
FABACEAE	*Pterocarpus indicus*	NE	Tree	x	x	x	x
FABACEAE	*Sesbania nudiflora*	EX	Tree	x			
FABACEAE	*Tamarindus indica*	EX	Tree	x		x	
LAMIACEAE	*Gmelina arborea*	EX	Tree	x		x	
LAMIACEAE	*Premna odorata*	NE	Tree	x			
LAMIACEAE	*Vitex negundo*	NE	Shrub	x		x	
LAMIACEAE	*Vitex parviflora*	NE	Tree				x
LAURACEAE	*Persea gratissima*	EX	Tree	x			x

Family	Species	Endemicity	Growth From	Additional Stations			
				Transect 1	Transect 2	Transect 3	Transect 4
LECYTHIDACEAE	*Barringtonia asiatica*	NE	Tree			x	
LYTHRACEAE	*Lagerstroemia speciosa*	NE	Tree	x		x	
MALVACEAE	*Hibiscus rosa-sinensis*	EX	Shrub				
MALVACEAE	*Pachira aquatica*	EX	Tree	x			
MELIACEAE	*Azadirachta indica*	EX	Tree	x			x
MELIACEAE	*Melia dubia*	NE	Tree	x			
MELIACEAE	*Sandoricum koetjape*	EX	Tree	x			x
MELIACEAE	*Swietenia macrophylla*	EX	Tree	x		x	x
MORACEAE	*Artocarpus heterophyllus*	EX	Tree	x			x
MORACEAE	*Broussonetia luzonica*	NE	Tree			x	
MORACEAE	*Ficus balete*	PE	Tree	x			x
MORACEAE	*Ficus concinna*	EX	Tree				
MORACEAE	*Ficus elastica*	EX	Tree	x			
MORACEAE	*Ficus fistulosa*	NE	Tree	x			
MORACEAE	*Ficus nota*	NE	Tree				x
MORACEAE	*Ficus pseudopalma*	PE	Shrub	x			
MORACEAE	*Ficus religiosa*	EX	Tree	x			
MORACEAE	*Ficus septica*	NE	Tree/Shrub				
MORACEAE	*Ficus ulmifolia*	PE	Tree				
MORACEAE	*Morus alba*	NE	Tree			x	
MORACEAE	*Streblus asper*	NE	Tree	x			
MORINGACEAE	*Moringa oleifera*	EX	Tree	x			
MUNTINGIACEAE	*Muntingia calabura*	EX	Tree	x			
MYRTACEAE	*Callistemon citrinus*	EX	Shrub	x			
MYRTACEAE	*Eucalyptus camaldulensis*	EX	Tree			x	
MYRTACEAE	*Psidium guajava*	EX	Tree		x		x
MYRTACEAE	*Syzygium cuminii*	EX	Tree	x			
MYRTACEAE	*Syzygium samarangense*	EX	Tree	x			
NYCTAGINACEAE	*Bougainvillea spectabilis*	EX	Shrub				

Family	Species	Endemicity	Growth From	Additional Stations			
				Transect 1	Transect 2	Transect 3	Transect 4
PHYLLANTHACEAE	*Antidesma bunius*	NE	Tree	x			
POACEAE	*Eleusine indica*	NE	Grass				
POACEAE	*Saccharum spontaneum*	NE	Grass				
POACEAE	*Thyrsostachys siamensis*	EX	Bamboo				
PODOCARPACEAE	*Podocarpus costalis*	PE	Shrub				x
RUBIACEAE	*Morinda citrifolia*	NE	Tree	x			
RUBIACEAE	*Mussaenda philippica*	NE	Shrub/Tree				x
RUBIACEAE	*Neolamarckia cadamba*	NE	Tree				x
RUTACEAE	*Citrofortunella microcarpa*	EX	Tree/Shrub				x
RUTACEAE	*Citrus maxima*	EX	Tree			x	
SAPOTACEAE	*Chrysophyllum cainito*	EX	Tree	x		x	
SAPOTACEAE	*Manilkara sapota*	EX	Tree	x			
STERCULIACEAE	*Sterculia foetida*	NE	Tree	x			
STRELIZIACEAE	*Ravenala madagascariensis*	EX	Tree				
VERBENACEAE	*Lantana camara*	EX	Shrub				

Annex 2.3-1

Climatological Normals

Republic of the Philippines
Department of Science and Technology
Philippine Atmospheric, Geophysical and Astronomical Services Administration
Climatology and Agrometeorology Division
CLIMATE AND AGROMET DATA SECTION
PAGASA Science Garden Complex, Agham Road, Diliman Quezon City, Philippines
Telefax: (632)-434-2698

CLIMATOLOGICAL NORMALS

STATION: **NAIA (MIA), PASAY CITY**
PERIOD: **1981 - 2010**

LATITUDE: **14°30'25.75"N**
LONGITUDE: **121°00'15.90"E**
ELEVATION: **21m**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16a)	(16b)
MONTH	RAINFALL		TEMPERATURE						VAPOR PRESS. (mbs)	RH (%)	MSLP (mbs)	WIND		CLOUD AMT. (okta)	NO. OF DAYS W/	
	AMOUNT (mm)	NO. OF RD	MAX (°C)	MIN (°C)	MEAN (°C)	DRY BULB (°C)	WET BULB (°C)	DEW POINT (°C)				DIR (16pt)	SPD (mps)		TSTM	LTNG
JAN	6.8	2	30.2	22	26.1	26	22.6	21.2	25.1	75	1013.4	E	3	5	0	0
FEB	4.2	1	31	22.5	26.7	26.6	22.7	21.1	24.9	72	1013.2	E	3	4	0	0
MAR	4	1	32.5	23.6	28	27.9	23.4	21.7	25.7	68	1012.4	E	4	4	0	1
APR	16	1	34.1	25	29.5	29.4	24.5	22.7	27.4	67	1010.8	ESE	4	4	1	3
MAY	70.4	10	33.8	25.5	29.7	29.4	25.3	23.9	29.4	72	1009.3	W	3	5	5	12
JUN	265.2	14	32.5	25.1	28.8	28.5	25.3	24.2	30	77	1008.7	W	3	6	7	13
JUL	316.7	16	31.3	24.6	28	27.7	25.1	24.2	30.1	81	1008.4	W	3	6	8	13
AUG	418.4	19	30.8	24.6	27.7	27.4	25.1	24.3	30.3	83	1008	W	3	7	6	8
SEP	255.2	16	31	24.6	27.8	27.5	25.2	24.4	30.5	83	1008.8	W	2	6	8	11
OCT	283.4	14	31.1	24.3	27.7	27.5	24.8	23.8	29.4	80	1009.6	E	2	6	5	8
NOV	99	8	31.1	23.7	27.4	27.2	24.2	23.1	28.1	78	1010.8	E	2	5	1	3
DEC	28.6	3	30.2	22.7	26.5	26.3	23.1	21.9	26.1	76	1012.5	E	2	5	0	0
ANNUAL	**1767.8**	**101**	**31.6**	**24**	**27.8**	**27.6**	**24.3**	**23**	**28.1**	**76**	**1010.5**	**E**	**3**	**5**	**41**	**72**

Definition of Terms:

Climatological Normals - Period averages computed for a uniform and relative long period comprising at least three (3) consecutive10-year period.
Rainfall Amount (column 2) - The amount of precipitation (rain, hail, etc.) expressed in millimeters depth of the layer of the water which has fallen.
Number of Rainy Days (column 3) - A rainy day is defined as a period of 24 hours beginning at 8AM to 8 AM of the next day during which at least 0.1 mm of rain is recorded.
Maximum Temperature (column 4) - The maximum temperature in °C recorded for the day, usually occurring in the early afternoon.
Minimum Temperature (column 5) - The minimum temperature in °C recorded for the day, usually occurring during early hours of the morning (before sunrise).
Mean Temperature (column 6) - The average of the maximum and minimum temperature in °C recorded for the day. Mean Temperature = Maximum + Minimum / 2
Dry Bulb Temperature (column 7) - It gives the air temperature in °C at the time of observation.
Wet Bulb Temperature (column 8) - It gives the temperature in °C that an air parcel would have if cooled adiabatically to saturation at constant pressure by evaporating water in it.
Dew Point Temperature (column 9) - The temperature in °C at a given pressure, to which the air must be cooled to become saturated. It is the temperature when atmospheric moisture begins to condense to liquid forming “dew” upon objects.
Vapor Pressure (column10) - Denotes the partial pressure of water vapor in atmosphere in millibars (mbs). As the water evaporates, additional water vapor is introduced into space above and pressure increases slightly as the new vapor is added. The increasing pressure is due to an increase in the partial pressure of water vapor.
Relative Humidity (column 11) - The ratio of the amount of water vapor actually in the air to the maximum amount the air can hold at that temperature.
Mean Sea Level Pressure (column 12) - The force exerted by the weight of the atmosphere on a unit area at the mean sea level. It is also the atmospheric pressure at mean sea leve measured in millibars (mbs).
Prevailing Winds (column 13 & 14) - The prevailing wind direction expressed using the 16 compass points which is most frequently observed during a given period while the average wind speed in meters per second is the arithmetic average of the observed wind speed.
Cloud Amount (column 15) - The amount of cloud present in the sky, expressed in oktas of the sky cover. Okta is the function used in denoting cloud amount and is equal to 1/8 of the whole sky.
Days with Thunderstorm (column 16a) - A thunderstorm day is defined as an observational day during which thunder is recorded at the station.
Days with Lightning (column 16b) - A day with lightning is reported whenever lightning is observed.

PREPARED BY: **CADS/CAD/PAGASA**

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CLIMATE AND AGROMET DATA SECTION
PAGASA Science Garden Complex, Agham Road, Diliman Quezon City, Philippines
Telefax: (632)-434-2698

CLIMATOLOGICAL NORMALS

STATION: **SCIENCE GARDEN, QUEZON CITY**
PERIOD: **1981 - 2010**

LATITUDE: **14°38'41.35"N**
LONGITUDE: **121°02'40.45"E**
ELEVATION: **43m**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16a)	(16b)
MONTH	RAINFALL		TEMPERATURE						VAPOR PRESS. (mbs)	RH (%)	MSLP (mbs)	WIND		CLOUD AMT. (okta)	NO. OF DAYS W/	
	AMOUNT (mm)	NO. OF RD	MAX (°C)	MIN (°C)	MEAN (°C)	DRY BULB (°C)	WET BULB (°C)	DEW POINT (°C)				DIR (16pt)	SPD (mps)		TSTM	LTNG
JAN	18.5	4	30.6	20.8	25.7	25.3	22.2	20.9	24.6	76	1012.3	N	1	5	1	0
FEB	14.6	3	31.7	20.9	26.3	26	22.3	20.8	24.4	73	1012	NE	1	5	0	0
MAR	24.8	4	33.4	22.1	27.8	27.6	23.2	21.5	25.4	69	1011.3	SE	1	4	2	1
APR	40.4	5	35	23.7	29.4	29.2	24.4	22.7	27.2	67	1009.7	SE	1	4	4	2
MAY	186.7	10	34.7	24.7	29.7	29.3	25.3	23.9	29.5	72	1008.5	S	1	5	12	8
JUN	316.5	18	33.1	24.6	28.8	28.4	25.5	24.5	30.6	79	1008.1	SW	1	6	17	9
JUL	493.3	22	31.9	24.1	28	27.5	25.2	24.4	30.5	83	1007.7	SW	2	6	19	9
AUG	504.2	23	31.3	24.2	27.8	27.3	25.2	24.5	30.6	84	1007.4	SW	2	7	17	6
SEP	451.2	22	31.6	24	27.8	27.2	25.1	24.4	30.4	84	1010.6	SW	1	6	18	9
OCT	296.6	18	31.6	23.5	27.6	27	24.7	23.9	29.5	83	1008.8	N	1	6	11	6
NOV	148.8	14	31.4	22.7	27.1	26.5	24.1	23.2	28.4	82	1010.1	N	1	5	5	1
DEC	78.7	8	30.5	21.6	26	25.5	22.8	21.7	25.9	79	1011.5	N	1	5	1	0
ANNUAL	**2574.4**	**153**	**32.2**	**23.1**	**27.7**	**27.2**	**24.2**	**23**	**28.1**	**78**	**1009.8**	**N**	**1**	**5**	**107**	**51**

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PREPARED BY: **CADS/CAD/PAGASA**

Annex 2.3-2

Climatological Extremes

Republic of the Philippines
Department of Science and Technology
Philippine Atmospheric, Geophysical and Astronomical Services Administration
Climatology and Agrometeorology Division
CLIMATE AND AGROMET DATA SECTION
PAGASA Science Garden Complex, Agham Road, Diliman Quezon City, Philippines
Telefax: (632)-434-2698

CLIMATOLOGICAL EXTREMES

STATION: **NAIA (MIA), PASAY CITY**
YEAR: **AS OF 2018**

LATITUDE: **14°30'25.75"N**
LONGITUDE: **121°00'15.90"E**
ELEVATION: **21m**

MONTH	TEMPERATURE (°C)				GREATEST DAILY RAINFALL (mm)		STRONGEST WINDS (mps)			SEA LEVEL PRESSURES (mbs)			
	HIGH	DATE	LOW	DATE	AMOUNT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN	35.8	01-07-1989	14.8	01-18-1961	55.3	01-03-1970	20	ENE	01-12-1986	1022.3	01-27-1987	1004.4	01-01-1950
FEB	35.1	02-21-1998	14.6	02-01-1962	20.5	02-18-2017	20	E	02-28-1988	1021.4	02-01-1998	1003.8	02-21-2001
MAR	36.5	03-30-1978	16.0	03-03-1963	36.0	03-07-2011	26	E	03-29-1992	1021.1	03-02-1987	1002.4	03-06-1999
APR	37.8	04-23-1948	18.7	04-01-1994	63.0	04-04-1992	22	ESE	04-06-1986	1019.9	04-23-1987	1002.8	04-21-2001
MAY	38.2	05-18-2014	19.1	05-11-1950	229.1	05-27-1960	31	SW	05-22-1976	1015.9	05-09-1957	992.2	05-17-1989
JUNE	38.0	06-02-1991	20.0	06-22-1954	353.8	06-01-1958	36	S	06-29-1964	1016.0	06-07-1997	974.6	06-29-1964
JULY	36.4	07-26-2016	18.3	07-28-1948	472.4	07-20-1972	36	W	07-08-1986	1014.9	07-07-1953	990.1	07-16-2014
AUG	36.5	08-15-2017	17.4	08-09-1949	401.8	08-10-1947	30	WSW	08-16-1984	1015.2	08-12-1958	992.8	08-24-1978
SEP	35.6	09-08-2017	19.1	09-15-1950	228.9	09-08-1963	40	NNW	09-28-2006	1016.2	09-18-2005	986.7	09-30-1995
OCT	36.0	10-24-1976	18.0	10-23-1981	274.5	10-09-1978	27	W	10-18-1985	1017.0	10-25-1986	977.9	10-14-1970
NOV	35.8	11-17-1972	17.2	11-26-1949	121.7	11-14-1977	56	W	11-19-1970	1019.4	11-03-1989	899.4	11-03-1995
DEC	34.2	12-29-1978	16.3	12-18-1955	125.5	12-15-2015	25	NW	12-30-1950	1020.9	12-08-1960	995.5	12-02-2004
ANNUAL	**38.2**	**05-18-1969**	**14.6**	**02-01-1962**	**472.4**	**07-20-1972**	**56**	**W**	**11-19-1970**	**1022.3**	**01-27-1987**	**899.4**	**11-03-1995**
Period of Record	**1947 - 2018**				**1949 - 2018**		**1950 - 2018**			**1950 - 2018**			

PREPARED BY: **CADS/CAD/PAGASA**

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CLIMATOLOGICAL EXTREMES

STATION: **SCIENCE GARDEN, QUEZON CITY**
YEAR: **AS OF 2018**

LATITUDE: **14°38'41.35"N**
LONGITUDE: **121°02'40.45"E**
ELEVATION: **43m**

MONTH	TEMPERATURE (°C)				GREATEST DAILY RAINFALL (mm)		STRONGEST WINDS (mps)			SEA LEVEL PRESSURES (mbs)			
	HIGH	DATE	LOW	DATE	AMOUNT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN	34.7	01-17-1998	15.5	01-27-1987	55.8	01-16-1988	24	ESE	01-17-1972	1021.4	01-21-2005	998.8	01-22-1989
FEB	35.6	02-24-1967	15.1	02-04-1987	61.7	02-22-2013	22	SSE	02-02-1992	1021.7	02-14-2017	1002.3	02-09-1985
MAR	36.8	03-26-1983	14.9	03-01-1963	65.0	03-31-2012	13	S	03-16-1992	1021.0	03-05-2005	997.8	03-28-1988
APR	38.0	04-25-1998	17.2	04-05-1963	64.8	04-21-2015	26	SSE	04-07-1992	1016.9	04-05-1998	1001.4	04-16-2007
										1016.9	04-03-2017		
MAY	38.5	05-14-1987	17.8	05-03-1962	166.0	05-20-1966	21	N	05-10-1992	1015.1	05-28-1986	992.4	05-17-1989
JUNE	38.0	06-02-1993	18.1	06-27-1961	334.5	06-07-1967	37	SW	06-25-1972	1014.9	06-07-1997	978.7	06-26-1993
JULY	36.2	07-20-1998	17.7	07-23-1961	246.4	07-07-2002	36	NNW	07-09-1977	1015.0	07-01-1979	989.2	07-15-1978
AUG	36.1	08-17-2017	17.8	08-23-1964	391.4	08-07-2012	32	N	08-22-2000	1015.3	08-23-2002	994.2	08-24-1978
SEP	35.6	09-10-2017	20.0	09-08-1964	455.0	09-26-2009	35	NE	09-28-2006	1016.0	09-28-1997	987.4	09-30-1995
OCT	35.4	10-09-2003	18.6	10-31-1967	209.3	10-18-1975	30	SE	10-11-1989	1016.0	10-25-1986	978.7	10-23-1988
NOV	35.0	11-01-2001	15.6	11-12-1962	169.9	11-20-1966	50	NNW	11-03-1995	1019.1	11-18-1979	980.6	11-03-1995
DEC	34.9	12-06-2018	15.1	12-13-1988	135.5	12-15-2015	22	SE	12-22-1997	1020.0	12-27-2001	998.1	12-02-2004
ANNUAL	**38.5**	**05-14-1987**	**14.9**	**03-01-1963**	**455.0**	**09-26-2009**	**50**	**NNW**	**11-03-1995**	**1021.4**	**01-21-2005**	**978.7**	**06-26-1993** **10-23-1988**
Period of Record	**1961 - 2018**				**1961 - 2018**		**1961 - 2018**			**1961 - 2018**			

PREPARED BY: **CADS/CAD/PAGASA**

Annex 2.3-3

Daily Wind Data

(on CD)

Annex 2.3-4

Beaufort Windscale

The Beaufort Wind Force Scale

Force	Description	Wind Speed (m/s)	Land Condition
0	Calm	0.0 to 0.02	Smoke rises vertically
1	Light air	0.3 to 1.5	Direction of wind shown by smoke
2	Light breeze	1.6 to 3.3	Wind felt on face; vane moved by wind
3	Gentle breeze	3.4 to 5.4	Leaves in constant motion; wind extends light flags
4	Moderate breeze	5.5 to 7.9	Raises dust and loose paper; small branches are moved
5	Fresh breeze	8.0 to 10.7	Wavelets form on inland water; small trees with leaves begin to sway
6	Strong breeze	10.8 to 13.8	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty
7	Near gale	13.9 to 17.1	Whole trees in motion; inconvenience felt when walking against the wind; umbrellas discarded in exposed places
8	Gale	17.2 to 20.7	Breaks twigs off trees; generally impedes progress
9	Strong gale	20.8 to 24.4	Slight structural damage; roofing dislodged; larger branches break off
10	Storm	24.5 to 28.4	Seldom experienced inland; trees uprooted; considerable structural damage occurs
11	Violent storm	28.5 to 32.6	Very rarely experienced; accompanied by widespread damage
12	Hurricane	32.7 and over	Very rarely experienced; accompanied by widespread damage

Source: National Meteorological Library and Archive Fact Sheet 6 – The Beaufort Scale (version 1)

Annex 2.3-5

Fuel Consumption of Equipment and Vehicle Fleet

	Equipment Name	Annual Quantity	Capacity	Fuel Consumption	Total Fuel Consumption		Net Fuel Consumption		Electricity Consumption		
			kW	gal/hr	(gal/hr)	(lbs/hr)	(tonnes/yr) (Q)	(kL/yr) (Q)	(kW)	(MWh)	(MWh/year)
Construction Phase											
Station Box	20T Crawler crane with clamshell	3	154	3.783783784	11.35135135	80.69562162	320.6413024	373.73			
	Concrete Pump	1		6.25	6.25	44.430625	176.5435742	205.77			
	Excavator	6		5.12	30.72	218.385408	867.7469761	1,011.42			
	De-watering pump	1	79.1	1.943488943	1.943488943	13.81606855	54.89767753	63.99			
	Concrete Buggy	6		0.45	2.7	19.19403	76.26682407	88.89			
	Concrete Vibrator	8		0.42	3.36	23.885904	94.90982551	110.62			
	High pressure washer	2		0.42	0.84	5.971476	23.72745638	27.66			
	Power trowel	6		0.42	2.52	17.914428	71.18236913	82.97			
	Gantry crane	1							45.50	0.05	
	Hand Tools										
	Total							1,965.04			
TBM	Tunnel Boring Machine	1							2,100.00	2.10	18,396.00
	25T Gantry Crane	1							45.50	0.05	398.58
	Backfill Grouting Plant	1	15	0.368550369	0.368550369	2.619987715	10.4104319	12.13			
	25T Locomotive	2	400	9.828009828	19.65601966	139.7326781	555.2230345	647.15			
	9 m3 Muck Skip	6									
	Segment Car	2									
	Ventilation Fan	1	50	1.228501229	1.228501229	8.733292383	34.70143965	40.45			
	20T Excavator	1		5.1200	5.12	36.397568	144.624496	168.57			
	Total							868.30			
NATM	Load Header	1	300								
	Backhoe	1		5.1200							
	Dumptruck	1		5.34	5.34	37.961526	150.8388298	175.81			
	Gantry crane	1							45.5	0.05	398.58
	Grab bucket	1									
	Cement silo	1									
	Concrete plant	1									
	aggregate hopper	1									
	Shotcrete machine	1		0.5	0.45	3.199005	12.71113735	14.82			
	Concrete pump	1		6.3	6.25	44.430625	176.5435742	205.77			
	Axial flow fan	1		1.2	1.22	8.672858	34.46130569	40.17			
	Pipe	1									
	Slide control	1									
	Electrical precipitator	1									
	Compressor	1									
	Water and sewage	1									
	Power supply system	1									

	Total							436.57			
											19,193.16
Operations Phase											
	Station Requirements										
1	MMS Depot								400.00		
2	Quirino Highway								400.00		
3	Tandang Sora								400.00		
4	North Ave								400.00		
5	Quezon Avenue								400.00		
6	East Avenue								400.00		
7	Anonas								400.00		
8	Katipunan								400.00		
9	Ortigas North								400.00		
10	Ortigas South								400.00		
11	Kalayaan								400.00		
12	BGC								400.00		
13	Lawton East								400.00		
14	Lawton West								400.00		
15	FTI								400.00		
16	NAIA Terminal 3								400.00		
									6,400.00	6.40	42,048.00
	Trains (Express)								3,600.00	3.60	28,014.48
	Trains (Local)								3,600.00	3.60	77,263.20
	Total								13,600.00	13.60	147,325.68

Annex 2.3-6

GHG Calculations

Scope 1 Emissions

Sector	Energy												
Category	Diesel consumption activities												
	Energy Consumption			CO_2		CH_4		N_2O		GWP			Total Annual Cumulative GHG Emissions
	Consumption (kL/Year)	Energy Content Factor (TJ/kL)	Consumption (TJ/Year)	Emission Factor (kg/TJ)	CO_2 Emissions	Emission Factor (kg/TJ)	CH_4 Emissions	Emission Factor (kg/TJ)	N_2O Emissions	CO_2	CH_4	N_2O	Tonnes of CO_2-e
	A	B	C = A*B	D	E = (C*D)/1,000	F	G = (C*F)/1,000	H	I = (C*H)/1,000	J	K	L	M = (E*J) + (G*K) + (I*L)
Construction Phase													
Mobile Sources	3,269.91	0.0386	126.22	74,100.00	9,352.79	3.00	0.38	0.60	0.08	1.00	28.00	265.00	9,383.46
Total													**9,383.46**

Scope 2 Emissions

Sector	Energy				
Category	Purchased Electricity				
	Energy Consumption				Total Annual Cumulative GHG Emissions
	Consumption (kWh)	Consumption (MWh/year))	Electricity Emission Factor (tCO2/MWh)	T&D Losses	Tonnes of CO_2-e
	A	B = (A/1,000)*24*365	C	D	E = (B*C)/(1-D)
Construction Phase					
Electricity	2,236.50	19,591.7400	0.59	0.20	14,497.89
	-	-	-	0.20	-
Total					**14,497.89**
Operations Phase					
Electricity	13,600.00	147,325.6800	0.59	0.20	109,021.00
					-
Total					**109,021.00**

Annex 2.3-7

Laboratory Certificates for Ambient Air

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

Date of Sampling: March 27 to 31, April 3 to 5 and May 3 to 5, 2017

Station I.D.	Location	TSP (µg/Ncm)	PM_{10} (µg/Ncm)	Pb (µg/Ncm)	NO_2 (µg/Ncm)	SO_2 (µg/Ncm)	O_3 (µg/Ncm)
A1	Trinoma Mindanao Ave., Parking Area Near Landmark	103.1	37.2	ND	31.9	3.5	ND
A2	MMDA Impounding Ultra 2 Pasig	159.7	77.4	ND	28.3	ND	ND
A3	BGC Market Market Parking Area	112.5	54.7	ND	37.3	1.6	ND
A4	PNR FTI Station Taguig City	204.3	81.4	ND	37.2	ND	ND
A5	World Citi Medical Center	93.6	57.1	ND	28.3	2.0	ND
A6	Rolling Hills Resort Valenzuela City	57.5	44.2	ND	15.7	5.3	ND
^National Ambient Air Quality Guideline Values (NAAGQV)		**230**	**150**	**1.5***	**150**	**180**	**140****
Remarks		**Passed**	**Passed**	**Passed**	**Passed**	**Passed**	**Passed**

All Parameters = Corrected to 25°C, 760mmHg; ND = Not Detected
^RA 8749 (Philippine Clean Air Act of 1999)
*Evaluation of this guideline is carried out for 24-hour averaging time and averaged over three moving calendar months
**Evaluation of this guideline is carried out for 1-hour averaging time

Prepared by: Jerec O. Ceria
QA/QC Assistant

Certified by: Walter G. Fiesta
QA/QC Manager

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CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

Trinoma Mindanao Ave, Parking Area Near Landmark

Sampling Time	**Average dB(A)**	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	**Remarks**
March 27 to 28, 2017 0845H - 1045H	**63.6**	60	Exceeded
1045H - 1245H	**63.8**	65	Within
1245H - 1445H	**62.7**	65	Within
1445H - 1645H	**63.3**	65	Within
1645H - 1845H	**64.3**	65	Within
1845H - 2045H	**62.6**	60	Exceeded
2045H - 2245H	**63.7**	60	Exceeded
2245H - 0045H	**58.7**	55	Exceeded
0045H - 0245H	**56.6**	55	Exceeded
0245H - 0445H	**55.0**	55	Within
0445H - 0645H	**54.4**	55	Within
0645H - 0845H	**63.5**	60	Exceeded

***Category	"B"	A section or contiguous area which is primarily commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Jerec O. Ceria
QA/QC Assistant

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

Centris Area Back of BPO 3 Bldg.

Sampling Time	**Average dB(A)**	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	**Remarks**
March 28 to 29, 2017 1210H - 1410H	**62.3**	65	Within
1410H - 1610H	**63.1**	65	Within
1610H - 1810H	**63.8**	65	Within
1810H - 2010H	**64.1**	60	Exceeded
2010H - 2210H	**64.3**	60	Exceeded
2210H - 0010H	**62.2**	55	Exceeded
0010H - 0210H	**63.2**	55	Exceeded
0210H - 0410H	**61.4**	55	Exceeded
0410H - 0610H	**62.9**	55	Exceeded
0610H - 0810H	**63.8**	60	Exceeded
0810H - 1010H	**63.7**	60	Exceeded
1010H - 1210H	**63.2**	65	Within

***Category "B" A section or contiguous area which is primarily commercial area
0900 H – 1800 H – 65 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 60 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 55 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 60 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]
Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:
Jerec O. Ceria
QA/QC Assistant

Certified by:
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CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

BCDA Field Office Taguig

Sampling Time	**Average dB(A)**	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	**Remarks**
March 29 to 30, 2017 1510H - 1710H	**64.6**	65	Within
1710H - 1910H	**69.1**	65	Exceeded
1910H - 2110H	**64.4**	60	Exceeded
2110H - 2310H	**64.5**	60	Exceeded
2310H - 0110H	**59.4**	55	Exceeded
0110H - 0310H	**59.9**	55	Exceeded
0310H - 0510H	**61.0**	55	Exceeded
0510H - 0710H	**65.2**	60	Exceeded
0710H - 0910H	**63.9**	60	Exceeded
0910H - 1110H	**64.2**	65	Within
1110H - 1310H	**64.5**	65	Within
1310H - 1510H	**64.7**	65	Within

***Category	"B"	A section or contiguous area which is primarily commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by: Jerec O. Ceria
QA/QC Assistant

Certified by: Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

PNR FTI Station Taguig City

Sampling Time	Average dB(A)	DENR Standard Maximum Allowable Noise Level, dB(A)***	Remarks
March 30 to 31, 2017 1545H- 1745H	**76.5**	65	Exceeded
1745H - 1945H	**75.8**	65	Exceeded
1945H - 2145H	**74.0**	60	Exceeded
2145H - 2345H	**73.5**	60	Exceeded
2345H - 0145H	**70.6**	55	Exceeded
0145H - 0345H	**69.3**	55	Exceeded
0345H - 0545H	**68.4**	55	Exceeded
0545H - 0745H	**75.3**	60	Exceeded
0745H - 0945H	**74.1**	60	Exceeded
0945H - 1145H	**76.0**	65	Exceeded
1145H - 1345H	**75.8**	65	Exceeded
1345H - 1545H	**75.0**	65	Exceeded

***Category	"B"	A section or contiguous area which is primarily commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

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Certified by:

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CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

Brgy. Blue Ridge A, Quezon City

Sampling Time	Average dB(A)	DENR Standard Maximum Allowable Noise Level, dB(A)***	Remarks
May 4 to 5, 2017 1605H - 1805H	**51.4**	65	Within
1805H - 2005H	**53.5**	60	Within
2005H - 2205H	**54.3**	60	Within
2205H - 0005H	**54.3**	55	Within
0005H - 0205H	**51.3**	55	Within
0205H - 0405H	**51.4**	55	Within
0405H - 0605H	**51.5**	55	Within
0605H - 0805H	**52.4**	60	Within
0805H - 1005H	**53.3**	60	Within
1005H - 1205H	**51.8**	65	Within
1205H - 1405H	**52.4**	65	Within
1405H - 1605H	**52.4**	65	Within

***Category "B" A section or contiguous area which is primarily commercial area
0900 H – 1800 H – 65 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 60 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 55 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 60 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:
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CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

Landcom Village II, Tandang Sora, Quezon City

Sampling Time	Average dB(A)	DENR Standard Maximum Allowable Noise Level, dB(A)***	Remarks
May 2 to 3, 2017 0835H - 1035H	**69.2**	50	Exceeded
1035H - 1235H	**71.9**	55	Exceeded
1235H - 1435H	**72.2**	55	Exceeded
1435H - 1635H	**71.1**	55	Exceeded
1635H - 1835H	**72.9**	55	Exceeded
1835H - 2035H	**72.5**	50	Exceeded
2035H - 2235H	**71.0**	50	Exceeded
2235H - 0035H	**68.9**	45	Exceeded
0035H - 0235H	**64.4**	45	Exceeded
0235H - 0435H	**71.4**	45	Exceeded
0435H - 0635H	**69.0**	45	Exceeded
0635H - 0835H	**73.1**	50	Exceeded

***Category "A" A section or contiguous area which is primarily used for the residential purposes
0900 H – 1800 H – 55 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 50 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 45 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 50 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]
Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:
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QA/QC Assistant

Certified by:
Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

Capitol Commons Ortigas

Sampling Time	Average dB(A)	DENR Standard Maximum Allowable Noise Level, dB(A)***	Remarks
April 4 to 5, 2017 1342H - 1542H	**65.0**	65	Within
1542H - 1742H	**63.7**	65	Within
1742H - 1942H	**64.8**	65	Within
1942H - 2142H	**63.2**	60	Exceeded
2142H - 2342H	**65.6**	60	Exceeded
2342H - 0142H	**64.2**	55	Exceeded
0142H - 0342H	**65.0**	55	Exceeded
0342H - 0542H	**68.3**	55	Exceeded
0542H - 0742H	**70.2**	60	Exceeded
0742H - 0942H	**79.0**	60	Exceeded
0942H - 1142H	**80.0**	65	Exceeded
1142H - 1342H	**77.0**	65	Exceeded

***Category "B" A section or contiguous area which is primarily commercial area
0900 H – 1800 H – 65 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 60 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 55 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 60 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Jerec O. Ceria
QA/QC Assistant

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

World Citi Medical Center

Sampling Time	Average dB(A)	DENR Standard Maximum Allowable Noise Level, dB(A)***	Remarks
April 3 to 4, 2017 0835H - 1035H	**63.3**	45	Exceeded
1035H - 1235H	**63.5**	50	Exceeded
1235H - 1435H	**63.2**	50	Exceeded
1435H - 1635H	**63.7**	50	Exceeded
1635H - 1835H	**63.5**	50	Exceeded
1835H - 2035H	**63.4**	45	Exceeded
2035H - 2235H	**63.5**	45	Exceeded
2235H - 0035H	**63.0**	40	Exceeded
0035H - 0235H	**63.0**	40	Exceeded
0235H - 0435H	**63.5**	40	Exceeded
0435H - 0635H	**63.8**	40	Exceeded
0635H - 0835H	**69.9**	45	Exceeded

***Category "AA" A section or contiguous area which requires quietness such as areas within 100 m from hospitals
0900 H – 1800 H – 50 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 45 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 40 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 45 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]
Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by: Jerec O. Ceria
QA/QC Assistant

Certified by: Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Engr. Angelica A. Celicious

Rolling Hills Resort Valenzuela City

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
May 3 to 4, 2017 1315H - 1515H	**52.0**	65	Within
1515H - 1715H	**54.3**	65	Within
1715H - 1915H	**58.3**	65	Within
1915H - 2115H	**57.3**	60	Within
2115H - 2315H	**56.8**	60	Within
2315H - 0115H	**57.5**	55	Exceeded
0115H - 0315H	**54.7**	55	Within
0315H - 0515H	**53.2**	55	Within
0515H - 0715H	**55.0**	60	Within
0715H - 0915H	**52.4**	60	Within
0915H - 1115H	**53.7**	65	Within
1115H - 1315H	**53.1**	65	Within

***Category	"B"	A section or contiguous area which is primarily commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:
Jerec O. Ceria
QA/QC Assistant

Certified by:
Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Date of Sampling: July 10-15, 17-19 & 26-27, 2017

Station I.D.	Location	TSP (μg/Ncm)	PM_{10} (μg/Ncm)	NO_2 (μg/Ncm)	SO_2 (μg/Ncm)
A1	Valenzuela Depot – Hyundai (Along Mindanao Ave. near Intersection going to NLEX)	***521***	***209***	26.8	17.1
A2	Mindanao Ave. – Quirino Highway (Pacific Global Medical Center)	***248***	***191***	20.8	ND
A3	Landcom Village II, Brgy. Tandang Sora, Quezon City along Mindanao Ave.	85.9	41.3	4.5	ND
A4	EDSA near Quezon Ave. – Avida Towers area, former Manila Seedling Bank	94.9	78.7	8.2	ND
A5	Anonas – World Citi Medical Center	72.7	29.1	17.9	ND
A6	North Ave. – Trinoma Open Parking Lot	66.0	47.2	6.7	1.8
A7	Meralco Ave. cor. Shaw Blvd. – Estancia Mall, Capitol Commons	60.0	34.0	10.3	ND
A8	V. Luna St. near East Ave. – AFP Medical Center	67.4	40.2	5.0	0.9
A9	Meralco Ave. cor. Julia Vargas Ave. – MMDA Impounding Area	31.9	19.6	15.7	ND
A10	Katipunan – Inside Blue Ridge A	***265***	86.3	8.6	1.4
A11	BGC – Market Market Parking Lot	110.4	***193***	21.0	ND
A12	Cayetano – BCDA Field Office	74.6	71.5	14.6	1.7
A13	FTI PNR Station	209.7	34.8	27.3	2.0
A14	BGC – 11th St. cor. 38th St.	51.0	25.2	9.8	1.4
National Ambient Air Quality Guideline Values (NAAQGV)^		**230**	**150**	**150**	**180**
Remarks		**A1, A2 & A10 Exceeded**	**A1, A2 & A11 Exceeded**	**Passed**	**Passed**

TSP, PM_{10}, NO_2, SO_2 = Corrected to 25°C, 760mmHg; ND – Not Detected
^RA 8749 (Philippine Clean Air Act of 1999)

Prepared by:

Kristin Anne C. Castillo
QA/QC Officer

Certified by:

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CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A1 Valenzuela Depot – Hyundai (Along Mindanao Ave. near Intersection going to NLEX)

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 10-11, 2017 1105H - 1305H	***81.4***	65	Exceeded
1305H - 1505H	***82.1***	65	Exceeded
1505H - 1705H	***79.6***	65	Exceeded
1705H - 1905H	***76.0***	65	Exceeded
1905H - 2105H	***77.6***	60	Exceeded
2105H - 2305H	***77.3***	60	Exceeded
2305H - 0105H	***77.4***	55	Exceeded
0105H - 0305H	***74.6***	55	Exceeded
0305H - 0505H	***74.6***	55	Exceeded
0505H - 0705H	***80.3***	60	Exceeded
0705H - 0905H	***79.7***	60	Exceeded
0905H - 1105H	***78.5***	65	Exceeded

***Category	"B"	A section which is primarily a commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Kristin Anne C. Castillo
QA/QC Officer

Certified by:

Walter G. Fiesta
QA/QC Manager

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CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A2 Mindanao Ave. – Quirino Highway (Pacific Global Medical Center)

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 10-11, 2017 1250H - 1450H	***78.9***	50	Exceeded
1450H - 1650H	***76.6***	50	Exceeded
1650H - 1850H	***72.1***	50	Exceeded
1850H - 2050H	***70.3***	45	Exceeded
2050H - 2250H	***70.8***	45	Exceeded
2250H - 0050H	***67.4***	40	Exceeded
0050H - 0250H	***70.3***	40	Exceeded
0250H - 0450H	***68.7***	40	Exceeded
0450H - 0650H	***72.4***	40	Exceeded
0650H - 0850H	***76.8***	45	Exceeded
0850H - 1050H	***70.6***	45	Exceeded
1050H - 1250H	***68.6***	50	Exceeded

***Category "AA" A section which requires quietness such as areas within 100 meters from hospitals
0900 H – 1800 H – 50 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 45 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 40 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 45 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:
Kristin Anne C. Castillo
QA/QC Officer

Certified by:
Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A3 Landcom Village II, Brgy. Tandang Sora, Quezon City along Mindanao Ave.

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 11-12, 2017 1300H - 1500H	***76.3***	55	Exceeded
1500H - 1700H	***77.5***	55	Exceeded
1700H - 1900H	***77.6***	55	Exceeded
1900H - 2100H	***75.5***	50	Exceeded
2100H - 2300H	***75.2***	50	Exceeded
2300H - 0100H	***71.2***	45	Exceeded
0100H - 0300H	***70.4***	45	Exceeded
0300H - 0500H	***72.1***	45	Exceeded
0500H - 0700H	***74.2***	50	Exceeded
0700H - 0900H	***75.1***	50	Exceeded
0900H - 1100H	***77.8***	55	Exceeded
1100H - 1300H	***77.4***	55	Exceeded

***Category	"A"	A section which is primarily reserved used for residential purposes
0900 H – 1800 H –	55	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	50	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	45	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	50	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Kristin Anne C. Castillo
QA/QC Officer

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A4 EDSA near Quezon Ave. – Avida Towers area, former Manila Seedling Bank

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 11-12, 2017 1515H - 1715H	***70.4***	65	Exceeded
1715H - 1915H	***71.9***	65	Exceeded
1915H - 2115H	***76.1***	60	Exceeded
2115H - 2315H	***71.4***	60	Exceeded
2315H - 0115H	***72.1***	55	Exceeded
0115H - 0315H	***70.4***	55	Exceeded
0315H - 0515H	***70.1***	55	Exceeded
0515H - 0715H	***70.9***	60	Exceeded
0715H - 0915H	***73.6***	60	Exceeded
0915H - 1115H	***71.8***	65	Exceeded
1115H - 1315H	***75.8***	65	Exceeded
1315H - 1515H	***71.1***	65	Exceeded

***Category "B" A section which is primarily a commercial area
0900 H – 1800 H – 65 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 60 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 55 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 60 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:
Kristin Anne C. Castillo
QA/QC Officer

Certified by:
Walter G. Fiesta
QA/QC Manager

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A5 Anonas – World Citi Medical Center

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 12-13, 2017 1610H - 1810H	***75.4***	50	Exceeded
1810H - 2010H	***75.7***	45	Exceeded
2010H - 2210H	***76.1***	45	Exceeded
2210H - 0010H	***71.4***	40	Exceeded
0010H - 0210H	***68.5***	40	Exceeded
0210H - 0410H	***64.5***	40	Exceeded
0410H - 0610H	***73.3***	40	Exceeded
0610H - 0810H	***78.9***	45	Exceeded
0810H - 1010H	***77.8***	45	Exceeded
1010H - 1210H	***78.3***	50	Exceeded
1210H - 1410H	***78.0***	50	Exceeded
1410H - 1610H	***77.3***	50	Exceeded

***Category "AA" A section which requires quietness such as areas within 100 meters from hospitals
0900 H – 1800 H – 50 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 45 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 40 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 45 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

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QA/QC Officer

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A6 North Ave. – Trinoma Open Parking Lot

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 12-13, 2017 1740H - 1940H	**58.7**	65	Within
1940H - 2140H	***60.9***	60	Exceeded
2140H - 2340H	**57.1**	60	Within
2340H - 0140H	***59.9***	55	Exceeded
0140H - 0340H	***59.6***	55	Exceeded
0340H - 0540H	***59.7***	55	Exceeded
0540H - 0740H	**58.1**	60	Within
0740H - 0940H	**56.4**	60	Within
0940H - 1140H	**60.5**	65	Within
1140H - 1340H	**58.5**	65	Within
1340H - 1540H	**59.2**	65	Within
1540H - 1740H	**60.4**	65	Within

***Category "B" A section which is primarily a commercial area
0900 H – 1800 H – 65 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 60 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 55 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 60 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

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Certified by:

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CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A7 Meralco Ave. cor. Shaw Blvd. – Estancia Mall, Capitol Commons

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 13-14, 2017 2050H - 2250H	***64.2***	60	Exceeded
2250H - 0050H	***58.9***	55	Exceeded
0050H - 0250H	***59.7***	55	Exceeded
0250H - 0450H	***59.2***	55	Exceeded
0450H - 0650H	***57.7***	55	Exceeded
0650H - 0850H	***62.2***	60	Exceeded
0850H - 1050H	***62.9***	60	Exceeded
1050H - 1250H	**62.4**	65	Within
1250H - 1450H	**60.7**	65	Within
1450H - 1650H	**56.7**	65	Within
1650H - 1850H	***66.6***	65	Exceeded
1850H - 2050H	**60.6**	65	Within

***Category "B" A section which is primarily a commercial area
0900 H – 1800 H – 65 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 60 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 55 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 60 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

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Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A8 V. Luna St. near East Ave. – AFP Medical Center

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 14-15, 2017 0730H - 0930H	***62.8***	45	Exceeded
0930H - 1130H	***63.2***	50	Exceeded
1130H - 1330H	***62.5***	50	Exceeded
1330H - 1530H	***62.5***	50	Exceeded
1530H - 1730H	***62.9***	50	Exceeded
1730H - 1930H	***68.6***	50	Exceeded
1930H - 2130H	***67.6***	45	Exceeded
2130H - 2330H	***64.6***	45	Exceeded
2330H - 0130H	***63.9***	40	Exceeded
0130H - 0330H	***64.6***	40	Exceeded
0330H - 0530H	***66.0***	40	Exceeded
0530H - 0730H	***65.8***	45	Exceeded

***Category	"AA"	A section which requires quietness such as areas within 100 meters from hospitals
0900 H – 1800 H –	50	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	45	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	40	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	45	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

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TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A9 Meralco Ave. cor. Julia Vargas Ave. – MMDA Impounding Area

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 14-15, 2017 2200H - 0000H	***54.7***	55	Exceeded
0000H - 0200H	***57.8***	55	Exceeded
0200H - 0400H	***58.1***	55	Exceeded
0400H - 0600H	**53.5**	55	Within
0600H - 0800H	**59.3**	60	Within
0800H - 1000H	**56.3**	60	Within
1000H - 1200H	**58.9**	65	Within
1200H - 1400H	**61.1**	65	Within
1400H - 1600H	**57.1**	65	Within
1600H - 1800H	**60.5**	65	Within
1800H - 2000H	***69.1***	60	Exceeded
2000H - 2200H	***70.4***	60	Exceeded

***Category	"B"	A section which is primarily a commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Kristin Anne C. Castillo
QA/QC Officer

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A10 Katipunan – Inside Blue Ridge A

Sampling Time	**Average dB(A)**	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	**Remarks**
July 17-18, 2017 1120H - 1320H	**49.0**	55	Within
1320H - 1520H	**53.7**	55	Within
1520H - 1720H	***57.7***	55	Exceeded
1720H - 1920H	**50.8**	55	Within
1920H - 2120H	***57.0***	50	Exceeded
2120H - 2320H	**49.3**	50	Within
2320H - 0120H	***50.5***	45	Exceeded
0120H - 0320H	***48.7***	45	Exceeded
0320H - 0520H	***51.8***	45	Exceeded
0520H - 0720H	***50.5***	50	Exceeded
0720H - 0920H	***51.4***	50	Exceeded
0920H - 1120H	**53.6**	55	Within

***Category	"A"	A section which is primarily reserved used for residential purposes
0900 H – 1800 H –	55	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	50	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	45	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	50	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Kristin Anne C. Castillo
QA/QC Officer

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A11 BGC – Market Market Parking Lot

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 17-18, 2017 1240H - 1440H	***73.3***	65	Exceeded
1440H - 1640H	***69.1***	65	Exceeded
1640H - 1840H	***69.3***	65	Exceeded
1840H - 2040H	***68.7***	60	Exceeded
2040H - 2240H	***68.3***	60	Exceeded
2240H - 0040H	***66.7***	55	Exceeded
0040H - 0240H	***62.3***	55	Exceeded
0240H - 0440H	***62.1***	55	Exceeded
0440H - 0640H	***62.3***	55	Exceeded
0640H - 0840H	***68.4***	60	Exceeded
0840H - 1040H	***68.9***	60	Exceeded
1040H - 1240H	***68.9***	65	Exceeded

***Category "B" A section which is primarily a commercial area
0900 H – 1800 H – 65 dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H – 60 dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H – 55 dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H – 60 dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]
Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:
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QA/QC Officer

Certified by:
Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A12 Cayetano – BCDA Field Office

Sampling Time	**Average dB(A)**	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	**Remarks**
July 18-19, 2017 1435H - 1635H	***67.0***	65	Exceeded
1635H - 1835H	***69.0***	65	Exceeded
1835H - 2035H	***69.0***	60	Exceeded
2035H - 2235H	***64.3***	60	Exceeded
2235H - 0035H	***64.2***	55	Exceeded
0035H - 0235H	***63.0***	55	Exceeded
0235H - 0435H	***63.3***	55	Exceeded
0435H - 0635H	***63.6***	55	Exceeded
0635H - 0835H	***64.4***	60	Exceeded
0835H - 1035H	***66.4***	60	Exceeded
1035H - 1235H	**64.4**	65	Within
1235H - 1435H	***65.8***	65	Exceeded

***Category	"B"	A section which is primarily a commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Kristin Anne C. Castillo
QA/QC Officer

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A13 FTI PNR Station

Sampling Time	Average dB(A)	DENR Standard Maximum Allowable Noise Level, dB(A)***	Remarks
July 18-19, 2017 1525H - 1725H	**67.7**	65	Exceeded
1725H - 1925H	**67.9**	65	Exceeded
1925H - 2125H	**68.5**	60	Exceeded
2125H - 2325H	**85.2**	60	Exceeded
2325H - 0125H	**74.4**	55	Exceeded
0125H - 0325H	**79.7**	55	Exceeded
0325H - 0525H	**82.9**	55	Exceeded
0525H - 0725H	**86.4**	60	Exceeded
0725H - 0925H	**85.0**	60	Exceeded
0925H - 1125H	**85.7**	65	Exceeded
1125H - 1325H	**85.2**	65	Exceeded
1325H - 1525H	**85.0**	65	Exceeded

***Category	"B"	A section which is primarily a commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

Kristin Anne C. Castillo
QA/QC Officer

Certified by:

Walter G. Fiesta
QA/QC Manager

CRL Calabarquez Corporation

TEST RESULTS

Customer : **Delta Tierra Consultants, Inc.**
Attn : Ms. Angelica A. Celicious

Station A14 BGC – 11th St. cor. 38th St.

