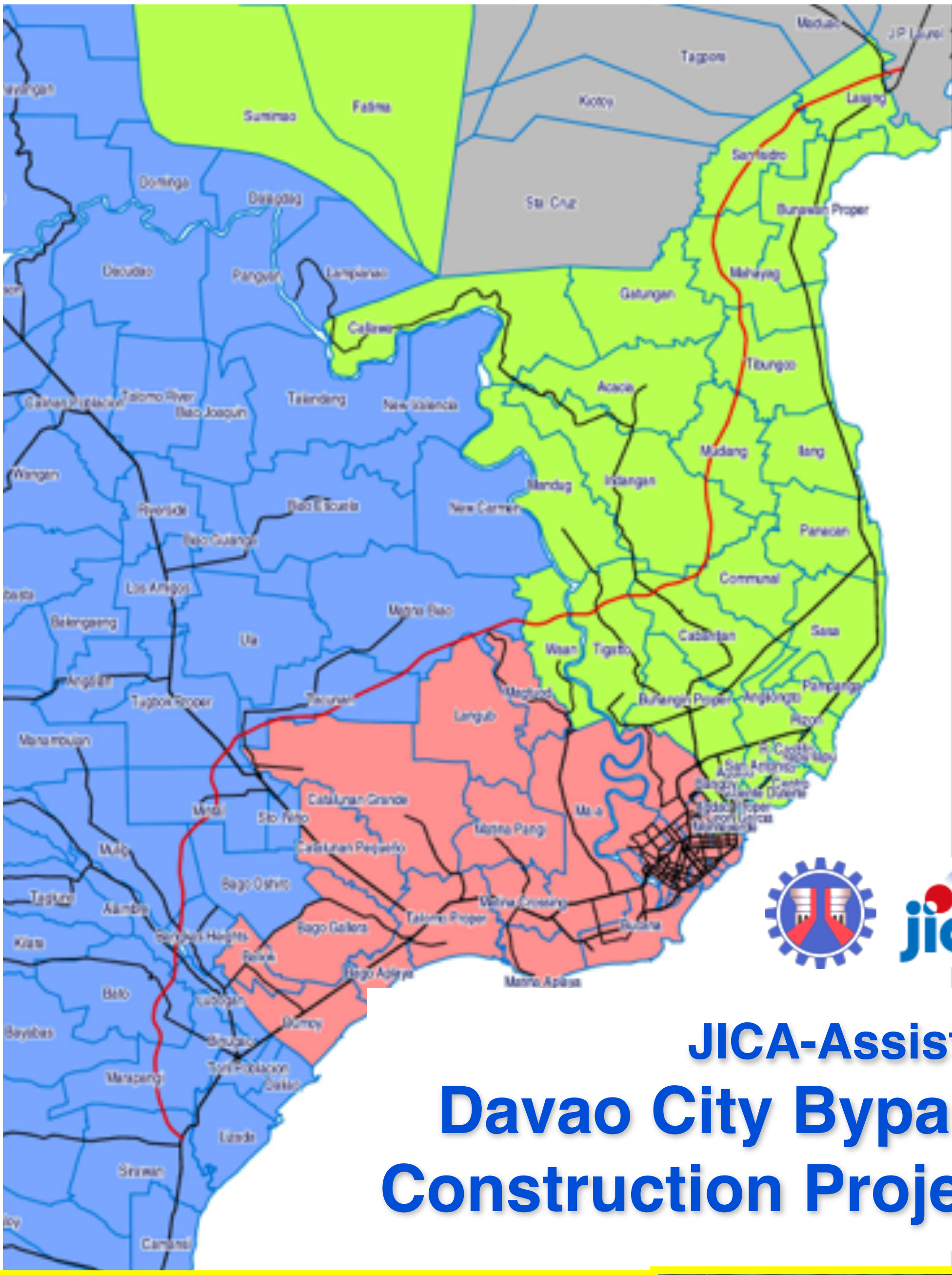
Environmental Impact Statement



JICA-Assisted
Davao City Bypass Construction Project

ECOSYSCORP, INC.

August 2014

PROJECT FACT SHEET

PROJECT NAME: Davao City Bypass Construction Project

PROJECT LOCATION: Davao City Davao Del Sur and Panabo City Davao Del Norte

PROJECT PROPONENT: Department of Public Work and Highways-Project Planning Division

OFFICE ADDRESS: Bonifacio Drive, Port Area, Manila

CONTACT PERSON: Engr. Maximo Ewald M. Montaña

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EIA PREPARER **ECOSYSCORP, INC.**

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PROJECT DESCRIPTION

In recent years the Midanao Region has been showing faster economic growth than the rest of the country, and the signing of the *Bangsamoro Peace Framework Agreement* between the government and the Moro Islamic Liberation Front (MILF) in October 2012 is expected to accelerate the recent economic development.

Being the third and the most major city in Mindanao, Davao is expected to play a leading role in the economic growth. Major urban roads in Davao City have **4-lanes** (**2-lane**s per direction), but are insufficient to ease it severe traffic congestion. Similarly, traffic from and to Sasa and Panabo Ports is also frequently experiencing traffic congestion, affecting the transportation of goods.

In July 2010, JICA conducted a Master Plan on High Standard Highway Network Development, which proposed improvement of the Tagum-Davao-General Santos Corridor and the construction of a diversion road in Davao City as a priority project.

Road widening and improvement project of the above corridor is on-going for many parts of sections, such as **4-lane** widening of present **two-lane** section, and slope protection construction by World Bank and other funds.

The Department of Public Works and Highways (DPWH) conducted a Business Case Study (BCS) of the Davao City Bypass Project. The study results, both economic and financial aspects shall be the basis to determine whether the Project is qualified for a Public-Private-Partnership (PPP) and/or as a conventional Government project.

DPWH is studying the utilization of Yen loan as one of candidate sources of funding in order to implement the Davao City Bypass Project. Both JICA and DPWH recognized that this Project is a very important project for traffic improvement in Davao City and Mindanao Eastside Area as agreed upon in the Minutes of Discussion on the contents of Preparatory Survey for the Project in 1 February 2013.

Davao City Bypass is necessary due to the following reasons:

- To reduce traffic congestion of Davao City Urban Center where average travel speed is less than **20 km/hr**;
- To disperse urbanization outside Davao City Urban Center which is already over-saturated;

- To strongly support economic activities of not only Region XI but also the entire Mindanao;
- To provide better access to Sasa Port and Panabo Port; and
- Diversion road is getting congested and it has to climb up and down the mountain (gradient is **6.5-7.0%**)

The Project is primarily consist of **three** (**3**) major components as follows:

1) Road Section (**37.17 km**);
2) Tunnel Section (**2.28 km**); and
3) Bridge Section (**5.13 km**)

The proposed Davao City Bypass Project a **44.58-kilometer** bypass road designed to provide a relative high speed road that allows a safe and efficient movement of traffic. It has a design speed of **60 kph**, which is in accordance with Road Safety Design Manual (DPWH, 2004) as well as consideration to the topographic condition.

Initially, the number of lanes required is set as **2-lanes**. The roadway's carriageway width of **3.5 m** is also in accordance with Road Safety Manual (DPWH, 2004). The shoulder is design at **2.5 m**. The Road Right-Of-Way (RROW) is between **50-60 m**. Future expansion from **2-lanes** to **4-lanes** is considered in the design depending on the traffic demand after 2027.

The proposed **2.3 kilometer** tunnel section will be located between Matina and Davao River in Brgy. Magtuod, Davao City. First phase of the tunnel will have a **2-lane** roadway, with a carriageway of **3.5 m** on each direction. Shoulder width on both sides is set at **1.25 m**. The **5-meter** vertical clearance of the tunnel is based on standard clearance specification.

A total of **45 bridges** are planned to be constructed along the main road. Superstructure types recommended are Reinforced Concrete Deck Girder (RCDG), Pre-Stressed Concrete Girder (PSCG), and PC Box Girders. There are **12** proposed bridge overpass, **18** at-grade intersections, and **six** (**6**) underpasses.

The start of the alignment in Brgy. Sirawan, Toril, Davao City along the Davao-Digos National Highway (Pan-Philippine Highway) is geographically situated at approximately **6°59'59.13"N 125°28'55.52"E**. Heading towards Brgy. Marapangi, and Bato it will follow a slightly northwesterly direction. The bypass alignment will then shift to a northerly direction crossing over the Lipadas River, then traversing Brgy. Alambre, Bangkas Heights towards Brgy. Mulig. It will change to a northeasterly direction towards the University of the Philippines (UP) Mindanao Campus in Brgy. Mintal, then again return to a northerly route en route to Davao-Bukidnon National Highway.

The alignment will then cross the Davao-Bukidnon Road in Brgy. Mintal, then cross over the Talomo River, and proceed to a northeasterly direction towards agricultural lands in Brgy. Tacunan. Before entering the west portal of the tunnel section (**7°7'31.04"N 125°32'56.19"E**) in Brgy. Magtuod, the alignment will cross Matina River and coming out from the east portal of the tunnel at **Sta. 21+280**, approximately at geographic coordinates **7°7'55.20"N 125°33'56.43"E**, the bypass alignment will continue in the same direction towards Brgy. Waan. It will then cross Davao River and proceed towards Brgy. Tigatto, keeping its easterly path en route to Brgy. Cabantian. The alignment will change its course to a northerly direction as it reaches Brgy. Communal, then traverse through Brgys. Indangan, Mudiang, Tibungco, and Mahayag where parts of the existing mine tenement (quarry) of Holcim Cement Corporation are located. The alignment will keep its northerly track until it arrives at Brgy. San Isidro, where it will change to a northeasterly direction.

From Brgy. San Isidro, the alignment will maintain its northeasterly direction then traverse through Brgy. Lasang, then cross Lasang River until it intersects the Davao-Agusan National Highway in Brgy. J.P. Laurel, Panabo City where the alignment will terminate (**7°16'17.65"N 125°40'5.47"E**).

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ABBREVIATIONS

AB	Auger Boring
ADB	Asian Development Bank
AET	Apparent Effects Threshold
AFMA	Agriculture and Fisheries Modernization
AG	Agricultural Land Zone
AGF	All Ground Fasten
AISC	American Institute of Steel Construction
amsl	above mean sea level
API	Aerial Photograph Interpretation
ASSHTO	American Association of State Highway and Transportation Officials
AWFP	Annual Work and Financial Plan
BCS	Business Case Study
BHS	Barangay Health Stations
BNS	Barangay Nutrition Scholar
BOD	Biological Oxygen Demand
BPI	Bureau of Plant Industry
CAC	Cases against Children
CADT	Certificates of Ancestral Domain Title
CAO	City Agriculture's Office
CAO	City Assessor's Office
CARI	Contractor's All Risk Insurance
CAW	Cases against Women
CBD	Central Business Sub-zone
CDA	Cooperative Development Authority
CENRO	City Environment and Natural Resources Office
CICL	Children in Conflict with the Law
CLUP	Comprehensive Land Use Plan
CMP	Community Mortgage Program

CMVR	Compliance Monitoring and Validation Report
CNO	Certificate of Non-Overlap
CO2	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CPDC	City Planning and Development Coordinator
CPP	Communist Party of the Philippines
CRIC	City Resettlement Implementation Committee
Cu	Copper
CZO	Comprehensive Zoning Ordinance
DA	Department of Agriculture
DAO	Department Administrative Order
DBE	Design Basic Earthquake
DC-UPNET	Davao City Urban Poor Network
DED	Detailed Engineering Design
DIA	Direct Impact Areas
DCWD	Davao City Water District
DED	Detailed Engineering Design
DENR	Department of Environment and Natural Resources
DENR-FMB	Department of Environment and Natural Resources-Forest Management Bureau
DEO	District Engineering Office
DIA	Direct Impact Area
DLPC	Davao Light and Power Company
DO	Department Order
DOH	Department of Health
DOT	Department of Tourism
DPWH	Department of Public Works and Highways
DSWD	Department of Social Welfare Development
DTI	Department of Trade Industry
ECA	Environmental Critical Areas

ECC	Environmental Compliance Certificate
EGF	Environmental Guarantee Fund
EIA	Environment Impact Assessment
EIARC	Environmental Impact Assessment Review Committee
EIS	Environmental Impact Study
ELRD	Environmental Laboratory and Research Division
EMA	External Monitoring Agent
EMB	Environmental Management Bureau
EMF	Environmental Monitoring Fund
EMP	Environmental Management Plan
EMoP	Environmental Monitoring Plan
EO	Executive Order
EPRT	Emergency Preparedness and Rescue Team
ERP	Emergency Response Plan
ESHO	Environment and Safety Health Officer
ESSD	Environment and Social Safeguards Division
EVF	East Valley Fault
EVZ	East Valley Zone
FBI	Field-Based Investigation
FHWA	Federal Highway Administration
FMB	Forest Management Bureau
FS	Feasibility Study
GDP	Gross Domestic Product
GCL	Ground Concentration Levels
GOP	Government of the Philippines
GPS	Global Positioning System
Ha	Hectare
HEC	Hydraulic Engineering Circular
Hg	Mercury
HSC	Hydraulic Control Structure

HWL	High water level
IEC	Information Education and Communication
IIA	Indirect Impact Areas
IMP	Impact Mitigation Plan
INC.	Iglesia Ni Cristo
IO	Implementing Office
IPRA	Indigenous Peoples Right Act
IRR	Implementing Rules and Regulations
IROW	Infrastructure Right-of-Way
IS	Informal Settler
JICA	Japan International Cooperation Agency
LARRIPP	Land Acquisition, Resettlement, Rehabilitation and Indigenous People's Policy
LCMP	Localized Community Mortgage Program
LGU's	Local Government Units
LOS	Level of Service
LRIP	Livelihood Restoration and Improvement Program
LSA	Liquefaction Susceptibility Analysis
MCE	Maximum Considered Earthquakes
MGB	Mines and Geosciences Bureau
mg/L	milligram per Liter
MDL	Method Detection Limits
MILF	Moro Islamic Liberation Front
MMT	Multipartite Monitoring Team
MNLF	Moro National Liberation Front
MOA	Memorandum of Agreement
MOO	Manual of Operations
N-NE	North-Northeast
NAAQS	National Ambient Air Quality Standards
NAMRIA	National Mapping and Resource Information Authority
NCIP	National Commission on Indigenous Peoples

NDF	National's Democratic Front
NGCP	National Grid Corporation of the Philippines
NGO	Non-Government Organizations
NHA	National Housing Authority
Ni	Nickel
NIPAS	National Integrated Protected Areas System
NOEL	No Observed Effects Level
NO	Nitrogen
NO_2	Nitrogen Dioxide
NO_3-N	Nitrate as nitrogen
NPA	National People's Army
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
O&M	Operation and Maintenance
OCPDC	Office of the City Planning and Development Coordinator
OCL	Omnibus Commitment Line
OPB	Out-Patient Benefit
PAGASA	Philippine Atmospheric Geophysical and Astronomical Service Administration
PAPs	Project Affected Persons
PAR	Philippine Area of Responsibility
PCA	Philippine Coconut Authority
PCB	Primary Care Benefit
PCI	Pre-stressed Concrete Institute
PCO	Pollution Control Officer
PCUP	Philippine Commission of the Urban Poor
PGA	Peak Ground Acceleration
PHILSSA	Philippine Support Agencies
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PIAC	Permanent International Association of Road Congresses
PMS	Periodic Maintenance Service

PNP-TMG	Philippine National Police-Traffic Management Group
PO	People's Organization
PO_4 P	Phosphate as Phosphorous
PPD-PS	Project Planning Division-Planning Service
PPE	Personal Protective Equipment
PPP	Public-Private Partnership
PSCG	Pre-stressed Concrete Girder
PSHA	Probabilistic Seismic Hazard Assessment
QRF	Quick Response Fund
RA	Republic Act
RAP	Resettlement Action Plan
RCDG	Reinforced Concrete Deck Girder
RCPC	Reinforced Concrete Pipe Culvert
RHU	Rural Health Units
RPM	Revised Procedural Manual
ROW	Right-of-Way
RROW	Road Right-of-Way
SAFDZ	Strategic Agriculture and Fisheries Development Zone
SHFC	Social Housing Finance Corporation
SLE	Soil Liquefaction Evaluation
SMT	Sectoral Monitoring Team
SO_2	Sulfur Dioxide
STP	Standard Penetration Test
TDZ	Tourist Development Zone
TEFASCO	Terminal Facilities and Services Corporation
TMG	Traffic Management Group
TMUs	Terrain Mapping Units
TOR	Terms of Reference
TP	Test Pit
TSP	Total Suspended Particulate

TSS	Total Suspended Solids
UDHA	Urban Development and Housing Act
UP	University of the Philippines
UPAO	Urban Poor Affairs Office
UPMO	Unified Project Management Office
USeP	University of Southeastern Philippines
VIM	Visibility Index Meter
WCPD	Women and Children Protection Desk
W-NW	West-Northwest
WVM	Wind Velocity Meter

APPENDICES:

Appendix A	**Accountability Statement of EIS Preparers**
Appendix B	**Accountability Statement of Project Proponent**
Appendix C	**Attendance Sheets**
Appendix D	**Proof of Compatibility with the Existing Land Use Plan**
Appendix E	**DENR FMB Memorandum Order No. 2012-02**
Appendix F	**Air Quality Sampling Results**
Appendix G	**Calibration Certificate of Air Quality Sampling Equipment**
Appendix H	**Certificate of Non-Overlap**

EXECUTIVE SUMMARY

PROCESS DOCUMENTATION OF THE CONDUCT OF EIA

The EIA Team

ECOSYSCORP, INC. is a private Environmental Consulting Firm that specializes in the conduct and preparation of Environmental Impact Assessment (EIA), Resettlement Action Plan (RAP), and related environmental researches. It has been involved in numerous infrastructure projects since its incorporation in 1994. The EIA Team is led by its *Team Leader* **Ms. Annabelle N. Herrera**, a Social Impact Specialist and an accredited EIA Preparer by the DENR-EMB with a Team Leader category. Other environmental experts specializing in various environmental disciplines compose the EIA Team.

Table I briefly describes the Preparers' field of expertise and the EIA module assigned to each expert.

Table I Preparers' Field of Expertise and EIA Module Assignment

Preparers	Field of Expertise	EIA Module Assignment
Ms. Annabelle N. Herrera	Team Leader, Environmental and Social Impact Assessment and Resettlement	Social Impact Assessment, Public Participation, Information, Education and Communication, Environmental Management and Monitoring, Institutional Framework
Mr. Carlo D. Dayanghirang	Geology and Geohazard Assessment	Geology and Geohazard Assessment
Mr. Mario Sandoval	Hydrogeology	Hydrogeology
Mr. Charlon Gonzales	Air Quality Specialist	Air Quality and Noise Level Modeling
Dr. James Namocatcat	Terrestrial and Freshwater Ecology	Freshwater Ecology, Terrestrial Ecology (Riparian and Lakeshore), Water Quality

Attached as **Appendix A** and **B** are the Accountability Statements of the EIS Preparers and Proponent, respectively.

EIA Study Schedule

Table II below presents the EIA activities undertaken and completed by the Team in the duration of the study. The issues and concerns raised during the open forum of the consultation meetings, as well as the attendance sheets, and photo documentations are attached as **Appendix C** (**Volume II** of this Report).

Table II Activities Completed by the EIA Team 1/6

Activities	Date, Time, & Venue	Sectors/LGUs/Concerned Government	Number of Participants
IEC Meetings			
Davao City	December 2 2013, 9:00 A.M. Davao City Hall	*City Officials*: City Mayor's Office Chief of Staff; Assistant City Assessor; City Engineering Department; CENRO; City Planning and Development Office, Head & Staff *Barangay Officials*: Chairman Brgy. San Isidro; Chairman Brgy. Mulig; Chairman Brgy. Tigatto; Chairman Brgy. Tacunan; Chairman Brgy. Alambre; Chairman Brgy. Mintal; Brgy. Kagawad Indangan; Brgy. Kagawad Mahayag; Brgy. Kagawad Mudiang; Brgy. Kagawad Catalunan Grande; Brgy. Kagawad Bato; Brgy. Secretary Marapangi *Other Participants*: DPWH-Region XI; JICA Study Team; and EIA & RAP Team	24
Panabo City	December 5, 2013, 8:00 AM 2nd floor Mayor's Office Panabo City Hall	*City Officials*: City Mayor, City Vice-Mayor, Sanguniang Panglungsod Staff, City Planning and Development, Coordinator Head, CENRO, City Administrator, Engineering Department, Tagum City PPDO, Brgy. Kagawad J.P Laurel, *Other Participants*: DPWH-ESSD Central Office, DPWH-Region X JICA Study Team, EIA & RAP Team	16
Toril District Brgy. Bato, Brgy. Marapangi, Brgy. Alambre, Brgy. Sirawan, Brgy. Bangkas Heights, Brgy. Mulig, Brgy. Bayabas, Brgy. Lubogan	December 19, 2013 1:00PM Brgy. Marapangi Toril District Davao City	*Brgy. Bato* Brgy. Kagawad, Don Lorenzo Phase I Assn., Land Owners *Brgy. Marapangi* Barangay Chairman, Brgy. Kagawad, Brgy. Tanod, Brgy. Purok Leaders, Brgy. Staff, Miravine Com. Head, Tribal Leader, Gagmay Kristohanong Katilingban Leader, CAM & Company Rep, Nest Farm Inc Rep. *Brgy. Alambre* Brgy. Chairman	50

Table II	Activities Completed by the EIA Team 2/6		
Activities	**Date, Time, & Venue**	**Sectors/LGUs/Concerned Government**	**Number of Participants**
Public Scoping Meetings			
Toril District	December 19, 2013 1:00PM Brgy. Marapangi Toril District Davao City	*Brgy. Sirawan* Brgy. Chairman, Brgy. Kagawad, Chairman Pag-asa Construction Cooperative *Brgy. Bangkas Heights* Brgy. Staff *Other Participants* DPWH-Region XI, DPWH-ESSD Manila DENR-EMB Region XI, EIA & RAP Team	50
Buhangin District Brgy. Cabantian, Brgy. Communa, Brgy. Indanganl	December 18, 2013 8:00AM Brgy. Hall of Cabantian Buhangin District Davao City	*Brgy. Cabantian* Brgy. Kagawad, Brgy. Secretary, Alsons Devt. Corp. Rep. *Brgy. Indangan* Brgy. Kagawad *Brgy. Communal* Brgy. Kagawad *Other Participants*: DPWH-Region XI, DPWH-ESSD Manila DENR-EMB Region XI, EIA & RAP Team	12
Buhangin District Brgy. Tigatto, Brgy. Waan	December 18, 2013 1:00PM Brgy. Hall of Tigatto, Buhangin District Davao City	*Brgy. Tigatto* Barangay Chairman, Brgy. Kagawad, Brgy. Secretary, Brgy. Purok Leaders, Brgy. Council for Women *Brgy. Waan* Brgy. Kagawad *Other Participants*: DPWH-Region XI, DPWH-ESSD Manila DENR-EMB Region XI, EIA & RAP Team	14
Talomo District *Brgy. Catalunan Grande, Brgy. Langub, Brgy. Magtuod*	December 16, 2013 8:00AM, Brgy. Catalunan Grande Gym Talomo District Davao City	*Brgy. Catalunan Grande* Brgy. Kagawad, Brgy. Secretary, Brgy. Lupong, Brgy. Purok Leaders, Brgy. Dev't Council, Land Owners, Datu Undali IP Rep., *Brgy. Langub,* Brgy. Chairman *Brgy. Magtuod* Brgy. Chairman, Brgy. Kagawads *Other Participants:* DPWH-Davao City District Engineering Office, DPWH-ESSD Manila, EIA & RAP Team	25

Table II Activities Completed by the EIA Team 3/6

Activities	Date, Time, & Venue	Sectors/LGUs/Concerned Government	Number of Participants
Public Scoping Meetings			
Tugbok District Brgy. Mintal, Brgy. Bago Oshiro, Brgy. Tugbok Proper, Brgy. Matina Biao, Brgy. Tacunan	December 16, 2013 1.00PM Brgy. Mintal Community Gym 3rd District Tugbok Davao City	*Brgy. Mintal* Brgy. Chairman, Brgy. Kagawad, Mintal Comprehensive High School Principal, Mintal Elementary School Principal, PNP-Station Commander, *Brgy. Bago-Oshiro* Brgy. Kagawad, Department of Agri. RFO XI, Farmer , Landowners, Davao City Treatment Rehabilitation Center for Drug Dependents, DSWD Representative *Brgy. Tugbok Proper* Brgy. Chairman, Brgy. Kagawad, Tugbok Progressive Coconut Farmers Coop Chairman, *Other Participants*: DPWH-Tugbok RROW Agent, DPWH-ESSD Manila, EIA & RAP Team	29
Bunawan District Brgy. Mahayag, Brgy, Bunawan, Brgy. Mudiang, Brgy. Tibungco, Brgy. Lasang, Brgy. San Isidro	December 17, 2013 1:00PM Brgy. Hall of Mahayag 2nd District Bunawan Davao City	*Brgy. Mahayag* Brgy. Chairwoman, Brgy. Kagawad, Brgy. Purok Leaders, Zetryl Chem Phils. Rep., Residents *Brgy. Mudiang* Brgy. Kagawad , Mudiang Farmer Assn, President, Urban Association Rep, Land Owners *Brgy. Tibungco* Brgy. Kagawad, Brgy. Council for Women Rep, *Brgy. San Isidro* Brgy. Chairman, Brgy. Kagawad, San Miguel Elementary School Rep, Devine Mercy Homeowners Assn. President *Brgy. Lasang* Brgy. Chairman, Barangay Kagawads, Brgy. Administrator, Rolex Industrial Corp. Secretary, PHILFRESH Clerk, Land Owners, *Other Participants*: DPWH-ESSD Central Office, DPWH-Region XI, EMB Region XI, EIA & RAP Team	52

Table II Activities Completed by the EIA Team 4/6			
Activities	**Date, Time, & Venue**	**Sectors/LGUs/Concerned Government**	**Number of Participants**
Public Scoping Meetings			
Brgy. J.P. Laurel, Panabo City	December 20, 2013 8:00AM 3rd floor, Conference Room Panabo City Hall	*Brgy. J.P. Laurel* Punong Barangay, CPDC Panabo City, Panabo City CENRO-SR EMS, *Other Participants:* DPWH- Region XI, DPWH-ESSD Manila, EMB Region XI, EIA & RAP Team	6
Consultation Meetings with Land Owners & Structure Owners			
Toril District Brgy. Mulig, Brgy. Marapangi, Brgy. Alambre, Brgy. Lubogan, Brgy. Bato, Brgy. Sirawan, Brgy. Bangkas Heights	June 16, 2014 2:00PM Brgy. Hall of Marapangi Toril District Davao City	*Brgy. Mulig* Land Owners *Brgy. Marapangi* Punong Barangay, Brgy. Kagawad, Brgy. Secretary, Anflocor Mgt.& Investment Corp. Rep., NESTFARM Rep., Land Owners *Brgy. Alambre* Punong Barangay, Brgy. Kagawad, Brgy. Land Owners, *Brgy. Lubogan* Land Owners *Brgy. Bato* Land Owners & tenants *Other Participants:* DPWH-Region XI, JICA-Study Team Rep., EIA & RAP Team	43
Buhangin District *Brgy. Tigatto, Brgy. Waan*	June 17, 2014 9:00AM Brgy. Hall of Tigatto, Buhangin District Davao City	*Brgy. Tigatto* Brgy. Chairman, Brgy. Kagawad, Brgy. Secretary, Brgy. Purok Leader, Land Owners *Brgy. Waan* Brgy. Kagawad *Other Participants:* DPWH- District Engineering Office Rep, JICA Study Team Rep., EIA & RAP Team	16
Buhangin District *Brgy. Cabantian, Brgy. Communal, Brgy. Indangan*	June 17, 2014 2:00PM Brgy. Hall of Cabantian Buhangin Davao City	*Brgy. Cabantian* Brgy. Kagawad, ALSONS Dev't. Corp, Land Owners *Brgy. Communal* Land Owners *Other Participants:* DPWH-Davao City District Engineering Office, EIA & RAP Team	18

Table II Activities Completed by the EIA Team 5/6			
Activities	**Date, Time, & Venue**	**Sectors/LGUs/Concerned Government**	**Number of Participants**
Consultation Meetings with Land Owners & Structure Owners			
Bunawan District Brgy. Tibungco, Brgy. Mudiang, Brgy. Lasang, Brgy. San Isidro, Brgy. Mahayag	June 18, 2014 9:00AM Brgy. Hall of Mahayag Bunawan District Davao City	*Brgy. Mahayag* Brgy. Chairwoman, Brgy. Kagawad, Land Owners *Brgy. Tibungco* Brgy. Kagawad *Brgy. Lasang* Brgy. Chairman, Land Owners *Brgy. San Isidro* Brgy. Chairman, Land Owners, Holcim Davao Plant Representatives *Other Participants:* DPWH-Davao City District Engineering Office, EIA & RAP Team	33
J.P. Laurel, Panabo City	June 18, 2014 2:00PM Brgy. J.P. Laurel Brgy. Hall Panabo City	*Brgy. J.P. Laurel* Brgy. Chairman, Brgy. Kagawad, Brgy. Secretary, Land Owner	4
Tugbok District Brgy. Mintal, Brgy. Matina Biao, Brgy. Tugbok Proper, Brgy. Tacunan	June 19, 2014 9:00AM Brgy. Mintal Covered Court Tugbok District Davao City	*Brgy. Mintal* Brgy. Kagawad, Land Owners *Brgy. Tugbok Proper* Brgy. Kagawad, Land Owners *Brgy. Tacunan* Brgy. Kagawad, Land Owners *Other Participants:* DPWH- RROW Agent Davao City District, Engineering Office, JICA Study Team, EIA & RAP Team	81
Talomo District *Brgy. Catalunan Grande, Brgy. Magtuod*	June 19, 2014 2:00 PM Brgy. Hall of Catalunan Grande Talomo District Davao City	*Brgy. Catalunan Grande* Brgy. Kagawad *Brgy. Magtuod* Brgy.Kagawad *Other Participants:* *JICA Study Team, EIA & RAP Team*	3
Baseline Data Gathering and Characterization			
Terrestrial Ecology (Flora & Fauna)	April 2 to April 8, 2014 At the **20** sampling sites established along the proposed Bypass alignment	Terrestrial Ecology Sampling Team	8

Table II Activities Completed by the EIA Team 6/6			
Activities	**Date, Time, & Venue**	**Sectors/LGUs/Concerned Government**	**Number of Participants**
Fresh Water Ecology Sampling	April 2 to April 8, 2014 W1 – Lasang River, Brgy. Communal W2 – Davao River, Brgy. Tigatto W3 – Matina River, Brgy. Langub W4 – Talomo River, Brgy. Mintal W5 – Lipadas, Bangkas Heights	Freshwater Ecology Sampling Team	8
Water Quality Sampling	April 2 to April 8, 2014 W1 – Lasang River, Brgy. Communal W2 – Davao River, Brgy. Tigatto W3 – Matina River, Brgy. Langub W4 – Talomo River, Brgy. Mintal W5 – Lipadas, Bangkas Heights	Water Quality Sampling Team	5
Air Quality & Noise Level Sampling	March 31 and April 1, 2014	Air Quality and Noise Level Sampling Team	6
Hydrogeology Survey	June 18-20, 2014	Hydrogeology Expert	2

EIA Methodology

The Land

Geology

The study followed the procedure prescribed by DENR DAO 2000-28 dated 14 March 2000 and the guidelines specified in Mines and Geosciences Memorandum Circular 2000-33.

Images/available photographs were used in the geomorphological analysis of terrain features for the following considerations:

1) To determine the extensions of the terrain, geological and geomorphological features along the road corridor for continuity and uniformity given the length of the project; and

2) Establish a basic understanding on the occurrence of major geological features in the area (e.g. lineaments)

In this undertaking, the methodologies are described in the succeeding sections.

Document Review and Inception

This activity focused in the acquisition, consolidation, evaluation, assessment and analysis of existing documents, reports and literature covering the project site.

Background information were gathered on the possible origin of the various geological lineaments observed in the images used. To put it in proper prospective, the aerial extent of the study area is quite extensive where in closely investigating each of the geological features/lineament on the ground will take time, effort and resources which is beyond the scope of the study. However, the proper understanding of lineation given and their possible ramification to the project must be identified. Here, results of survey works and research done by various workers listed in the references were freely referred to.

Remote Sensing and Aerial Photo Interpretation

The combined use of aerial photograph interpretation (API) and terrain analysis using available imageries (e.g. aerial photographs and satellite imageries/Google Earth and NAMRIA Maps). Remote sensing and image analysis are integral to the activity. Landform and terrain mapping units (TMUs) are identified, delineated and characterized in terms of prominent terrain qualities and attributes of the project site.

The images help identify, locate and characterize geological/geomorphic hot-spots such as geological structures (e.g. lineaments, fault lines), mass movement zones, slope instabilities, etc. that may affect road corridor. Distribution and location of loose alluvial sediment and bedrocks were also identified.

Relief and Topography

The general landscape of the project site is marked by complex morphologies. Many are structurally controlled. Most of these structures are associated either by faults and/or stratigraphic lines. Relief varies from rugged mountains to rolling hills with elevations between **10 meters** and **481 meters** above sea level.

The topography manifests high dissection particularly towards the mountainous and rugged relief where passages of various geologic lineaments are strongly manifested. The high relief and mountainous areas appear generally elongated towards the north-northwest. This elongation runs roughly co-linear with the direction of anticlines and synclines of Quaternary-Tertiary sedimentary rocks.

Most of the drainages-lines in the area are structurally-controlled. They flow generally from west-northwest towards east-southeast. All empty their loads towards Davao Gulf in the east.

Genetic Terrain Mapping

The geomorphological survey allows a macro-terrain classification along the road corridor. The application of geo-engineering/genetic geomorphological survey allows quick and synoptic recognition of mass movement zones, problem areas and strategic sites along the road corridor for early incorporation of counter/mitigation measures that might be needed. Identification of major lineaments, geohazard-prone areas (e.g. landslides, floods, liquefaction, subsidence, etc.) that might impact the project is a major consideration. Coverage of this survey highlights the following site characteristics:

- terrain management units;
- geomorphologic processes (e.g. gullying, soil erosion);
- relief-morphologic relationships;
- lithology;
- soil and pedologic properties;
- hydrologic situation; and
- vegetation and land uses

Terrestrial Ecology

Flora

Plants were surveyed using a *modified belt transect method*, along a transect length of at least **100 m**. Majority of plants surveyed in all stations were weeds, except in riparian habitats where remnant stands of trees were recorded.

Fauna

Avifauna (Birds)

Birds were surveyed using the *transect count method* along a transect length of at least **1 km**. Birds were identified using local names by acoustic calls and visual appearance with the aid of field guides (*Kennedy et al., 2000*). Mist nets were also used to capture birds.

Herpetofauna

Frogs were sampled using the cruising or opportunistic method. Riparian habitats in **four** (**4**) locations (Figure 1) were thoroughly searched for frogs, aided by the frog's vocalization. Identification of frogs was based on Alcala (1986) and Alcala and Brown (1998), after performing biometrics to confirm species identification.

Bats and Non-Volant Mammals

Bats were captured using mist nets in **four** (**4**) locations (Figure 1) installed along probable flyways and fruiting areas. *Non-volant mammals* were sampled using live traps baited with fried coconut strips and laced with peanut butter. Traps were installed in decaying logs and probable habitats. No small mammals were captured throughout the sampling period.

Abundance, Frequency, Importance Value, and Species Diversity were calculated using the following formulas (Brower, 1989):

1. Abundance (*A*) is the total number of a single species in the area. Relative abundance is the abundance of a given species (*Ai*) as a proportion of the sum of the abundance for all species ($\sum Ai$):

$$RA_i = \frac{Ai}{\sum A_i} x 100$$

2. Frequency (*f*) is the chance of finding a given species within a sample, $f_i = j_i/k_i$, where f_i is the frequency of species i, j_i is the number of quadrats in which species i occurs, and k is the total number of quadrats taken. Relative frequency is then the frequency of a given species (f_i) as a proportion of the sum of the frequencies for all species ($\sum f_i$):

$$Rfi = \frac{fi}{\sum fi} x 100$$

3. Importance Value = R*A* + R*F*

4. Species diversity was computed using Simpson's index of diversity, where a value close to 1.0 is considered highly diverse.

$$Ds = \frac{\sum ni\,(ni - 1)}{N(N-1)}$$

The Water

Hydrology

Hydrological report prepared by the JICA Study Team was utilized in this Report

Hydrogeology

The hydrological study for the proposed project was undertaken from May to August 2014. Actual reconnaissance and field survey of the study area was conducted from 17-20 June 2014. The following are the basic methodologies adopted in the hydrological study for this EIA report:

- Compilation and review of geologic literature, particularly on hydrogeology of Davao City;
- Collection of well data from the Davao City Water District (DCWD);
- Field geologic inspection of the tunnel corridor and location of wells around the area;
- Correlation of boring logs along the tunnel corridor and relating the cross section to the known geology of the area;
- Determination of the density of the rocks penetrated by the borings by analysis of the standard penetration test (SPT) results;
- Determination of the hydraulic conductivity of the lithologic units based on the grain sizes and density of the rocks;
- Determination of the hydrogeological condition based on the water level measurements during the boring and the estimated hydraulic conductivity of the various lithology units; and
- Evaluation of the results of the investigation to determine how the tunnel construction may affect the ground water regime

Water Quality

Water samples from the **five** (**5**) catchment areas crossed by the proposed Davao City Bypass Road Construction Project were collected and analyzed in accordance with the prescribed procedures described in DAO 34-1990 and EMB-DENR Manual for Ambient Water Quality

Monitoring Volume I for DO, pH, TSS, BOD, COD, Oil and Grease, and Total and Fecal Coliforms (**Table III**).

Table III Method of Analysis of the Water Samples

Parameters	Method of Analysis
• pH, Dissolved oxygen (DO)	pH meter; Azide Modification (Winkler Method)
• Biological Oxygen Demand (BOD_5)	Azide Modification (Dilution Technique)
• Chemical Oxygen Demand	Titrimetric
• Total Suspended Solids (TSS)	Gravimetric
• Fecal Coliform/Total Coliform	Multiple Tube Fermentation/Membrane Filter
• Oil-and-Grease	Gravimetric Method (Petroleum Ether Extraction)

Freshwater Ecology

Freshwater fishes and macroinvertebrates were sampled using a *D-frame Dip net* following the guidelines described by the US Environmental Protection Agency Rapid Bioassessment Protocol II (*Barbour et al., 1999*). D-frame dip net was used to sample fishes especially in deep and fast moving waters. The net was submerged and moved in a sweeping motion against the water current. Spotted fishes were also tracked and captured using the net. Captured freshwater fauna were documented using a digital camera and identified using Guide to Philippine Freshwater Fauna and taxonomic information from *www.fishbase.org*.

The Air

Air Quality

The methods of sampling and analysis of TSP, SO_2, NO_2, CO and CO_2 for the ambient air quality monitoring were based on the DENR standard. The methodologies are discussed in this section and presented in **Table IV**.

Table IV Methods of Ambient Air Sampling and Analysis	
Parameters	**Sampling Methodology/Analysis**
Total Suspended Particulates (TSP)	High Volume - Gravimetric Method
Sulfur Dioxide (SO_2)	Bubbler- Pararosaniline Method
Nitrogen Dioxide (NO_2)	Bubbler - Griess Saltzman Reaction
Carbon Monoxide (CO) and Carbon Dioxide (CO_2)	Direct Reading – Gas Analyzer

Total Suspended Particulates (TSP)

The method employed for sampling total suspended particulates was the use of high volume sampler and employing the gravimetric method of analysis. Air was drawn through a glass-fiber filter paper and desiccated for **24-hours** after sampling. The concentration of TSP in ambient air was calculated by dividing the total particulates collected by the total normal volume of air sampled.

Sulfur Dioxide (SO_2)

Sulfur dioxide in ambient air was collected into a solution of sodium tetrachloromercurate (TCM) by aspirating air through an impinger and treated in the laboratory with formaldehyde and especially purified, acid-bleached pararosaniline containing phosphoric acid to control pH. Sulfur dioxide concentration was then determined by the difference between the absorbance of the sample and blank multiplied by the calibration factor divided by the total volume of air sampled corrected to normal temperature and pressure.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide in ambient air was analyzed using the Griess-Saltzman Reaction method. Nitrogen dioxide in ambient air was absorbed in an azo dye forming reagent that produces a stable red-violet color and read by a spectrophotometer at **550 nm**. The difference between the absorbance of the sample and blank multiplied by the calibration factor, divided by the total volume of air sampled, gave the concentration of NO_2 in ambient air.

Carbon Monoxide (CO) and Carbon Dioxide (CO_2)

Carbon Monoxide and Carbon Dioxide in air were measured by a direct-reading gas analyzer equipped with a special sensor for the gases. The minimum detection limit for CO_2 and CO are **10 ppm** and **1 ppm**, respectively. The average value obtained during monitoring was recorded.

Noise Level (24-Hours)

Ambient noise level monitoring at the **seven** (**7**) stations established along the proposed bypass alignment was carried out within a **24-hour** sampling period (morning 0500-0900H, day time 0900H-1800H, evening 1800-2200H, & night time 2200-0500H) using a sound level meter. The monitoring was in accordance with the provision provided in the NPCC Memorandum Circular 002 (1980), which sets the median of **seven** (**7**) maximum readings comparable to the standard and the sampling procedure outlined by *Wilson* (*1989*). A total of **50** readings within a **10-minute** monitoring period were recorded per station wherein the median of the seven maximum-recorded noise levels gave the noise level comparable to the standard.

<u>The People</u>

Socio Economic Survey

The survey instrument was designed based on the type of information needed from the groups. For example for Group A, the questions are geared more towards the type of assets to be affected, primary and secondary source of income, and other information on assets that are bound to be loss.

Questions for Group B are focused on determining their socio-economic status using indicators such as primary source of income, food and poverty threshold, and access to basic social services.

Public Participation

Consultation Meetings

Consultation meetings with the different sectors to be affected by the project were undertaken from November to December 2013. Summary of the salient issues and concerns raised, as well as comments and suggestions made are summarized in **Table V**. Responses to queries are also presented in the Table.