Sampling Time	Average dB(A)	**DENR Standard** Maximum Allowable Noise Level, dB(A)***	Remarks
July 26-27, 2017 1145H - 1345H	**58.9**	65	Within
1345H - 1545H	**59.3**	65	Within
1545H - 1745H	**63.7**	65	Within
1745H - 1945H	**62.9**	65	Within
1945H - 2145H	***60.7***	60	Exceeded
2145H - 2345H	***61.8***	60	Exceeded
2345H - 0145H	***63.3***	55	Exceeded
0145H - 0345H	***56.5***	55	Exceeded
0345H - 0545H	***59.3***	55	Exceeded
0545H - 0745H	***62.5***	60	Exceeded
0745H - 0945H	***63.0***	60	Exceeded
0945H - 1145H	**63.4**	65	Within

***Category	"B"	A section which is primarily a commercial area
0900 H – 1800 H –	65	dB (Daytime)[Maximum allowable limit based on division of 24-hour sampling]
1800 H – 2200 H –	60	dB (Evening)[Maximum allowable limit based on division of 24-hour sampling]
2200 H – 0500 H –	55	dB (Nighttime)[Maximum allowable limit based on division of 24-hour sampling]
0500 H – 0900 H –	60	dB (Morning)[Maximum allowable limit based on division of 24-hour sampling]

Note: Monitoring was conducted on a 2-hour interval. In practice, the start of sampling time is used as the basis for noise divisions.

Prepared by:

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Certified by:

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PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-1997-017F

DENR Recognized Laboratory with C.R No. 011/2018

Original Issue	☑
Duplicate issue by request	☐
Revision Copy	☐

CERTIFICATE OF ANALYSIS

Customer : AECOM PHILIPPINES, INC.

Address : 14/F BGC Stopover Corporate Center 2nd Avenue cor. 31st Street Bonifacio Global City, Taguig

Attention : MR. AQUINAS HYACITH TOLEDO

CAN : 113551
Date of Issue : 7/12/2019
RAN : 120624
INVOICE # : -
Date Received: 6/24/2019
Date Sampled: 6/20-23/2019
Date Analyzed: 6/24-6/28/2019

RESULTS OF ANALYSIS

Sample Descriptions	Parameters	Results	Units	Method	DAO 2000-81 Standards
Ambient Air Monitoring					
24 Hours Monitoring					
AQ1: Near NAIA T3 (St. Therese of the Child Jesus Parish)	Total Suspended Particulates (TSP) [b]	52	µg/Ncm	Gravimetric	230
1440H-1440H	Particulate Matter 10 (PM_{10}) [c]	45	µg/Ncm	Gravimetric	150
6/21-22/2019	Nitrogen Dioxide (NO_2) [d]	9.1	µg/Ncm	Griess-Saltzman	150
	Sulfur Dioxide (SO_2) [a]	<4	µg/Ncm	Pararosaniline	180
AQ2: Sitio Fort Bonifacio Health Center	Total Suspended Particulates (TSP) [b]	58	µg/Ncm	Gravimetric	230
(Near the National Nutrition Council)	Particulate Matter 10 (PM_{10}) [c]	47	µg/Ncm	Gravimetric	150
1140H-1140H	Nitrogen Dioxide (NO_2) [d]	6.1	µg/Ncm	Griess-Saltzman	150
6/20-21/2019	Sulfur Dioxide (SO_2) [a]	<4	µg/Ncm	Pararosaniline	180
AQ3: Dr. Arcadio Santos National High School	Total Suspended Particulates (TSP) [b]	54	µg/Ncm	Gravimetric	230
1715H-1715H	Particulate Matter 10 (PM_{10}) [c]	47	µg/Ncm	Gravimetric	150
6/21-22/2019	Nitrogen Dioxide (NO_2) [d]	10.0	µg/Ncm	Griess-Saltzman	150

Not valid without Ostrea dry seal

Sample Descriptions	Parameters	Results	Units	Method	DAO 2000-81 Standards
	Sulfur Dioxide (SO_2) [a]	3	µg/Ncm	Pararosaniline	180
1 Hour Monitoring					
AQ1: Near NAIA T3 (St. Therese of the Child Jesus Parish)	Total Suspended Particulates (TSP) [b]	31	µg/Ncm	Gravimetric	300
1445H-1545H	Particulate Matter 10 (PM_{10}) [c]	21	µg/Ncm	Gravimetric	200
6/22/2019	Nitrogen Dioxide (NO_2) [d]	64	µg/Ncm	Griess-Saltzman	260
	Sulfur Dioxide (SO_2) [a]	20	µg/Ncm	Pararosaniline	340
AQ2: Sitio Fort Bonifacio Health Center	Total Suspended Particulates (TSP) [b]	25	µg/Ncm	Gravimetric	300
(Near the National Nutrition Council)	Particulate Matter 10 (PM_{10}) [c]	19	µg/Ncm	Gravimetric	200
1145H-1245H	Nitrogen Dioxide (NO_2) [d]	17	µg/Ncm	Griess-Saltzman	260
6/21/2019	Sulfur Dioxide (SO_2) [a]	16	µg/Ncm	Pararosaniline	340
AQ3: Dr. Arcadio Santos National High School	Total Suspended Particulates (TSP) [b]	32	µg/Ncm	Gravimetric	300
1720H-1820H	Particulate Matter 10 (PM_{10}) [c]	25	µg/Ncm	Gravimetric	200
6/23/2019	Nitrogen Dioxide (NO_2) [d]	20	µg/Ncm	Griess-Saltzman	260
	Sulfur Dioxide (SO_2) [a]	23	µg/Ncm	Pararosaniline	340

Note: The customer is given 7 days upon receipt to raise questions or clarification on any part or content of the certificate, otherwise the result(s) is/are deemed accepted.

Total # of Samples : 6 **Total Analysis** : 24

Sample Submission : Sampled by the OMLI staff

Reference : USEPA 40 CFR , Part 50, Appendices [a] A, [b] B and [c] J; [d] Methods of Air Sampling and Analysis 3rd ed. by J.P Lodge.

Remarks : Results relate only to the items tested and received by the laboratory.

Certified Correct by:

MA. CRISTINA F. REFERENTE, RCh
PRC No. 0007398
Laboratory Head

Authorized by:

ALVIN B. BASCO, RCh
PRC No. 0011786
Head of Operations

OSTREA MINERAL LABORATORIES, INC.
Assaying and Environmental Testing Specialist
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Email : customer.service@ostrealabs.com.ph

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PNS ISO/IEC 17025:2005
LA-1997-017F

DENR Recognized Laboratory with C.R No. 011/2018

Original Issue	☑
Duplicate issue by request	☐
Revision Copy	☐

CERTIFICATE OF ANALYSIS

Customer : AECOM PHILIPPINES, INC.

Address : 14/F BGC Stopover Corporate Center 2nd Avenue cor. 31st Street Bonifacio Global City, Taguig

Attention : MR. AQUINAS HYACITH TOLEDO

CAN : **113551A**
Date of Issue : 7/12/2019
RAN : 120624
INVOICE # : -
Date Received: -
Date Sampled: 6/20-23/2019
Date Analyzed: -

RESULTS OF ANALYSIS

Locations	**Morning (5:00am-9:00am) Noise, dBA**	**Daytime (9:00am - 6:00pm) Noise, dBA**	**Evening (6:00pm - 10:00pm) Noise, dBA**	**Nighttime (10:00pm - 5:00am) Noise, dBA**
Noise Monitoring (4 Time Zones)				
AQ1: Near NAIA T3 (St. Therese of the Child Jesus Parish)*	57	58	59	54
AQ2: Sitio Fort Bonifacio Health Center (Near the National Nutrition Council)*	55	55	50	45
AQ3: Dr. Arcadio Santos National High School**	39	42	40	37
*1980 NPCC Memorandum Circular No. 002, Class A	50	55	50	45
**1980 NPCC Memorandum Circular No. 002, Class AA	45	50	45	40

Note: The customer is given 7 days upon receipt to raise questions or clarification on any part or content of the certificate, otherwise the result(s) is/are deemed accepted.

Total # of Samples : 3 **Total Analysis** : 12
Sample Submission : Sampled by the OMLI staff
Reference : Direct Reading - Sound Level Meter, Equipment Instruction Manual
Remarks : Results relate only to the items tested and received by the laboratory.

Certified Correct by:

MA. CRISTINA F. REFERENTE, RCh
PRC No. 0007398
Laboratory Head

Authorized by:

ALVIN P. BASCO, RCh
PRC No. 0011786
Head of Operations

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Annex 2.3-8

Vibration Accelerometer Readings for Additional Stations in the 2019 ECC Amendment

Table 1: Acceleration of in Measurement Period in Shrine of Saint Therese of the Child Jesus

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
12:36	0.007593	0.008804
12:51	0.006206	0.006820
13:06	0.009228	0.010913
13:21	0.006416	0.005936
13:36	0.005197	0.004720
13:51	0.005725	0.005012
14:06	0.008230	0.009347
14:21	0.009640	0.011643
14:36	0.010933	0.014295
14:51	0.005377	0.005707
15:06	0.006067	0.006660
15:21	0.005906	0.004974
15:36	0.005666	0.005737
15:51	0.006215	0.005887
16:06	0.005654	0.005911
16:21	0.005595	0.006049
16:36	0.006636	0.007214
16:51	0.005450	0.005118
17:06	0.006603	0.008020
17:21	0.004862	0.004502
17:36	0.004879	0.004669
17:51	0.007099	0.007380
18:06	0.006131	0.005618
18:21	0.004894	0.004007
18:36	0.005667	0.005912

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
18:51	0.004236	0.003685
19:06	0.006845	0.008381
19:21	0.004053	0.003940
19:36	0.004716	0.003999
19:51	0.003565	0.003740
20:06	0.004168	0.003612
20:21	0.004711	0.003709
20:36	0.004307	0.003878
20:51	0.003340	0.003816
21:06	0.003513	0.004204
21:21	0.003940	0.003801
21:36	0.003688	0.003976
21:51	0.007890	0.012218
22:06	0.005864	0.006166
22:21	0.003568	0.003637
22:36	0.003786	0.003592
22:51	0.003798	0.003849
23:06	0.003341	0.003818
23:21	0.003794	0.003683
23:36	0.003579	0.003573
23:51	0.004514	0.003778
00:06	0.003591	0.003447
00:21	0.003298	0.003306
00:36	0.004180	0.004364
00:51	0.004274	0.003324
01:06	0.003820	0.003467

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
01:21	0.003957	0.003492
01:36	0.003969	0.003670
01:51	0.004382	0.003649
02:06	0.003754	0.003775
02:21	0.004014	0.003283
02:36	0.004413	0.003472
02:51	0.004657	0.003326
03:06	0.002862	0.003477
03:21	0.002757	0.003431
03:36	0.002768	0.003194
03:51	0.002947	0.003157
04:06	0.002985	0.003274
04:21	0.003126	0.003358
04:36	0.003747	0.003299
04:51	0.004542	0.004424
05:06	0.002926	0.003370
05:21	0.003254	0.003220
05:36	0.003235	0.003421
05:51	0.003784	0.004616
06:06	0.003885	0.003384
06:21	0.003998	0.004060
06:36	0.004312	0.004469
06:51	0.003207	0.003718
07:06	0.004714	0.005312
07:21	0.004109	0.004981
07:36	0.004453	0.003632

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
07:51	0.005116	0.004439
08:06	0.003784	0.004997
08:21	0.004379	0.004258
08:36	0.004283	0.004736
08:51	0.003760	0.003801
09:06	0.005420	0.005556
09:21	0.004763	0.005476
09:36	0.006658	0.006575
09:51	0.006534	0.007155
10:06	0.004620	0.004113
10:21	0.005412	0.004546
10:36	0.005190	0.005265
10:51	0.005411	0.005035
11:06	0.006580	0.007094
11:21	0.006120	0.007030
11:36	0.004708	0.005384
11:51	0.004770	0.004566
12:06	0.004611	0.005039
12:21	0.004320	0.003976

Table 2: Acceleration of in Measurement Period in American Manila Cemetery

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
17:02	0.004179	0.003975
17:17	0.004511	0.003374
17:32	0.004577	0.003385
17:47	0.004502	0.003319
18:02	0.004211	0.003373
18:17	0.003929	0.003513
18:32	0.003412	0.003154
18:47	0.003796	0.003122
19:02	0.003752	0.003979
19:17	0.003861	0.002930
19:32	0.003501	0.003479
19:47	0.003856	0.003357
20:02	0.003007	0.002854
20:17	0.003287	0.003248
20:32	0.002886	0.003379
20:47	0.003102	0.003268
21:02	0.003584	0.003514
21:17	0.003570	0.003235
21:32	0.003320	0.003025
21:47	0.003180	0.003206
22:02	0.003222	0.003211
22:17	0.002992	0.003379
22:32	0.003005	0.003088
22:47	0.003042	0.003392
23:02	0.003431	0.003375

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
23:17	0.003627	0.003259
23:32	0.003938	0.002839
23:47	0.003934	0.003335
00:02	0.002830	0.003311
00:17	0.004386	0.003220
00:32	0.003656	0.003048
00:47	0.003164	0.003041
01:02	0.003447	0.003484
01:17	0.002666	0.003601
01:32	0.002963	0.002962
01:47	0.003749	0.003182
02:02	0.004071	0.003568
02:17	0.003882	0.003239
02:32	0.004187	0.003254
02:47	0.002945	0.003003
03:02	0.003113	0.003529
03:17	0.004858	0.003105
03:32	0.003740	0.003338
03:47	0.003507	0.003148
04:02	0.004284	0.003057
04:17	0.003136	0.003457
04:32	0.005288	0.003829
04:47	0.003128	0.003019
05:02	0.003566	0.003200
05:17	0.002885	0.003570
05:32	0.003628	0.003208

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
05:47	0.002642	0.003011
06:02	0.003345	0.002984
06:17	0.003482	0.003189
06:32	0.003330	0.003427
06:47	0.002621	0.003098
07:02	0.005645	0.008212
07:17	0.003797	0.004621
07:32	0.003416	0.003318
07:47	0.003433	0.003638
08:02	0.003186	0.003318
08:17	0.004033	0.002973
08:32	0.003959	0.004669
08:47	0.003245	0.003342
09:02	0.003557	0.003634
09:17	0.003502	0.003350
09:32	0.003792	0.003198
09:47	0.003554	0.003716
10:02	0.003185	0.002968
10:17	0.004195	0.003062
10:32	0.003720	0.003423
10:47	0.002995	0.003130
11:02	0.004629	0.004630
11:17	0.003569	0.003507
11:32	0.005070	0.004339
11:47	0.004153	0.004358
12:02	0.003458	0.003400

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
12:17	0.003419	0.003226
12:32	0.003164	0.003315
12:47	0.003178	0.003242
13:02	0.005529	0.003733
13:17	0.004747	0.003781
13:32	0.004189	0.004162
13:47	0.004402	0.003695
14:02	0.003823	0.003750
14:17	0.004470	0.003518
14:32	0.004029	0.004150
14:47	0.004469	0.003697
15:02	0.004874	0.004012
15:17	0.003331	0.003423
15:32	0.003237	0.003345
15:47	0.003875	0.003684
16:02	0.004152	0.003874
16:17	0.003482	0.003161
16:32	0.003095	0.003307
16:47	0.003777	0.003196

Table 3: Acceleration of in Measurement Period in Administration Building of United Hill Village

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
17:44	0.003778	0.003581
17:59	0.003665	0.003056
18:14	0.004031	0.003272
18:29	0.003362	0.003216
18:44	0.003692	0.003250
18:59	0.003776	0.003047
19:14	0.003239	0.003197
19:29	0.002982	0.003331
19:44	0.003512	0.002825
19:59	0.003323	0.002995
20:14	0.004558	0.003103
20:29	0.003962	0.002954
20:44	0.003273	0.003275
20:59	0.003734	0.003242
21:14	0.003655	0.003434
21:29	0.003554	0.003179
21:44	0.003716	0.003481
21:59	0.003333	0.002742
22:14	0.003616	0.003239
22:29	0.003506	0.002788
22:44	0.003510	0.002880
22:59	0.003559	0.003284
23:14	0.003612	0.003308
23:29	0.003979	0.003169
23:44	0.003439	0.002910

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
23:59	0.004337	0.002805
00:14	0.003647	0.003214
00:29	0.004017	0.003173
00:44	0.003652	0.004117
00:59	0.004474	0.003037
01:14	0.004204	0.003272
01:29	0.003804	0.003004
01:44	0.004185	0.003183
01:59	0.003980	0.003149
02:14	0.003996	0.003075
02:29	0.005055	0.003305
02:44	0.003651	0.003013
02:59	0.004006	0.003417
03:14	0.004090	0.002954
03:29	0.004926	0.003330
03:44	0.004554	0.003179
03:59	0.004193	0.003526
04:14	0.003476	0.002921
04:29	0.003977	0.003250
04:44	0.003330	0.003320
04:59	0.003815	0.003089
05:14	0.003664	0.002991
05:29	0.003896	0.003545
05:44	0.004216	0.002885
05:59	0.003874	0.003323
06:14	0.004039	0.003033

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
06:29	0.003530	0.003002
06:44	0.003734	0.003243
06:59	0.004012	0.003588
07:14	0.003773	0.003320
07:29	0.004455	0.004050
07:44	0.003868	0.003352
07:59	0.005652	0.005289
08:14	0.005483	0.007479
08:29	0.005441	0.006692
08:44	0.004944	0.007082
08:59	0.004769	0.005986
09:14	0.005143	0.005169
09:29	0.003963	0.003479
09:44	0.004636	0.003850
09:59	0.004111	0.003452
10:14	0.005120	0.007590
10:29	0.004531	0.006591
10:44	0.004947	0.005792
10:59	0.004653	0.006459
11:14	0.011214	0.007978
11:29	0.004811	0.007114
11:44	0.005107	0.006552
11:59	0.005369	0.007255
12:14	0.005352	0.007934
12:29	0.005381	0.006573
12:44	0.005130	0.005905

Time	Acceleration of Accelerometer 1 (Serial No: 30242), m/s2	Acceleration of Accelerometer 2 (Serial No: 30180), m/s2
12:59	0.006155	0.006474
13:14	0.004881	0.006397
13:29	0.005793	0.006964
13:44	0.005228	0.008200
13:59	0.003790	0.002870
14:14	0.004197	0.003021
14:29	0.004220	0.002981
14:44	0.003684	0.003268
14:59	0.004199	0.003296
15:14	0.003904	0.003421
15:29	0.003833	0.003239
15:44	0.003304	0.003388
15:59	0.003960	0.003046
16:14	0.003653	0.003199
16:29	0.003413	0.002957
16:44	0.003684	0.003189
16:59	0.004469	0.003195
17:14	0.003715	0.003272
17:29	0.003662	0.003532

Annex 2.3-9

Calibration Certificates for Vibration Accelerometer

Unit 02 Open TBI, DOST-PEZA, ASTI Compound
C.P. Garcia Ave., Univ. of the Philippines Diliman Campus
Quezon City, Philippines 1101
Email: tektongeo@gmail.com
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TektonGeoMetrix INCORPORATED

Measurement and assessment of baseline vibration condition at various sites in Metro Manila for the Proposed Mega Manila Subway Project

A. Introduction

A vibration study was conducted at nine sites in Metro Manila for a proposed Mega Manila Subway Project. Fieldwork was conducted on various dates in March and April 2017 during which seismic recording instruments were deployed to collect 24-hour data of ambient vibration at each site. This vibration study report describes:

a. Methodology used in data collection and analysis;
b. Measured baseline levels of vibration in the various sites;
c. Spatial or temporal patterns in the vibration levels.

B. Methodology

The approach used in this study follows that prescribed in the British Standard 7385 (1993). The Philippines' Environmental Management Bureau has not defined any vibration standards or procedures of investigation in the Philippines.

At each site, a 24 hour sampling was undertaken where vibration was recorded using an 8-channel Geometrics Geode seismic data recorder connected to geophones (or velocity sensors). Two sets of triaxial sensors and two additional sets of vertical sensors created the 4 sets of sensors that are spread 3m apart around each observation area. The triaxial sensors have a natural frequency of 10 Hz while the two vertical sensors have a natural frequency of 4.5Hz with no filters applied during recording. Sampling rate for all channels is at 500 samples per second and the system performed around a dynamic range of about 120dB from 0.5 Hz to 250 Hz. The system was timed to record for 90 seconds readings every fifteen minutes throughout the whole 24 hours.

The seismic sensors were deployed on the concrete pavement or road surface, each sensor being set with a peg into a drilled hole on the ground. The data recording was supervised by a crew of four which alternated on 12 hours shifts.

The vibration data gathered by the seismic instruments were processed to reveal both amplitude of the waveforms, and their spectral signature. The 90 seconds long waveform gathered every 15 minutes is stored as SEG2 format by the recorder. Data from each site were merged to create the 24-hour vibration profile for the sites and then converted to ASCII. Each record was then shifted to align to midnight, in order to detect any temporal patterns in the vibration. The vibration data were converted to m/s velocity, dB vibration and acceleration in m/s2. Each record was also analyzed using Fourier transform to derive the spectral signature. The response between the 10Hz and 4.5Hz sensors was also used to infer some site characteristics.

C. Survey sites

Nine survey sites and schedules for the survey were a-priori defined. The various field measurement sites are located in the different parts of Metro Manila where facilities of the subway system are intended to be located. The sites are predominantly urban settings, near centers of commerce and transportation. The distribution of the sites follows a general northerly direction traversing the metropolis. The list of the sites is shown in **Table 1** while the schedule of actual vibration survey for each site is shown in **Table 2**.

Table 1. Sites and their geographic coordinates

Site	Latitude (deg, min)	Longitude (deg, min)
Rolling Hills, Valenzuela	14° 41.7084'	121° 1.3466'
Tandang Sora St.	14° 39.8917'	121° 3.9971'
Trinoma, Mindanao Ave,	14° 39.0861'	121° 2.0766'
Centris Walk, Quezon Ave.	14° 38.5321'	121° 2.4757'
Aurora Blvd, WCMC	14° 37.6418'	121° 3.8212'
Blue Ridge, Proj. 4	14° 37.1429'	121° 4.3445'
Capitol Com., Meralco Ave	14° 34.5616'	121° 3.7442'
BCDA Field Office	14° 31.6809'	121° 3.4459'
PNR-FTI Station	14° 30.3963'	121° 2.1319'

Table 2. Dates of vibration survey for the nine sites

March 27-28, 2017 – Trinoma Parking Lot, Mindanao Ave.
March 28-29, 2017 - Centris Walk, Quezon Ave.
March 29-20, 2017 – BCDA Office, Cayetano Blvd
March 30-31, 2017 - FTI PNR Station
April 3-4, 2017 – World City Medical Center, Aurora Blvd.
April 4-5, 2017 – Capitol Commons, Meralco Ave.
May 2-3, 2017 – Landcom Subd., Tandang Sora St.
May 3-4, 2017- Rolling Hills Resort, Valenzuela City
May 4-5, 2017 – Blue Ridge A, Project 4, Quezon City

The actual survey sites are shown in **Figure 1**. The sites were mostly vacant areas near the roads in commercial areas, except for the site in Rolling Hills in Valenzuela which is residential. Land cover is mostly built-up, and the terrain at the sites is generally flat except for the buildings, roadworks and parking facilities that are typical of urbanized development.

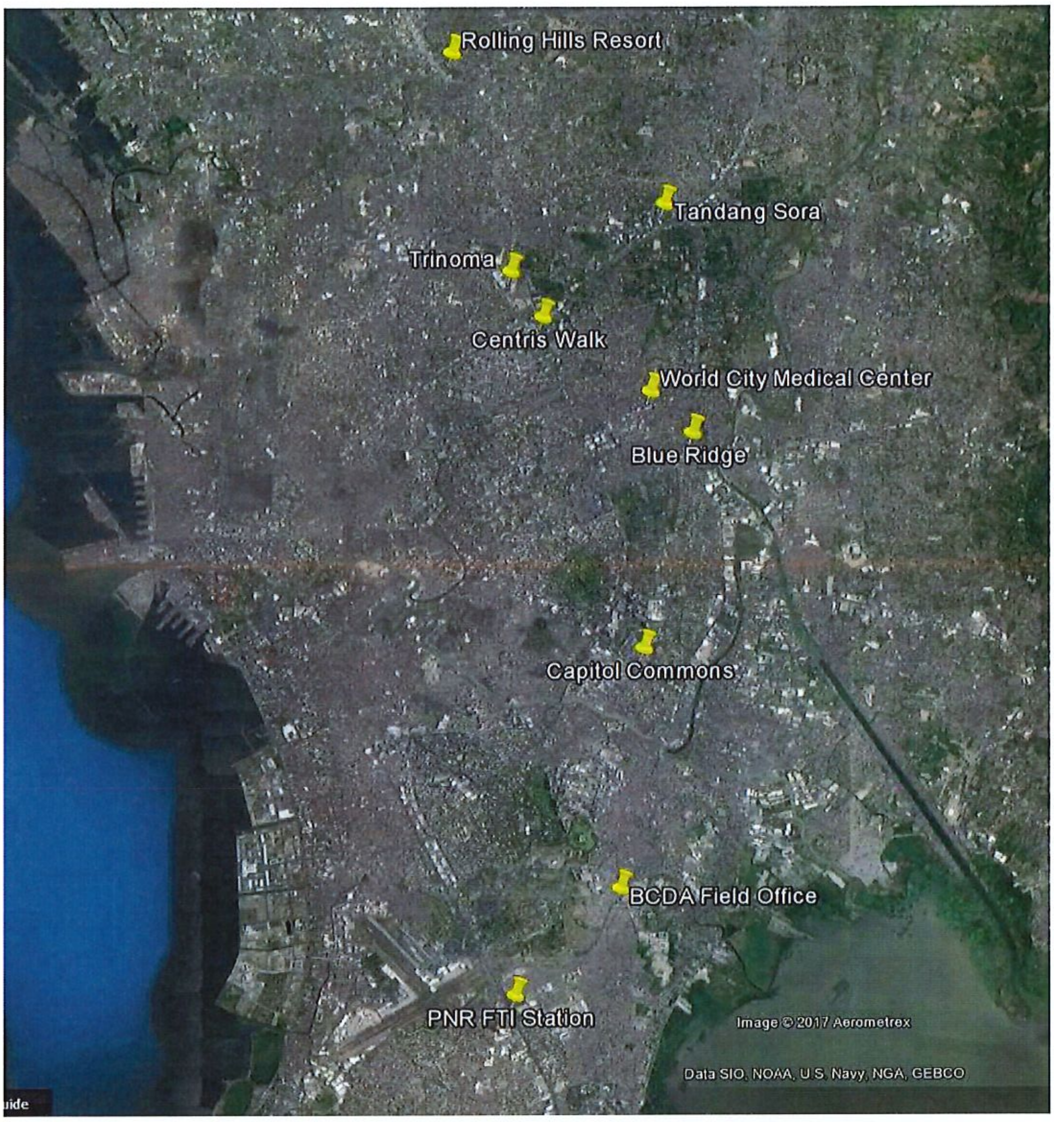

Figure 1. Map of vibration survey sites.

D. Baseline vibration levels

An example of the 90 seconds of recorded vibration is shown in **Figure 2**. The figure shows eight channels of data displayed as vertical lines with time running from top to bottom, in milliseconds unit. The first three lines on the left shows the vertical, north-oriented horizontal and east-oriented horizontal for the first triaxial sensor. This is followed by the next set of vertical and horizontal sensors for the other triaxial sensors. All these triaxial sensors have 10 Hz center frequency. The last two lines on the right are the two vertical sensors with 4.5 Hz center frequency. The amplitude is recorded in units of 10E-6 cm/s and shown in plots with 0dB equivalent to 10E-6cm/s.

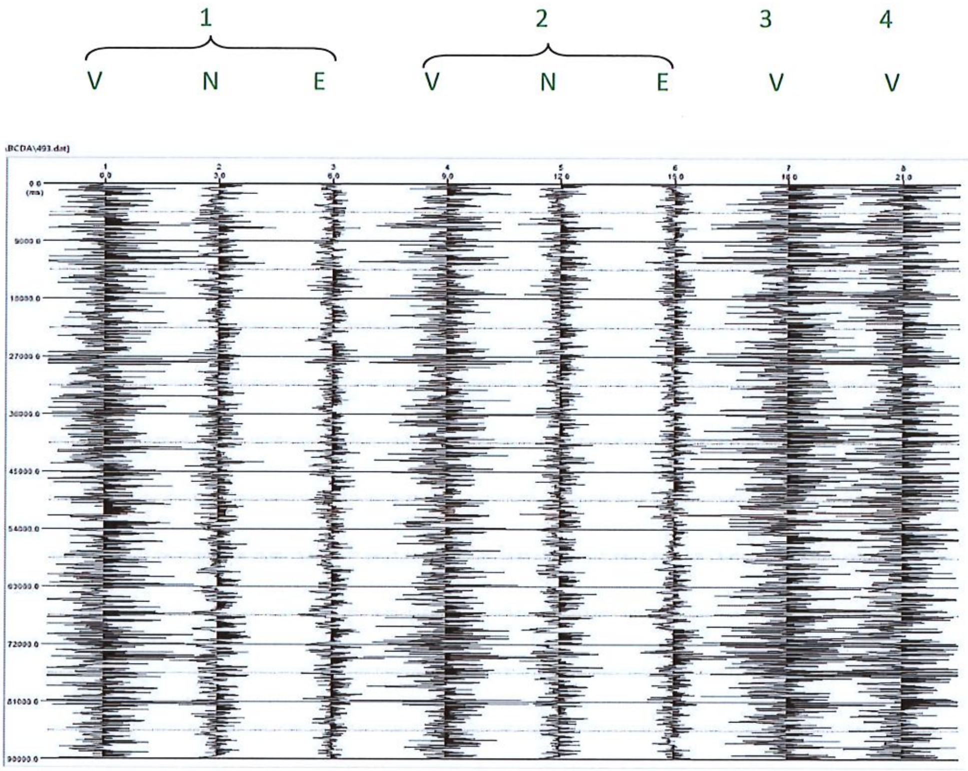

Figure 2. Sample of a 90-seconds of vibration data for the BCDA site showing the 8 channels of record, with the two triaxial sensors occupying three lines each on the left (each oriented at vertical, north and east), and the two vertical sensors on the right. Time in milliseconds is marked on the left.

Table 3. Reaction of humans and buildings to various levels of vibration. Vibration dB level in column 2 is same as those shown in other charts in this report (Caltrans, Technical Advisory, 2002).

Velocity Level, PPV (cm/sec)	Velocity Level, PPV (dB) (0 dB = 10E-6cm/s)	Human Reaction	Effect on Buildings
0.015 to 0.048	84 to 94	Threshold of perception: Possibility of intrusion	Vibration unlikely to cause damage of any type
0.2	106	Vibrations readily perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.25	108	Level at which continuous vibrations begin to annoy people	Virtually no risk of "architectural" damage to normal buildings
0.51	114	Vibrations annoying to people in buildings	Threshold at which there is a risk of "architectural" damage to normal dwellings such as plastered walls or ceilings.
1.02 to 1.52	120 to 124	Vibrations considered unpleasant by people subjected to continuous vibrations	Vibration at this level would cause "architectural" damage and possibly minor structural damage.

Regular samples of vibration data over the 24 hour observation period for each station were plotted along with a GoogleEarth image of the site in the following figures. Each pair of figures shows the baseline vibration for each site as this level changes throughout the day. For each site, some notable features can be distinguished indicating in some instances the human activity that causes the background vibration.

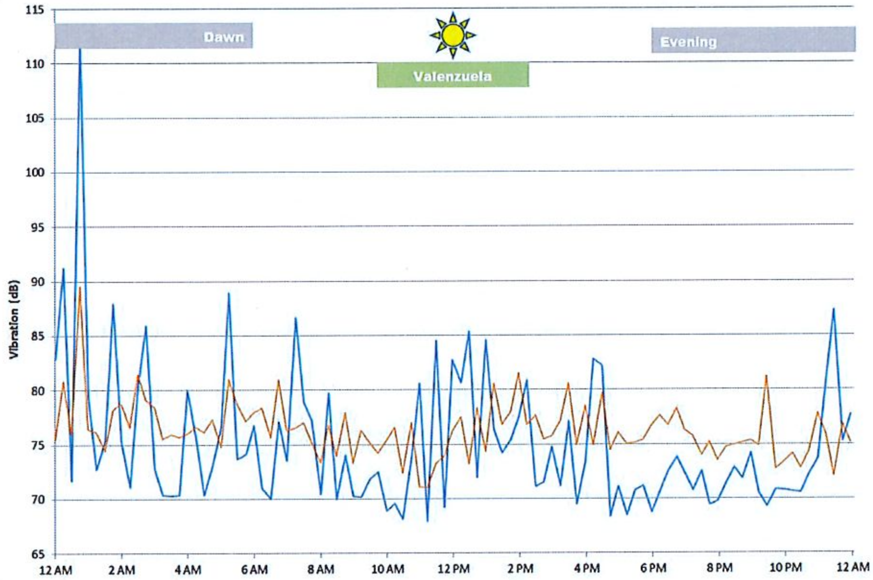

Figure 3. Rolling Hills

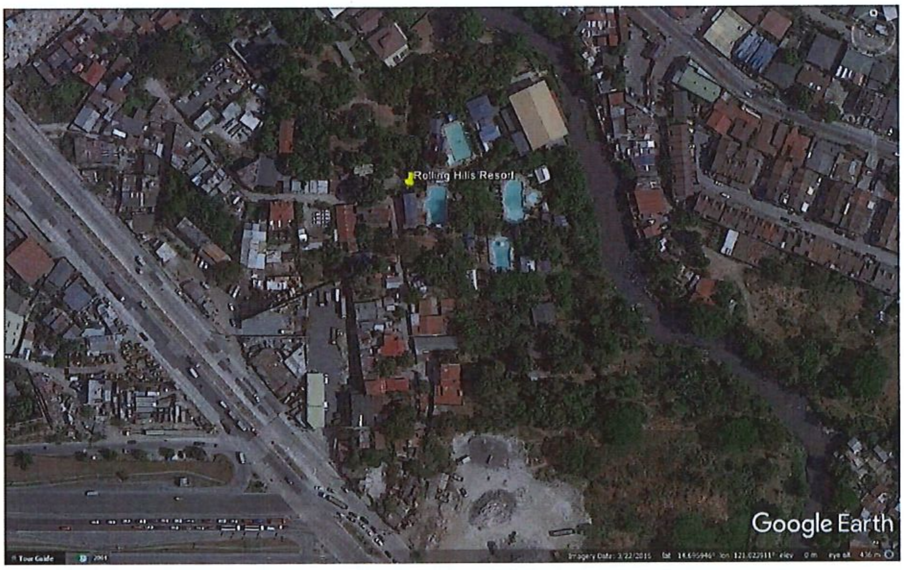

Figure 4. Rolling Hills Site in Google Earth image

The Rolling Hills observation site is located in the residential with adjoining recreational area in Valenzuela City. This site has among the lowest level of background vibration with minimum levels at around 70 VdB (vibration decibel) with 0 VdB referred to 10E-6 cm/s. Background root mean squared (RMS) vibration remained almost constant through the day, with slight increase of a few VdB in the dawn/early morning hours. Above this background, occasional impulsive vibration is recorded throughout the day, with a lull in the every evening. The impulsive events may be coming from road traffic of heavy trucks in the nearby highway, and reaches a peak which exceeds 100dB which is perceptible and annoying to people at rest.

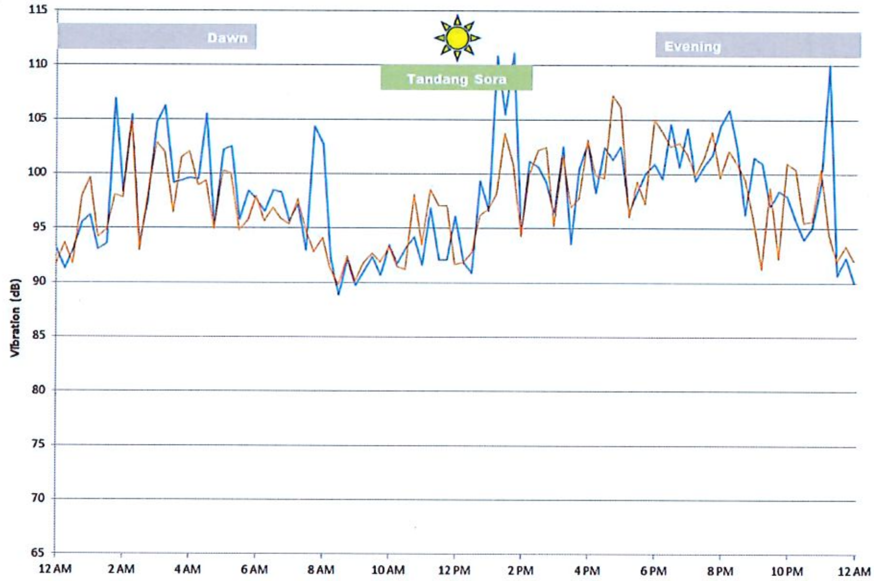

Figure 5. Tandang Sora

Figure 6. Tandang Sora site

The Tandang Sora observation site is located also in a residential area and near a major highway, and has among the highest level of vibration among the nine sites. Vibration at this site averages around 97 VdB with the lowest RMS background level at around 90 dB and the highest RMS background level at 102 VdB. The site has a district low level from early morning to around noon, and may reflect the truck ban hours of 7 a.m. to 10 a.m. This observation is supported by the frequent impulsive events through the day, which may be caused by trucks, and their complete absence during the truck ban hours. The peak vibration reaches up to 110 VdB and is definitely perceptible to humans.

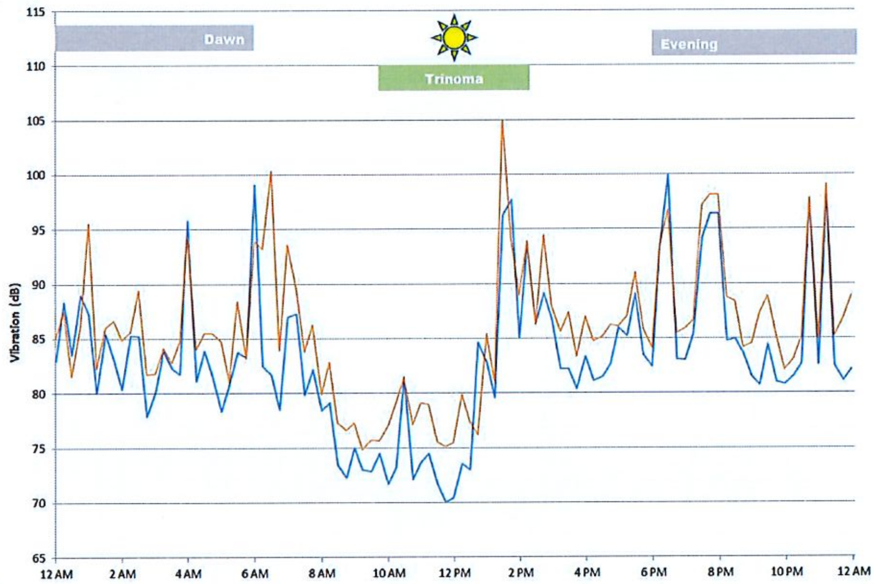

Figure 7. Trinoma

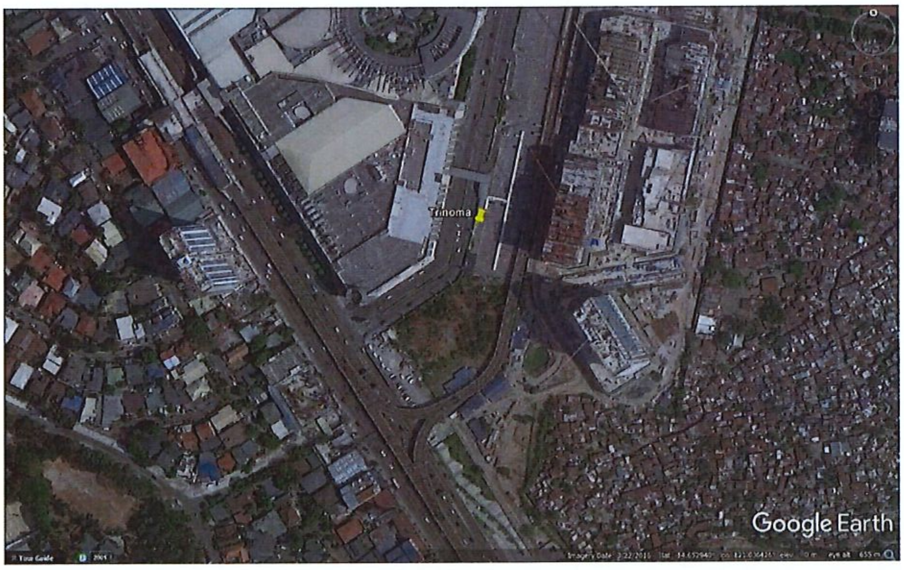

Figure 8. Trinoma Site

The Trinoma observation site is located is a parking area near the Trinoma Mall. It is near the main road artery of Metro Manila which is EDSA. Background RMS vibration at this site ranges from a low of around 72 VdB and a high of around 87 VdB. The site shows a distinct vibration low in the mornings , which lasts until around noon when the vibration abruptly picks up. This may represent two daily events , one event being the opening of the mall when cars start moving in and out of the mall and into the parking areas, and the other event may be the daily recurrence of the trucks that start plying EDSA at around this time. The impulsive events with the highest peak level exceeding 100 VdB occur in the afternoon and early evening and may be caused by trucks on the highway.

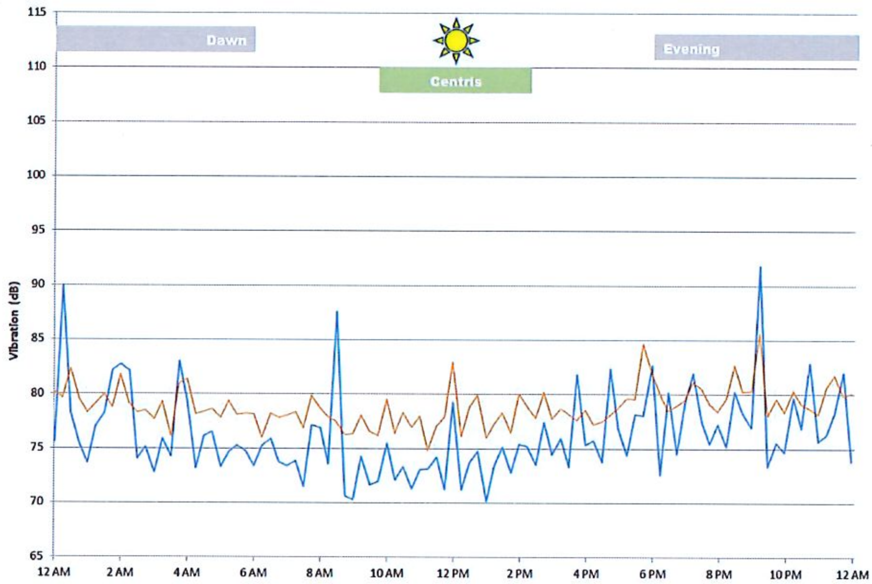

Figure 9. Centris Walk

Figure 10. Centris Walk in Google Earth

The Centris Walk observation site is located between a commercial area and a residential area and represents the lowest level of vibration in all the nine sites. This site background RMS vibration at around 72 VdB and remains almost constant throughout the day. Its high RMS background level reaches up to only 79 VdB which occurs from early evening to midnight. The level of vibration is markedly different for the triaxial sensors (red and blue lines in **Figure 9**) which reflect the traffic in the area. A source of lower frequency vibration (possibly air conditioning units) may be operating throughout the day thereby producing a constant background noise (green and purple lines in Figure 9). Only occasional impulsive events are observed, with subdued vibration whose peak reaches only 83 to 90 VdB.

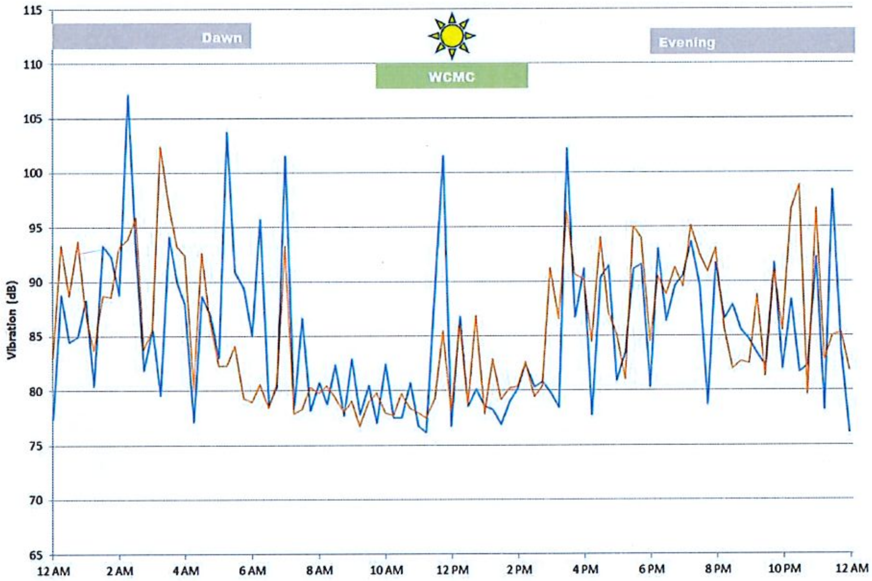

Figure 11. World City Medical Center

Figure 12. World City Medical Center

The World City Medical Center observation site is located inside an open parking lot between buildings inside this compound. This site has the third lowest level of vibration with a background RMS vibration at around 77 VdB. The level of vibration markedly changes from very quiet mornings to highly busy period of frequent impulsive vibrations from mid-afternoon to dawn. The high level of traffic may represent the in and out movement of cars into the parking lots and the nearby road traffic. The impulsive events are constant, with peak vibration reaching 95 to 102 VdB.

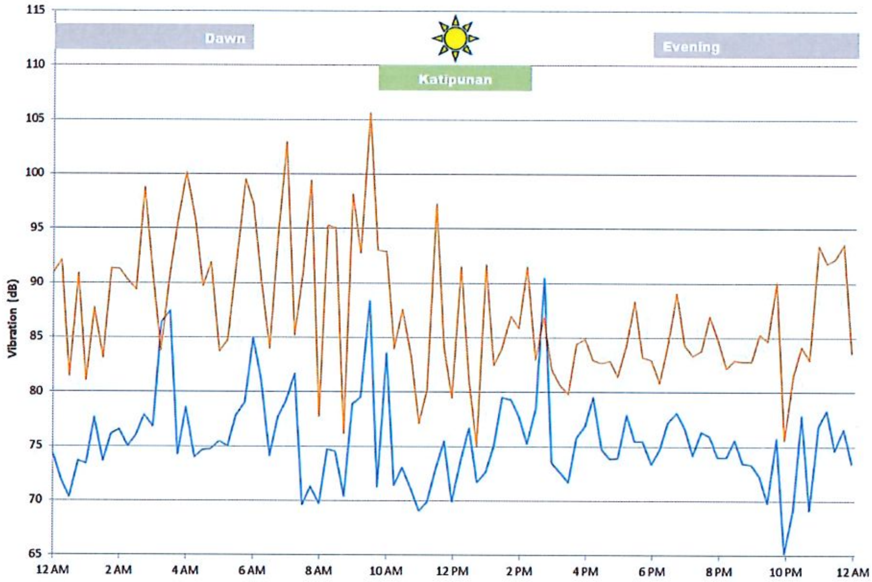

Figure 13. Blue Ridge

Figure 14. Blue Ridge

The Blue Ridge observation site is near a residential area along a road. The site is distinctly busy, with constant impulsive events throughout the day. The background RMS vibration level is almost constant throughout the day, but showing distinct and almost parallel lines between the low frequency sensors and the high frequency sensors (the pairs of red & blue, and green & purple in **Figure 13**). The separate trends between the two sets of lines are observed even during the impulsive events. The constant separation between the two sets of lines suggests that some horizontal heterogeneity in the observation sites are present, with the low frequency sensor being located in a portion that resonates at low level while the high frequency sensors resonates at a different level. This overall background vibration at this site is low RMS level between 73 and 86 VdB. Impulsive events peak between 88 to 100 VdB.