Table V Summary of Issues, Concerns, Comments, and Suggestion During Consultation Meetings with the Project Affected Persons (1/3)

Queries/Concerns/Suggestions/ Comments	Responses To Queries
Plans on existing roads to be intersected by the bypass alignment	Existing roads will be maintained; The type structure to be built at the intersections shall depend on the type of road to be intersected
Schedule of project implementation;	No definite time table of project it would depend on the processing and approval of permits required
If owners of lands to be affected by the bypass alignment be compensated	Yes. The first option of the government is to negotiate with the land owners to donate the affected land. If the landowner declined to donate, the government will then offer compensation based on the present BIR zonal valuation of the property
If ALSONS' existing development project in Brgy. Cabantian was considered in the bypass alignment selection	Yes all developments along the bypass alignment were considered in the alignment selection process.
Entitlements of the landowners on top of the tunnel section;	Entitlements of the landowners on top of the tunnel section will have to be consulted with the DENR-LMS (Department of Environment and Natural Resources-Land Management Services);
Compensation for affected residential structure owners or communities on the top of the tunnel section tunnel section	Resettlement of existing communities and/or compensation residential structure owners on top of the tunnel section will not be necessary since the tunnel opening will be at least 200 m below the surface. In addition, construction of the tunnel section will employ modern technologies without blasting activities
Clarification on ownership of mineral resources is noted	All mineral resources found within the country is owned by state as stipulated in the constitution
Security cameras should be installed in the tunnel section of the bypass road	The suggestion was noted.
Structural integrity of the road should be considered with respect to potential occurrences of high intensity earthquakes	Aside from the study undertaken by the geologist of the JICA Study Team, a geo-hazard specialist who is a member of the EIA Study Team will conduct a thorough geological study along the alignment, particularly at the tunnel section to ensure stability of the structure to be constructed
If law on eminent domain will be exercised during the ROW acquisition	DPWH will first negotiate and offer the landowner compensation based on the present Bureau of Internal Revenue (BIR) zonal valuation. If the landowner refuses to settle, only then will the government exercise its power of "Eminent Domain"
Locals should benefit from the project through employment and short-term business opportunities	Priority in hiring of qualified workers in the impact areas is stipulated as one of the conditions of the ECC. Qualified workers in the direct impact area (DIA) will only be required to secure endorsement from the Brgy. Chairman as a proof of residency in the area
Probable safety hazard to farmers accessing their lands adjacent to the bypass road	The type and size of culverts to be constructed at barangay road intersections will be designed in consideration with the farm implements utilized by the farmers to ensure safe and unhampered access to farmlands
Close coordination with the LGUs must be carried out to consider future projects that may be affected by the bypass alignment;	A series of coordination meetings with the LGUs has been conducted since the start of the project survey. The Public Scoping Meeting which is an integral part of EIA study is another form of information campaign conducted on a barangay level;

Table V Summary of Issues, Concerns, Comments, and Suggestion Raised During Consultation Meetings with the Project Affected Persons (2/3)

Queries/Concerns/Suggestions/ Comments	Responses To Queries
Possible stagnation of water along natural waterways crossed by the alignment due to improper management of construction spoils and debris, which may also cause dengue outbreak	The concern raised is noted. Part of the EIA study is the assessment of waterways crossed by the alignment to ensure possible water stagnation and/or pollution of affected rivers and creeks will not occur
If coconut trees to be cut will be given to the land owners	Once the DPWH purchased the property for ROW purposes, everything will be included in the payment. The cut coconut trees will be turned over to DENR-FMB (Forest Management Bureau)
If there will be a disturbance compensation for the land owners	A RAP will be prepared and implemented prior to construction of the project to ensure compensation of all affected PAPs are properly settled
Classification of the bypass road, national or expressway;	The proposed bypass is a national road;
If the land owners to be affected based on final alignment survey could express objection	Yes. However, the government can exercise its power of eminent domain, after which the land owner may contest it through court proceedings
Management of the remaining **30 m** ROW to prevent informal settling (if the entire 60 m ROW will be acquired at once)	There should be a concerted effort between the barangay and city officials, with the participation of the police force to discourage possible informal settlement in the remaining idle **30 m** ROW
Valuation standard to be adopted in the compensation of coconut and banana tree (industrial crops)	Compensation on coconut trees will be based on existing guidelines of the Philippine Coconut Authority (PHILCOA), while payment on banana trees will be according to the current valuation standards of the Department of Agriculture (DA)
If blasting will be utilized during construction at the tunnel section	Results of the study undertaken at the tunnel section showed that the geological profile identified in the area is categorized under the soft type, therefore blasting is not necessary during construction of the tunnel
Possible occurrence of slope failure at the tunnel section area due to existence of fault lines	The structural integrity of the tunnel structure will be the utmost concern of the Design Team. The tunnel structure will be designed with consideration to the existing fault lines and other geological factors to ensure its stability to withstand high intensity earthquake occurrences
Possible loss/damage of spring water resources in the tunnel section	Part of the Environmental Impact Assessment (EIA) is to identify existence of natural water sources to assess the potential effects of the project and recommend appropriate mitigation measures
Entitlements of settlers whose application of sales patent is still in process;	This concern is noted and will be referred to the DENR-LMS;
If the landowner has rights to any natural resources or treasures that maybe extracted from his property, particularly at the tunnel section	The landowner only has surface rights to his land. According to the national law, mineral resources found within the country's land such as gold are considered as property of the state
If schools to be affected by the proposed bypass alignment will be relocated	Yes. As much as possible re-alignment of bypass sections affecting educational facilities and other institutional structures will be considered. If cannot be avoided, coordination with the agency will be undertaken
Close coordination with Urban Development and Housing Authority Office (UDHAO) and Urban Poor Affairs Office (UPAO) must be undertaken to prevent violent encounters with the informal settlers during relocation	The issue is noted. The UDHAO and UPAO should be involved to ensure peaceful relocation procedure

Table V	**Summary of Issues, Concerns, Comments, and Suggestion Raised During Consultation Meetings with the Project Affected Persons (3/3)**
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
If toll fee will be collected from the bypass road users	The bypass road is just a National Highway, not an expressway so no toll fee will be collected
If affected informal settlers will be relocated	Affected informal settlers will be relocated. The LGU concerned will provide the relocation lot, while the DPWH will assist in the development of the relocation site;
If alternative livelihoods will be provided affected informal settlers	The RAP to be prepared and implemented prior to the construction of the proposed bypass road shall include livelihood restoration and improvement program designed for the identified Informal Settlers and PAPs
If the project is funded through a loan or grant	The feasibility study phase of the project is a grant from JICA
Concern on the presence of fault lines along the alignment	A geo-hazard specialist, who is a member of the JICA Study Team is undertaking the study on the existing ground hazards, particularly at the tunnel section. The findings will be included in the EIS report to be submitted to the DENR
Depth of the tunnel from the surface	The proposed depth of the tunnel from the surface will be **200 m**
Bypass sections traversing flood-prone areas like Waan-Tigatto area might be submerged during occurrence of flash floods	A comprehensive hydrological study will be undertaken at flood risk areas to determine the type of structures to be constructed to prevent flooding
Width of the road way at the tunnel and highway section	The bypass road construction will be initially constructed as a **2-lane** road. The carriageway of the highway on embankment and cut sections will be **3.5 m** on each direction, with **2.5 meter** shoulders on each side, and a **2 meter** shoulder margin. The total road width is approximately **16 m**. At the tunnel section, the carriageway is **3.5 m** on each direction and a **1.25 m** shoulder on each side, with a roadway width of **9.5 m**
By tradition, Muslims does not allow mosques to be relocated	Since the alignment is not final yet, re-alignment at sections which will affect school, church, and mosques will still be considered. If re-alignment is not possible, then a series of consultation meetings will have to be undertaken with the concerned groups

Photo No. 1 ALSONS Development *Project Officer* **Ms. Jeanette P. Cabaya** wants to know if their development project in Brgy. Cabantian was considered during the alignment selection of the bypass road.

Photo No. 2 **Mr. Jonathan Villegas**, *Kagawad*, *Brgy. Communal* inquires on the entitlements of the land owners that will be traversed at the tunnel section.

Photo No. 3 Catalunan Grande *Bagobo Tribe Peacekeeper* **Mr. Cesar Udang** pointing out his concern regarding the structural integrity of the bypass road to withstand high intensity earthquake occurrences.

Photo No. 4 *Brgy. Chairman* **Erwin A. Piatos** of San Insidro asking if the bypass road will affect the *Piatos Elementary School* in San Isidro.

Photo No. 5 *Brgy. Kagawad* **Arnold Sumalinog** of Brgy. Tibungco asking if landowners to be affected by the project will be compensated. Moreover, he also wants to know if coconut trees to be cut will be given to landowners as well.

Photo No. 6 *Brgy. Kagawad* **Ruben G. Albano** of Brgy. Lasang inquiring about the valuation standard that will be adopted in the compensation of coconut and banana trees.

Photo No. 7 *Kagawad* **Joseph M. Sarile** of Brgy. Mahayag wants to know when the final survey of the alignment will be undertaken.

Photo No. 8 **Edgar Allan Orteza** *Brgy. Kagawad* of San Isidro inquires if local motorists can use the bypass road.

Photo No. 9 *Kagawad* **Rizalino C. Sobrepeña** of Brgy. Mintal wants to know if toll fee will be collected from the bypass road users.

Photo No. 10 **Ms. Minda Aurora Benavides**, *Chairman* of the *Tugbok Coconut Farmers' Cooperative* is asking if blasting will be carried out at the tunnel section. She also raised her concern on the possible occurrence of slope failure at the tunnel section due to presence of fault lines surrounding the area.

Photo No. 11 *Brgy. Chairman* **Wilfredo Anfone** of Tugbok Proper wants some clarification if the proposed project is a new road or will just be widening of existing roads.

Photo No. 12 *Kagawad* **Mr. Mark O. Peregrino** of *Brgy. Bago Oshiro* is asking about the compensation for affected landowners, and if relocation and alternative livelihoods will be provided to the affected informal settlers.

SUMMARY OF BASELINE CHARACTERIZATION

Discussed hereafter are the summary of the baseline data gathering for the **four** (**4**) aspects of the environment that includes The Land, The Water, The Air, and The People.

The Land

Land Use Classification

A Comprehensive Zoning Ordinance (CZO) for 2013-2022 was subsequently enacted by the City Council in 2013, incorporating as an integral part the Comprehensive Land Use Plan (CLUP), which incorporated the discussions below.

In Davao City's 2013-2022 Land Use Plan, it shows that the proposed Bypass alignment will traverse through **three** (**3**) major zones and **six** (**6**) sub-zones with various planned land uses that include the following:

(i) Major Urban Zone - *are Poblacion areas comprising the central business districts and the built-up areas including urbanizable land adjacent to the central business district. The sub-zones below shall be traversed by the Bypass at various locations:*

- Medium Density Residential Sub-zone (R-2) - *for housing/dwelling;*
- Minor Commercial Sub-zone (C-1) - *referred to as the Central Business sub-zone (CBD), a C-1 district principally for trade, services and business activities*;
- Medium Industrial *Sub*-zone (I-2) - *for pollutive/non-hazardous and pollutive/ hazardous manufacturing and processing establishments; and*
- General Institutional Sub-zone (Sins) - *Refers to areas with an established organization or foundation especially one dedicated to education, public service or culture*

(ii) Agricultural Land Zone (Ag) - *Area devoted for cultivation/fishing and pasteural activities*:

- Prime Agricultural Land (*the area for all types of agricultural activities identified and delineated in the Watershed Code and areas declared as Strategic Agriculture and Fisheries Development Zone (SAFDZ) per Republic Act No. 8435, otherwise known as Agriculture and Fisheries Modernization Act (AFMA*); and
- Agri-Non Tillage Land (*Those areas consisting of 12,240 identified and declared as* Environmentally *Critical Areas (ECA) in the Watershed Code of Davao City*

(iii) Agro-Industrial Zones (AgI) - *A division of an area designed primarily for integrated farm operations and related product, processing activities for farm products such as bananas, pineapple, sugarcanes, etc.*

Zones Traversed by the Bypass Alignment

The beginning of the alignment in Brgy. Sirawan will traverse an area classified as ***Medium Industrial Sub-zone***. From Sta. 2+000 in Brgy. Marapangi to Sta. 9+000 in Brgy. Mintal, the alignment will generally traverse through ***Medium Density Residential Sub-zone***. From Sta. 9+000-10+000 the bypass will pass through the University of the Philippines (UP) Mindanao Campus in Brgy. Mintal, which is categorized as ***General Institution Sub-zone***. The only commercial areas to be traversed by the alignment are in Brgy. Mintal along the Davao-Bukidnon National Highway (Sta. 12+000).

From the medium residential areas in Mintal, the alignment will then traverse through areas categorized as ***Prime Agricultural Land Sub-zones*** in Brgy. Tacunan, which are primarily planted to banana, of export quality. Other high-value commercial fruit trees grown in the area are durian, pomelo, mango, mangosteen, lanzones, and rambutan.

Areas crossed by the bypass alignment before the tunnel section at Sta. 19+000 in Matina Biao are categorized as ***Agri-Non Tillage Land Sub-zones***. Also belonging to the same sub-zones are the areas crossed by the alignment after the tunnel section in Brgy. Waan (Sta. 21+300). An approximate **3-kilometer** stretch from Sta. 24+900-27+000 in Brgy. Cabantian, ***Medium Density Residential Sub-zones*** areas will be traversed by bypass alignment, while in Brgy. Mudiang the alignment will cut cross ***Agri-Non Tillage Land Sub-zones***.

Medium Industrial Sub-zones in Brgy. Tibungco will be traversed by alignment section 32+500-35+000. This covers a portion of the existing mine tenement (quarry) of Holcim Cement Corporation. From Sta. 35+000-41+000, which encompasses Brgys. Mahayag and San Isidro, the bypass alignment will traverse through areas zoned as ***Agro-Industrial Zones***.

Towards the end section, the alignment will traverse through the ***Medium Industrial Sub-zones*** in Brgy. San Isidro and Lasang. The end segment of the bypass alignment Sta. 44+000-44+458 is located within Brgy. J.P. Laurel, Panabo City. From Lasang River to approximately **100 m** before the Davao-Agusan National Highway, the areas are dedicated to agricultural activities, while those fronting the National Highway are intended for commercial uses.

Geology

The area bisected by the bypass road corridor is cut by young geologic lineaments. Aside from bedding, layering and jointing's, it appears that part of the lineaments are faults/fractures which may have been formed during the Quaternary. Features, characteristics and relationship of these geologic structures require a more detailed investigation. These faults are notably earmarked by the alignment of several structural outliers, as plotted in the morpho-structural and morpho-hazards maps.

As an example, the north-northeast (N-NW) fault system which appears younger and "Recent" needs serious consideration. Morphologically, this fault system post-dates the present Davao River contributing to the current avulsion, pulsative shifts and migrations of the river. Faults variably strike between **30 degrees** northeast and due north. Dips towards northwest-west vary between **20** and **35 degrees**. Associated scarps of this fault system are poorly weathered with minor clay and gaugy infillings.

The youthful prominence of structural ridges and peaks as an isolated, detached and high relief terrain exhibits an irregular alignment. The youthfulness of this feature and structural control supports the notion of neotectonism of the north-northwest fault zones towards the recent period.

Relicts of chutes, cut-offs, meander benches and island bars appears predominant along the present morphology of Davao River. Geomorphologically, this suggests a dynamic and pulsative behavior of Davao River. The pulsative shifts and migration of Davao River from east to west appears to point to a prominence of the downthrown features of the north-northwest faults which cut the by-pass tunnel is another geological manifestation of a neotectonism within in the area.

Moreover, the pulsative shifts and migration of the River from east to west indicates that the west bank of Davao River (looking downstream) will be subjected to a higher degree of erosion compared to the eastern bank. This is an early indication that the bridge abutment on the west bank will require more protection from scouring and erosion than the east bank.

The area bisected by the bypass road has numerous features of ground instabilities. These features shown in the morphostructural and morpho-hazards maps may poise considerable challenge in the engineering design and construction of the by-pass road if present within the limits of the road corridor. Most profound features are the presence of mass-movement zones specially on the side slopes of the hill cut by the tunnel corridor which will requires a serious and an in-depth geotechnical investigation prior to construction.

The tunnel corridor is underlain by chiefly massive and fairly indurated Tertiary marine sedimentary rocks. Jointing and fracturing are common due to the formation of an anticline. The strikes directions of prominent discontinuity conditions are perpendicular to the general axis of the bypass tunnel.

The presence of scars from previous slides along the side slopes of the hill cut by the tunnel corridor will have to be closely investigated to ensure that there will be no future slope failure towards the tunnel openings.

The proposed bypass corridor is located at the southern end of the Agusan-Davao Basin, a north-south trending elongated basin between the Pacific Cordillera and the Central Mindanao Cordillera. The Central Cordillera is thrust westwards over the Lanao-Bukidnon Highlands. The Pacific Cordillera is thrust westwards over the Agusan Davao Basin. The thrusting of the different arcs in the area commonly results to the tilting of the different rock layers which are exposed the bedding of sediment rocks, jointing or fracturing and reflect as extensive linear features in the images.

This study showed there are more active fault lines within the **100 km** radius around Davao City than reflected in the active fault map of PHIVOLCS. Significant of these active faults are the *Davao Gulf Reverse Faults* bordering Samal Island, a pop-up structure with a thrust fault offshore at the east coast and a reverse fault[1] off shore at its west coast. Offshore seismic profile shows these faults to not extend into the main island of Mindanao. These faults can generate approximately **7.2 magnitude** earthquake and a potential near-source tsunami generator for Davao City. This means that there will be no lead time between a tsunami generated and the time it reaches the coastal area around Davao Gulf. Further, a **7.2 M** earthquake can generate ground shaking with a relatively higher PGA values especially in soft soil and can cause considerable damage to poorly designed structures. Liquefaction will also be a distinct possibility in susceptible areas.

Pedology/Soil Classifications

The terrain traversed by the road corridor is covered by various soils and surficial materials, which are generally formed by in situ weathering of different rock types.

[1] Thrust / Reverse Faults - faults formed by horizontal compressive stresses. Because the hanging wall moves up relative to the footwall, most of these faults place older rocks over younger rocks. Younger over older relations can occur when previously deformed rocks are thrust faulted.

Regolithic-Dominated Soils are essentially made up of regolithic materials, which are residual products of weathering of the underlying bedrocks. They are essentially fragmented and loosely clasted with reworked loamy clays and very clayey coarse sands. Their sites are very stony with depth which seldom exceeds **2.0 meters** below ground surface.

Principally comprised of weathered talus and transported earth debris, the *Colluvial-Dominated Soils* are mixtures of slope debris and reworked soils and rock fragments transported by gullies, slope wash and overland run-offs are essential components. Materials are generally loose and poorly clasted by loamy sands and moistened clays.

Alluvial Complex Soils and surficial materials are essentially loose alluvial materials with admixtures of saprolitic and regolithic soils.

Volcanic Soils and surficial materials are very prominent and widespread towards the southern and southwestern end of the by-pass road corridor, where volcanic deposits dominate, which are by-products of deep weathering, alteration and saprolitization of volcanic debris comprised principally of pyroclastics and other ejectas from the eruptions of volcanic centers like Mt. Apo.

Reworked Loam are friable mixtures of volcaniclastics and fluvial sands, silts and clays with usual admixtures of fine volcanic gravels and cobbles. Many are loosely clasted by highly moistened clayey volcanic ash. On the other hand, *Reworked Alluvial Loam* soils are friable mixtures of floodplain and reworked and weathered alluvial sands, gravels, clays and silts. They are pebbly and partly humic especially at top **20 cm**. Presence of oxide is low. Soil color is dominantly grayish brown.

Fluvial Deposits Soils and surficial materials are chiefly weathered fluviatiles formed by the actions of rivers and floodplain sedimentations. *Calcareous Soils* are found in area underlain by limestone. Surface materials are friable and loose mixtures of calcareous and fossiliferous sands, clays and lime.

The presence of *Fluvio-Coastal Soil* is partly crossed by the proposed axis of the bypass road at Km 38+000, Km 34+000 and Km 33+000, where soils are friable mixtures of floodplain and mixed-flat sediments. From Km 38+000 up to Km 40+000, the proposed axis of the bypass road crosses areas covered by *Mixed-Tidal Flat Soils*. These soils and surface materials are dominantly comprised of coastal sands, silts, clays with usual mixtures of channel gravels.

Boring tests carried out at the bridge sites showed that BH-18, 19 and 20 have a thick presence of very soft to very loose fluvial sediments. BH-1 to BH-17 show a favorable subsurface condition.

Boring, standard penetration test, seismic velocity logging and laboratory test of soil were carried out at **eight** (**8**) locations along the proposed tunnel corridor. The boring results showed that the uppermost material consists of sand and clay layer, with recorded blow counts between **14<N<45** in the upper stretches of layer and hitting practical refusals towards the bottom (**60>N**).

Terrestrial Ecology

Flora

Survey of plants along the study sites recorded a total of **185 species**; resolved into **one** (**1**) species of zingiber, **two** (**2**) fern allies, **two** (**2**) pandans, **five** (**5**) palms, **15** grasses, **17** ferns, **18** shrubs, **26** herbs, **27** vines, and **62** trees. Of the species identified, **10** are Philippine endemics, while **seven** (**7**) species that include *Vitex parviflora* (molave), *Drynaria quercifolia* (kabkab/Oak-leaf fern) *Diplodiscus paniculatus* (balobo), *Ficus ulmifolia* (isis), *Afzelia rhomboidea* (balayong), *Pterocarpus indicus echinus* (prickly narra), and *Pterocarpus indicus indicus* (smooth narra) are either categorized as **endangered** or **vulnerable**.

Out of the **185** species records of trees and understory flora, only **10** species are **Philippine endemics** – Cananga odorata (*Ilang-ilang*), Terminalia calamansanai (*Kalamansanai*), Lygodium flexuosum (*Nito*), Diplodiscus paniculatus (*Balobo*), Artocarpus blancoi (*Antipolo*), Ficus ulmifolia (*Isis*), Ficus pseudopalma (*Niyug-niyugan*), Ficus nota (*Tibig*), Leucosyke capitellata (*Alagasi*), and Leea philippinensis (*Kaliantan*).

Based on DAO 2007-01 listing, *Vitex parviflora* (Molave) and *Drynaria quercifolia* (Kabkab/Oak-leaf Fern) are categorized as **Endangered** and **Vulnerable**, respectively, while the IUCN Redlist (2014) lists *Vitex parviflora* (Molave), *Diplodiscus paniculatus* (Balobo), *Ficus ulmifolia* (Isis), *Afzelia rhomboidea* (Balayong), *Pterocarpus indicus echinus* (Prickly Narra), and *Pterocarpus indicus indicus* (Smooth Narra) as **Vulnerable**.

Fauna

Avifauna (Birds)

A total of **336** individuals of birds were recorded, resolved into **29** species and **22** families dominated by *Collocalia esculenta* with a relative abundance of **22.26%**, followed by *Passer montanus* and *Pycnonotus goiavier* with a relative abundance of **11.90%** and **11.31%**, respectively.

Of the identified species, **29** bird species are distributed into **19** residents, **six** (**6**) Philippine endemics, and **five** (**5**) migrant species where *Calidris temminckii* is rarely seen or observed. The Silvery kingfisher (*Alcedo argentata*) is the **only** species encountered which is categorized as **Vulnerable** (*IUCN Redlist, 2014*). *A. argentata* is mostly observed along streams in or near lowland forests. Its population is suspected to be undergoing a rapid decline as a result of habitat loss, hence, the **Vulnerable** category. The other **28** species encountered are categorized as **Least Concern**. These species occupy extremely large range, have very large population size, and are not sufficiently decreasing in number. The Temminck's Stint (*Calidris temminckii*) is an occasional migrant to the Philippines and is rarely encountered. The species was observed along the riparian habitats of the Matina River at Brgy. Matina Biao, along with the *A. argentata,* flying back and forth along river banks or perching on rocks. Other than these **two** (**2**) species, no other species of exemplary status was encountered.

Herpetofauna

About **74** frog individuals were captured were resolved into **five** (**5**) species and 4 families dominated by Cane Toad (*Bufo marinus*) with a relative abundance of **71.62%**, followed by the crab-eating frog (*Rana cancrivora*) with a relative abundance of **24.32%**.

All amphibians recorded in the surveys are categorized as "**Least Concern**" by *IUCN Redlist* (*2014*).

Mammals

A total of **50** individuals of bats were captured using mist nets in **nine** (**9**) net-nights at **three** (**3**) sampling locations, resolved into **four** (**4**) species representing only Family Pteropodidae, dominated by the lesser dog-faced fruit bat (*Cynopterus brachyotis*) with a relative abundance of **64%**, followed by the greater musky fruit bat (*Ptenochyrus jagori*) with a relative abundance of **20%**.

Except for the Greater musky fruit bat (*Ptenochirus jagori*), which is a **Philippine Endemic**, the rest of the bat species are widely distributed in Southeast Asia and are also categorized as "**Least Concern**" by *IUCN Redlist* (*2014*).

The Philippine Eagle

The **critically endangered** Philippine Eagle (*Pithecophaga jefferyi*) was **neither heard nor observed** along riparian habitats of the proposed bypass road project. Moreover, no traces nor signs of its mobility along these areas near the proposed bypass road were observed, as the Philippine eagle is largely **restricted in high altitude primary forest habitats**.

P. jefferyi is said to be found in **four** (**4**) major islands - Eastern Luzon, Samar, Leyte, and Mindanao, where the latter is believed to support a greater bulk of the species' population. Presently, an estimated of **82** to **233** breeding pairs spread in approximately **14,000 km^2** of remaining forests in Agusan del Sur, Bukidnon, Cotabato, Davao del Dur, Davao Oriental, Misamis Occidental, South Cotabato, Sarangani, and Davao City of Mindanao.

According to the Philippine Eagle Student Workbook (JICA), major habitats of *P. jefferyi* species are not distributed along or near the project area. Interviews were carried out with the Department of Environment and Natural Resources-Protected Areas and Wildlife Bureau (DENR-PAWB) Region XII and Central Office, and with the Philippine Eagle Foundation in Malagos, Davao City, a known authority on distribution of Philippine eagles. Accordingly, the nesting and activity areas of the Philippine eagle are restricted in the high altitude primary forest habitats of Mt. Apo National Park area, particularly at Brgy. Sibulan (**N 7°8'24.40", E 125°38'40.40"**), Davao City, about **7.24 miles** (**11.6 km**) from its nearest point in the project, and at Brgy. Salaysay (N 7°21'23.68", E 125°14'39.10") in Marilog District, about **24.7 miles** (**39.5 km**) from the project site.

Moreover, all the **interviewed specialists** concur to the prior finding that no species of *P. jefferyi* were heard nor observed along the proposed project site as it is impossible to observe the Philippine eagle in this location. The project site, generally, runs along disturbed and "open" areas, which neither serve as habitat for the Philippine eagle nor as a feeding area.

Though, it was suggested by one of the experts that the **6 km** hunting ground of the *P. jefferyi* could extend to the project site if the deteriorating secondary forest area near the tunnel section of the alignment will be rehabilitated and protected.

The Water

Hydrology

Davao City's political boundaries encompass **eight** (**8**) different watersheds. Talomo-Lipadas Watershed is a major source of drinking water, where approximately **99%** of the urban population of Davao City obtain their drinking water from within these river basins.

Davao, Lasang, Talomo, Lipadas and Matina Rivers are the **five** (**5**) major river systems that will be crossed by the bypass road corridor are. A number of smaller river systems will also be traversed by the proposed bypass alignment.

Flooding is a common occurrence in specific locations in Davao City. Generally, floods can be classified into riverine floods along the river system, localized floods in urban area due to combination of cloudburst, saturated soil, poor infiltration rates and inadequate or poorly built /maintained drainage lines, flooding due to typhoon and storm surge in the coastal areas, subsiding coastline; and flood flow impedance by high tide.

For this project, the study is focused on riverine flood especially in road sections were bridges will be constructed. As part of the study, interviews of old time residents were made in pre-identified river sections Results of the interview revealed that flood risks on the major river system is very high.

Hydrogeology

Most of the water wells of Davao City Water District (DCWD) are located in Dumoy, and the rest of water wells are placed in Tugbok, Panacan, Toril, Dacoville, Batulosa, Lumondado, and Riverside. These wells have an average depth of **120-150 m**.

The aquifers of groundwater in Davao City are recharged perennially by rainfall on the southern flanks of Mount Apo, Mount Tipolog and Mount Talomo. These areas are covered by highly porous pyroclastic materials and permeable highly fractured volcanics that receive and store sufficient groundwater to recharge the aquifers in the lowlands.

Located on the southwest of Davao City, the Dumoy Well Field is the main groundwater source for the DCWD. The well field is situated at the foot slopes at the east of Mount Talamo blanketed by volcanic mud flow. The slopes of Mount Talamo serve as the watershed area for the deep aquifers while the shallow aquifers are recharged by the Talamo River. The Dumoy Field is approximately **8 km** wide and **13 km** in length along the coast of Talamo Bay. There are **30 wells** operated by DCWD and several private industrial wells in the area. The production of each well is range of 1**,617-4,700 liters/minute**. And the well depth ranges from **90-152 m**.

Panacan on the other hand is located at about **5 km** northeast of Davao City where the alluvium is underlain by the Mandug Formation and Bunawan Limestone. There are **two** (**2**) operating wells with an average depth of **104 m**, and total production of the **two** (**2**) wells **is 2,000 liters/minute**.

The drillers described the claystone and mudstone units as sticky and plastic although they are often tight and compact. Such lithologic units may be porous but hardly permeable. They will not transmit or allow water to flow through them. They are commonly referred to as **aquitards**. Very little ground water may be expected from these layers even if they are completely saturated.

Except for the sandy sections encountered in **TBH-06** and **TBH-07**, most of the sand layers are thin and discontinuous. They are most likely lenticular and confined within thick clay beds. Owing to their limited thickness, these layers can contribute only a small amount of ground water.

The gravel layers consist of rounded to sub-rounded pebbles and occasional cobbles cemented with fine sand, silt and clay. In a similar manner as the poorly sorted sand, the fine cementing materials restrict the flow of water through the gravel. Therefore, ability of the gravel to transmit water is also significantly reduced.

Samal Limestone is composed of fragments of corals mixed with calcareous clay. The great amount of clay in the formation ensures that the formation will also be poorly permeable.

The hydraulic conductivity of clays and silty clays varies from about **1x10-6** to **1x10-3 cm/sec**. For clean sands, the average hydraulic conductivity is about **1x10-2 cm/sec** though it may decrease further if finer materials are mixed with the sand

Since the DCWD supplies water to the more populated areas in Magtuod and Langub, only a few shallow wells have been constructed to provide water for the unserved areas. However, these wells are located far from the proposed tunnel alignment. Furthermore, no springs have been observed although some residents report that seepages occur occasionally in the valleys, in the project area.

The boring logs indicated the presence of ground water in only **three** (**3**) of the **eight** (**8**) boreholes, which appears that the seepages in the valleys observed by residents are soil water that oozes out of the ground when the water is blocked by impermeable rocks.

These observations confirm the low porosity and permeability of the lithologic units penetrated by the boreholes. They suggest further that rainwater infiltration into the Masuhi Formation is minimal and that it runs off rapidly away from the peaks and ridges towards lower grounds.

The steep slopes and the outward dip of the beds away from the anticline allows the rainwater to flow rapidly towards the lower elevations. Coupled with the thin soil cover, sparse vegetation and nearly impervious rock exposures and flash floods would occur but only a small amount of rainwater will infiltrate into the underlying rocks. In effect, ground water recharge would be extremely low in the ridges above the proposed tunnel.

This phenomenon is confirmed from the water level measurements in boreholes TBH-04, TBH-06 and TBH-07. In TBH-06, the water level settled near the bottom of a thin sand layer. These observations suggest that the aquifers are unconfined and are at best perched water table aquifers.

It can be safely concluded that the Masuhi Formation is neither a good groundwater reservoir nor will it allow water to flow through it. The Mandug Formation which occurs near the southwest portal will be slightly more permeable but the volume of water stored in the sand and gravel layers will not be substantial because of the limited saturated thickness.

Water Quality

Results of laboratory analyses suggest that water quality parameters generally conform to the prescribed limits for Class C (primarily used for the propagation and growth of fish and other aquatic resources) waters, except total coliform and fecal coliform counts. The high coliform counts observed at the **five** (**5**) sampling stations, particularly in W4-Talomo River, Brgy. Mintal with **1.6×10^4 MPN/100 ml**, strongly indicate contamination from both human and animal sources from communities lying along each river stretch.

Only W2-Davao River, Brgy. Tigatto exhibited Oil-and-Grease contamination at **0.62 mg/L**, although less than the prescribed limit of **1.0 mg/L**. The contamination may be attributed to inadvertent oil spills coming from dump trucks that frequent the area to haul sand and gravel, particularly when dump trucks are washed in the river channel.

Since quarrying activities are carried out in W2-Davao River, Brgy. Tigatto, the observed total suspended solids (TSS) level was highest at **82 mg/L**. The rest recorded **<4 mg/L** TSS value. BOD5 values across all sites also conform to Class C limit, but BOD5 was highest in W4-Talomo River, Brgy. Mintal, suggesting organic contamination from communities living nearby. Correspondingly, Chemical Oxygen Demand (COD) level in W2-Davao River, Brgy. Tigatto was also highest at **14.5 mg/L**. It is to be noted that COD is an effluent standard described in DAO 35-1990 for industrial and municipal wastewater effluents.

Freshwater Ecology

About **31** individuals of freshwater fish and **one** (**1**) freshwater shell were collected across **five** (**5**) river sampling stations, dominated by mosquito fish (*Gambusia affinis*) with a relative abundance of **37.5%**, followed by tilapia (*Oreochromis nilotica*), and spotted barb (*Puntius binotatus*), with a relative abundance of **25** and **21.88%**, respectively.

All freshwater biota recorded from study sites are categorized as **Least Concern** based on *IUCN Redlist* (2014).

The Air

Climatology

Based on the Modified Coronas Classification, climate in the study area belongs to **Type IV**, where rainfall is more or less evenly distributed. Areas belonging to this climate type resembles to those regions under Type II having no dry season.

Latest climatological normal data obtained from PAGASA showed that the Cities of Davao and Panabo receive an annual rainfall amount of **1759.1 mm**, the highest rainfall amount of which was recorded in June at **186.7 mm** is. The study area experiences about **174** rainy days in a year. The most number of rainy days of **18** is recorded in observed in June

Davao and Panabo experience a relatively warm annual mean temperature of **27.9°C**. From March to May hot temperature averaging around **32.6°C** is usually experienced. Cooler weather is usually experienced in January and February, with a mean average temperature of **23.3°C**.

Relative humidity in the project area is at its highest in July at **83%**. The least humid month is April having a relative humidity of **77%**. Annually, relative humidity in the Davao City and Panabo City is measured at **81%**.

The Philippines sit astride the typhoon belt, and the country suffers an annual onslaught of dangerous storms from July through October. These are especially hazardous for northern and eastern Luzon and the Bicol and Eastern Visayas regions, but Manila gets devastated periodically as well.

Typhoon is locally termed as "Bagyo". Statistics from PAGASA showed that from 1948 to 2004, around an average of **20** storms and/or typhoons per year enter the Philippine Area of Responsibility (PAR). In 1993, a record **19** typhoons made landfall in the country making it the most in one year.

Two (**2**) types of air streams occur in the study area throughout the year, the northerly and southerly winds. The wind coming from the north prevails in Davao and Panabo Cities from November to April, and carries an average speed of **2 mps**. On the other hand, the southerly wind which predominates from May to October has a varying speed of **1-2 mps**.

Impacts of the Project on Climate Change

The bypass road has approximate length of **44.58 km** with an average road width of approximately average **55 m**. The area to be developed for the bypass project based on the preliminary design is approximately **245.2 ha** of agricultural area, mainly coconut plantations. Cutting of trees in the project site is expected to have impact on climate change, particularly the loss of absorb CO_2. According to the quantitative analysis done by the JICA Study Team, cutting of trees is calculated to have an estimated lost volume of CO_2 sink of **5,754 t-CO2/Year** in 2016 during construction period. For reference, the estimated lost volume of CO_2 sink due to incineration of cut coconut trees is **35,242 t-CO_2/Year** in 2016.

Operation of the construction equipment and machineries during the 3-year implementation of the bypass project is expected to generate a total of **93,393 t-CO_2**, based on the **31,131 t/year** CO_2 generation

Decrease in the generation of exhaust gas emissions, particularly CO2 is expected due to operation of the bypass road. Based on the projection carried out by the JICA Study Team, approximately **4.92%** decrease rate in CO_2 is expected based on a **216,682** Total Vehicle Time (TVT) and **5,896,668** Total Vehicle Kilometer (TVK) in Year 2023. In the Year 2033, the projected decrease rate in CO_2 generation is estimated at **2.77%** based on a TVT of **297,710** and TVK of **7,210,408**.

Air Quality and Noise Level

Air Quality

Results of the Total Suspended Particulates (TSP) sampling at the **seven** (7) sampling sites established along the bypass alignment ranged from **20.5** to **298.5 µg/Ncm** to **298.5 µg/Ncm**. These values are within the DENR Standard of **300 µg/Ncm** for a **1-hour** averaging time.

A very low TSP concentration level of **20.5 µg/Ncm** was recorded at Sta. 6-B during the daytime sampling period probably due to almost zero vehicular traffic in the area. Similarly, the observed TSP concentration level at Sta. A7-2 (daytime period) of **29.6 µg/Ncm** is way below the DENR standard. On the other hand, the TSP concentration level recorded at Sta. A1 of **298.5 µg/Ncm**, is just slightly below the DENR standard limit. An equally high TSP level was observed at Sta. A2 (**275.9 µg/Ncm**).

The **1-hour** sampling period result showed that theSO_2 concentration level recorded at the **seven** (**7**) sampling stations ranged between **<0.5 to 6.1 µg/Ncm**, and are very well within the standard concentration level set by the DENR for SO_2 of **340 µg/Ncm**. The ground concentration levels (GCL) recorded at Sta. A6-5 (night time), Sta. A7-1 (morning), Sta. A7-2 (daytime), Sta. A7-3 (daytime), and Sta. A7-4 (evening) is **<0.5 µg/Ncm**. The highest SO_2 concentration level of **6.1 µg/Ncm** was observed Sta. A1 during the daytime sampling period.

In terms of NO_2, the observed concentration levels observed at the sampling sites ranged from **<0.2** to **13.9 µg/Ncm**, which are all within the DENR standard of **180 µg/Ncm** for NO_2. Sta. A3 (daytime) recorded the highest NO_2 concentration level of **13.9 µg/Ncm**, while the lowest GCL of **1.8 µg/Ncm** were observed at Sta. A6-4 (evening), Sta. A6-5 (night time), Sta. A7-4 (evening), and Sta. A7-5 (night time).

The CO concentration levels observed which ranged from **< 1.0** to **1.0 parts per million** (**ppm**) are very well within the DENR standard of **30 ppm** for CO on a **1-hour** averaging time. The minimum CO level of **<1.0 ppm** were observed at Sta. A3 and A3. The rest of the sampling stations recorded a CO level of **1.0 ppm**.

Results of the 1-hour period CO_2 sampling ranged from **306** to **1348 ppm**. The highest concentration level was observed at Sta. A5 (daytime), while the lowest concentration level was recorded at Sta. A6-5 during the night time sampling period. It should be noted that there is no standard established for CO_2.

Noise Level

Sampling results of the **10-minute average** noise level daytime monitoring along Sta. N1 to N5 showed that existing noise levels exceeded the permissible DENR limit of **55 dBA** for *Class "AA"* and **65 dBA** for *Class "B"* categorized areas.

Sound generated by the passing vehicles during the sampling at Sta. N2 and Sta. N3 (both categorized as *AA* areas) are the identified sources of noise. The observed daytime noise level of **72 dBA** and **74 dBA**, respectively exceeded the DENR standard of **55 dBA**. While at *"B"* categorized areas (Sta. N1, N4, and N5), the observed noise level ranged from **72-80 dBA**. The values recorded exceeded the DENR limit of **65 dBA** for daytime noise level standard.

Relatively, a high noise level of **80 dBA** was observed at Sta. N4. The high noise recorded can be attributed to the volume of vehicles passing along the highway and the perennial blowing of horns along the Davao-Bukidnon National Highway.

Results of the **24-hour** monitoring (**10-minute** average every hour) at Sta. N6 showed that the observed noise levels during the **four** (**4**) sampling periods (morning, daytime, evening, & night time) which ranged from **52-69 dBA**, exceeded the DENR standard for area classified as *"A"* area for all the **four** (**4**) sampling periods. Noise sources during the sampling are crowing of roosters, sound from slight rain, sounds from stereo, and barking of dogs.

Similarly, the monitoring carried out at Sta. N7 revealed the same results. The observed noise level within the **24-hour** monitoring ranged from **53-70 dBA**, and clearly exceeded **45 dBA** set by the DENR for Class *"AA"* areas. Sources of noise identified during the time of sampling include noise generated by the passing vehicles and children playing near the sampling location. The highest noise level of **70 dBA**, which was observed between 0530-0540H was most likely generated by the movements of children going to the school. The relatively high noise level range of **68-69 dBA** during the evening time monitoring can be attributed to the sound from the falling rain.

The People

Existing Secondary Data

Davao City has a total household population estimated at 1**,443,890** based on the 2010 Census. This constituted **32.43%** of the total population in the Southern Mindanao Region (**4,468,563**), **5.71%** of the total population in Mindanao (**23, 375,527**); and, **1.57%** of the total Philippine population (**92,337,852**).

Given the total household population and a total land area of **244,000 hectares**, Davao City's population density was estimated at **5.9** persons per hectare in 2010. Varying urbanization levels are reflected in the City's household population in urban and rural barangays. It is worth to note that out of **23** barangays that are within the Direct Impact Area (DIA), **22** are classified as **urban barangays**.

Other socio-economic indicators are shown in the **Table VI**. As presented in the said table, estimated income is small comparing with Manila City and the rate of unemployment is lower than the national average.

Table VI Socio-Economic Indicators for Davao City			
Item	**Value**	**Year**	**Remarks**
Population in Davao City (Persons x 1,000)	1449.3	2010	Annual Increase rate 2.7% (1990/849.4 -2000/1147.1-2010)
Average Income in Davao Region (Peso/family/year)	166,000	2009	Manila: 354,645 Peso/family/year (2009)
Average Expenditure in Davao Region (peso/family/year)	142,000	2009	Manila: 321,197 Peso/family/year (2009)
Unemployment Rate in Davao Region (%)	4.6	2011	National average : 6.4% (2011)
Annual Poverty threshold (Peso/person/year)	17,040	2009	Poverty incidence (2009) Davao City 13.2%, Davao region 31.3%
Area (km2)	2,444km2	2010	
Population Density (Persons/km2)	593	2010	

As reported in the CLUP, of the **1,283,078** household population from ages **five** (**5**) years and older, a very high **97.09%** reached various levels of educational attainment distributed as follows: **35.48%** high school education, followed by **28.52%** who attended elementary education, **13.98%** (academic degree holder), **12.45%** (college undergraduate), and the rest had either reached pre-school, or post- secondary, or baccalaureate studies.

Based on 2007 data, **188,731** (**62.88%**) of the **300,141** households either owned or amortized home lots. In addition, **48,337** (**16.10%**) were renting, **51,529** (**17.17%**) were occupying lands for free with consent from the owner and **7,690** (**2.56%**) households were occupying lands for free without consent from the owners.

Influx of migrants from rural areas in and around the City in search for better opportunities are the primary causes of informal settlements in Davao City. Aside from having poor living conditions, they are also vulnerable to natural and human- made hazards.

An inventory of informal settlers initiated by the LGU's partner organizations in **nine** (**9**) barangays of the City was done in 2012. The said inventory showed that there were **16,517** settler-families in the **nine** (**9**) barangays; most of whom are occupying danger zones, followed by those dwelling in privately- owned lands. **Among the project-affected barangays, Talomo and Tigatto have the most number of informal settlers**. It is important to note here that none of the informal settlers in these areas will be affected by the Project**. Based on preliminary site investigation only a few informal settlers in Brgy. Lasang maybe impacted by the Project, which is not included on the list.**

The City Government of Davao has been actively responding to the need for housing of the underprivileged through different programs and projects, which were institutionalized through the approval of City Ordinance No. 014- 07 - Comprehensive Urban Shelter Services Development Code, also known as the Shelter Code of Davao City in 2007. The ordinance strengthened the LGU's tasks, as are mandated in R.A. 7279 or the Urban Development and Housing Act (UDHA) of 1992. It's main objective it to promote just, dynamic, and comprehensive land tenure security and urban services development program in cooperation with people's organization (POs), non-government organizations (NGOs), private sectors and other key shelter agencies.

Out of its **182** barangays, **106** (**58.24%**) are served by Level III water supply system operated by the Davao City Water District (DCWD). The remaining **76** barangays are served by Level I and II water supply systems. There are **41,833** households in these **76** barangays being served by Level I and Level II water supply facilities.

The Davao Light and Power Company (DLPC) is a major provider in Davao Region and supplies the power requirement of Davao City. The City also has a standby diesel power plant with a **46** MW capacity for sustained operations. It is capable of supplying **19.86** per cent of electricity requirement of DLPC. Based on the 2013-2022 CLUP, all project-affected barangays are fully energized.

Acute respiratory infection topped the list of the leading causes of diseases in Davao City for 2011-2012. Dengue cases have remarkably increased from **3,176** cases in 2008 to **7,326** in 2012, or an increase of about **130.67 percent**. Respiratory diseases, pneumonia, diarrhea, and healthy lifestyle-related diseases also remained prevalent. Though, malnutrition was included in the leading causes, it can be noted that it has decreased over the **5-year** period.

Cerebrovascular diseases, atherosclerosis & diseases of the heart are always the top **four** (**4**) causes of death in the City. For the last **five** (**5**) years, it can be observed that **eight** (**8**) out of **10** leading causes of deaths remained prevalent. Pneumonia, significantly surged from **404** deaths in 2008 to **1,049** deaths in 2012, or an increase of about **160** percent.

In the **182** barangays of Davao City, there are about **160** Barangay Health Stations (BHS) and **11** Satellite Health Stations (SHS) in the This means that the BHS to population ratio is **1:9,034**, which is not conforming to the national standard of **1:5,000**. Of these, **73** are attached to other structures in the barangay either at a barangay hall or school. Some barangays without BHS are served by the BHS in the adjacent barangays.

Davao City has **16** Rural Health Units (RHU). The RHU to population ratio is calculated at **1:84,587**, which is way below the national standard of **1:20,000**. Currently, the **16** Main Health Centers or RHUs are PhilHealth-accredited for Primary Care Benefit (PCB) Package, previously the Out-Patient Benefit (OPB) Package.

In terms of medical personnel there are **217** deployed in various RHUs/BHS, District Hospital, and Birthing Facility. These consist of **14** doctors**, 15** dentists, **68** nurses, **90** midwives, **14** Medical Technologists and **14** Sanitary Inspectors.

In terms of medical facilities Davao City has **29** hospitals, of which **27** are privately owned while **two** (**2**) are owned by the government. Most hospitals are located in the urban areas. Private Hospitals in Davao City have a total of **162** doctors, **1,476** nurses and **14** dentists with a bed capacity of **2,292**. Aside from hospitals, there are also **126** private lying-ins operating citywide.

As of 2012, out of the **308,976** households in the city, **271,577** households or **87.90** percent have sanitary toilets. However, the proportion of households with sanitary toilets is lower than Department of Health (DOH) Target of **91%**. Most households without toilet are found in the coastal barangays of Buhangin, Toril and Agdao District and in the rural areas of Paquibato District. On the other hand, households with sanitary toilets are found in the urban barangays of Talomo, Buhangin and Poblacion District while those households with shared toilets are found in the urban barangays of Buhangin and Bunawan District.

The crime data in Davao City showed that, of the total **7,153** crimes against persons from 2006 to 2012, more than half (**4,973** or **69.52%**) were attributed to physical injury, followed by murder (**1,448 or 20.24%**), Rape (**387 or 5.41%**) and Homicide (**345 or 4.82%**).

More crimes against property were reported than crimes against person with **17,535** cases. The number is taken from the sum of reports from 2006 to 2012. Theft is the most common type of crime against property (**13,032** or **70.98%**) followed by robbery (**4,969** or **27.06%**), carnapping

(**337 or 1.84%**) and cattle rustling (**22** or **0.12%**). Most of the cases reported are in Police Station (PS) 1 Sta. Ana (**3,065** or **30.59%**) followed by PS3 Talomo (**2,518** or **25.13%**).

Davao City have Women and Children Protection Desk (WCPD) that handles cases involving children and women. Identified cases are of **three** (**3**) types namely: (i) Cases Against Children (CAC), (ii) Cases Against Women (CAW), and (iii) Crimes Involving Children in Conflict with the Law (CICL). Most of the cases reported are coming from PS1 Sta. Ana.

In 2010, PNP reported that out of **182** barangays in the city, **10** barangays were categorized as less influenced, two were influenced and **24** barangays were threatened by Armed Groups with ideological leaning (e.g. Communist Party of the Philippines (CPP)-National Democratic Front (NDF)-National People's Army (NPA))

The City has public and private venues and facilities for indoor and outdoor recreation as well as activities such as athletics and other sports. These are located in the Central Business District and in the outskirts of the city. The City-owned Davao City Recreational Center (Almendras Gym) has been a venue of various events such as sports tournament and assemblies. Public sports and recreational facilities are accessible to all. On the other hand, private recreational facilities are available for a fee through membership in sports club and associations. Local athletes are trained through schools and membership in Sports Clubs.

Socio-Economic Profile of Project-Affected Persons Based on Interview Survey

The Davao City Bypass will traverse **five** (**5**) sub-districts with **23** barangays in Davao City and **one** (**1**) barangay in Panabo City, Davao del Norte (refer to **Table VII**). As previously mentioned out of the **23** barangays to be traversed by the Project, **22** are classified as urban barangays. The lone rural barangay, is Matina-Biao of District 1, Tugbok Sub-District.

Table VII Areas Traversed by the Davao City Bypass Project

	No.	Barangays
DAVAO CITY		
District 1		
Toril Sub-District	7	Sirawan, Marapangi, Bato, Mulig, Alambre, Bangkas Heights, Lubogan
Tugbok Sub-District	4	Mintal, Tugbok Proper, Tacunan, Matina-Biao
District 2		
Talomo Sub-District	2	Catalunan Grande, Magtuod

District 3		
Buhangin Sub-District	5	Cabantian, Indangan, Communal, Tigatto, Waan
Bunawan Sub-District	5	Mahayag, San Isidro, Lasang, Mudiang, Tibungco
DAVAO DEL NORTE		
Panabo City	1	J. P. Laurel
Total	**24**	

The most populous project-affected barangays are: Catalunan Grande, Tibungco, and Cabantian. It is important to note at this point that the Bypass alignment is located away from settlement areas where the majority of the populace resides.

Majority of Project-Affected Persons' (PAPs) have household size between **0-3** (**45.77%**) and **4-6** (**36.82%**), which is consistent with data obtained from the CLUP, which gave **4.2** as the average household size of families residing in urban barangays.

In terms of household structure, majority has households consisting of parents and children (nuclear) living together, with **116** respondents, or **57.7%**. This is followed by those living with parents and/or siblings, or extended families, with **18.4%**. There is also a significant number of PAPs living alone (**9.5%**), and households living in one structure (joint).

Bisaya/Binisaya is the most common dialect spoken by PAPs. It is the mother tounge of **52.7%** of the respondents, followed by '*Cebuano*" with **26.9%**, then by "*Boholano*" with **5.0%**, and *Hiligaynon/Ilongo* with **4.0%**. The remaining **15.4%** are shared among the "*Davaweño*" and "*Tagalog*," "*Ilocano*" dialects.

Approximately**45.3%**, or more than half of the respondents stated that they have been residents of the area from the 1990's and 2000's. There is also a significant number of respondents who have been residing in the area from the 40's to the 60's (**26.9%**).

PAPs' standard of living and socioeconomic status is evaluated using the following indicators: (i) primary source of income, (ii) tenure on land occupied; (iii) access to basic social services --- source of lighting, water supply, toilet facilities, health and educational facilities and (iv) poverty threshold.

Results of the survey showed that the main source of income is farming (**26.4%**), followed by own business (**22.9%**), and professional practice (**15.9%**).

Majority of the PAPs (**79.10%**) own their land; the rest are tenants (**7.5%**), occupying land with permit (**7.0%**).

In terms of educational attainment, result shows that majority of respondents for both sexes have no formal schooling with **33.8%** for husbands, and higher for females with **49.3%**.

Majority of interviewed PAPs' source of drinking water are from Level III (**46.8%**), Level II (**34.8%**) water supply systems. In terms of source of lighting, majority, or **78.6%** are serviced by the DLPC; **10.5%** admitted they obtain power from illegal connections, some still utilize kerosene lamps, and the rest are either using oil lamps, or petromax.

For their health needs **50.3%** depend on barangay health centers. A few (**11.9%**) go to hospitals, and the rest access private clinics and hospitals. In terms of sanitation, majority or **68%** use semi-flush toilet facilities, **25%** with flush facilities, and a few still using the Antipolo and open pit type. For their mode of transportation, the top three answers are: (i) tricycles and pedicabs (**59.7%**), and (ii) jeep, bus, and tricycle (**15.9%**), and (iii) jeepney (**12.4%**), which accounts for **88%** of total respondents.

A relatively high percentage of the surveyed households (**66.7%**) are earning above the poverty threshold, which is **P 14,831** for a family of **four** (**4**) in Region XI DAVAO Region. The remaining **20.9%** are living below the poverty food threshold.

Results show that **23.4%** of the male respondents can be tapped for local labor requirements during construction phase. In terms of female respondents majority or **49.8%** can engage in small enterprises such as eateries during construction period to be able to augment their family income.

When asked if they were in favor of the Davao Bypass project, a significant majority (**83.1%**) responded "Yes". Among the reasons cited, the following were mentioned the most number of times:

For "Yes" answer:

(i) It will bring economic development to the City;

(ii) Better accessibility; and

(iii) It will improve living conditions in the barangay

For "No" answer:

(i) It will entail loss of land and livelihood derived from it

When asked if they have other concerns about the project, the following are the top answers:

(i) Just compensation for lost assets;

(ii) Early compensation for affected properties ad crops;

(iii) Implement livelihood programs; and

(iv) That the project be implemented soon

SUMMARY OF IMPACTS IDENTIFICATION, MITIGATION AND ENHANCEMENT MEASURES

Presented in **Table VIII** are the potential impacts identified during implementation of the project. Also discussed in the matrices are the corresponding mitigations for the negative impacts, while the enhancement measures are recommended for positive impacts.

Table VIII Impact Identification, Mitigation and Enhancement (1/18)

Impacts	Duration and Type of Impacts	Intensity of Impacts	Mitigation/Enhancement Measures
PRE-CONSTRUCTION PHASE			
THE LAND			
Geology			
Ground Shaking Incidence of ground shaking due to generation of high magnitude earthquakes given that Davao City is in the fringes of an active seismic zone with known earthquake generators may cause damage to the bypass road	*Long-term, Negative*	High	• During the Detailed Engineering Design (DED) the Consultant must conduct a site specific Probabilistic Seismic Hazard Assessment (PSHA) to determine the site specific Design Based Earthquake (DBE); and • Given the tectonic/seismic framework, ground acceleration coefficient in the area can be higher than the standard set by the NSCP especially in soft soil
Liquefaction Incidence of liquefaction due to presence of loose, unconsolidated sediments with shallow water table in the alluvial and coastal plains traversed by the alignment	*Long-term, Negative*	High	• Undertake a site specific Liquefaction Susceptibility Analysis (LSA) which will take into consideration the result of PSHA; and • Results of the LSA and PSHA shall be considered in the design of the foundation for the bridges and tunnel section of the project
Liquefaction Incidence of liquefaction-induced lateral movement, particularly at ground with a sandy layer thicker than **5 m**	*Long-term, Negative*	High	• Results of the geo-technical survey undertaken showed that BH-17 to BH-20 shall be considered for soil liquefaction assessment; • A more detailed geo-technical test following the specification for soil liquefaction shall be undertaken during the DED stage
Liquefaction Incidence of liquefaction-induced lateral movement, particularly at ground with a sandy layer thicker than **5 m**			• Results of the geo-technical survey undertaken showed that **BH-18** to **BH-20** shall be consider for soil liquefaction assessment; • A more detailed geo-technical test following the specification for soil liquefaction shall be undertaken during the DED stage; • Adopt remediation measures that aims to increase the soils liquefaction resistance through densification, increase its strength, and/or improving its drainage. The most common remediation measures are as follows: ➢ Surcharge; ➢ Drains; ➢ Compaction Piles; and ➢ Deep Soil-Cement Mixing Methods

Table VIII Impact Identification, Mitigation and Enhancement (2/18)

Impacts	Duration and Type of Impacts	Intensity of Impacts	Mitigation/Enhancement Measures
PRE-CONSTRUCTION PHASE			
THE LAND			
Geology			
Compressible materials at the site could be subjected to settlement due to elastic deformation (upon load application) and/or compression particularly at fill and embankment sections and bridge sites	*Long-term, Negative*	High	• A site specific LSA must be undertaken to determine which layer will likely experience soil compressibility and by how much (in meters) for a given earthquake magnitude
Occurrence of fault rupture and creep due presence of pre-existing fault lines in the areas traversed by the bypass road corridor	*Long-term, Negative*	High	• Conduct a detailed assessment of the identified geological lineaments bisecting the critical components of the project (i.e. tunnel and bridge structures) to determine their potential to movement in the event of a high magnitude earthquake
Incidence of of slope failure, soil erosion, and rock fall at high cut sections (**10-20 m**) widely underlain by unconsolidated soil layers of sand and gravel due to cut (stress release), weathering, erosion and water infiltration	*Long-term, Negative*	High	• Standard Slope Gradient for Cut based on Road Earthwork - Guideline for Stability of Cut Slopes and Natural Slopes: June 2009 (issued by Japan Road Association) will be used as the standard slope gradient of the project road;
Terrestrial Ecology (Flora)			
Loss of natural vegetation covers due to stripping and clearing along the ROW of the bypass alignment and riparian areas of the waterways	*Long-term, Negative*	High	• "Permit To Cut" will be secured from DENR-FMB Region XI prior to any tree cutting activities; • Limit site clearing and construction works within the required **40-60 m** RROW to avoid unnecessary cutting of trees; • Cut trees will be surrendered to DENR-FMB Region XI for proper inventory and disposal; • Cut trees will be considered for re-use. Cut vegetation spoils shall be disposed to sites designated by the CENRO of Davao City and Panabo City; • Tree planting shall be undertaken at sites designated by the DENR-FMB Region XI. Replacement ratio of cut naturally growing trees shall be **1:100**, strictly with indigenous species such as *Vitex parviflora* (Molave), Pterocarpus indicus echinus (Prickly Narra), *Pterocarpus indicus indicus* (Smooth Narra), *Canangа odorata* (Ilang-ilang), *Lygodium flexuosum* (Nito); *Diplodiscus paniculatus* (Balobo); • Seedling donation and identification of common planting sites shall be encouraged to expedite implementation of tree replacement; and • Quarterly inspection of the tree planting site/s shall be carried out to monitor if survival of the species introduced reached the required **85-90%** rate.

Table VIII Impact Identification, Mitigation and Enhancement (3/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
PRE-CONSTRUCTION PHASE			
THE LAND			
Terrestrial Ecology (Flora)			
Loss of planted trees, agri-industrial trees such as coconut, and high-value commercial trees such as banana, mango, durian pomelo, rambutan, lanzones mangosteen, and papaya	*Long-term, Negative*	High	• ""Permit To Cut" will be secured from the Philippine Coconut Authority (PCA) prior to any coconut tree cutting activity; • Limit site clearing activities and construction works within the required **40-60 m** RROW; • Compensation of coconut trees will be in accordance to existing guidelines of the Philippine Coconut Authority (PCA); and • Replacement ratio for every coconut tree cut shall be **1:1**; • Replacement ratio of planted trees shall be **1:50**, preferably indigenous species or fast growing species such as *Gmelina arborea* (Gmelina), *Acacia auriculiformis* (Japanese acacia), *Acacia mangium* (Mangium), and *Swietenia mahagoni* (Common mahogany); and • Compensation of planted trees, commercial fruit-bearing trees and other cultivated agricultural crops shall be in accordance with the prevailing market values from the Department of Agriculture (DA) and concerned City Assessor's Office (CAO)
THE PEOPLE			
Assets and Properties			
The propose bypass alignment will hamper the **3-year** mine development plan of Holcim Philippines in Bunawan Sub-District (i.e. Brgy. Indangan, Mudiang, Tibungco, Mahayag, and San Isidro)	*Long-term, Negative*	High	• Coordination with the Holcim management have been initiated during the conduct of the Feasibility Study (FS); • Close coordination with the Holcim management will be undertaken to resolve RROW issue along Holcim's existing mine tenement area; • Re-alignment of the bypass alignment shall be considered during the DED; and • Suggestions raised by the Holcim representatives during the consultation meeting to consider re-alignment of the bypass section to the mined out areas shall be studied
Acquisition along the 40-60 m ROW of the bypass road alignment will entail displacement of formal residential structures	*Long-term, Negative*	High	• Limit acquisition within the 40-60 m RROW to minimize displacement of residential and commercial structures; and • Prompt payment of compensation at replacement cost for structures (DPWH R. A. 8974)

Table VIII Impact Identification, Mitigation and Enhancement (4/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
PRE-CONSTRUCTION PHASE			
THE PEOPLE			
Assets and Properties			
Acquisition along the **40-60 m** ROW of the bypass road alignment will entail displacement of institutional structures such as chapels (Sto. Niño Chapel in Brgy. Tigatto and San Isidro Piatos in Brgy. Mahayag)	*Long-term, Negative*	High	• Relocation and relocation/reconstruction of affected institutional structures will be undertaken in the soonest possible time in close coordination with the leaders of the religious sectors concerned
Possible displacement of government-owned structures (DA ROS Livestock and Poultry Development Farm, Small Ruminance Multiplier Farm) in Brgy. Bago Oshiro, Davao City	*Long-term, Negative*	High	• Compensation/restoration of the affected government-owned structures will be based on the inter-agency agreement between DPWH and the government agency concerned
Possible displacement of informal structures in Brgy. Lasang (along the riparian areas of Lasang River)	*Long-term, Negative*	High	• Provide in-city relocation to avoid disruption of livelihood activities and social networks; and • Assist the informal settler (IS) families access Community Mortgage Program (CMP) for the relocation house and lot; and • Cash compensation at replacement cost as defined in the Implementing Rules and Regulations of R. A. 8974
Income			
Loss of income of tenant farmers	*Long-term, Negative*	High	• Implementation of the Livelihood Restoration and Improvement Program designed during RAP Finalization in DED stage
CONSTRUCTION PHASE			
THE LAND			
Geology			
Incidence of of slope failure, soil erosion, and rock fall at high cut sections due to cut (stress release), weathering, erosion and water infiltration	*Long-term, Negative*	High	• Planting along cut slope sections utilizing the following: ➢ Sowing when the slope gradient is 1.0:1.0 or less (gentle) to prevent soil erosion; ➢ Vegetation base material spraying when the slope gradient is from 0.5:1.0 to 1.0:1.0 to prevent erosion at soil and rock slopes; ➢ Vegetation mat when the slope gradient is 0.8:1.0 or less (gentle) to prevent erosion at soil and rock slopes;

Table VIII Impact Identification, Mitigation and Enhancement (5/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASE			
THE LAND			
Incidence of of slope failure, soil erosion, and rock fall at high cut sections due to cut (stress release), weathering, erosion and water infiltration	*Long-term, Negative*	High	➢ Sowing when the slope gradient is 1.0:1.0 or less (gentle) to prevent soil erosion; ➢ Vegetation base material spraying when the slope gradient is from 0.5:1.0 to 1.0:1.0 to prevent erosion at soil and rock slopes; ➢ Vegetation mat when the slope gradient is 0.8:1.0 or less (gentle) to prevent erosion at soil and rock slopes; ➢ Vegetation sandbag to prevent soil erosion by planting the inside of "Grating Crib Works using Precast Blocks"; ➢ Sodding when the slope gradient is 1.0:1.0 or less (gentle) to prevent erosion at soil slopes; and ➢ Planting of sapling (landscaping when the slope gradient is 1.4:1.0 or less (gentle) to prevent erosion at soil slopes • Construction of appropriate protection structures on different slope types such as the following: ➢ Mortar/Concrete Spraying (Shotcrete) at rock slopes to prevent weathering, erosion, and permeation of runoff; ➢ Grouted Riprap the steep soil slopes to prevent weathering, erosion, permeation of runoff, and slipping of surface soils; ➢ Concrete Pitching at steep rock slopes to prevent erosion, permeation of runoff, and of slipping of rocks; ➢ Grating Crib Works using Precast Blocks at sandy soil slopes when slope gradient is 1.0:1.0 or less (gentle) to prevent erosion; ➢ Grating Crib Works using Shotcrete at soil and rock slopes to prevent erosion and slipping of surface soils or rocks; ➢ Stone/Rubble-Concrete Masonry underneath of soil and rock slopes to prevent erosion and slipping of surface soils or rocks; ➢ Mat Gabion underneath of soil slopes where the spring water is present to improve drainage and prevent slipping of slopes; ➢ Rock Bolt Type Anchor should be combined with Grating Crib Works and etc. to prevent surface failure or slope failure in soil and rock slopes; and ➢ Ground Anchor should be combined with Grating Crib Works and etc. to prevent slope failure or landslide

Table VIII Impact Identification, Mitigation and Enhancement (6/18)

Impacts	Duration and Type of Impacts	Intensity of Impacts	Mitigation/Enhancement Measures
CONSTRUCTION PHASE			
THE LAND			
Pedology and Soil			
Loss of fertile topsoil due to cut and fill activities	*Long-term, Negative*	Low	• Loss of fertile topsoil is considered minimal since the volume of earth materials to be cut is almost proportion to the volume of soil to be used as fill material for embankment; and • Embankment materials for filling will be sourced within the vicinity of the project site to ensure the same type and chemical properties of the soils
THE WATER			
Hydrology			
Possible aggravation of the existing flooding condition at identified flood risks areas such as Lasang River, Lacanon River, Bunawan River, Davao River, Lipadas River and due to inappropriate drainage design	*Long-term, Negative*	High	• Design of the bridges, culverts, and road side ditches shall follow the standards and criteria below: ➢ DPWH Design Guidelines, Criteria and Standards for Public Works and Highways published in 1980; ➢ FHWA (Federal Highway Administration, USA), HEC (Hydraulic Engineering Circular) series; and; ➢ U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-HMS, HEC-RAS and HY-8 Manuals and Technical References • The above-mentioned standards will be proposed for the hydrologic and hydraulic design criteria and will cover the following items: ➢ Hydrologic Design; ➢ Design Frequency or Return Period; ➢ Runoff Computation Methods, Runoff Coefficients; ➢ Rainfall Intensity; ➢ Level of Development in the Watersheds; ➢ Hydraulic Design; ➢ Manning's Roughness Coefficient; ➢ Expansion and Contraction Loss Coefficients; and ➢ Freeboard

Table VIII Impact Identification, Mitigation and Enhancement (7/18)

Impacts	Duration and Type of Impacts	Intensity of Impacts	Mitigation/Enhancement Measures
CONSTRUCTION PHASE			
THE WATER			
Hydrology			
Possible aggravation of existing flooding condition due to localized flooding caused by the inadequate temporary drainage facilities	*Short-term, Negative*	High	• Temporary but sufficient drainage facilities will be constructed to ensure unhampered flow of rain water to prevent localized flooding during high precipitation periods; and • If possible, stream flow regime will be temporarily diverted to allow continuous flow of water
Possible decrease in stream flow or worst stagnation due to improper management of cut vegetation spoils and construction debris	*Short-term, Negative*	High	• Spoils of cut vegetation covers will be regularly hauled and disposed to sites duly-approved by the CENRO of Davao City and Panabo City to avoid impediment of water flow that may cause stagnation; and • Temporary stockpiles of vegetation spoils and construction debris will not be located anywhere near the waterways
Hydrogeology			
Possible contamination of existing groundwater sources	*Short-term, Negative*	Low	• Inventory survey showed that there are no existing groundwater sources along the proposed bypass; • To prevent possible contamination of groundwater sources in the project area, motorpool areas, repair yards, concrete batching plants, and storage facilities of hazardous substances will not be located anywhere near existing wells and other groundwater sources; • Hazardous wastes materials such as used motor oils, paints, and other toxic substances will be regularly hauled and disposed at sites duly approved by the DENR Region XI. Disposal will be will be handled exclusively by DENR-accredited company; and • In case of accidental spillage of hazardous substances, immediate and extensive clean-up of the affected areas will be undertaken to prevent possible seepage and result to contamination
Possible seepage in the tunnel construction site	*Short-term, Negative*	Low	• This impact is unavoidable but temporary in nature. Limited amount of water may be expected from the sand and gravel layers and can dissipate easily; and • Provision of side diches along the side to avoid ponding of water inside the tunnel construction area.

Table VIII Impact Identification, Mitigation and Enhancement (8/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASES			
THE WATER			
Water Quality			
Possible increase in the oil & grease level of the waterways due to oil spill from construction vehicles, equipment, and machineries	*Short-term, Negative*	High	• Provision of oil-spill kit to construction equipment and machineries; • Prohibit washing of construction equipment along waterways; and • On-site maintenance and repair of construction vehicles, equipment, equipment and machineries must be avoided, especially near waterways
Potential increase in coliform contamination of the affected waterways due to improper management of domestic and solid wastes to be generated by the construction workers	*Short-term, Negative*	High	• Provision of temporary sanitation facilities such as portalets and trash bins for proper management of domestic and solid wastes; • Strict enforcement of proper waste segregation scheme; • Regular disposal of generated domestic and solid wastes to sites duly approved by the concerned LGUs; and • Strict implementation of daily inspection of the areas provided with temporary sanitation facilities to ensure proper waste management
Increase in turbidity of waterways due foundation works along riverbed	*Short-term, Negative*	High	• Unavoidable but temporary in nature. Clarity of water will return to normal once foundation works along the river bed are completed; and • A work gap must be observed to allow sufficient settling time of disturbed sediments
Possible increase in siltation along the waterways due to surface run-off	*Short-term, Negative*	High	• Provision of silt fences or silt curtains made of geotextiles to physically intercept run-off during high precipitation periods; • Construction of temporary basins or siltation ponds along the waterways to trap silt; • Locate temporary stockpiles of un-recycled soil materials and construction spoils away from the waterways; and • Cover temporary stockpiles of earth materials with tarpaulin or sack materials
Possible increase in pH level of the waterways due to concrete spillage during bridge construction activities	*Short-term, Negative*	Medium	• Closely supervise concrete pouring and related construction works at the bridge sites; • Installation of nets and mesh materials at bridge construction sites to minimize effects of accidental concrete spillage; and • Prohibit washing of transit concrete mixers along the waterways

Table VIII Impact Identification, Mitigation and Enhancement (9/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASES			
THE WATER			
Freshwater Ecology			
Possible increase in siltation rate of the waterways crossed by the bypass alignment due to surface run-off from exposed and cleared construction sites	*Short-term, Negative*	Low	• Provision of silt fences or silt curtains made of geotextiles to physically intercept run-off during high precipitation periods and prevent further disturbance to existing freshwater biota; and • Construction of temporary basins or siltation ponds along the waterways to trap silt
Increase in turbidity in the water column due to piling along the riverbed would slightly increase the mortality rates among fish larvae/juveniles including other planktonic organisms			• Provision of from geotextile silt screens/curtains to reduce turbidity; and • Implementation of a work gap during piling activities to allow the settling of suspended to keep TSS levels at acceptable level
THE AIR			
Air Quality			
Possible increase in the level of TSP at the construction sites and adjacent areas, particularly at dust sensitive receptors areas (i.e. residential areas, schools, hospitals) due to grubbing, bulldozing, stripping, earthmoving and other related activities	*Short-term, Negative*	High	• Regular spraying of water at exposed and cleared construction areas particularly those adjacent to dust sensitive receptor areas to minimize dust re-suspension; • Strict enforcement of the **20 kph** speed limit along the construction areas, particularly at dust sensitive receptor areas; • Temporary stockpiles of un-recycled earth materials and construction spoils will be covered with tarpaulin or sack materials; • Regular hauling and disposal of muck earth materials and construction spoils to sites duly-approved by the DENR and/or LGUs concerned; and • Provision of tarpaulin or sack materials to delivery and hauling trucks to minimize dust re-suspension
Possible increase in the ground concentration levels of SO_2 and NO_2 due to exhaust gas emissions from various construction vehicles, equipment, and machineries	*Short-term, Negative*	High	• Strict compliance to Periodic Maintenance Service (PMS) of construction equipment, machineries, and vehicles to ensure these are in good working conditions; and • Strict implementation of the daily routine check-up of construction vehicles, equipment, and machineries

Table VIII Impact Identification, Mitigation and/or Enhancement (10/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASE			
THE AIR			
Noise Level			
Possible increase in the noise level in the area due to operation of various construction equipment and machineries, particularly at noise sensitive receptor areas such as residential areas, schools, hospitals, and places of worships (catholic chapel, mosques, and other religious buildings)	*Short-term, Negative*	High	• Construction areas adjacent to noise sensitive receptor areas will be enclosed with metal sheets to maintain noise level at permissible limit; • Installation of noise suppressors to construction equipment, machineries, and vehicles whenever necessary to maintain noise generated at permissible level; • Daytime scheduling of high noise generating construction activities to minimize noise disturbance to nearby residential and other noise sensitive receptors areas. Consultation with affected resident shall be undertaken to gather consensus; and • Strict compliance to PMS of the construction equipment, machineries, and vehicles to ensure that these are in good working conditions at all times
THE PEOPLE			
Employment			
Availability of temporary employment during construction period. Female members of the community, particularly wives of farmers can engage in small scale business enterprises such as eateries, and supply of other goods and services	*Short-time, Positive*	High	• Included as one of the ECC conditions; • Qualified skilled workers and laborers in the DIA will be given priority in hiring during construction period; • Applicant workers will be required to secure certification from their respective barangays to confirm residency status in the area; and • Strict screening of female members of the community to ensure that those who will be given priority in the business concessions to be created are the directly affected persons
Basic Service Utilities			
Possible interruption of water and power supply, and telecommunication services	*Short-term, Negative*	High	• Close coordination with concerned utility companies will be undertaken to expedite relocation and restoration affected utilities, and minimize inconvenience to affected consumers; • Close coordination with the National Grid Corporation of the Philippines (NGCP) regarding affected transmission lines; and • Affected consumers will be notified in advance to enable them to prepare and undertake the necessary measures. Posting of public notice at conspicuous areas such as city/municipal/barangay halls, schools, and places of worships

Table VIII Impact Identification, Mitigation and/or Enhancement (11/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASE			
THE PEOPLE			
Basic Service Utilities			
Possible decrease in the yield of drinking and domestic water sources due to excavation works during construction of the tunnel	*Short-term, Negative*	Low	• Although the overlying rocks do not hold much ground water and there is no presence of wells or springs with appreciable yields, tunnel construction must be limited within the tunnel itself to avoid possible effects to the groundwater regime; and • Temporary sources of potable drinking and domestic water will provided to affected residents to ensure continuous supply
Possible increase in demand of water supply which may lead to completion between local residents and migrant workers	*Short-term, Negative*	Low	• Temporary source of water supply shall be provided in the worker's camps, field offices, and other temporary facilities to prevent possible competition between local residents and migrant workers
Basic Social Service Facilities			
Increase in demand of access to basic social service services such as health centers due to in-migration of workers	*Short-term, Negative*	Low	• Provision of basic social service facilities such as health care center within the work sites to reduce competition between migrant workers and local residents
Public Health, Solid Waste Management, and Sanitation			
Spread of communicable diseases due to poor sanitation and improper waste management within the workers' camps and all areas provided with temporary sanitation facilities	*Short-term, Negative*	Medium	• Provision of adequate temporary sanitation facilities such as portable toilets and trash bins at all construction sites, workers' camps, field offices, temporary facilities yard, batching plants, and all other temporary facilities; • Strict implementation of proper waste management scheme; • Regular hauling and disposal of generated solid and domestic wastes to sites approved by Davao City and Panabo City; and • Daily inspection of workers' camps and all areas provided with temporary sanitation facilities to ensure proper wastes management
Possible spread of infectious diseases due to in-migration of workers infected with sexually transmitted disease (STD) and HIV/AIDS	*Long-term, Negative*	Medium	• Strict medical screening of migrant workers during hiring period; • Regular medical check-up of workers; and • Undertake group consultations to promote awareness among the community and workers on how to prevent transmission of STDs and HIV/AIDS

Table VIII Impact Identification, Mitigation and/or Enhancement (12/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASE			
THE PEOPLE			
Occupational Health and Safety			
Incidence of temporary hearing problem due to long-term exposure to high noise levels due to operation of construction equipment and machineries	*Short-term, Negative*	High	• Provision of adequate personal protective equipment (PPE) such as ear muffs, especially to heavy equipment operators and other workers exposed to high noise level; and • Wearing of the provided PPE such as hard hats, safety boots, safety gloves, reflectorized vests, and other related safety gears will be strictly implemented
Incidence of upper respiratory ailments due to due to long-term exposure to dust and exhaust gas emissions generated by the construction equipment and machineries	*Short-term, Negative*	High	• Provision of gas/protective masks to heavy equipment operators and workers exposed to dust and gaseous air pollutants emitted by the heavy equipment and machineries; and • Wearing of the provided PPE will be strictly implemented
Operation of construction equipment and machineries during implementation of the project Operation of the concrete batching plant, motorpool area, repair yard, stockyard and temporary facilities yard	*Short-term, Negative*	High	• Personnel will be comprehensively trained on handling of toxic materials, safety procedures, and educated on health standards; • Provision of medical clinic and first aid station facilities supervised by a registered nurse at the work areas and field offices; • Regular medical check-up of workers'; • Formulation of an Emergency Response Plan (ERP) to quickly respond to any type of emergency situation within the construction area; and • Provision of a stand-by emergency vehicle within the construction areas at all times
Safety of Residents in the Impact Areas			
Excavation areas and exposed construction sites may pose hazard to the safety of nearby residents Mobilization of various construction vehicles, equipment, and machineries during implementation of the project will pose hazard to the safety of residents, particularly children	*Short-term, Negative*	High	• Construction sites adjacent to settlement areas shall be enclosed with metal sheets particularly excavation areas to limit public access, especially children, • Installation of adequate reflectorized traffic warning and safety signs written in the local dialect (Visayan) and the vernacular (Tagalog) along the entire stretch of the construction areas; • Provision of safe crosswalks and pedestrian lanes at construction areas near settlement areas, particularly schools; and • Designation of well-trained traffic aides at construction sites near settlement areas and schools to assist and guide pedestrians

Table VIII Impact Identification, Mitigation and/or Enhancement (13/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASE			
THE PEOPLE			
Safety of Residents in the Impact Areas			
Mobilization of the construction vehicles, heavy equipment and machineries in the agricultural areas may pose hazard to farmers and plantation workers	*Short-term, Negative*	High	• Provision of safe temporary crossings for farmers and plantation workers with appropriate consideration to farm implements ;and • Designate safety personnel in areas where major construction activities will be carried out to prevent occurrence of untoward incidents
Proximity of temporary construction facilities such as motorpool, material stock yard, temporary facilities yard, concrete batching plants, generator power station, muck soil stock yard, etc. may pose risk to the safety of residents, especially children due to negligence and unawareness	*Short-term, Negative*	High	• All temporary construction facilities shall be located at least **1 kilometer** away from the nearest settlement area; and • All temporary construction facilities will be securely fenced and guarded to limit access to public, especially children
Safety of Motorists			
Construction of at-grade intersections, overpass bridges, and underpass bridges along the roads intersected by the bypass alignment. Mobilization of the various construction equipment and machineries at the road intersections. Excavation works at the road intersections	*Short-term, Negative*	High	• Provision of adequate reflectorized warning and traffic safety signs written in the local dialect (Visayan) and the vernacular (Tagalog) along the entire stretch of the construction sites, particularly at road intersections; • Installation of sufficient impact resistant concrete barriers; • Provision of sufficient lighting in all construction areas to provide illumination during night time; • Designate safety personnel and well-trained traffic aides/flagmen at critical construction areas to assist and guide motorists; and • Parking of idle construction vehicles, equipment, machineries, and vehicles along the roads will be prohibited, especially during night time
Peace and Order			
Conflict of interest between local residents and migrant workers	*Short-term, Negative*	Low	• All temporary construction facilities shall be provide with security personnel to monitor entry and exit of workers; and • Strict implementation of curfew hours within the workers' camps

Table VIII Impact Identification, Mitigation and/or Enhancement (14/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
CONSTRUCTION PHASE			
THE PEOPLE			
Traffic			
Possible traffic congestion along the major roads and intersections affected by the construction of the bypass road sections and intersections	*Short-term, Negative*	High	• As part of the DED, a sound TMP and re-routing schemes will be prepared and submitted to the City Governments of Davao and Panabo for approval; • Strict implementation of the approved TMP along major roads and intersections affected by the construction of the project; • Delivery of construction materials will be undertaken during night time when traffic volume is low; • Hauling and disposal of construction spoils and debris will be done during the night; an • Strict enforcement of the “No Parking“ policy of idle construction equipment, machineries, and vehicles along the major thoroughfares and intersections
DEMOBILIZATION/DECOMMISSIONING PHASE			
THE WATER			
Hydrology			
Possible clogging of waterways due to abandoned construction spoils and debris	*Long-term, Negative*	Medium	• The ESHO of the Contractor must ensure that all bridge construction sites are clear of abandoned construction spoils and debris; and • Ocular inspection of the inspection construction areas along the waterways must be conducted by the MMT to validate compliance of the Contractor
Water Quality			
Possible contamination of the affected waterways, particularly coliform due to abandoned wastes generated by the construction workers	*Short-term, Negative*	High	• The ESHO of the Contractor must ensure that: ➢ All temporary sanitation facilities provided at the construction sites are completely dismantled; and ➢ Residual domestic and solid wastes are properly disposed to sites duly-approved by the City Governments of Davao and Panabo • Ocular inspection of the construction sites provided with temporary sanitation facilities shall be conducted by the MMT to validate compliance of the Contractor

Table VIII Impact Identification, Mitigation and/or Enhancement (15/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
DEMOBILIZATION/DECOMMISSIONING PHASE			
THE PEOPLE			
Public Health, Solid Waste Management, and Sanitation			
Possible spread of communicable diseases due to abandoned domestic and solid wastes from the temporary sanitation facilities	*Short-term, negative*	High	• The ESHO of the Contractor must ensure that: ➢ All temporary sanitation facilities are completely and properly dismantled; and ➢ All domestic and solid wastes are properly disposed to site/s duly approved by the City Governments of Davao and Panabo • A joint site inspection at the work sites must be undertaken by the MMT to validate total dismantling of the temporary sanitation facilities
Informal Settlement			
Incomplete closure of the workers' camps and field offices may result to informal settlement	*Long-term, Negative*	High	• To ensure complete closure of the temporary construction facilities, all structures within the premises must be totally dismantled and the area is restored to its original state; and • Ocular inspection shall be conducted by the MMT to validate complete closure of the temporary construction facilities and restoration of the sites to their original state
OPERATIONAL PHASE			
THE LAND			
Land Use and Classifications			
The newly constructed Bypass Road will provide better access to *Tourist Development Zones* (*TDZ*), particularly in Toril Sub-District	*Long-term, Positive*	High	• Regular inspection and maintenance of the new Bypass Road shall be undertaken by the District Engineering Office (DEO) who has jurisdiction over the project based on DWPH Standard Maintenance Manual for Roads and Bridges to ensure optimum service level to road users
Conversion of roadside agricultural and agro-industrial land into other uses (e.g., residential or commercial)	*Long-term, Negative*	High	• Request the Mayor and City Council of Davao City and Panabo City to enact an ordinance prohibiting illegal conversion of such lands into other uses; and • Regular inspection and monitoring along the Bypass Road must be undertaken by the City Governments of Davao and Panabo to discourage possibility of illegal conversion of existing land uses to other purposes

Table VIII Impact Identification, Mitigation and/or Enhancement (16/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
OPERATIONAL PHASE			
THE LAND			
Geology			
Mt. Apo is classified dormant and have no clear eruption record in historical time. In the event of an eruption, the southern end of the bypass road corridor which is approximately **25 km east** of the peak of Mt. Apo will affected by ash fall and lahar.	*Long-term, Negative*	Low	• Impacts of hazards due to lava flows, volcanic bombs, volcanic gases etc. will be confined to areas within the **10 km** radius eruption hazard zone
Slope failure, landslides and increased erosion rates along newly vegetated/mulched cut sections and embankments	*Long-term, Negative*	High	• DPWH, particularly its DEO who has jurisdiction over the Bypass Road shall undertake regular inspection and maintenance of the vegetated cut sloes slopes until fair level of stabilization is achieved based on standard DPWH Maintenance Works for Roads and Bridges
Slope failure and rock fall along cut sections with slope protection structures	*Long-term, Negative*	High	• DPWH, particularly its DEO who has jurisdiction over the Bypass Road shall undertake regular inspection and maintenance of the slope protection structures based on standard DPWH Maintenance Works for Roads and Bridges
THE WATER			
Hydrology			
Possible aggravation of the flooding condition along identified flood risks areas	*Long-term, Negative*	High	• DPWH, particularly its DEO who has jurisdiction over the Bypass Road shall undertake regular inspection and maintenance of drainage facilities based on standard DPWH Maintenance Works for Roads and Bridges; and • Conduct interviews with local residents regarding occurrence of flood in the identified risks areas, especially after continuous and high precipitation periods to help enhance future maintenance work programs
THE AIR			
Air Quality			
Decrease in gaseous emissions, particularly CO_2 due faster and smoother traffic flow	*Long-term, Positive*	High	• The green belt to be established along the roadsides of the newly constructed the Bypass Road will serve as natural filters for exhaust gas emissions. Likewise the trees will provide settling areas for the suspended particulate matters; • An anti-smoke-belching monitoring station shall be set-up at air pollution sensitive areas; and • Strict implementation of penalties for violators in accordance with the Philippine Clean Air Act (R.A. 8749) and its Implementing Rules and Regulations (IRR)

Table VIII Impact Identification, Mitigation and/or Enhancement (17/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
OPERATIONAL PHASE			
THE AIR			
Noise Level			
Increase in noise level in areas traversed by the Bypass Road due to significant volume of traffic	*Long-term, Negative*	High	• A green belt area shall be established along the road sides of the new Bypass Road in accordance with the DPWH D.O. 15, Series of 2000, which can act as noise barrier between the bypass and noise sensitive areas; and • Installation of noise barrier at identified noise sensitive receptors areas adjacent to the bypass road shall be considered
THE PEOPLE			
Land Use			
Illegal conversion of roadside area into non-designated land use, such as commercial, residential, and a combination of both due to influx of in-migrants or new settlers	*Long-term, Negative*	High	• Strict adherence to Davao City Land Use Plan; • Request the Mayor and City Council of Davao City and Panabo City to enact an ordinance prohibiting illegal conversion of such lands into other uses; • Implementation of D.O. 15 Series of 2000 to provide buffer between Bypass and roadside areas, so as to discourage illegal conversion of agricultural and agro-industrial to residential, commercial, or a mix of both and • Regular inspection and monitoring along the Bypass Road must be undertaken by the City Governments of Davao and Panabo to discourage illegal conversion of existing land uses to other purposes
Safety of Motorists			
Incidence of fire inside the tunnel section Vehicular accidents involving motorbikes, overloaded trucks, and trucks over the allowable vertical clearance limit Accidental oil spill or spill of other hazardous and toxic wastes	*Long-term, Negative*	High	• Tank lorries carrying hazardous and toxic materials shall be prohibited from using the tunnel; • Motorbikes and tricycles shall not be allowed to use the bypass tunnel; • Tank lorries carrying hazardous and toxic materials must be prohibited from using the tunnel; • Vehicles over the height limit shall not be allowed to use the tunnel; • Thorough clean-up shall be immediately undertaken in case of accidental spill oil and other chemicals; • Strict implementation of the tunnel accident action flow shown in **Figure 7.2.2-1 Chapter 7** of this Report

Table VIII Impact Identification, Mitigation and/or Enhancement (18/18)			
Impacts	**Duration and Type of Impacts**	**Intensity of Impacts**	**Mitigation/Enhancement Measures**
OPERATIONAL PHASE			
Faster and Smoother Travel			
The newly constructed Bypass Road will provide faster and smoother travel to motorists from the southern to the northern end of Davao City, as well as adjacent areas such as Panabo City and the Municipality of Digos	*Long-term, Positive*	High	• Regular inspection and maintenance of the new Bypass Road, including all appurtenant structures installed, shall be undertaken by the DPWH Davao City DEO who has jurisdiction over the project based on DWPH Standard Maintenance Manual for Roads and Bridges to ensure optimum service level to road users

1 PROJECT DESCRIPTION

1.1 PROJECT LOCATION AND AREA

1.1.1 Project Location

The proposed Davao City Bypass Project is located in the City of Davao and the City of Panabo in Davao, Del Norte (see **Figure 1.1.1-1**). Shown in **Table 1.1.1-1** are the approximate geographic coordinates of the alignment on a by-kilometer section.

Geographically situated at approximately **6°59'59.13"N 125°28'55.52"E**, the alignment will start along the Davao-Digos Highway (Pan-Philippine Highway) in Brgy. Sirawan, Toril, Davao City approximately **500 m south** of Lipadas Bridge. It will then proceed on a slightly northwesterly towards Brgy. Marapangi, and Bato. The bypass alignment will then shift to a northerly direction crossing over the Lipadas River, then traversing Brgy. Alambre, Bangkas Heights towards Brgy. Mulig. From this point, it will change to a northeasterly direction towards the University of the Philippines (UP) Mindanao Campus in Brgy. Mintal, then again return to a northerly route en route to Davao-Bukidnon National Highway.

As the alignment passes through Tugbok Proper, it will cross the Davao-Bukidnon Road (**7°5'57.21"N 125°29'38.77"E**), cross over the Talomo River, and then proceed to a northeasterly direction towards agricultural lands in Brgy. Tacunan. The alignment will then cross the Matina River before entering the west portal of the tunnel section (**7°7'31.04"N 125°32'56.19"E**) in Brgy. Magtuod. Coming out of the east portal of the tunnel **Sta. 21+280**, approximately at **7°7'55.20"N 125°33'56.43"E**, the bypass alignment will continue in the same direction towards Brgy. Waan, cross Davao River and proceed towards Brgy. Tigatto. The alignment will keep its easterly path en route to Brgy. Cabantian. As the alignment reaches Brgy. Communal, it will then change to a northerly direction, then traverse through Brgys. Indangan, Mudiang, Tibungco, and Mahayag where parts of the existing mine tenement (quarry) of Holcim Cement Corporation are located. The alignment will keep its northerly track until it arrives at Brgy. San Isidro, where it will change to a northeasterly direction.

From Brgy. San Isidro, the alignment will maintain its northeasterly direction then traverse through Brgy. Lasang, then cross Lasang River until it intersects the Davao-Agusan National Highway in Brgy. J.P. Laurel, Panabo City where the alignment will terminate (**7°16'17.65"N 125°40'5.47"E**).