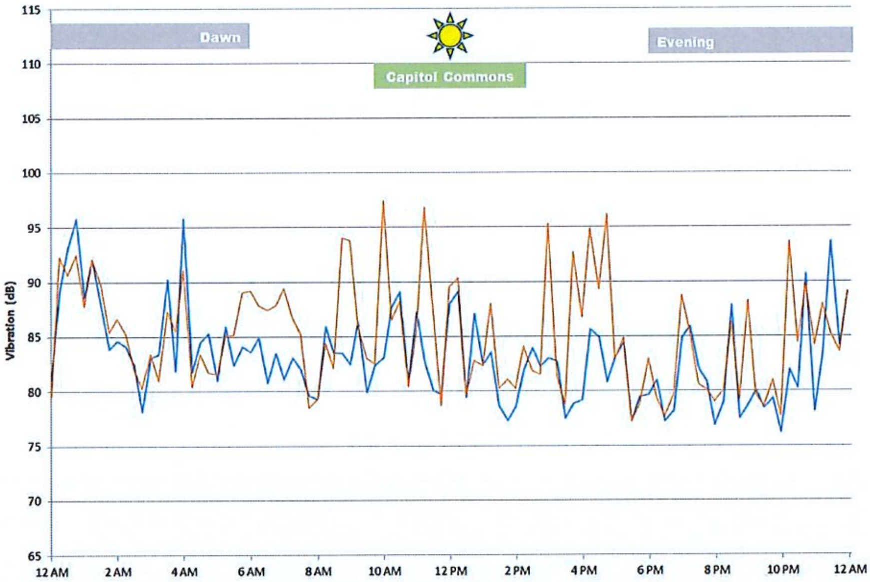

Figure 15. Capitol Commons

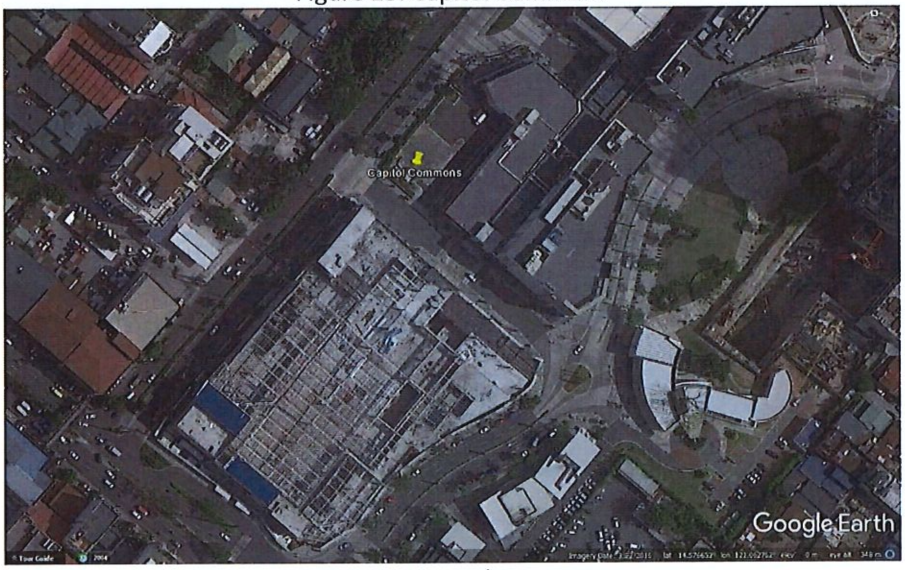

Figure 16. Capitol Commons

The Capitol Commons observation site is located is a parking area between two commercial buildings and a residential area. Background RMS vibration at this site is almost constant through the day, ranging from around 78 VdB to around 85 VdB. The impulsive events occur all day with the highest peak level being subdued, peaking only from around 88 VdB to around 94 VdB.

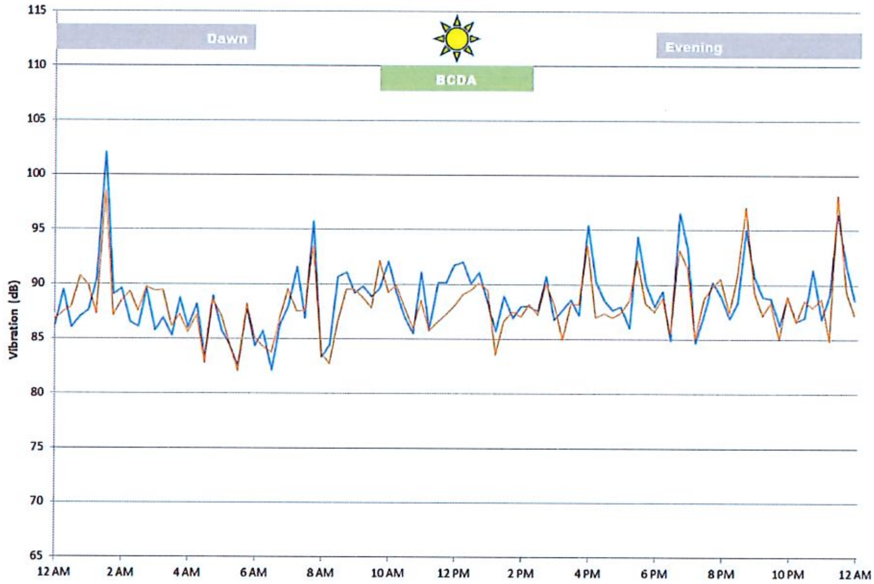

Figure 17. BCDA

Figure 18. BCDA

The BCDA Field Office hosts the most stable and flat vibration level among the sites, with the background vibration RMS varying only by around 5 VdB. The impulsive events at this site are also muted, likely owing to the considerable distance of this site from any busy highways with truck traffic. The peak values for the impulsive events reach only up to 95 VdB and rarely reaching 100 VdB.

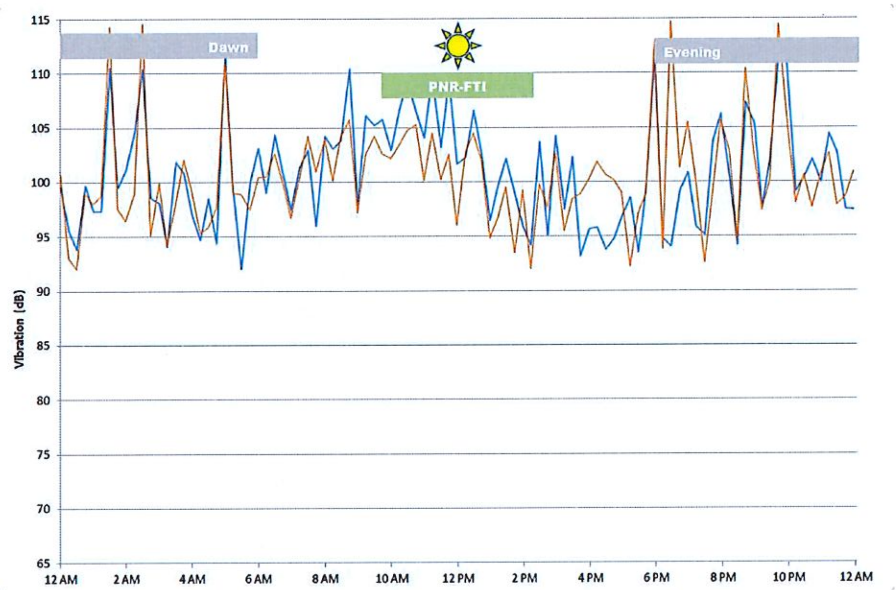

Figure 19. PRN-FTI Station

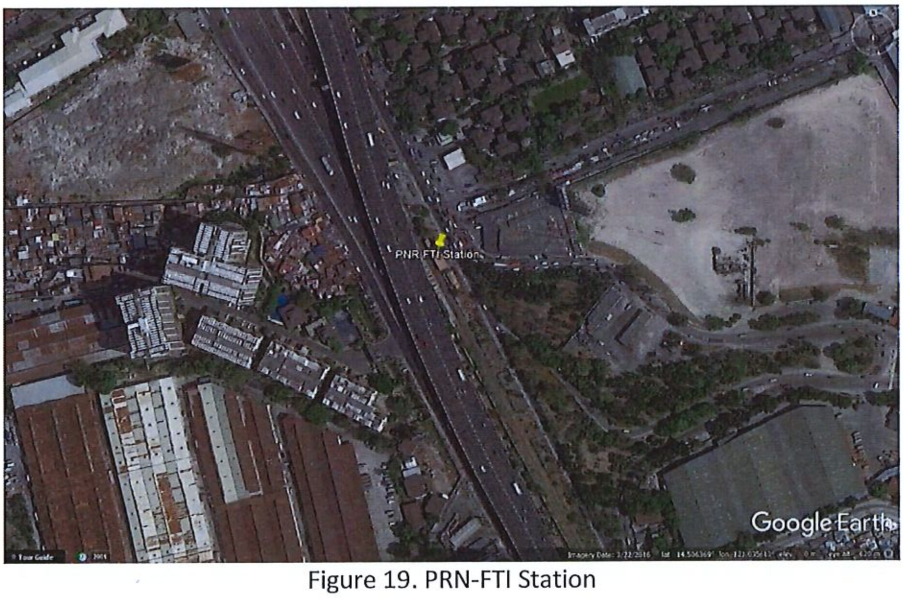

Figure 19. PRN-FTI Station

The PNR-FTI Station observation site is near a major highway and near a busy intersection of smaller streets. This site markedly has the highest level of vibration among the observation sites. The lowest background RMS value at this site is around 95 VdB and is observed in the late afternoons. From mind-morning to noon, the site has a background vibration level at around 104 VdB. The peaks of the impulsive events at this site reach beyond 110 VdB, levels which are highly perceptible to humans.

E. Summary

Observations of vibration at the various sites proposed for Mega Manila Subway facilities indicate that the sites vary in levels of vibration from a low of 64 VdB to a high of 114 VdB. The areas with the highest levels of vibration are in PNR-FTI Station and Tandang Sora, where road traffic appears to dominate the vibration. In both sites, the vibration level is almost sustained the whole day, ranging from 90 VdB to 110 VdB. The sites with lowest levels of vibration are Centris Walk and Rolling Hills in Valenzuela, where vibration levels at both sites range only between 70 VdB to 80 VdB. This is despite the short duration events that occur in Valenzuela where road traffic occasionally causes a spike in vibration. In all sites, the source of impulsive and short duration vibration is likely the vehicular traffic, most of which are common during the afternoons and early evenings. The Tandang Sora, Trinoma, PNR-FTI and World City Medical Center sites have the most pronounced changing pattern of vibration over the 24 hour period, and these are likely caused by the commercial activity and road traffic affecting these sites. In most sites, the level of vibration is below annoyance level, except for PNR-FTI where vibration exceeds 110 VdB in various times of the day. Tandang Sora also experiences such levels of vibration, but only occasionally.

Table 4. Summary of vibration observations, indicating the peak acceleration and velocity (in m/s and dB) for each of the stations, and the time that these peak values were observed.

Survey dates	Particulars	Peak time Acceleration	Recorded Peak Acceleration (m/s^2)	Recorded Peak Velocity (m/s)	Peak time (Velocity & Vibration)	Vibration Level (dB)
May 3-4, 2017	Valenzuela Depot / Rolling Hills	Same	1.74	0.00268	12:45am	112
May 2-3, 2017	TandangSora	Same	2.52	0.00361	1:45pm	111
March 27-28, 2017	North Avenue / Trinoma	Same	1.05	0.00179	1:30pm	105
March 28-29, 2017	Quezon Avenue / Centris	Same	0.10	0.00028	9:15pm	91
April 3-4, 2017	Anonas / World City Med. Cntr.	5:15am	0.57	0.00229	2:15am	107
May 4-5, 2017	Katipunan / Blue Ridge	4:00am	0.39	0.00155	9:30am	105
April 4-5, 2017	Ortigas South / Capitol Commons	11:30pm	0.40	0.00074	10:00am	97
March 29-30, 2017	CayetanoBlvd / BCDA Field Offc.	Same	0.10	0.00126	10:00am	102
March 30-31, 2017	PNR-FTI	6:30pm	3.50	0.00539	2:30am	114

Annex 1. Charts of Velocity and Acceleration for the monitoring sites

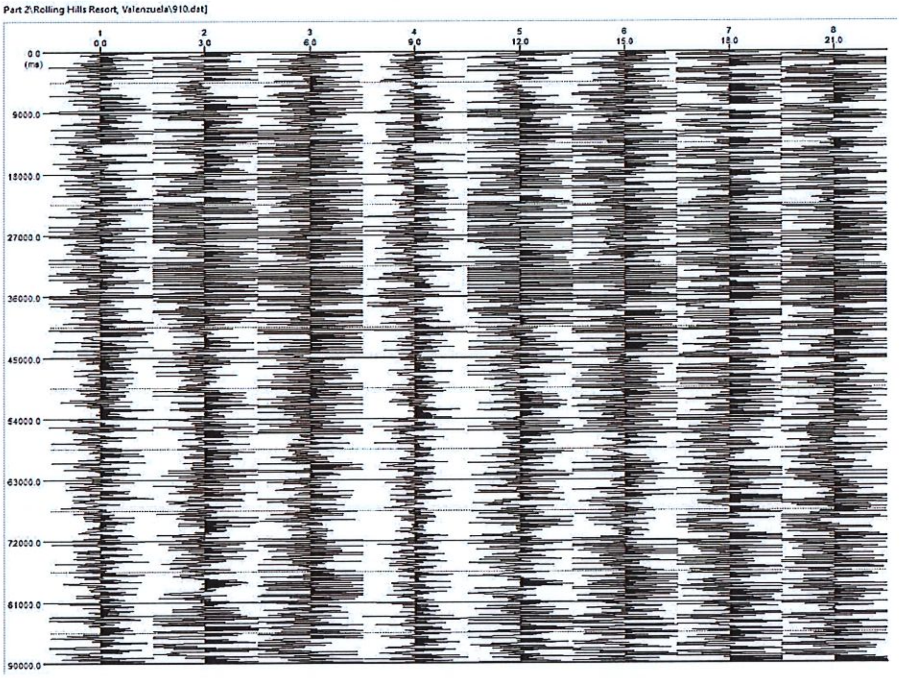

Plate 1. Seismogram for Rolling Hills Subd. Valenzuela, showing the 8 channels record. Here and in all suceeding figures, the leftmost 10Hz and the rightmost 4.5Hz sensors are used for the figure to compare high frequency and low frequency vibration.

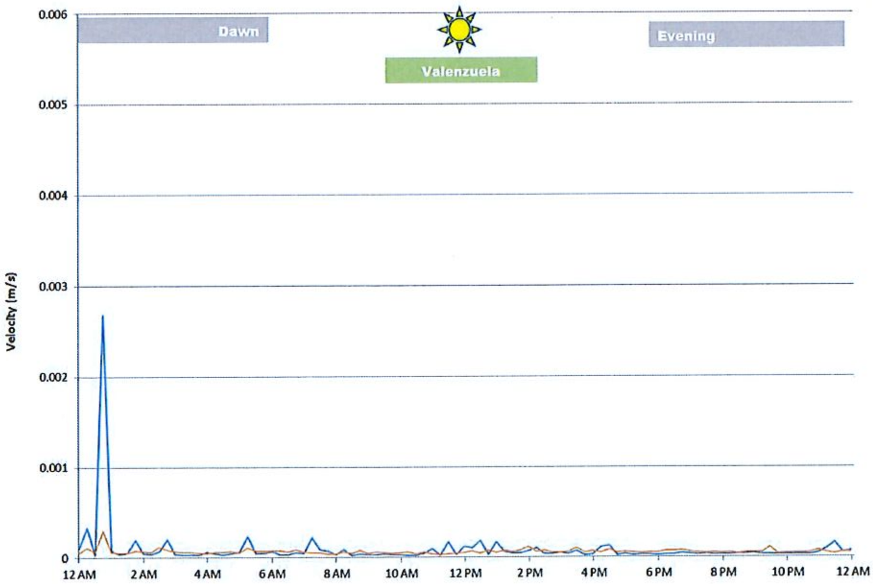

Plate 2. Velocity (m/s) for Rolling Hills Subd. Valenzuela

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INCORPORATED

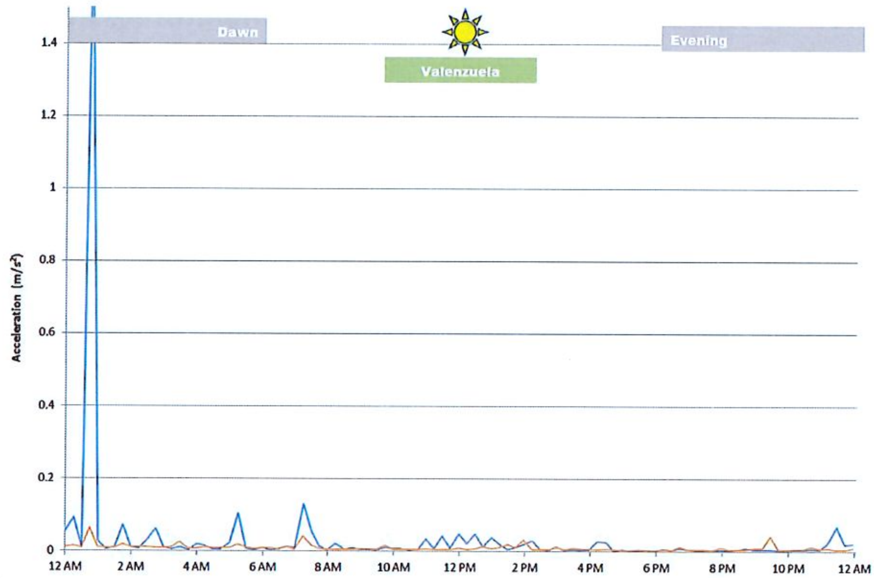

Plate 3. Acceleration (m/s^2) for Rolling Hills Subd. Valenzuela

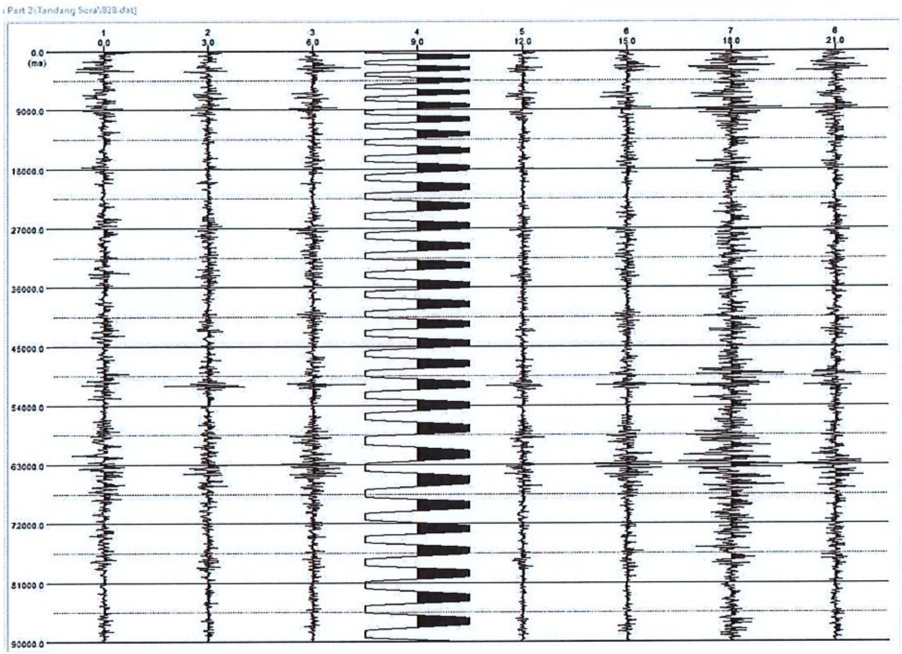

Plate 4. Seismogram for Tandang Sora, showing the 8 channels record. Channel 4 data was discarded for poor electrical or physical coupling.

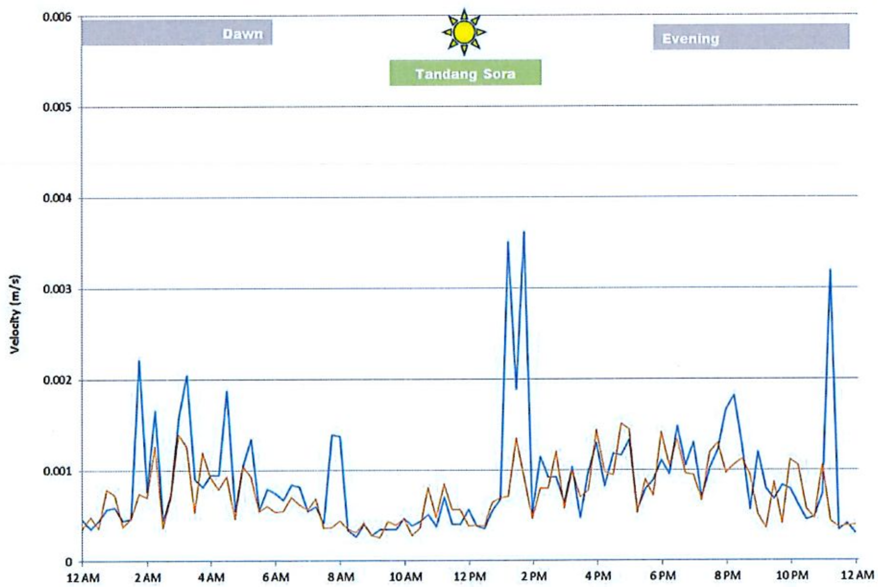

Plate 5. Velocity (m/s) for Tandang Sora St., Quezon City

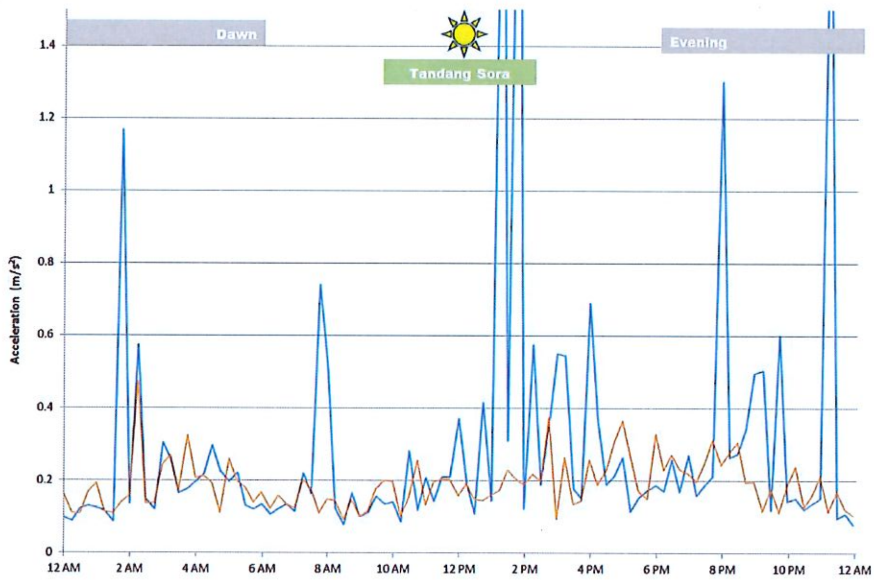

Plate 6. Acceleration (m/s^2) for Tandang Sora St., Quezon City

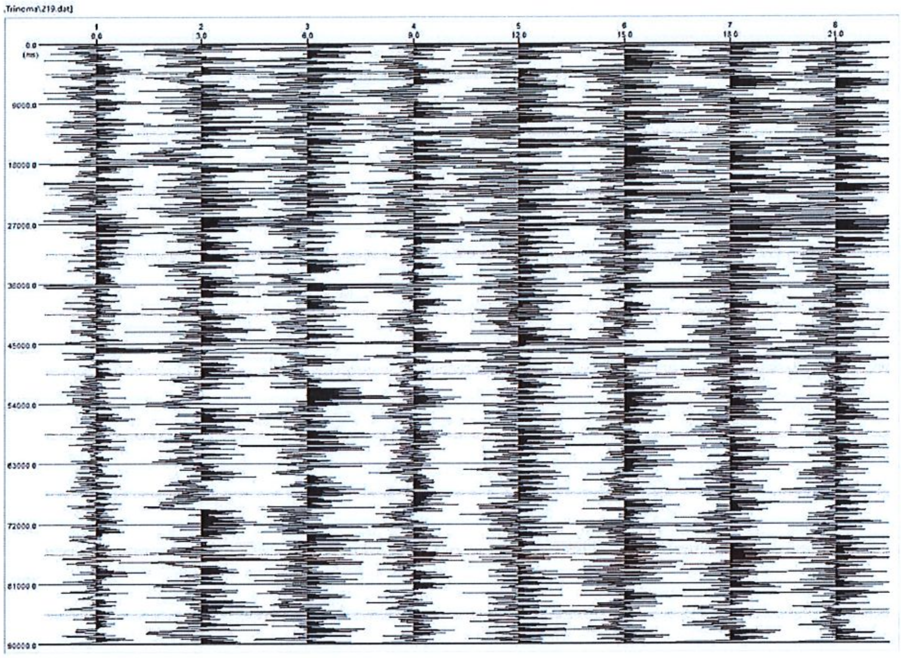

Plate 7. Seismogram for Trinoma, showing the 8 channels record.

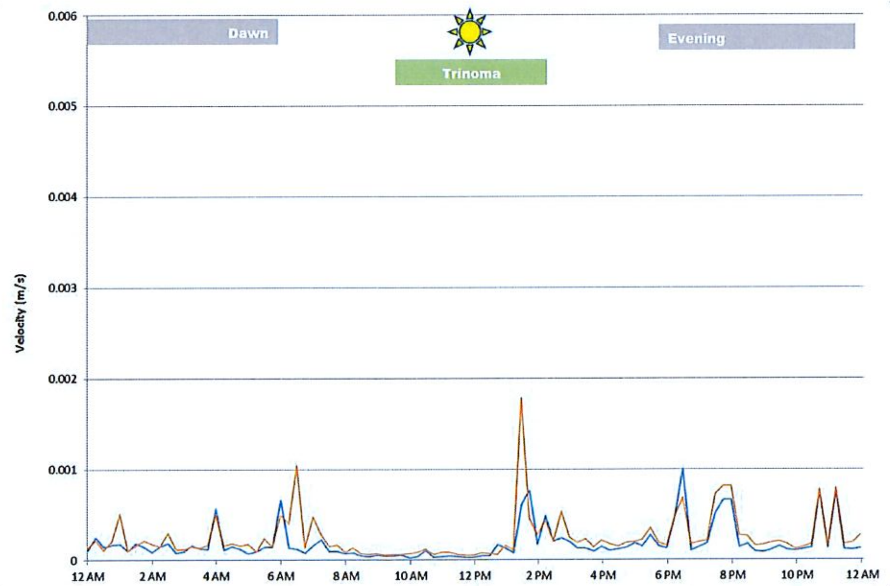

Plate 8. Velocity (m/s) for Trinoma., Quezon City

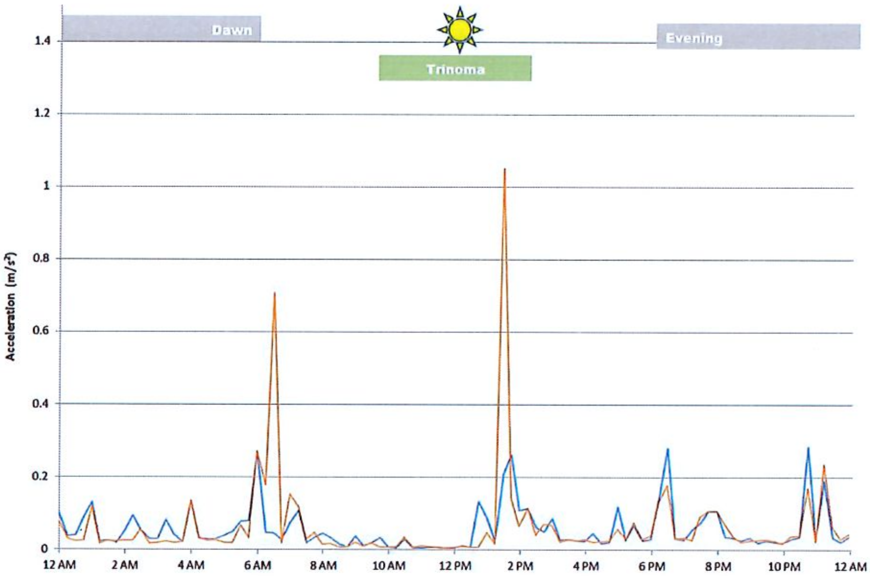

Plate 9. Acceleration (m/s^2) for Trinoma, Quezon City

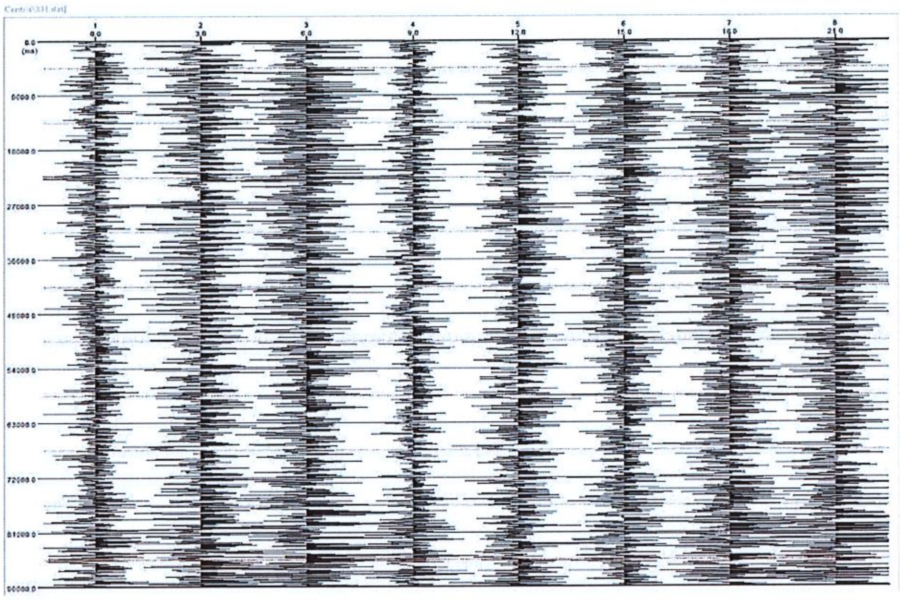

Plate 10. Seismogram for Centris, showing the 8 channels record.

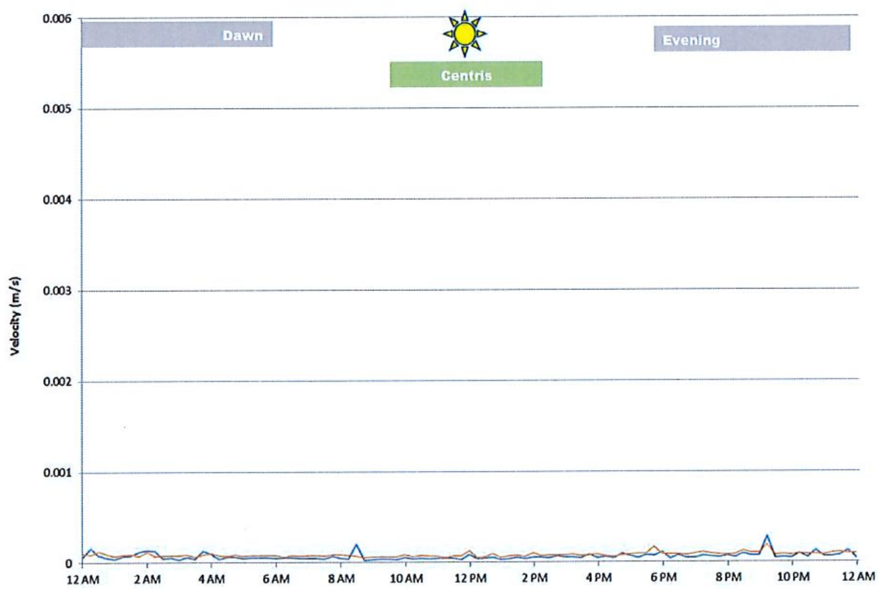

Plate 11. Velocity (m/s) for Centris Walk, Quezon City

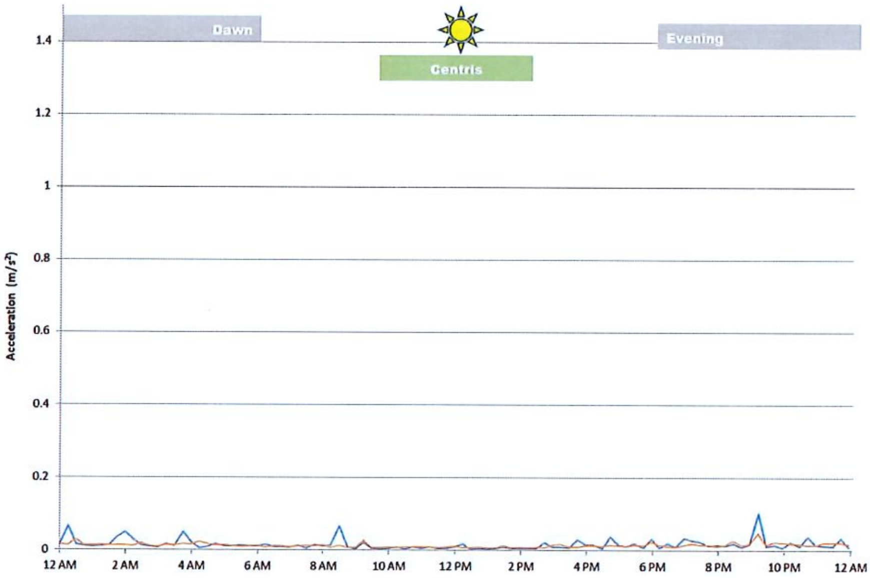

Plate 12. Acceleration (m/s^2) for Centris Walk, Quezon City

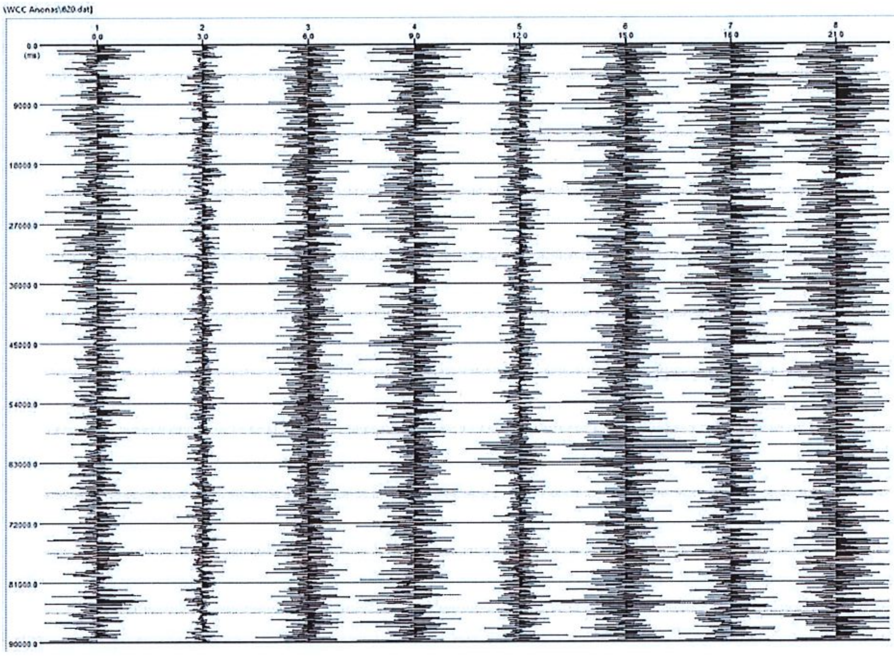

Plate 13. Seismogram for WCMC, showing the 8 channels record.

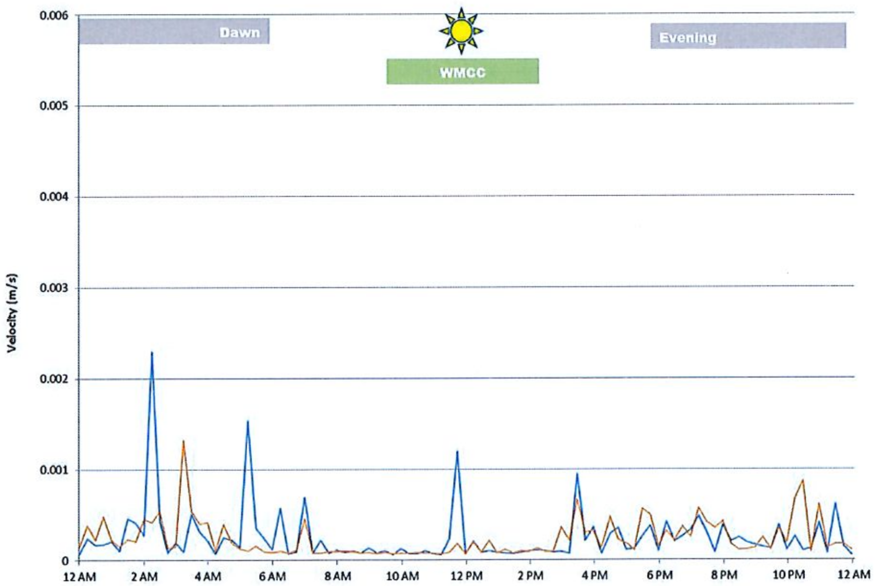

Plate 14. Velocity (m/s) for World City Medical Center, Aurora Blvd., Quezon City

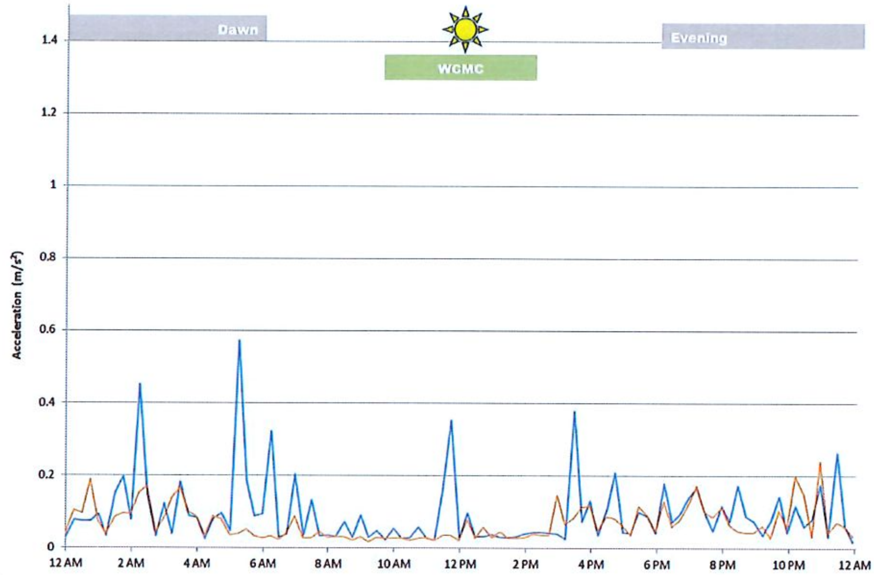

Plate 15. Acceleration (m/s^2) for World City Medical Center, Aurora Blvd., Quezon City

TektonGeoMetrix INCORPORATED

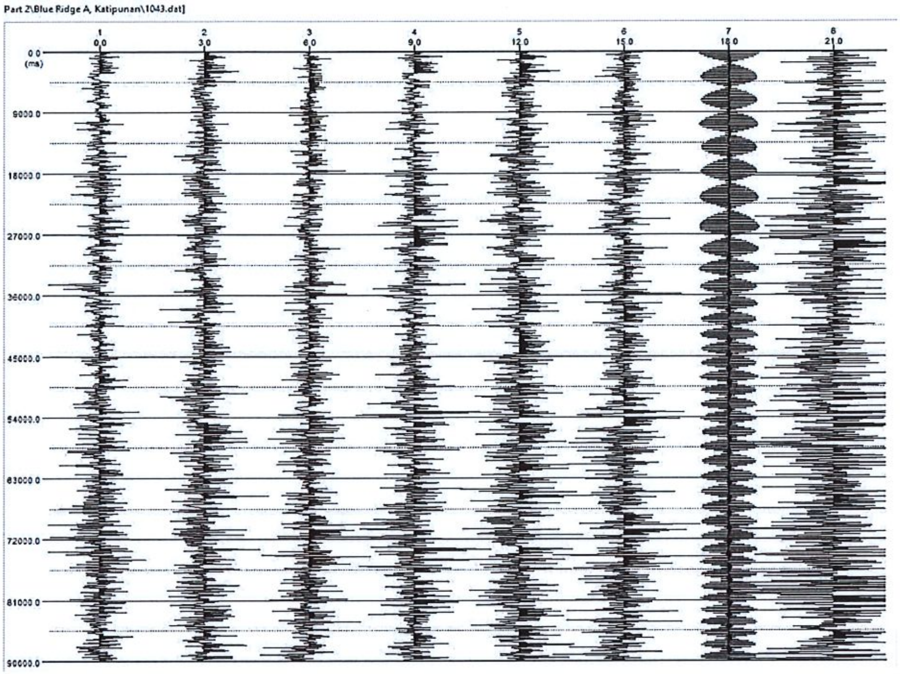

Plate 16. Seismogram for Katipunan, showing the 8 channels record. Channel 7 is affected by poor electrical coupling in the sensor.

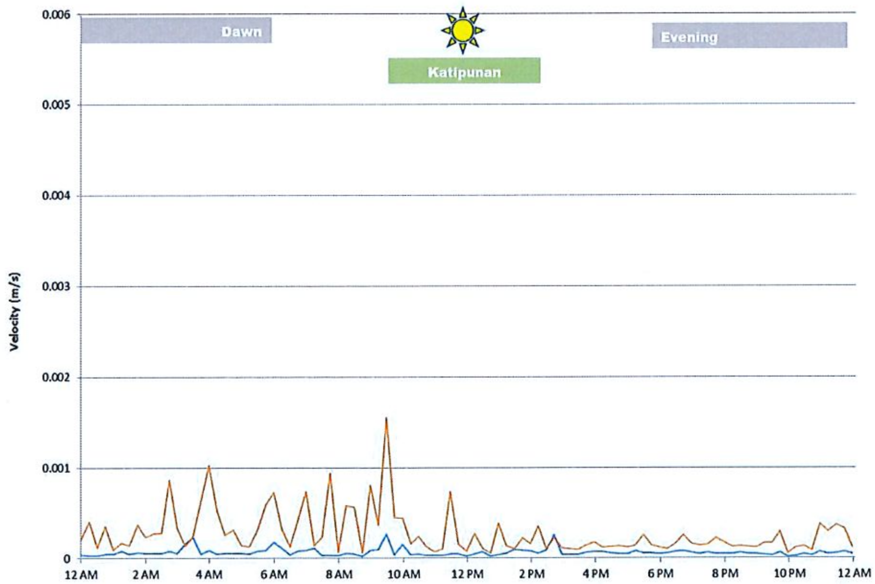

Plate 17. Velocity (m/s) for Blue Ridge, Quezon City

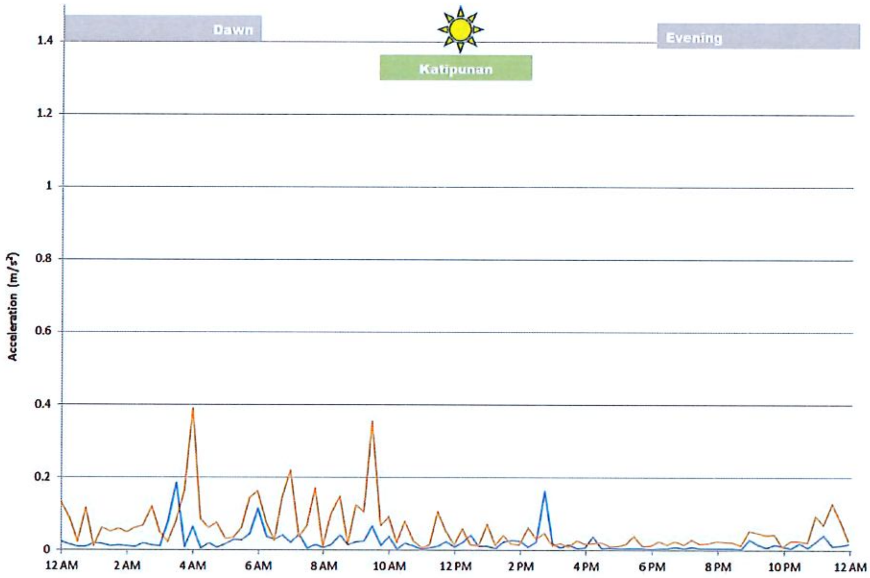

Plate 18. Acceleration (m/s^2) for Blue Ridge, Quezon City

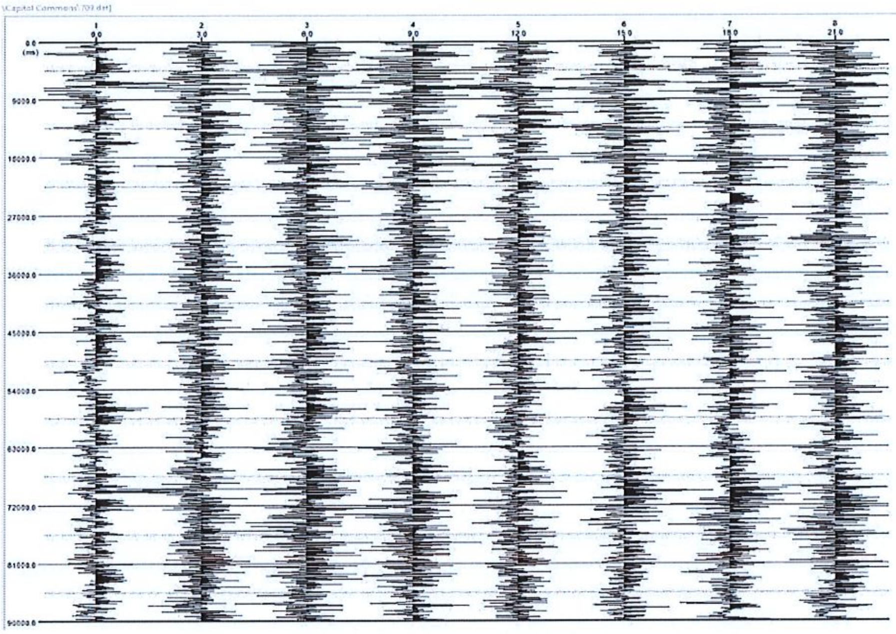

Plate 19. Seismogram for Capitol Commons, showing the 8 channels record.

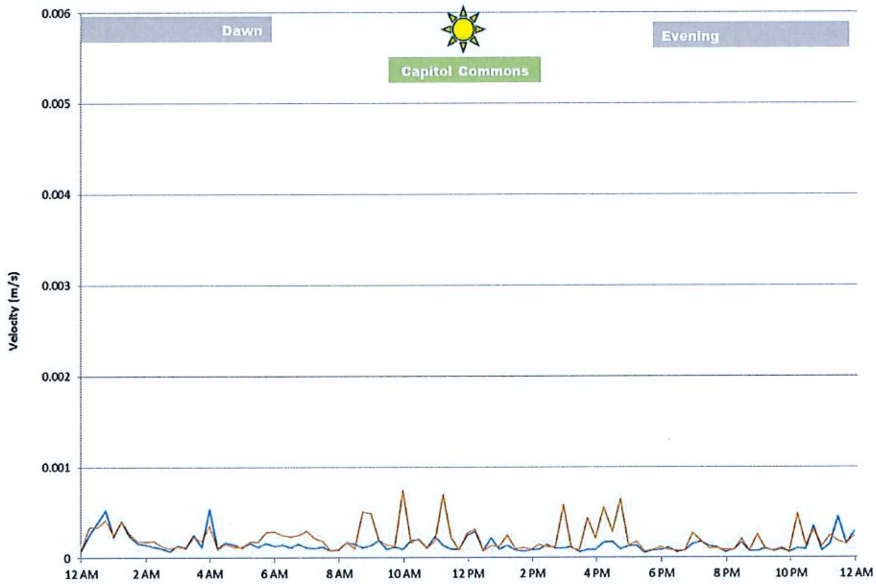

Plate 20. Velocity (m/s) for Capitol Commons

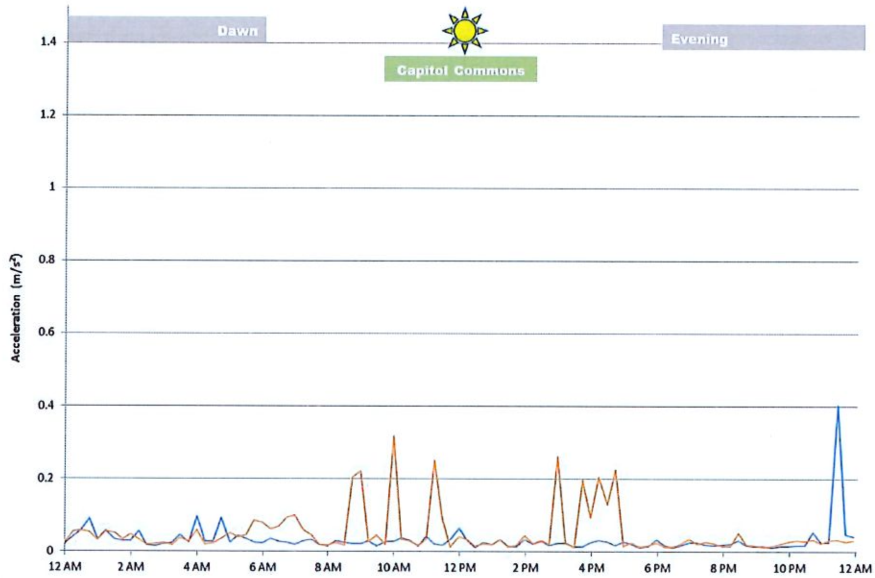

Plate 21. Acceleration (m/s^2) for Capitol Commons

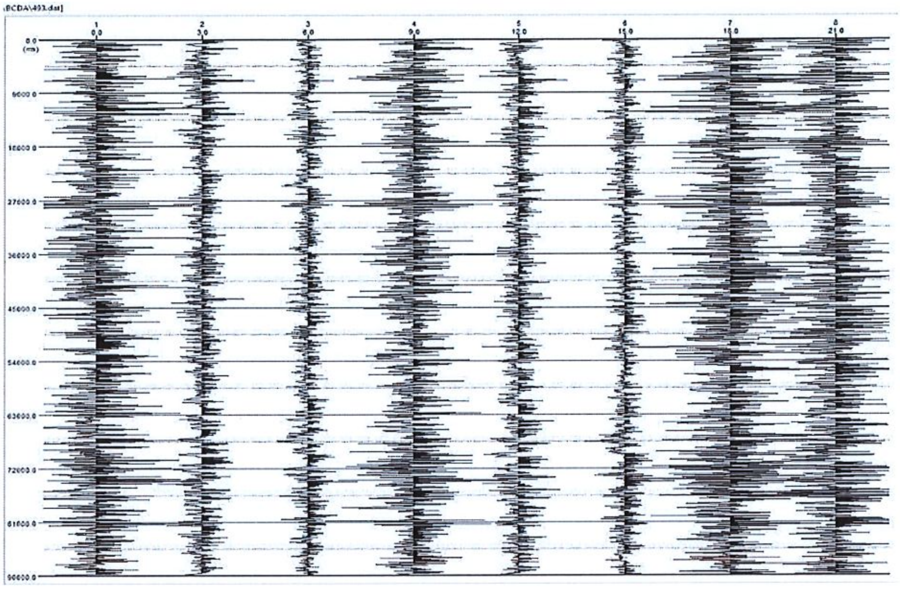

Plate 22. Seismogram for BCDA, showing the 8 channels record.