Source: JICA Study Team, July 2014

Figure 1.1.1-1 Project Area and Location

Table-1.1.1-1	Geographic Coordinates of the Proposed Davao City Bypass Alignment Per Kilometer (1/2)
Station	**Coordinates**
KM 0+00	6°59'59.13"N 125°28'55.52E
KM 1+000	7°0'25.68"N 125°28'37.31"E
KM 2+000	7°0'57.52"N 125°28'31.09"E
KM 3+000	7°1'29.36"N 125°28'35.74"E
KM 4+000	7°2'0.51"N 125°28'31.40"E
KM 5+000	7°2'29.37"N 125°28'46.19"E
KM 6+000	7°3'0.05"N 125°28'49.33"E
KM 7+000	7°3'31.73"N 125°28'56.14"E
KM 8+000	7°4'3.96"N 125°28'54.43"E
KM 9+000	7°4'35.89"N 125°28'58.64"E
KM 10+000	7°4'57.20"N 125°29'22.82"E
KM 11+000	7°5'25.82"N 125°29'26.01"E
KM 12+000	7°5'54.38"N 125°29'35.70"E
KM 13+000	7°6'15.22"N 125°29'59.27"E
KM 14+000	7°6'27.39"N 125°30'29.40"E
KM 15+000	7°6'29.07"N 125°31'2.33"E
KM 16+000	7°6'42.99"N 125°31'31.51"E
KM 17+000	7°6'58.77"N 125°31'59.95"E
KM 18+000	7°7'14.19"N 125°33.25.02"E
KM 19+000	7°7'31.04"N 125°32'56.19"E
KM 20+000	7°7'46.20"N 125°33'56.43"E
KM 21+000	7°7'55.20"N 125°33'56.43"E
KM 22+000	7°7'52.86"N 125°34'28.03"E
KM 24+000	7°8'12.08"N 125°35'28.20E
KM 25+000	7°8'20.22"N 125°35'58.60"E
KM 26+000	7°8'29.21"N 125°36'29.29"E

Table-1.1.1-1	Geographic Coordinates of the Proposed Davao City Bypass Alignment Per Kilometer (2/2)
Station	**Coordinates**
KM 27+000	7°8'41.13"N 125°36'58.75"E
KM 28+000	7°9'12.0"N 125°37'7.87"E
KM 29+000	7°9'44.07"N 125°37'4.61"E
KM 30+000	7°10'16.33"N 125°37'5.67E
KM 31+000	7°10'46.26"N 125°37'17.58"E
KM 32+000	7°11'16.32N 125°37'29.90E
KM 33+000	7°11'47.83"N 125°37'37.85E
KM 34+000	7°12'20.09"N 125°3741.57"E
KM 35+000	7°12'52.13"N 125°37'35.98"E
KM 36+000	7°13'18.72"N 125°37'18.43E
KM 37+000	7°13'50.27"N 125°37'11.72"E
KM 38+000	7°14'22.04"N 125°37'18.64"E
KM 39+000	7°14'49.42"N 125°37'35.31E
KM 40+000	7°15'12.56"N 125°37'58.14E
KM 41+000	7°15'34.93"N 125°38'21.57"E
KM 42+000	7°15'54.49"N 125°38'46.44"E
KM 43+000	7°16'7.09"N 125°39'16.58E
KM 44+000	7°16'18.28"N 125°39'47.00"E
KM 44+458 end of Alignment	7°16'17.65"N 125°40'5.47E

Photo No. 1.1.1-1 Taken at the start of the proposed **Davao City Bypass Construction Project** alignment, **Sta. 0+000** along the Davao-Digos National Highway in Brgy. Sirawan, Davao City.

Photo No. 1.1.1-2 The proposed bypass alignment will intersect the existing Bayabas-Eden Road in Brgy. Marapangi, Davao City between **Sta. 2+800-2+900**.

Photo No. 1.1.1-3 A view of the area to be traversed by the bypass alignment in Brgy. Bato, Davao City.

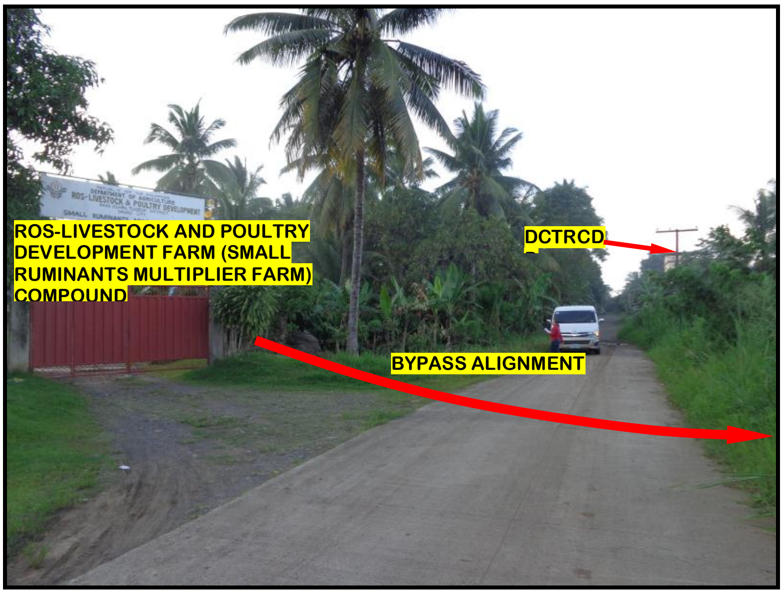


Photo No. 1.1.1-4 Bypass alignment crossing an existing road in Brgy. Bago Oshiro, traversing in between the ROS-Livestock and Poultry Development Farm of the Department of Agriculture (DA) and the Davao City Treatment and Rehabilitation Center for Drug Dependent (DCTRCDD).

Photo No. 1.1.1-5 Some residential structures likely to be affected by the proposed bypass alignment along U.P. Road in Brgy. Mintal (**Sta. 9+600-9+700**).

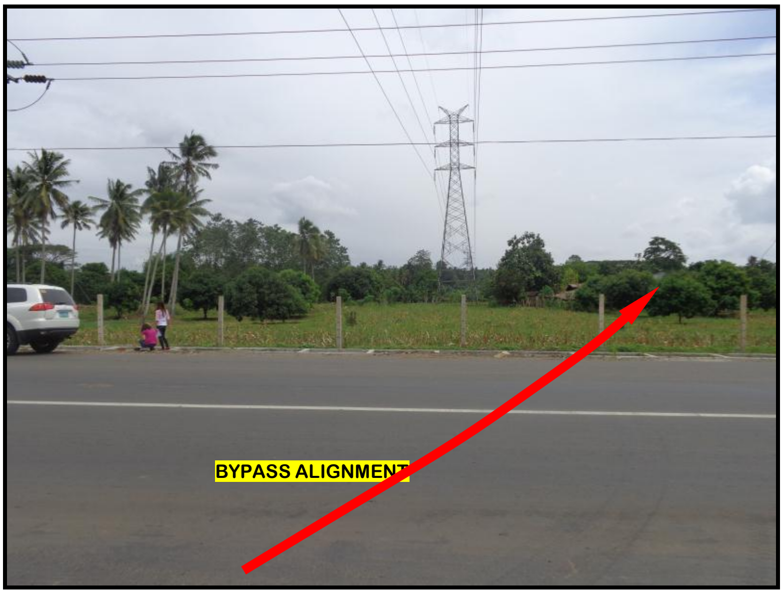


Photo No. 1.1.1-6 Bypass alignment intersecting the Davao-Bukidnon National Highway in Brgy. Mintal, Tugbok District between **Sta. 12+300-12+400**.

Photo No. 1.1.1-7 Taken at the intersection of the proposed bypass alignment and Mintal Road, between **Sta. 12+900-13+000** in Brgy. Mintal.

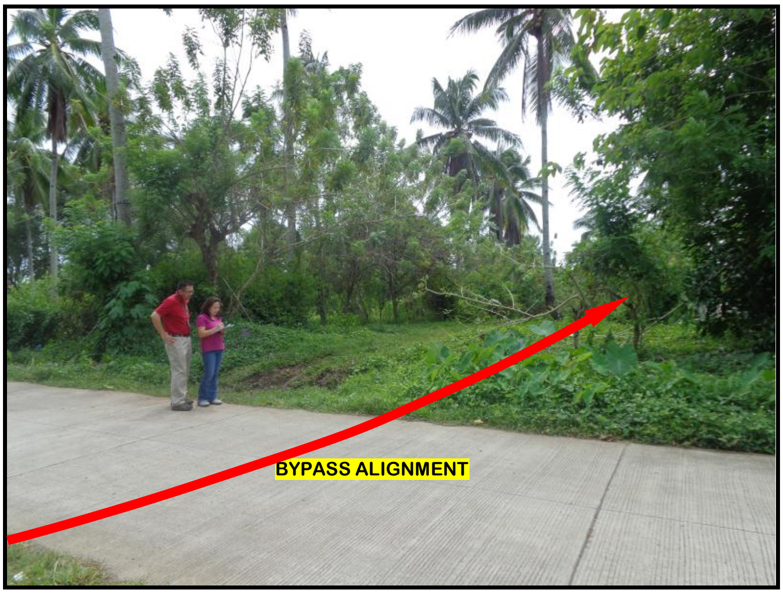


Photo No. 1.1.1-8 Taken at the intersection of the proposed bypass alignment and Catalunan Grande Road in Brgy. Tacunan.

Photo No. 1.1.1-9 Taken at the west side of the proposed tunnel crossing the Matina River approximately at **Sta. 19+000**.

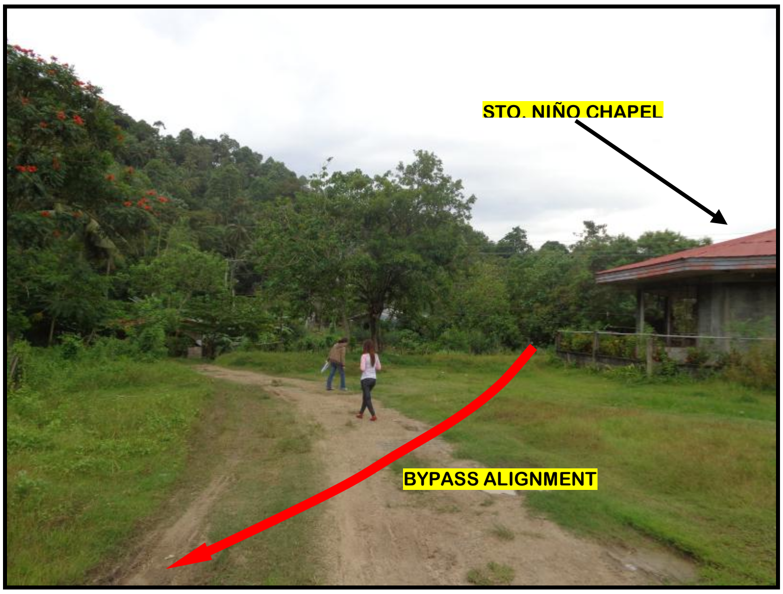


Photo No. 1.1.1-10 A view of the surroundings to be traversed by the bypass alignment (intersecting Mandug Road at **Sta. 23+500**) in Brgy. Tigatto. Notice the Sto. Niño Chapel on the right side of the photo that may be affected the alignment.

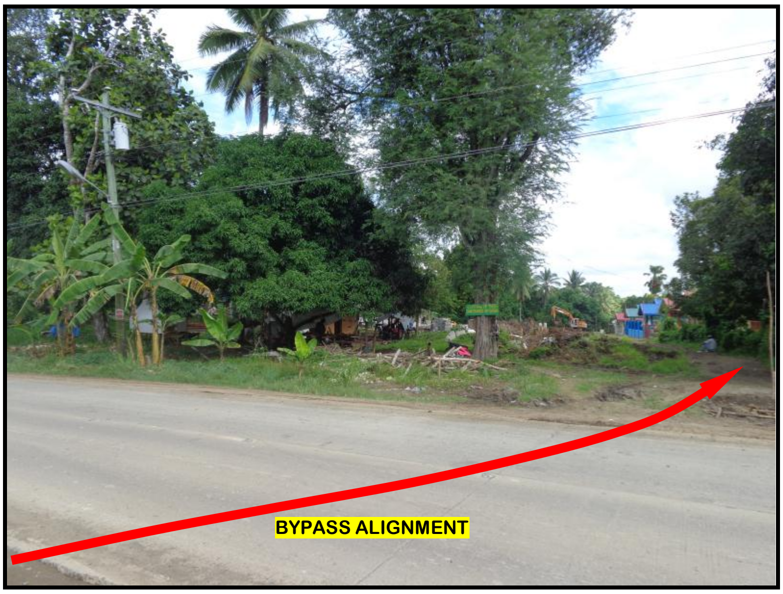


Photo No. 1.1.1-11 Bypass alignment intersecting the Cabantian Road between **Sta. 25+500-25+600** in Brgy. Cabantian.

Photo No. 1.1.1-12 Bypass alignment intersecting the Malagamot Road in Brgy. Indangan, between **Sta. 28+700-28+800**.

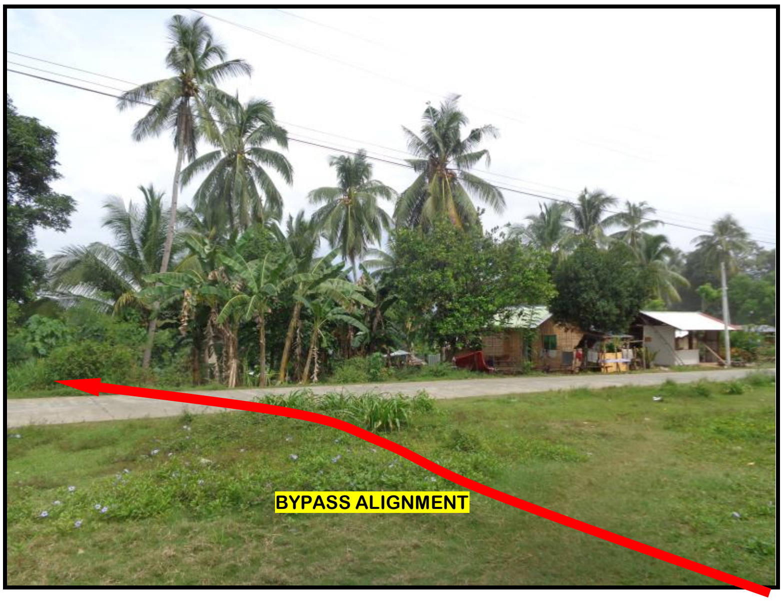


Photo No. 1.1.1-13 Bypass alignment crossing the Acacia-Ilang Road in Brgy. Tibungco at **Sta. 31+000**.

Photo No. 1.1.1-14 Photo of the taken at the intersection of the bypass alignment and Buhangin Road in Brgy. Mahayag between **Sta. 38+300-38+400**.

Photo No. 1.1.1-15 Taken at the intersection of the proposed bypass alignment and an existing road in Brgy. San Isidro between **Sta. 40+500-40+600**. Also shown in the photo is the San Isidro Piatos Chapel that will likely be affected by the alignment.

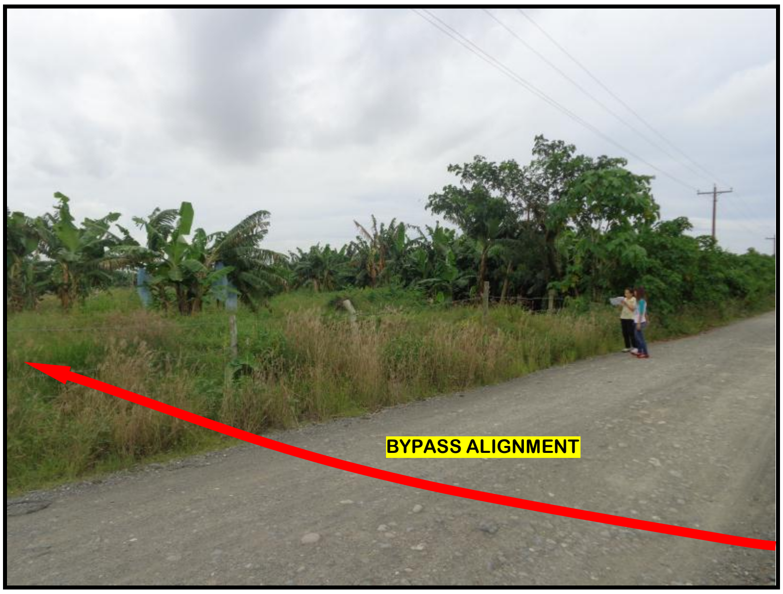


Photo No. 1.1.1-16 Bypass alignment traversing the Dole Fresh Fruit Banana Plantation in Brgy. Lasang between **Sta. 41+800-42+000**.

Photo No. 1.1.1-17 Photo of the taken at the vicinity of the proposed bypass alignment crossing an existing road in Brgy. Lasang at **Sta. 44+000**.

Photo No. 1.1.1-28 General view at the terminus of the proposed bypass alignment along the Davao-Agusan National Highway in Brgy. J.P. Laurel, Panabo City.

1.1.2 Rationale for Selection of Primary and Secondary Impact Areas

The primary (direct) and secondary (indirect) impact areas were delineated based on the potential effects of the proposed Davao City Bypass Construction Project to the receiving environment.

The **Direct Impact Areas** (**DIA**) are those areas identified within the required **40-60 m** ROW of the bypass alignment. The DIAs are mostly agricultural areas primarily planted to agri-industrial trees such as coconut, and high-value commercial trees among others banana, durian, pomelo, rambutan, papaya, mangosteen, coffee, and cacao. The bypass alignment will also traverse through residential areas where a number of structures, both formal and informal will be affected.

Indirect Impact Areas (**IIAs**) are those areas within the **250 m** radius of the alignment which will be indirectly influence during construction activities due to possible increase in air pollution and noise level. Areas to be affected by the possible traffic congestion due to diversion of vehicle flow are also considered as IIAs.

Figure 1.1.2-1 shows areas to be directly and indirectly affected by the proposed bypass project.

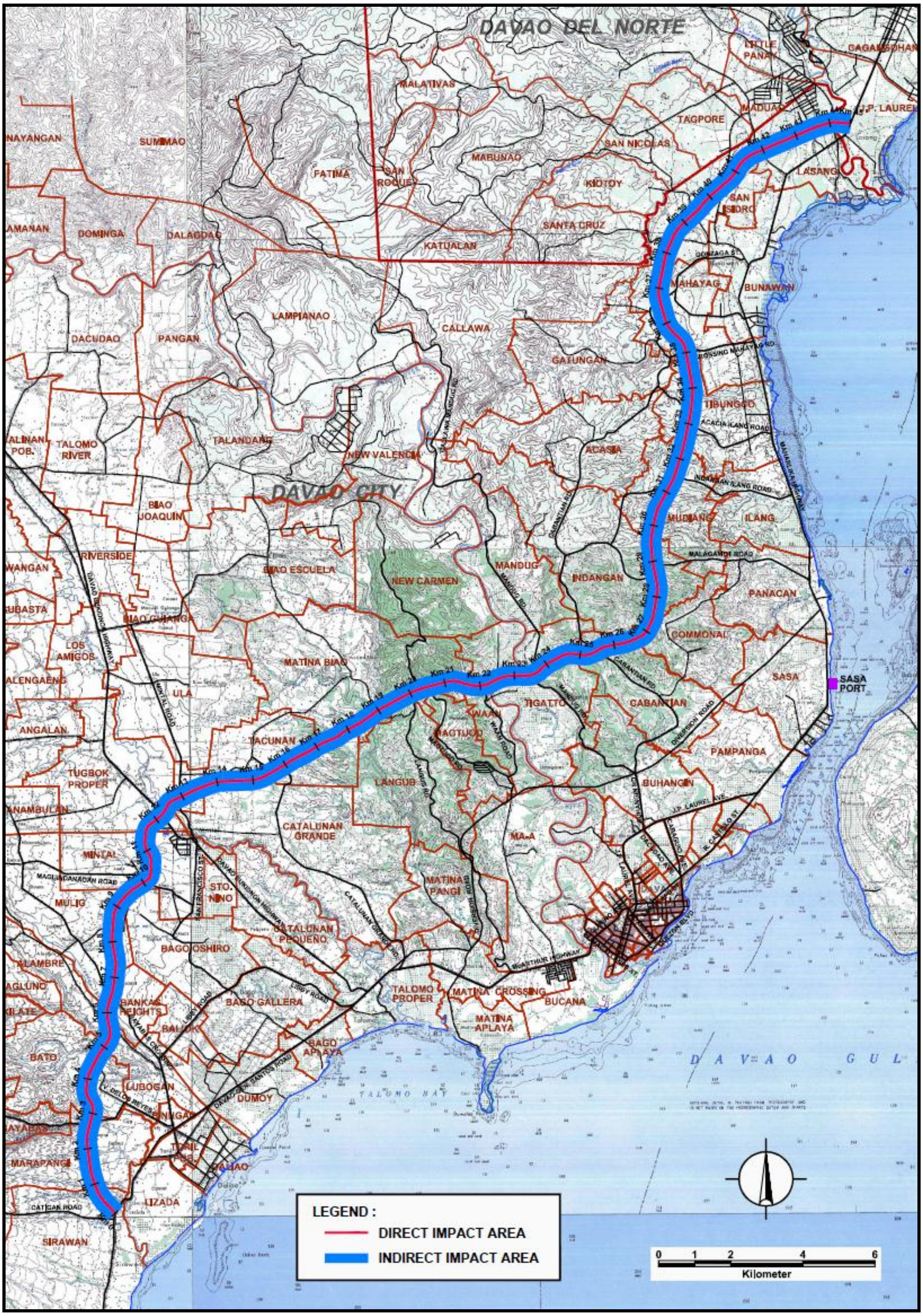
1.1.3 Accessibility of the Project Site

Davao City is one of the premier cities in the Philippines, where the road network system is well-established. The project site can easily be accessed through existing City, Barangay, Provincial Roads, and National Highways.

On the south, the project area can be accessed through *Davao-Digos National Highway* and existing roads among others *Bayabas-Eden Road*, *Bayabas-Crossing Road*, *San Miguel Proper Road*, *Maguindanaoan Road*, and *Mintal Road* (Figure.

The center section of the alignment is accessible via Davao-Bukidnon National Highway. Other roads available include *Catalunan Grande Road*, *Langub Road*, *Magtu-od Road*, *Waan Road*, *Mandug Road*, and *Cabantian Road*.

The existing *Davao-Agusan National Highway* is the arterial road on the north section of the project. A number of City and Barangay Roads linked to the National Highway are Mahayag Road, Indangan-Ilang Road, Acacia –Ilang Road, and Crossing-Mahayag Road.



Source: JICA Study Team, July 2014

Figure 1.1.2-1 Impact Area Map

1.2 PROJECT RATIONALE

The Mindanao has for decades lagged behind the rest of the Philippines in terms of economic development despite its agro-fishery, mineral and human resources potentials. However, in recent years the region has been showing faster economic growth than the rest of the country, and the signing of the *Bangsamoro Peace Framework Agreement* between the government and the Moro Islamic Liberation Front (MILF) in October 2012 is expected to accelerate the recent economic development. Davao City, the third and the most major city in Mindanao, is expected to play a leading role in the economic growth. Major urban roads in Davao City have **4-lanes** (**2-lane**s per direction), but are insufficient to ease it severe traffic congestion. Similarly, traffic from and to Sasa and Panabo Ports is also frequently experiencing traffic congestion, affecting the transportation of goods.

In July 2010, JICA conducted a Master Plan on High Standard Highway Network Development, which proposed improvement of the Tagum-Davao-General Santos Corridor and the construction of a diversion road in Davao City as a priority project.

Road widening and improvement project of the above corridor is on-going for many parts of sections, such as **4-lane** widening of present **two-lane** section, and slope protection construction by World Bank and other funds.

Regarding Davao City Bypass Project, the Department of Public Works and Highways (DPWH) conducted a Business Case Study (BCS) and the study results, both economic and financial aspects was the basis to determine whether the Project is qualified for a Public-Private-Partnership (PPP) and/or as a conventional Government project.

DPWH is studying the utilization of Yen loan as one of candidate sources of funding in order to implement the Davao City Bypass Project. Both JICA and DPWH recognized that this Project is a very important project for traffic improvement in Davao City and Mindanao Eastside Area as agreed upon in the Minutes of Discussion on the contents of Preparatory Survey for the Project in 1 February 2013.

Davao City Bypass is necessary due to the following reasons:

- To reduce traffic congestion of Davao City Urban Center where average travel speed is less than **20 km/hr**;
- To disperse urbanization outside Davao City Urban Center which is already over-saturated;

- To strongly support economic activities of not only Region XI but also the entire Mindanao;

- To provide better access to Sasa Port and Panabo Port; and

- Diversion road is getting congested and it has to climb up and down the mountain (gradient is **6.5-7.0%**)

1.3 PROJECT ALTERNATIVES

1.3.1 Alignment Selection of the Davao City Bypass

1.3.1.1 Davao City Bypass Development Strategy

The Davao City Bypass development strategy was proposed as follows:

- Bypass should be so planned that through traffic can be diverted to the Bypass. (Road standards should be as high as possible and a bypass length should be as shorter as possible);

- Bypass should also be so planned that the Urban Center related traffic from/to surrounding areas can be diverted to the Bypass. (Existing roads which intersect with the Bypass should be improved);

- Bypass should be so planned that it will guide sound urbanization of inland areas of the city; and

- Bypass should be planned to provide easier access to other transport facilities, such as an airport and sea ports

1.3.1.2 Basic Policy of Alignment Study

Basic policies for selecting the optimum alignment were established as follows:

- Since the alignment selected by BCS has been consulted with Davao City Government, it will be a basis for alignment study;

- Tunnel section will be selected in due consideration of topographic and geological conditions;

- Existing and planned development should not be affected as much as possible;

- Alignment will be so selected to minimize relocation of people;

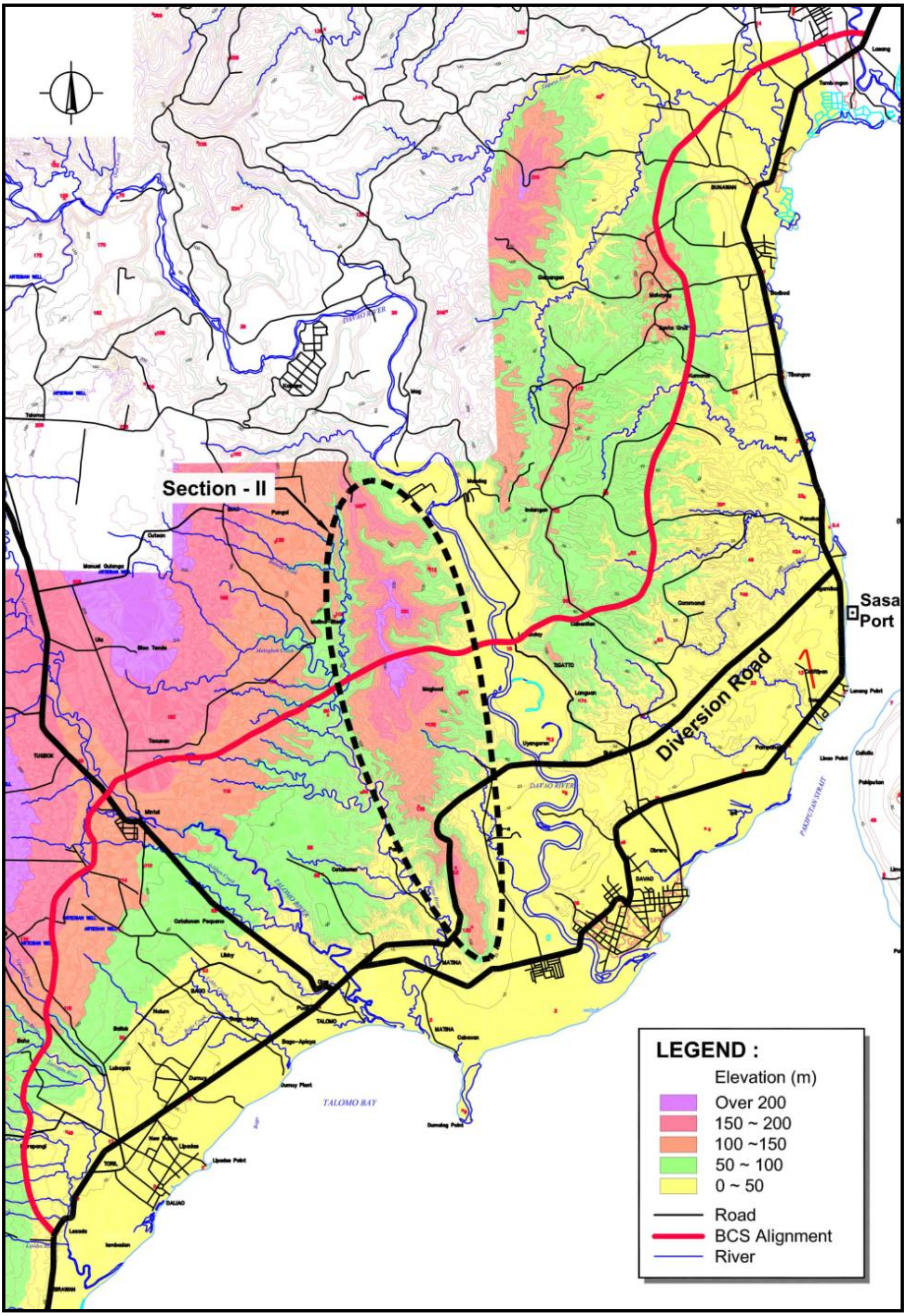
- How to connect with intersecting roads will be carefully studied;

- Connection with the Davao International Airport, Sasa Port, private ports, etc. will be carefully considered; and

- Consensus on selected alignment will be reached with not only government agencies but also residents in the affected areas

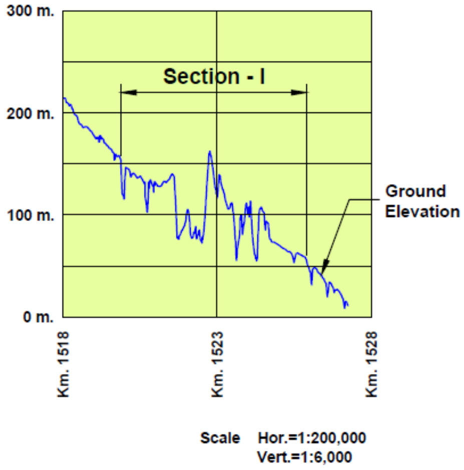
1.3.1.3 Terrain Characteristics

The terrain characteristic in terms of ground elevation of the Project Area is shown in **Figure 1.3.1-1.**



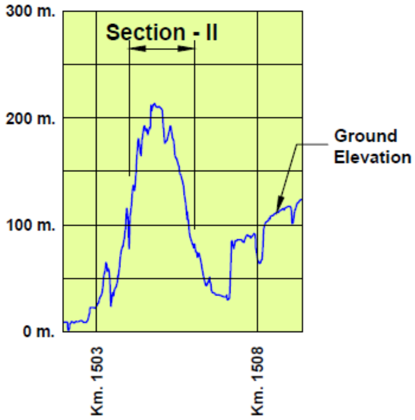
Source: JICA Study Team, July 2014

Figure 1.3.1-1 Terrain Characteristics of the Study Area



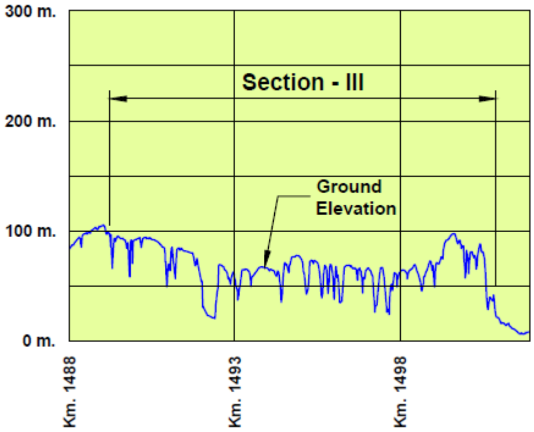
Section-1: South Section

- The topography is quite complex and undulating; and
- Located at the foot of Mt. Apo, of which slope has been eroded/ scoured and numerous rivers/ valleys were formed



Section-II: Tunnel Section

- Elevation varies from 15m to 215m within 2km section, ground inclination varies from about 10% to **12%**; and
- A tunnel is needed



Section-III: North Section

- The topography is quite complex and undulating; and
- The Plateau was eroded/scoured and numerous rivers/valleys were formed

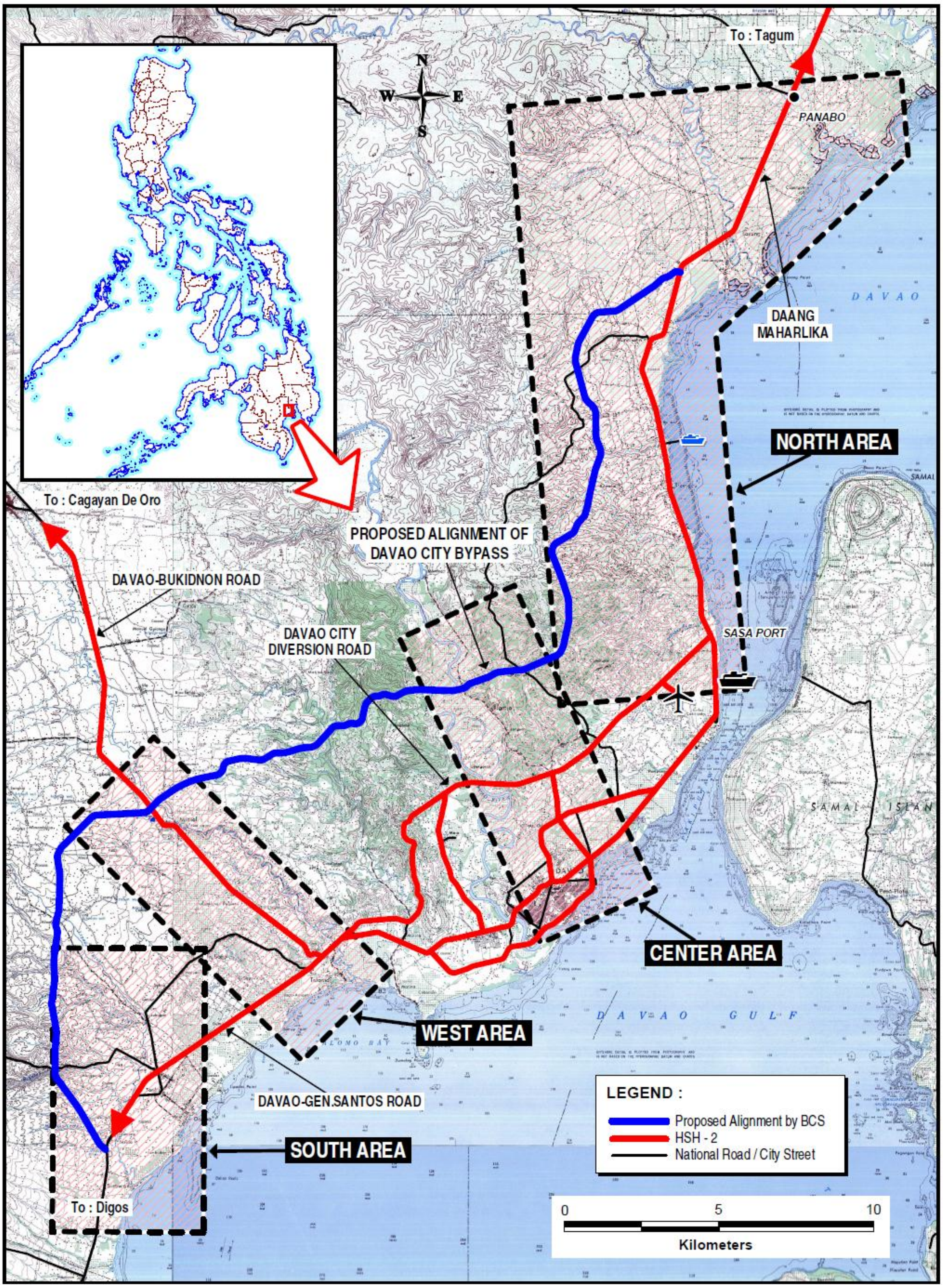
1.3.1.4 Possible Spaces (Corridors) for the Bypass

Urban development is progressing mainly along the following National Roads;

- Davao- General Santos Road in the south;
- Davao- Bukidnon Road in the west;
- Diversion Road in the center; and
- Daang Maharlika in the north

Due to existing development along the above national roads, the spaces where the bypass can pass through (or the bypass corridors) is rather limited.

Based on the latest satellite photos, the possible spaces (corridors) for the bypass for the above **four** (**4**) areas was identified and are presented in **Figure 1.3.1-2**.



Source: JICA Study Team, July 2014

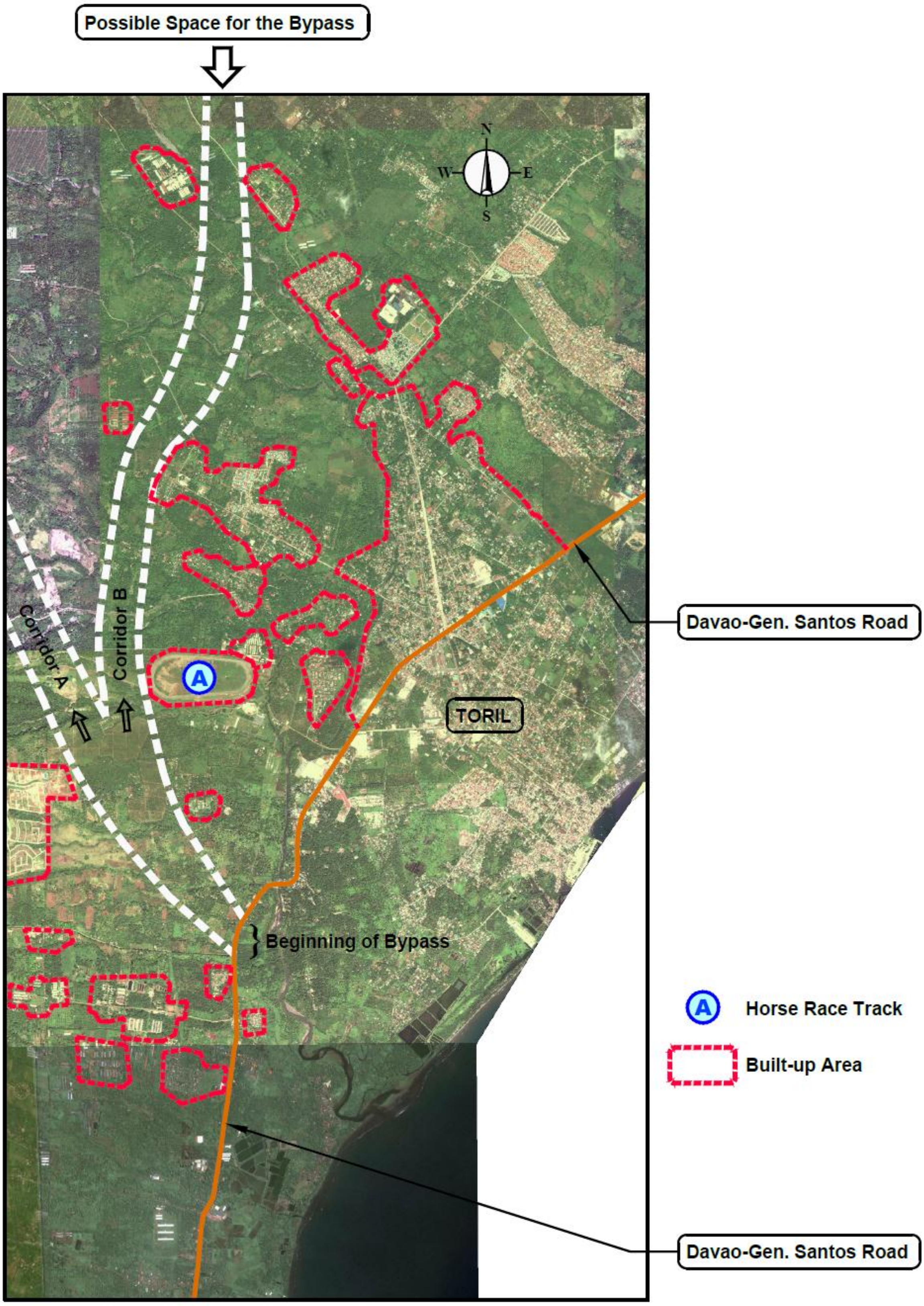
Figure 1.3.1-2 Areas for Study on Possible Space (Corridor) for the Bypass

(1) Possible Space for the Bypass in the South Area

In the south area, urban development is progressing along Davao-General Santos Road. The said is urban development is illustrated in **Figure 1.3.1-3**.

Beginning of the Bypass: Since Toril is one of the busiest urban areas in Davao City and there is no large urban areas in the south of Toril, the Bypass should start at the south of Toril.

Possible Space for the Bypass: There are **two** (**2**) possible spaces (corridors) for the Bypass. **Corridor A** is the space proposed by the Business Case Study which passes through the in-land area along the slope of Mt. Apo and the terrain is quite complex (or undulating). Corridor A passes through far from the urban areas. Whereas **Corridor B** passes through the open areas closer to the urban center with the shorter road length than Corridor A. Alternative alignments along Corridors A and B are studied for detailed comparison of advantages of alignments.



Source: JICA Study Team, July 2014

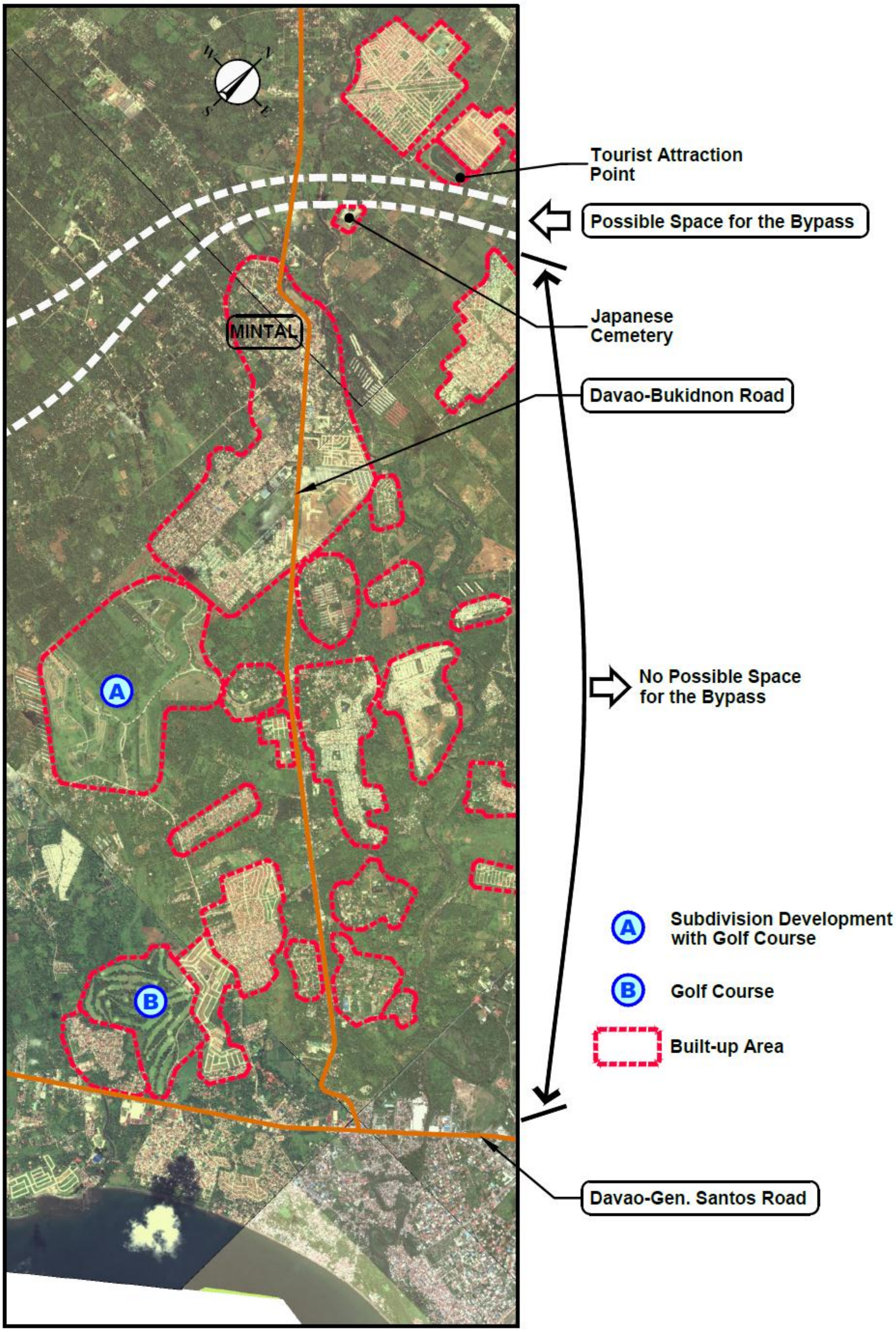
Figure 1.3.1-3 Possible Spaces (Corridors) for the Bypass in the South Area

(2) Possible Space for the Bypass in the West Area

In the west area, road sides along Davao-Bukidnon Road is highly urbanized as shown in **Figure 1.3.1-4**, there is no space for the Bypass to pass through up to Mintal. Possible space for the Bypass is only located at the north of Mintal.