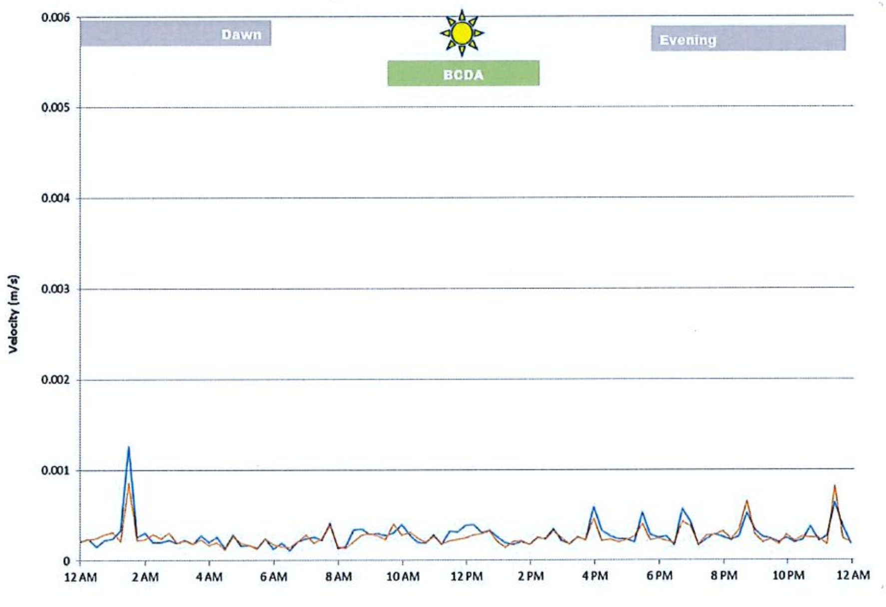

Plate 23. Velocity (m/s) for BCDA Field Office

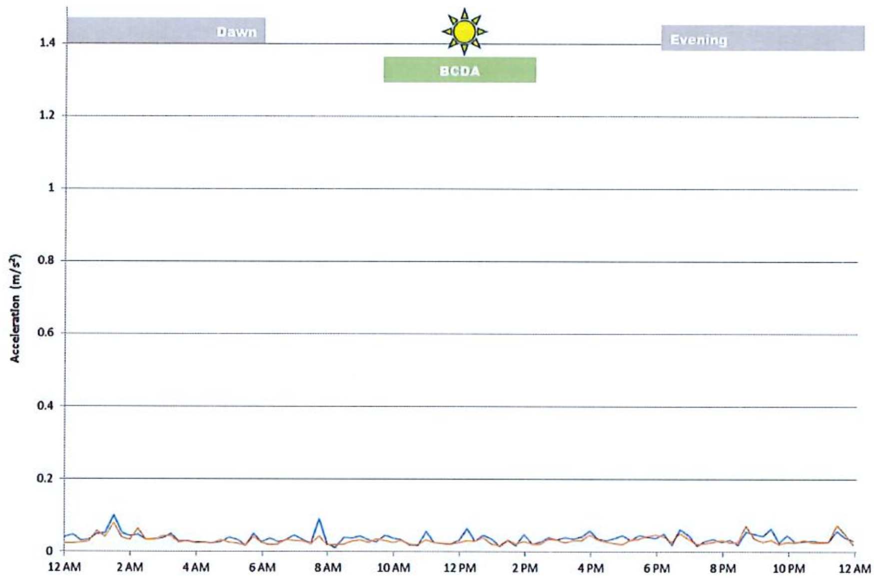

Plate 24. Acceleration (m/s^2) for BCDA Field Office

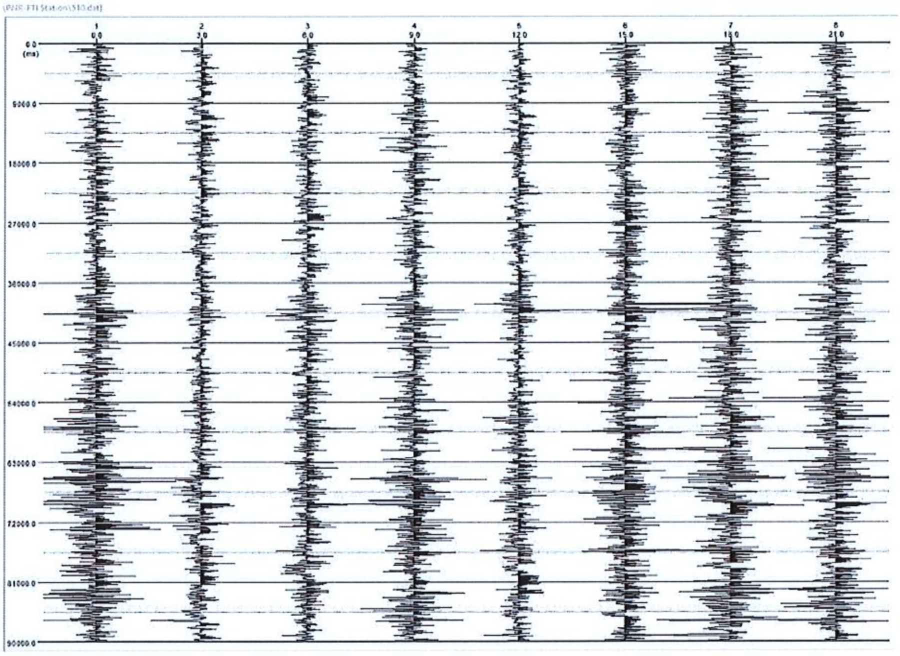

Plate 25. Seismogram for PNR-FTI, showing the 8 channels record.

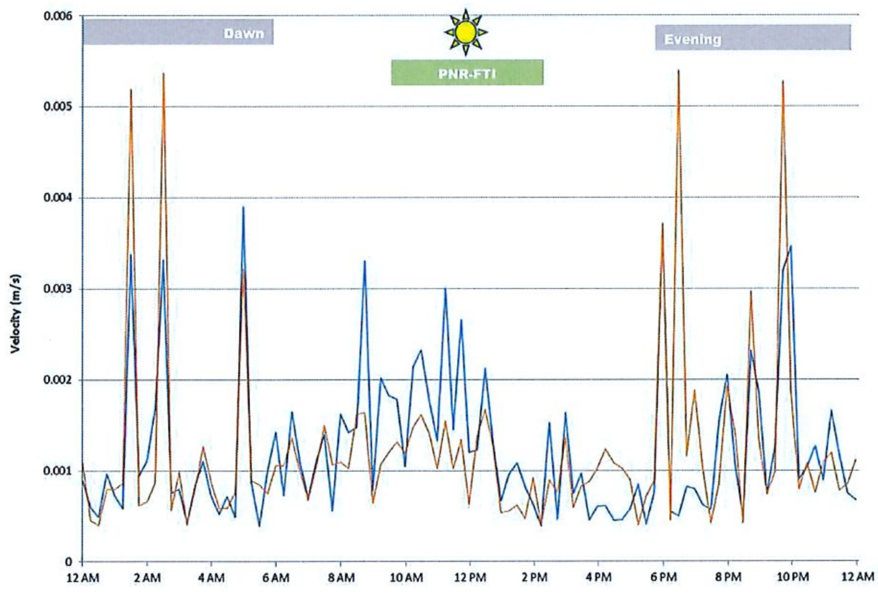

Plate 26. Velocity (m/s) for PNR-FTI

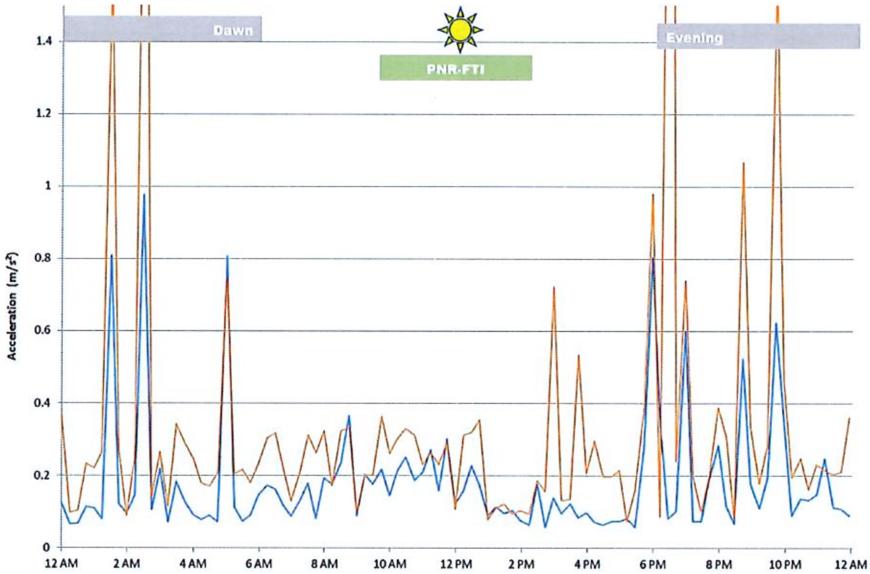

Plate 27. Acceleration (m/s^2) for PNR-FTI

Annex 2.4-1

Public Hearing Documentation

Department of Transportation

Metro Manila Subway Project (MMSP) Phase 1

Environmental Performance Report and Management Plan

Public Hearing Documentation

Project Number: MNLD19050
Document Number: R19-17
09 September 2019

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Prepared by	Checked by	Approved by
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1. Public Hearing

The Public Hearing meeting of the MMSP was conducted last 03 September 2019 from 9:00 AM to 02:00 PM at the Tandang Sora Function Hall, TESDA Women's Center located at the East Service Road, Taguig City. The Public Hearing was attended by 102 people whose received copies of the invitation letters are attached in **Annex B** while the stakeholders present during the Public hearing with respect to the stakeholder list presented in the PDS are shown in **Table 1**. The Public hearing was moderated by Atty. Sim C. Flores of the Environmental Management Bureau – National Capital Region. Also present in the Public hearing were representatives of the DOTr and the JICA Design Team (JDT) (the designers and General Consultant of the MMSP), the Review Committee and case handlers of the MMSP. The attendance sheets are attached in **Annex C**.

Table 1. Stakeholder List vis à vis Representatives Present at the Public Hearing

Stakeholder/Organization	Head	Attendance during the Public Hearing
Proposed List of Stakeholders in the PDS		
Environmental Management Bureau - National Capital Region (EMB-NCR)	Jacqueline Caancan	Representatives present
Office of the Mayor – Taguig	Lino Cayetano	-
Office of the Mayor – Pasay	Antonio Calixto	-
Office of the Mayor – Parañaque	Edwin Olivarez	Representative present
City Planning and Development Office (CPDO) – Taguig	Arch. Hilda Candelario	Representative present
CPDO – Pasay	Engr. Merlita Lagmay	Representative present
CPDO – Parañaque	Engr. Benigno Rivera	Representative present
Megaworld Corporation		-
Church of St. Therese Child of Jesus	Msgr. Albert Conco	-
Church of St. Nazarene		Representative present
Makati South Hills Subdivision	Robert Pasiloc	Representative present
United Parañaque Subdivision 1		Representatives present
United Parañaque Subdivision 2		-
United Parañaque Subdivision 3		Representative present
United Parañaque Subdivision 4		Representative present
United Parañaque Subdivision 5		-
Barangay San Martin de Porres, Parañaque City	Michael Thor Singson	Representatives present
Barangay 183, Pasay City	Ruth Cortez	Representative present
Barangay Fort Bonifacio, Taguig City	Jorge Daniel Bacobo	Representative present
Barangay Western Bicutan, Taguig City	Perlita Carmen	Representative present
Women's Organization		Representative present
Dr. Arcadio Santos National Highschool	Concepcion C. Bernaldez	Representative present
Farmer's Association		-
Senior Citizen's Group	Pasay	Representative present
Youth		-
General Public		-
Barangay Sto. Nino, Taguig City		Representative present
Bonifacio Naval Station Homeowners Association		Representative present
National Nutritional Council		Representative present
Stakeholders Present at the Public Hearing but not in the Original Stakeholder List		
Green Cross, Inc.		Representative present
GHD		Representative present
Philippine National Bank (Local Branch)		Representative present
City Environment and Natural Resources Office (CENRO) - Pasay		Representative present
City Environment and Natural		Representative present

Stakeholder/Organization	Head	Attendance during the Public Hearing
Resources Office (CENRO) - Parañaque		
City Environment and Natural Resources Office (CENRO) – Taguig		Representative present
Technical Education and Skills Development Authority (TESDA) by Lawton Avenue		Representative present
MMDA		Representative present
City Engineer's Office - Pasay		Representative present
Malugay - LGU		Representative present
PNP- SPD		Representative present
Sitio Malugay		Representative present
Barangay 183, Villamor		Representative present
Brangay 184, Maricaban		Representative present

2. Summary of Issues and Concerns

	Questions and Suggestions	Response
1.	UPS 1 will be highly affected, so how DOTr will ensure that all the options will be taken into consideration in which the homeowners will not be affected?	**USEC Timothy John Batan, DOTr** DOTr understands during the coordination and consultation meetings, the affected stakeholders have commentaries and by then and now DOTr already taking efforts to have an alternative to minimize or mitigate the negative effects of the Project. USEC Batan discussed the whole project by showing the budget, process and interconnectivity of the Railway Projects to help in communicating with stakeholders and for them to feature and understand more the project. In the study, 3 considerations were considered, first the PNR Calamba, second is C6 Project and Taguig intermodal project.
2.	I believe there's also a government property in the area that is not south of where UPS is, if you do that you will not hit any existing community. As you try to go up, emerge the subway, how about the PNR is be the one to go down and meet the train below?	**USEC Timothy John Batan, DOTr** The location of the Taguig intermodal is already existed, so we cannot go further as e will interconnect all the railway projects. And it is also needed to consider the elevation, also the possible route for that, already have structures like the NAIA X.
3.	Construct bridge instead of temporary road. Then the shift yard instead in our village maybe we can put it in the north after the construction? Have you explored everything that we can do?	**USEC Timothy John Batan, DOTr** At this point, the previously discussed options are the current best possible situation. The 15 meters permanent works requirement for the future east service road and the 10 meters temporary. The meters we can shift it but the 15 meters permanent future service road is too difficult as we want also to replicate it as much as possible.
4.	Your team were asking for another loan for that part of the original FTI station to Bicutan which is about 1.5 km, now why do you have to go down if you're really get set to Bicutan why you have to go down and can't attain a maximum speed for a high speed train down under because you're now approaching the terminal station which is Bicutan. In the PNR station once you're approaching a terminal the train go slow, so from FTI, isn't it more logical that you just stay upgrade or in the surface and have a transit station in the FTI. Because you encroach too much in the UHV. And why you can't put the new east service road on top of the subway?	**USEC Timothy John Batan, DOTr** The entire loan is already committed and fully funded. Two project that are relevant in this area. First, the North- South Commuter Railway. The 148 km of the 3 PNR railways (Clark, Malolos and Calamba) all were connected and the subway and the north south (3 PNR railways) projects is connected

		to bus intermodal. In short, the 3 PNR railway systems is a single integrated system, it means, 148 km, 37 stations, 3 regions, 22 LGUs, you can ride a train in Clark airport and get off in PNR Calamba, no transferring. The second project is the subway, the subway in the transport road map We're bounded by Laguna de Bay, manila bay and mountain ranges of Rizal in the left and right of the project, that geographical configuration constraints us to plan in north south basis. And in the railway system were trying to build 3 north south mass transit. We want to interconnect all the railways and the bus intermodal.
5.	Suggesting exploring the cucumber road instead of the east service road. The Paje to cucumber Road has no commuters as there were only few people living the area. And UHV are willing to go down to Cucumber Road. So UHV residents are willing to remove the east service road and go down in the Cucumber Road just don't encroach with their properties.	**USEC Timothy John Batan, DOTr** If the suggestion will be pursued, we need to revise the design. But we will try to explore that.
6.	Instead of using the properties of the 200 tax payers, try to borrow temporarily to ARCA south lfor 5 years.	**USEC Timothy John Batan, DOTr** We'll look into that.
7.	We're worried that we might experience flooding in the low land area of Pasay, if the gathered soil will be placed in the reclamation area of Maricaban.	**Allan Mandanas, AECOM** The site is only an option, but it doesn't mean that it is already decided and agreed to place it in the Maricaban area. Also,it needs to undergo new permits. And in case it will be pursue the gather soil can be use in the Pasay City projects such as the reclamation.
8.	In the study it is found out that the soil is soft, so what if flooding occurs during the pre-construction? Instead in Barangay 183 why try to divert it in Villamor gold course? Aside of less residents to be affected, concerns in the vibration can be avoided. Then during the construction, the traffic will be a bottle neck in St. Therese and how about the private cars that will pass through. NAIA terminal 3 already have an international flight so the residents will be having in the access road due to heavy traffic. For the post-construction, how about our safety?	**Engr. Mikaela Eloisa Mendoza, DOTr** It is part of the consideration, as the option is yet final. It is not just the land/ soil were being studied but also the social impacts. DOTr will consider all of it. Traffic impact assessment is also part of the study. We'll investigate it. We're assuring the residents that we're securing the security of all the communities.
9.	Why the original plan going only to FTI changed to Bicutan? What will be our assurance that we will not be affected or disturb by the	**USEC Timothy John Batan, DOTr**

	project, we're just 30 to 40 meters way from the project site construction. Last year, it is stated that 15 meters will only be affected but why as of to date it expands?	Due to the network DOTr builds. For the convenience of the people from north going to south. Interconnectivity of all the railway system for convenience of all the commuters. Majority of the contractors are Japanese Companies. It is procured of the JICA guidelines, there were requirements to be followed, with this, the communities will be assured that they will not be affected. The noise and vibration will be in tolerable level. We're currently conducting study on how we can go inside the PNR right of way to lessen the affected properties and communities.
10.	Two options were presented, in the option 1 or A can we already identify the structures to be affected?	**Christina Fernandez, DOTr** To know the areas to be affected, socioeconomic survey/ profiling must be conducted first. Currently we only have the drawings, so we need to undergo parcellary survey then identify in the ground to confirm the results of the parcellary then after that we will conduct socio-economic survey.
11.	The Nazarene Church will also be affected, our concern is, we're hoping to pay us within the year for us to look for another place.	**Christina Fernandez, DOTr** The principle of no properties to be replace not until it will be paid will be follow. We can't hold on to pay the properties within the year. There were rental subsidy, temporarily in case we did not meet the allotted time.
12.	Is there a establish system for compensation? DOTr will not neglect or forsaken?	**Christina Fernandez, DOTr** We have entitlement matrix, but we don't have yet the valuing, but it will be either Landbank or DBP. No. As it is part of the agreement with JICA and affected persons, that is why we conduct Resettlement Action Plan (RAP).
13.	What will happen if the owner of the lot and structure is not the same.	**Christina Fernandez, DOTr** The important is, we must know the owner of the land/ lot. The owner of the structure must show presents the tax declaration of the improvements of the structure for us to have a basis. If no evidence were presented, they will be listed as informal settlers (ISF)
14.	It was mentioned in Geology that most of the area is Adobe soil, it can be brittle if constant activities being done that may cause	**Engr. Mikaela Eloisa Mendoza, DOTr**

	subsidence.	Geotechnical investigation was conducted, the results of the study shows that the soil is good. In terms of vibration we have counter measures, for example, in railroad there were anti vibration in it to lessen the strong impact of the vibration.
15.	What will happen if we're many who will need to share for the payment or compensation of the property? We acquired it to our dead parents, but the Title is still in the name of our grandfather. if the property were acquired from their death parents, the pro	**Christina Fernandez, DOTr** Any properties that were still owned/ named by dead person must undergo extra judicial settlement. The siblings should discuss how it will be divided. Then after the agreement to whom the title will be transfer, that will be the time DOTr will come in. Once the property has been tagged, you can ask for help in the help desk of DOTr to assist you in transferring the title. Also stated that extra judicial settlement is a process of transferring if the owner already died.
16.	Where will be the relocation site of the affected residents and if money compensation how much and what is the process?	**Christina Fernandez, DOTr** If it has a title, the current value that will be release by GFI will be applied. The resettlement is only applied for ISFs.
17.	Is the Cucumber Road to be considered? The FTI station will be remove? In the mode of access is there other alternatives?	**Engr. Mikaela Eloisa Mendoza, DOTr** As mentioned, the FTI station will only move in the PNR. The FTI station is needed for the intermodal connection. As of now, there were no alternatives as we are avoiding increasing the social impacts.
18.	How about the environment? The trees to be cut? The properties can be replace but how about the environment?	**Engr. Mikaela Eloisa Mendoza, DOTr** Based on the map most of the right of way is a built-up area. The trees to be affected will undergo tree inventory to identify the trees then will submit to DENR for tree cutting permit and before DENR issued the permit. DOTr will required to replace what will be cut. In the new law, the trees to be affected must be subjected for payment. With this, appraisal is needed as the owner of whom planted the trees or vegetation will need to be paid.
19.	How will be the settlement of payment if the lot was sold but the title is still named from the previous owner?	**Christina Fernandez, DOTr** DOTr will only compensate the person who is in the Title.

	Also, would like to suggest if you were going to plant trees in every station can we plant fruit bearing and dwarf trees?	

Majority of the issues and concerns raised during the Public hearing revolved around issues of compensation during the right-of-way acquisitions for the MMSP and issues with resettlement of affected stakeholders along the changed alignment. Photos taken during the public hearing are attached in **Annex D**. The Pro-Forma Public Hearing List of Issues is presented in **Annex E**.

Annexes

Annex A – Presentation Materials of the Public Hearing

Annex B – Received Copies of Invitations for the Public Hearing

Annex C – Attendance Sheets from the Public Hearing

Annex D – Photo Documentation from the Public Hearing

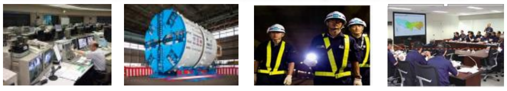
Annex E – Pro-Forma Public Hearing List of Issues

Annex A

Presentation Materials of the Public Hearing

Metro Manila Subway Project (MMSP) – Phase 1

Amendment of the Environmental Compliance Certificate



Public Hearing

3 September 2019
TESDA Taguig

MMSP Public Hearing Activities

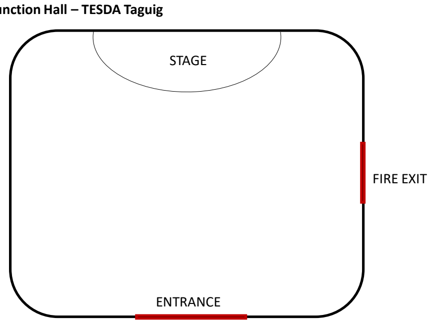
TIME	PROGRAM OF ACTIVITIES	PERSON RESPONSIBLE
8:00 – 9:00 AM	Registration	Proponent/Preparer Department of Transportation
9:00 – 9:30 AM	Invocation National Anthem Opening Remarks Briefing and Orientation on the purpose of the Public Hearing Rules on the Conduct of Public Hearing	AECOM AECOM Proponent - Department of Transportation EMB Engr. Regina Paula Eugenio Hearing Officer Atty. Sim C. Flores
9:30 – 10:00 AM	Presentation on the description of the Project including alternatives Presentation of the EIA Study process and results	Proponent/Preparer Department of Transportation EMB Engr. Regina Paula Eugenio AECOM
10:00 AM – 1:00 PM	Open Forum	Hearing Officer Atty. Sim C. Flores
1:00 – 1:30 PM	Recapitulation of issues raised and the proponent's response Next Steps	Hearing Officer Atty. Sim C. Flores EMB Engr. Regina Paula Eugenio

National Anthem & Invocation

Opening Remarks

Safety Moment

Tandang Sora Function Hall – TESDA Taguig



Public Hearing Objectives

- To discuss proposed Metro Manila Subway Project (MMSP) extension section
- To present the findings of baseline studies
- To present potential environmental impacts and mitigations
- Present response to issues and concerns raised during scoping

Public Hearing Decorum

- General
  - Kindly maintain an organized atmosphere.
  - Questions and comments there will be entertained during the open forum. Take note of your question or concern until the open forum.
  - Please do not interrupt the presentation.
- Open Forum
  - If you have a question or concern, please raise your hand and wait until the facilitator acknowledges you.
  - The facilitator will approach and ask for name and affiliation.
  - Speak clearly so that all can hear.

Project Fact Sheet

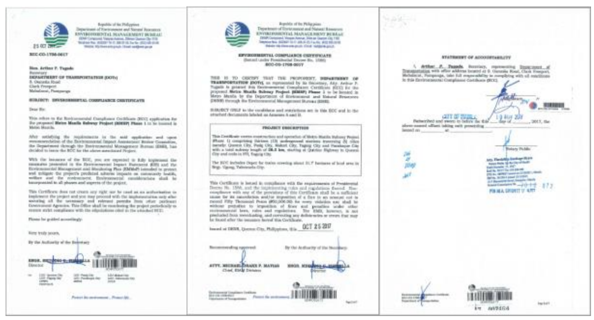
Project Name	Metro Manila Subway Project (MMSP)
Location	Metro Manila: Valenzuela (Depot), Quezon, Pasig, Makati, Taguig, Pasay and Parañaque
Nature of Project	Railway/Subway
Project Scale	No. of Subway Station: 15 total Total Length: 36 km
ECC Reference No.	ECC CO 1708-0017 Issued: 25 October 2017 For 13 stations and the subway alignment
Proposed Expansion Area	Relocation of former Cayetano Station to the proposed Lawton East and Lawton West Stations. Extension to proposed NAIA Terminal 3 Station. Connection of the proposed FTI station to increase interoperatbility with the NSCR project.

Proponent Profile

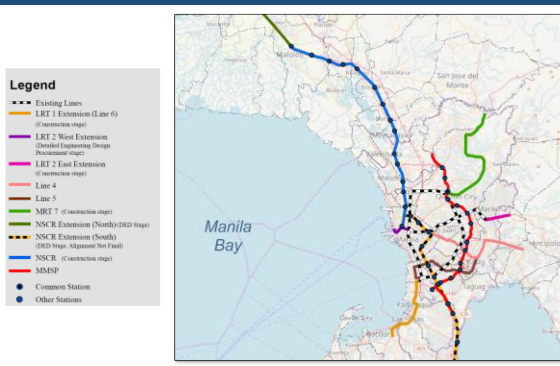
Project Proponent	Department of Transportation (DOTr)
Proponent Address	Apo Court along Sergio Osmeña Sr., Clark Freeport Zone, Mabalacat, Pampanga 2009
Proponent Representative	Sec. Arthur Tugade DOTr Secretary
Contact Details	Engr. Mikaela Eloisa D. Mendoza Project Manager Engr. Jim Benedict G. Petate Email: jimpetate.dotr@gmail.com Tel. No.: (0921) 414-6425

MMSP Environmental Compliance Certificate: ECC-CO-1708-0017

- Granted: 25 October 2017



THE RAILWAY NETWORK



Project Rationale

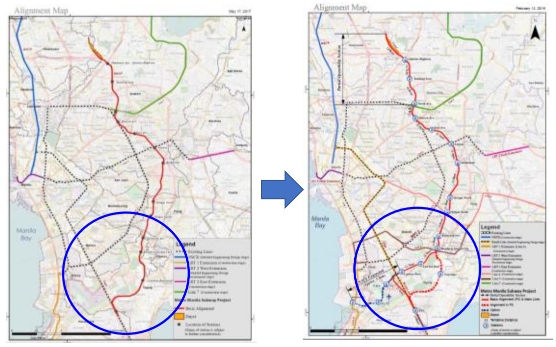
"The National Capital Region (NCR) or Metro Manila is among the most populated regions of the Philippines which had a population of 12,877,253 in 2015" (PSA, 2015)

"The public transport services in Metro Manila are comprised road based public utility vehicles, taxis and mass transit systems. Despite the wide range of available modes of public conveyance, the public transport system in the Philippines is regarded as unsafe, unhealthy, unreliable and uncomfortable." (Delgra III, 2018)

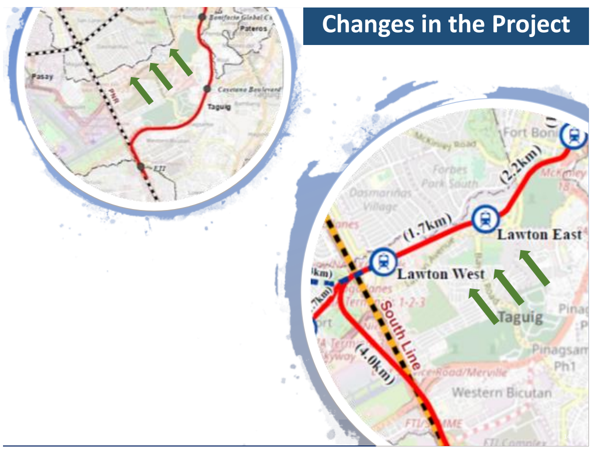
Changes in the Project

The proposed basic alignment is within the fault zone, approximately 23 meters west and 41 meters east of different segments of the WVF.

Changes in the Project



Changes in the Project



Project Components

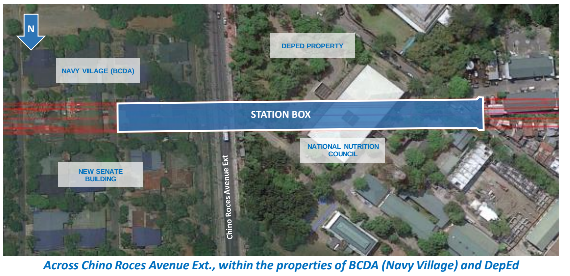
Original Project Components in ECC CO 1708-0017 Issued on 25 October 2017	Proposed Changes/Expansion
13 underground station traversing 5 cities	15 underground stations traversing 7 cities • Removal of proposed Cayetano Station • Inclusion of Lawton East Station • Inclusion of Lawton West Station • Inclusion of NAIA Terminal 3 Station
Underground alignment totaling 28.7 km	Underground alignment totaling 36 km • Extension of rail line from Lawton West to NAIA Terminal 3 Stations. • Extension of line from FTI to Bicutan PNR Station to increase interoperability with the NSCR project.
Depot with an area of 31.7 ha	No Change

Lawton East Station

Located within the properties of NAMRIA and MEGAWORLD, Barangay Fort Bonifacio, Taguig City

Length of Station Box	277 m
Width of Station Box	21 m
BGC-LE Interstation Tunnel Depth (from ground level to top of tunnel)	18-35 m (under study)
Construction Timeline	5 years

Lawton West Station



Across Chino Roces Avenue Ext., within the properties of BCDA (Navy Village) and DepEd

Length of Station Box	307 m
Width of Station Box	21 m
LE-LW Interstation Tunnel Depth (from ground level to top of tunnel)	18-20 m (under study)
Construction Timeline	5 years

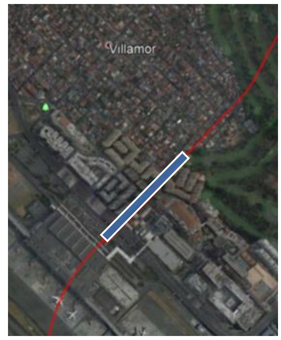
FTI Station

Parallel to East Service Rd. between Cucumber Rd. and Marian Rd., Barangay San Martin de Porres, Parañaque City

Length of Station Box	560 m
Width of Station Box	39 m
Tunnel Depth	18 m
Construction Timeline	5 years

NAIA T3 Station

Option 1



NAIA T3 Station

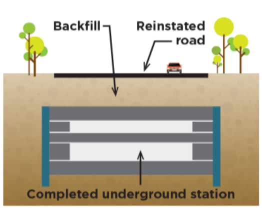
Option 2

Tunneling Methods

Tunneling Methods for MMSP

Cut-and-Cover Method

FOR STATIONS

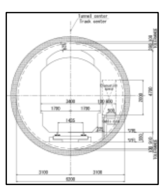


- Tunneling method is subject to change -

Tunneling Methods for MMSP

Shielded Tunneling Method

USE OF TUNNEL BORING MACHINES (TBM) FOR INTERSTATIONS (where not applicable NATM will be used)



- Tunneling method is subject to change -
NATM = New Austrian Tunneling Method

Technical Parameters

Route Length	Approx. 36 km
Gauge	Standard (1,435mm)
Fleet Count	30 trains, 8-car
Maximum Speed	120 kph 80 kph (Operational Speed for Phase I)
Train Capacity	2,242 passengers at 7pax/m^2
Signaling	CBTC
Platform Screen Doors	Full Height
Headway	5 minutes
Typical Platform Width	Island: 10 m, Side: 7 m
Power Supply	1.5kV DC, Overhead Rigid Catenary
Depot Area	30 ha

PROJECT TIMELINE

Activity	Expected date
PO Section Construction	2019
PO Section Operation	2022
Remaining Section Construction	2021
Full Section Operation	2025

EIA Results

EIA Process

Date	Step
Stakeholder consultation meetings: 8-9 Oct 2018 Social preparation surveys: 16 May - 3 Jun 2019 Perception Surveys: 30 May – 4 Jun 2019	**Category A - Project** IECs + Initial Perception Survey
1 July 2019	**Public Scoping**
17 July 2019	Technical Scoping
Between 18 June and 21 July	Baseline Studies and Environmental Impact Assessment
	ECC Application to EMB/ Submission of draft EIS
3 Sep 2019	Public Hearing
	EMB Assessment Process
	ECC Approval

Project Phases

- Pre-Construction Phase (2019)
- Construction Phase (2019-2025)
- Operation Phase (2025-)
- Abandonment Phase

Direct Impact Areas (Extension Section)

Biophysical Impacts:

- The three (3) additional subway stations including construction yards and shield machine bases including FTI station ;
- The interoperability area between FTI Station and Bicutan PNR Station;
- The underground tunnel portion of the alignment;
- Areas directly adjacent to construction areas
- Waterways within or in the vicinity of the stations

Socio Cultural Impacts:

- Settlement along the alignment affected by the resettlement;
- Communities utilizing the road network outside 1 km of the construction sites; and
- The 19 barangays and 7 cities hosting the MMSP alignment

Indirect Impact Areas (Extension Section)

Biophysical Impacts:

- The surface above the underground tunnel portion of the alignment in terms of noise and vibration

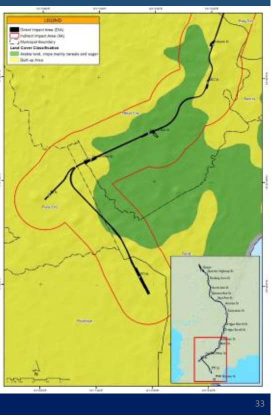
Socio-Cultural Impacts:

- The rest of Metro Manila.
- Road networks within Metro Manila
- Receiving communities that will host the resettled people

The Land

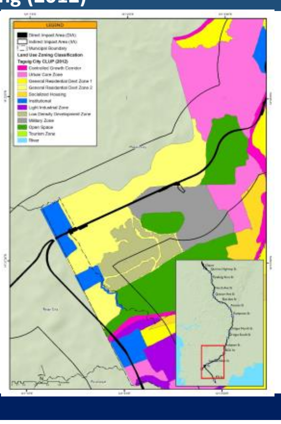
Baseline Studies – The Land

- Parts of the extension section of the MMSP alignment traverse across the land cover classification of Arable lands (35%) while majority of the alignment falls under the Built-up zone classification (65%).



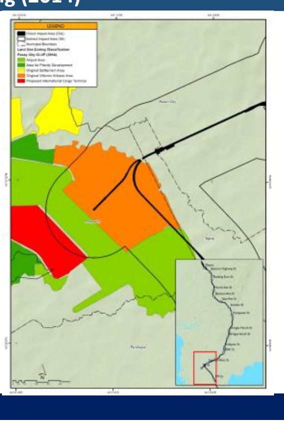
Taguig City Zoning (2012)

- Military zone
- General Residential Development zone
- Institutional zone



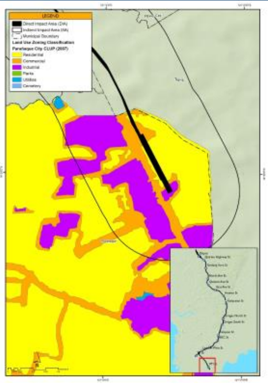
Pasay City Zoning (2014)

- Original Villamor Airbase Area



Parañaque City Zoning (2007)

- Residential
- Commercial
- Industrial



Protected Areas

Baseline Studies – The Land

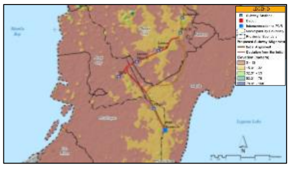
Land Use - Potential Impacts & Mitigation

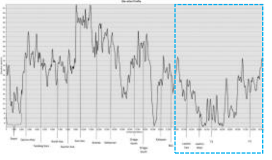
Potential Impacts	Phase			Mitigation
	P	C	O	
Conversion of the existing land use to other use • Residential, Institutional, and Industrial zones into Mixed-use zones	✓	✓	✓	• Define the allowable uses in the mixed-use zones with the view of incorporating it in the CLUPs. These uses will be compatible with the land uses of the surrounding areas.
Land values by the MMSP station are expected to increase	✓	✓	✓	• Gentrification in Lawton East and Lawton West, since BGC is already identified as lifestyle districts. Therefore, no parties would be excluded from the property market because of the increases of lands/properties. Provide for inclusionary zoning in the mixed development area.

Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

- MMSP alignment is within Central Plateau portion of Metro Manila
- Extension alignment elevations: 4 – 30 masl





Station Name	Elevation (masl)
Lawton East Station	12
Lawton West Station	9
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	13
Food Terminal Inc. (FTI) Station	22
Bicutan Interconnection	37

Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

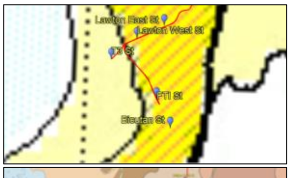
- Slope gradients: 0 - 8 %
- Slope classification: Flat to low slope

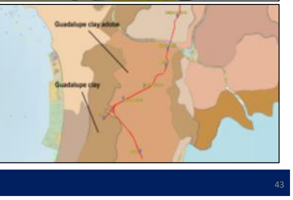
Station Name	Slope (%)
Lawton East Station	0 - 8
Lawton West Station	
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	
Food Terminal Inc. (FTI) Station	
Bicutan Interconnection	

Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

- Geologic Formation:
  - Lawton East & West + FTI + Bicutan: Guadalupe Formation → "adobe"; tuffaceous sandstone, tuffaceous siltstone
  - NAIA T3: Recent alluvial deposits
- Soil Series:
  - Guadalupe series: Residual soil of water-laid volcanic tuff. Poorly drained, clayey soils. Overlies hard and massive tuff. Developed from Diliman Tuff member.
    - Lawton East & West + FTI + Bicutan: Guadalupe clay adobe
    - NAIA T3: Guadalupe clay

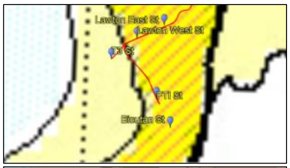




Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

Station Name	Geologic Formation	Residual Soil Mantle Thickness (m)
Lawton East Station	Guadalupe (Tuff)	~ 1.5
Lawton West Station	Guadalupe (Tuff)	~ 1.5 – 4.25
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	Recent	no drilling
Food Terminal Inc. (FTI) Station	Guadalupe (Tuff)	1.19 – 10.15 none
Bicutan Inter-operability	Guadalupe (Tuff)	no drilling



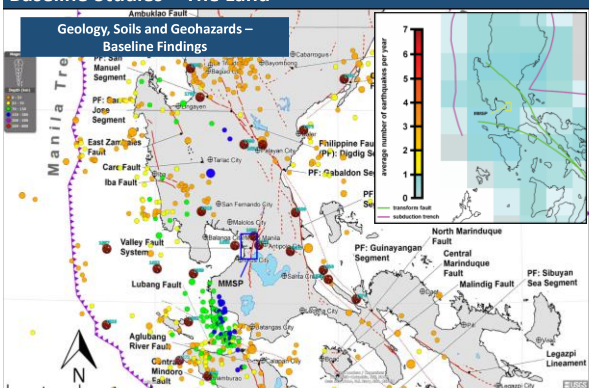
Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

Class	Soil Description	Vs30 Range (m/sec)
A	Hard rock	Vs30 > 1500
B	Rock	760 < Vs30 ≤ 1500
C	Very dense soil and soft rock	360 < Vs30 ≤ 760
D	Stiff soil	180 < Vs30 ≤ 360
E	Soft soil	Vs30 < 180
F	Soils requiring site-specific evaluation	Vulnerable to failure

Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings



Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

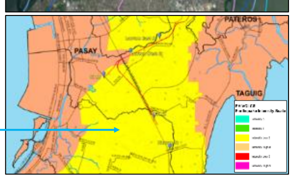
Seismic Source	Calculated PGA Values				
	Average (g)	Rock (0.6 g)	Hard Soil (1.07 g)	Med. Soil (0.87 g)	Soft Soil (1.39 g)
West Valley Fault (central)*	0.619	0.371	0.662	0.538	0.860
East Valley Fault*	0.332	0.199	0.356	0.289	0.462
Manila Bay source (1863 Earthquake)	0.281	0.168	0.300	0.244	0.390
Laguna – Banahaw Fault	0.201	0.120	0.215	0.175	0.279
Philippine Fault Zone (Infanta Segment)*	0.172	0.103	0.184	0.150	0.239
Lubang – Verde Island Passage Fault*	0.101	0.061	0.109	0.088	0.141
Manila Trench (12.5°-14° N)*	0.032	0.019	0.034	0.028	0.044
Manila Trench (14°-16° N)*	0.026	0.016	0.028	0.023	0.036
Philippine Fault Zone (Digdig Segment)*	0.084	0.050	0.090	0.073	0.117
East Zambales Fault*	0.042	0.025	0.045	0.037	0.059
Casiguran Fault	0.024	0.014	0.025	0.021	0.033

Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

- Computed peak ground acceleration (PGA) values for hard soil exceed 500-year return period PGA values → earthquake events that would produce these computed PGA values are less likely to occur than earthquakes of weaker magnitude

%g	MMI	Perceived Shaking (MMI)	Potential Damage (MMI)	PEIS	Description (PEIS)
9.2 – 18	VI	Strong	Light	VI	Very Strong
18 – 34	VII	Very Strong	Moderate	VII	Destructive
34 – 65	VIII	Severe	Moderate to Heavy	VIII	Very Destructive
65 – 124	IX	Violent	Heavy	VIII	



Baseline Studies – The Land

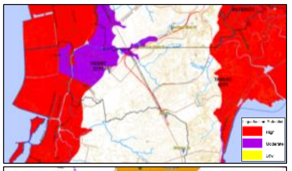
Geology, Soils and Geohazards – Baseline Findings

Station Name	Distance (km)
Depot	8.80
Quirino Highway Station	7.40
Tandang Sora Station	6.40
North Avenue Station	5.20
Quezon Avenue Station	4.80
East Avenue Station	3.20
Anonas Station	1.50
Katipunan Station	0.71
Ortigas North Station	0.64
Ortigas South Station	0.72
Kalayaan Station	0.87
Bonifacio Global City (BGC) Station	0.64
Lawton East Station	1.80
Lawton West Station	3.00
Ninoy Aquino International Airport (NAIA) Terminal 3 Station	4.30
Food Terminal Inc. (FTI) Station	1.60
Bicutan Inter-operability	0.72

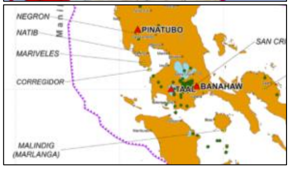
Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

- Liquefaction potential: Along Lawton West & NAIA T3



- Volcanic hazards: Volcanic quakes & ground rumbling (Taal Volcano) and ashfall (Pinatubo Volcano & Taal Volcano)



Baseline Studies – The Land

Geology, Soils and Geohazards – Baseline Findings

Station Name	READY for GMMA Project	UP NOAH 100-Year Map
Depot	Low to Moderate	High
Quirino Highway Station	Low	Medium to High
Tandang Sora Station	Not Susceptible	Low to Medium
North Avenue Station	Low	Low
Quezon Avenue Station	Moderate	Low to Medium
East Avenue Station	Not Susceptible	Medium
Anonas Station	Low to Moderate	Medium to High
Katipunan Station	Low	Low to Medium
Ortigas North Station	Low	Not Susceptible
Ortigas South Station	Low	Low to Medium
Kalayaan Station	Low	Low
Bonifacio Global City (BGC) Station	Low	Low
Lawton East Station	Low	Medium to High
Lawton West Station	Low	Medium to High
NAIA Terminal 3 Station	Low	Medium
Food Terminal Inc. (FTI) Station	Low	Medium
Bicutan Interconnection	Low	Low to Medium

Baseline Studies – The Land

Geology, Soils and Geohazards - Impacts & Mitigation

Potential Impacts	Phase		Mitigation
	C	O	
Alteration of topography	✓	✗	• Repair / restore disturbed ground surface that follows same or improved slope conditions as original
Contamination / pollution of soil due to solid waste generation / spillage of liquid compounds / waste	✓	✓	• Implement proposer waste management and disposal system to prevent contamination of surrounding soil and groundwater • Use strong, non-reactive materials for pipes and other buried components to ensure integrity of these components and prevent chemical contamination
Tunneling may encounter buried / unexposed faults	✓	✗	• Perform detailed geotechnical investigations to identify unknown fault zones • Coordinate with PHIVOLCS on discover of new fault zones • Reroute alignment if encountered faults are found to be active
Excavation of voluminous amounts of soil & rock (9.4 M metric tonnes / ~ 522,000 truckloads of soil at 10 m^3); generation of slurry	✓	✗	• Provide proper and sufficient storage of extracted substrate materials (5 sites: Valenzuela City, Malabon City, Mandaluyong City, Pasay City Reclamation Area, C6-Taguig City) • Repurpose or reuse excavated soil & rock (after determination of suitability) • Provision of a slurry treatment plant / process circuit
Tunneling will alter underground stress distribution / weaken bearing capacity	✓	✗	• Perform tunnel deformation analysis prior to tunneling • Use appropriate tunnel support technologies

Baseline Studies – The Land

Geology, Soils and Geohazards - Impacts & Mitigation

Potential Impacts	Phase		Mitigation
	C	O	
Tunnel flooding due to ingress of groundwater and rainwater	✓	✓	• Provide dewatering pumping system in tunnel construction area • Construction of temporary drainage, detention/siltation ponds and bund walls in construction areas to manage localized flooding • Stations will be provided with permanent bund walls with water-sealed panels, tempered glass, water-proof iron doors and drainage pumping stations • Use appropriate tunnel lining materials • Formulate and implement emergency preparedness plans in the event of flooding
Tunneling may affect pressure conditions of overlying soil & rock, potentially leading to subsidence	✓	✓	• Perform tunnel deformation analysis prior to tunneling • Install piezometers and groundwater monitors • Use appropriate tunnel lining materials
Continuous operation of TBM & heavy construction equipment may produce strong ground vibrations that could induce liquefaction or collapse	✓	✗	• Determine minimum depth of influence of vibration • Perform liquefaction tests to identify liquefiable soil • Use vibration dampers when necessary • Use appropriate tunnel lining materials and support technologies
Strong ground shaking impact on project as a result of location in seismically active area (surface shaking > subsurface shaking)	✓	✓	• Design structures based on realistic and acceptable seismic values guided by PHIVOLCS assessment, geotechnical information and NSCP standards • Use appropriate tunnel support and lining technologies • Formulate and implement emergency preparedness plans in the event of earthquakes

Baseline Studies – The Land

Terrestrial Vegetation – Baseline Findings

- **Flora Species:** A total 98 morpho-species in 82 genera and 36 Families were recorded along the four (4) transects
- **Endemicity:** 4 Philippine endemic species found (2019 EPRMP). 11 threatened species were recorded

Baseline Studies – The Land

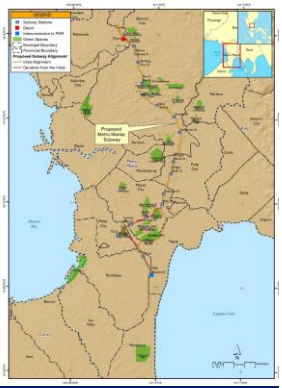
Terrestrial Vegetation- Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
Vegetation within MMSP alignment could potentially be cleared	✓	✓	✗	• Clear delineation of the extent of vegetation removal on plans and on the ground prior to removal activities. Secure tree cutting permit. Provision of offset sites for cleared areas
11 threatened plant species recorded	✓	✓	✗	• Conduct tree inventory • Conduct tree balling activity, as necessary • Secure tree cutting permit from DENR

Baseline Studies – The Land

Terrestrial Wildlife – Baseline Findings

- **Wildlife Species:**
- 213 species
  - 6 amphibians
  - 12 reptiles
  - 184 birds
  - 11 mammals was recorded
- *Recorded birds (184 species) represent approximately 37% of the known total for Luzon mainland*
- **Range Distribution**
  - 92 species (43% of the total) native but non-endemics/ resident breeding non-endemics with
  - 67 species (31% of the total) migratory birds
  - 29 species (14% of the total) endemics
  - 19 species (9% of the total) introductions
  - 6 species (3% of the total) migrants with resident breeding populations



Baseline Studies – The Land

Terrestrial Wildlife - Potential Impacts & Mitigation

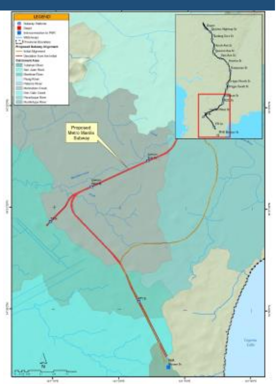
Potential Impacts	Phase P	Phase C	Phase O	Mitigation
Potential loss of wildlife habitat due to clearing activities.	×	✓	×	• Impacts and restrictions to the movement of wildlife is not expected since areas that will be cleared are patchy, limited, and mostly occupied by more mobile organisms (capable of flight) hence, they could easily transfer to other areas.
Potential loss of threatened wildlife species.	×	✓	×	• Areas where threatened species will not be affected by vegetation clearing activities. Recorded threatened birds are highly mobile and could easily transfer to nearby greenspaces.