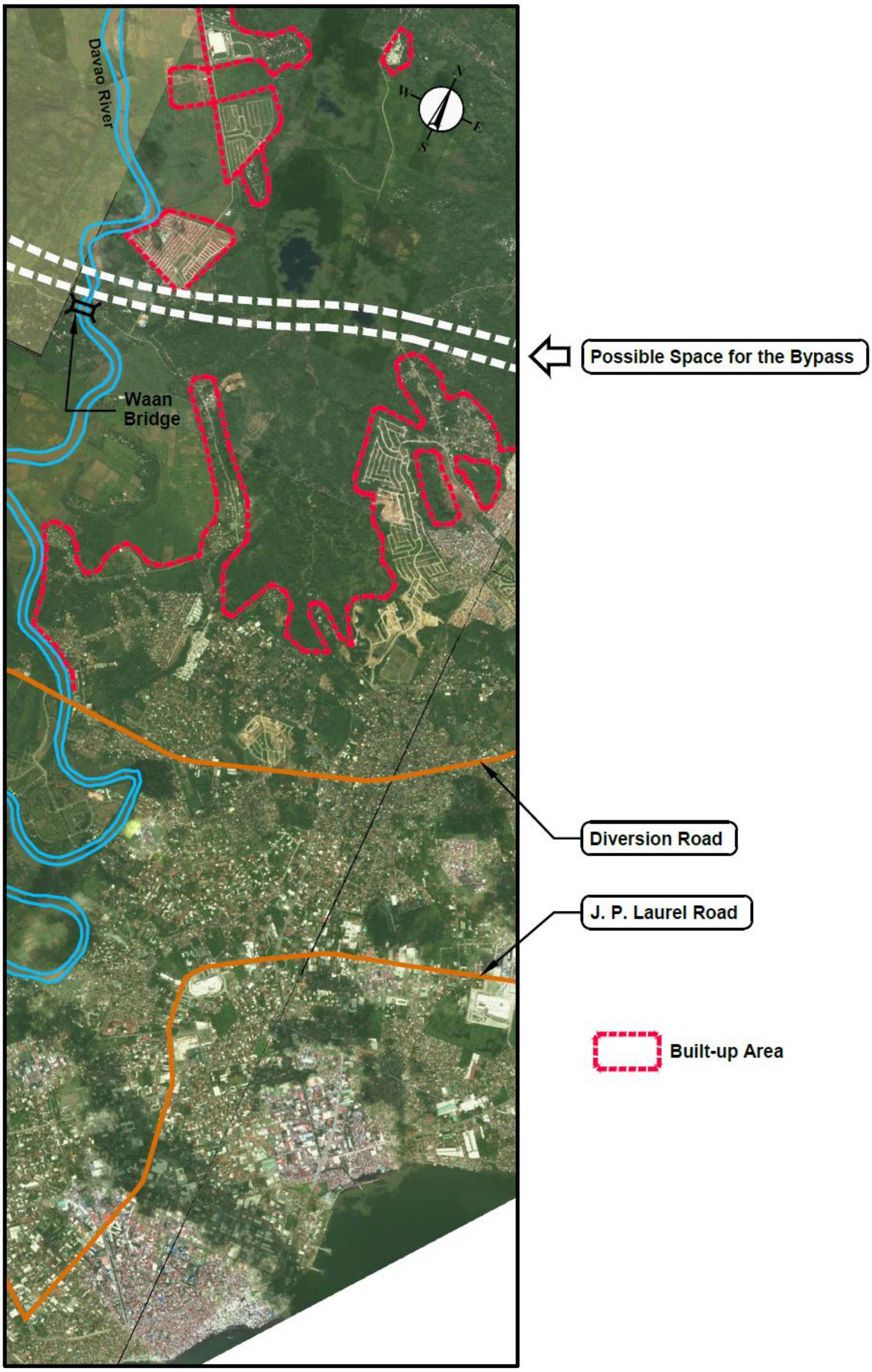
(3) Possible Space for the Bypass near Davao River in the Center Area

Possible space for the Bypass near Davao River in the Center Area is shown in **Figure 1.3.1-5**. There is narrow space for the Bypass near the existing Waan Bridge.



Source: JICA Study Team, July 2014

Figure 1.3.1-4 Possible Space (Corridor) for the Bypass along Davao-Buidnon Road (West Area)



Source: JICA Study Team, July 2014

Figure 1.3.1-5 Possible Space for the Bypass Near Davao River (Center Area)

(4) Possible Space for the Bypass in the North Area

1) Traffic Condition along Daang Maharlika

Urbanization and industrial estates are progressing along Daang Maharlika along which relatively high concentrations of commercial activities are observed at Panacan, Tibungco, and Bunawan (see **Figure 1.3.1-6**). In these areas, through traffic is highly disturbed by parked vehicles on the road and local traffic of tricycles and jeepneys.

Photo No. 1.3.1-1 Photo showing the existing traffic condition at Panacan

Photo No. 1.3.1-2 Photo showing the existing traffic condition at Tibungco

2) Ports in the North Area

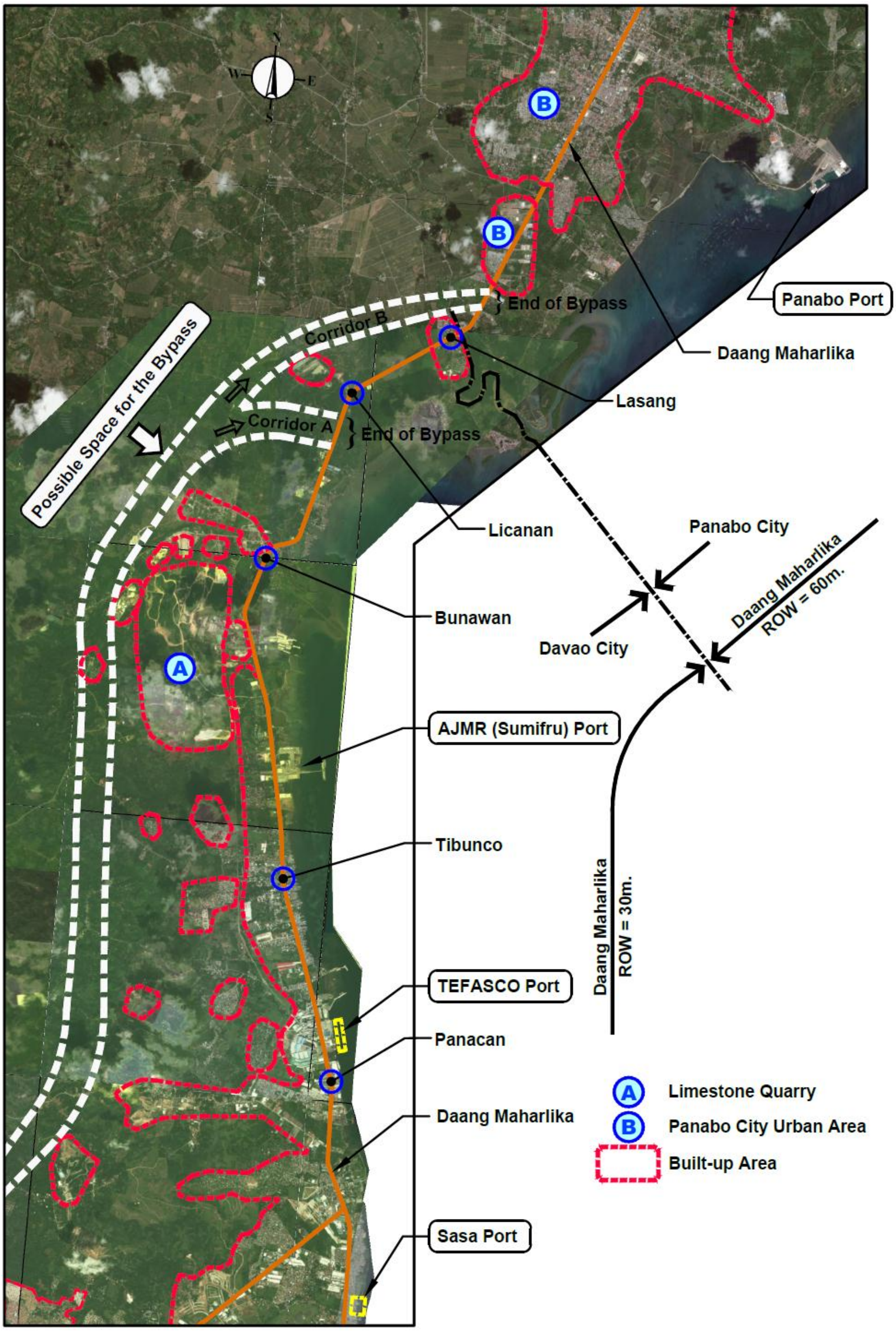
Sasa Port is the only public port in the north area of Davao City. The other **three** (**3**) private ports are Terminal Facilities and Services Corporation (TEFASCO) Port, AJMR (Sumifro) Port, and Panabo Port.

The Bypass should be so planned that accessibility to these ports will be improved to support economic development. These ports are used by manufacturing companies and agro-industry in the study area.

3) Possible Space for the Bypass

In the north area, possible space for the Bypass is available almost in parallel with Daang Maharlika. Available space is found at **2-3 km** west of Daang Maharlika as shown in **Figure 1.3.1-6**. There are **two** (**2**) options (Corridor-A and Corridor-B) for the end point of the proposed Bypass and are presented as follows:

1) Corridor-A: Ends at slightly south of Licanan; and
2) Corridor-B: ends at southern end area of Panabo City



Source: JICA Study Team, July 2014

Figure 1.3.1-6 Possible Spaces (Corridors) for the Bypass in the North Area

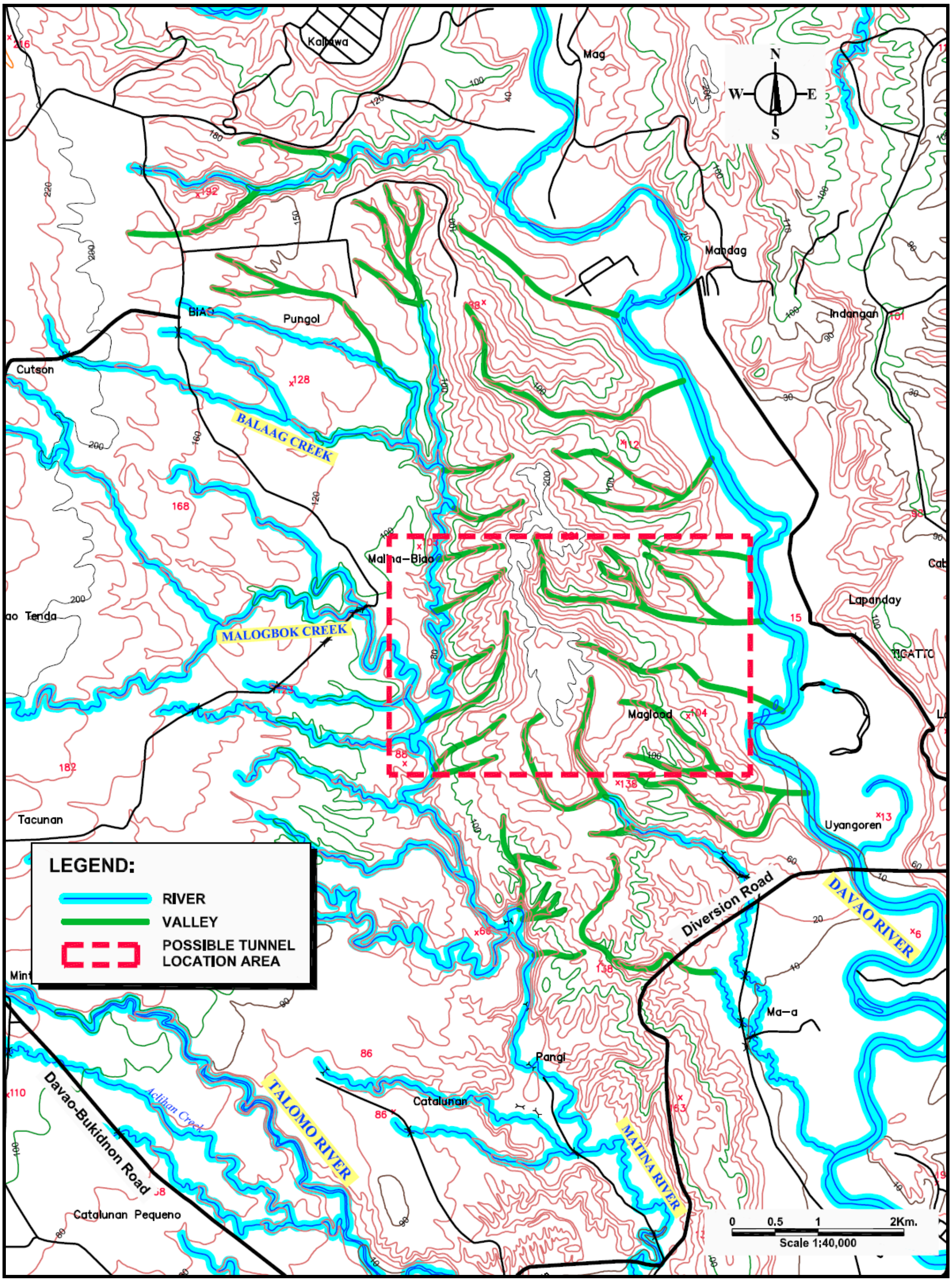
1.3.2 Selection of Center Section Alignment

The Center Section includes a **tunnel**. Firstly, tunnel alternative alignments were studied, and then the Center Section alignments which include approach sections to a tunnel were evaluated.

1.3.2.1 Topographical Feature

The topographical feature of the tunnel section is shown in **Figure 1.3.2-1**, and summarized as follows:

- Elevation varies from **15 m** to **215 m** within the length of about **1.5 km** to **2.0 km**;
- Ground surface gradient ranges from **10%** to **15%**;
- The mountain is surrounded by **two** (**2**) rivers; Davao River at the east side and Matina River at the west side; and
- The mountain has been eroded and many valleys are formed



Source: *JICA Study Team, July 2014*

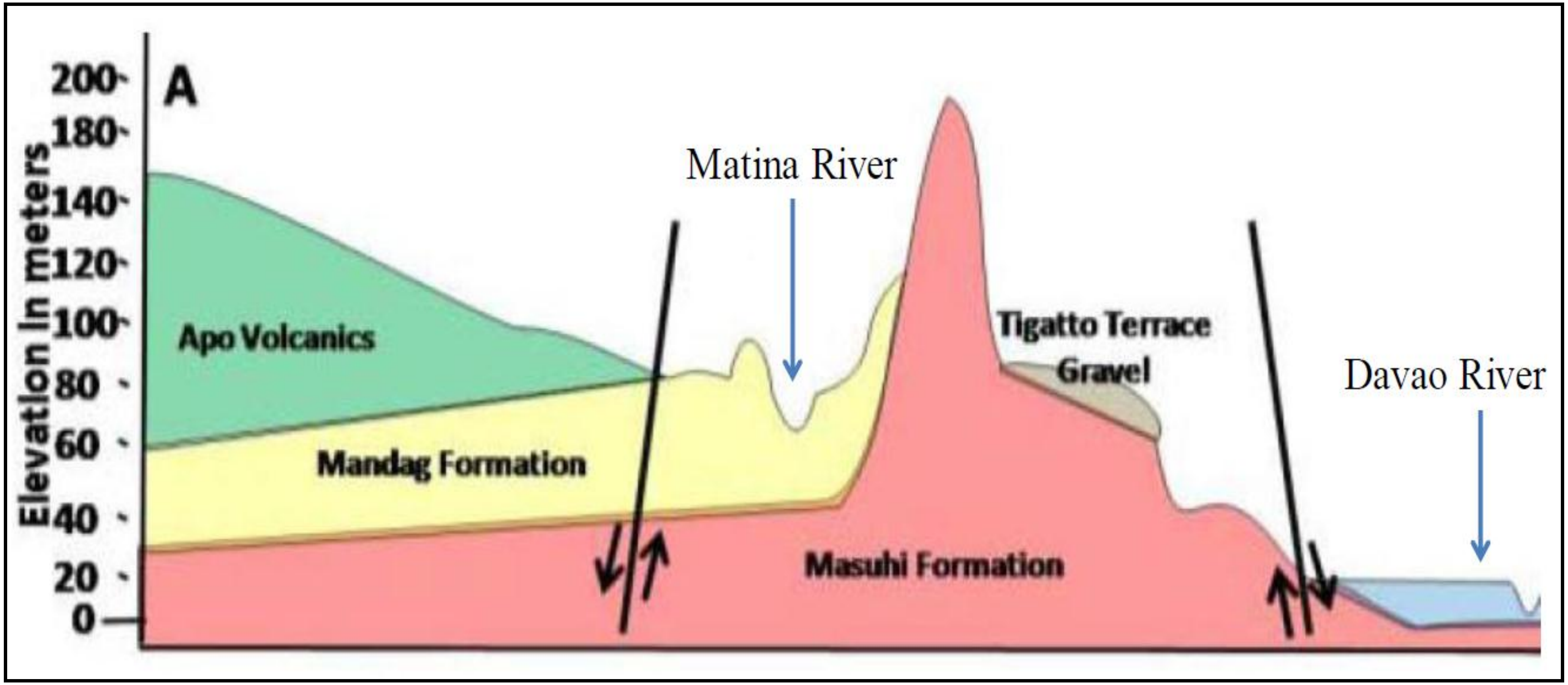
Figure 1.3.2-1 Topographical Feature of the Tunnel Section

Photo No. 1.3.2-1 Photo showing the west side of the area to be traversed by the proposed tunnel.

Photo No. 1.3.2-2 Taken at the east side section of the tunnel.

1.3.2.2 Geological Structures

As shown in **Figure 1.3.2-2**, the geologic structure of the tunnel section is primarily made of Masuhi Formation. This formation is composed of sandstone, mudstone, and conglomerate of the Tertiary Miocene Pliocen (see **Photo No. 1.3.2-3**). It is expected that tunnel excavation can be done **without blasting**.



Source: JICA Study Team, July 2014

Figure 1.3.2-2 Geological Profile at the Tunnel Section

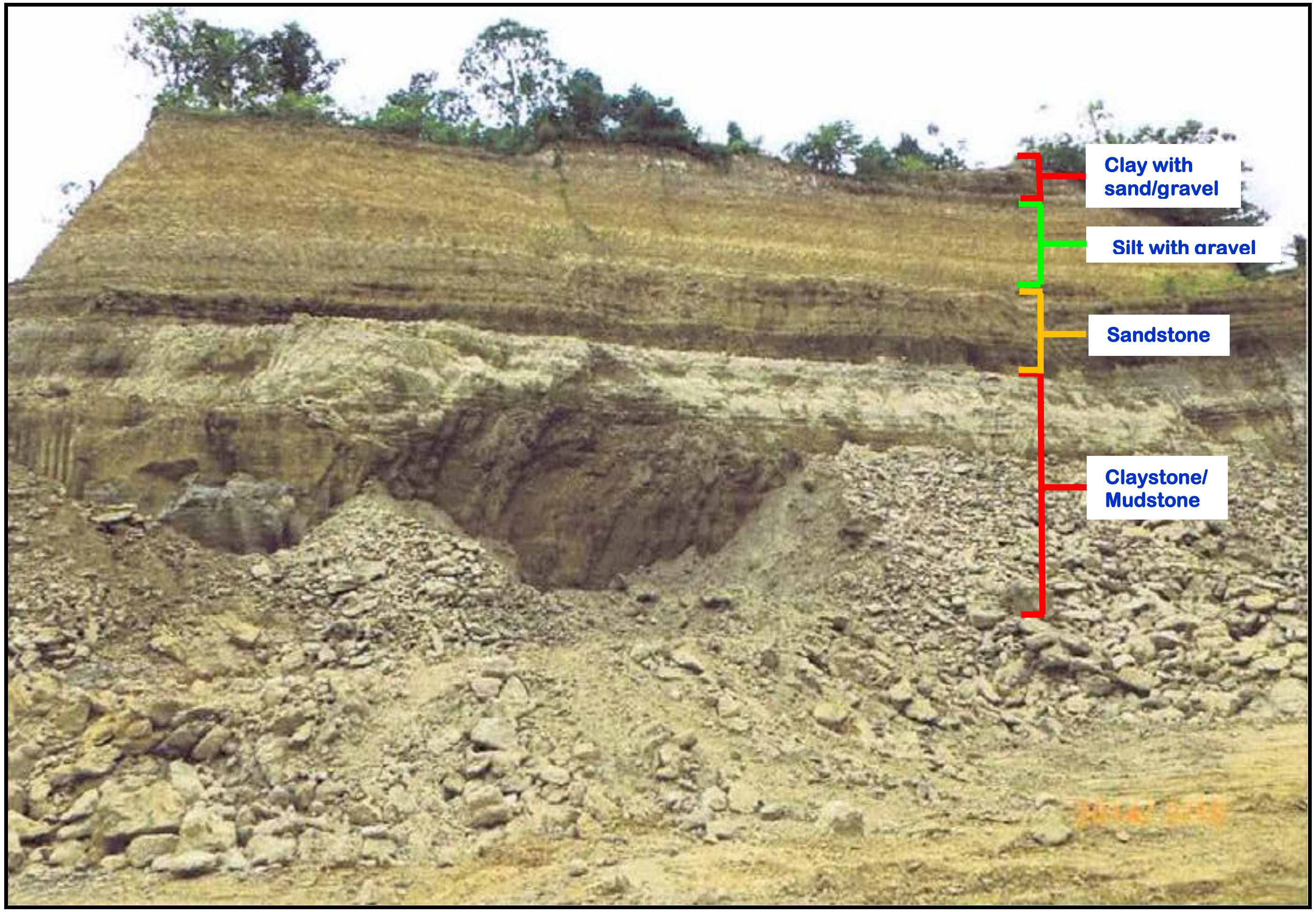


Photo No. 1.3.2-3 Excavated condition at a quarry site about **1 km** from the tunnel section.
(*Source: JICA STUDY Team, July 2014*)

1.3.2.3 Topography vs. Tunnel Center Line

A tunnel centerline must be selected in due consideration of easier construction and operation/maintenance. In the selection of tunnel centerline, it is quite important to analyze topographical characteristics of tunnel corridor. **Figure 1.3.2-3** shows the location of the centerline against topography.

(1) Type-1: Tunnel Centerline is Perpendicular to Mountain Slope

A tunnel centerline is selected almost perpendicular to the mountain slope. This is the most ideal type for a tunnel on the condition that the mountain slope is not subjected to a landslide.

When a tunnel portal is selected at the middle of slope, an access road to a tunnel portal during construction is needed.

(2) Type-2: Tunnel Centerline is Diagonal to Mountain Slope

A tunnel centerline is selected diagonal to the mountain slope. When an inclination of rock layers is the same as that of a mountain slope, unsymmetrical earth pressure is expected, thus, this type of tunnel location should be avoided as much as possible.

(3) Type-3: Tunnel Centerline Passes at Valley

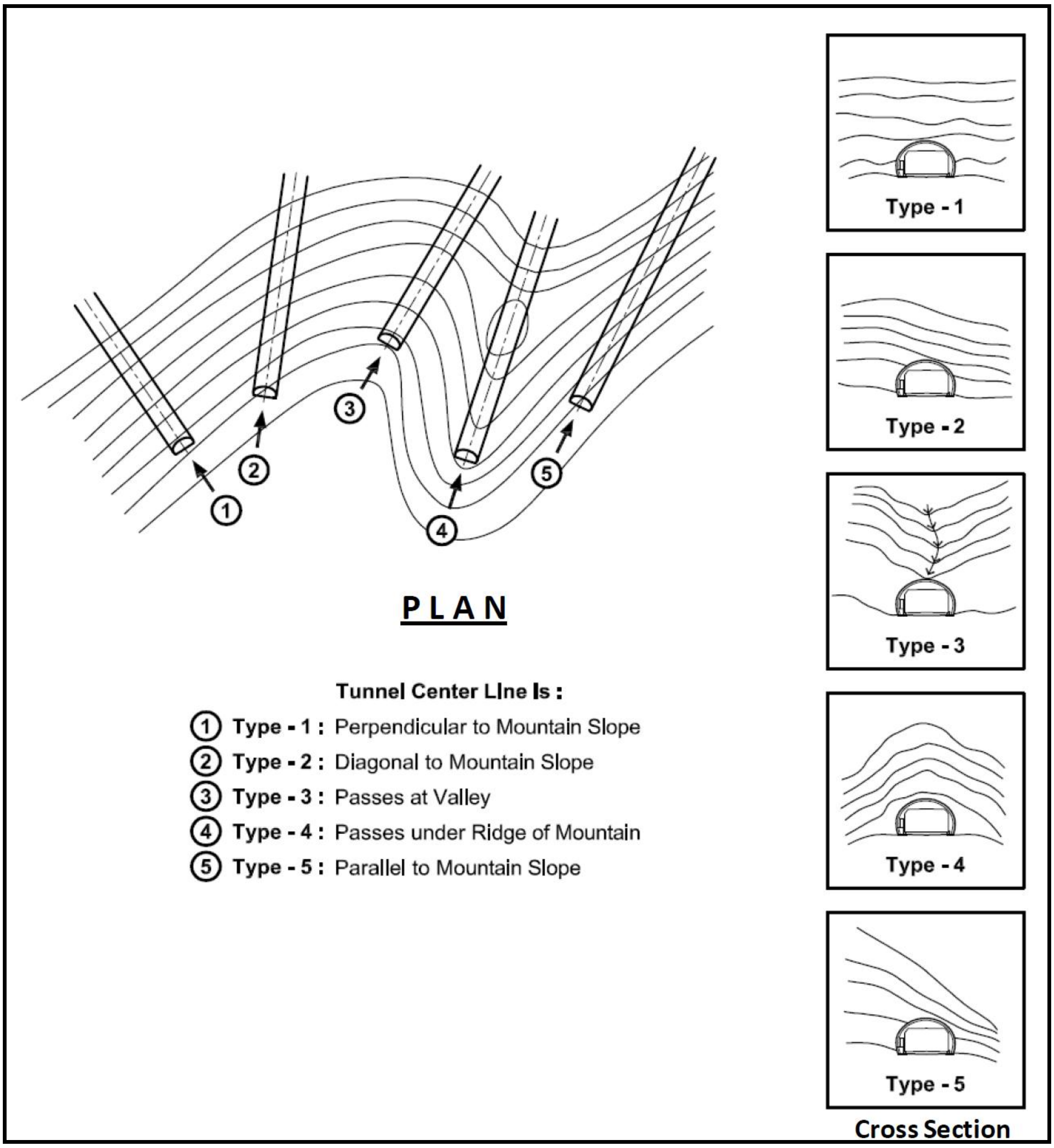
Valley is usually subjected to water flow, debris flow, etc., a tunnel location should not be selected at this type of location.

(4) Type-4: Tunnel Centerline Passes under Ridge of Mountain

When bedrocks are found and thickness of weathered rock is thin, no problem is expected. There are some cases that talus deposit is quite thick due to past collapse of a mountain, detailed geological analysis is needed.

(5) Type-5: Tunnel Centerline is almost Parallel to Mountain Slope

There are cases that earth thickness over a tunnel drastically changes at one side of a tunnel and unsymmetrical earth pressure is subjected to a tunnel cross section, this type of location should be avoided as much as possible.



Source: JICA Study Team, July 2014

Figure 1.3.2-3 Topography Against the Tunnel Centerline

1.3.2.4 Alternatives of Tunnel Alignment

(1) Alternatives and Pres-Screening

The following **three** (**3**) groups of alternative alignments were compared:

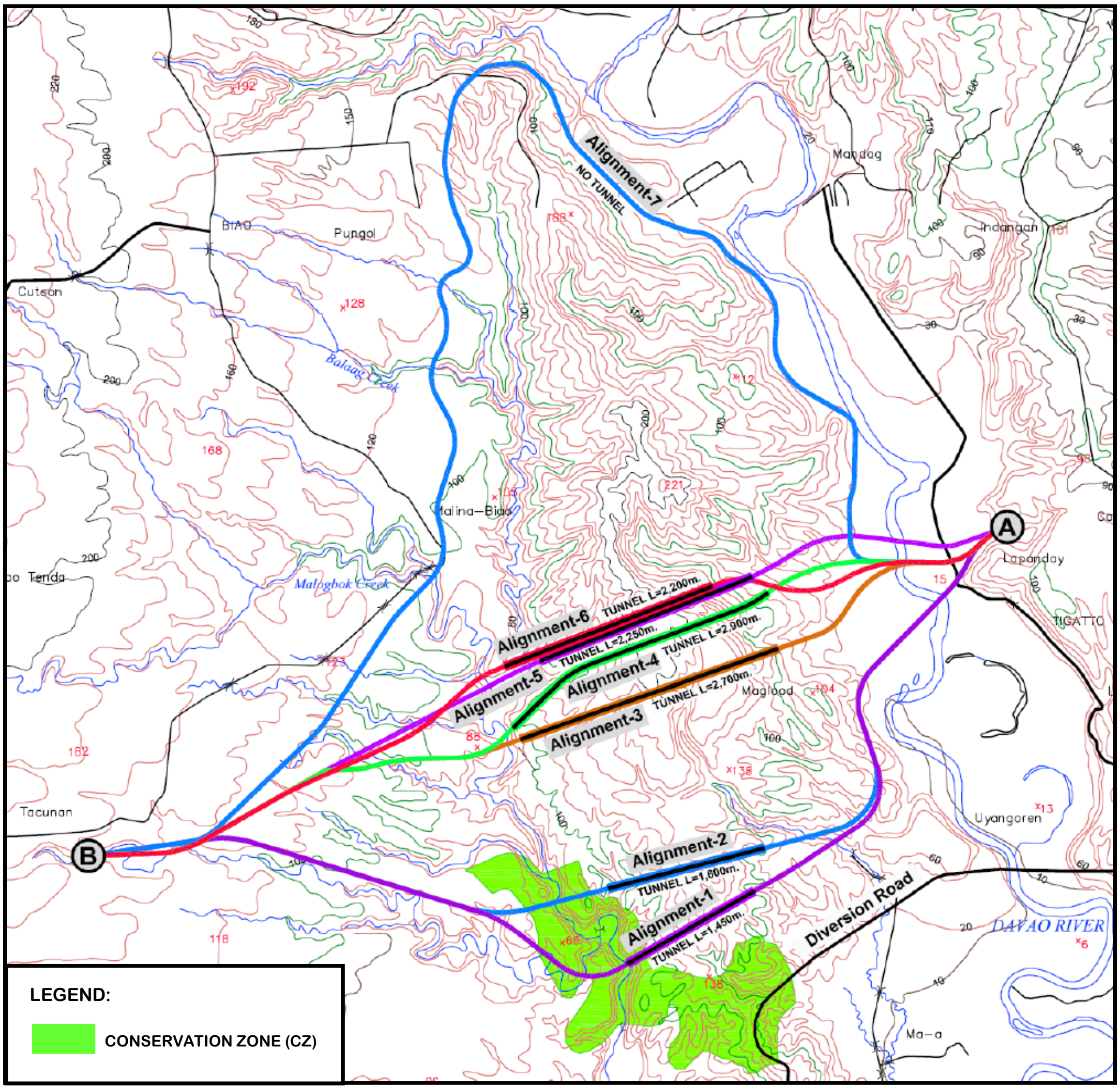
Group-1	Alternative which requires a shorter tunnel length. Topographic conditions are evaluated and two (2) alternative alignments are selected.
Group-2	Alternative which requires a shorter road length and attracts more traffic, since the bypass should attract as many traffic as possible to reduce traffic problems in the Urban Center. Four (4) alternatives are selected.
Group-3	Alternative which does not require a tunnel. This alternative requires a long detour to climb up/down the mountain. This group intends to reduce construction cost; however, function of a bypass is sacrificed. A few traffic is expected to divert to a bypass of this group. One (1) alternative is selected.

Table 1.3.2-1 presents the summary of the **seven (7)** alternatives that were selected, while the alignments are shown in **Figure 1.3.2-4**.

Table 1.3.2-1 Alternatives of Tunnel Section

Group	Alter-native	Concept	Road Length between A&B	Tunnel Length (m)	Attracted Traffic (2013 OD) (veh/day)	Pre-screening
1	1	• Reduce Tunnel Length	12.0 km (+2.1 km)	1,450	3,500	×
	2	• Reduce Tunnel Length	11.4 km (+1.5 km)	1,600	3,600	×
2	3	• Make road length shorter to attract traffic on bypass	9.9 km (+0.1 km)	2,700	5,300	O
	4	• Make road length shorter to attract traffic on bypass	9.9 km (+0.1 km)	2,900	5,300	O
	5	• Make road length shorter to attract traffic on bypass	9.8 km (+0.0 km)	2,250	5,300	O
	6	• Make road length shorter to attract traffic on bypass	9.9 km (+0.1 km)	2,200	5,300	O
3	7	• Alignment which does not require tunnel	18.6 km (+8.8 km)	0 (No Tunnel)	1,600	×

Source: JICA Study Team, July 2014



Source: *JICA Study Team, July 2014*

Figure 1.3.2-4 Alternative Alignments of Tunnel Section

1) Pre-Screening

Two (**2**) alternatives, namely Alternatives -1and -2, are screened out from the alternatives due to the following reasons:

- Although tunnel length becomes shorter than Group-2 alternatives, road length becomes longer by **2.1km** (Alternative-1) and **1.5km** (Alternative-2);
- Due to longer road length or travel length, attract less traffic on the bypass than Group-2 alternatives, which means less contribution for reduction of traffic problems in the urban center; and
- Approach road section to a west tunnel portal passes through Conservation Zone, thus it is not favorable for road construction

Comparison of Alternatives which Passed the Pre-Screening

Five (**5**) alternatives, namely Alternatives 3, 4, 5, 6, and 7 passed the pre-screening, which are subjected to the detailed comparison. Profiles of tunnel section of **four** (**4**) alternatives are shown in **Figure 1.3.2-5**. Comparison of tunnels is shown in **Table 1.3.2-2**.

Table 1.3.2-2 Comparison of Alternative of Tunnel Portion

Alt.	Tunnel Length (m)	Elevation of Portal		Vertical Grade of Tunnel Approach		Issues	Tunnel Construction Cost (Million Php)
		West side	East side	West side	East side		
3	2,700m (+500m)	70.0	49.5	3.4%	3.7%	• 500 m longer than Alt.6; and • East approach requires high embankment or a viaduct.	2,371 (1.21) (878M. Php/km)
4	2,900m (+700m)	65.0	58.2	4.6%	5.0%	• Longest tunnel required; and • Tunnel has to pass under a deep valley, special construction method for 200 m section required.	2,562 (1.31) (883M. Php/km)
5	2,250m (+50m)	60.0	57.5	3.1%	2.5%	• 50 m longer than Alt.6; and • At west side of west portal, low ground area for 500 m in length exists where bridges and high embankment is needed.	1,993 (1.02) (886 M. Php/km.)
6	2,200m (0)	60.0	59.0	3.8%	4.0%	• Shortest tunnel; and • East approach needs high embankment or viaduct	1,949 (1.00) (886M. Php/km)
7	No Tunnel						

Source: JICA Study Team, July 2014

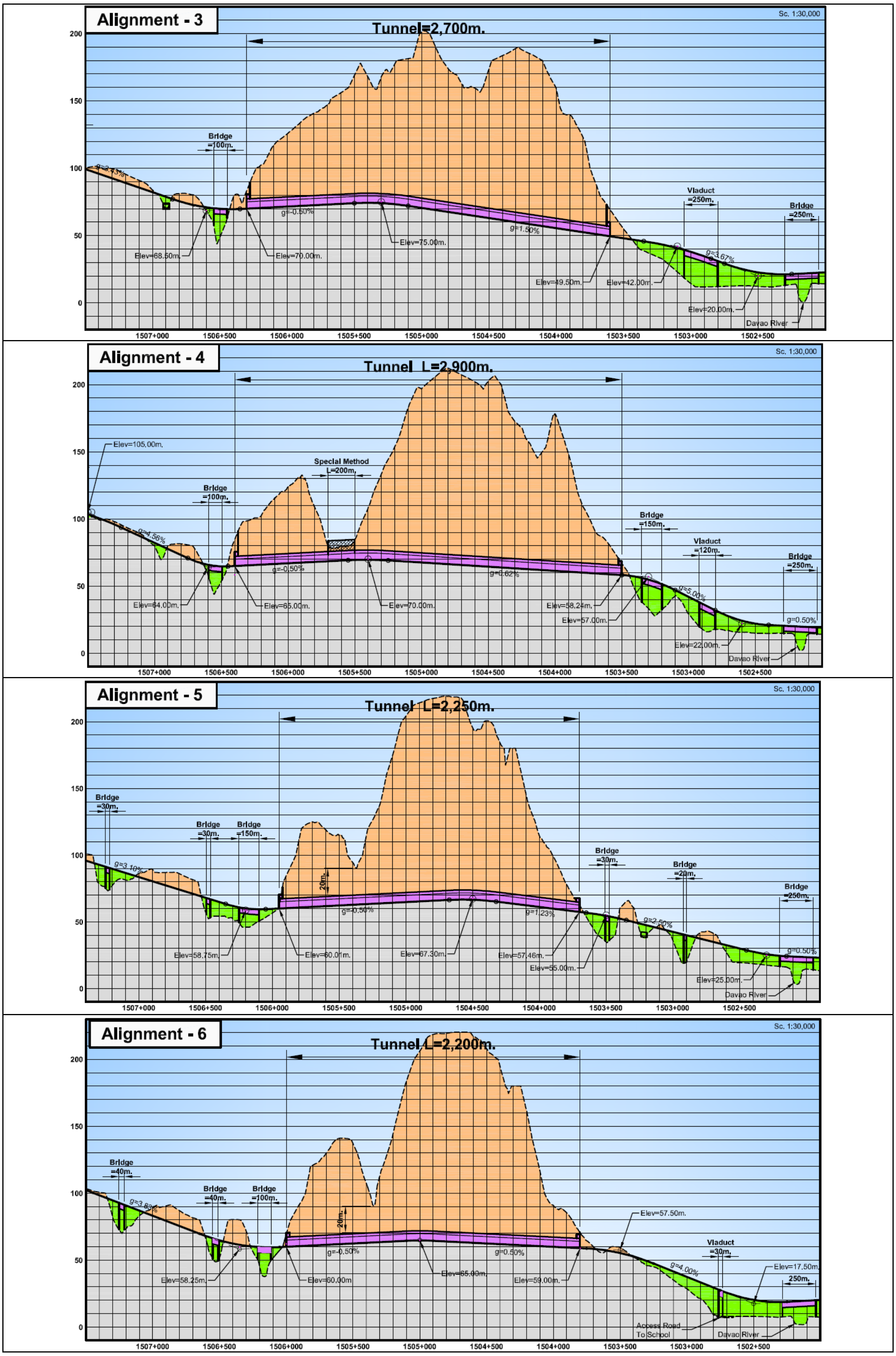


Figure 1.3.2-5 Profile of Tunnel Section *(Source: JICA Study Team, July 2014)*

1.3.2.5 Evaluation of Alternatives of Center Section as a Whole

Alternatives based on a tunnel alignment are shown in **Figure 1.3.2-6**.

(1) Evaluation Items

The following evaluation criteria were established:

a) Traffic Volume Attracted on to the Bypass

When attracted traffic is higher, the better

b) Cost

Construction cost and ROW acquisition cost was estimated. The lesser the cost, the better.

c) Connection with the Urbanized Area

The bypass should have better connection with the urbanized area. The shorter access distance from the bypass to the urbanized area, the better.

d) Impact on Natural Environment

Two (**2**) factors were considered for this criteria.

d-1) Cut Slope Erosion: When a slope is cut, it is subjected to erosion, thus lesser slope cutting in terms of cut volume (in $\mathbf{m^3}$), the better.

d-2) Tree Cutting: When more trees are cut, it is subjected to more possibility of flooding due to less filtration of rain water into the ground and also subjected to loss of absorption capacity of CO_2. Thus, lesser tree cutting, the better.

e) Social Impact

For the project's potential impact to the society, t**wo** (**2**) factors were also considered.

e-1) Number of Affected Houses/Buildings: When more houses/ buildings are affected and more residents will be force to relocate, the more impacts on their lives and livelihood. Thus, the lesser number of houses/buildings, the better.

e-2) Affected Agricultural Land: Most of the areas long the Project are agricultural plantation area, such as coconuts, bananas and mangoes. Many people along the project area rely their livelihood on agricultural plantation. When more agricultural land are taken by the project, the more people's lives and livelihood are affected. Impact on agricultural plantation was measured by a road length (in km) which passes through agricultural land.

f) Construction Period

Construction period was estimated. The shorter construction period, the better.

g) Road Network

Additional new link is better to strengthen the road network.

h) Impact of Residential Development

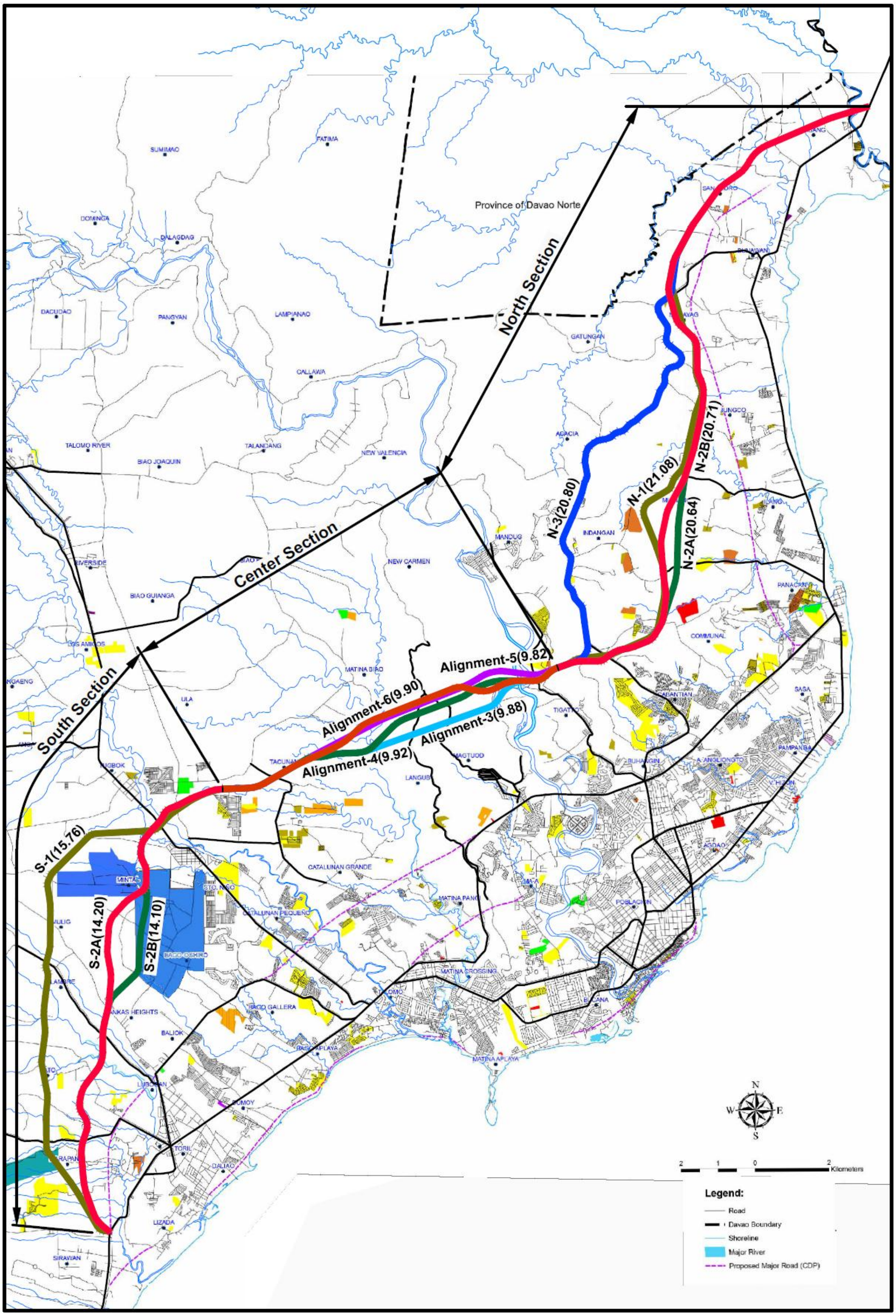
The proposed Bypass should support for the future residential area development. The nearer development area, the better.

i) Operation & Maintenance Cost (O&M)

Operation and Maintenance (O&M) Cost was estimated. The lesser, the O&M Cost, the better.

j) Other Aspects

Other aspects were evaluated by segregation of positive impacts and negative impacts.



Source: JICA Study Team, July 2014

Figure 1.3.2-6 Topographical Feature of the Tunnel Section

(2) Evaluation Criteria

a) For items quantified, the following criteria were established:

• For the alternative which achieve the lowest value (or highest value)	⇨	Good (○)
• For the alternative within 10% difference compared to the lowest (or highest)	⇨	Medium (△)
• For the alternative over 20% difference compared to the lowest (or highest)	⇨	Bad (X)

b) For items narratively described, impact was subjectively evaluated.

c) When all alternatives have the same value, the item(s) was not evaluated.

d) Evaluation

- Assessed by number of items evaluated as "Good", "Medium", and "Bad"; and
- An alternative which has more number of "Good" and least number of "Bad"

e) Overall Evaluation

Two (**2**) cases were tested as follows:

Case-1: Equal Rating for all evaluation items (or no weight was considered for each item); and

Case-2: Weighted Rating: Evaluation items of cost and number of houses/buildings affected were given three (3) times heavier weight.

(3) Evaluation of Alternatives

Result of the evaluation of alternative Case 1 is presented in **Table 1.3.2-3**.

(4) Recommendations

Alternative 6 was evaluated to be the most advantageous compared to the other alternatives in all aspects. It was **recommended** for the alignment of the Center Section due to the following:

- **Traffic Volume Attracted:** Alternatives 3-6 would attract much more traffic than Alternative 7;

- **Cost:** The cost is slightly higher than Alternative 7, but by only **2%** difference;

- **Impact to Natural Environment:** Almost the same evaluation result among Alternatives 3-6, but much better than Alternative 7 and

- **Number of Affected House/Buildings:** The least number of houses/buildings affected among all the alternatives

Though Alternative 7 is the cheapest for O & M cost among the alternatives, attracted traffic of Alternative 7 is much lower than others. Alternative 7 will not function as a bypass road and will not contribute to the reduction of traffic problems in the Urban Center and economic activities in Mindanao as a whole. So, Alternative 6 was recommended based on the total evaluation result.

Table 1.3.2-3 Evaluation Of Alternatives Of Center: Case-1 (1/2)

Evaluation Item		Alternative 3		Alternative 4		Alternative 5		Alt.ernative6	
Concept of Alternative		• To avoid a tunnel to pass under a deep valley; and • To select narrower river crossing at west portal		• To avoid passing through residential area at east side; and • To select narrower river crossing at west portal		• To achieve shorter tunnel length; • To avoid passing through residential area at east side; and • To achieve more than 20m earth cover at a deep valley		• To achieve shorter tunnel length; • To avoid passing through residential area at east side; • To achieve more than 20m earth cover at a deep valley; and • To select narrower river crossing at west portal	
Road Length (km)		9.87 (+0.05km (1.01))		9.92 (+0.1km) (1.01)		9.82 (0.0) (1.00)		9.90 (+0.08km) (1.01)	
Tunnel Length (km)-		2.70 (+0.5km) (1.23)		2.90 (+0.7km) (1.32)		2.25 (+0.05km) (1.02)		2.20 (0.0) (1.00)	
Traffic Volume Attracted (veh/day in 2013 OD)	North Section: N-1 & N-2 South Section: S-2	5,320 (1.00)	-	5,320 (1.00)	-	5,320 (1.00)	-	5,320 (1.00)	-
	North Section: N-3 South Section: S-1	3,490 (1.00)	-	3,490 (1.00)	-	3,490 (1.00)	-	3,490 (1.00)	-
Cost (Million Php)	Construction Cost	3,525 (1.11)	-	3,486 (1.21)	-	3,240 (1.02)	-	3,189 (1.00)	-
	Row Acquisition Cost	128 (1.03)	-	124 (1.00)	-	132 (1.06)	-	134 (1.08)	-
	Total	3,653 (1.10)	△	3,970 (1.19)	X	3,372 (1.01)	○	3,323 (1.00)	○
Connection with the Urbanized Area		• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-
Impact on Natural Environment	Slope Cutting (m^3)	0.35 Million (1.06)	○	0.33 Million (1.00)	○	0.38 Million (1.15)	X	0.35 Million (1.06)	○
	Tree Cutting (Coconut, Mango, etc. & Secondary Forest)	5.17 km (1.01)	○	5.10 km (1.00)	○	6.02 km (1.18)	X	5.20 km (1.02)	○

Table 1.3.2-3 Evaluation Of Alternatives Of Center: Case-1 (2/2)

Evaluation Item		Alternative 3		Alternative 4		Alternative 5		Alt.ernative6	
Social Impact	No. of Affected Houses/ Buildings	45 (3.75)	X	16 (1.33)	X	16 (1.33)	X	12 (1.00)	○
	Affected Agri-land (Coconut, Banana, Mango, etc.)	4.43km (1.05)	○	4.23km (1.00)	○	4.30km (1.02)	○	4.30km (1.02)	○
Other Aspect s	Positive					• Shorter construction period thanAlt.3 & 4 but longer than Alt.6	△	• At approach section to east portal, bridge construction not needed, thus tunnel construction period is the shortest and easier than others.	○
	Negative	Longer construction period	X	• Longest construction period • Special construction method required at the middle of the tunnel	X				
Evaluation		○=3 △=1 X = 2		○= 3 △= 0 X = 3		○2 △1 X= 3		○=6 △=0 X = 0	
Recommendation								**Recommended**	

Source: JICA Study Team, July 2014

1.3.3 Selection of the South Alignment

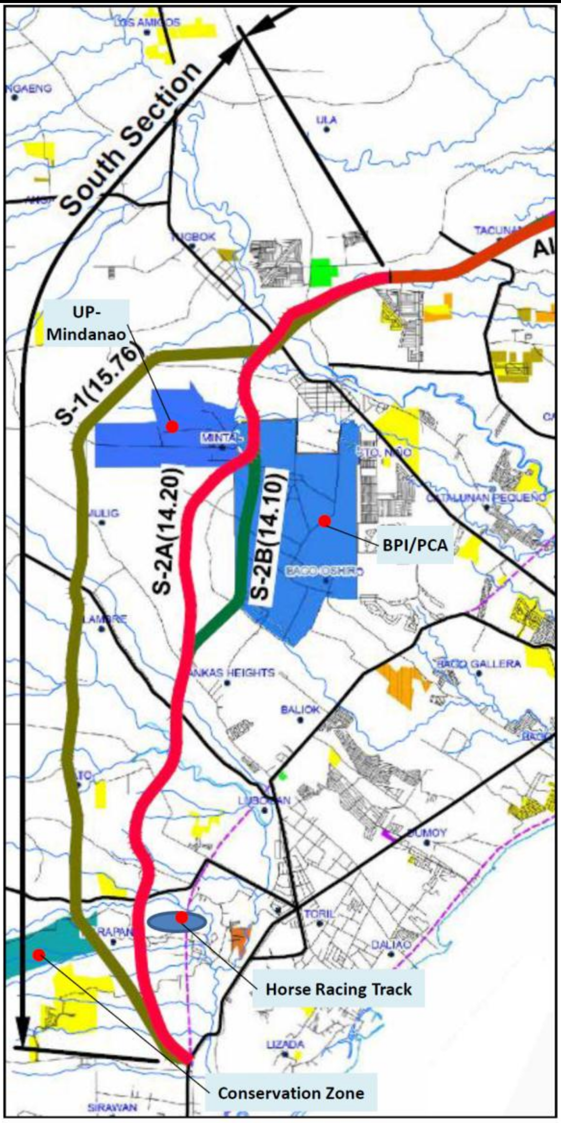
1.3.3.1 General Characteristic of the South Area

Characteristics of the south area are as follows:

- Located at the foot of Mt. Apo;
- Due to rivers and valleys, the topography is undulating;
- Urbanization is progressing towards the mountain side from Davao-General Santos Road and Davao-Bukidnon Road;
- The University of the Philippines-Mindanao (UP-Mindanao) owns wide area of land in the Bypass Corridor;
- The Bureau of Plant and Industry (BPI) and the Philippine Coconut Authority (PCA) owns wide area of land in the Bypass Corridor;
- The horse racing track was recently developed near the beginning of the Bypass; and
- Possible spaces/corridors for the Bypass is shown in **Figure 1.3.1-3**

1.3.3.2 Alternative Alignments of South Section

During the alignment selection for the south section of the proposed Davao City Bypass, **three** (**3**) alternative alignments were studied. These alternatives are presented in **Figure 1.3.3-1**.



Alignment S-1

- This is the alignment proposed by the business Case Study;
- The alignment is generally far from the existing urbanized area;
- It avoids to pass through UP-Mindanao land and passes west side of UP-Mindanao; and
- Topography is undulating, thus high cut of slope, high embankment and longer bridges are required

Alignment S-2A

- The alignment selected is closer to the existing urbanized area;
- It passes between UP-Mindanao and BPI.
- It avoids the Conservation Area;
- It passes near the recently developed Horse Racing Track;
- The topography is gentler than S-1, but many river has to be crossed; and
- Most of the lands along the alignment are designated as “Residential Area” in the Davao City Future Land Use Plan

Alignment S-2B

- The only difference between S-2A and S-2B is whether the alignment passes through BPI/PCA land. This alternative alignment passes through BPI/PCA land; and
- There are many informal settlers in the BPI/PCA land which is a Government Land

Source: JICA Study Team, July 2014

Figure 1.3.3-1 Alternative Alignments of South Section

1.3.3.3 Evaluation of Alternative Alignments

The same evaluation criteria adopted for the Center Section were used. Evaluation results are shown in **Table 1.3.3-1** for Case 1 and **Table 1.3.3-2** for Case 2.

Table 1.3.3-1 Evaluation Of Alternatives Of South Section : Case-1

Evaluation Item			S-1		S-2A		S-2B	
Concept of Alternative			• Alignment selected by BCS; • Not to affect UP Mindanao land		• Closer to existing urbanized area • Pass through future residential area		• Closer to existing urbanized area • Pass through BPI/PCA land	
Road Length (km)			15.8 (+1.7km) (1.12)		14.2 (+0.1km) (1.01)		14.1 (0.00) (1.00)	
a.) Traffic Volume Attracted (veh/day in 2013 OD)	North Section	N-1 N-2	2,680 (0.54)	X	4,990 (1.00)	○	4,990 (1.00)	○
		N-3	2,360 (0.52)		4,540 (1.00)		4,540 (1.00)	
b) Cost (Million Php)	Construction Cost		3,100 (1.77)	-	1,777 (1.02)	-	1,750 1.00	-
	ROW Acquisition Cost		292 (1.10)	-	286 (1.08)	-	265 (1.00)	-
	Total		3,392 (1.68)	X	2,063 (1.02)	○	2,015 (1.00)	○
O&M Cost (Thousand Php/Year)			947 (1.21)	X	789 (1.00)	○	784 (1.00)	○
c.) Connection with the Urbanized Area			• Far from the urbanized area	△	• Nearer to the urbanized area	○	• Nearer to the urbanized area	○
d) Impact on Natural Environment	Slope Cutting (m^3)		1.76 Million (3.59)	X	0.49 Million (1.00)	○	0.50 Million (1.02)	○
	Tree Cutting (km)		13.5 (1.08)	○	12.5 (1.00)	○	12.5 (1.00)	○
	Flood (No. of crossing river)		10	-	10	-	10	-
	Earthquake (High Embankment) (km)		2.5 (2.77)	X	0.9 (1.00)	○	0.9 (1.00)	○
	Biology (Location of Philippine Eagle's Habitants)		• Nearer than other alternatives, but still far distance (more than 10km)	△	• Far from Mt. Apo, Philippine Eagle's habitants	○	• Far from Mt. Apo, Philippine Eagle's habitants	○
e) Social Impact	No. of Affected Houses/Buildings		85 (1.55)	X	55 (1.00)	○	64 (1.16)	X
	Affected Agri-Land (km.)		**14.2** **(1.03)**	○	**13.8** **(1.00)**	○	**13.8** **(1.00)**	○
f) Construction **Period**			• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-
g.) Road Network			• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-
h.) Impact of **Residential Development**			• Passes through Conservation Area for 400 m	X	• Passes through future Residential Area, thus vitality support residential area development	○	• Does not fully support future residential area development	X
i.) O&M Cost **(Thousand Php/Year)**			947 (1.21)	X	789 (1.00)	○	784 (1.00)	
Other Aspects	Positive		• This scheme adversely affect traffic attraction at both centre and north sections					
	Negative			X			•	
Evaluation			○=2 △=1 X= 8		○= 10 △= 0 X= 0		○=8 △=0 X = 2	
Recommendation					**Recommended**			

Source: ***JICA Study Team, July 2014***

Table 1.3.3-2 Evaluation Of Alternatives Of South Section : Case-2

Evaluation Item			S-1		S-2A		S-2B	
Concept of Alternative			• Alignment selected by BCS • Not to affect UP Mindanao land		• Closer to existing urbanized area • Pass through future residential area		• Closer to existing urbanized area • Pass through BPI/PCA land	
Road Length (km)			15.8 (+1.7km) (1.12)		14.2 (+0.1km) (1.01)		14.1 (0.00) (1.00)	
a.) Traffic Volume Attracted (veh/day in 2013 OD)	North Section	N-1 N-2	2,680 (0.54)	X	4,990 (1.00)	○	4,990 (1.00)	○
		N-3	2,360 (0.52)		4,540 (1.00)		4,540 (1.00)	
b.) Cost (Million Php)	Construction Cost		3,100 (1.77)	-	1,777 (1.02)	-	1,750 1.00	-
	ROW Acquisition Cost		292 (1.10)	-	286 (1.08)	-	265 (1.00)	-
	Total		3,392 (1.68)	xxx	2,063 (1.02)	○	2,015 (1.00)	○
O&M Cost (Thousand Php/Year)			947 (1.21)	X	789 (1.00)	○	784 (1.00)	○
c.) Connection with the Urbanized Area			• Far from the urbanized area	△	• Nearer to the urbanized area	○	• Nearer to the urbanized area	○
d.) Impact on Natural Environment	Slope Cutting (m^3)		1.76 Million (3.59)	X	0.49 Million (1.00)	○	0.50 Million (1.02)	○
	Tree Cutting (km)		13.5 (1.08)	○	12.5 (1.00)	○	12.5 (1.00)	○
	Flood (No. of crossing river)		10	-	10	-	10	-
	Earthquake (High Embankment) (km)		2.5 (2.77)	X	0.9 (1.00)	○	0.9 (1.00)	○
	Biology (Location of Philippine Eagles Habitants)		13.5 (1.08)	○	12.5 (1.00)	○	12.5 (1.00)	○
e.) Social Impact	No. of Affected Houses/Buildings		85 (1.55)	xxx	55 (1.00)	○	64 (1.16)	xxx
	Affected Agri-Land (km)		**14.2** **(1.03)**	○	**13.8** **(1.00)**	○	**13.8** **(1.00)**	○
f.) Construction Period			• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-
g.) Road Network			• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-
h.) Impact of Residential Development			• Passes through conservation area for 400 m	X	• Passes through future residential area, thus vitally support residential area development	○	• Does not fully support future residential area development	X
i.) O&M Cost (Thousand Php/Year)			947 (1.21)	X	789 (1.00)	○	784 (1.00)	○
Other Aspects	Positive		• This scheme adversely affect traffic attraction at both centre and north sections					
	Negative			X				
Evaluation			○=2 △=1 X = 12		○= 10 △= 0 X= 0		○=8 △=0 X= 4	
Recommendation					**Recommended**			

Source: JICA Study Team, July 2014

1.3.3.4 Recommendations

Alternative S-2A is recommended due to the following reasons:

- **Traffic Volume Attracted:** more traffic will be attracted than Alternative S-1. The same traffic as Alternative S-2B will be attracted;
- **Cost:** the cost is slightly higher than Alternative S-2B, but only 2% difference;
- **Impact on Natural Environment:** Almost the same evaluation as Alternative S-2B. Much better than Alternative S-1;
- **Number of Affected Houses/Buildings:** The least number of houses/buildings affected among the three alternatives; and
- **Compatibility with the Future Land Use:** Alternative S-2A vitally support the future residential area development, whereas Alternative S-2B passes through BPI/PCA land where the urbanization id restricted.

1.3.4 Selection of North Section Alignment

1.3.4.1 Where to End the Bypass

The Bypass is connected to Daang Maharlika at the north end. There are **two** (**2**) options for the end point as shown in **Figure 1.3.4-1**.

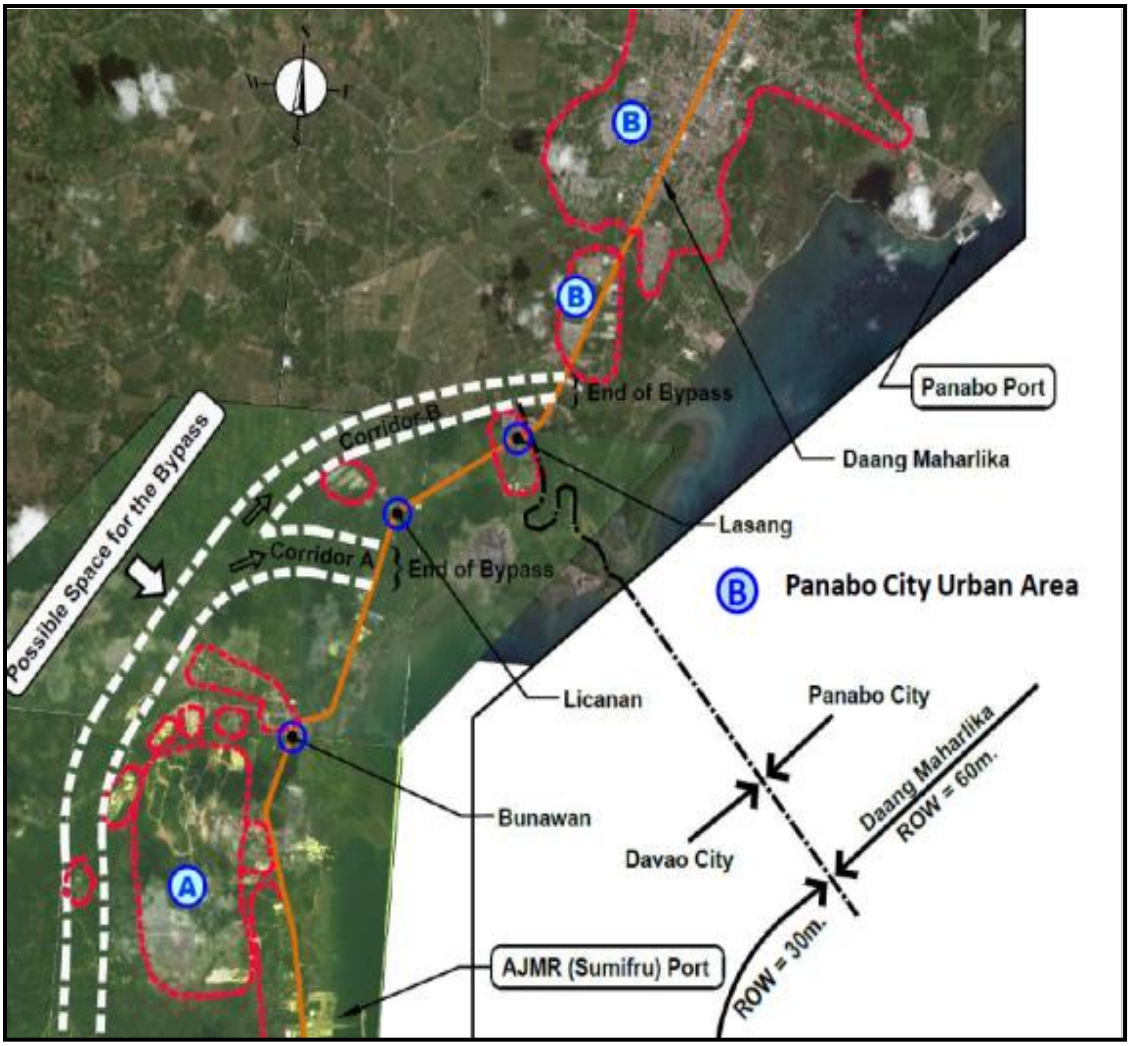
1) **Option-1:** End the Bypass between Bunawan and Licanan within Davao City; and
2) **Option-2:** End the Bypass at the boundary between Davao City and Panabo City

Option 1 is the end point recommended by BCS, however, DPWH Region XI recommended to extends the Bypass and end at the beginning of Panabo City. The reasons are as follows:

- ROW width of Daang Maharlika is:
  - Within Davao City ……….. 30 m
  - In Panabo City …………… 60 m
- Lasang Bridge at the boundary between Davao City and Panabo City was built with a **4-lane** bridge. Both sides of this bridge have been fully developed, thus further widening of the bridge is difficult;

- Lasang area of Daang Maharlika will be a traffic bottleneck in the future;
- Whereas, Daang Maharlika within Panabo City has wide road ROW of **60 m**. various measures can be adopted, when traffic congestion becomes a problem;
- Panabo City is also fast growing city and urbanization along Daang Maharlika is progressing, thus roadsides will be fully urbanized. Extension of the Bypass to Panabo City will become quite difficult, unless the Bypass is extended now; and
- When the Bypass is extended to Panabo City, access to Panabo Port will be improved

In view of the above, **it is recommended that the Bypass should be extended up to the beginning of Panabo City and connected with Daang Maharlika which has 60 m road ROW.**



Source: JICA Study Team, July 2014

Figure 1.3.4-1 Condition of the Bypass at the North End Area

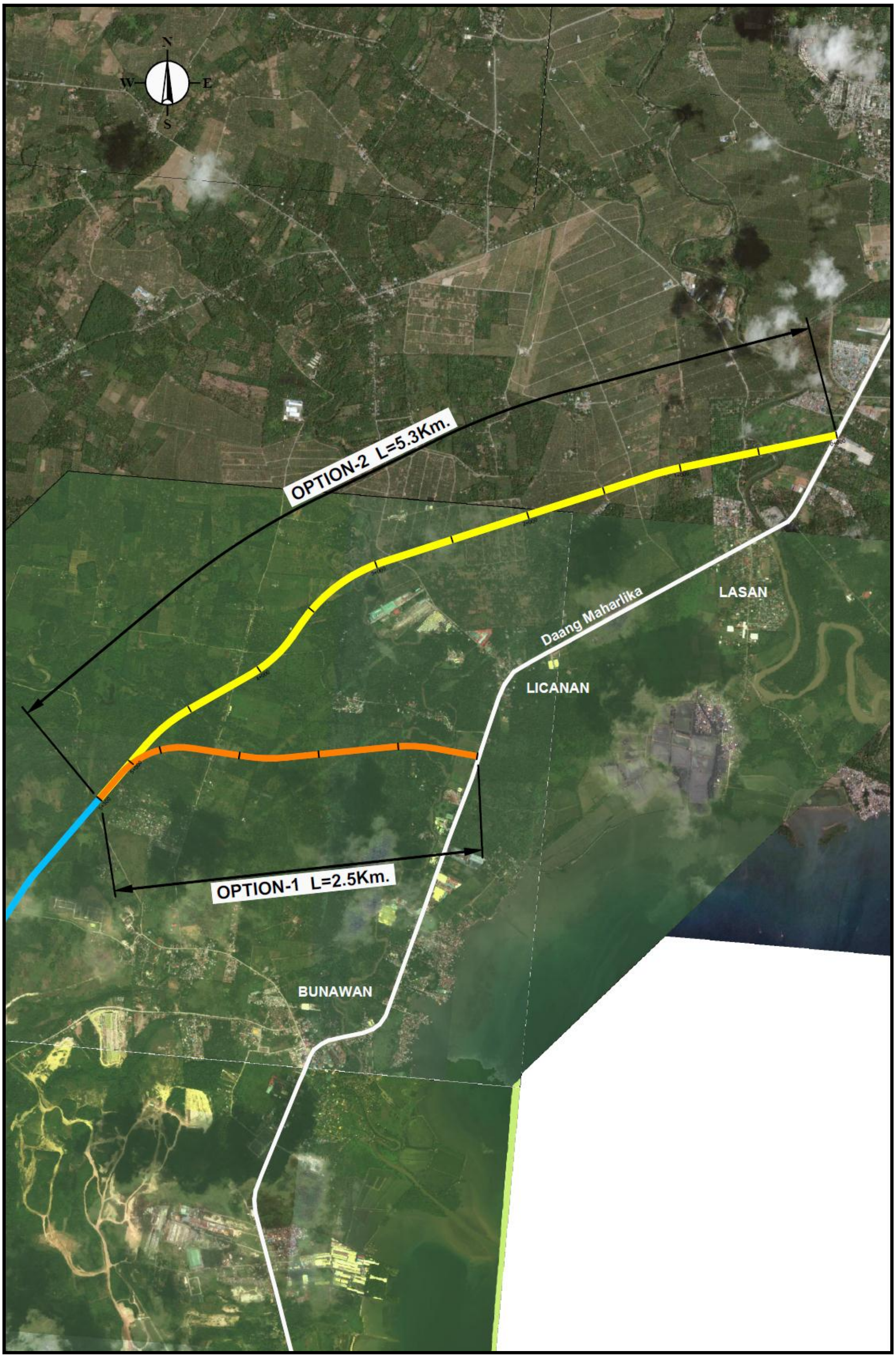
(1) Cost Comparison

Alignments of Option-1 and Option-2 are shown in **Figure 1.3.4-2**, and estimated construction cost and ROW cost are shown in **Table 1.3.4-1**.

Table 1.3.4-1 Cost of Option-1 And Option-2

		Option-1	Option-2	
			Option-2 Cost	Additional Cost
Road Length (km)		**2.5**	**5.3**	**+2.8**
Bridge Length (km)		**70.0**	**130.0**	**+60.0**
Cost (Million Php)	Construction Cost	139.7	301.8	+162.1
	ROW Cost	52.5	111.3	+58.8
	Total	**192.2**	**413.1**	**+220.9**

Source: JICA Study Team, July 2014



Source: JICA Study Team, July 2014

Figure 1.3.4-2 Option 1 & 2 Alignments

1.3.4.2 Alternative Alignments of the North Section

For the north section of the Bypass, **four** (**4**) alternatives were developed and compared. These alternatives are shown in **Figure 1.3.4-3**.

Alignment N-1

- The alignment proposed by BCS; and
- This alignment goes towards inland area at the mid-section, resulting in far from the urbanized area and longer road length

Alignment N-2A

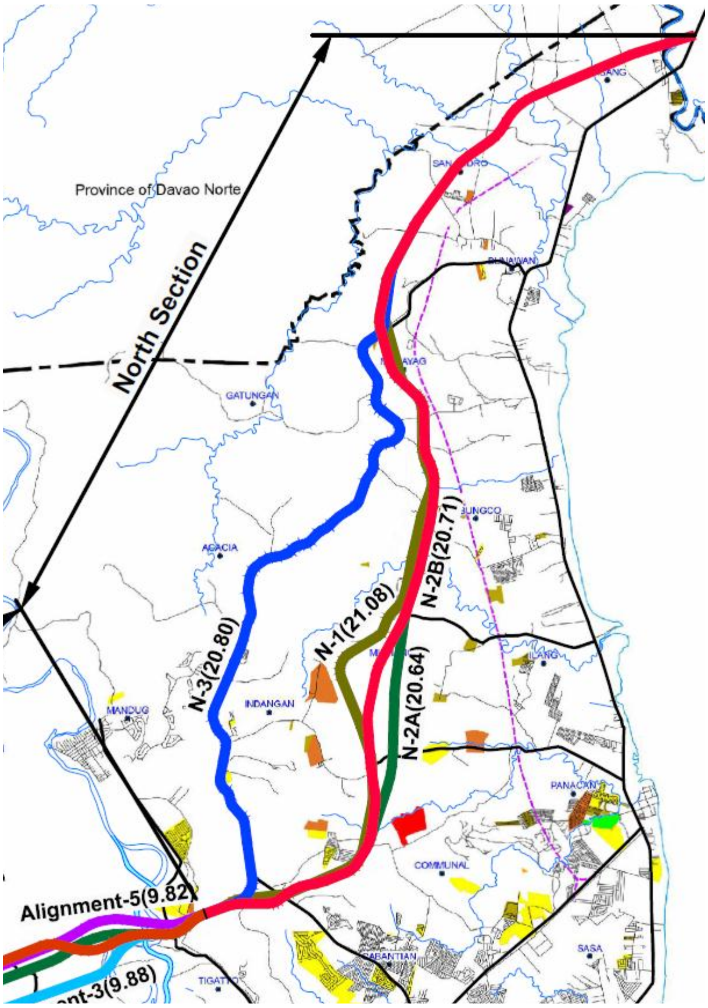
- Closer to the urbanized area and shorter road length than Alternative N-1

Alignment N-2B

- Same concept as Alternative N-2A

Alignment N-3

- To convert the existing City Road to the Bypass.



Source: JICA Study Team, July 2014

Figure 1.3.4-3 Alternatives Alignments of the North Section

1.3.4.3 Evaluation of Alternatives

(1) Evaluation Criteria

The same evaluation criteria adopted for the Center Section.

(2) Evaluation Result

Evaluation results are shown in **Table 1.3.4-2** for Case 1 and **Table 1.3.4-3** for Case 2.

1.3.4.4 Recommendations

(1) Alternative N-2B

It is recommended that **Alternative N-2B should be adopted for the North Section**. Although Alternative N-3 is the cheapest alternative, it has the following disadvantages.

- It is intended to convert the existing City Road where its roadsides are rapidly urbanizing. It is estimated that **780** houses/buildings (or about **3,350** people) are required to be relocated, which will cause various social problems;
- Implementation of relocation of this magnitude will take a long time, thus completion of the Bypass will be much delayed than other alternatives;
- Since this alignment is far from the existing urban areas, less traffic will be attracted;
- This alignment also affects traffic attraction of South and Center Sections, thus overall viability will be affected;
- This alternative contributes less for strengthening of road network in the north area; and
- During construction, existing traffic on this City Road is adversely affected due to construction work

(2) Alternative N-1

Alternative N-1 is disadvantageous for the following items compared to Alternative N-2:

- Construction cost is much higher;
- Environmentally less advantageous due to more slope cutting required; and
- Socially less advantageous due to high number of houses/buildings to be relocated

(3) Alternative N-2A and N-2B

As evaluated, both **Alternatives N-2A and N-2B** were almost the same. The only difference is the construction cost. Alternative N-2B is recommended due to less construction cost than Alternative N-2A.

Table 1.3.4-2 Evaluation Of Alternatives Of North Section : Case 1 (1/2)

Evaluation Item			N-1		N-2A		N-2B		N-3	
Concept of Alternative			• Alignment selected by BCS		• Closer to urbanized area than N-1		• Closer to urbanized area than N-1		• To convert existing city road to bypass	
Road Length (km)			21.1 (+0.5km) (1.02)		20.6 (0.0) (1.00)		20.7 (+0.1km) (1.00)		20.8 (+0.2km) (1.01)	
a.) Traffic Volume Attracted (veh/day in 2013 OD)	South Section	S-2A, S-2B	4,270 (1.00)	○	4,270 (1.00)	○	4,270 (1.00)	○	3,850 (0.90)	△
		S-1	3,150 (1.00)		3,150 (1.00)		3,150 (1.00)		2,690 (0.85)	
b.) Cost (Million Php)	Construction Cost		3,564 (1.98)	-	3,314 (1.84)	-	3,157 (1.75)	-	1,800 (1.00)	
	ROW Acquisition Cost		442 (1.27)	-	431 (1.24)	-	433 (1.25)	-	347 (1.00)	
	Total		4,006 (1.87)	X	3,745 (1.74)	X	3,590 (1.67)	X	2,147 (1.00)	○
c.) Connection with the Urbanized Area			• Nearer than N-3	○	• Nearer than N-3	○	• Nearer than N-3	○	• Far from Urbanized Area	△
d.) Impact on Natural Environment	Slope Cutting (m^3)		2.45 Million (3.45)	X	1.10 Million (1.55)	X	0.96 Million (1.35)	X	0.71 Million (1.00)	○
	Tree Cutting (km)		17.0 (1.06)	○	17.0 (1.06)	○	16.8 (1.04)	○	16.1 (1.00)	○
	Flood (No. of Crossing River)		5	-	5	-	5	-	5	-
	Earthquake (High embankment) (km)		5.0 (10.0)	X	2.3 (4.60)	X	1.9 (3.80)	X	0.5 (1.00)	○
	Biology (Philippine Eagle's Habitants)		• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives (far from Mt. Apo, Philippine Eagle's habitants)	-	• Same condition with the other alternatives (far from Mt. Apo, Philippine Eagle's habitants)	-
e.) Social Impact	No. of Affected Houses/ Buildings		270 (4.66)	X	60 (1.03)	○	58 (1.00)	○	780 (13.40)	X
	Affected Agri-Land (km		**15.7** **(1.03)**	○	**15.8** **(1.03)**	○	**15.3** **(1.00)**	○	16.3 (1.07)	○
f.) Construction Period			• Shorter construction period than N-3	○	• Shorter construction period than N-3	○	• Shorter construction period than N-3	○	• Longer construction period due to utilizing existing road • Existing traffic on the city road is adversely affected during construction	X

Table 1.3.4-2 Evaluation Of Alternatives Of North Section : Case 1 (2/2)

Evaluation Item		N-1		N-2A		N-2B		N-3	
g.) Road Network		• Road network in north area is strengthened due to additional new link	○	• Road network in north area is strengthened due to additional new link	○	• Road network in north area is strengthened due to additional new link	○	• Less contribution for strengthening of road network	X
h.) Impact of Residential Development		• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-
i.) O&M Cost (Thousand Php/Year)		1,184 (1.10)	X	1,225 (1.13)	X	1,210 (1.12)	X	1,080 (1.00)	
j.) Other Aspects	Positive	• Attract more traffic in the south and center sections	○	• Attract more traffic in the south and center sections	○	• Attract more traffic in the south and center sections	○	• This scheme adversely affect traffic attraction at both south and centre sections	X
	Negative							• Implementation is difficult due to large number of house relocation	
Evaluation		○7 △0 X =9		○= 8 △= 0 X= 6		○=8 △=0 X = 4		○=6 △=2 X= 5	
Recommendation				**Recommended**					

Source: *JICA Study Team, July 2014*

Table 1.3.4-3 Evaluation Of Alternatives Of North Section : Case 2 1/2

Evaluation Item			N-1		N-2A		N-2B		N-3	
Concept of Alternative			• Alignment selected by BCS		• Closer to urbanized area than N-1		• Closer to urbanized area than N-1		• To convert existing city road to bypass	
Road Length (km)			21.1 (+0.5km) (1.02)		20.6 (0.0) (1.00)		20.7 (+0.1km) (1.00)		20.8 (+0.2km) (1.01)	
a.) Traffic Volume Attracted (veh/day in 2013 OD)	South Section	S-2A, S-2B	4,270 (1.00)	○	4,270 (1.00)	○	4,270 (1.00)	○	3,850 (0.90)	△
		S-1	3,150 (1.00)		3,150 (1.00)		3,150 (1.00)		2,690 (0.85)	
b.) Project Cost (Million Php)	Construction Cost		3,564 (1.98)	-	3,314 (1.84)	-	3,157 (1.75)	-	1,800 (1.00)	
	ROW Acquisition Cost		442 (1.27)	-	431 (1.24)	-	433 (1.25)	-	347 (1.00)	
	Total		4,006 (1.87)	xxx	3,745 (1.74)	xxx	3,590 (1.67)	xxx	2,147 (1.00)	○
c.) Connection with the Urbanized Area			• Nearer than N-3	○	• Nearer than N-3	○	• Nearer than N-3	○	• Far from Urbanized Area	△
d.) Impact on Natural Environment	Slope Cutting (m^3)		2.45 Million (3.45)	X	1.10 Million (1.55)	X	0.96 Million (1.35)	X	0.71 Million (1.00)	○
	Tree Cutting (km)		17.0 (1.06)	○	17.0 (1.06)	○	16.8 (1.04)	○	16.1 (1.00)	○
	Flood (No. of Crossing River0		5	-	5	-	5	-	5	-

Table 1.3.4-3 Evaluation Of Alternatives Of North Section : Case 2 2/2

Evaluation Item		Evaluation Item		Evaluation Item		Evaluation Item		Evaluation Item	
	Earthquake (High Embankment) (km)	5.0 (10.0)	X	2.3 (4.60)	X	1.9 (3.80)	X	0.5 (1.00)	○
e.) Social Impact	Biology (Philippine Eagle's Habitants)	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives (far from Mt. Apo, Philippine Eagle's Habitants)	-	• Same condition with the other alternatives (far from Mt. Apo, Philippine Eagle's Habitants)	
	No. of Affected Houses/ Buildings	270 (4.66)	xxx	60 (1.03)	○	58 (1.00)	○	780 (13.40)	xxx
	Affected Agri-Land (km)	**15.7 (1.03)**	○	**15.8 (1.03)**	○	**15.3 (1.00)**	○	16.3 (1.07)	○
f.) Construction Period		• Shorter construction period than N-3	○	• Shorter construction period than N-3	○	• Shorter construction period than N-3	○	• Longer construction period due to utilizing existing road. • Existing traffic on the city road is adversely affected during construction	X
g.) Road Network		• Road network in north area is strengthened due to additional new link	○	• Road network in north area is strengthened due to additional new link	○	• Road network in north area is strengthened due to additional new link	○	• Less contribution for strengthening of road network	X
h.) Impact of Residential Development		• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-	• Same condition with the other alternatives	-
i.) O & M Cost (Thousand Php/Year)		1,184 (1.10)	X	1,225 (1.13)	X	1,210 (1.12)	X	1,080 (1.00)	○
j.) Other Aspects	Positive	• Attract more traffic in the south and centre sections	○	• Attract more traffic in the south and centre sections	○	• Attract more traffic in the south and centre sections	○	• This scheme adversely affect traffic attraction at both south and centre sections	
	Negative							• Implementation is difficult due to large number of house relocation	
Evaluation		○6 △0 X =7		○= 7 △= 0 X= 4		○7 △0 X = 4		○=4 △=2 X= 7	
Recommendation				**Recommended**					

Source: JICA Study Team, July 2014

1.3.5 Zero Option

Summarized in Table **1.3.5-1** is the evaluation of with the project and without project.

Though the Project will affect the pollution, natural environment and social environment, traffic will be drastically improved in the city area.

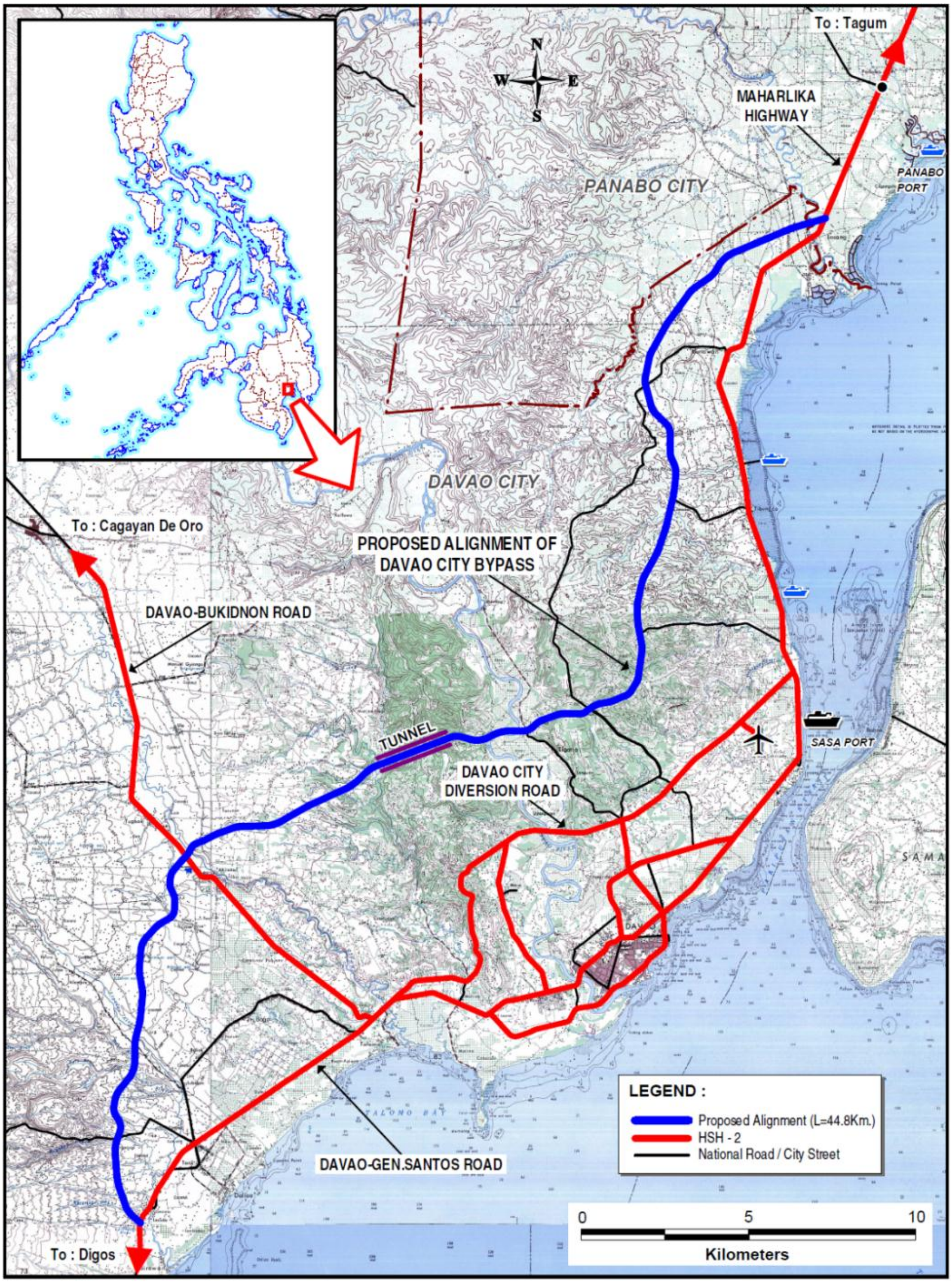
Table 1.3.5-1 Evaluation of With and Without the Bypass Project

Evaluation Item	Parameter	With Project	Without Project	Remarks
Traffic	Total Travel Time (Y2023)	216,682 veh*hrs/day ○	235,299 veh*hrs/day X	18,617 veh*hrs saving in Davao City
Pollution	Air, Noise	Air pollution and noise will occur during construction X	None ○	Along Bypass Area
	CO_2 (Y2023)	642,400 ton/year ○	676,968 ton/year X	34,568 ton/year decrease during operation
Natural Environment		Tree cutting slope cutting may occur during construction X	None ○	
Social Environment		Resettlement necessary (125 structures) X	None ○	

Source: JICA Study Team, July 2014

1.3.6 Recommended Alignment of the Bypass

After careful considerations of the alternatives studied, the alignment of the Bypass has been selected. The recommended Davao City Bypass Road alignment is shown in **Figure 1.3.6-1**.



Source: JICA Study Team

Figure 1.3.6-1 Recommended Alignment of the Bypass

1.4 PROJECT COMPONENTS

The proposed Davao City Bypass Road Construction Project is primarily consists of **three** (**3**) major components as follows:

1) Road Section (**37.17 km**);
2) Tunnel Section (**2.28 km**); and
3) Bridge Section (**5.13 km)**

1.4.1 Roadway Section

1.4.1.1 General

The proposed Davao City Bypass Project a **44.58-kilometer** bypass road designed to provide a relative high speed road that allows a safe and efficient movement of traffic. It has a design speed of **60 kph**, which is in accordance with Road Safety Design Manual (DPWH, 2004) as well as consideration to the topographic condition.

Initially, the number of lanes required is set as **2-lanes**. The roadway's carriageway width of **3.5 m** is also in accordance with Road Safety Manual (DPWH, 2004). The shoulder is design at **2.5 m**. The Road Right-Of-Way (RROW) is between **50-60 m**. Future expansion from **2-lanes** to **4-lanes** is considered in the design depending on the traffic demand after 2027.

The general design concepts of the proposed bypass road are as follows:

- Road design is based on two-lanes, considering four-lanes widening in the future;
- To minimize the road construction cost and soil disposal impact, the volume of cutting and embankment should be balanced as much as possible; and
- To consider not only the accessibility of connecting road and roadside area but also high mobility function of the bypass

The general design criteria of the bypass are presented in **Table 1.4.1-**1.