The Water

The Water

Hydrology – Baseline Findings

- The MMSP extension section site is located within five catchments:
  - Pateros River Catchment
  - Maricaban Creek Catchment (sub-catchment of Paranaque River)
  - Don Galo Creek Catchment (sub-catchment of Paranaque River
  - Paranaque River
  - Muntinlupa River
- Waterbodies within and in the vicinity of the MMSP extension section include the Maricaban Creek and Don Galo Creek



The Water

The Water

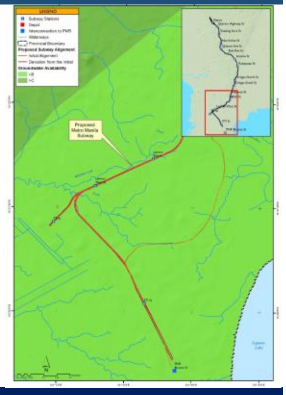
Surface Water Quality and Aquatic Ecology – Baseline Findings

- DENR monitoring data show that the Maricaban Creek and Paranaque River currently have poor water quality
- Sources of pollution include solid wastes from domestic, commercial, and industrial activities, and wastewater discharges from households, commercial/institutional establishments, and industries
- Overall stream health condition of Maricaban Creek and Don Galo Creek has poor rating

The Water

Hydrogeology – Baseline Findings

- The MMSP extension section consists of Class I (B) aquifers based on MGB
- Class I (B) aquifers are fairly extensive and productive aquifers with moderate to high permeability

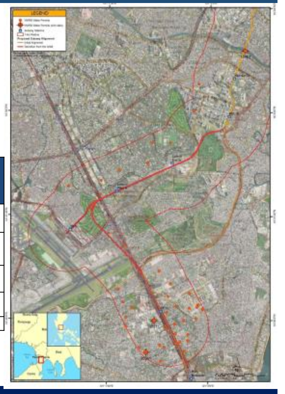


The Water

Hydrogeology – Baseline Findings

- A total of 46 deep wells have been granted NWRB permits as of June 2019 within a 1 km radius from the MMSP extension section

Stations	No. of Deep Wells within the 1 km radius from the MMSP extension section alignment	Purpose
Taguig	16	Domestic – 7; Industrial – 6; Commercial – 2 and Office – 1
Paranaque	22	Domestic – 12; Industrial – 5; Municipal – 3 and Commercial – 2
Makati	8	Domestic – 7 and Industrial – 1
Pasay	0	NA
Total	**46**	



The Water

Hydrology and Hydrogeology - Potential Impacts & Mitigation

Potential Impacts	Phase C	Phase O	Mitigation
Ground disturbance during construction activities may temporarily disrupt natural drainage flow which may result to the development of new surface runoff paths	✓	×	• All trench and foundation will be backfilled • Tunnelling works using TBM are not anticipated to impact river/stream waterflows
Fresh and potable will be required during the construction and operation phase of the project	✓	✓	• The project will not be extracting water from surface waters crossed or within the vicinity of the MMSP extension section • Potable water will be sourced from local water utility providers
Flooding of excavated site or ground deformation/subsidence should cut and cover method encounter productive groundwater table	✓	×	• Groundwater levels and ground subsidence will be closely monitored during construction activities • Criteria for decisions such as "alarm" or "danger" will be prepared based on measured changes of water and subsidence level • Mitigating measures may include chemical grouting, installation of supporting piles, and sealing of walls to stop the leakage of water
Groundwater dewatering during the tunneling works could potentially induce groundwater drawdown	✓	×	• Conduct of a detailed hydrogeological study during the detailed engineering design stage • Installation of monitoring wells to monitor change of surrounding groundwater levels • Coordination with NWRB regarding tunneling activities and its potential impact on the water table

The Water

Water Quality and Aquatic Ecology - Potential Impacts & Mitigation

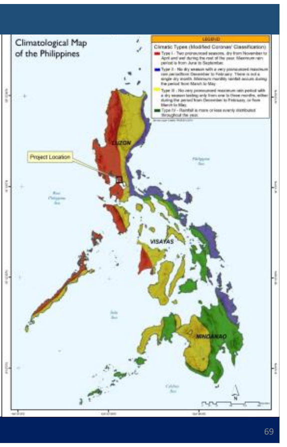
Potential Impacts	Phase C	Phase O	Mitigation
Siltation and sedimentation of waterways during earth moving activities	✓	×	• Provision of erosion and sediment control measures and spill prevention techniques including silt screens, drain channels, diversion dams, sumps, and/or settling ponds in construction areas as necessary • Provision of physical barriers or bunds to surround spoil and building material stockpiles • Use of surplus soil as backfill and appropriate disposal of remaining surplus soil after construction • Conduct of regular water quality monitoring
Contamination of groundwater as a result of tunneling activities	✓	×	• Treatment of dewatered groundwater from tunneling activities to meet DAO 2016-08 standards prior to discharge • Conduct of regular water quality monitoring
Contamination of waterways with hydrocarbons and project wastes	✓	✓	• Preparation and implementation of a Waste Management Program • Preparation of a Wastewater Management Plan • Provision of adequate spillage protection for fuel storage facilities • Proper disposal of hazardous wastes through DENR-accredited hazardous waste transportation and disposal companies • Provision of temporary sanitation facilities for construction camps • Treatment of wastewater that will be generated during the operations phase prior to discharge • Conduct of regular water quality monitoring

The Air

Baseline Studies – Air

Climate and Meteorology – Baseline Findings

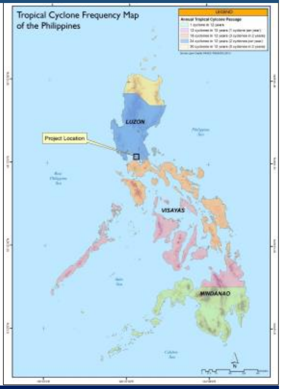
- **Climate**: Classified as Type 1 - two pronounced seasons: dry from November to April and wet during the rest of the year. Maximum rain period is from June to September.



Baseline Studies – Air

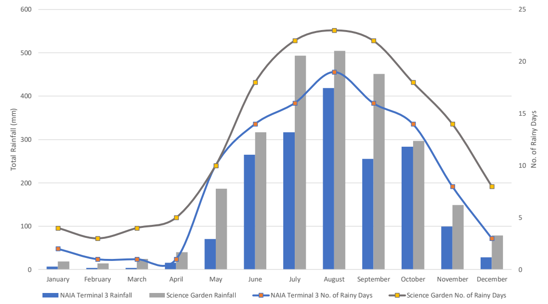
Climate and Meteorology – Baseline Findings

- **Typhoon Frequency**: 2 per year



Baseline Studies – Air

Climate and Meteorology – Baseline Findings

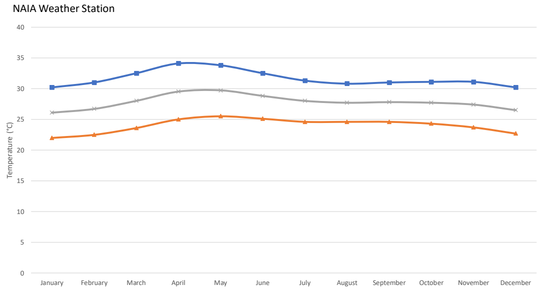


Source: PAGASA

Baseline Studies – Air

Climate and Meteorology – Baseline Findings

NAIA Weather Station



Source: PAGASA

Baseline Studies – Air

GHG Assessment – Baseline Findings

Global GHG Profile:

Annual GHG emissions from human sources have increased by 10,000 million tons of CO2-e between 2000 and 2010, coming from **energy supply (47%), industry (30%), transport (11%), and buildings (3%)** sectors. Accounting for indirect emissions raises the contributions of the buildings and industry sectors.

- The IPCC Fifth Assessment Report (AR5) estimated that the global GHG emissions coming from human activities totaled nearly **49 billion tons of CO2-e in 2010**.
- Economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion.

Baseline Studies – Air

GHG Assessment– Baseline Findings

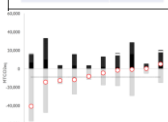
Philippine GHG Profile

GHG emissions conducted in 2000 showed that the Philippines emitted approximately **21.767 million tons of CO2-e** (including LULUCF).

The Philippine GHG emissions in the year 2000 due to fuel consumption was estimated to be at **69.67 million tons of CO2-e** (excluding LULUCF)

Baseline Studies – The Air

GHG Assessment - Potential Impacts & Mitigation

<table>
<tr><th rowspan="2">Potential Impacts</th><th colspan="3">Phase</th><th rowspan="2">Mitigation</th></tr>
<tr><th>P</th><th>C</th><th>O</th></tr>
<tr><td><table><tr><th>Project GHG Contribution</th><th>% Cont.</th></tr><tr><td>Global Transport Sector</td><td>0.00035%</td></tr><tr><td>Philippine Transport Sector</td><td>0.092%</td></tr><tr><td>Annual Global Emission</td><td>0.00005%</td></tr><tr><td>Annual Philippine Emission</td><td>0.11%</td></tr></table></td><td>×</td><td>✓</td><td>✓</td><td rowspan="2">• Consideration of fuel and equipment efficiency prior to construction and operation activities;
• Maximizing fuel efficiency through scheduling of vehicle and equipment transport to avoid traffic;
• Optimization of equipment and vehicle loadings to reduce fuel weight and improve fuel efficiency;
• Regular maintenance of vehicles and construction equipment
• Reduce fuel and electricity use, and help reduce costs associated with equipment downtime;
• Monitoring of equipment to eliminate unnecessary use and to increase efficiency of use;
• Offset GHG releases by means of implementing CO2 sequestration through progressive rehabilitation</td></tr>
<tr><td></td><td>×</td><td>✓</td><td>✓</td></tr>
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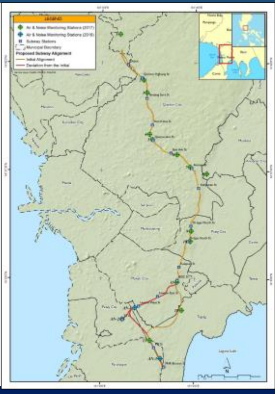
Baseline Studies – Air

Ambient Air Quality – Baseline Findings

Sampling Stations

- **AN-1:** Near proposed Lawton West Station by the National Nutritional Council
- **AN-2:** Near proposed NAIA Terminal 3 Station at Resorts Drive next to
- **AN-3:** Near proposed FTI Station at inside the Dr. Arcadio Santos National Highschool Compound.



Baseline Studies – Air

Ambient Air Quality – Baseline Findings

Station ID	Location	TSP	PM10	NO_2	SO_2
AN1	Sitio Fort Bonifacio Health Center (Near National Nutrition Council)	58	47	6.1	ND
AN2	Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City	52	45	9.1	ND
AN3	Dr. Arcadio Santos National Highschool, Barangay San Martin De Porres, Paranaque City	54	47	10	3
NAAQGV		230	150	150	180

Existing Sources of Air Pollution: TSP & PM10 primarily generated by vehicles. TSP and PM10 are kept suspended in air by movement of vehicles. SO_2 and NO_2 are generated from the combustion of fossil fuel by vehicles.

Baseline Studies – The Air

Ambient Air Quality- Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
Fugitive dust emissions	×	✓	×	• Dust suppression by watering of roads and stockpiles • Trucks that deliver construction material will be covered • Performance of regular ambient air quality monitoring • Provision of appropriate PPEs to workers and personnel • Regular ambient air quality monitoring
Emission from burning of fossil fuels	×	✓	×	• Vehicles must have passed emission tests and will undergo regular maintenance • Selection of low sulfur fuel as practicable • Optimization of cargo loading to maximize fuel efficiency • Regular ambient air quality monitoring

Baseline Studies – Air

Noise Environment – Baseline Findings

Station ID	Location	Classification and Standards	Average per time period (dB) - Wet Season			
			Morning (5:00 AM to 9:00 AM)	Daytime (9:00AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00AM)
AN1	Sitio Fort Bonifacio Health Center (Near National Nutrition Council)	A	55	55	50	45
AN2	Shrine of St. Therese of the Child Jesus Parish, Newport City Complex, Pasay City	A	57	58	59	54
AN3	Dr. Arcadio Santos National Highschool, Barangay San Martin De Porres, Paranaque City	A	39	42	40	37
Standard (A)			50	55	50	45

Existing Sources of Noise: Noise associated with commercial, residential, and industrial activities can be considered as existing sources of noise pollution.

Baseline Studies – The Air

Noise - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
Increase in noise and vibration due to construction machinery	×	✓	×	• Selection of machines that generate less noise • Scheduling of construction activities to reduce disturbance to sensitive receptors • Regular maintenance of machinery • Building of enclosures • Noise monitoring
Exposure of construction workers to noise	×	✓	×	• Wear appropriate PPEs • Limit worker exposure to loud machineries • Implementing permissible noise levels for construction workers as suggested by Department of Labor and Employment (DOLE).
Noise coming from construction activities may cause nuisance to residents	×	✓	×	• Installation of noise barriers. • Continuous monitoring and survey for complaints from residents nearby the areas to assess the extent of the impact • Minimize construction activities in the evening as much as practicable • Maintenance of equipment • Informing residents of construction activities. • Noise monitoring

Baseline Studies – Air

Vibration– Baseline Findings

Field Activity	Date and Time Conducted	Map Reference	
Shrine of Saint Therese of the Child Jesus	from 12:36 of 4th July 2019 to 12:36 of 5th July 2019	14° 31' 17.3856" N, 121° 0' 58.4814"E	NAIA Terminal 3 Station
American Manila Cemetery	from 17:02 of 5th July 2019 to 17:02 of 6th July 2019	14° 32' 38.382" N, 121° 2' 54.7476" E	Lawton East Station
Administration Building of United Hills Village	from 17:44 of 6th July 2019 to 17:44 of 7th July 2019	14° 30' 2.6922" N, 121° 2' 30.732" E	FTI Station

Baseline Studies – Air

Vibration – Baseline Findings

Affected Area	Max Velocity, mm/s	Max. velocity in 8 to 80 Hz, VdB	Criteria, VdB (US DOT)	Compliance
Shrine of Saint Therese of the Child Jesus	0.065	96.3	84	No
American Manila Cemetery	0.013	82.8	84	Yes
Administration Building of United Hill Village	0.026	88.3	84	No

Baseline Studies – Air

Vibration– Baseline Findings

- As study conducted at ABMC found that during subway operation:

Sensitive Receptor	Projected Vibration Level, VdB	Assessment Criteria, VdB	Assessment Criteria
House	61.5	72	Category 2 (Residential); Frequent Events
Office	71.1	75	Category 3 (Institutional); Frequent Events

Baseline Studies – Air

Vibration– Baseline Findings

Criteria		Acceptable Level (mm/s)		Reference
		Day	Night	
Human Comfort		0.3 to 0.6	0.2	British Standard BS 6472-1992 "Evaluation on Human Exposure to Vibration in Buildings"
Structural Damage		12.5	12.5	British Standard 7385: Part 2-1993 evaluation and measurement for vibration in buildings part 2
Common Services	Steel	100	100	German Standard DIN 4150-3. 1888 Structural Vibration – Part 3: Effects of vibration on structures
	Clay, concrete, metal (other than steel)	80	80	
	Masonry, plastic	50	50	
	Telecommunications	50	50	
Building contents		0.5 to 0.9	0.5 to 0.9	

Baseline Studies – The Air

Vibration - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	

TBM and drilling during construction and subway operation may potentially result into an increase of ground vibration	×	✓	✓	• Strategic scheduling of vibration-induced works.
				• Installation of vibration control measures:
				  • Vibration insulating sleeper
				  • Sleeper with elastic layer directly fastened track
				  • Secondary lining
				• Conduct Monitoring

The People

Baseline Studies – The People

Demographic and Socio-Economic Profile – Baseline Findings

Demographic Feature	Taguig	Pasay	Paranaque
Median Age	26	27	27
Population Structure: 0 – 14 15 – 64 64 - over	 228,744 (28.42%) 554,185 (68.85%) 29,986 (2.73%)	 103,682 (24.94%) 297,303 (71.38%) 15,357 (3.69%)	 167,349 (25.13%) 471,360 (70.79%) 27,113 (4.07%)
Population Growth Rate (2010 – 2015)	4.32%	1.12%	2.39%

- **Lifestyle Districts:** The project-affected communities (BGC, Newport City, and the gated communities of Barangay San Martin de Porres) are lifestyle districts.

Baseline Studies – The People

Public Health– Baseline Findings

- 3-tier health system (primary, secondary and tertiary) for all 3 host LGUs <u>for resident population</u>
- Each LGU has city-owned hospital
- Private health care system include world-class tertiary facility (St. Luke's)
- Transient / *in situ* population to increase because of construction work force

Baseline Studies – The People

Cultural Heritage – Baseline Findings

- Only National Nutrition Council of the Phil and Nutrition Center of the Phil (NCP) Buildings to be directly impacted. NCP is listed in the Phil Registry of Cultural Properties; interior design has cultural value.

NCP

Baseline Studies – People

Community Consultations

- IEC activities carried out with key stakeholder groups and activities including:
  - Barangay Officials (Ft Bonifacio: June / SMDP: 3 June/Western Bicutan:27 May / Bgy 183: 10 May)
  - Homeowners Associations (United Village: 3 June / Makati South Hills: 3 June)
  - City Planning and Development Offices:
    - Parañaque City (23 May)
    - Pasay City (3 May)
    - Taguig City (11 April)




Baseline Studies – The People

Perception Survey

- <u>**Most Mentioned Positive Impacts**</u>
- Improved mass transportation (35% of 587 multiple responses)
- Employment (20%)
- Increased Business (18%)
- General Progress of Community (17%)
- <u>**Most Frequently Mentioned Negative Impacts:**</u>
- Loss of property (19% of 518 multiple responses)
- Removal of trees and vegetation (12%), and
- safety and security issues (12%)
- <u>Common Concern: Loss of Property and timeliness of compensation</u>

Baseline Studies – The People

Demographic and Socio-Economic Profile - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
Households and business and institutional stakeholders may potentially experience anxiety and stress because of the threat of displacement and disruption of everyday activities.	✓	✓	×	• Timeliness and transparency of information • Regular communication with affected stakeholders • A Resettlement Action Plan covering issues of compensation including the cost of relocation and disruption of business operations is in progress to mitigate the impact of land acquisition for the project.

Baseline Studies – The People

Demographic and Socio-Economic Profile - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
<u>**Displacement of Residents, Properties and Business / Institutional Establishments**</u> • About 200-250 residential structures excluding residential condominiums may be demolished. • • The proposed land acquisition will reduce the land area (est. 20ha) of United Hills Village 1 by approximately one-fifth and the number of households (est. 650) by 35%. • An estimated 140 non-residential, mostly business, structures would be potentially impacted directly or indirectly.	✓	✓	×	• Timeliness and transparency of information • Regular communication with affected stakeholders • A Resettlement Action Plan covering issues of compensation including the cost of relocation and disruption of business operations is in progress to mitigate the impact of land acquisition for the project.

Baseline Studies – The People

Demographic and Socio-Economic Profile - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
• The prospects of land acquisition, particularly the estimated four hectare at Barangay San Martin de Porres, would limit the property market in terms of area and value • Within BGC, particularly the areas (Lawton East and West) and Newport City: acquisition of land would have from existing owners will disrupt their and their tenants' business operations. • Long term land and property values are expected to increase	×	✓	✓	• Compensation measures will be determined by the on-going RAPs

Baseline Studies – The People

Public Health - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
The workforce including transients (e.g., ambulant vendors, hangers-on, visitors, etc) in construction sites of project footprints could potentially be carriers and/or causes of communicable diseases	×	✓	×	• Before and during employment, health conditions of personnel at construction sites should be monitored. • Training in, enforcement of, and monitoring of compliance with, Occupational Health and Safety Code.

Baseline Studies – The People

Public Health - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
No expected impact to NPC.	×	✓	×	Assessment what aspects of the 'interior design' could be removed and preserved elsewhere. A photo-documentation of the entire 'interior design' be made to serve as a historical memory

Baseline Studies – The People

Traffic Impact Assessment – Baseline Findings

Vehicle Composition

Subway Station	Surveyed Roads	Private Cars/ Taxis	PUJ	AUV	Bus	Small Trucks	Big Trucks	Motor cycles	Tricycles	Non-Motorized Transport
Lawton East	Lawton Avenue	56.2%	1.9%	0.4%	0.4%	0.6%	0.2%	35.8%	0.1%	4.5%
Lawton West	Lawton Avenue Chino Roces Avenue Ext.	43.0%	1.5%	1.6%	0.2%	1.0%	0.3%	47.1%	0.2%	5.1%
NAIA Terminal 3	Andrews Avenue Resort Drive	67.3%	0.5%	4.5%	0.7%	1.3%	0.1%	24.6%	0.1%	1.0%
FTI	East Service Road Cucumber Road	13.0%	3.6%	0.1%	0.0%	2.9%	0.0%	65.7%	12.8%	1.8%

PUV Availability within 400-meter Radius

Subway Station	Taxis	PUJs	AUVs	City Bus, P2P	Tricycles
Lawton East	✓	✓	✓		
Lawton West	✓	✓	✓		
NAIA Terminal 3	✓	✓	✓	✓	
FTI	✓	✓	✓	✓	✓

- **AM Peak = 7:00AM to 8:00AM**
- **PM Peak = 6:00PM to 7:00PM**
- Majority of vehicles are cars; followed by motorcycles for Lawton East, Lawton East, and NAIA Terminal 3 Stations
- Majority of vehicles for FTI Station are motorcycles

Baseline Studies – The People

Traffic Impact Assessment – Baseline Findings

Subway Station	Surveyed Roads	AM Peak (7:00AM – 8:00AM)		PM Peak (6:00PM – 7:00PM)	
		Overall Network V/C Ratio	LOS	Overall Network V/C Ratio	LOS
Lawton East	Lawton Avenue	0.76	D	0.53	C
Lawton West	Lawton Avenue Chino Roces Avenue Ext.	0.64	C	0.64	C
NAIA Terminal 3	Andrews Avenue Resort Drive	0.77	D	0.62	C
FTI	East Service Road Cucumber Road	0.75	D	0.63	C

Level of Service	Volume-to-Capacity Ratio (V/C)	Remarks
A	≤ 0.20	Free flow traffic
B	0.21 – 0.50	Free flow traffic
C	0.51 – 0.70	Moderate traffic
D	0.71 – 0.85	Moderate to heavy traffic
E	0.85 – 1.00	Heavy traffic
F	> 1.00	Forced flow. Stop and go

- Average volume-to-capacity ratio for the roads adjacent to MMSP stations ranged from LOS C to LOS D during peak periods
- Several road segments already experiencing heavier congestion (LOS E to LOS F) due to bottlenecks at intersections and roadside friction (e.g. PUV loading/unloading, vehicles stalling along the road, etc.)
- Traffic is concentrated towards Manila Bound during AM Peak
- Traffic is distributed during PM Peak

Baseline Studies – The People

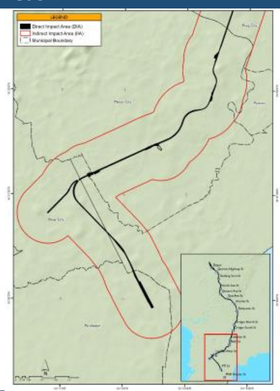
Traffic Impact - Potential Impacts & Mitigation

Potential Impacts	Phase			Mitigation
	P	C	O	
Increase in traffic congestion due to mobilization of workers, heavy equipment and construction	×	✓	×	• Traffic management plan (TMP) will be developed (road closures, traffic rerouting, etc.) for all stations during construction • Proper coordination of TMP with DPWH, MMDA, LGUs, estate management, home owners associations and developers • Provision of alternate routes • Proper construction phasing to minimize disruption & scheduling of transport of heavy equipment
Traffic Decongestion	×	×	✓	• Regular preventive maintenance of the subway system to maintain efficient, reliable, and safe subway operation and maintain its economic and social benefits. • Provide convenient and close linkages to other rail lines and other modes of transportation
Increased vehicular flow in areas adjacent to stations	×	✓	✓	• Conversion of construction yards into sidewalks, taxi bays, loading and unloading stations or central stations for public utility vehicles to reduce or even remove roadside friction • Provide better walkability and connectivity with other transport modes • Coordination with MMDA, LGUs, and local estate developers to assign traffic enforcers in critical areas • Utilization of acquired lands for transit oriented development (TOD)

Open Forum

Salamat Po!

Map of Impact Areas



Baseline Studies – People

Community Consultations

- **Key Issues Raised:**
  - Options to FTI Station
  - Timely information to residential / business / institutional stakeholders
  - Clear measurement of area to be affected including households
    - Residential / Business / Institutional Structures to be Affected
  - Compensation
  - Vibration and other forms (e.g., noise, dust, flooding, etc.) of nuisance during construction
  - Location of Entrance / Exit Points
  - Traffic impacts including alternate routes especially during construction
  - Damage to built-up areas
  - Right-of-Way (ROW)
  - Construction Methods
  - Disposal Area / Area for Debris
  - Informal Settlers to be Affected
  - Impact on existing amenities and lifestyles during construction and operation

List of Issues and Concerns

Questions and Suggestions	Who?	Response
What are the properties/areas to be displaced? The presenter did not specify it. Kindly be specific on the properties to be affected. Where the alignment is should be located? As it is not clearly presented	DOTr	
What will be the effect of the project in the private properties?	DOTr	
If it is a subway, do you mean there will be no impact/ effect/ distraction in the surface, only in the ground?	DOTr	
What law will apply regarding the Right of Way (ROW)? What agency will identify the market value?	Tin Tin	

List of Issues and Concerns

Questions and Suggestions	Who?	Response
If the homeowners protest for the negotiation, how long will it take?	DOTr	
Considering this is a Village, what will happen to the perimeter wall? It's only a temporary perimeter fence, how about for permanent?	DOTr	
The red line in the presented map, will it be displace?	DOTr	
What will be the right of way of the residents in the subdivision if the roads will be block and temporarily abolish?	DOTr	
Why it was channeled here? can you just realign it to the service road? Or in SLEX and PNR area?	DOTr	
While the construction is ongoing, will the proponent provide temporary location for the communities worship? How about the housing of their Pastor will it also be provided?	DOTr	

List of Issues and Concerns

Questions and Suggestions	Response
In case, where will the residents will be resettle?	DOTr
will DENR-EMB give certification clearance?	DENR
The process is an cut and cover, is it the one more cost effective?	DOTr
How about the effect of noise and vibration? What will be the volume, strength of shaking? Assumption of the result will do.	AECOM
Talking about roads, do you also considering volume of traffic?	AECOM

List of Issues and Concerns

Questions and Suggestions	Response
For the properties, what will be the process, is it payment first before displacement or displacement first before payment?	DOTr
In the first meeting/ discussion of the project only few properties will be affected, why now in the realignment, the affected areas/ properties increase in numbers?	DOTr
What is the intensity of the tunnel boring? In assumption only.	AECOM
How deep is the TPM?	DOTr
How the management of debris will be done during the construction and operation?	DOTr

List of Issues and Concerns

Questions and Suggestions	Response
In the next consultation/ meeting provide solution regarding the traffic and utilities (water lines and electricity)	
Build the stations (bus station, train stations) together or in one place so that the commuters will not walk too long.	
The communities agreed to readjust the alignment or relocate in the PNR area or property owned government where they will not be affected.	
The presentation brings more confusion in the communities. They suggest to provide them the specific list of the affected areas/ properties, for them to gather the communities to be affected and discuss the issues and actions to be done and to present their objection.	

List of Issues and Concerns

Questions and Suggestions	Response
Can we feel vibration?	
Will structural integrity of my dwelling be affected?	
Effect of earthquake and flooding to the project? What happens during emergency	DOTr

Annex B

Received Copies of Invitations for the Public Hearing

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Mr. Alberto Sonco
Administrator
Church of St. Therese Child of Jesus (Pasay)
20 Newport Boulevard, Newport City Complex
Barangay 183, Villamor Airbase, Pasay
1309 Metro Manila, Philippines

Dear **Mr. Sonco**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

The Public Hearing will be conducted as part of the requirements of the proponent's application for an amendment of the Environmental Compliance Certificate. Interested parties will be given the opportunity to express freely their concerns/support/opposition/questions about the project.

Kindly register in person or submit your opinion(s) in a concise position paper to this Office or email it at eiamd.emb.co@gmail.com/eia@emb.gov.ph three (3) days before the said hearing. Those who will not be able to register or submit written positions may be given the opportunity to share their issues on the day of the hearing itself.

Herewith is the project's Executive Summary for the Public (ESP) for your reference. The project's Environmental Performance Report and Management Plan (EPRMP) is downloadable at our website: **www.eia.emb.gov.ph** *(kindly access the Notice of Public Hearing/ Consultation link found in our web page)*. The copies of the ESP and EIS are available in this Office and in the following offices:

1) **EMB NCR**
   Address: East Ave., Diliman, Quezon City, 1101 Metro Manila
   Telephone No.:(02) 931-2397

2) **City Government of Parañaque**
   San Antonio Ave., San Antonio, Parañaque, 1700 Metro Manila

For more details, please contact the Environmental Impact Assessment and Management Division (EIAMD) of this Office at Tel. Nos. (02) 920-2240 to 41 and look for the project case handlers **Engr. Regina Paula Eugenio** and **Mr. Gemini Candelario** and **Engr. Dexter Tabada**.

Sincerely yours,

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ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

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Republic of the Philippines
Department of Environment and Natural Resources
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Website: http://www.emb.gov.ph

20 August 2019

United Parañaque Subdivision 5 Homeowners Association
Tindalo St., SMDP
E. Service Rd., Parañaque
Metro Manila, Philippines

Dear **Sir/Madam**:

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

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20 August 2019

Megaworld Corporation
McKinley Hill Information Center
Upper McKinley Road corner
Florence Way Street, Taguig

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Received by:
Christian Dizon

Contact person: Candasa
loc: 6365

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20 August 2019

Mr. Benigno Rivera
CPDO
City Planning and Development Office (CPDO) - Parañaque
San Antonio Ave., San Antonio, Parañaque
1700 Metro Manila, Philippines

Dear **Mr. Rivera**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

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Chief, EIA and Management Division

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Website: http://www.emb.gov.ph

20 August 2019

Mr. Jorge Daniel Bacobo
Barangay Chairman
Barangay Fort Bonifacio (Taguig)
Lawton Ave., Taguig
1630 Metro Manila, Philippines

Dear **Mr. Bacobo**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

4: 4:30

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

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Brgy Fort (02) 587-35..

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Website: http://www.emb.gov.ph

20 August 2019

3 Sto. Nino, Zone 3
Fort Bonifacio, Taguig City

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

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JOYCE C IBANEZ

Republic of the Philippines
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Website: http://www.emb.gov.ph

20 August 2019

TANGGAPAN NG
KALIHIM NG BARANGAY
ORAS: 2:47
PETSA: 08/23/19
TINANGGAP NI: Rhavyn [illegible] Butalid

Ms. Perlita Carmen
Barangay Chairman
Barangay Western Bicutan (Taguig)
Sampaguita St., Taguig City
Metro Manila

Dear **Ms. Carmen**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Chief, EIA and Management Division

Republic of the Philippines
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Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Tesda Women Center
Gate 1 Tesda Complex
East Service Road
South Superhighway Taguig

Dear **Sir/Madam**:

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Telephone No.: (02) 931-2397

2) **City Government of Parañaque**
San Antonio Ave., San Antonio, Parañaque, 1700 Metro Manila

For more details, please contact the Environmental Impact Assessment and Management Division (EIAMD) of this Office at Tel. Nos. (02) 920-2240 to 41 and look for the project case handlers **Engr. Regina Paula Eugenio, Mr. Gemini Candelario** and **Engr. Dexter Tabada**.

Sincerely yours,

ENGR. ESPERANZA A. SERRA
Chief, EIA and Management Division

TESDA Women's Center
RECEIVED
By : Janey
Date : 8/27/2019
Time : 12:10 PM

1pax

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Mr. Lino Cayetano
Mayor
Office of the Mayor - Taguig
Gen. A Luna St., Taguig
1637 Metro Manila, Philippines

Dear **Mr. Cayetano**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

call back this afternoon

ENGR. ESPERANZA A. SAJUL # 640-3458
Chief, EIA and Management Division

1-2 fax

PAMAHALAANG
LUNGSOD TAGUIG
PANGKALAHATANG TANGGAPAN
TINANGGAP
0827-19
PETSA
NI: Ronwald
ORAS: 10:08
KONTROL BLG. 190827-8

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Upper West McKinley Subdivision
Upper McKinley Road cor. C5 Road
Fort Bonifacio

Dear **Sir/Madam**:

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RECEIVED
AUG 27 2019
Dyanne Roxas
957-9570

Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
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Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

UPS-IV HA INC.
RECEIVED
DATE: 8-29-19
TIME:
BY:

United Parañaque Subdivision 4 Homeowners Association
Marcelo Green UPS
Parañaque City

Dear **Sir/Madam**:

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

3-5 ban

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Ms. Normita Castillo
President
Office of Senior Citizen Affairs
Derham St., Pasay City

Dear **Ms. Castillo**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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8-28-19
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DATE
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PASAY CITY

1) **EMB NCR**
Address: East Ave., Diliman, Quezon City, 1101 Metro Manila
Telephone No.: (02) 931-2397

2) **City Government of Parañaque**
San Antonio Ave., San Antonio, Parañaque, 1700 Metro Manila

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Sincerely yours,

8040926 - OSCA office
Cristina B. Castaneda
09176368462
CP

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Mr. Adrian Martinez
City Youth Development Officer
Youth's Organization
Rm. 418 Pasay City Hall Bldg.
F.B. Harrison St., Pasay City Philippines

Dear **Mr. Martinez**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Jaja

Republic of the Philippines
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ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Ms. Merlita Lagmay
CPDO
City Planning and Development Office (CPDO) - Pasay
F.B. Harrison St., Pasay
Metro Manila, Philippines

Dear **Ms. Lagmay**:

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CPDO
RECEIVED
DATE: 08-28-2019
BY: [illegible]
834-04-39

Sincerely yours,

[signature]

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
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Website: http://www.emb.gov.ph

20 August 2019

Ms. Ruth Cortez
Barangay Chairman
Barangay 183 (Pasay)
Manlunas St., Pasay
1300 Metro Manila, Philippines

Dear **Ms. Cortez**:

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

BRGY. 183 ZONE 20
VILLAMOR, PASAY CITY
RECEIVED
DATE: 08-27-19
BY: Alice 2:10 pm

(02) 853-1953
853-0907

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Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
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20 August 2019

Office of Senior Citizen
De Sahagun, Taguig
1636 Metro Manila, Philippines

Dear **Sir/Madam**:

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

RECEIVED:
Name: Tambis
osca office
OFFICE FOR SENIOR CITIZENS AFFAIRS
555 79 26

Protect the environment... Protect life...

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Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
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Website: http://www.emb.gov.ph

20 August 2019

Mr. Michael Thor Singson
Barangay Chairman
Barangay San Martin De Porres (Parañaque)
East Service Road, San Martin de Porres
Parañaque City

Dear **Mr. Singson**:

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

2 pcs

821-08-39 / 37

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Department of Environment and Natural Resources
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20 August 2019

Federation of Senior Citizen's Association
Sto. Niño Street, San Martin de Porres
Parañaque

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

1-2 DAY

827-9722

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Ms. CORAZON B. MANDAR
Principal
Dr. Arcadio Santos National High School
Dr. Arcadio Compound, East Service Road
Parañaque City, Metro Manila

Dear **Ms.** MANDAR :

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Received by:
Anabelle S. Dumagpit
8/27/19
835 76 88

Protect the environment... Protect life...

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
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20 August 2019

Mr. Eugene Babia
President
United Parañaque Subdivision 1 Homeowners Association
United Hills Subdivision
Parañaque City

Dear **Mr. Babia**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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   Address: East Ave., Diliman, Quezon City, 1101 Metro Manila
   Telephone No.: (02) 931-2397

2) **City Government of Parañaque**
   San Antonio Ave., San Antonio, Parañaque, 1700 Metro Manila

For more details, please contact the Environmental Impact Assessment and Management Division (EIAMD) of this Office at Tel. Nos. (02) 920-2240 to 41 and look for the project case handlers **Engr. Regina Paula Eugenio, Mr. Gemini Candelario** and **Engr. Dexter Tabada**.

Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

UNITED HILLS HOMEOWNERS ASSOCIATION INC.
TEL. No. 823-2930
RECEIVED BY:
DATE: 8/27/19 8232930

Protect the environment... Protect life...

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Mr. Eugene Babia
President
United Parañaque Subdivision 3 Homeowners Association
United Hills Subdivision
Parañaque City

Dear **Mr. Babia**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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UNITED HILLS HOMEOWNERS
ASSOCIATION, INC.
TEL. NO. 823-2930
RECEIVED BY:
PRECY DELFIN
DATE: 8/27/19

Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

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Department of Environment and Natural Resources
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Website: http://www.emb.gov.ph

20 August 2019

Hon. Imelda Calixto-Rubiano
Mayor
Office of the Mayor - Pasay
F.B. Harrison St., Pasay
Metro Manila, Philippines

Dear Hon. Calixto-Rubiano:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

OFFICE OF THE CITY ADMINISTRATOR
4:40pm
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#1008
PASAY CITY
#833261

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

531-1974
531-9798 - CENRO
834-0433 - planning
831-5925 - engineering
831-5222 - mayor's office

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Website: http://www.emb.gov.ph

20 August 2019

Ms. Hilda Candelario
CPDO
City Planning and Development Office (CPDO) - Taguig
Gen A. Luna St., Taguig
1637 Metro Manila, Philippines

Dear **Ms. Candelario**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

795 - 9999
836

555-7815/795-9999 loc. 813/836/838 - Aura

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

National Nutrition Council

Dear **Sir/Madam**:

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

NATIONAL NUTRITION COUNCIL
Records, Administrative Division
RECEIVED
Date: 8-27-19 Ctr. #
By: [signature] Santos

816-42-39 - 1 pax

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DENR Compound, Visayas Avenue, Diliman Quezon City 1116
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Website: http://www.emb.gov.ph

20 August 2019

Mr. Robert Palisoc
President
Makati South Hills Subdivision Homeowners Association
Makati South Hills Subdivision

Dear **Mr. Palisoc**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

8-27-19
824-90-05
4 to 4:30 - 1 pax

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Website: http://www.emb.gov.ph

20 August 2019

Ms. Cora Panlilio
Manager
United Parañaque Subdivision 2 Homeowners Association
3190 Tindalo Street
United Parañaque Subdivision 2

Dear **Ms. Panlilio**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

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8/27/19

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-1517, 928-3725; Fax No.: (632) 920-2258
Website: http://www.emb.gov.ph

20 August 2019

Mr. Edwin Olivarez
Mayor
Office of the Mayor - Parañaque
San Antonio Ave., San Antonio, Parañaque
1700 Metro Manila, Philippines

Dear **Mr. Olivarez**:

We are pleased to invite you to attend the **Public Hearing** of the proposed **Expansion of the Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr).** The said hearing is scheduled on **3 September 2019 (Tuesday)** at **9:00 AM** *(registration starts at 8:00 AM)* and will be held in the **TESDA, Tandang Sora Function Hall, Taguig City.**

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Sincerely yours,

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OFFICE OF THE ... TRATOR
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DATE & TIME: 8/20/19
RECEIVED BY: Pula

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

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20 August 2019

Church of St. Nazarene (Parañaque)
6257 W Service Rd., Parañaque
1709 Metro Manila, Philippines

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Rev. Nelson C. Alastoy
#09565642823 -1 cp
1 pax

Sincerely yours,

ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman Quezon City 1116
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20 August 2019

Bonifacio Naval Station

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Sincerely yours,

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ENGR. ESPERANZA A. SAJUL
Chief, EIA and Management Division

Annex C

Attendance Sheets from the Public Hearing

(1)

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, isayas Avenue, Diliman Quezon City 1116
Telephone Nos.: (632) 927-15-17, 928-37-25; Fax No.: (632) 920-22-58
Website: http://www.emb.gov.ph / Email: mail@emb.gov.ph

ATTENDANCE

Activity: Public Hearing of Proposed **Amendment of Metro Manila Subway Project (MMSP)** of the **Department of Transportation (DOTr)**

Date/ Time: September 03, 2019 / 9:00 AM

Venue: **TESDA, Tandang Sora Function Hall, Taguig City**

Name	Company/Agency	Contact No.	Signature
1. PHILIP DABAO	DOTr	09088851494	
2. Janina Capistrano	DOTr	09177657852	
3. Teresa Banta	DOTr	09175750868	
4. TJ Bata			
5. GABRIEL ANACLETO	DOTR.	09260138530	
6. CRISTINA FERNANDEZ	DOTr	09279207864	
7. Marie Avila	DOTr	09261911408	
8. SHIENNA SADIA	DOTr		
9. RAISA VERA U. TAYABAN	DOTr		
10. Beo Bensurto	DOTr		
11. SHEKINAH TIBAY	JDT	09398396063	
12. Angelica A. Aguilar	JDT	0915 348 4640	
13. JIM PETATE	DOTr	0921 414 6425	
14. LK Parages	DOTr	09562655841	

2

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Telephone Nos.: (632) 927-15-17, 928-37-25; Fax No.: (632) 920-22-58
Website: http://www.emb.gov.ph / Email: mail@emb.gov.ph

NAME	COMPANY / AGENCY	CONTACT NO.	SIGNATURE
15. NORDY Q. PIMENTEL	MMDA	09328543039	[signature]
16. PIA M ADID	GHD	09988685871	[signature]
17. BEA ALVAREZ	GHD	09171625664	[signature]
18. LUISA REGODON	GHD	09068058218	[signature]
19. Shuntaro Miyoshi	JDT	09770971841	[signature]
20. Satish Bhagat	JDT	09458417307	[signature]
21. HIDEMITSU NAKAMURA	JDT	0956-074-4642	nakamura [signature]
22. WATARU MORIMOTO	MMSPGC	09282206629	[signature]
23. KEITH ALLENBY	MMSPGC	09175570403	[signature]
24. ALFRED MENDOZA	MMSP - OGC	09271910547	[signature]
25. Matias Juan	MMSP - OGC	09175440704	[signature]
26. Severino Dudelon	MMSP - OGC	09177136140	[signature]
27. ALFONSO PALANGAN	MMSP - OGC		[signature]
28. SIMEON ZAMORA Jr	DASMUTS	09108836224	[signature]
29. LORETO R. COMADRE	BRNGY. WBICUTAN	09993417926	[signature]
30. NELSON C. ALASTOY	CHURCH OF THE NAZARENE	09565642823	[signature]
31. RHYNOR P. LIMA	Z3 FORT BONIFACIO TAGUIG city	09991714759	[signature]
32. Carmeli Chaves	JDT	09177944773	C. Chaves
33. JOCELYN BAUTISTA	BRGY KAGAWAD	09333340156	[signature]

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Website: http://www.emb.gov.ph / Email: mail@emb.gov.ph

3

NAME	COMPANY/AGENCY	CONTACT NO.	SIGNATURE
34. YOLANDA D. TEDDORO	PIONEER LOT HOA	09469941482	
35. Roselle Ramos	Zone LEB Malugay	09500383110	
36. Loranie M. Norte	Aguilar NAI	09266981904	
37. EVELYN B. DACANAY	P.A.N.A.i Malugay	09398453731	
38. Felicidad Arebalo [illegible]	DHAI Malugay	09171773155	
39. FIDEL CRUZ	DOTr	09173849286	
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103.			
104.			
105.			
106.			
107.			
108.			
109.			