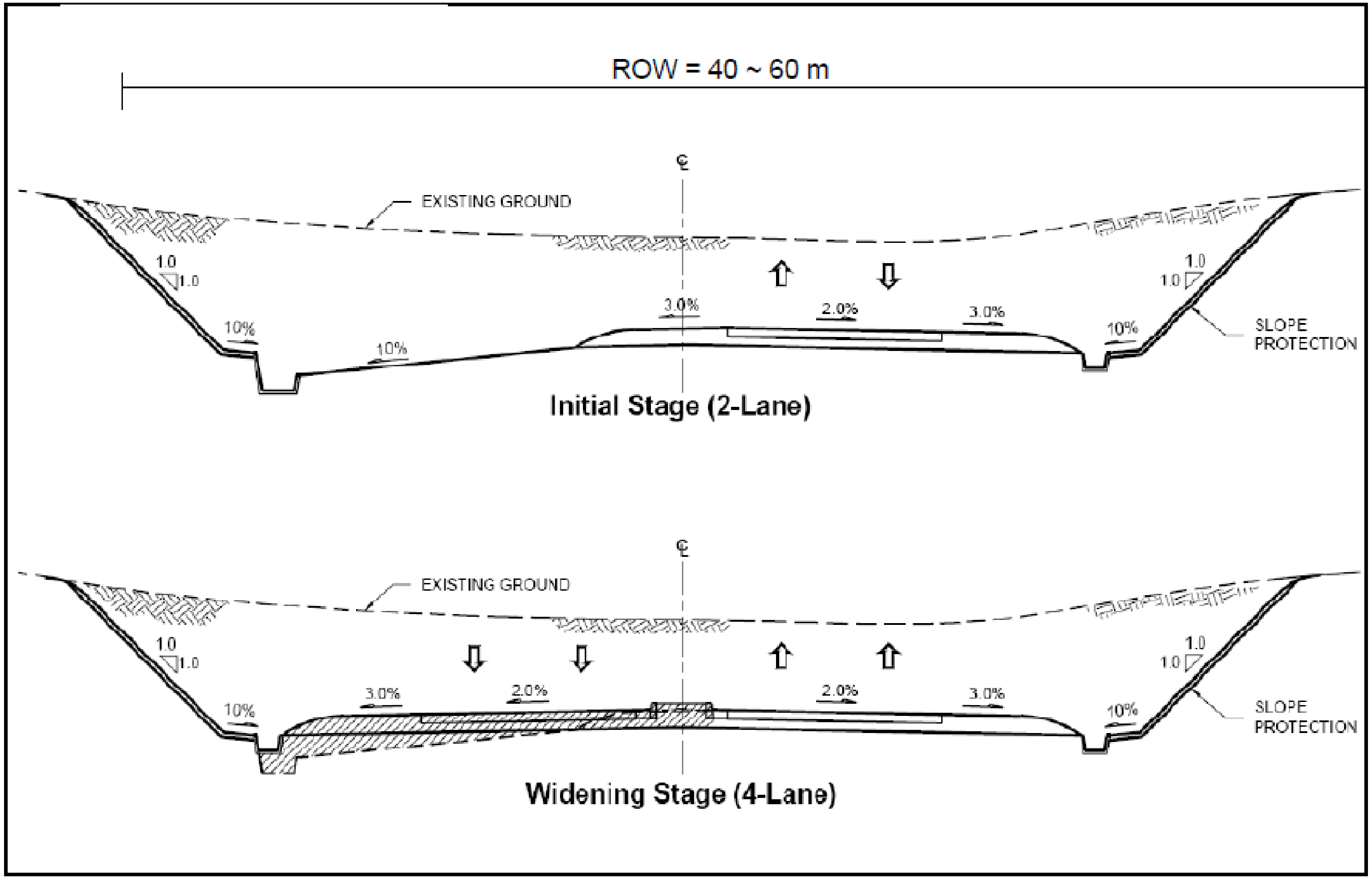
Table 1.4.1-1 Design Criteria of the Bypass Alignment	
Design Speed	60 km/hr
Minimum Horizontal Radius	123 m (Target: 250 m)
Minimum Vertical Gradient	5 % (Flat 6% (Rolling) 8% (Mountainous) (Target: Less than 6%)
Road Right-Of-Way (RROW)	40-60 m
Source: JICA Study Team, July 2014	

1.4.1.2 Road Cross Section

(1) Cut/Embankment Cross Section

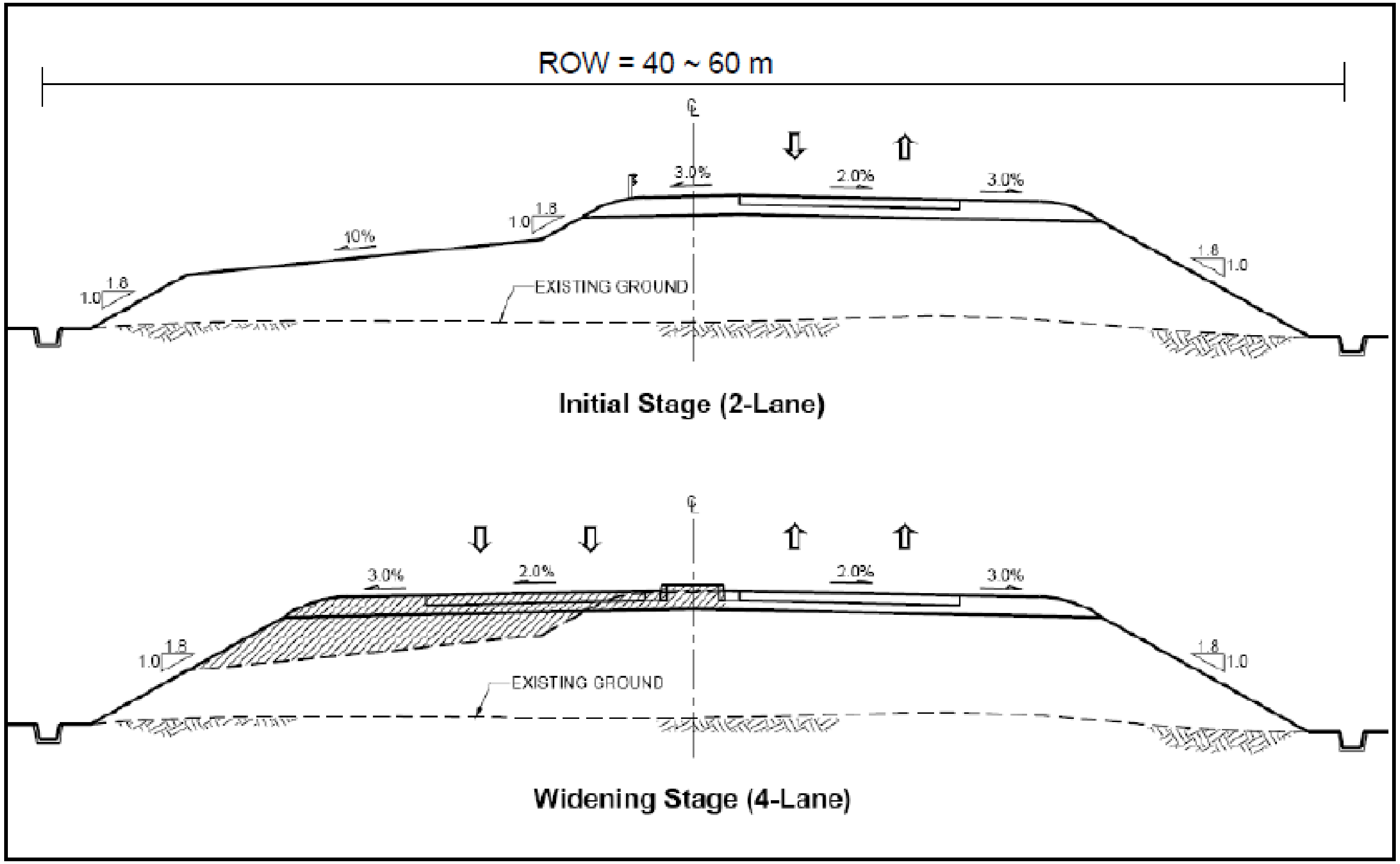
The Study Team proposes to provide **4-lane** cut/embankment cross section instead of a **2-lane** for the Davao City Bypass (**Figure 1.4.1-1** and **Figure 1.4.1-2**). Although it might be expensive at the initial stage, still it would be beneficial due to the following:

- Minimal traffic impact during widening construction work (as widening road work may affect 1-lane closed that would cause serious effect on the bypass traffic;
- Reduced waste cost of slope protection facilities' demolition during initial stage;
- Additional embankment at the embankment section might cause erosion as shown in **Figure 1.4.1-3**; and
- It is also one way of development control within the ROW



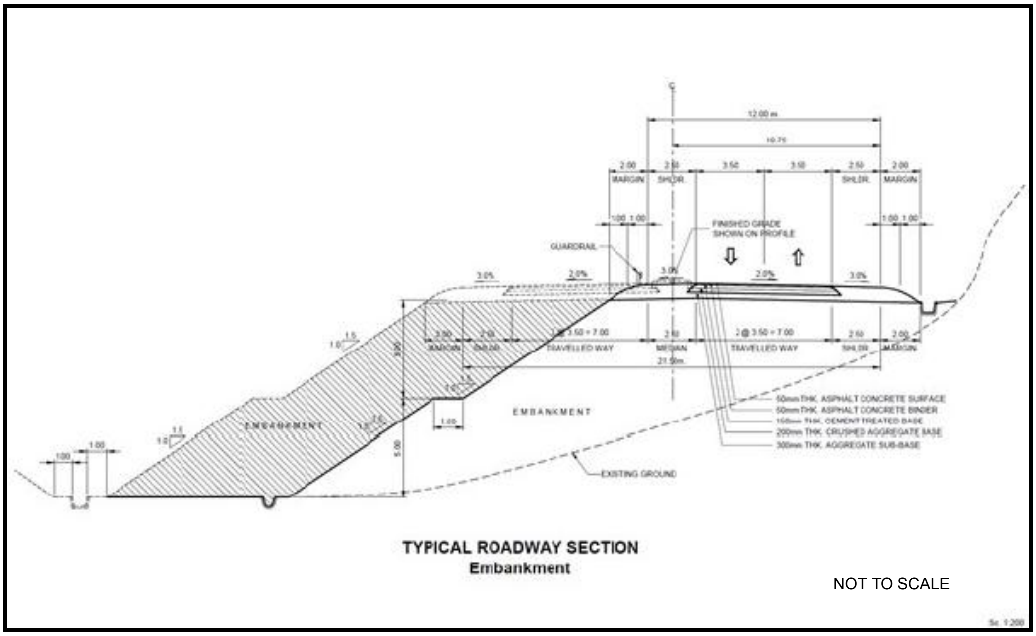
Source: JICA Study Team, July 2014

Figure 1.4.1-1 Typical Cross Section of Cut Section (Initial and Widening Stages)



Source: JICA Study Team, July 2014

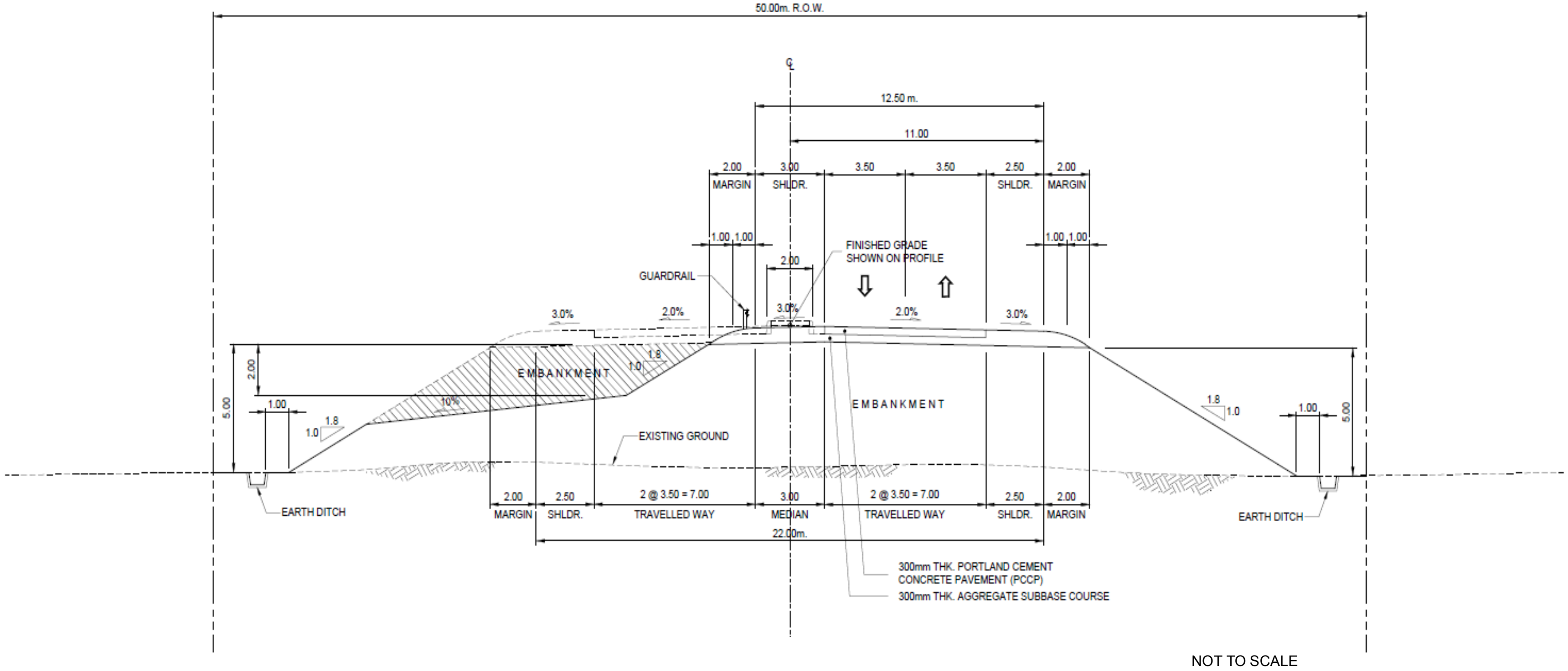
Figure 1.4.1-2 Typical Cross Section of Embankment Section (Initial and Widening Stages)



Source: JICA Study Team, July 2014

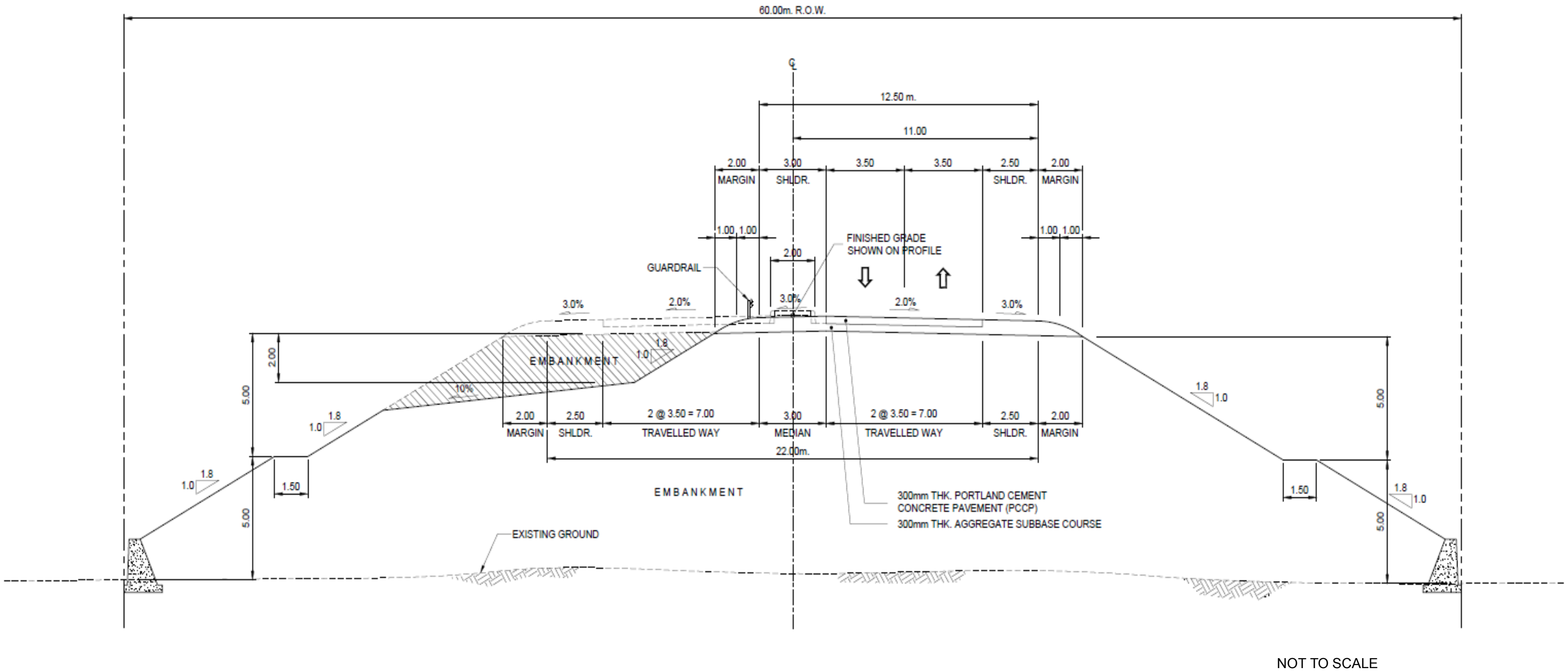
Figure 1.4.1-3 Typical Roadway Cross Section (Embankment)

Figures 1.4.1-4a to **1.4.1-4d** present the typical road cross section at cut and embankment sections of the bypass alignment



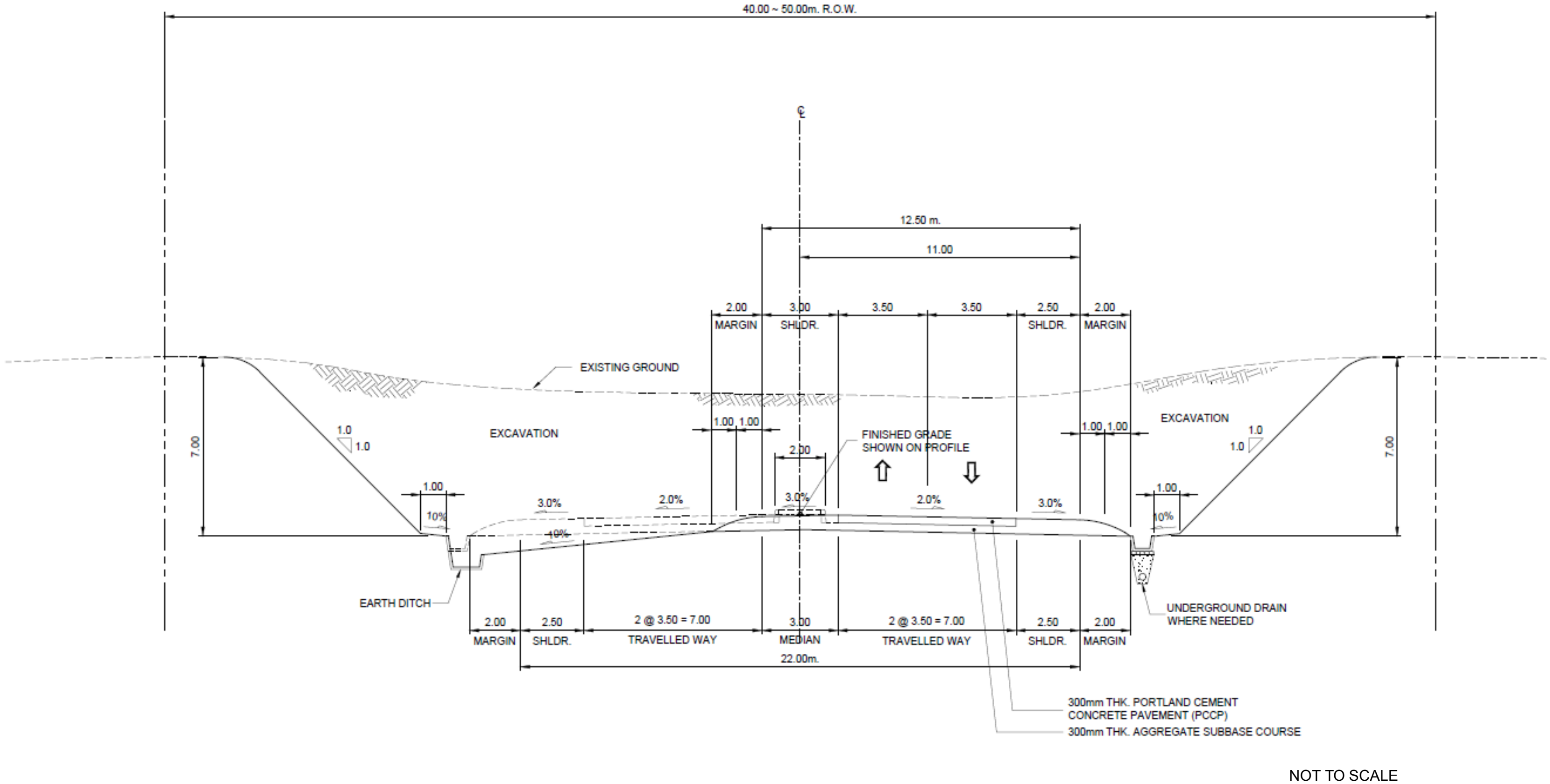
Source: JICA Study Team, July 2014

Figure 1.4.1-4a Typical Cross Section of Embankment-1



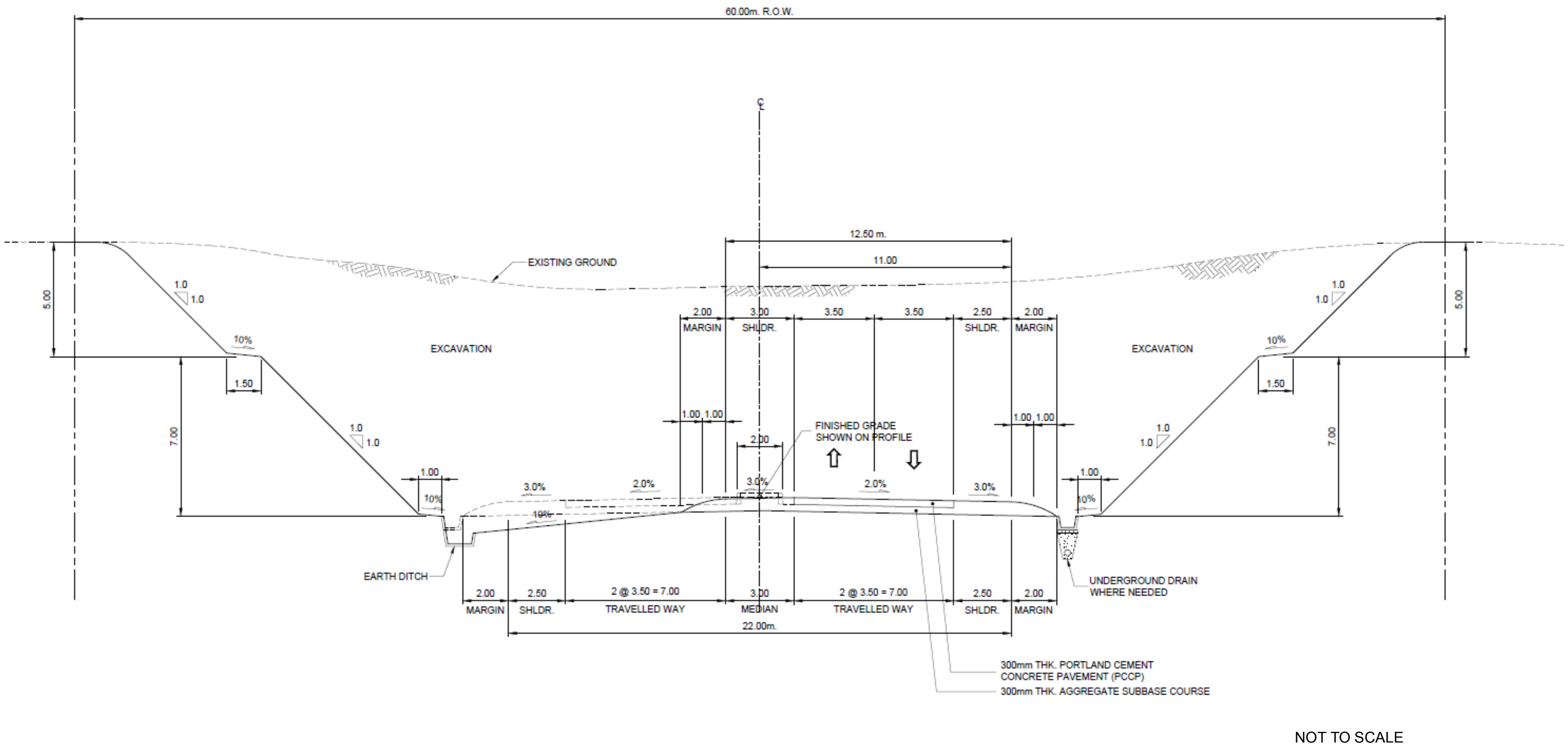
Source: JICA Study Team

Figure 1.4.1-4b Typical Cross Section of Embankment-2



Source: JICA Study Team

Figure 1.4.1-4c Typical Cross Section of Cut-1



Source: JICA Study Team

Figure 1.4.1-4d Typical Roadway Cross Section of Cut 2

1.4.1.3 High Cut/Embankment Section

Table 1.4.1-2 shows the total length of high embankment and cut section based on the preliminary design.

Table 1.4.1-2 Embankment and Cut Section Length

	5 m > H ≤ 10 m	10 m < H	Total (Unit in km)
Cut Section	4.30	6.00	10.30
Embankment Section	3.70	1.60	5.30
Total	**8.00**	**7.60**	**15.60**

Source: JICA Study Team, July, 2014

Note: Not including bridge and tunnel section

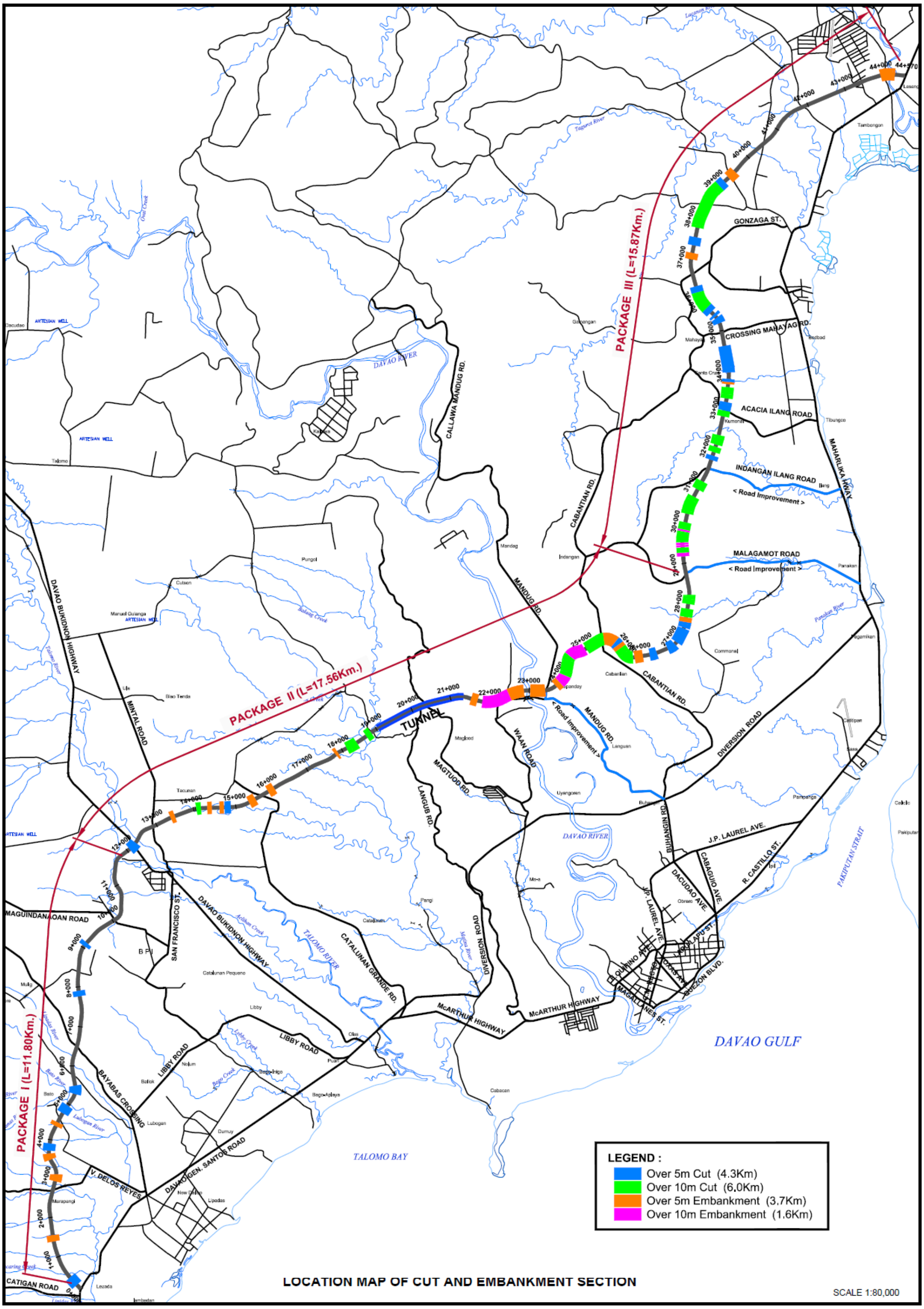
A map showing the location map of the high embankment and cut sections is presented in **Figure 1.4.1-5**.

Summarized in **Table 1.4.1-3** is the estimated cut and embankment volume for Package I-III.

Table 1.4.1-3 Estimated Volume of Cut Soil and Embankment

	Cut Volume (1,000 m^3)	Embankment (1,000 cu m^3)
Package I	541	406
Package II	1,677	1,519
Package III	2,891	522
Total	**5,109**	**2,447**

Source: JICA Study Team, July, 2014



Source: *JICA Study Team, July 2014*

Figure 1.4.1-5 Location Map of Cut and Embankment Section

1.4.1.4 Crossing Section

In order to improve the accessibility after the construction of the Bypass, crossing roads are designed. The technical approach of the design are as follows:

1) To provide crossing road to improve accessibility after the bypass construction; and

2) To provide flyover at crossing major road underneath to provide high traffic function at the bypass road users

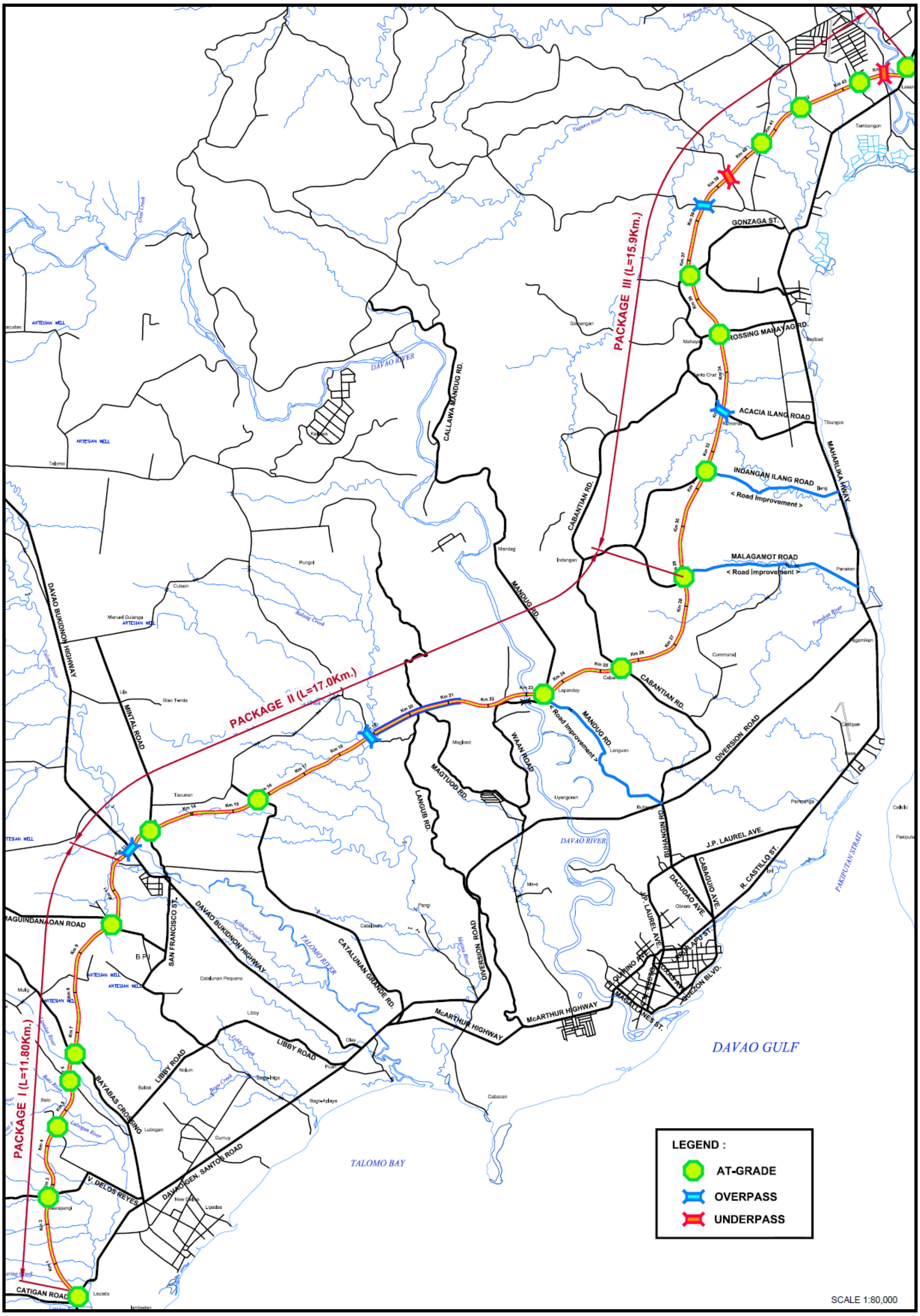
    - (Beginning Point) Flyover during widening stage (see **Figures 1.4.1-7 a-b**);
    - (End Point) Flyover during widening stage (see **Figures 1.4.1-8 a-b**); and
    - Davao-Bukidnon Road Flyover from the initial stage (see **Figures 1.4.1-9 a-b**)

There are **three** (**3**) types of intersections proposed for the bypass alignment as shown in **Table 1.4.1-4**. Also included in the Table are the number of intersections per type. **Figure 1.4.1-6** shows the location of the intersection, while **Figures 1.4.1-7 a-b** to **Figures 1.4.1-9 a-b** present the **three** (**3**) major intersection types considering future widening

Table 1.4.1-4 Number and Types of Intersections

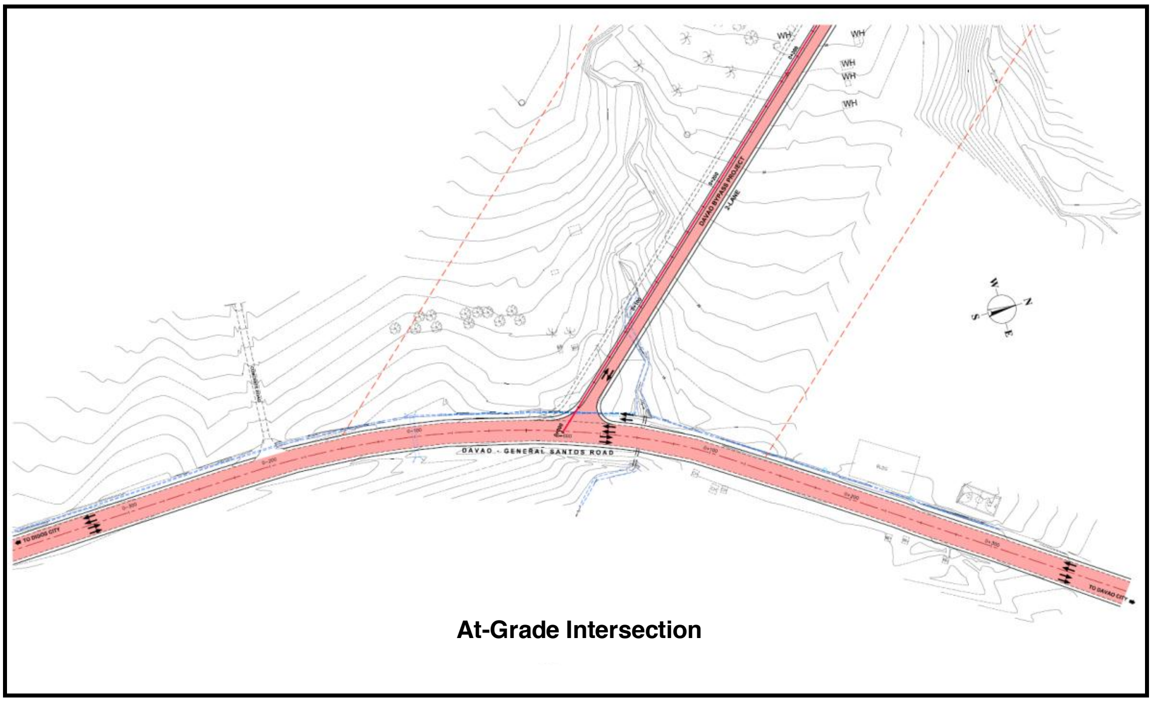
Intersection Type	No. of Intersection
At-Grade	18
Overpass	12
Underpass	6
TOTAL	**36**

Source: JICA Study Team, July, 2014



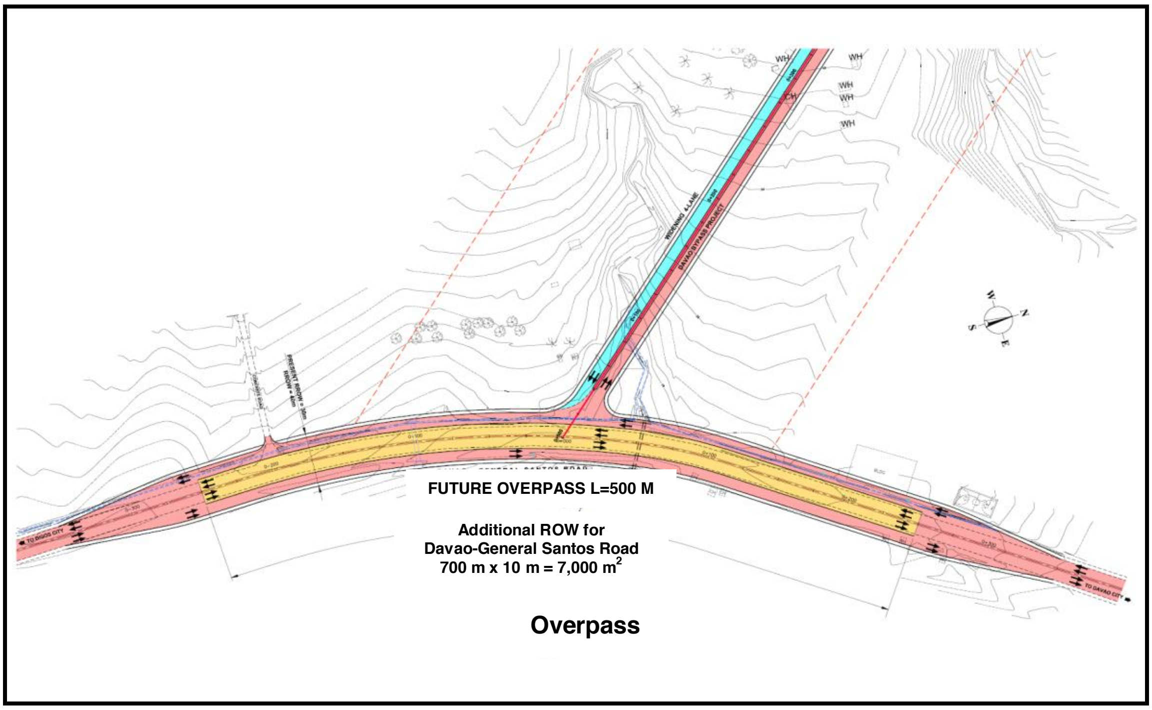
Source: JICA Study Team, July 2014

Figure 1.4.1-6 Location Map of Intersection Types



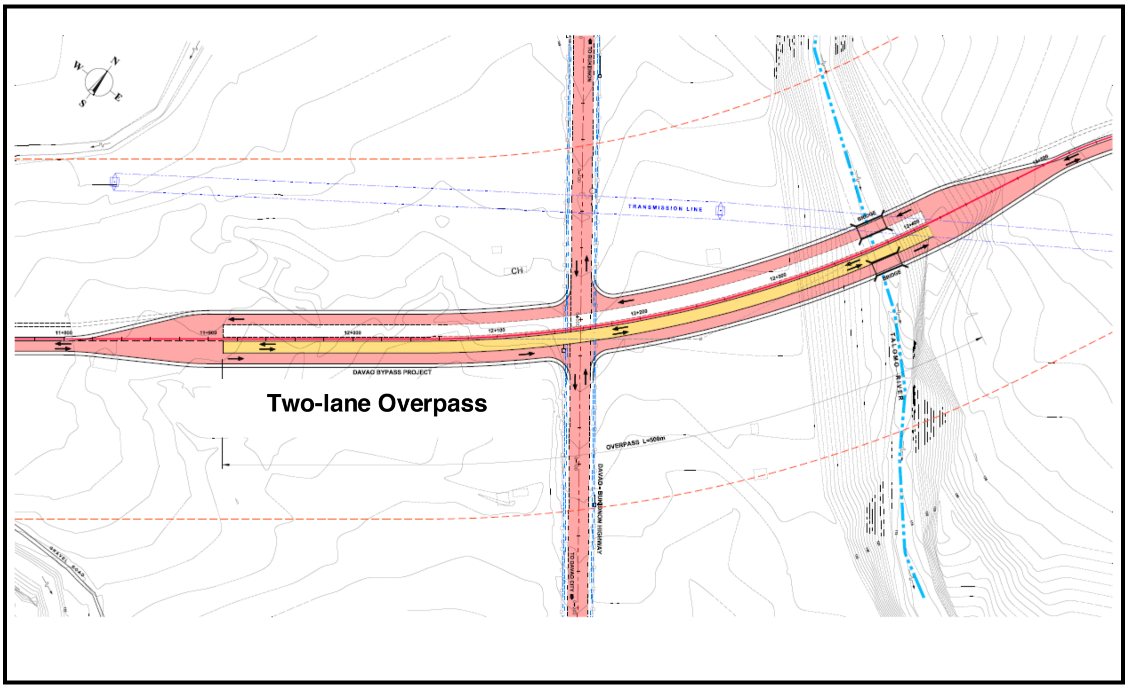
Source: JICA Study Team, July 2014

Figure 1.4.1-7a Intersection of Davao-General Santos Road, 0+000 (Initial Stage)



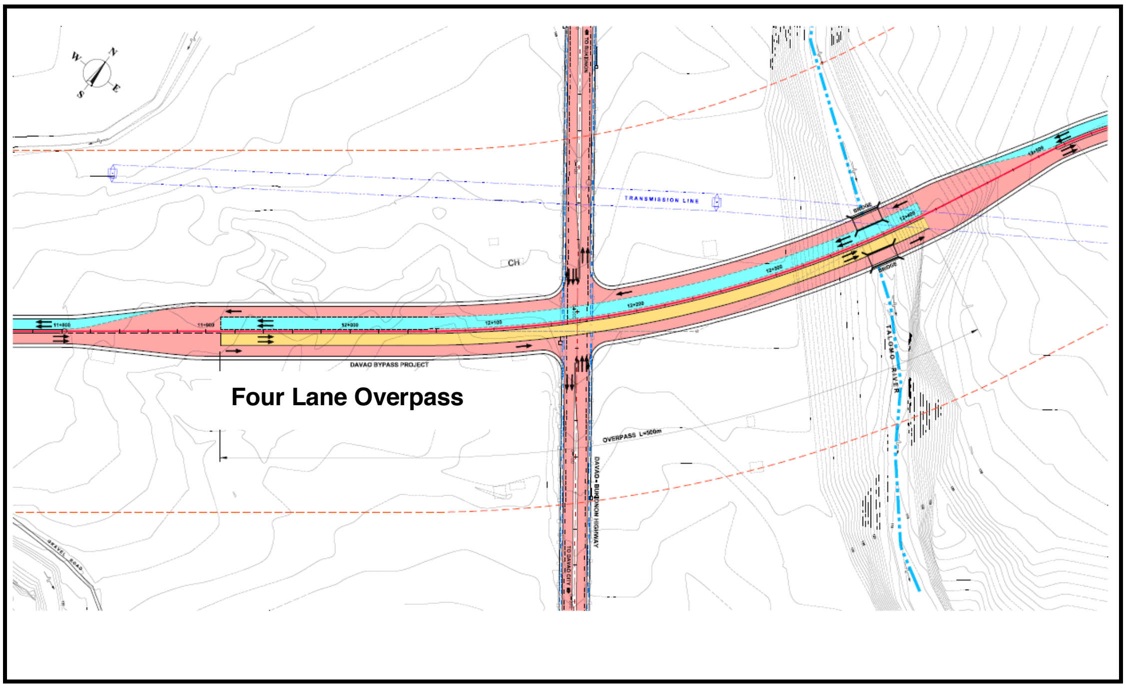
Source: JICA Study Team, July 2014

Figure 1.4.1-7b Intersection of Davao-General Santos Road, 0+000 (Widening Stage)