Annex D

Photo Documentation from the Public Hearing

USEC TJ Batan of DOTr, giving opening remarks

USEC TJ Batan of DOTr, presenting the Project

The Stakeholders listening to the Presentation

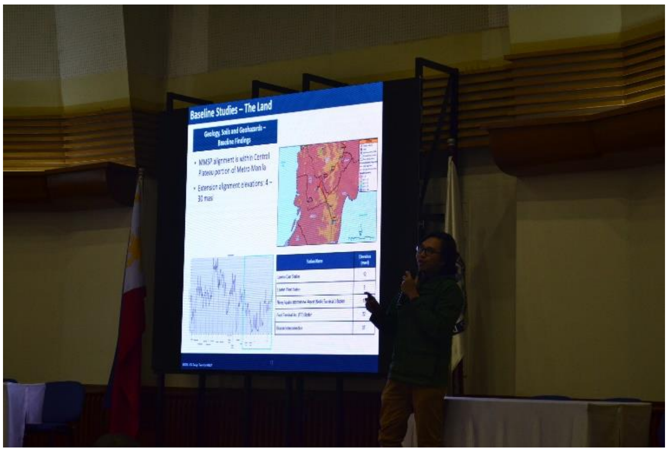
The Stakeholders listening to the Presentation

Atty. Sim Flores, Public hearing Moderator

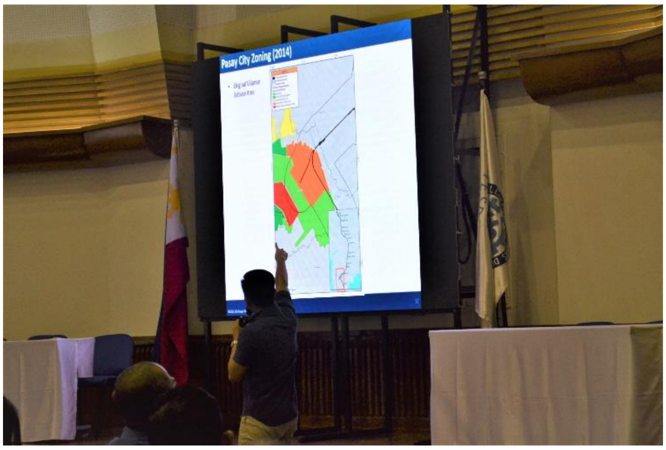
Documentation of the Public Hearing

Engr. Jim Benedict Petate presenting the Project

Richard P. Andal presenting the Air and Noise Baseline Study



Allan Mandanas, presenting Geology study



Gio Zaragosa presenting the Land Use study

Wilfredo Palarca presenting the People study

Jec dela Cruz presenting traffic Study

Stakeholders raising questions in open forum

Stakeholders raising questions in open forum

Public Hearing Banner

Public Hearing Banner

Annex E

Pro- Forma Public Hearing List of Issues

PRO-FORMA PUBLIC HEARING LIST OF ISSUES

<table>
<tr><td>Project Name</td><td>Metro Manila Subway Project</td><td>Project Location</td><td><table><tr><td>Barangay</td><td>Municipality/City</td><td>Province</td><td>Region</td></tr><tr><td>East Service Road</td><td>Parañaque City</td><td>Metro Manila</td><td>NCR</td></tr></table></td></tr>
<tr><td>Proponent Name</td><td>Department of Transportation (DOTr)</td><td>Proponent Address</td><td>S. Osmeña Road, Clark Freeport, Mabalacat, Pampanga</td></tr>
<tr><td>Proponent Contact Person</td><td>Engr. Jim Benidict G. Petate</td><td>Proponent Means of Contact</td><td>Landline No (632) 790-8300 Fax No.
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<tr><td>EMB/DENR Hearing Representatives</td><td>Atty. Sim C. Flores</td><td>Place of Public Hearing</td><td>Tandang Sora Function Hall, TESDA Women Center, Tgauig City</td></tr>
<tr><td></td><td></td><td>Date of Public Hearing</td><td>03 September 2019</td></tr>
</table>

ISSUES / CONCERNS TO BE INCLUDED IN THE SCOPE OF THE EIA STUDY

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion	Proponent's / EIA Consultant's Response
1. People	UPS 1 will be highly affected, so how DOTr will ensure that all the options will be taken into consideration in which the homeowners will not be affected? We believe that this strategy is intermobility is very stellar. That said, we believe that you take into consideration not just the economical, logistic factor but also the social factor as well, specifically with the concern in our village, we believe that the original project was intended to stop at FTI, and now you're concerned is UPS 1 and areas besides it such as Malugay and UPS 2 will be	Mr.Patrick Salazar	It was stated by **USEC Batan of DOTr,** first of all, we don't develop a projects with we don't care mentality, we don't. On the other hand, it is just really unfortunate that we have a canvass, na yung tinatranaho po natin ngayon is already to built up, what that's mean, kung sana po nagawa, alam nyo po kung kelan yung unang version ng subway network natin? 1977. So sana po kung naisip at nagawa yung mga proyektong ito kung kelan yung metro manila was not as built up as today, then we could have or may be even avoided or we could have even further minimize the intrusion of the existing structures across Metro Manila, with that having been said it is not one or the open, that is the extreme, on the other hand we don't have a

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	affected because our area is needed for construction yard, we believe that for the same reason, you're pointing a lot of investment of this project as mentioned an average of hundred million just to put up a big project, with all the great engineers, architects and all the project engineers with global experience and expertise, we believe that this is not a first time that you folks will encountering this kind of scenario wherein several houses, tax payers through the years and one of the oldest subdivisions outside of Metro Manila will be affected. With this comment, how you will ensuring that all other options are taken into consideration with all of		choice, meron at meron po tayong matatamaan just because yun na po yung nadatnan naming and on the other hand, as sir Patrick mentioning, we exert a lot of efforts to make sure that we explore options that will minimize the extent of the affected stakeholders, iba iba po tawag naming dyan, e do value engineering, cost benefits analysis, optioneering, but in the end, we try to explore options to minimize the impacts not just to persons and structures affected but also with environment. The consequence by us, being funded by the ODA, we are just borrowing from the bank. When borrowing po sa mga development lender, from the multilateral, bilateral development lender they are very mindful po of our assurances to make sure that we comply to environmental and

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion	Proponent's / EIA Consultant's Response
	great minds of your engineers, architects that this homeowners will not be affected?		social safeguards, there's a process into that so we comply po sa requirements at proseso. Actually, po the original phase 1, if you would notice the title is Metro Manila Subway Project Phase 1, why? If you would look up of our 2014 road map for transportation and infrastructure in the greater capital region, it was JICA dream plan, the transport road map identified the needed infrastructure investments in transport in the entire capital region, I say greater capital region, when we do our planning in th 90's, in the 2000 you heard mega manila, but as of this decade we are now planning for the entire greater manila. We need the subway. Why do we need the subway?

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			1977 pa naisip yung subway, kung dati pa nagawa maiiwasan sana to ngayon pero walang choice na may matatamaan at matatamaan kasi ito na yung nadatnan. We did our best para maiwasan talaga na may maapektuhan. We do FS study such as value engineering, cost benefits analysis. We do social safeguards para maiwasan o mabawasan yung maapektuhan Gumawa ng Transport road map nung 2014, which identified the transportation Road plans take consideration na geology and geography. MM has 2 geographic constraint, left manila bay and kanan laguna de bay at mountain ranges of antipolo. With this, di naman tayo pwede magbuild sa manila or laguna bay or even in mountain kaya napili

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			yung north south for mass transport. So ang plan is to develop the north south. Which has 3 north south mass transport corridors. I call it corridor to the left, corridor to the right and corridor in the middle. Notice po, the corridor to the left is the LRT 1 (monumento to Bacoor), the middle is the PNR Clark and calamba while the right corridor there is no north south road so kung gusto naming magtayo wala kaming choice kundi pumunta sa ilalim kaya nabuo yung subway. Sir Patrick is correct that the phase 1 is really intended to end in FTI, phase 1 is 36 km, para po yang X e, PNR Clark and calamba starts at the upper left it goes down to the lower right to calamba. Subway you see its current end of the upper, the quirino highway mindanao, it will go further north

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			to Bulacan and will go all the way down to cavite. In Cavite po we will have a middle, right also pero nag X na yung left will be the extension of the yellow line (shows in the presentation) middle will be the extension of the red line and right will be PNR Calamba. The original phase 1 is the FTI station but there is a chnges to make it inter-operatable to PNR Calamba, so we need to make space essentially, the subway is coming from under going to emerge literally underground merge with viaduct, merge with PNR calamba, to have connectivity, fastest travel from north to south, from quezon city to calamba. One major consideration is the C6-C7 project, one of our biggest design challenges, we tried to deal

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			with C6 project, you need to see it para maappreciate mo yung difficulty of the design project, it has 6 different ramps, if you would notice po, SLEX is there behind, the train is the PNR calamba, the design challenge po is ilang poste yung need daanan. So yung Taguig intermodal andyan, we wanted to bring the FTI station of the calamba and FTI staion of the subway as close as possible to ITX however because of all the poste (napakaraming poste) we had to move the stations a little to the south and that is where the UHV located, yun yung major design consideration number 2.
2. Land	I know you need to go already, but a couple of things po. You said that because of all the—mga poste po you had to move to	Mr. Patrick Salazar	**USEC Batan, DOTr** Thank you, sir. I will first, answer po the horizontal alignment issue. Essentially sir, what is anchoring us to this, if I may, into this

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	the south—again im not an engineer—but just looking at this really amazing map—oh by the way I'd just like to congratulate you again in terms of being able to find way to be the parang leader 'no? To find ways, you know? Somehow, I believe that are also government properties in the area that is not south of where UPS but I think more—part of UPS. I think if you do that, you will not hit any existing community. So those are one of the—that's one of the questions. The other would be, as you try to go up 'no—to merge/diverge yung subway. How about the PNR is the		location is the location of the Taguig intermodal. Nandiyan na po kasi yung Taguig intermodal. So, we cannot go too far away from the Taguig intermodal—otherwise we lose the interconnectivity situation. Aside from that po, we have explored locating north of the C6 -C7. However, sir ang concerns po diyan is a combination of the NAIA flight path, as well as yung pinaggalingan po namin sa Nichols. Yung pinanggalingan po kasi namin sa Nichols an upgrade elevation because po of NAIA X. If you're familiar po with NAIA Ex. NAIA X po kasi—gumanun siya eh—so gumanun po si NAIA X—so we cannot—they already occupied po yung po level po na tinatawag. So medyo mahirap po to move futher North. To move further south naman po, the

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	one who is going down and meet yung train below—again im not an engineer—what I'm saying is just like what I said earlier. You have all the amazing talent and engineers with global experience. This is not the most complex that they have done. I believe that your engineers will find ways to be able to avoid this—and I know you need to go—probably will set up a meeting with you, USEC, directly.		concern is the distance po from Taguig intermodal. Now sir, I think I need to go into the final point, probably, that I would like to share with you today. Which is—go to the map of the station—we did some rethinking po kasi of the design assumptions. This is the subway box. Just for every one's reference po so we're on the same page…what you see here is SLEx sa baba. Yung color brown po na linya is PNR right of way. East service road po yung sunod and yung blue box po is the subway station. I will explain. Umpisa po tayo baba—paakyat. I'll give you numbers. Again, let just discussed this po. Coming from the border of SLE bilang po tayo ng 20—roughly 20—it's actually 21. Bilang po tayo ng 21 meters. So galing po sa border ng

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			SLEx, bilang ka po ng 20 meters, that is PNR right of way. Yun po yung existing PNR. Bilang ka po ng additional 15meters…that becomes east service road. East service road going up—that's already—I understand—this is not clear to me pero—yung border po ba na 'yun village na mismo 'yun? Walang commercial line of properties. So SLEx, 20 meters PNR, 15 meters east service road and then residential properties. Now ang current design assumption po namin is the PNR-calamba station, and the subway FTI station will practically be side-by-side. What does that mean? The PNR-calamba station will occupy that space between SLEx and the blue box, roughly. So parang nandito po yung PNR calamba station, yung subway station po, nandito. So, it's not one

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			on top of the other. So, what we are doing now is ipasok na natin yung subway station doon sa ilalim nung calamba station—so that the blue box we can move down—we can move towards the west. That is what we are working on now. Now, excuse me sir ah. I will give numbers, but I strongly strongly qualify these are subject to further detailed design study. Again, from SLEx, and width po kasi—and width na kinakailagan for the PNR calamba station—yung nasa taas—will need to occupy the entire 20 meters—PNR right of way—all the way—estimate—to the 15meter east service road. Meaning the existing 20 meters po ni PNR right of way plus 15 meters of east service road, roughly 35—will be occupied by the PNR calamba station. Ngayon

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			po subway—don't worry po nandoon siya sa ilalim—doon sa ilalim. Problem po, and problem po namin ngayon is the PNR calamba station brings us all the way to the border of east service road and the residential area doon po sa…so siyempre kailangan—I mean we cannot not have east service road, so we need to replicate east service road—doon po sa taas. So, in a post-construction scenario—mamaya na po yung during construction ah—always distinguish between during construction temporary work requirements and after construction permanent works requirement. Doon po muna ako sa after construction permanent works. What we are imagining to happen now after construction is this—bilang po ulit tayo. We'll start from the border—SLEx. PNR

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			calamba station will occupy 35 meters width. So, occupy the 20 meters of PNR—occupy the 50 meters of east service road. Plus, we need another 15 meters, roughly, to replicate east service road. So, what we are imagining—exploring po—what we are exploring now is a permanent works requirement of 15 meters to the right of the edge of the service road. That is permanent works. However, po, during construction, during construction we need two things. We need to replicate east service road still, kasi we cannot close this 5 year. We still need the 15 meters plus we need space for our construction yard. Cause we need to mobilize equipment in the area. So east service road is currently 15 meters. If we can reduce it, we will reduce it. Medyo we will incur temporary

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			inconvenience lang po kasi liliit yung current po na east service road liliit. So, if that's alright—better—temporary lang naman eh—di ba kaysa lakihan natin—and then we need around 8 to 10 meters—basta sasagarin po namin yan—sabihin na nating 10. We need 10 meters for the yard. So, during construction, the temporary works area that we required—bilang po ulit tayo—SLEx count 35—yung 35 mo is the 20 PNR right of way, the 15 east service road tapos patungan niyo po nung 15 na diversion road—yung temporary diversion east service road—plus another 10. So, we are looking at around 25 po to the right of east service road. Now we will optimize this—bakit po—again we can't aggressively minimize but based on our current evaluation, we cannot eliminate

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			the encroachment into the residential properties po…and one of the things we are looking at is we're looking at the parcel tax. Because depending on the parcel tax if possible, let's not go beyond one road—i-column natin—let's not go beyond one column of parcels. So that's what we're trying to explore now. So, this one is no longer our latest footprint. This one is calamba station subway station configuration. What we did was calamba station—bring the subway under. Explain ko lang po sa inyo why that is difficult to do. That is difficult to do because remember po yung sinasabi kong—we needled through C-6—nandito po kasi yung C-6 eh—after needling thorough C-6, we have to make a rather sharp -- the thing po kasi with trains is there are limits—

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			there are limits to our curves, there are limits to our gradients. So, there are these constraints. So, coming from C-6—currently the reason for why this exists—again this was not made without though. The reason for why this exists is because we wanted to keep a straight line. Paglabas po namin ng C-6, after naming maka-ahon doon sa mga poste ng C-6—diretso ka, ito 'yun. So ang pinag-aaralan po namin ngayon kasi ang instruction ko po is do not touch the C-6 interface because that took almost a year to resolve. So, we're not touching the C-6 interface but we are going to do a relatively sharp turn to the right so that we can make the station—we can transfer the station under PNR calamba station.

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	Again po, thank you very much, I know you're extending time. Really appreciate yung detailed explanation. Again, I'm not an engineer, you have all the best engineers. Probably yung temporary po na additional 15 meters for east service road, baka pwede po mag-create na lang tayo ng bridge sa taas? And then yung shipyard instead of moving again into the village, baka po pwedeng yung natapos na pong construction from the north baka po pwede din. Again, I think from a home owner's perspective, kung temporary lang siya you'll use my home. Again, have you explored everything else that we can do. Yun po.		**USEC Batan, DOTr** At this point po, that is our current best possible situation. Again, po we did distinguish. The 15 meters permanent works requirement for the future east service road and the 10 meters temporary which will be used during construction. Yung 10 meters po na temporary, we can shift it here and there—here and there—here and there—pero and mahirap po would be the 15 meters future permanent east service road which, as much as possible po kasi we want to replicate the existing width—but—we are working on it.

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	Good morning USEC Batan. I'm Dr. Qiumio from United Hills Village. So my question is, first, you are asking for another loan for that part from the original FTI station to Bicutan which is just about 1.5 kilometers. Now why do you have to go down? If you really like—deadset to go to Bicutan, why do you have to go down? And at, you can't attain maximum speed for a high-speed train down under because you are now approaching the terminal station which is Bicutan. You know in a—in the PNR	Dr. Maria Elena Quimio	**USEC Batan, DOTr** Ulitin ko po yung na-explain ko kanina, if you don't mind. Number one po ma'am, what we are using with our JICA and ADB facilities are multi-tranche facilities. What multi-tranche facilities mean po is the entire loan is already committed—but we draw down on a tranche basis, to save po on commitment fees. So, as I—balik tayo doon sa presentation kanina. So, as I mentioned po kanina, we started po kasi ma'am with a big picture of the entire network. I'll comment lang po quickly on the loan and then I'll go into the design considerations po for having the

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	stations, once you're approaching the terminal, you go slow. So, from FTI, isn't it more logical that you just stay upgrade or on the surface and then if you really—you are set to go to Bicutan, just stay on the surface…so you don't like—and have a transit station in the FTI. What we don't like is you—you know this TOD—this something like you—you build commercials—so you encroached too much on the UH—the United Hills Village. And so—and also, why can't you put your new east service road on top of the subway? What I mean sir is, why do you have to spend so much?		subway on the PNR in this area. The entire network ma'am is currently fully funded—ayan dito na lang tayo—wag na tayong lumayo. Basta ma'am yung sa loan what I'm saying po is that we're going to the next tranche. The first tranche was signed po January of 2019. **USEC Batan, DOTr** I'll explain it ma'am.

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	I think it will be another 1.5 billion dollars.		There are two projects po that are relevant in this area. Project number one po is what we call the North-South Commuter Railway also known as the PNR-clark and the PNR-calamba. So PNR-clark is the line that you see colored green sa taas—going all the way down. It becomes color blue—all the way down. Previously ma'am, the PNR-clark and PNR-calamba project was chop-chopped into three. It was chopped into a 38-kilometer phase one form tutuban, malolos. Originally, yung nadatnan po namin—scheduled for implementation 2014 to 2022. Pero ma'am, nabanggit ko rin po kanina, we have this thing po that we made in 2014. It's called our transportation-infrastructure roadmap for the greater capital region. So, this roadmap for transportation infrastructure in the

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			GCR, listed all the transportation investments that we assumed we will need for next 30 or 40 years po—yung assumption ng transport road map. Now, one of the decisions po that we made—project 1 po muna, mamaya po yung project 2—one of the decisions that we made for project one, pagsabay-sabayin na natin 'yan. Let's do the 38 kilometers together with the 53 kilometers going to clark airport, and the other 56 kilometers down to calamba. So right now, as it stands, the north-south commuter railway system project, PNR-clark phase one, PNR-clark phase two, and PNR-calamba is a single integrated system. What does that mean? That means po 148 kilometers, 37 stations, 3 regions—region 3, region 4A and NCR, 22 local governments—you

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			can ride a train in clark airport—get off PNR calamba. So wala pong transfer. So that's project number one. Project number two po is the subway. The subway po in our transport road map—if you look at the project name of the subway it's the Metro manila subway project phase 1. Why is called phase 1? Because if you look at our transport roadmap po, phase 2 will be a further extension of the subway to the north of Bulacan—so that's the red line po—hindi po yung red line sa kanan ah—yung red line sa kanan is MRT 7—yung red line po sa gitna, sa taas—that is the subway. That will be extended further into the north and dito po sa baba—that will be extended further into the south into cavite—into das marinas. Why are we doing that? I mention po

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			kanina. If you noticed ma'am the geographical configuration of our capital, we have these two things to notice, we are bounded by manila bay to the left and we are bounded by laguna de bay and the mountain ranges of antipolo to the right. Why do I say that? Because that geographical configuration constraints us to plan on a north-south basis. And the entire transport roadmap—at least for rail po—we are trying to build three mass transit north-south corridors through our capital. Those three are—yung sa kaliwa ma'am, you see the yellow? —that is LRT 1 which we are extending to cavite—we started this and which we are further extending down to dasmarinas and there are thoughts to extend it to Tagaytay actually. So that's the line to the left. The two additional

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			corridors—I call it—im sorry for myself—I call it the line to the left, the line in the middle, and the line to the right—kasi ma'am if you notice, yellow po yung nasa kaliwa. Yun pong north-south commuter rail natin, will start from upper left but it will end up in lower right. Yung subway po natin will start from upper right but phase 2 will eventually lead it to—not lower left but middle. So, you imagine ma'am, you have line one, you have the subway, and then you have the NSCR. So those are two projects. Project number three ma'am. Isa po kasi doon sa mga nadatnan namin na projects is yung concept po natin ng provincial intermodal exchanges. You might have heard about this po yung Paranaque intermodal exchange along coastal. We also have the Taguig intermodal

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			exchange, formerly called the south ITS, if you may have read. Iniba po kasi namin yung pangalan. Sabin namin, bakit south—southwest? Just call it where it is para mas amdali yung geographic identification. So Taguig ITEx po. Yung Taguig ITEx is located, diyan po sa may C-6. So, near the C-6 – SlEx Intersection. What we wanted to do ma'am, is we wanted to make sure that both the subway and the north-south commuter rail projects are connected to that bus intermodal. Actually, ma'am Malabo lang dito but that already says Taguig common station. We will rename the entire TITEx subway FTI station and NSCR—north-south commuter rail FTI station into the Taguig common station. We're doing the same thing. Ma'am last point po.

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			There's another configuration po kasi that is very important to note. Yung concept po natin ng operational interoperability of riding a train in clark all the way to riding a train calamba. That exists po not just within the north-south commuter rail—that also exists between the north-south commuter rail and the subway—meaning po ma'am, you can ride a subway train coming po from quezon city in the north—same subway train brings you—you emerge from underground—you connect with PNR-calamba—the southern section of NSCR, and you end up po in calamba already. So those are the design considerations.

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	Well said USEC, but my question still isn't answered. My question is why do you have built another subway trail underneath the UHV? You know the one in front of UHV all the way to Bicutan when cannot attain the speed of a high-speed train because you are now approaching your terminal. You are not going in to surface. So why can't you—because I know you know have this extension two all the way to calamba. So why can't you just go on a gradient—probably from somewhere libingan ng mga bayani then come out at the FTI, have a small transit station—a ticketing station—and then stay at grade or on the		

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	surface from FTI to Bicutan—because that's just about a few meters distance. It's very impractical for two stations which are just about 400 meters away—you know spend another 1.5 billion dollars—because when you're approaching a terminal, your tendency is to slow down. So, I think it's more practical that you don't dig under the ground, especially because—do you have a soil profile for this?—for the UHV—you know the one in front of UHV? Do you have a soil profile? Do you have a layer of profile of the soil? UHV? Do you—can we have it? DO you have all of the laboratory analysis?		 Yes ma'am.

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	So can you document it?		Yes ma'am. **USEC Batan, DOTr** I thought if I may answer po. Ma'am I think po number one, FTI station is not—when we say terminal station po kasi—end station. FTI station po kasi ma'am is not a terminal station po. Ma'am Nakita po ba akong gumaganoon kanina? Explain ko ma'am, please indulge me. Ma'am, we hear you. That's why we're here. That's why we were there the last time you met with our team, that's why I'm here today because I've come back to deliver the output of what we think about after the hearing.

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			Previously ma'am, ang configuration po natin in this area is SLEx, Calamba station, PNR calamba station—yung sa NSCR po natin, subway station. The subway station is not under calamba station. So what we are working on now po is to bring the subway station into under the calamba station in order for us po to—again ma'am I've noticed—I noted po kasi kanina—where that change will substantially—majority po—bring us out of UHV, but as of this time, we are still unable to fully bring it out—pero ang laki na po. From 70 meters, we are now looking at 15 permanent, 25 temporary. So yun po yung nature ng ongoing design namin.

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	Pero ibabalik nyo po?		**USEC Batan, DOTr** I will give it back lang. Sorry ma'am, 25 po—25—you have to make a distinction po between our temporary works requirement, during construction and our permanent works requirement after construction. Ang permanent works requirement po namin after construction is only 15 meters and the purpose of that 15 meters is the restoration of east service road. Yung existing east service road po kasi, kakailanganin na po siya kainin nung PNR-calamba station—so we need to make space for around 15 meters to the right. Pero during construction po in addition to the 15 permanent, we need a 10 temporary for construction. Yung 10 temporary po na 'yun, during construction lang.

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	Ilan po yung mababalik?		**(USEC Batan)** The 10 po—the 10. The temporary **will get back.** But the permanent works will become the road. We're still identifying the—again this movement of the subway station to under the PNR-calamba station is recent and we're updating po the extent of which properties will be affected.
	Thank you USEC Batan. I'm encouraged with your talk, especially looking at that station I'm gonna be here. I'm growing gray hair every day when I heard this thing, but im encouraged with your talk. You were saying, you need 35 meters and the 15	Mr. Eugene Babia	**USEC Batan, DOTr** 25 lang sir. 15 plus 10.

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	meters…		
	--for the east service road restoration, you need 15, right?		Yes sir 15 for east service road restoration--
	15 para 'di ka matamaan doon right?		Correct Sir.
	Since you are writing entirely the road network landscape—		Yes.
	--and for your—also a thing to look at. Can I encourage your team to look at the **cucumber road** that goes out to Bicutan and make it the new east service road? Whether it's—		Papatayin na po natin yung east service road here. Temporary lang?
	whether you can make that permanent actually and you		Ay sir hindi po kayang temporary yung east service road na 'yun—

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	can make it temporary.		You'll still need 10.
	Yung east service road, you can do the construction yard. Yung east service road can be the construction yard.		Noted sir. We will consider.
	You can eat that entirely. Tapos—		Understood, I hear you.
	Yeah yeah—if you build that east service road, right now yung sa cucumber		
	That's a big—that's a big road ah. Please ask—		
	Kasi once this is constructed, wala ng use yung mga taga-bicutan to ride a jeep to FTI. Wala na silang use eh. Yun		Understood sir.

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	lang naman yung gamit ng east service road na 'yan eh. --yung mga taga-bicutan can ride the subway going to that terminal exchange, 'di ba? So I would like to request that you look at the option of writing entirely the landscape. **Mr. Patrick Salazar** joined in the discussion and stated that Pero starting from Paje going to—let's say cucumber road—walang bumababa diyan na sumasakay sa jeepney. Kasi ang nandiyan lang is UHV 1, Makati south hills, United 2, and then factor in na wala na wala na, lupa na lang. So literally from Paje all the way to FTI,		**USEC Batan, DOTr** Sir itong sinasabi niyo pong cucumber road, this is open public road? Okay. If you're going to pursue this, we have to change our station use assumption ah. If this is possible, that means that all entry and exits—almost all entry and exits to our station will come from the cucumber road**.** We will

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	walang bumababa doon na jeepney riders. So kami na tiga United and ano, willing kami na dumaan doon sa cucumber road kahit maglakad kami pababa doon sa village namin. Sure ako doon, walang bumababa sa stretch na 'yun— **Mr. Patrick Salazar** It is open and then siguro a few meters na lang para madugtong doon		explore. Understood. Naiintindihan ko po yung sinasabi niyo sir—na parang ok lang na patayin itong segment na 'to ng east service road is what you're saying. Sir clarify ko lang po yung construction yard ah. There is the big construction yard where we will have the storing, the piling, the everything—and there is the construction yard—the strip na kailagan po namin to surround our asset. Kasi kunyari ito po yung asset—you need a strip around. So yun po yung mini-minimize po namin. But just to ano po sir—just to clarify na yung Malaki pong construction yard will already be over there. Nandoon na po siya. Wala na po siya dito. Yung sinasabi ko po kaninang temporary

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	I'm sure talaga yung sa service road walang dadaan. *cheers and applause from crowd* Ay lahat kayo willing na patanggalin yung east service road? *more cheers and applause* **Mixed voices** YES! **Mr. Patrick Salazar** USEC and then just to—so first po yung cucumber road, please look at that option—		na 10 meters, yun lang po yung strip pa-ikot po ng asset namin that we need during construction. Sir last na po 'yun. So, ma'am we will have other consultations as we move forward. Again, po I super qualified kanina that this is our general thinking pa lang. It's most likely going to be what we will be working on but we need a lot further detail designs to implement this.

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	and I encourage you po, please pass by that area especially on a Sunday para makita niyo po. Maluwag po siya. Last na lang po USEC. So we're trying to solve po for east service road 'no yung temporary, the cucumber. Yun naman pong construction yard—I think po instead of talking into 200 houses na taxpayers, maybe you can just talk to one company—ARCA—ARCA south. Hiramin niyo muna yung area nila to be—you know for them as part of there community service, to help in progress. Bakit hindi po ARCA yung magpahiram ng area for temporary construction yard for 5 years. Anyway—you know they are		Okay maraming Salamat po. Thank you.

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	one of the major companies helping in nation building? I'm sure they'll be glad to be part of this amazing project sir.		
	Magandang hapon po. Gusto ko pong batiin ang lahat ng mga speakers na napakagagaling pi ng presentation sa araw na ito. Ako po si Mr. Armando Ricaford, isa po akong kagawad sa barangay 184 dito sa may Maricaban area. Actually po this is not a direct question…parang concern lang. Ah kasi po tungkol ito doon sa reclamation area ng Pasay City. Kasi before, ang presentation po sa amin, yung itatambak doon ay manggagaling sa may Cavite area…at so wala na bang	Mr. Armando Ricaford	**Atty Sim Flores, DENR** Ok we have a response from the proponent. Meron ba tayong studies na ginawa with regards to the reclamation doon sa Maricaban area. **Sir Allan Mandanas, AECOM** Hello. Hi sir, good afternoon po. With regards po doon sa reclamation—ah—yung tambakan nung pinaghukayan doon sa MMSP…options lang po yung five sites na 'yun so it doesn't mean na itatambak talaga yung doon sa site na 'yun kasi before mo itambak yung mga soil na yun—yung soil or yung rock na galing doon sa underground na

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	masyadong magiging epekto sa amin sa low-lying areas ng Pasay City…Kaya nga lang po kanina sa presentation…nakita ko na iyong i-eextract na soil from the project ay doon na ilalagay ngayon sa reclamation area. So ito po ay magkakaroon na ng epekto doon sa low-lying areas ng Pasay City sapagkat ang assumption ko po is yung madi-displace na tubig doon ay, of course, pupunta doon sa low-lying areas ng Pasay city kasi ito pong Maricaban Creek, Dunggalo Creek, at tsaka Paranaque Creek—magkakadugtong po 'yan ay tributary ng Manila Bay. So sa ngayon nga lang po, madalas na nagbabaha doon sa amin…kaunting ulan		'yun…kailangan pa ng sariling permit doon sa mga lugar na 'yun. So kunwari yung reclamation area—diba isang option yung reclamation? It doesn't mean na doon itatambak talaga 'yun. Kumbaga kung matuloy yung project ng pasay city—yung sa reclamation na yun…pwede nilang magamit yung soil na tinatawag as fill material doon pero yun ay kung matuloy yun—kung maawardan sila ng sarili nilang permit. So magiging dependent itong projects na 'to. So ano lang yun—parang niraise lang yung possibility na magamit yun soil doon sa particular project samin. Kasi may ganung project na iniiisip at merong need yung project na yun ng materials na pwedeng makuha from this MMSP, but it doesn't mean an automatic na itatambak yun doon

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	lang—flash flood at ah inaabot ng ilang oras bago nagsusub—days pa—bago nagsusubiside ang tubig. So ngayon po pag tinambakan niyo po reclamation area na galing doon sa in-extract na soil from the project…of course po yung madi-displace na area pupunta doon sa lugar namin. So sana po mabigyan ng consideration…kung paano ire-resolve yung problem na 'yan. Maraming salamat po. Yes po		kasi kailangan pa ng sariling—yung reclamation project na yun, kailangan pa niya ng sariling ECC niya. So yun po basically. **Atty. Sim Flores, DENR** So kagawad…ok na po ba yung sagot? Next question po.

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	Good afternoon po, I am Gerald John Sobrevega, a barangay kagawad from barangay 183 villamor. So, I have three concerns po sa pre-construction, during construction, and sa post construction. For the pre-construction po, kasi nakita na natin na based on study na the barangay 183 or the area ng NAIA 3 station are Guadalupe clay—so medyo malambot na yung area because of the Maricaban creek. So, some part of na madadaanan po kahit na underground ay nasa taas po niya ay a residential. So medyo malambot na yung lupa tapos a residential po yung nasa taas…so ang worry po namin	Gerald John Sobrevega	**Engr. Mikaela Eloisa D. Mendoza, DOTr** Magandang hapon po. Yung tungkol po doons a unang tanong—kasama po yun sir sa pinag-aaralan po namin. Yung nabanggit ko nga po at sinabi po na rin naman po 43aming sa inyo na option po yun. Sa ngayon di pa naman po naming nafa-finalize kung aling option po yung kung saan kami pupunta. So hindi lang po yung lupa yung pinag-aaralan namin—kasama po doon yung social impact. So mahalaga po yun sir, yung nabanggit niyo po—na siyempre yung mga residente po yung nandoon although underground po kami—well hindi naman po ganoon kalaki yung impact during and after construction. Magkakaroon lang po tayo ng limitation pag dating

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	siyempre…pati worry po ng mga tao na residente naming—Papano po kapag nagkaroon ngang—katulad ng in-explain ni sir kanina pagka—pagmeron tayong paglindol o mga disasters and everything...so based doon po sa presentation kanina…kasi dating daanan din po yung golf course. Diba the golf course rin po is under pa rin po ng Villamor. Baka na lang natin doon na lang i-divert—isang suggestion lang po—na di na dumaan sa residential. The option one—dadaanan pa rin yung residential…the option two—mas malaki yung residential area yung madadaanan. So kung ang way po from the NAIA station papunta sa FTI—baka		doon sa paggamit natin sa lupa natin pagkatapos po ng construction. So yun po…kasama po siya sa pag-aaral. Yung pangalawa naman po sir—tama po kayo sa traffic management. Mahirap po yun kasi very challenging po yung area—lalo na po nung—meron na pong NAIA Ex. Yun po yung nabanggit niyo kanina na bottleneck po doon sa area kasi…yung plano po siguro nung paglagay po nung mismong ramp pababa po doon sa area ay medyo hindi po maganda—pero kasama po sa pinag-aaralan naming yung traffic management during construction and during operations. Mahalagang nabanggit niyo po itong traffic management—hindi lang patukoy sa proyekto naming kasi pwede po naming isama iyon—pwede po

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	pwede pong i-move na natin kasi ganun din naman eh. Medyo Nakita lang po naming sa map kanina na lumiko siya---tapos papunta pa rin siya sa direction ng ano. Bakit hindi na lang natin siya diretsuhin na dadaan na lang siya sa Villamor golf course para walang in danger sa taas para in case of the—para wala rin po kaming concern sa vibration and sa iba pa nating yung worries ba. Yun din po yung isang concern din namin. Next naman po for the—during construction…yung concern po namin sa yung during construction ay yung traffic…kung Nakita niyo sir—tinitignan din po namin yung pagka-count—yung pagsu-survey ng inyong tao		naming gawaan ng paraan sa future po. And then third po sir—security. Napakahalaga po ng security sa Pilipinas. Yung mga consultant po natin—karamihan po sa kanila ay hapon dahil alam naman po ng lahat na itong proyekto po natin ay funded by JICA—Japan International Cooperation Agency. Sa simula hindi po nila naiintindihan yung konsepto ng security kasi hindi po tulad sa bansa nila yung bansa po natin—napakadami po ng threat…di lang po sa security—safety po ng mga tao. So magmula po ng simula habang dine-design po namin yung project, lalo na po doon sa partial operability section. Nakikipag-ugnayan po kami sa office of transport security para po ma-coordinate namin yung design po

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	doon sa area namin…at ah doon sila sa may area sa barangay 183—but if pupuntahan natin yung mismong location sa harap ng shrine of st therese—bottleneck siya—na from pagbaba mo ng skyway—ng skyway from papunta ka ng—papunta sa amin—bottleneck siya so sobrang—I don't think kung papano gaawin yung security measures doon or yung traffic scheme doon kung papaano siya gagawin pero medyo challenging yung location and most number ng mga dumadaan nga doon yung private din kasi kasi may international flights na ang terminal three. So yun po yung isang concern namin. Wala na ring dadaanan ang		naming base po sa kanilang requirements—to ensure po na safe—secure po yung mga pasahero po natin. Yun po. Bukod po doon, kasama na po sa traffic management—nakikipag-coordinate din po kami sa ibang agencies such as MMDA—DPWH. Yun po. Sana po mapanatag po kayo doon sa ginagawa naming para doon sa proyekto. Salamat po.

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	mga residente namin kasi ang pinakamalapit na hospital doon sa amin ay yung Philippine Airforce General Hospital. Yun po. Doon lang yung tanging daan—yun lang yung way—so baka pwede nating i-consider din yung mga about sa traffic scheme para mabigay rin sa amin ahead of time because aminado kami na kulang talaga ang tao for the traffic—pati mga flag mans po natin kung meron man—para ma-coordinate po namin. Next our concern po sa post-construction—the security of our residence. Yung barrio po, for the information of everyone—the barangay 183, ang buong land area po niyan is 217 hectares—so yung 53		

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	hectares po—so before the barangay—the barrio itself—na meron po kaming, as of 2015—meron po kaming thirty-two thousand residents. 2015 pa lang po yun ah—hindi pa included yung mga nakatira sa condo. So security-wise, kasi 20 lang—plus yung PCP namin—kulang din yung mga ka-pulisan doon plus the additional pa na volume na papasok doon sa amin lugar. So medyo isang challenge din po doon yung security. I think, basically sir na magdadagdag ng mga CCTV cameras but I think that's—hindi sapat para doon lang sa dami—sa volume ng tao na pupunta doon sa area—especially doon sa terminal 3, that I think is the last		

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	station? So yun po yung mga concern baka pwede po nating I consider na madagdagan din yung ating ano diyan—hindi lang yung installation ng CCTV cameras—even the manpower for the security force is madgdagan po. Yun lang po. Yes po.		**Atty. Sim Flores, DENR** Kagawad Sobrevega, na-address po ba ang inyong concerns? Thank you, next question please.
	Magandang hapon po sa inyong lahat. Ako po si Mehito dela Rosa ng Sitio malugay, Paranaque city. Ang unang tanong ko lang po. Bakit po nabagao ang	Mr. Mehito dela Rosa	**Engr. Mikaela Eloisa D. Mendoza** Sir kanina po sa unang bahagi po nitong programa…nandito po yung aming boss naming na si undersecretary timothy john batan po. Pinaliwanag po niya kanina na

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	plano na dumiretso na po sa Bicutan—samantalang doon sa original plan ay hanggang FTI na. Panggalawa, kami po ay nakatira sa isang sitio ng Paranaque na kung saan po tatamaan. Ang gusto ko po malaman dito…ano po ang insurance namin na—kasi kami po ay around 30 to 40 meters away doon sa magiging site ng construction. Ang ibig ko pong sabihin…nakakasiguro po ba kami na hindi kami matatamaan—maiistorbo ditto sa gagawing construction? Salamat po.		yung koneksiyon po namin—itong proyekto pong ito na metro manila subway project papunta sa Bicutan ay may kinalaman po sa pagbuo po ng aming network. Kumbaga sir, para po sa convenience po ng mga tao—manggagaling po sa norte papunta po sa calamba ng PNR po ng DOTr. Mas Mabuti po na i-diretso po papuntang Bicutan yung metro manila subway project para di na po mahirapan yung mga tao na lumipat pa ng ibang linya kung sakaling gusto nilang pumunta ng Bicutan po—ng calamba. Yun po. Pag dating naman po doon sa construction, sinisigurado po namin na hindi po kayo ma—kumbaga—maiistorbo…

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	(Atty Sim, DENR) Yung question ni sir is…first bakit dumiretso—bakit nabago yung plano—from Bicutan—yung original. And then yung panggalawa, ano yung assurance ng community na hindi sila tatamaan—pag dating ng construction.		So yun po sir. Yun atin pong magiging contractor para po sa metro manila subway project will be majority Japanese company. It will be procured po through—tinatawag po natin na JICA guidelines. Meron po tayong social safeguards pag dating po dito sa ating proyekto na metro manila subway project—bilang ito po ay funded by JICA—nabanggit rin po ito kanina ni USEC na maswerte po dahil yung proyekto po mismo ay sumusunod po sa JICA guidelines. Yun po yung aming masisiguro sa inyo na from 30 to 40 meters po sir—nabanggit ko po kanina—hindi po kayo maaapektuhan—within kumbaga tolerable levels po yung magiging

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			noise level, vibration doon po sa area.
	Mehito de la Rosa Meron lang po akong idadagdag na katanungan kasi last year po, na hindi pa po pumupunta yung mga nagsukat doon galing sa kalsada. Ang sinasabi ay 15 meters lang from the highway ang sasakupin. Tapos nung magsukat, bakit 70 meters na from the highway. Napakarami pong tatamaan na mga bahay—kasi yan po ay mostly residential areas po 'yan.		**(Atty Sim, DENR)** Thank you maam. Sir Dela Rosa, ok na po ba? **Engr. Mikaela Eloisa D. Mendoza** Sir kanina rin po dito sa unang bahagi po nitong programa—pinarating po ni USEC TJ po na ang kasama po sa pinag-aaralan po namin ngayon kung paano po namin mai-uurong po yung estasyon po ng subway papunta pa po sa loob ng PNR right of way. Mababawasan po yung maaapektuhan kasi ang goal naman po namin—ma-minimize yung social impact po ng proyekto. Yun lang po Salamat.

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			Atty. Sim Flores, DENR Sige po, next question na tayo.
	Kagawad De La Cruz said, Good Afternoon po. Follow up lang po ng konti dun sa tanong ni Kagawad Sobrevega, kasi sa ngayon po, nagpresent kayo ng dalawang option pagdating doon sa papuntang terminal 3, which is dadaan ng Newport City. Okay, doon sa option 1, pwede na po ba nating ma-identify… Ito kasi yung mas diretso, mas konti yung iikutan sa residential; yung option 2, yung iikot pa sa residential. So sa ngayon, yung option A na pinag-uusapan natin, although nagpro-propose ng another option si Kagawad	Kagawad Gemma Dela Cruz	**(Christina Fernandez, DOTr)** Para po kasi natin malaman nang saktong-sakto ma'am, kung sino yung mga matatamaan, ang pamamaraan po, magkakaroon muna ng socio-economic profiling, o socio-economic survey. So pag na-identify na po sa pamamagitan ng Parcellary survey, kasi sa ngayon po drawing pa lang po yung nakikita natin, malalaman lang po natin yung saktong-saktong sukat kapag inilapat na natin yung drawing sa lupa, so magkakaroon ng Parcellary survey. May mga Geodetic engineers na bababa doon para makita sa inyong mga hangganan ng boundaries. 'pag nakuha na po yung hangganan ng boundaries,

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	Sobrevega, na totally walang ma-apektuhan doon sa residential. Under the present option of option A, pwede ba naming malaman kung alin yung mga identified structures na ma-aapektuhan under option A; ito ba yung bukas— sa pinag-uusapan natin is subway pero definitely may mga open tayo na talagang may mga building na ma-aapektuhan. Yun po yung gusto naming malaman, kung identified na po natin yung mismong mga structures na affected, if ever na yung option A talaga ang matitirang pwede ninyong gawin.		pupunta sila sa Assessors' office, o kaya Tax Mapping Division, para makita naman kung ano yung mga parcels, o parsela ng lupa, na nakapaloob po doon sa hangganan, yung boundary ng ating alignment, at saka pa lang po sila bababa doon sa ground, i-identify kung ano 'yung mga natukoy na structures, saka po magkakaroon ng socio-economic survey, saka pa lang po tayo makakapag-generate ng masterlist of structures and affected persons nung proyekto. So medyo mahaba-haba pa po ng kaunti ang proseso.
	Pastor Nelson said, kahit anong iwas po ng [subway], tatamaan na po talaga kami kasi diyan po yung terminal	Pastor Neslon Alastoy	**Christina Fernandez, DOTR** Yung prinsipyo po ng walang tanggalan hangga't hindi nababayaran, mananatili po 'yun

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	ng PNR at ng subway. Ang aming concern po, kasi simbahan po 'yan, and we have 100+ members, plus yung mga tinutuluyan po ng aming mga pastor. So my concern is, kasi talangang maaalis talaga kami diyan eh, kasi identified na po kami, kailangan po before, atleast 1 year yung pagitan, mabayaran na po kami para makabili na kami ng sariling property. Kasi, mahirap po kasi na sisirain nila yung aming simbahan, and then wala kaming sanctuary, wala kaming place. Yun po ang aming concern, as a pastor sa samahan, mahirap po kasing maghanap ng property lalo na mahal ngayon ang property dito. Hindi po kami pwedeng pumunta ng		kasi hindi lang po 'yun inuutos ng batas, ng lokal na batas (10752), kung hindi, matingkad po 'yun na nakalagay sa JICA guidelines on environment and social considerations. Kaya lang sir, mukhang sa tapat na pag-uusap, mahirap panghawakan yung 1 year before ay dapat mabayaran na kaagad yung mga affected property owners. Pero 'yung isang tinitiyak ay hindi matatanggal yung mga naninirahan doon hangga't hindi sila nababayaran ng sapat o ng buo. Depende po 'yun sa kalalagayan ng kanilang property documents. Pero 'yung karanasan po natin doon sa ibang mga project areas, sa maagang pagpasok ng appraisal, kasi hindi naman po siya basta pine-presyuhan lang, ang tawag po natin sa 10752 yung "Full Replacement Cost," kaya kung

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	province kasi ang aming place, na church, ay Paranaque. So dapat, Paranaque din po ang property namin. Kasi sa bawat cities, mayroon po kaming simbahan, hindi po kami pwedeng mag doble. Yun po yung concern namin, atleast 1 year yung, nakabili na kami ng property at nakapagpatayo na kami ng church, o ng worship place.		magkano talaga 'yung presyo nung [property], kung worship house po 'yan o residential house po 'yan, kailangan po 'yang i-replace. Hindi po katulad nung dating batas na "Reproduction Cost," ngayon ang gagamitin natin ay "Replacement Cost." Kumabaga, 'yung ibabayad po sa inyo ay hindi na natin pag-iisipan kung kakasyasiya o hindi. Ang kailangan lang po as early as now, dahil tayo po ay nakatitiyak na tatamaan ang ating struktura, sana makapaghanap ng alternative na lugar na pwedeng lipatan para hindi man umabot ng 1 year, may enough time tayo para makapagpatayo. Ganun pa man, kung halimbawa po ay hindi tayo aabot talaga, kunyari nasakal tayo doon sa allowance, sa time na ibinigay ng DOTr sa kung ano pa mang dahilan, mayroon po tayong

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			tinatawag na rental subsidy, para doon sa mga residential structure owners, pansamantala habang naghahanap siya ng kaniyang malilipatan. Pero again, hindi po natin siya isasagad kung kailan makakahanap. May mga sapat na panahon na allowance na ipro-provide sa kanila. Pero as early as now, kung kayo po ay tiyak na tiyak, kasi nasa may puno po kayo nung tatamaan ng istasyon, mas mainam pong makapaghanap-hanap ng alternative na lugar na malilipatan po kaagad.
	Pastor Nelson responded, yun nga po kasi ang concern namin, kasi ang hirap maghanap po ng place ngayon. Kasi lalo na church po kami, kami 'yung lulugar, pero saan po kami kukuha… kayo po ba ang magbabayad?		**(Christina Fernandez, DOTr)** Yun pong rental subsidy, may ilalaan pong subsidy pero hindi po siya pangmatagalan. Kumbaga, parang transition po siya habang naghahanap, kung kaagad-agad na kailangang alisin.

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	Pastor Nelson responded, Napakahirap po kasing maghanap ng property… mahirap talaga. Kasi ayaw po naming pumunta ng province kasi hindi naman pwede kami sa probinsya eh. Kasi home po kami ng metro manila district eh. So 'yun po 'yung concern namin, kailangan po na atleast makahanap kami ng property. Siguro, ang aming target na place, 'yung pinakamalapit lang. 'Yun lang po ang concern namin kasi mahirap po na mag scatter ang aming mga member eh. Hirap sila… kasi ayaw namin silang malayo, hindi na sila makakapag simba sa amin.		**(Christina Fernandez, DOTr)** Ang pinaka strategic po talaga ay mas malapit doon sa dati ninyong inalisan kasi more or less, hindi masyadong maapektuhan ang presyo po. Isang idea lang siguro sa compensation para po doon sa lupa, kasi ang gagamitin po natin ay doon sa bagong batas, 'yung current market value, so hindi na po katulad nung dati na BIR nasusunod 'yung value. Sa current market value po, kung 'yung prevailing value ng lupa sa kapaligiran, more or less hindi po masyadong malalayo doon, para makapili kayo ng kaparehas na lupa na aaalisan ninyo. Syempre po kung pipiliin natin na lugar ay medyo high end at mahal na mahal kumpara dun sa dating tinitirhan natin, mukhang mahihirapan talaga tayong humanap ng

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			aangkop doon sa presyo na ibabayad sa atin ng gobyerno. Pero kung similar area, more or less, similar 'yung value. Kailangan nating maghanap-hanap ng ire-replace natin na lupa.
	Atty. Sim Flores, DENR Follow up lang, in relation sa tanong. Mayroon na po ba tayong established system para sa ganitong mga compensation?		**(Christina Fernandez, DOTr)** Mayroon na po tayong „"Entitlement Matrix" na sinusundan sa ngayon. Pero in terms of valuation, depende po 'yan. Kasi ang gagwin po ng DOTr, kailangan niya po ng partnership sa government financing institutions. So it's either Land Bank of the Philippines or Development Bank of the Philippines. Para bababa sa lugar ninyo para lapatan ng katumbas na presyo yung strukturang magigiba, at lupa. So once they submit to us 'yung appraisal report nila, 'yun pa lang yung magiging basis natin for offering to buy sa land na mga

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			affected.
	Atty. Sim Flores, DENR So let's say na sina Pastor, one month from now, nakahanap ng property, how will the DOTr help them in acquiring the property?		**(Christina Fernandez, DOTr)** Wala po kasi kaming choice kung hindi hintayin 'yung appraisal ng GFI. Sa ngayon po, wala pa tayong appraisal report kasi hindi pa natin naisasagawa yung Parcellary mapping. Once ang Parcellary mapping or planning is done, at naibigay po sa amin, tsaka pa lang namin ma-proproduce yung documents, tsaka pa lang po namin siya masu-submit sa DBP or Land Bank para gawaan po nila ng appraisal report. So bababa po sila dun sa area kasi maraming mga factors na kailangan silang tingnan: zoning, location, best use of land.
	Atty. Sim Flores, DENR But definitely, hindi po sila pababayaan ng DOTr?		**(Christina Fernandez, DOTr)** Definitely po opo, kasi dalawa po yung sisingil sa amin. Sisingilin

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			kami ng mga apektadong tao at sisingillin po kami ng JICA. Kasi kasama po 'yun sa agreement ng Pilipinas at ng Bansang Hapon, na dapat hindi siya ihiwalay doon sa resettlement action plan na usually ay ginawa dalawang bansa. At dahil nag-sign po ang Pilipinas doon, kailangan po niyang sundin, so meron po tayong resettlement action plan. So yung guidelines ng Japan at guidelines ng Pilipinas, sinubukan siyang pagyapkapin para protected yung project-affected persons.
	Aleni Quizon said, Mayroon po kasing mga tatamaang residential sa Maluhay, San Martin de Porres. Mostly po doon, yung totong ay ari hindi sila nakatira. So sabihin na natin may mga	Aleni/Neng Quizon, LGU Paranaque	**(Christina Fernandez, DOTr)** asked, Ma'am may question lang po ako sa tanong ninyo. 'Yung number one question ninyo is, may mga may-ari na hindi nakatira doon, paano yung mga nakapag develop ng property. Yung tanong

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	nag squat for how many years na. Tapos, nakapagpaganda na sila ng mga bahay. Ngayon, syempre naman po, talaga naman pong kung sinong nagbabayad ng tax, yung land owner, siya yung babayaran ninyo. Papaano naman po 'yung mga taong nag stay dun na nakapagpaganda ng kanilang bahay? Ano po 'yung magiging programa o solusyon para sa kanila? Yun po yung una kong tanong. Pangalawa po, 'yun po bang ating subway, nabanggit po kanina na tutumbukin ang right of way ng PNR, tama po? Isa sa tanong ko doon, kung ganoon din naman po pala na ipapasok siya sa riles ng PNR, bakit po napakalaki		ko ma'am, mayroon ba silang consent or authority from the owners na i-develop yung property?

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	ng magiging area na sasakupin pa sa residential, na kung tutuusin ilalim lang naman po sila? Eh ang station naman po kasi [ay] FTI, at tsaka parang ang layo layo naman po. Tapos isa pa, sana naman po i-consider na tumbukin na lang 'yung PNR line po. Kasi katulad po dito, pag dating po ng Bicutan, lilihis po iyan pababa. Kung talagang riles po yung tutumbukin, atleast maiiwasan din po yung further damage sa residential, dahil along Sitio De Asis po [ay] Bicutan, tapos lilihis ng riles. So isa po yun sa kinakatakot namin, baka mayroon uling madagdagan na residential na masagasaan. Kaya sana po pakiconsider po yun, na sana riles na lang		

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	po yung tumbukin. **Aleni Quizon responded**, hindi rin kasi nila ma-locate kung sino 'yung may-ari. Malalaman na lang pala nila na nagbabayad sa city hall ng tax. Syempre, automatic naman po 'yan, kung sino talaga yung tax payer, 'yun naman po talaga ang mabibigyan ng payment. Paano po yung mga taong nakatira doon na for how many years, sabihin na nating nag squat sila, ano po 'yung plano ninyo po para sa kanila?		**(Christina Fernandez, DOTr)** responded, importante po na malaman natin kung sino yung may-ari ng lupa. Ang pagkakahagip ko ma'am, iba yung may-ari ng lupa, [at] iba ang may-ari ng struktura. So mababayaran ba may-ari ng struktura? Kailangan po nating tingnan natin dito, una, ano po yung maipapakita ng may-ari ng struktura na proof na siya ang may-ari nung lupa? Sa atin po, ang pwedeng ipakita, 'yung tax declaration, or proof of the ownership nung structures. Ang tanging maipapakita niya dapat sa atin para maniwala tayo at kilalanin natin 'yung kanyang pagmamay-ari o lehitimong pagmamay-ari ng struktura ay 'yung tax declaration ng improvements or ng structures.

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			Pag wala 'yun maam, ipagpapalagay po natin na informal settler family 'yung may-ari ng struktura at idadaan po siya sa proseso ng prequalification, kung siya ay magqua-qualify for relocation. Pero ma'am, kung halimbawa po na kilala ninyo 'yung may-ari, makahingi kayo sa kanya ng affidavit, or waiver doon sa structure na pagmamay ari ninyo, ibig sabihin kikilalanin niya na kayo ang nagpatayo ng bahay, kayo ang nagpagawa ng bahay, at doon kayo naninirahan sa ganito kahabang panahon. At dahil I-a-allow kayo, pwede kayong mag apply ng tax declaration, [at] mababayaran po kayo ng DOTr at each replacement cost. So kailangan mayroong tax declaration. So pinakamainam ngayon [ay] hanapin [ang] may-ari at kausapin na kayo ay

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			naninirahan doon, at kayo ang nagmamay-ari, or apply po kayo ng tax declaration kung kayo ay mapapagbigyan dahil sa mahabang panahon na kayo nakatira doon at hindi nagpapakita may ari. Depende po 'yun kung ano 'yung treatment sa inyo ng local government. So sa alternative side, kung talagang wala tayong ma-proproduce, hindi naman po papayag ang COA na wala tayong maipapakitang proof. Kasi lagot naman ang DOTR, kahit naman po siguro sa kahit anong transaction sa gobyerno. Ika-candidate po natin siya for relocation. Papasok po sya, kung qualified, sa panlipunang pabahay ng gobyerno.
	Atty. Sim Flores, 'Yung second question po ni ma'am, yung sa right of way ng PNR. Bakit daw		**Engr. Mikaela Eloisa D. Mendoza** answered, Tungkol po doon sa pangalawang tanong,

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	napakalaki ng area?		'yung nabanggit ninyo po kanina. Kasi nagkaroon po kami ng presentation noong nakaraang buwan. Ang sinabi po namin sa inyo, roughly 17 meters po 'yung maapektuhan papasok ng residential area. 'Yung nabanggit po namin kanina, ipapasok po namin 'yung subway sa ilalim po ng PNR right of way, 'yun po 'yung na-isip naming solusyon para mabawasan po namin 'yung maapektuhang residential area. 'Yun na po yung nakita naming solusyon para mabaswasan po talaga 'yung maaapektuhan. 25 po ma'am 'yung initial po na assessment na kakailanganin. Galing po sa e-service road, 15 meters po para doon sa gagamitin natin na diversion ng e-service road. Tapos kailangan pa po natin ng 10 meters para po doon sa

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			construction yard naman po ng aming istasyon. 25 po.
	Dr. Quimio said, I want to direct this question to the Geologists or to any of the JICA scientist. This is actually a general concern because you mentioned that manila is almost a big chunk of adobe. Do you have a depth for that? **Dr. Quimio** said, Yes, along san martin de pores	Dr. Maria Elena Quimio	**Allan Mandanas, AECOM** It varies depending where you are. **Allan Mandanas, AECOM** Based po doon sa initial drilling report, naglalaro po between 1-10 meters 'yung soil profile so underneath nun, doon po yung mas sturdy na [layer]. Baka doon na po 'yung talagang adobe, 'yung strong na adobe. Unlike dito sa BGC, makikita ninyo nasa gilid lang po ng C-5 'yung exposure ng adobe. So depende po sa lugar kung nasaan kayo.

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	Dr. Quimio said, Have you encountered any study, both local or foreign or from literature, wherein they say anything about the effect of constant vibrations on the surrounding soil? Knowing that this is a big mass of adobe and adobe is not really that hard. It's hard if it is not subjected to stress. But it's sand; I understand it's about 50% sand so it can be brittle once subjected to constant stress or to constant vibration.		**Allan Mandanas, AECOM** For now, wala pa akong na-encounter na specific study about that. But I think the subway station would be located at a level that is assumed to have minimal effects in terms of vibration doon sa overlying materials niya.
	Dr. Quimio said, Kasi ang concern ko diyan, in time, in medium or long range, you create this cracks on the surroundings and cause		**Engr. Mikaela Eloisa D. Mendoza** Nabanggit po kanina ni USEC na we have already conducted geotechnical investigation. So far

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	subsidence or ground level lowering, and then affect the foundation of houses in the surrounding area. Would you tell us any…		po, 'yung findings po ng aming mga consultants for the design, they always say that we have good soil along the alignment. You're worried po about the vibrations. We have study on the effect on the houses especially by the vibrations po, we have some countermeasures po we are using. For example, this is just an example and hindi lang po ito 'yung nag-iisang counter measure, we have rubber pads po sa aming mga… 'yun pong makikita ninyo sa riles. Yung riles po mismo, sa ilalim po noon, meron po tayong anti-vibration para kahit umaandar man 'yung train sa loob ng tunnel, hindi po ganoon kalakas yung magiging vibration po niya.
	Ms. Ramos said, ang concern po lang po, kasi po nag ta-tagging na po doon sa mga tabing-bahay sa amin.	Geraldine Ramos, Barangay Malugay	**Christina Fernandez, DOTr** answered Unang tanong po ma'am, naisalin na po ba yung pagmamay-ari mula doon sa

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	So dun po sa side na 'to sa Suungan, kami na po 'yung kasunod, na hindi pa raw kami affected. If ever po konting urong na lang, kami na 'yun. Private po 'yung sa amin, 200 m^2, pero po acquired po namin 'yun sa grandparents po namin, [noong] 1969. Updated din po kami sa taxes. Ang concern ko po, ang dami po naming magkakamag-anak doon. Apo na po ako, may mga uncle pa po ako. So papano po kung babayaran po kami… Paano po kung hindi po kami magkakakasya doon sa ibabayad, may ma-aavail po ba kaming relocation [or whatever]? **Ms. Ramos said,** Sa lolo pa po ang pangalan, isa pa lang		dating mayari? **Christina Fernandez, DOTr** Kailangan po muna nating i-daan

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	po siyang pangalan. Patay n apo siya.		sa extrajudicial settlement of estate. Ano man pong pag mamay-ari; ano mang property na nakamatayan ng orihinal na may-aring nakapangalan sa titulo, kailangan po siyang i- subject sa extrajudicial settlement of estate. Lahat ng magkakamag-anak na… lahat ng mga anak ng lolo at lola ninyo, kailangan pong mag usap-usap para magkasundo sila kung paano hahatiin 'yung property ni lolo at ni lola. Tsaka po siya ilalapat sa papel, ipapa-publish, [tapos] babayaran [ang] estate tax. Kailangan pong madaliin hangga't mayroong amnesty ngayon sa BIR. At pagka naisalin siya sa kung sino po 'yung matutukoy ninyo na magiging ultimate na may-ari ng bahay, tsaka pa lang po natin pag-uusapan kung sino babayaran. Kung halimbawa po na nagkasundo 'yung lahat ng mga

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			anak nung lolo at lola… lahat po ba ay buhay, lahat ng mga anak?
	Ms. Ramos said, patay na po 'yung iba. 'Yung kasama ko po 'yung bunsong anak.		**Christina Fernandez, DOTr** Kung mayroon pong patay, kasama rin po yun sa e-EJS natin. Kasi po 'yung share niya, kailangan pong pag-usapan din para dun sa mga naiwan niyang anak. Pinakamainam siguro ma'am, once na na-tag ang inyong property, 'yung house ninyo, once na-determine natin o na ascertain natin na kayo po ay tatamaan, makipag usap po kayo sa help desk namin. Mayroon po kaming ide-designate na mga help desks sa mga cities and municipalities or barangays, makipag-ugnayan po kayo doon para po ma-assist namin kayo ma'am. Kasi medyo may kamahalan kung magbabayad po kayo sa labas. So pwede pong tumulong ang DOTr.

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			Para po maisalin o maiproseso 'yung pagsasalin ng titulo mula doon sa namatay patungo doon sa kung sino 'yung mapapagkasunduan na magiging tagapag mana. So once na matatakan kayo, ma-tag kayo, at ma-interview kayo, mayroon namang contact number doon. Tawag kayo kaagad sa amin para po may mag-assist sa inyo. **Christina Fernandez, DOTr** So ito po yung extrajudicial settlement of estate natin, maidagdag ko lang. Ito po 'yung paraan para mailipat ang isang pag mamay-ari ng namatay doon sa kanyang mga tagapagmana. Kung wala po ito, hindi natin mapapatituluhan 'yung property, [at] hindi natin maililipat sa

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			pangalan natin, mga tagapagmana. Ito po 'yung proseso, gagawa po tayo ng extrajudicial settlement of estate. Kumbaga mag-uusap usap lahat ng mga tagapag mana kung kanino mapupunta ang portion na ito, ang portion na ito, kanino mapupunta. Mag -uusap na rin sila kung papaano babayaran 'yung taxes para mailipat 'yung titulo. Isang tip para matulungan po ninyo rin 'yung mga sarili po natin, maggawa kayo ng family tree mula doon sa lolo at lola ninyo na namatay, tapos kung sino-sino yung mga anak niya, tapos kung sino-sino 'yung naging anak ng anak nya, hanggang sa'yo ma'am na apo, kasi kung ikaw yung aktibong kumikilos. Para ma-identify natin Atty. kung halimbawa may namatay na anak si lolo at lola, magiging

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			tagapagmana naman 'yung succession ng mga anak ng namayapang anak ni lolo't lola. Gawa na kayo ng family tree para pag nag-usap tayo, medyo mapapadali yung ating kwentuhan. **Christina Fernandez, DOTr** So hindi lang po ito applicable sa project natin, kung meron kayong properties sa mga probinsya ninyo na ganyan, ito po 'yung pwede ninyong gawin, extrajudicial settlement.
	Ms. Cynthia said, kung sakaling darating na po 'yung project subway sa aming lugar, paano po yung mga affected residence ng mga mamayan sa aming barangay, kung may place na… kung ililipat, saan at kung babayaran, paano at sino at ano yung magiging	Cynthia Zape	**Christina Fernandez, DOTr** Ma'am yung homeowners association po ba ninyo, ito po ay nasa kasalukuyang housing project, katulad ng community mortage program?

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	proseso o sistema sa amin? Bilang homeowners, BOD po kasi kami. Kung may tutulong sa amin, may favor kagaya po nung binanggit ninyo, para sa madaling proseso. Marami po kasi kami. Sa Fort Bonifacio po, homeowners association po ng Zone 3.		
	Ms. Cynthia said, Hindi po.		**Christina Fernandez, DOTr** Basta po inorganize nyo po yung inyong association?
	Ms. Cynthia said, Proclamation No. 124 po siya ni then-president Joseph Estrada.		**Christina Fernandez, DOTr** so wala pa pong naisasalin na entitlement mula sa city—
	Ms. Cynthia said, Mayroon po kaming CELA tapos,		**Christina Fernandez, DOTr** Nagbabayad na rin po kayo ng

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	tapos na rin po kami sa DENR. Nagbabayad na [kami] ng tax sa city hall of Taguig.		monthly?
	Ms. Cynthia added, and taxes.		**Christina Fernandez, DOTr** sa taxes, nagbabayad po kayo sa taxes?
	Ms. Cynthia clarified, Sa property.		**Christina Fernandez, DOTr** so parang ngayon Atty., mayroon silang pinanghahawakan na ownership via CELA. Hindi pa nga lang naisasalin 'yung titulo; hindi pa nga lang siya naiisalin sa titulo.
	Ms. Cynthia clarified, Hindi, tapos na po sa DENR.		**Christina Fernandez, DOTr** May titulo na rin po kayo?
	Ms. Cynthia confirmed, Yes.		**Christina Fernandez, DOTr** Kung kayo po ay […] ang tawag po sa inyo ay legal owners ng mga properties. Kung ano po 'yung

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	Ms. Cynthia clarified, Mayroon na po, individual titles.		kinuwento ko kanina na paraan, kung may pinanghahawakan tayong titulo, tapos nasukat na 'yung inyong property – **Christina Fernandez, DOTr** kung ano po 'yung current market value na ilalabas ng GFI para sa kanyang appraisal report, 'yun po 'yung mag a-apply po sa offer natin sa inyo. 'Yung relocation po, mag a-aaply po 'yun sa mga qualified informal settler families; 'yun pong mga pamilya na walang pinanghahawakang titulo o proweba na sila yung nag mamay-ari ng tinitirahan nila. Bawat city or municipality, depende po sa volume ng tataman na pamilya, mag se-set up po tayo ng help desk para individual po ma-assist 'yung mga property owners na maaapektuhan. So

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	Ms. Cynthia said, mayroon din po kasi kaming list ng mga informal settlers dun sa vicinity, ma'am. Yung mga area na nandun		makikipag uganayan kami sa inyong barangay captains or barangay kagawad[s] para tulungan kami na i-set up dun yung help desks. **Christina Fernandez, DOTr** mas maganda po 'yun ma'am para ma i-assist ninyo rin kami kapag binabaan na namin during socio economic profiling
	Rubin Belen asked, itatanong ko lang po yung northbound na ruta ng subway. Sabi ninyo kanina, sabi ni USEC wala na yung Cayetano station. Tapos papalit ang Lawton East at West. Tapos diretso na sa FTI station. Tama po ba 'yun? Ngayon po, nabanggit ni USEC, na yung station ng FTI ay ililipat na at doon na lang sa ilalim ng Bicutan. Tama po ba? Pero yung iko-	Mr. Rubin Belen	**Engr. Mikaela Eloisa D. Mendoza** Yun pong station ng subway, 'yung FTI station po, mayroon pa rin po noon pero ilalagay na po namin sa ilalim ng PNR station. Kumbaga iu-urong na po namin papalayo ng residente towards the PNR right of way.

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	consider po nila, yung ruta ng cucumber tapos papunta sa signal, papunta sa Bicutan, sa may service road		
	Sir Robin asked, Pwede mo bang i-skip natin yung FTI station, diretso na lang from Lawton west, diretso na sa Bicutan? Skipping FTI station, pwede po ba yun?		**Engr. Mikaela Eloisa D. Mendoza** Inexplain po kanina ni USEC TJ na ang rason po kung bakit may FTI station for both the MMSP and for the south commuter po, yung PNR po natin, dahil po mayroon po tayong intermodal sa FTI. At kapag tinanggal po natin yung station sa FTI, mawaaala po yung connectivity po natin doon sa intermodal. Yung tinatawag po natin na Taguig intermodal transport exchange, 'yung TITX po.
	Sir Robin asked, Hindi po pwede na diretso from Lawton west to Bicutan?		**Engr. Mikaela Eloisa D. Mendoza** Less than 2 km po.

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	Ang distansya po ba ng FTI station to Bicutan, ilan po yun?		
	Sir Robin said, Dahil it's just 957 meters going there. So that's just a kilometer. So, hindi ba masyadong malapit yun between station?		**Engr. Mikaela Eloisa D. Mendoza** Not really sir. Kanina po, sinubukan po nu USEC TJ na i-compare 'yung greater capital region na we're trying to develop to that of the Tokyo Metropolitan area. Kung mapapansin po natin, at makikita naman po natin sa internet, lalo na po 'yung mga nakapunta na po sa Tokyo metropolitan area. Yung distansya po ng mga istasyon, nag a-average po ng less than a 1 km to 1.5 km po at most. Ganun po kalalapit yung mga istasyon. So really, it's not about the distance between the stations.

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	Sir Robin asked, another question, there is a mode of access, a whole structure, are there any other alternatives instead of cut and fill? reverse traction would be change them.		**Engr. Mikaela Eloisa D. Mendoza** Right now sir, we don't have other alternatives. That's the most efficient kasi sir, remember, we're also trying to minimize the social impact. If we're going to construct there using other methodology, baka mas matagalan pa po 'yung time po na ma-apektuhan namin yung area.
	Sir Robin asked, as against halimbawa sa costing nyo, sa mga na displace na tao, at saka bahay?		**Engr. Mikaela Eloisa D. Mendoza** Yes.
	Sir Robin said, Sabi mo, mas mura yung cut and fill.		**Engr. Mikaela Eloisa D. Mendoza** No sir, we're talking about the time that the people will be affected by the construction, sir.
	Sir Robin said, have you		**Engr. Mikaela Eloisa D.**

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	considered your time in the position compared to the other access towards the building of the station. Pwede po ba underground lahat?		**Mendoza** Yes sir.
	Sir Robin clarified, So pwede underground lahat?		**Engr. Mikaela Eloisa D. Mendoza** If pwede sir, pero sir, meron pong ibang… for example sir. Banggitin ko na 'yung ibang pwede alternative. Yung isa pa pong alternative would be the New Austrian tunneling method (NATM). It's a form of a controlled blasting so may blasting po na magaganap sa ilalim. Right now sir, I don't think mayroon tayong capability to do the NATM. But ofcourse the Japanese, they have the capability. Pero it's a difficult one. We will also need a shaft. So basically sir,

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			mayroon pa ring social impact dun sa ground level.
	Sir Robin asked, Vertical shaft?		**Engr. Mikaela Eloisa D. Mendoza** Yes, in terms of construction timeline, most probably mas matagal po ng kaunti kasi we need a big space for the station. Kasi sir, if [it] we're just the tunnel, 'yung tunnel po natin, 'yung tren lang po 'yung dadaan doon. Pero doon po mismo sa station natin, kailangan po natin doon ng contours. Doon po pumapasok 'yung mga tao, tapos nandoon po sila bumibili ng ticket. Doon po sila dumadaan para makapunta po doon sa ating pinaka platform, 'yung kung saan po tayo naghihintay ng tren, kung saan po tayo pwedeng sumakay.
	Sir Robin asked, Nabanggit ninyo na doon kumukuha ng		**Engr. Mikaela Eloisa D. Mendoza**

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	ticket, doon dumadaan ang tao. Hindi ba pwedeng incline siyang papasok sa loob na lang papuntang station? Hindi po ba pwede na halimbawa, inclined siya, papasok doon sa loob. As an access and other personal, and other supplies.		Sir, I'm trying to imagine po kung ano po 'yung dinedescribe ninyo. Kumabaga, kung ito po 'yung tunnel, tapos meron po tayong platform, kasi doon po maghihintay 'yung mga pasahero. Yung question nyo po is, for example, meron ka lang na parang hagdan, I-drill mo 'yung tunnel papunta doon, pero kumbaga 'yung incline na 'yun, 'yung lang po mismo 'yung hagdan, para makapunta ka po sa platform? Ganun po ba?
	Sir Robin answered, Oo, pwede mong lagyan ng walkway para sa mga tao, pwede ring lagyan ng access para sa equipment, material, supplies.		**Engr. Mikaela Eloisa D. Mendoza** Yun sir, medyo alanganin po. Siguro masyado pong masikip kung ganoon pong butas 'yung gagawin lang po natin –
	Sir Robin said, Pwede mong pagkasyahin eh. Yung		**Engr. Mikaela Eloisa D. Mendoza**

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	shaftings.. pwede 'yun eh. **Sir Robin said**, Pag-aralan po ninyo 'yung other access instead of cut and fill. In that way, wala kayong masyadong tatamaan sa surface. **Sir Robin said**, Yun na nga yung sinasabi ko, 'yung inclined sya, stay sa cucumber area, or further north sa may dating Shell area. You can access na nakainclined siya, as big as the tunnel na 6.3 or 6.5 diameter, dalawang tunnel po 'yun, access ramp. Modern engineering, modern mining, pwede mong suportahan lahat 'yun dahil doon lahat ng mga equipment. Pwede		Malaki po sir yung mga equipment po natin. **Engr. Mikaela Eloisa D. Mendoza** Sir do you have any particular mode na pwede nyong ipro-pose sa ating propose--- **Engr. Mikaela Eloisa D. Mendoza** Maybe sir we can have a written proposal on that matter para po ma I submit natinnsa DOTr para maintindihan din nila yung gusto ninyong ipro-prose. Apart from submitting your alternative proposal sir, tingnan din po natin 'yung timeline as you see the cut and cover and the one you've been telling us po.

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	rin po sa ibabaw dadalhin na lang sa loob, for the construction ng FTI station, hindi ka na mag cut and fill, wala ka nang made-destroy na surface. Some suggestion ko lang po yun. Yung access lang po yun. Kasi yung cut and fill, marami kayong tatamaan. Pero kung siguro inclined sya, 6.8 lang para lang kayong nag tunnel na inclined. Yung tunnel ng subway would be horizontal. Pero yung sinasabi ko pag mula sa west, sa Lawton west dire-diretso na yun a-akyat na 'yun papunta sa Bicutan station, wala na 'yung FTI station. Kasi distance sya between Lawton west hanggang FTI, Bicutan		

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	station, 3 kilometers.		
	Sir Ferrer said, Concern lang, naririnig ko lang po kasi is more on structure. Papaano naman po 'yung environment natin na matatamaan at masisisra? Ano po 'yung pwede nating gawin sana? Kasi sa mga bahay o mga building, kapag nasira, mayroon tayong alternative na gagwin; babayaran natin. Paano po 'yung mga puno na mas nauna pa sa atin dito, sisirain. Kasi mayroon po 'yan sa may, 'yun pong sa may Feldera gumawa ng tulay, nasira yung plant box, nasira yung mga puno, nasira yung mga halaman, na which is 'yun yung piniprevent natin. Kailangan natin yung [mga puno]. Maganda nga	Mr. Adrian Ferrer, CENRO Pasay	**Ms. Kathleen Cruz, AECOM** Thank you po sa question sir. Based doon sa mapa natin kanina, karamihan po ng dadaanan ng subway, plus nung stations po, is built-up areas na po. Pero tama po kayo, mayron pong ibang mga stations na may mangilan-ngilan pa rin pong mga puno. And bago po mag simula ng clearing activities si DOTr, magkakaroon po muna sila ng tinatawag na tree inventory para ma-identify kung ilang puno talaga 'yung kailangan putulin, at kung mayron bang mga threatened species or endemic species na maaapektuhan ng kanilang [activities]. I su-submit po 'yun kay DENR para po mag-apply sila ng tinatawag na tree cutting permit. So i-evaluate po ni DENR. Pero bago po sila makapag-putol, kailangan po

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	'yung structure natin, maganda 'yung pavement. Paano naman po 'yung mga nasisira natin. So tulad po sa BGC, maraming puno diyan, pag natamaan siguro hihingi ng permit kay DENR na pwedeng putulin. So ano po 'yung pwede nilang gawin para ma-preserve naman natin 'yung environment natin, di lang [mag]paganda lang ng structure. Kailangan din natin siguro ng […] matataas nga 'yung mga building natin or 'yung sa train,' yung mga poste nila, imbes na puno 'yung nakalagay dun, poste. Ano po yung pwede ng… mayroon bang project din si [DOTr] para dito?		nilang makakuha ng tree cutting permit, and normally po si DENR, pag nag issue po siya ng tree cutting permit, mayron pong replacement po na requirement. So sa bawat puno po na puputulin, i re-require po ni DENR na palitan po ni DOTr with a certain number or ratio sa isang puno; 50 trees sa isang off set area para naman po ma- address nila na palitan po yung punong na putol na. So I think 'yun po 'yung isa sa mga mag a-address ng concern ninyo na, na puro po structures 'yung pinapaganda. Pag nagputol naman po ng puno for the clearing activities, magkakaroon po ng off set tsaka replacement po nung mga puno pong puputulin as required po ni DENR. Baka may gusto pa pong i -add si DOTr doon sa greening projects.

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			Christina Fernandez, DOTr Utos po ng bagong batas -- Kung dati po ay hindi binabayaran 'yung bawat puno, sa bagong batas po binabayaran din 'yung matatamaang puno so bukod po dun sa inventory na ginagawa ng DOTr, pina pa -check sa DENR, ni require din po kami na magkaroon ng appraisal sa bawat punong tatamaan at bukod po dun sa replacement, sa mga nangawala o mga mawalang puno, kailangan din pong bayaran 'yung may-ari na nagtanim ng puno. 'Yun po, may compensation kamukha ng structures replacement cost din po. **Allan Mandanas, AECOM** Dagdag ko lang po, may dues po 'yung development na may green spaces. So pwedeng maging considerations sa maging design ng DOTr, especially dun sa mga

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			stations nila na may commercial areas, 'yung may konting green [area]. So pwedeng isa 'yun sa mga compensation method. In addition, or possibly in addition doon sa sinabi nina Ma'am and Kathleen Cruz na 'yung tree inventory, tree offsetting, tsaka 'yung compensation yung pagkawala ng puno.
	Aleni Quizon, Dagdag question ko lang po, mayroon po kasing mga lote sa amin na kabibili lang. Kumabaga, nakuha na 'yung titulo, pero 'yung pangalan ng title, dun pa rin sa original owner. So papaano po ang magiging settlement po? Yun po bang bago ngayon na nakabili noon, o same pa rin, hahanapin pa rin yung original na nadoon sa title? Tapos isa pa po, bago po	Aleni Quizon	**Christina Fernandez, DOTr** Iniimagine ko na habang hinihintay mo yung subway, namimitas ka ng manga doon sa station. Masarap isipin ma'am. Is it possible kaya na… oo nga ano, parang karamihan puro ornamental plants. Baka timely na explore natin yung mga bayabas.

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	ninyo sagutin 'yan, may dagdag lang po ako regarding dun sa greenery. I love trees po kasi po isa rin ako sa mahilig sa farming, [mahilig sa] gardening. Suggest ko lang po, kung pwe-pwede po. Kung sakali po na sa bawat station, tutumbasan yung mga punong pinutol, suggest ko lang po na pwede po bang kung sakali pong magtatanim ng puno sa mga station… hindi pa po ba pwede yung matataas? Uso na po ngayon yung mga dwarf, [yung mga] bonsai. Actually po, collector po ako ng ganoon. Sa rooftop lang po namin ako nakapagtanim ng mga ganyan. Hilig ko po 'yun. Kaya bilang dagdag suhestyon, baka po pwe-		

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	pwede na ang mga ilagay po sa ating mga station ay 'yung mga dwarf. At kung pwede po sana is 'yung mga fruit bearing po. Hindi po 'yung mga ornamentals lang. Kasi maging totoo po tayo, na dumadating na po talaga 'yung mga krisis. Nagkaka-ubusan na rin po ng pagkain. So instead ng ornamental, bakit hindi po mga fruit bearing na mga dwarf ang gamitin po na pananim sa ating mga station? **Aleni Quizon** Karamihan po kasi ng mga bata natin, hindi na po nila alam 'yung mga native fruits natin. So bakit hindi po kaya na maging educational din po na mahalin natin ang sariling atin? Although collector din		**Christina Fernandez, DOTr** Sige ma'am Salamat po. I-require ng DENR yun sir, na dapat fruit-bearing sa mga surroundings ng station, tapos may nakalagay na 'ito ay Bayabas, ito ay kaymito'. Pero balik po ako

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	po ako ng imported, pero collector din po ako ng native fruits natin. Hindi alam ng mga bata kung ano 'yung balimbing, hindi alam ng mga bata kung ano 'yung mga Karamay o what. Na kung tutuusin napaka nutritious din po niya. So bakit hindi po gamitin din natin na 'yon na… actually po mayron po ako na bonsai na balimbing sa bahay, mayron po akong bonsai na karamay, na namumunga po sila na nasa container lang po sila. So 'yun, gusto kong I-share 'yung knowledge na iyan dahil kumbaga 'yung ating community is more on development na, wala nang mapagtaniman. So bakit hindi ganon, I-apply natin ang ganong kaalaman.		doon sa unang tanong mo tungkol doon sa title. Sa totoo lang… actually sa [Brgy.] Ugong, 'yun din po ang aming karanasan. 'Yung kausap namin, during the FS stage ay iba. Tapos bigla ngayon na kailangan na naming mag start ng offer to buy, iba na 'yung may hawak ng title. Ito 'yung problema natin ma'am. 'Yung limitation ng DOTr ay kung sino lang po ang nakapangalan sa title, siya lang po yung pwede nating kausapin. Pero 'yun po kasi 'yung proof of ownership na pwede nating panghawakan, unless na mayroon siyang deed of absolute sale. Tapos kailangan sigurong ipa-annotate sa title sa registry of deeds, para kahit papaano nakarehistro doon 'yung sale, at kikilalanin natin sa party 'yung

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			napagbentahan nung title. Pero kung hawak-hawak mo na 'yung titulo, maraming mga pamamaraan para mahawakan ng isang tao ang titulo na hindi nya pag mamay-ari. Additional information lang po, madali na po ngayong magpapalit ng deed of sale ng pangalan ng tao na bagong kabibili ng property. Two months, magagawa mo 'yun. So if you start now, in two months, im sure handa na ang DOTr para magbayad. **Christina Fernandez, DOTr** Ang importante dun kasi ma'am, ang kasaysasayan ng pagsasalin ng titulo. Kung ang kanyang panghahawakan lang ay physical na possession, nung owners copy of title, medyo maga-alala po kami na baka magbabayad kami doon sa hinding lehitimong… hindi po

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			natin binibigyan ng malisya pero posible po kasi y'un ma'am na possession niya yung titulo pero iba yung may-ari. Medyo nakakatakot po 'yun for DOTr, kasi kung sino lang po 'yung rehistradong pangalan, 'yun lang talaga ma'am 'yung pwede nating bayaran. Pwede nga ma'am, kung may additional documents kayo na magsusuporta sa titulo: deed of sale. Yung sa case ni ma'am kung foreclosed property mo na yan, na naremata na, na may order ang court na ibenta na para mabayaran yung nagpa- utang, I'm sure ma e-establish naman po kung sino ang talagang may-ari niyang lote. Bukod po doon sa possession, ang mahalaga po doon 'yung income branch 'yung nakalagay,

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion	Proponent's / EIA Consultant's Response
			annotation sa likuran ng titulo. Yun po kasi 'yung nagkwe-kwento sa kung ano 'yung kasaysayan ng pagsasalin ng mula sa isang pagmamay-ari patungo sa isang pagmamay-ari. So importante po 'yun ma'am. **Christina Fernandez, DOTr** So tama po yung sinabi ni ma'am kanina. Masyado pa pong maaga ngayon, baka ma-advise ninyo yung possessor nung title na baka I-process nya; simulan na niya 'yung proseso ng transfer kasi mabilis na lang po ngayon, computerized na.
3. Air	None	None	None
4. Water	None	None	None

STAKEHOLDER REPRESENTATIVES

Signature over Printed name	Signature over Printed name	Signature over Printed name	Signature over Printed name
Signature over Printed name	Signature over Printed name	Signature over Printed name	Signature over Printed name

* Attach List of Participants

EIA PERSONNEL | **REPRESENTATIVE/S OF THE PROJECT PROPONENT**

Signature over Printed name	Signature over Printed name	Signature over Printed name	Signature over Printed name

NOTED BY:
EIAM Division Chief/ Chief, R&E Section

Signature over Printed name

EIA CONSULTANTS:

Richard Andal
Signature over Printed name

Annex 2.6-1

Compliance Monitoring Reports

Compliance Monitoring Report (CMR)

DEPARTMENT OF TRANSPORTATION (DOTR)
The Columbia Tower, Brgy. Wack-wack, Ortigas Avenue, 1555 Mandaluyong City

MONITORING PERIOD COVERED: January - June 2019 (1st Semester 2019)

I. Basic Project Information

ECC Reference No.	ECC-CO-1708-0017
Project Title	Metro Manila Subway Project (Phase 1)
Project Type	Infrastructure Projects, Major Roads and Bridges, Tunnels and sub-grade roads and railways
Location	Quezon City, Pasig City, Makati City, Taguig City &Paranaque City, Quezon City, Metro Manila, NCR
Project Stage/Phase	Pre Construction
Contact Person	Beo Raven V. Bensurto - Environmental Analyst
Contact Number/Email	0905-457-0992/brvbensurto.dotr@gmail.com
EMP Approval	[X] During ECC Application Stage [ ] Updated after ECC Issuance, Approved on

Project Description in ECC:

This Certificate covers construction and operation of Metro Manila Subway Project (Phase 1) comprising thirteen (13) underground stations traversing five (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Parañaque City with a total subway length of 28.3 km, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City.

The ECC includes Depot for trains covering about 31.7 hectares of land area in Brgy. Ugong, Valenzuela City.

Changes in Project Design (if any):

Change in station location from Cayetano Blvd. to Lawton East &West. Additional station (NAIA Terminal 3) in Pasay City.

ECC Amendment Application is ongoing.

a. Project Area Geo-Coordinates

Area	Latitude	Longitude
Project Area 1	14.708584	121.013499
	14.708657	121.013999
	14.693676	121.022935
	14.694174	121.023506
Project Area 2	14.69005556	121.0275
	14.68862778	121.02861111
	14.69021944	121.02777778
	14.68881389	121.02972222
Project Area 3	14.67637393	121.0322222
	14.67282791	121.0325
	14.67284857	121.0322222
	14.67652223	121.0319444
Project Area 4	14.66019697	121.0366667
	14.65571238	121.0366667
	14.65436793	121.0363889
	14.65466207	121.0352778
Project Area 5	14.646744	121.036251
	14.644845	121.037478

Project Area 6	14.637479	121.048362
	14.636979	121.050663
Project Area 7	14.627604	121.063709
	14.625853	121.065218
Project Area 8	14.613997	121.069161
	14.611796	121.069723
Project Area 9	14.58783	121.064141
	14.585568	121.064129
Project Area 10	14.576748	121.062733
	14.57508	121.061246
	14.559048	121.056234
	14.557075	121.055577
	14.551218	121.055597
	14.546768	121.053874
	14.537087	121.041389
	14.53612	121.039087
	14.53066	121.02709
	14.529518	121.024604
	14.523041	121.013092
	14.519789	121.016473
	14.503861	121.037328
	14.498054	121.040492

b. Project Buffer Zone

Area	**Latitude**	**Longitude**

c. Carbon Sink/GHG Program Area Coordinates

Area	**Latitude**	**Longitude**

II. Executive Summary

a. Summary of Major Findings for the Monitoring Period

Condition / Requirement / Commitment	**Compliance Status &Summary of Actions taken**	**Recommendation**	**Commitment for the Next Reporting Period**
Compliance with ECC	Continuous compliance to the conditions of the ECC (The project is currently at the Detailed Engineering Design Phase) A letter requesting for an extension to comply with the ECC Conditions was sent to EMB on January 11, 2019.	Continuous compliance to the conditions of the ECC.	Continuous compliance to the conditions of the ECC.
Compliance with EMP	Mitigating measures stated in the EMP are being complied and considered in the final detailed design for applicable items. Monitoring of compliance is being observed.	Continuous compliance to the commitments stated in the EMP.	Continuous compliance to the commitments stated in the EMP.
Implementation of appropriate &effective env'tal impact remedial actions in case of exceedances	Not applicable yet as construction has not started yet.	There are no exceedances since construction has not started yet.	N/A

Complaints Management	DOTr Help Desk has been set up. Grievance redress mechanism is currently being polished. Continuous coordination with PAPs is being done.	Help desk will continue to log inquiries and complaints, if any.	Complaints and actions taken are being documented thru the help desk log book.
Realistic and sufficient budget for conducting the environmental monitoring and audit activities	The MMT MOA which includes the Budget allocation for EMF is under review for approval by DOTr and EMB.	N/A	Finalization of Memorandum of Agreement on the creation of MMT.
Accountability - qualified personnel are charged with the routine monitoring of the project activities in terms of education, training, knowledge and experience of the environmental team	PMO Environmental and Social Safeguard Officers (DOTr) have been designated and are also assisted by JICA Design Team (JDT) Environmental and Social Considerations Team (internal).	For PMO Environmental Officer to undergo PCO training and accreditation.	DOTr to appoint a PCO before the construction starts.

III. Results and Discussions

A. Compliance Monitoring

I. Status of Compliance to Project Description

Requirement	Description	Status of Compliance	Remarks
Project coverage/limits	The ECC covers the construction and operation of Metro Manila Subway Project (Phase 1) comprising of 13 underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Paranaque City, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City, The ECC includes Depot for trains in Brgy. Ugong, Valenzuela City.	Complied	The Project is currently in its detailed design phase. There will be an additional station in NAIA Terminal 3. Also, the Cayetano Blvd. Station has been replaced by 2 alternate stations (Lawton East &West Stations). An interconnection with the PNR Bicutan Station is under study. An EPRMP is currently being prepared for the ECC Amendment of the Project.
Components	Depot, underground stations and tunnels, entrances/exits, and interconnections (i.e. walkway, PUV bays, footbridges and etc.)	Complied	The Project is currently in its detailed design phase.

II. Status of Compliance to ECC Conditions

Condition No.	Description	Status of Compliance	Remarks
1	Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following: a.Project impacts and mitigating measures embodied in its EIS; b.Conditions stipulated in this Certificate; c.Environmental and human safety	Complied	Nine (9) IEC Meetings were conducted for the new sections on the months of April, May and June 2019 in the cities of Taguig, Pasay &Parañaque. Continuous dissemination of information through various platforms (e.g. social media, news clips, etc.)

	features of the project, and d.Health consciousness alerts for any project-induced discomfort (from dust, smell, noise, vibration) as the project progresses throughout the whole route.		
2	Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis;	Complied	SDP as RAP and LAP (As per EIS, “The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan) Updating of the RAP is ongoing.
3	Submit detailed waste management program for proper handling, collection and disposal of solid, hazardous and liquid waste to EMB Central Office (CO) and EMB National Capital Region (NCR) within six (6) months prior to project construction. Proof of implementation shall be submitted together with the CMR;	Complied	Construction phase will start in 4th quarter of 2019. The Demolition Contractor that will do the advance works should provide the detailed Waste Management Program. Waste management general framework was attached in the previous CMR submitted on July 17, 2018.
4	Ensure that all the existing waterways affected by the proposed project construction are maintained and not obstructed;	Complied	All contractors should have this condition in their Terms of Reference.
5	Submit a detailed demobilization plan for the construction yards within six (6) months prior to project construction. The plan should include the following: a.Coordination with concerned local government units to promote compatibility of adjoining land uses with the intended subway project station including its exit and entrance; and b. Allocation of at least 30% of total area of construction yards for green and open spaces, including but not limited to setting up of vertical and pocket gardens, mini open parks system to promote urban biodiversity	Complied	Attached draft layout and landscape concept for the PO Section in the previous submitted CMR on January 2019. ECC Condition 5b is only applicable to the stations.
6	Submit a detailed plan for earth balling and replanting of mature native/endemic trees within six (6) months prior to project construction. The plan should include the following a. specific recipient sites which have already been prepared and conditioned b. ensure high degree of survival c. provision for regular maintenance until trees have re-established in their new environment	Complied	Detailed plan for earth balling and replanting will be prepared after the issuance of the tree cutting &earth-balling permit. Tree validation and consolidation of requirements for the tree cutting and earth-balling permit application are ongoing.
7	Submit an approved Resettlement Action Plan (RAP) of the affected communities within six (6) months prior to project construction;	Complied	Updating of the RAP is ongoing.
8.1	A readily available and replenishable Environmental	Complied	MMT Formation is yet to be initiated.

	Guarantee Fund (EGF) to cover the following expenses: a. for further environmental assessments, compensations/indemnification for whatever damages to life and property that may be caused by the project; b. rehabilitation and/or restoration of areas affected by the project's implementation; and c. abandonment/decommissioning of the project facilities related to the prevention of possible negative impacts; and as a source of fund for contingency and clean-up activities.		The EGF Amount will be finalized upon finalization of the MMT MOA.
8.2	Establish a Multipartite Monitoring Team (MMT) composed of representative(s) from the local environmental Non -Government Organization (NGO), POs, and the Local Government Units per DAO 201 7- 15 . The MMT shall primarily oversee the compliance of the proponent with the Environmental Management and Monitoring Plan (EMMoP) and the ECC conditions	Complied	MMT members have been identified; to be convened. *See attached list of identified MMT Members for Cluster 1*
8.3	A replenishable Environmental Monitoring Fund (EMF) to cover all costs attendant to the operation of the MMT such as training, the hiring of technical experts and resource persons, fieldwork and transportation The amount and mechanics of the EGF, EMF and the establishment of the MMT shall be determined by the EMB Central Office and the proponent through a Memorandum of Agreement (MOA) which shall be submitted within sixty (60) days upon receipt of this Certificate	Complied	MMT Formation is yet to be initiated. The EMF Amount will be finalized upon finalization of the MMT MOA.
9	Establish an Environmental Unit (EU) within sixty (60) days from receipt of this Certificate that shall competently handle the environment-related aspects of the project. In addition to the monitoring requirements as specified in the Environmental Management and Monitoring Plan (EMMoP), the EU shall have the following responsibilities: a. Monitor actual project impacts vis-a -vis the predicted impacts and management measures in the EIS To include in the TOR for the advance works ESCT to draft TOR for advance works to include this condition b. Recommend revisions to the EMMoP, whenever necessary subject to the approval of EMB Central Office; c. Ensure that data gathered during monitoring activities are properly documented, assessed, evaluated and reported in	Complied	EU Organizational Structure was attached in the previously submitted CMR last January 2019.

	accordance with the standard formats; and c/o ESCT in coordination with DOTr d. Ensure that monitoring and submission of reports to EMB CO are carried out as required.		
10	The proponent shall ensure that its contractors and subcontractors are provided with copies of this ECC and that they will strictly comply with the relevant conditions of this Certificate;	Complied	ECC and EMP/EMoP to be included in the contractor's agreement/contract.
11	No activities shall be undertaken until and unless disposal sites of excavated materials have been identified, duly covered by agreement/ s and have been permitted in accordance with law. Proof of compliance shall be filed with the Regional Office having jurisdiction over the disposal area and shall be without prejudice to environmental safeguards that may be prescribed as warranted. Likewise, a copy of which shall form part of the requirement under Condition 3 hereof	Complied	Coordination with LGUs regarding the identification of spoils disposal sites is on-going. A site visit in Valenzuela for the tree relocation site is scheduled on July 15, 2019 (Monday).
12	No activities shall be undertaken other than what were stipulated in the final EIS. Any expansion and/or modification of the project beyond the project description or change in alignment/route that will cause significant impacts to the environment shall be subject to a new Environmental Impact Assessment; and	Complied	EPRMP preparation for the ECC Amendment is ongoing. *See attached cover page of the Project Description for Scoping submitted to DENR-EMB on June 07, 2019.*
13	In case of transfer of ownership of this Project, the same conditions and restrictions shall apply to the transferee or grantee who shall secure in writing the corresponding amendment of this ECC from the EMB Central Office within fifteen (15) working days reflecting such transfer.	Complied	Not applicable.

III. Status of Compliance to EMP Conditions

Impacts	**Mitigating Measures**	**Status of Compliance**	**Remarks**
Impact Mitigation Plan or Construction/ Contractor's Environmental Program	Impacts Management Plan and proposed mitigations are presented in the EIS	Complied	The Project is currently in its detailed design phase. Contractor will be required to draft their own Construction Environmental Management Plan and will incorporate conditions of the ECC and the EMP.

IV. Status of Compliance to Annex B of ECC

Condition/Requirement	**Description**	**Status of Compliance**	**Remarks**

Applicable laws and regulations	Strict compliance with the Revised National Structural Code of the Philippines	Complied	Designs should adhere to the Revised National Structural Code of the Philippines
	Compliance with the Sanitation Code of the Philippines	Complied	Adhere to the provisions of the Sanitation Code of the Philippines and applicable regulations by the Department of Health (DOH).
	Compliance with the Labor Code of the Philippines	Complied	Adhere to the applicable regulations of labor-related requirements of the Department of Labor and Employment (DOLE).
	Compliance with the Building Code of the Philippines	Complied	Designs and application of permits should adhere to the Building Code of the Philippines.
	Ensure compliance with the Ecological Solid Waste Management Act	Complied	To implement the waste management plan in accordance to the Ecological Solid Waste Management Act.
	Priority of employment shall be given to qualified local residents. Opportunities for qualified PWDs, women, senior citizens, where possible shall be considered. Adequate public information for jobs available to local residents in the affected areas will be provided .	Complied	Can be part of the Social Development Plan
	Conduct a detailed Traffic Impact Assessment (TIA) in coordination with the Metro Manila Development Authority (MMDA) and concerned LGU for every proposed station prior to project construction integrating proposed road expansion proiects (if any) of the concerned government agencies. Part of contractor's CEMMP during construction phase.	Complied	Preparation of the Traffic Impact Assessment (TIA) is on-going.

V. Status of Compliance to Socia Development Plan (SDP)

Condition/Requirement	**Description**	**Status of Compliance**	**Remarks**
ECC Condition no. 2 - Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis	SDP as RAP and LAP (As per EIS, "The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan"	Complied	Updating of the RAP is ongoing.

VI. Status of Compliance to Information Education Communication (IEC)

Condition/Requirement	**Description**	**Status of Compliance**	**Remarks**
ECC Condition no. 1 - Conduct an effective and	IEC meetings and information dissemination through various platforms.	Complied	Nine (9) IEC Meetings were conducted for the new sections on the months of

continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following: a. Project impacts and mitigating measures embodied in its EIS; b. Conditions stipulated in this Certificate; c. Environmental and human safety features of the project, and d. Health consciousness alerts for any projectinduced discomfort (from dust, smell, noise, vibration) as the project progresses throughout the whole route.			April, May and June 2019 in the cities of Taguig, Pasay &Parañaque. Continuous dissemination of information through various platforms (e.g. social media, news clips, etc.)

VII. Status of Compliance to Contingency/Emergency Response Plan or Equivalent Risk Management Plan.

Condition/Requirement	Description	Status of Compliance	Remarks
Contingency/Emergency Response Plan or equivalent Risk Management Plan	Prepare and follow ERP procedures and guidelines.	Complied	The Emergency Response Policy and Guidelines presented in the EIS will serve as general guideline for this project. Contractor will be required to prepare their own ERP to be reviewed by the PMO.

B. Impact Monitoring

I. Summary of Previous Monitoring

Findings/Issues	Recommendations	Action Plan
No previous monitoring conducted as project is still in its detailed design phase.	N/A	N/A

II. Current Monitoring and Findings

Table 2. Summary Status of Environmental Impact Management and Monitoring Plan Implementation

A. Ambient Water Quality Monitoring

B. Effluent Water Quality Monitoring

Overall Remarks on Water Quality Monitoring

No monitoring activities required yet as the project is still in its detailed design phase.

C. Ambient Air Quality Monitoring

D. Effluent Air Quality Monitoring

Overall Remarks on Air Quality Monitoring

No monitoring activity required yet as the project is still in its detailed design phase.

E. Noise Level Monitoring

Overall Remarks on Noise Level Monitoring

No monitoring activity required yet as the project is still in its detailed design phase.

Table 3. Report on Status of Environmental Budget Allocations and Expenses

Expense Item	Budget		Actual Expenses	
	Direct from Co.	Budget for MMT	Direct Co. Expense	MMT Expense
A. Implementation of Management Plans &Programs				
1. Environmental Impact Mitigation Plan	17000000.00	0.00	0.00	0.00
2. Social Development Plan	0.00	0.00	0.00	0.00
3. IEC Plan	0.00	0.00	0.00	0.00
4. Enhancement Program (if any)	0.00	0.00	0.00	0.00
B. Implementation of Monitoring Plans				
1. Self-Monitoring	0.00	0.00	0.00	0.00
2. Environmental Monitoring Fund (with MMT)	2700000.00	300000.00	0.00	0.00
3. Environmental Guarantee Fund	300000.00	0.00	0.00	0.00
TOTAL	**20000000.00**	**300000.00**	**0.00**	**0.00**

IV. Conclusions and Recommendations

A. Compliance Status

Environmental monitoring activities (i.e. air, water and noise sampling) have not yet commenced because the project is still at its detailed design stage. The relevant proof of compliance has been attached as Annexes.

B. Environmental Quality Status (applicable only if EQPLs have been set by the Proponent as its commitment or if opted to be mutually agreed upon by Proponent with the EMB and other members of the MMT)

Environmental monitoring activities (i.e. air, water and noise sampling) have not yet commenced because the project is still at its detailed design stage.

C. Environmental Management Plan Status

ECC Amendment application is ongoing.

D. Environmental Risk Categorization

Presented in the Project Environmental Monitoring and Audit Prioritization Scheme (PEMAPS).There are no updates on the draft PEMAPS as the project is on its detailed design phase.

E. Work Plan for Next Monitoring Period

1. MMT MOA Signing Finalization 2. Funds Allocation 3. Monitoring of Advance Works during the demolition phase. 4. Selection of sub-contractors for the advance works &general construction. 5. Amended ECC 6. Final RAP

V. Attachments

1. Sworn Accountability Statement (for the submitted CMR)

Compliance Monitoring Report (CMR)

DEPARTMENT OF TRANSPORTATION (DOTR)

Department of Transportation Clark Office S. Osmeña Road, Clark Freeport Zone, Mabalacat, Pampanga

MONITORING PERIOD COVERED: January - June 2018 (1st Semester 2018)

I. Basic Project Information

ECC Reference No.	ECC-CO-1708-0017
Project Title	Metro Manila Subway Project (Phase 1)
Project Type	Infrastructure Projects, Major Roads and Bridges, Tunnels and sub-grade roads and railways
Location	Quezon City, Pasig City, Makati City, Taguig City &Paranaque City, Quezon City, Metro Manila, NCR
Project Stage/Phase	Pre Construction
Contact Person	Mikaela Eloisa D. Mendoza
Contact Numbers	0917-329-2984
EMP Approval	[X] During ECC Application Stage [ ] Updated after ECC Issuance, approved on

Project Description:

The Metro Manila Subway Project (Phase 1) is comprised of thirteen (13) underground stations traversing five (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Parañaque City with approximately 25 km. mainline.
The current priority area is the approximately 4.5 km. Partial Operability Section (PO Section) which includes the first three stations (Quirino Highway Station, Tandang Sora Station &North Avenue Station) and the 29ha. Depot at Brgy. Ugong, Valenzuela City.
The list below shows the stations of the alignment as of July 2018:

• Depot at Brgy. Ugong, Valenzuela City
• Quirino Highway
• Tandang Sora
• North Avenue
• Quezon Avenue
• East Avenue
• Anonas
• Katipunan
• Ortigas North
• Ortigas South
• Kalayaan Avenue
• BGC
• Cayetano Blvd.
• FTI

The commencement schedule for the construction of PO Section will be in the 4th quarter of 2018 and the operations in the 2nd quarter of 2022. For the remaining stations, construction is scheduled to commence by 3rd quarter of 2020 and operations on the 3rd quarter of 2025.
As of July 2018, the only definite locations are the stations of the PO section.

Changes in Project Design (if any):

There is a plan to include the NAIA Extension in the alignment. Also, the Cayetano Blvd. Station is under study due to its proximity to a fault line. Currently, 2 alternate stations are being considered to replace the Cayetano Blvd. Station.

a. Project Area Geo-Coordinates

Area	Latitude	Longitude
Project Area 1	14.70010556	121.0173083
	14.68930278	121.028625
	14.67525	121.0321889
	14.65336389	121.0351278

b. Project Buffer Zone

Area	Latitude	Longitude

c. Carbon Sink/GHG Program Area Coordinates

Area	Latitude	Longitude

II. Executive Summary

a. Summary of Major Findings for the Monitoring Period

Condition / Requirement / Commitment	Compliance Status &Summary of Actions taken	Recommendation	Commitment for the Next Reporting Period
Compliance with ECC	Continuous compliance to the conditions of the ECC (The project is currently at its Detailed Engineering Design Phase)	Continuous compliance to the conditions of the ECC	Continuous compliance to the conditions of the ECC
Compliance with EMP	Mitigating measured stated in the EMP are being complied and considered in the final detailed design for applicable items. Monitoring compliance is included in regular internal audits.	Continuous compliance to the commitments stated in the EMP	Continuous compliance to the commitments stated in the EMP
Implementation of appropriate &effective env'tal impact remedial actions in case of exceedances	Not applicable yet as construction has not started yet	There are no exceedances since construction has not started yet.	N/A
Complaints Management	DOTr Help Desk has been set up. Grievance redress mechanism is currently being polished. Continuous coordination with PAPs is being done.	Help desk will continue to log inquiries and complaints, if any.	Complaints, if any and action taken will be included in the next reporting.
Realistic and sufficient budget for conducting the environmental monitoring	Budget allocation is being determined under the MMT MOA.	N/A	Drafting of Memorandum of Agreement on the creation of MMT

and audit activities			
Accountability - qualified personnel are charged with the routine monitoring of the project activities in terms of education, training, knowledge and experience of the environmental team	PMO Environmental and Social Safeguard Officers (Implementing Agency) Is also assisted by JICA Design Team (JDT) Environmental and Social Considerations Team (internal)	N/A	To be done through establishment of PMO HSE

III. Results and Discussions

A. Compliance Monitoring

I. Status of Compliance to Project Description

Requirement	Description	Status of Compliance	Remarks
Project coverage/limits	The ECC covers the construction and operation of Metro Manila Subway Project (Phase 1) comprising of 13 underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Paranaque City, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City, The ECC includes Depot for trains in Brgy. Ugong, Valenzuela City.	Complied	The Project is currently in its detailed design phase. The project will have the ECC amended should current ECC coverage be exceeded.
Components	The ECC covers the construction and operation of Metro Manila Subway Project (Phase 1) comprising of 13 underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Paranaque City, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City, The ECC includes Depot for trains in Brgy. Ugong, Valenzuela City.	Complied	The Project is currently in its detailed design phase. The project will have the ECC amended should current ECC coverage be exceeded.

II. Status of Compliance to ECC Conditions

Condition No.	Description	Status of Compliance	Remarks
1	Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use	Complied	N/A

	of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following:		
2	Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis;	Complied	SDP as RAP and LAP (As per EIS, “The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan”
3	Submit detailed waste management program for proper handling, collection and disposal of solid, hazardous and liquid waste to EMB Central Office (CO) and EMB National Capital Region (NCR) within six (6) months prior to project construction. Proof of implementation shall be submitted together with the CMR;	Complied	Construction phase will start in 4th quarter of 2018. Contractor that will do the advance works should provide the detailed Waste Management Program. Attached is the waste management framework to be implemented by the contractor.
4	Ensure that all the existing waterways affected by the proposed project construction are maintained and not obstructed;	Complied	DOTr to outsource Advance Work Contractor and should have this condition in their Terms of Reference.
5	Submit a detailed demobilization plan for the construction yards within six (6) months prior to project construction. The plan should include the following:	Complied	DOTr to outsource Advance Work Contractor and should have this condition in their Terms of Reference.
6	Submit a detailed plan for earth balling and replanting of mature native/endemic trees within six (6) months prior to project construction. The plan should include the following	Complied	Detailed plan for earth balling and replanting which will be determined by DENR will be prepared after the conduct of tree inventory and issuance of the tree cutting permit.
7	Submit an approved Resettlement Action Plan (RAP) of the affected communities within six (6) months prior to project construction;	Complied	RAP preparation (Detailed Design Phase) is currently on-going covering the PO Section (Quirino, Tandang Sora &North Avenue) and the Depot at Brgy. Ugong, Valenzuela City.
8.1	A readily available and replenishable Environmental Guarantee Fund (EGF) to cover the following expenses:	Complied	MMT Formation is yet to be initiated. The EGF Amount will be

	a. for further environmental assessments, compensations/indemnification for whatever damages to life and property that may be caused by the project; b. rehabilitation and/or restoration of areas affected by the project's implementation; and c. abandonment/decommissioning of the project facilities related to the prevention of possible negative impacts; and as a source of fund for contingency and clean-up activities.		finalized upon finalization of the MMT MOA.
8.2	Establish a Multipartite Monitoring Team (MMT) composed of representative(s) from the local environmental Non -Government Organization (NGO), POs, and the Local Government Units per DAO 201 7- 15 . The MMT shall primarily oversee the compliance of the proponent with the Environmental Management and Monitoring Plan (EMMoP) and the ECC conditions	Complied	MMT Formation is yet to be initiated. The MMT is planned to be formed in clusters. Cluster 1 will consists of representatives from Valuenzuela and Quezon City while Cluster 2 will consist of representatives of LGUs from other sections (Pasig, Taguig, Paranaque); The MMT MOA has been drafted, see attachment.
8.3	A replenishable Environmental Monitoring Fund (EMF) to cover all costs attendant to the operation of the MMT such as training, the hiring of technical experts and resource persons, fieldwork and transportation The amount and mechanics of the EGF, EMF and the establishment of the MMT shall be determined by the EMB Central Office and the proponent through a Memorandum of Agreement (MOA) which shall be submitted within sixty (60) days upon receipt of this Certificate	Complied	MMT Formation is yet to be initiated. The EMF Amount will be finalized upon finalization of the MMT MOA.
9	Establish an Environmental Unit (EU) within sixty (60) days from receipt of this Certificate that shall competently handle the environment-related aspects of the project. In addition to the monitoring requirements as specified in the Environmental Management and Monitoring Plan (EMMoP), the EU shall have the following responsibilities:	Complied	EU Organizational Structure has been drafted. Names of assigned persons/positions will be identified at later stage. Attached is the Draft EU Org. Structure.

	a. Monitor actual project impacts vis-a -vis the predicted impacts and management measures in the EIS To include in the TOR for the advance works ESCT to draft TOR for advance works to include this condition b. Recommend revisions to the EMMoP, whenever necessary subject to the approval of EMB Central Office; c. Ensure that data gathered during monitoring activities are properly documented, assessed, evaluated and reported in accordance with the standard formats; and c/o ESCT in coordination with DOTr d. Ensure that monitoring and submission of reports to EMB CO are carried out as required. c/o ESCT in coordination with DOTr		
10	The proponent shall ensure that its contractors and sub-contractors are provided with copies of this ECC and that they will strictly comply with the relevant conditions of this Certificate;	Complied	ECC and EMP/EMoP to be included in the contractor's agreement.
11	No activities shall be undertaken until and unless disposal sites of excavated materials have been identified, duly covered by agreement/ s and have been permitted in accordance with law. Proof of compliance shall be filed with the Regional Office having jurisdiction over the disposal area and shall be without prejudice to environmental safeguards that may be prescribed as warranted. Likewise, a copy of which shall form part of the requirement under Condition 3 hereof	Complied	Meetings with LGUs ongoing regarding the identification of spoils disposal sites.
12	No activities shall be undertaken other than what were stipulated in the final EIS. Any expansion and/or modification of the project beyond the project description or change in alignment/route that will cause significant impacts to the environment shall be subject to a new Environmental Impact Assessment; and	Complied	To consider for ECC amendment - NAIA extension (pre-feasibilty stage); realignment in Cayetano boulevard
13			

	To consider for ECC amendment - NAIA extension (pre-feasibilty stage); realignment in Cayetano boulevard	Complied	Not applicable at this stage

III. Status of Compliance to EMP Conditions

Impacts	Mitigating Measures	Status of Compliance	Remarks
Impact Mitigation Plan or Construction/ Contractor's Environmental Program	Impacts Management Plan and proposed mitigations are presented in the EIS	Complied	/A – The Project is currently in its detailed design phase. Contractor will be required to draft their own Construction Environmental Management Plan and will incorporate conditions of the ECC and the EMP.

IV. Status of Compliance to Annex B of ECC

Condition/Requirement	Description	Status of Compliance	Remarks
Applicable laws and regulations	Strict compliance with the Revised National LGU concerned Structural Code of the Philippines LGU concerned	Complied	LGU concerned
	Compliance with the Sanitation Code of the Philippines Department of Health (DOH) Philippines	Complied	Compliance with the Sanitation Code of the Philippines Department of Health (DOH) Philippines
	Compliance with the Labor Code of the Philippines Employment (DOLE)	Complied	Employment (DOLE)
	Compliance with the Building Code of the Philippines LGU concerned	Complied	LGU concerned
	Ensure compliance with the Ecological Solid Waste Management Act	Complied	LGU concerned
	Priority of employment shall be given to qualified local residents. Opportunities for qualified PWDs, women, senior citizens, where possible shall be considered. Adequate public information for jobs available to local residents in the affected areas will be provided .	Complied	Can be part of the Social Development Plan
	7. Conduct a detailed Traffic Impact Assessment (TIA) in	Complied	Part of contractor's CEMMP during construction phase

	coordination with the Metro Manila Development Authority (MMDA) and concerned LGU for every proposed station prior to project construction integrating proposed road expansion proiects (if any) of the concerned government agencies. Part of contractor's CEMMP during construction phase		

V. Status of Compliance to Socia Development Plan (SDP)

Condition/Requirement	Description	Status of Compliance	Remarks
ECC Condition no. 2 - Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis	SDP as RAP and LAP (As per EIS, "The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan"	Complied	the draft RAP and Land Acquisition Plan for the detailed design phase is ongoing preparation

VI. Status of Compliance to Information Education Communication (IEC)

Condition/Requirement	Description	Status of Compliance	Remarks
ECC Condition no. 1 - Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following: a. Project impacts and mitigating measures embodied in its EIS; b. Conditions stipulated in this Certificate; c. Environmental and human safety features of the project, and d. Health consciousness alerts for any project-induced discomfort (from dust, smell, noise, vibration) as the project progresses throughout the whole route.	IEC activities through stakeholder consultations for the RAP preparation is ongoing	Complied	Information of all IEC activities conducted (dates, stakeholder involved) will be included in the status. Documentations of all IEC activities are attached.

VII. Status of Compliance to Contingency/Emergency Response Plan or Equivalent Risk Management Plan.

Condition/Requirement	Description	Status of Compliance	Remarks
Contingency/Emergency Response Plan or equivalent Risk Management Plan	Prepare and follow ERP procedures and guidelines	Complied	The Emergency Response Policy and Guidelines presented in the EIS will serve as general guideline for this project. Contractor will be required to prepare their own ERP to be reviewed by the PMO.

B. Impact Monitoring

I. Summary of Previous Monitoring

Findings/Issues	Recommendations	Action Plan
No previous monitoring conducted as project is still in its detailed design phase.	N/A	N/A

II. Current Monitoring and Findings

Table 2. Summary Status of Environmental Impact Management and Monitoring Plan Implementation

A. Ambient Water Quality Monitoring

Station: San Juan River **Geo-Coordinate**- Lat:14.66694444, Long:121.0344444

Monitoring Objective: N/A	**Environmental Aspect:** N/A	**Environmental Impact:** Water Pollution

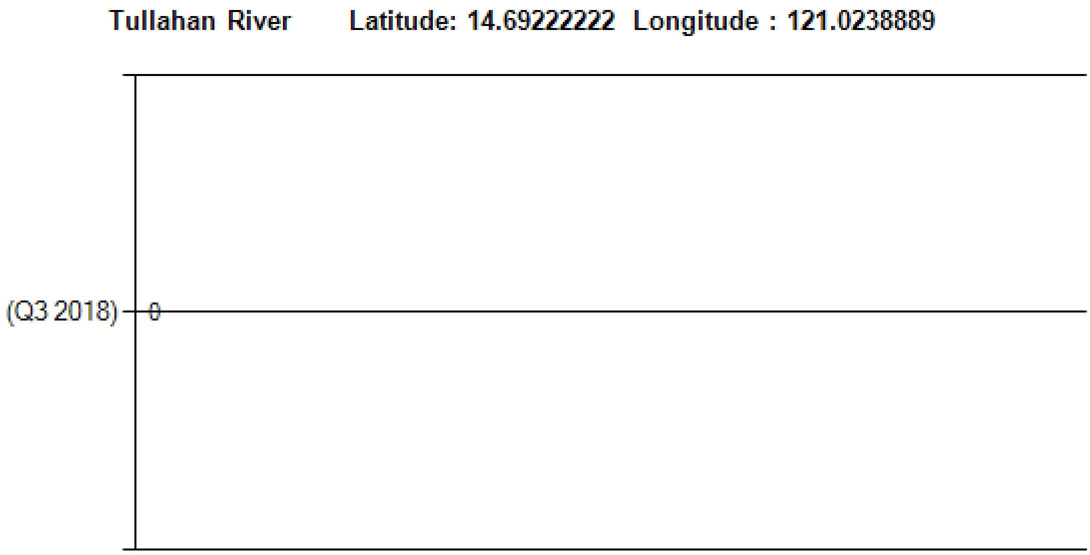
Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

Station: Tullahan River **Geo-Coordinate**- Lat:14.69222222, Long:121.0238889

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks
	Q3 2018	0	0.0000	0	N/A	Alert	No monitoring conducted and not required at this stage.

Station: Pasig River **Geo-Coordinate**- Lat:14.56777778, Long:121.0483333

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

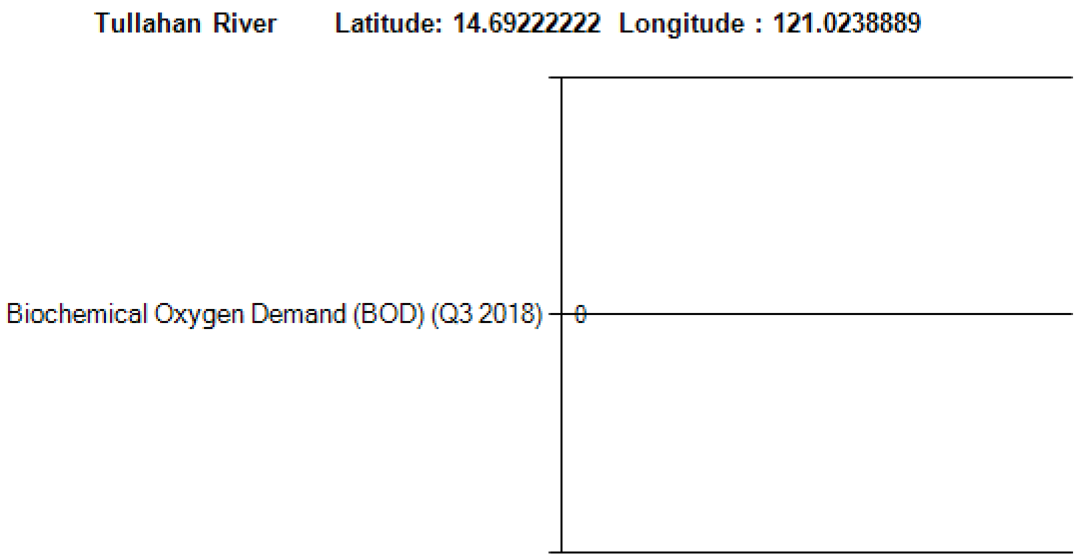


B. Effluent Water Quality Monitoring

Station: Tullahan River **Geo-Coordinate**- Lat:14.69222222, Long:121.0238889

Monitoring Objective:	Environmental Aspect:	Environmental Impact:
N/A	N/A	Water Pollution

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks
Biochemical Oxygen Demand (BOD)	Q3 2018	0	0.0000	0	N/A	Alert	No monitoring activity and not required at this stage.



Overall Remarks on Water Quality Monitoring

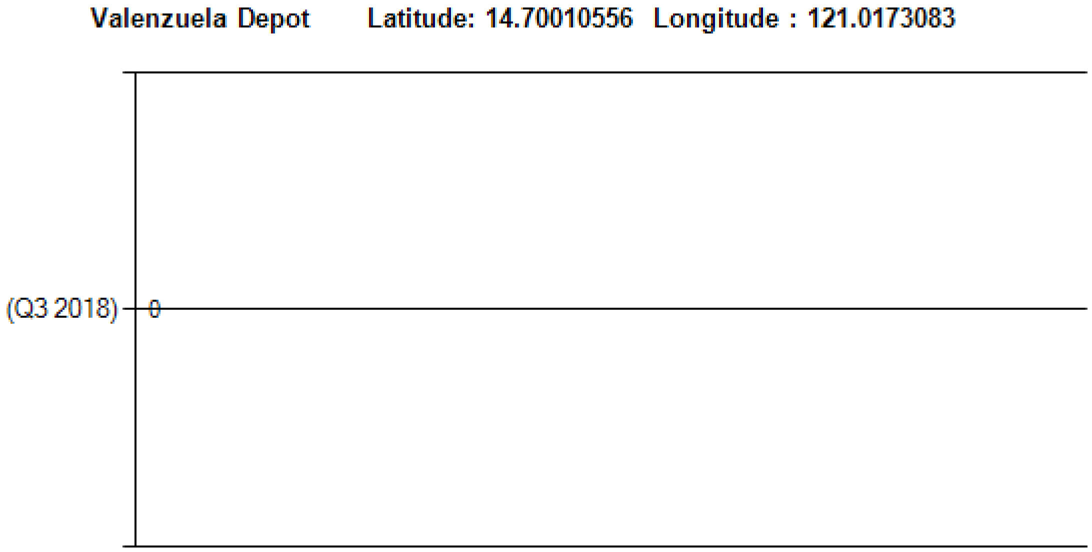
No monitoring activities and not required as the project is still in its detailed design phase.

C. Ambient Air Quality Monitoring

Station: Valenzuela Depot **Geo-Coordinate**- Lat:14.70010556, Long:121.0173083

Monitoring Objective:	Environmental Aspect:	Environmental Impact:
N/A	N/A	Air Pollution

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks
	Q3 2018	0	0.0000	0	N/A	Alert	No monitoring activity and not required at this stage.



D. Effluent Air Quality Monitoring

Station: Valenzuela Depot **Geo-Coordinate**- Lat:14.70010556, Long:121.0173083

Monitoring Objective:	Environmental Aspect:	Environmental Impact:
N/A	N/A	Air Pollution

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks
TSP	Q3 2018	0	0.0000	0	N/A	Alert	No monitoring activity and not required at this stage.

Valenzuela Depot Latitude: 14.70010556 Longitude : 121.0173083

Overall Remarks on Air Quality Monitoring

No monitoring activity and not required as the project is still in its detailed design phase.

E. Noise Level Monitoring

Station: Valenzuela Depot **Geo-Coordinate**- Lat:14.70010556, Long:121.0173083

Monitoring Objective: N/A	**Environmental Aspect:** N/A	**Environmental Impact:** Noise Level

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks
Daytime Noise	Q3 2018	0	0.0000	0	N/A	Alert	No monitoring activity and not required at this stage.

Overall Remarks on Noise Level Monitoring

No monitoring activity and not required as the project is still in its detailed design phase.

Valenzuela Depot Latitude: 14.70010556 Longitude : 121.0173083

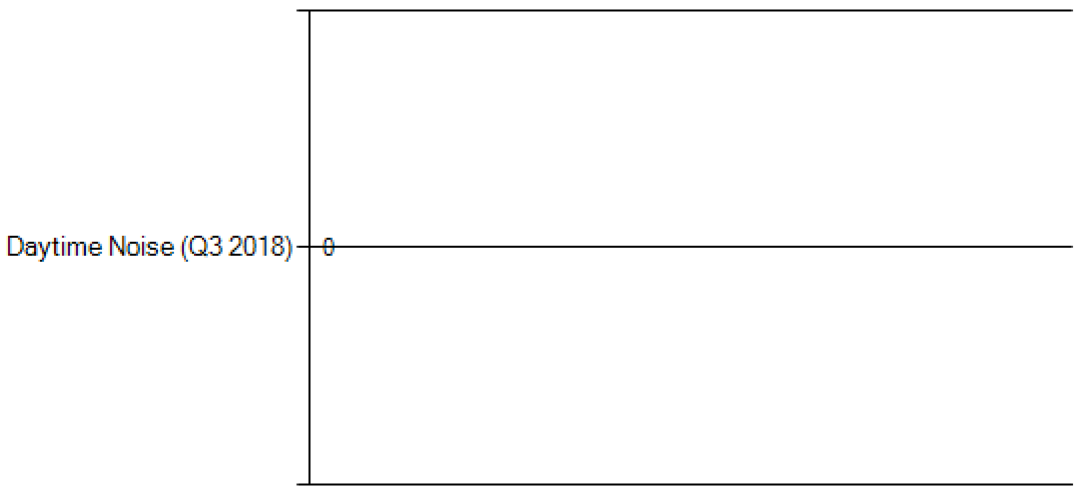


Table 3. Report on Status of Environmental Budget Allocations and Expenses

Expense Item	Budget		Actual Expenses	
	Direct from Co.	Budget for MMT	Direct Co. Expense	MMT Expense
A. Implementation of Management Plans &Programs				
1. Environmental Impact Mitigation Plan	17066667.00	0.00	0.00	0.00
2. Social Development Plan	0.00	0.00	0.00	0.00
3. IEC Plan	0.00	0.00	0.00	0.00
4. Enhancement Program (if any)	0.00	0.00	0.00	0.00
5. No additional item.	0.00	0.00	0.00	0.00
B. Implementation of Monitoring Plans				
1. Self-Monitoring	0.00	0.00	0.00	0.00
2. Environmental Monitoring Fund (with MMT)	2887200.00	266000.00	0.00	0.00
3. Environmental Guarantee Fund	175000.00	0.00	0.00	0.00
4. No additional item	0.00	0.00	0.00	0.00
TOTAL	**20128867.00**	**266000.00**	**0.00**	**0.00**

IV. Conclusions and Recommendations

A. Compliance Status

Environmental monitoring activities and MMT formation have not yet initiated because the project is still at its detailed design stage.

The relevant proof of compliance has been attached as Annexes.

B. Environmental Quality Status (applicable only if EQPLs have been set by the Proponent as its commitment or if opted to be mutually agreed upon by Proponent with the EMB and other members of the MMT)

N/A

C. Environmental Management Plan Status

No change in status as per current project coverage/limits. Additional measures or amendments will be presented should there be significant changes in the project design and specifications.

Budget indicated in the Report on Status of Environmental Budget Allocations and Expenses are only estimates and still based on the amount indicated in the Environmental Impact Statement (EIS).

D. Environmental Risk Categorization

Presented in the Project Environmental Monitoring and Audit Prioritization Scheme (PEMAPS); to be submitted on the second semi-annual report.

E. Work Plan for Next Monitoring Period

1. MMT Formation
2. MMT MOA Signing Finalization
3. Funds Allocation

4. Monitoring of Advance Works

V. Attachments

1. Other Documents
2. Other Documents
3. Approved Impact Mitigation Plan in the EIS
4. Approved Environmental Monitoring Plan in the EIS
5. Sworn Accountability Statement (for the submitted CMR)
6. Laboratory Results of Analysis from DENR-EMB recognized laboratory

Compliance Monitoring Report (CMR)

DEPARTMENT OF TRANSPORTATION (DOTR)

Department of Transportation Clark Office S. Osmeña Road, Clark Freeport Zone, Mabalacat, Pampanga

MONITORING PERIOD COVERED: July - December 2018 (2nd Semester 2018)

I. Basic Project Information

ECC Reference No.	ECC-CO-1708-0017
Project Title	Metro Manila Subway Project (Phase 1)
Project Type	Infrastructure Projects, Major Roads and Bridges, Tunnels and sub-grade roads and railways
Location	Quezon City, Pasig City, Makati City, Taguig City &Paranaque City, Quezon City, Metro Manila, NCR
Project Stage/Phase	Pre Construction
Contact Person	Mikaela Eloisa D. Mendoza
Contact Numbers	0917-329-2984
EMP Approval	[X] During ECC Application Stage [ ] Updated after ECC Issuance, approved on

Project Description:

The Metro Manila Subway Project (Phase 1) is comprised of thirteen (13) underground stations traversing five (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Parañaque City with approximately 25 km. mainline.
The current priority area is the approximately 4.5 km. Partial Operability Section (PO Section) which includes the first three stations (Quirino Highway Station, Tandang Sora Station &North Avenue Station) and the 29ha. Depot at Brgy. Ugong, Valenzuela City.
The list below shows the stations of the alignment as of July 2018:

• Depot at Brgy. Ugong, Valenzuela City
• Quirino Highway
• Tandang Sora
• North Avenue
• Quezon Avenue
• East Avenue
• Anonas
• Katipunan
• Ortigas North
• Ortigas South
• Kalayaan Avenue
• BGC
• Cayetano Blvd.
• FTI

The commencement schedule for the construction of PO Section will be in the 1st quarter of 2019 and the operations in the 2nd quarter of 2022. For the remaining stations, construction is scheduled to commence by 3rd quarter of 2020 and operations on the 3rd quarter of 2025.
As of January 2019, the only definite locations are the stations of the PO section.

Changes in Project Design (if any):

There is a plan to include the NAIA Extension in the alignment. Also, the Cayetano Blvd. Station is under study due to its proximity to a fault line. Currently, 2 alternate stations are being considered to replace the Cayetano Blvd. Station and also an additional station in Bicutan.

Once finalized, it will be applied for an ECC amendment and required studies will be undertaken.

a. Project Area Geo-Coordinates

Area	Latitude	Longitude
Project Area 1	14.708584	121.013499
	14.708657	121.013999
	14.693676	121.022935
	14.694174	121.023506
Project Area 2	14.69005556	121.0275
	14.68862778	121.02861111
	14.69021944	121.02777778
	14.68881389	121.02972222
Project Area 3	14.67637393	121.0322222
	14.67282791	121.0325
	14.67284857	121.0322222
	14.67652223	121.0319444
Project Area 4	14.66019697	121.0366667
	14.65571238	121.0366667
	14.65436793	121.0363889
	14.65466207	121.0352778

b. Project Buffer Zone

Area	Latitude	Longitude

c. Carbon Sink/GHG Program Area Coordinates

Area	Latitude	Longitude

II. Executive Summary

a. Summary of Major Findings for the Monitoring Period

Condition / Requirement / Commitment	Compliance Status &Summary of Actions taken	Recommendation	Commitment for the Next Reporting Period
Compliance with ECC	Continuous compliance to the conditions of the ECC (The project is currently at the Detailed Engineering Design Phase) A letter requesting for an extension to comply with the ECC Conditions was sent to EMB on January 11, 2019. *See attached letter received by DENR-EMB.	Continuous compliance to the conditions of the ECC	Continuous compliance to the conditions of the ECC

Compliance with EMP	Mitigating measures stated in the EMP are being complied and considered in the final detailed design for applicable items. Monitoring of compliance is being observed.	Continuous compliance to the commitments stated in the EMP	Continuous compliance to the commitments stated in the EMP
Implementation of appropriate &effective env'tal impact remedial actions in case of exceedances	Not applicable yet as construction has not started yet	There are no exceedances since construction has not started yet.	N/A
Complaints Management	DOTr Help Desk has been set up. Grievance redress mechanism is currently being polished. Continuous coordination with PAPs is being done.	Help desk will continue to log inquiries and complaints, if any.	Complaints and actions taken are being documented thru the help desk log book. *See attached help desk report.
Realistic and sufficient budget for conducting the environmental monitoring and audit activities	The MMT MOA which includes the Budget allocation for EMF is under review for approval by DOTr and EMB.	N/A	Finalization of Memorandum of Agreement on the creation of MMT.
Accountability - qualified personnel are charged with the routine monitoring of the project activities in terms of education, training, knowledge and experience of the environmental team	PMO Environmental and Social Safeguard Officers (DOTr) have been designated and are also assisted by JICA Design Team (JDT) Environmental and Social Considerations Team (internal). *See Environmental Unit Organizational Structure	For PMO Environmental Officer to undergo PCO training and accreditation.	DOTr to appoint a PCO before the construction starts.

III. Results and Discussions

A. Compliance Monitoring

I. Status of Compliance to Project Description

Requirement	**Description**	**Status of Compliance**	**Remarks**
Project coverage/limits	The ECC covers the construction and operation of Metro Manila Subway Project (Phase 1) comprising of 13 underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Paranaque City, starting at Quirino Highway in Quezon City	Complied	The Project is currently in its detailed design phase. There is a plan to include the NAIA Extension in the alignment. Also, the Cayetano Blvd. Station is under study due to its proximity to a fault line. Currently, 2 alternate stations

	and ends in FTI, Taguig City, The ECC includes Depot for trains in Brgy. Ugong, Valenzuela City.		are being considered to replace the Cayetano Blvd. Station and also an additional station in Bicutan. The project will have the ECC amended should current ECC coverage be exceeded. Discussion with DENR-EMB was undertaken to inquire the ECC amendments for the changes mentioned above. *See attached minutes of meeting.
Components	The ECC covers the construction and operation of Metro Manila Subway Project (Phase 1) comprising of 13 underground stations traversing (5) cities namely: Quezon City, Pasig City, Makati City, Taguig City and Paranaque City, starting at Quirino Highway in Quezon City and ends in FTI, Taguig City, The ECC includes Depot for trains in Brgy. Ugong, Valenzuela City.	Complied	The Project is currently in its detailed design phase. There is a plan to include the NAIA Extension in the alignment. Also, the Cayetano Blvd. Station is under study due to its proximity to a fault line. Currently, 2 alternate stations are being considered to replace the Cayetano Blvd. Station and also an additional station in Bicutan. The project will have the ECC amended should current ECC coverage be exceeded. Discussion with DENR-EMB was undertaken to inquire the ECC amendments for the changes mentioned above.

II. Status of Compliance to ECC Conditions

Condition No.	Description	Status of Compliance	Remarks
1	Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following:	Complied	Four (4) IECs were conducted on October 8 &9, 2018 participated by the land owners and other project-affected-people in Valenzuela City. Info-graphics were published in newspapers. *See attached IEC Documentation and attendance sheets, as well as newspaper copy (Manila Bulletin).
2	Implement a comprehensive	Complied	SDP as RAP and LAP (As per

	Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis;		EIS, “The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan” This condition was included in the letter sent to EMB regarding request to extend deadline to comply. *See attached Request Letter of Extension.
3	Submit detailed waste management program for proper handling, collection and disposal of solid, hazardous and liquid waste to EMB Central Office (CO) and EMB National Capital Region (NCR) within six (6) months prior to project construction. Proof of implementation shall be submitted together with the CMR;	Complied	Construction phase will start in 4th quarter of 2018. The Demolition Contractor that will do the advance works should provide the detailed Waste Management Program. Waste management general framework was attached in the previous CMR submitted on July 17, 2018. *See attached draft Terms of Reference for the Demolition Contractor.
4	Ensure that all the existing waterways affected by the proposed project construction are maintained and not obstructed;	Complied	DOTr to outsource Advance Work Contractor and should have this condition in their Terms of Reference.
5	Submit a detailed demobilization plan for the construction yards within six (6) months prior to project construction. The plan should include the following: a.Coordination with concerned local government units to promote compatibility of adjoining land uses with the intended subway project station including its exit and entrance; and b. Allocation of at least 30% of total area of construction yards for green and open spaces, including but not limited to setting up of vertical and pocket gardens, mini open parks system to promote urban biodiversity	Complied	DOTr to outsource Advance Work Contractor and should have this condition in their Terms of Reference. This condition is only applicable to the stations. *See attached draft layout and landscape concept for the PO Section.
6	Submit a detailed plan for earth balling and replanting of mature native/endemic trees within six (6) months prior to project	Complied	Detailed plan for earth balling and replanting which will be determined by DENR will be prepared after the issuance of

	construction. The plan should include the following: a.specific recipient sites which have already been prepared and conditioned b.ensure high degree of survival c.provision for regular maintenance until trees have re-established in their new environment		the tree cutting permit. Consolidation of requirements for the tree cutting and earth-balling permit application is on-going.
7	Submit an approved Resettlement Action Plan (RAP) of the affected communities within six (6) months prior to project construction;	Complied	Final RAP Report (Detailed Design Phase) covering the PO Section (Quirino, Tandang Sora &North Avenue) and the Depot at Brgy. Ugong, Valenzuela City is for review and approval of DOTr. This condition was included in the letter sent to EMB regarding request to extend deadline to comply. *See attached letter of request for extension in Item no. 2.
8.1	A readily available and replenishable Environmental Guarantee Fund (EGF) to cover the following expenses: a. for further environmental assessments, compensations/indemnification for whatever damages to life and property that may be caused by the project; b. rehabilitation and/or restoration of areas affected by the project's implementation; and c. abandonment/decommissioning of the project facilities related to the prevention of possible negative impacts; and as a source of fund for contingency and clean-up activities.	Complied	MMT Formation is yet to be initiated. The EGF Amount will be finalized upon finalization of the MMT MOA.
8.2	Establish a Multipartite Monitoring Team (MMT) composed of representative(s) from the local environmental Non -Government Organization (NGO), POs, and the Local Government Units per DAO 201 7- 15 . The MMT shall primarily oversee the compliance of the proponent with the Environmental Management and Monitoring Plan (EMMoP) and	Complied	Invitation Letters requesting for MMT representatives was sent to Valenzuela and Quezon City LGUs. The MMT is planned to be formed in clusters. Cluster 1 will consists of representatives from Valuenzuela and Quezon City while Cluster 2 will consist of representatives of LGUs from other sections (Pasig, Taguig,

	the ECC conditions		Paranaque); MMT MOA is for review and approval of DOTr and DENR-EMB. *See attached communication letters between DOTr and concerned LGUs (Valenzuela &Quezon City).
8.3	A replenishable Environmental Monitoring Fund (EMF) to cover all costs attendant to the operation of the MMT such as training, the hiring of technical experts and resource persons, fieldwork and transportation The amount and mechanics of the EGF, EMF and the establishment of the MMT shall be determined by the EMB Central Office and the proponent through a Memorandum of Agreement (MOA) which shall be submitted within sixty (60) days upon receipt of this Certificate	Complied	MMT Formation is yet to be initiated. The EMF Amount will be finalized upon finalization of the MMT MOA.
9	Establish an Environmental Unit (EU) within sixty (60) days from receipt of this Certificate that shall competently handle the environment-related aspects of the project. In addition to the monitoring requirements as specified in the Environmental Management and Monitoring Plan (EMMoP), the EU shall have the following responsibilities: a. Monitor actual project impacts vis-a -vis the predicted impacts and management measures in the EIS To include in the TOR for the advance works ESCT to draft TOR for advance works to include this condition b. Recommend revisions to the EMMoP, whenever necessary subject to the approval of EMB Central Office; c. Ensure that data gathered during monitoring activities are properly documented, assessed, evaluated and reported in accordance with the standard formats; and c/o ESCT in coordination with DOTr d. Ensure that monitoring and submission of reports to EMB CO are carried out as required.	Complied	EU Organizational Structure has been drafted. Names of the officers in charge for the PMO Environment &Social Considerations were identified. *See attached EU Org. Structure.

	c/o ESCT in coordination with DOTr		
10	The proponent shall ensure that its contractors and sub-contractors are provided with copies of this ECC and that they will strictly comply with the relevant conditions of this Certificate;	Complied	ECC and EMP/EMoP to be included in the contractor's agreement.
11	No activities shall be undertaken until and unless disposal sites of excavated materials have been identified, duly covered by agreement/ s and have been permitted in accordance with law. Proof of compliance shall be filed with the Regional Office having jurisdiction over the disposal area and shall be without prejudice to environmental safeguards that may be prescribed as warranted. Likewise, a copy of which shall form part of the requirement under Condition 3 hereof	Complied	Coordination with LGUs regarding the identification of spoils disposal sites is on-going. A letter requesting for soil disposal and tree relocation sites was sent to Valenzuela and Quezon City LGUs on November 23, 2018. *See attached letter received by Valenzuela and Quezon City LGUs.
12	No activities shall be undertaken other than what were stipulated in the final EIS. Any expansion and/or modification of the project beyond the project description or change in alignment/route that will cause significant impacts to the environment shall be subject to a new Environmental Impact Assessment; and	Complied	There is a plan to include the NAIA Extension in the alignment. Also, the Cayetano Blvd. Station is under study due to its proximity to a fault line. Currently, 2 alternate stations are being considered to replace the Cayetano Blvd. Station and also an additional station in Bicutan. *See attached minutes of meeting between DOTr, JDT and DENR-EMB regarding required ECC Amendments in Item No. 1.
13	In case of transfer of ownership of this Project, the same conditions and restrictions shall apply to the transferee or grantee who shall secure in writing the corresponding amendment of this ECC from the EMB Central Office within fifteen (15) working days reflecting such transfer.	Complied	Not applicable

III. Status of Compliance to EMP Conditions

Impacts	Mitigating Measures	Status of Compliance	Remarks

Impact Mitigation Plan or Construction/ Contractor's Environmental Program	Impacts Management Plan and proposed mitigations are presented in the EIS	Complied	The Project is currently in its detailed design phase. Contractor will be required to draft their own Construction Environmental Management Plan and will incorporate conditions of the ECC and the EMP.

IV. Status of Compliance to Annex B of ECC

Condition/Requirement	Description	Status of Compliance	Remarks
Applicable laws and regulations	Strict compliance with the Revised National Structural Code of the Philippines	Complied	Designs should adhere to the Revised National Structural Code of the Philippines
	Compliance with the Sanitation Code of the Philippines	Complied	Adhere to the provisions of the Sanitation Code of the Philippines and applicable regulations by the Department of Health (DOH).
	Compliance with the Labor Code of the Philippines	Complied	Adhere to the applicable regulations of labor-related requirements of the Department of Labor and Employment (DOLE).
	Compliance with the Building Code of the Philippines	Complied	Designs and application of permits should adhere to the Building Code of the Philippines.
	Ensure compliance with the Ecological Solid Waste Management Act	Complied	To implement the waste management plan in accordance to the Ecological Solid Waste Management Act.
	Priority of employment shall be given to qualified local residents. Opportunities for qualified PWDs, women, senior citizens, where possible shall be considered. Adequate public information for jobs available to local residents in the affected areas will be provided .	Complied	Can be part of the Social Development Plan
	7. Conduct a detailed Traffic Impact Assessment (TIA) in coordination with the Metro Manila Development Authority (MMDA) and concerned LGU for every proposed station prior to project construction integrating proposed road expansion proiects (if any) of the concerned government agencies. Part of	Complied	Preparation of the Traffic Impact Assessment (TIA) is on-going.

	contractor's CEMMP during construction phase		

V. Status of Compliance to Socia Development Plan (SDP)

Condition/Requirement	Description	Status of Compliance	Remarks
ECC Condition no. 2 - Implement a comprehensive Social Development Program (SDP) and submit a separate report together with the Compliance Monitoring Report (CMR) to the EMB Central Office using CMR Online on a semi-annual basis	SDP as RAP and LAP (As per EIS, "The SDP will be in the form of a Resettlement Action Plan and will also include a Land Acquisition Plan"	Complied	Final RAP Report (Detailed Design Phase) covering the PO Section (Quirino, Tandang Sora &North Avenue) and the Depot at Brgy. Ugong, Valenzuela City is for review and approval of DOTr. This condition was included in the letter sent to EMB regarding request to extend deadline to comply. *See attached Request Letter of Extension in Item No. 2.

VI. Status of Compliance to Information Education Communication (IEC)

Condition/Requirement	Description	Status of Compliance	Remarks
ECC Condition no. 1 - Conduct an effective and continuing Information, Education and Communication (IEC) Program through the use of most effective media to inform and educate all stakeholders, especially the contractors, workers, LGUs, businesses and local residents about the following: a. Project impacts and mitigating measures embodied in its EIS; b. Conditions stipulated in this Certificate; c. Environmental and human safety features of the project, and d. Health consciousness alerts for any project-induced discomfort (from dust, smell, noise, vibration) as the project progresses throughout the whole route.	IEC activities through stakeholder consultations for the RAP preparation is ongoing	Complied	Four (4) IECs were conducted on October 8 &9, 2018 participated by the land owners and other project-affected-people in Valenzuela City. Info-graphics were published in newspapers. *See attached IEC Documentation and attendance sheets, as well as newspaper copy (Manila Bulletin) in Item No. 1.

VII. Status of Compliance to Contingency/Emergency Response Plan or Equivalent Risk Management Plan.

Condition/Requirement	Description	Status of Compliance	Remarks
Contingency/Emergency Response Plan or equivalent Risk Management Plan	Prepare and follow ERP procedures and guidelines	Complied	The Emergency Response Policy and Guidelines presented in the EIS will serve as general guideline for this project. Contractor will be required to prepare their own ERP to be reviewed by the PMO.

B. Impact Monitoring

I. Summary of Previous Monitoring

Findings/Issues	Recommendations	Action Plan
No previous monitoring conducted as project is still in its detailed design phase.	N/A	N/A

II. Current Monitoring and Findings

Table 2. Summary Status of Environmental Impact Management and Monitoring Plan Implementation

A. Ambient Water Quality Monitoring

Station: Pasig River **Geo-Coordinate**- Lat:14.56777778, Long:121.0483333

Monitoring Objective: N/A	Environmental Aspect: N/A	Environmental Impact: Water Pollution

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

Station: Tullahan River **Geo-Coordinate**- Lat:14.69222222, Long:121.0238889

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

Station: San Juan River **Geo-Coordinate**- Lat:14.66694444, Long:121.0344444

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

B. Effluent Water Quality Monitoring

Station: Tullahan River **Geo-Coordinate**- Lat:14.69222222, Long:121.0238889

Monitoring Objective: N/A	Environmental Aspect: N/A	Environmental Impact: Water Pollution

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

Overall Remarks on Water Quality Monitoring

No monitoring activities and not required as the project is still in its detailed design phase.

C. Ambient Air Quality Monitoring

Station: Valenzuela Depot **Geo-Coordinate**- Lat:14.70010556, Long:121.0173083

Monitoring Objective: N/A	Environmental Aspect: N/A	Environmental Impact: Air Pollution

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

D. Effluent Air Quality Monitoring

Station: Valenzuela Depot **Geo-Coordinate**- Lat:14.70010556, Long:121.0173083

Monitoring Objective: N/A	Environmental Aspect: N/A	Environmental Impact: Air Pollution

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

Overall Remarks on Air Quality Monitoring

No monitoring activity and not required as the project is still in its detailed design phase.

E. Noise Level Monitoring

Station: Valenzuela Depot **Geo-Coordinate**- Lat:14.70010556, Long:121.0173083

Monitoring Objective: N/A	Environmental Aspect: N/A	Environmental Impact: Noise Level

Parameter	Period	Baseline	Result	Standard	Within Standard	EQPL	Remarks

Overall Remarks on Noise Level Monitoring

No monitoring activity and not required as the project is still in its detailed design phase.

Table 3. Report on Status of Environmental Budget Allocations and Expenses

Expense Item	Budget		Actual Expenses	
	Direct from Co.	Budget for MMT	Direct Co. Expense	MMT Expense
A. Implementation of Management Plans &Programs				
1. Environmental Impact Mitigation Plan	17066667.00	0.00	0.00	0.00
2. Social Development Plan	0.00	0.00	0.00	0.00
3. IEC Plan	0.00	0.00	0.00	0.00
4. Enhancement Program (if any)	0.00	0.00	0.00	0.00
5. No additional item.	0.00	0.00	0.00	0.00
B. Implementation of Monitoring Plans				
1. Self-Monitoring	0.00	0.00	0.00	0.00
2. Environmental Monitoring Fund (with MMT)	2700000.00	300000.00	0.00	0.00
3. Environmental Guarantee Fund	300000.00	0.00	0.00	0.00
4. No additional item	0.00	0.00	0.00	0.00
TOTAL	**20066667.00**	**300000.00**	**0.00**	**0.00**

IV. Conclusions and Recommendations

A. Compliance Status

Environmental monitoring activities (i.e. air, water and noise sampling) have not yet commenced because the project is still at its detailed design stage.

Started the MMT formation by sending request letters to concerned LGUs asking for representatives.

The relevant proof of compliance has been attached as Annexes.

B. Environmental Quality Status (applicable only if EQPLs have been set by the Proponent as its commitment or if opted to be mutually agreed upon by Proponent with the EMB and other members of the MMT)

Environmental monitoring activities (i.e. air, water and noise sampling) have not yet commenced because the project is still at its detailed design stage.

C. Environmental Management Plan Status

No change in status as per current project coverage/limits. Additional measures or amendments will be presented should there be significant changes in the project design and specifications.

Budget indicated in the Report on Status of Environmental Budget Allocations and Expenses are only estimates and still based on the amount indicated in the Environmental Impact Statement (EIS).

D. Environmental Risk Categorization

Presented in the Project Environmental Monitoring and Audit Prioritization Scheme (PEMAPS).There are no updates on the draft PEMAPS as the project is on its detailed design phase.

E. Work Plan for Next Monitoring Period

1. MMT Formation
2. MMT MOA Signing Finalization
3. Funds Allocation
4. Monitoring of Advance Works during the demolition phase.
5. Selection of sub-contractors for the advance works.

V. Attachments

1. Sworn Accountability Statement (for the submitted CMR)
2. Other Documents