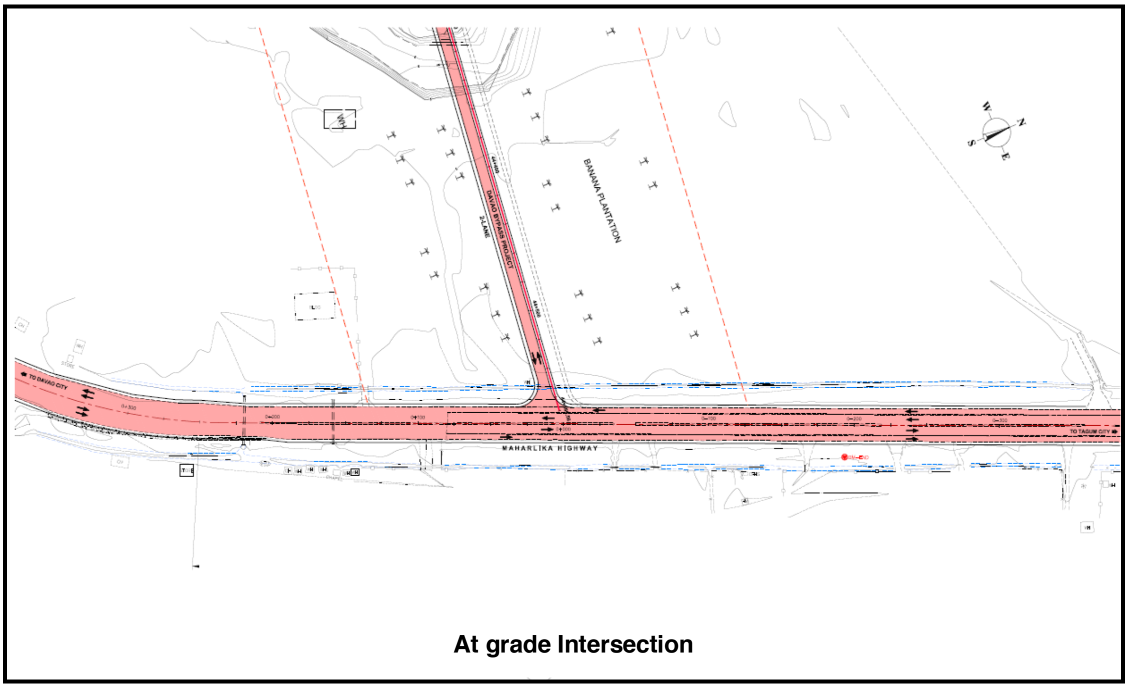
Source: JICA Study Team, July 2014

Figure 1.4.1-8a Intersection of Davao-Bukidnon Highway (12+150) (Initial Stage)



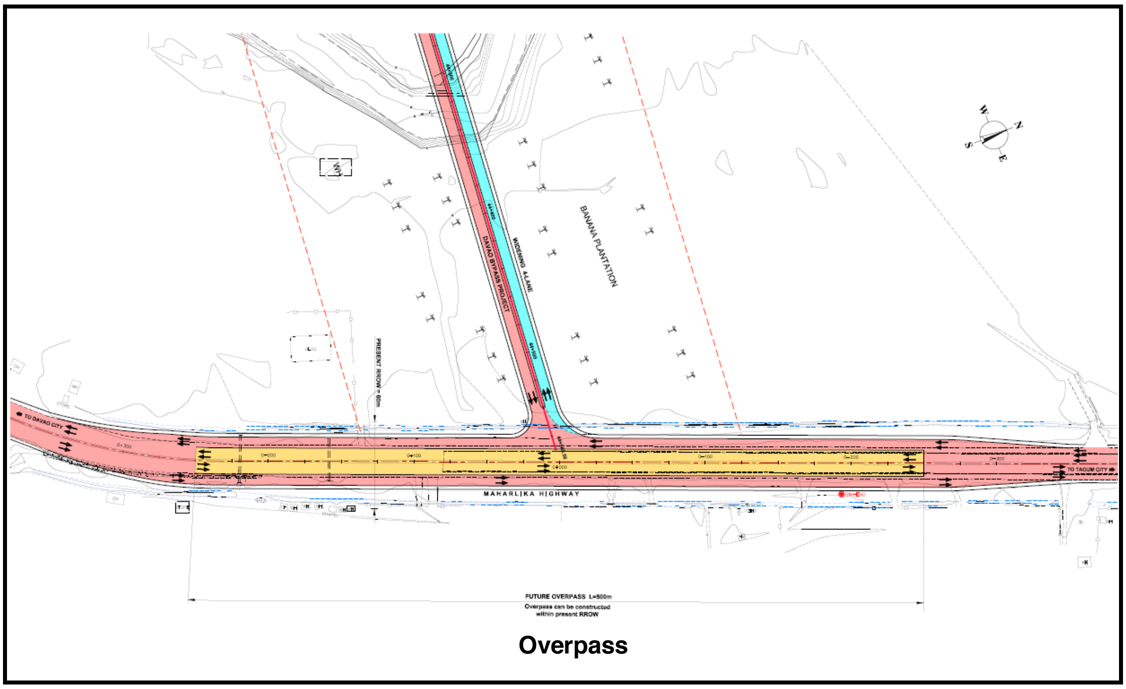
Source: JICA Study Team, July 2014

Figure 1.4.1-8b Intersection of Davao-Bukidnon Highway 12+150 (Initial Stage)



Source: JICA Study Team, July 2014

Figure 1.4.1-9a Intersection of Maharlika Highway 46+600 (Initial Stage)



Source: JICA Study Team, July 2014

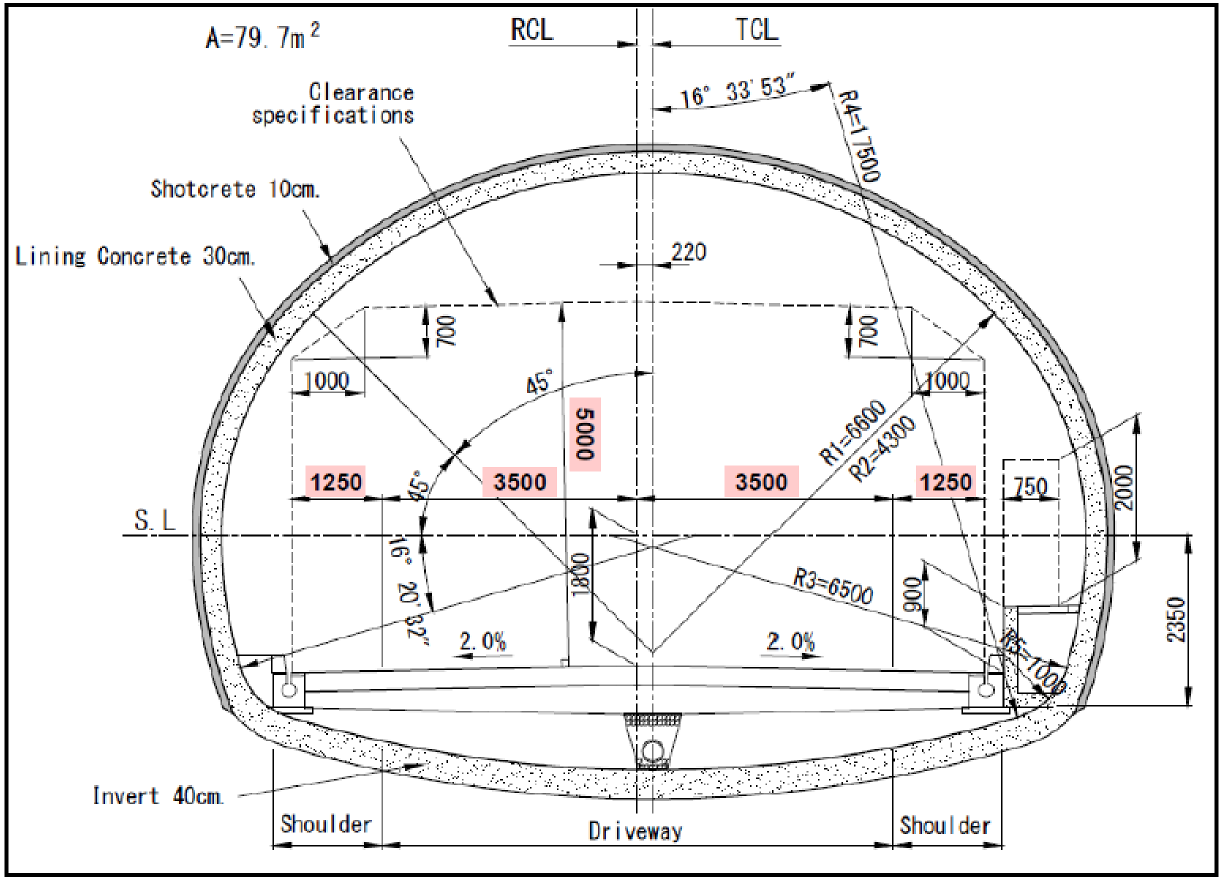
Figure 1.4.1-9b Intersection of Maharlika Highway 46+600 (Widening Stage)

1.4.2 Tunnel Section

The proposed tunnel section between Matina River and Davao River will span a stretch of approximately **2.3 km**.

First phase of the tunnel will have a **2-lane** roadway, with a carriageway of **3.5 m** on each direction. Shoulder width on both sides is set at **1.25 m**. The **5-meter** vertical clearance of the tunnel is based on standard clearance specification. It has vertical gradient of **0.5%** and a horizontal curvature of **3,000 m**. Illustrated in **Figure 1.4.2-1** is the typical cross section of the tunnel.

Overtaking inside the tunnel shall be prohibited to prevent traffic accident as much as possible. In addition, oil tankers and motorbikes will not be allowed inside the tunnel to avoid fire incidents.



Source: JICA Study Team

Figure 1.4.2-1 Tunnel Cross Section

Note: *Overtaking inside a tunnel shall not be allowed to prevent traffic accident as much as possible.*
Horizontal Curvature used: ***3,000 m***
Vertical Gradient used: ***0.5%***

Photo No. 1.4.2-1 Photo showing the portal of a **2-lane** tunnel in Japan. (*Source: JICA Study Team, July 2014*)

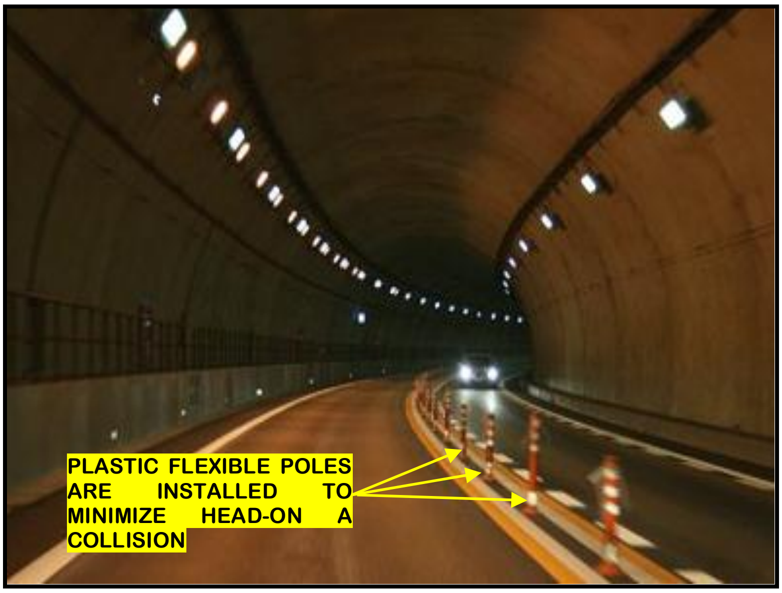


Photo No. 1.4.2-2 Photo showing the well-lighted interior of a **2-lane** tunnel in Japan. Notice the plastic (flexible) poles installed at the center of the roadway which serve as divides to minimize a head-on collision. (*Source: JICA Study Tea m, July 2014*)

1.4.2.1 Tunnel Facilities Based on Classification of Tunnel

Tunnel Facilities and Emergency Facilities are also important items in road tunnels. Tunnels provide emergency facilities based on the tunnel classification (length of tunnel and traffic volume) for traffic safety to minimize the occurrence of accidents. The Davao Bypass Tunnel is classified as category **A**.

Each tunnel shall be equipped with emergency facilities listed in **Table 1.4.2-1** in accordance with the CLASS of tunnel. This is for the prevention of traffic accidents and disaster mitigation as well as danger in cases of other emergencies.

Table 1.4.2-1 Japan Standard of Emergency Facilities to be Installed 1/2

Emergency Facilities		Classification of Tunnel	AA	A	B	C	D	Remarks
Information and Alarm Equipment	Telephone		O	O	O	O	O	Omitted in class D tunnel less than 200 m in length
	Pushbutton		O	O	O	O		
	Fire Detector		O	O				Omitted without ventilation system
	Emergency Alarm Equipment	Tunnel entrance information board	O	O	O	O	O	Omitted in tunnels less than 200 m in length
		In tunnel information board	O	△				To be installed in class A tunnels 3,000 m or more length
Fire Facilities	Fire Extinguisher		O	O	O	O	O	
	Fire Plug		O	O	△			To be installed in class B tunnels 1,000 m or more in length
Escape and Guidance Equipment	Guide Board	Emergency exit lamp	To be installed in tunnel with evacuation adits					
		Guide board (A)	To be installed in tunnel with evacuation adits					
		Emergency exit board	To be installed in tunnel with evacuation adits					
		Guide board (B)	O	O	O			To be installed in tunnels Without evacuation adits
	Smoke Discharge Equipment and Escape Passage		• Evacuation adits to be provided in tunnels of arround 750 m or more in length; • Smpke discharge equipment to be provided in tunnel of arround 1,500 m or more in length; and • Evacuation tunnels provided for those Class AA tunnels and class A tunnels of a length of 3,000 m or more which employ a two-way traffic system and a longitudinal ventilation system in which the length of one ventilation section is more than 2,000 m.					

Table 1.4.2-1 Japan Standard of Emergency Facilities to be Installed 2/2

Other Equipment	Hydrant		O	O	△			To be provided in Class B tunnels 1,000 m or more in length. Tunnels equipped with hydrants are to be provided with a water supply ports near the entrance
	Radio Communication Auxiliary Equipment	Leakage coaxial cables	O	△				To be povided in Class A tunnels 3,000 m or more in length.
	Radio Rebroadcast equipment		O	O				Entrances/Exit
	Loudspeaker Equipment		To be provided in tunnel equipped with a radio rebroadcasting equipment (with interruption function).					
	Water Sprinkler System		O					To be provided in Class A tunnels 3,000 m or more in length
	Observation	Type A (200 m intervals)	To be provided in tunnels with water sprinkler					
		Type B (emergency parking area)		△				To be rpovided in Class A tunnels 3,000 m or more in length
	Lighting Equipment for Power Failure		To be provided in tunnels 200 m or more in length					
	Emergency Power Supply Equipment	Independent power plant	To be provided in tunnels 500 m or more in length					
		Non-failure power supply equipment	To be provided in tunnels 200 m or more in length					

Source: JICA Study Team, July 2014

1.4.2.2 Operation System for Tunnel Facilities

Emergency systems are designed so that all the available facilities and functions are integrated to provide an efficient and rapid response to traffic accidents in the tunnel. An accident in the tunnel is generally reported by emergency telephones and push button equipment or CCTV monitoring. Fire is automatically reported by fire detectors.

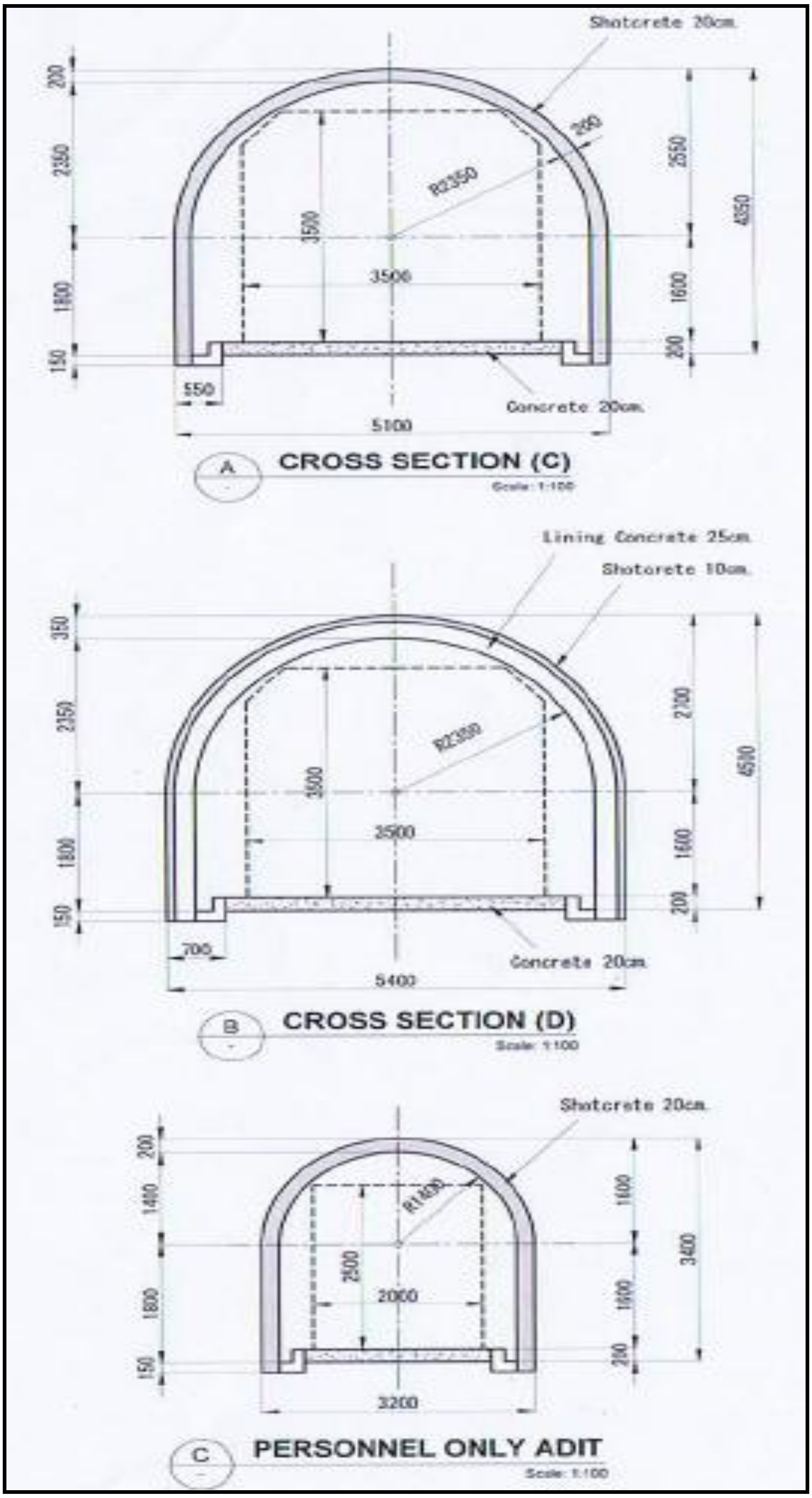
Notification of an emergency is received first by the switchboard of the central control and is transmitted to the administration office in-charge.

(1) Evacuation Tunnel (Emergency Tunnel)

From 1960 to 2000 (40 years), there are 94 fire incidents recorded in a 2-lane 2-way tunnels in Japan. About **60%** of incidents occurred at tunnel with traffic volume of less than **10,000** vehicles/days. Even in a short tunnel fire incidents occur.

In Japan, an evacuation tunnel is provided for a tunnel with more than **3,000 m**. The Study Team proposes to provide an evacuation tunnel for the Davao City Bypass tunnel, although its length is less than **3,000 m** to secure higher safety for road users during emergency cases.

Shown in **Figure 1.4.2-2** is the typical cross section of the evacuation tunnel. A detailed lay out plan of the tunnel evacuation presented in **Figure 7.2-4**, **Section 7.2.1.1** of this Report.



Source: JICA Study Team, July 2014

Figure 1.4.2-2 Cross Section of Evacuation Tunnel

1.4.2.3 Various Facilities Inside a Tunnel for Safe Operation

Emergency systems are designed so that all the available facilities and functions are integrated to provide an efficient and rapid response to traffic accidents in the tunnel. An accident in the tunnel is generally reported by emergency telephones and push button equipment or CCTV monitoring. Fire is automatically reported by fire detectors.

Notification of an emergency is received first by the switchboard of the central control and is transmitted to the administration office in-charge.

Enumerated below are the various facilities inside the tunnel for safe operation. Layout of these facilities are illustrated in **Figure 1.4.2-3**.

(A) Ventilation Equipment

(1) Jet Fan

(B) Monitoring Equipment

(2) Visibility Index Meter (VIM);

(3) Wind Velocity Meter (WVM);

(4) CO Meter (COM); and

(5) CCTV

(C) Equipment for Emergency Case

(6) Fire Hydrant;

(7) Fire Detection;

(8) Push Button Fire Notification; and

(9) Emergency Telephone

(D) Information Provision Equipment

(10) Variable Information Signboard;

(11) Exit Direction Signboard;

(12) Radio Broadcasting; and

(13) Loud Speaker

(E) Others

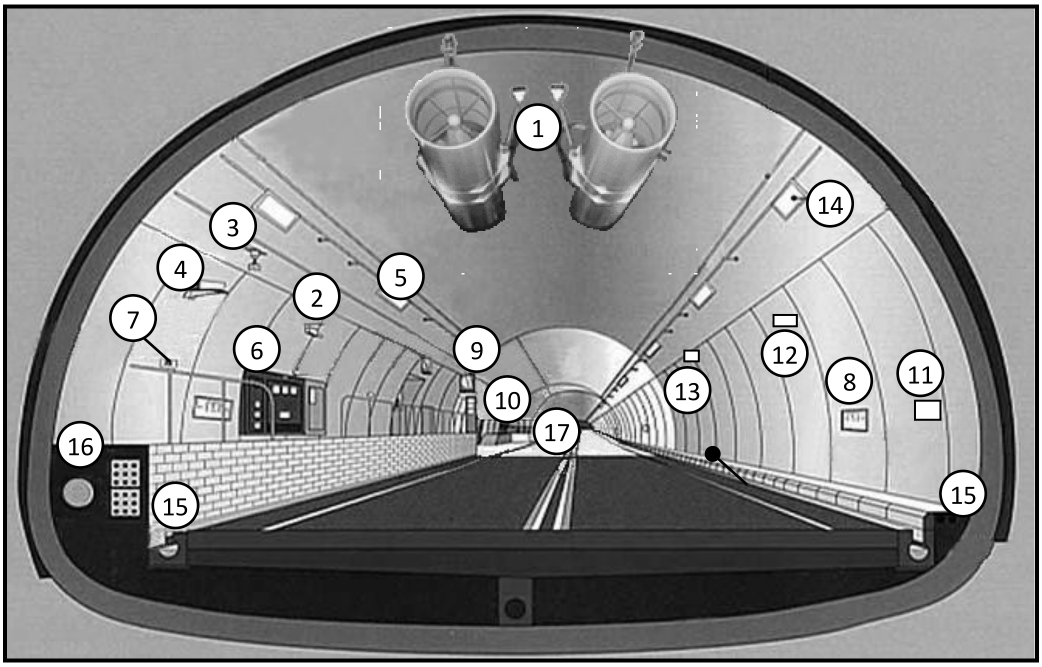
(14) Lighting;

(15) Cable Duct;

(16) Water Supply;

(17) Lay Bay (Emergency Stopping Bay); and

(18) Variable Information Signboard at Tunnel Portals



Source: JICA Study Team, July 2014

Figure 1.4.2-3 Layout of Various Facilities Inside a Tunnel for Safe Operation

Photo No. 1.4.2-3 Variable Information signboard (Type D). (*Source JICA Study Team, July 2014*)

(1) Tunnel Ventilation System

Exhaust Gas from vehicle contains carbon monoxide (CO) and soot which are harmful to the human body. Therefore it is necessary to install ventilation system for more than **500 m** length of tunnel to remove exhaust gas from vehicles.

1) Mechanical Ventilation Types

(a) Longitudinal Ventilation System

A system where the air is introduces to or removed from the tunnel roadway at a limited number of points, thus creating a longitudinal airflow within the tunnel. There are **two** (**2**) distinct types of tunnel longitudinal ventilation systems: those that employ an injection of air into the tunnel from centrally located fans; and those which use jet fans mounted within the tunnel cross-section.

(b) Transverse Ventilation System

It is defined by the uniform distribution of fresh air and/or uniform collection of vitiated air along the length of the tunnel. Space for ventilation duct is provided separately. Mechanical ventilation sends fresh air across the roadway space from the air supply duct.

(c) Semi-Transverse Ventilation System

Chief characteristic of this system is the uniform distribution of collection of air throughout the length of a tunnel. The roadway space uses two ventilation ducts of the transverse type and only one separate duct is needed. This system is more economical than the transverse system.

2) Fresh Air Requirement

The fresh air requirement is based on dilute the CO and soot discharge from vehicle running through the tunnel.

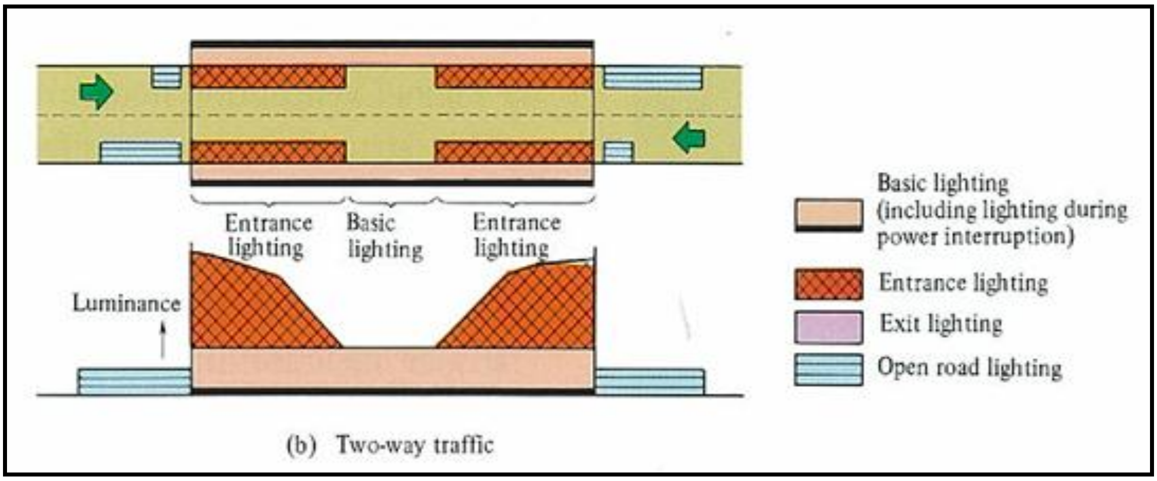
It is apparent that the majority of the soot is discharged from commercial vehicles. It is also noted that values are fixed correspondingly to combinations of design speeds and traffic volumes.

(2) Tunnel Lighting Facilities

Lighting facilities provide a very effective and safe driving and prevents traffic accidents in tunnel.

1) Tunnel Lighting Configuration

Tunnel lighting facilities consist of basic lighting for entrance and emergency lighting systems. The basic schematic tunnel lighting plan is shown in **Figure 1.4.2-4**.



Source: JICA Study Team, July 2014

Figure 1.4.2-4 Basic Schematic Tunnel Lighting Plan

2) Basic Lighting

The basic lighting provides drivers with the luminance required to visually perceive obstacles. Lights are distributed evenly along the entire length of the tunnel. Average road surface luminance is specified as shown in **Table 1.4.2-2**.

The table shows the relationships between vehicle speed and necessary average road surface luminance in ordinary tunnel under **50%** light transmittance per **100 m**.

Table 1.4.2-2 Average Road Surface Luminance

Design Speed (km/h)	Average Road Surface Luminance (cd/m²)
100	9.0
80	4.5
60	2.3
40	1.5

Source: JICA Study Team, July 2014

3) Control of Tunnel Lighting

The entrance lighting and the inside tunnel basic lighting are controlled independently. The entrance lighting is controlled in **four** (**4**) steps according to the luminance of the entrance to outside tunnel road.

The basic lighting is controlled in three steps according to the traffic volume and the luminance of the road. Tunnel lighting is controlled automatically by a photocell with a timer installed at the entrance of the tunnel. It also can be controlled from the operation office.

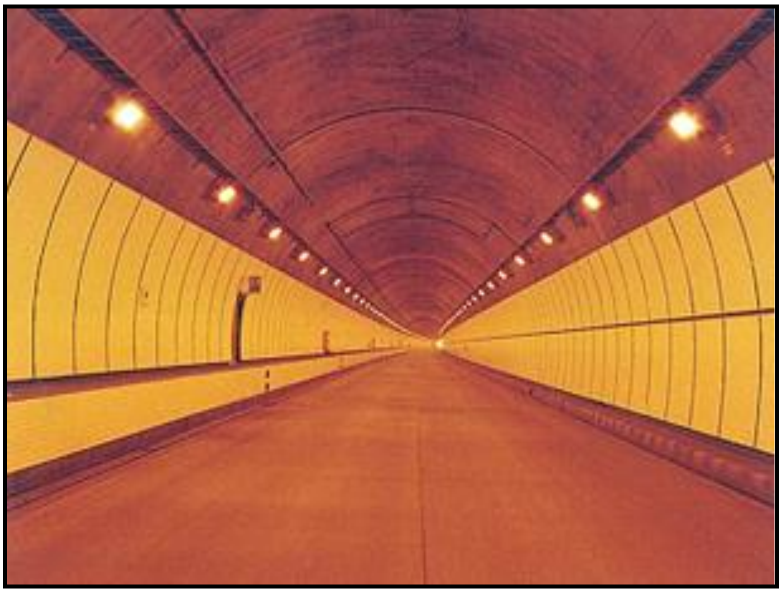


Photo No. 1.4.2-4 Basic lighting inside the tunnel. (*Source JICA Study Team, July 2014*)

(3) Radio Broadcast Relay System

This system is used to relay AM signals into tunnels, so drivers can catch them without interruption while in the tunnels. Tunnels with a length of **150 meters** or longer are usually equipped with this system.

(4) Radio Communication Facilities

Highway is equipped with traffic information gathering and providing facilities, such as variable road information signboards, and road lighting facilities.

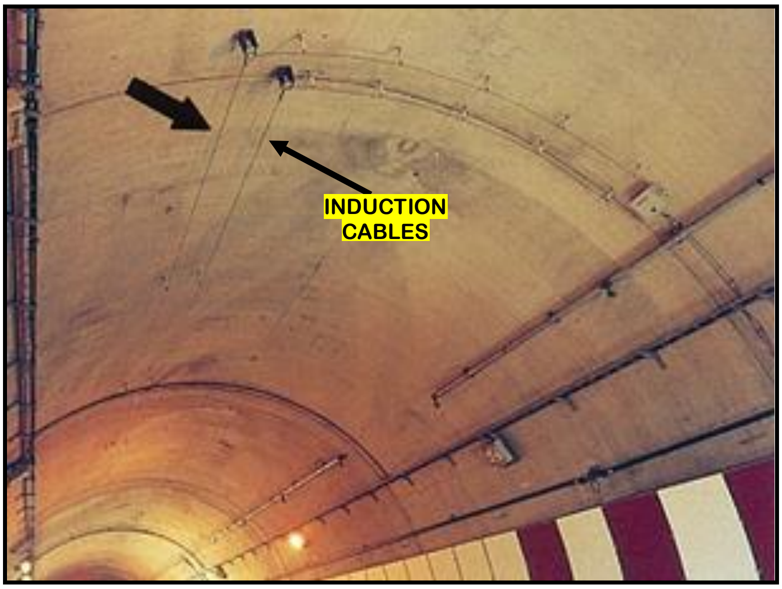
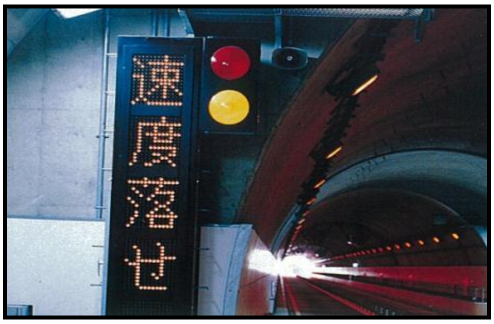


Photo No. 1.4.2-5 Photo showing the installed induction cable inside the tunnel. (*Source JICA Study Team, July 2014*)

(5) Emergency Telephone

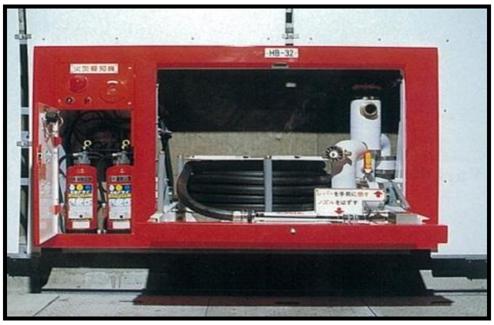
Emergency telephones are installed on the road side wall in tunnels to permit an immediate emergency call for traffic accident to the road administrator office. The emergency message can be transferred by the switch board to the police and fire stations.



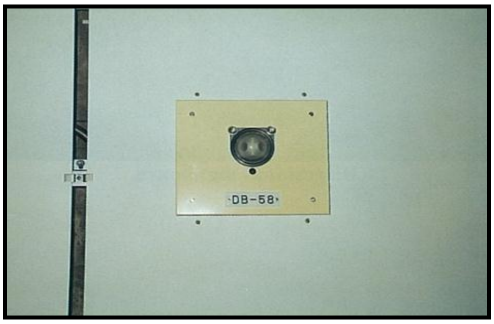
Variable Information Signboard

Emergency Telephone

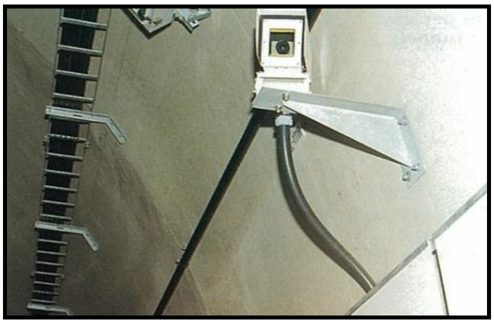
Push-Button Notification Equipment



Fire Hydrant

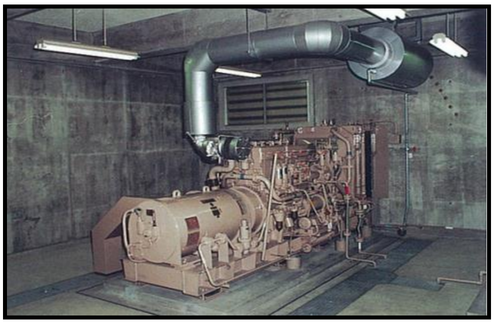


Automatic Fire Detector



Closed-Circuit Television (CCTV)

Direction Signboard



Generator (Uninterrupted Power)

Photo No. 1.4.2-6 Photos of the various facilities inside the tunnel for safe operation.
(*Source: JICA Study Team*)

1.4.3 Structural Design

To estimate the preliminary project cost, preliminary designs of structures (including bridge and box culvert) were made followed by the calculation of quantities.

1.4.3.1 Summary of Preliminary Design Results

(1) Bridge Structures

1) Crossing River/Waterway

In order to estimate the preliminary project cost, preliminary designs of structures (including bridge and box culvert) were undertaken followed by the calculation of quantities.

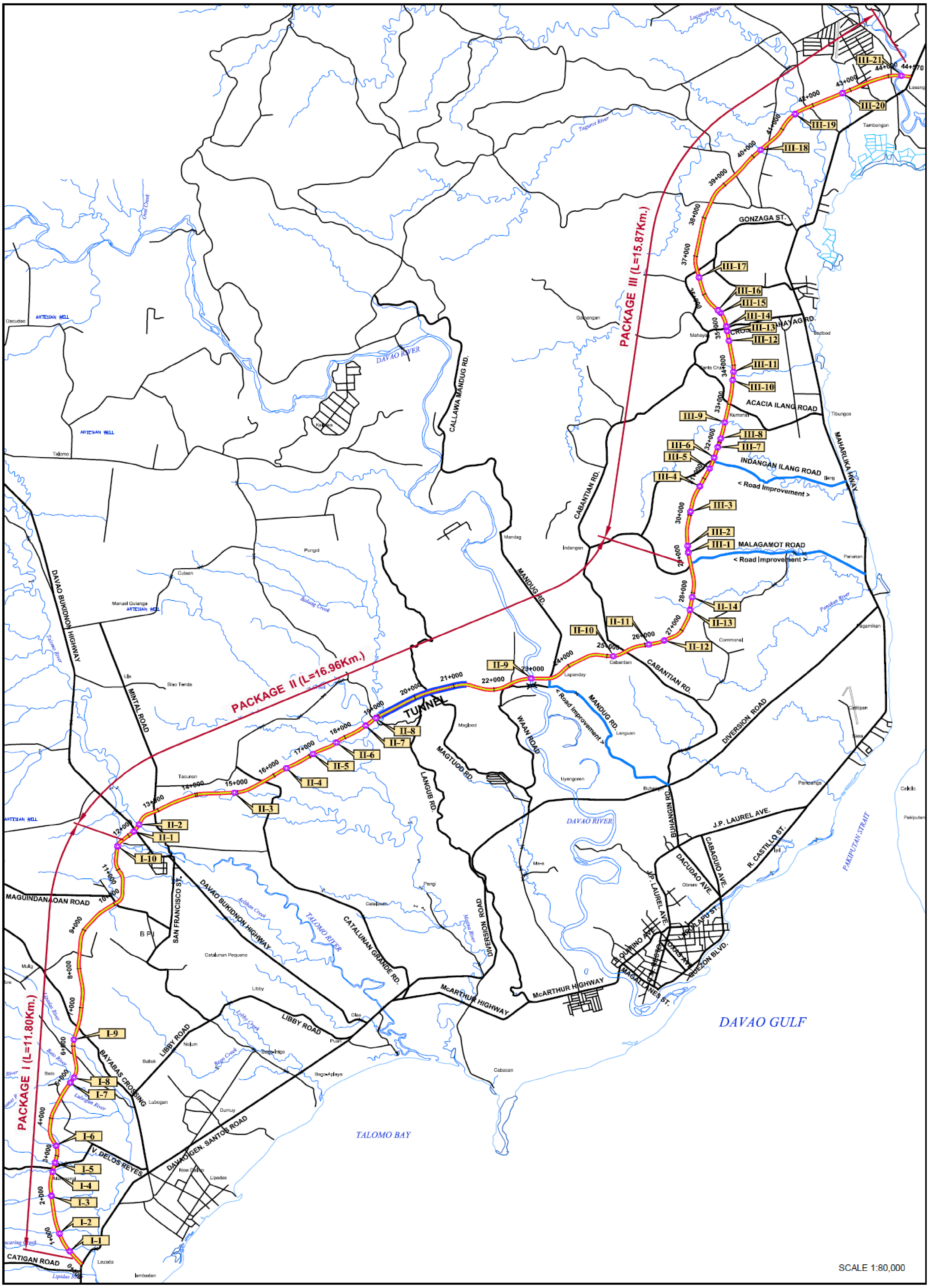
A total of **45** bridges (crossing rivers and waterways) are planned for the main road of the bypass alignment and **12** overpass bridges (crossing roads) for Package I-III (see **Table 1.4.3-1**). In this study, the commonly used type of superstructures are the Reinforced Concrete Deck Girder (RCDG), the Pre-stressed Concrete Girder (PSCG), and special bridge types are choose such as PC-Box girder and Steel Truss.

Figure 1.4.3-1 shows the location map of the proposed bridges along the bypass alignment.

Table 1.4.3-1 Summary of Preliminary Bridge Design Results

Package	Location (Sta.)	Sum Total of Bridges	Number of Bridges (Bypass Road)				No. of Overpass Bridges
			RCDG (L=<24 m)	PSCG (24<L< 40 m)	Cantilever PC-Box (L<60 m)	Steel Truss (L<60 m)	
I	0+000–11+700	10	0	9	1	0	2
II	11+700–28+800	14	0	14	0	0	4
III	28+800–44+570	21	0	20	1	0	6
TOTAL	**–**	**45**	**0**	**43**	**2**	**0**	**12**

Source: JICA Study Team, July 2014



Source: JICA Study Team, July 2014

Figure 1.4.3-1 Bridge Location Map

In accordance with the alignment design, the crossing conditions related to the ridge planning were identified. **Table 1.4.3-2** gives a summary of the typical condition of bridge crossing waterways.

Table 1.4.3-2 Typical Condition of Crossing Waterway

Category of Waterway	Crossing condition	Structure
River	Discharge Volume (50years) <80m^3/s	RCBC with freeboard
	Discharge Volume (50years) >80m^3/s	Bridge with freeboard
	Existing Water Way Width >10m	Bridge with freeboard
Irrigation Canal	Keep the same or more cross section of existing canal	Varies with freeboard

Source: JICA Study Team, July 2014

2) Crossing Road

In accordance with the alignment design, the crossing conditions related to the bridge planning were identified. Shown in **Table 1.4.3-3** is the list of the crossing roads and conditions, while **Table 1.4.3-4** presents the cross sectional configuration of crossing roads.

Table 1.4.3-3 List of Crossing Road (Except Crossing At Grade) 1/2

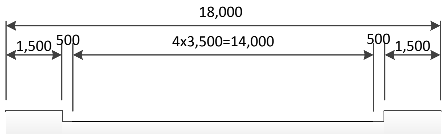
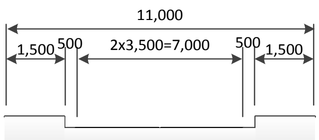
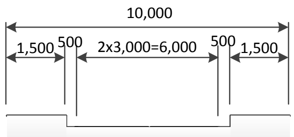
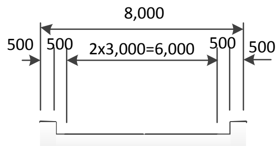
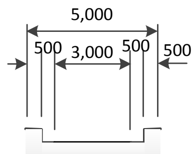
No.	PKG	Station	Crossing Road	Road Category		Skew Angles (deg.)	Type of Crossing
				Road Width (m)	Vertical Clearance (m)		
1	II	12+127	Davao-Bukidnon Rd.	18.0	5.2	85	Underpass
2	II	18+824	Barangay Rd.	5.0	4.0	90	Overpass
3	II	22+315	Barangay Rd.	5.0	4.0	90	Underpass
4	II	23+421	Barangay Rd.	5.0	4.0	65	Underpass
5	II	23+826	Mandug Rd.	8.0	4.9	90	Underpass
6	II	24+700	Subdivision Rd.	5.0	4.0	65	Overpass
7	II	25+470	Cabantian Rd.	10.0	4.9	90	Overpass
8	II	27+360	Barangay Rd.	5.0	4.0	90	Overpass
9	III	32+190	Barangay Rd.	5.0	4.0	85	Overpass
10	III	32+989	Acacia- Ilang Rd.	5.0	4.9	70	Overpass

Table 1.4.3-3 List of Crossing Road (Except Crossing At Grade) 2/2

No.	PKG	Station	Crossing Road	Road Category		Skew Angles (deg.)	Type of Crossing
				Road Width (m)	Vertical Clearance (m)		
11	III	33+465	Barangay Rd.	5.0	4.0	50	Overpass
12	III	33+965	Barangay Rd.	5.0	4.0	90	Overpass
13	III	34+390	Barangay Rd.	5.0	4.0	85	Overpass
14	III	38+425	Barangay Rd.	5.0	4.0	70	Overpass
15	III	39+355	Barangay Rd.	5.0	4.0	72	Underpass
16	III	44+097	Barangay Rd.	5.0	4.0	90	Underpass

Source: JICA Study Team, July 2014

Table 1.4.3-4 Cross Sectional Configuration Of Crossing Road

No.	Road Category	Road Width (m)	Cross Sectional Configuration	Vertical Clearance (m)
1	Davao-Bukidnon Road	18.0m		5.2 m (4.9+0.3 m)
2	National Road/ Provincial Road need not be widened	10.0m		5.2 m (4.9+0.3 m)
3	Municipality Road	10.0m		5.2 m (4.9+0.3 m)
4	Farm Road/Private Road/ Barangay Road (2-lane)	8.0m		4.0 m (3.8+0.2 m)
5	Farm Road/Private Road/ Barangay Road (1-lane)	5.0m		4.0 m (3.8+0.2 m)

Source: JICA Study Team, July 2014

3) Viaduct

(a) Sta. 18+425 – 18+720 Bridge through the Malogbok Creek (No. II-7)

Malogbok Creek is about more than 30 m in depth. Bridge length is **295 m** best girder type and span arrangement is **8-span** PSCG (AASHTO girder type V, **5@ 40+35+30+30 m**). Based on geotechnical survey result, foundation type is cast-in-place pile (**1.2 m diameter**)

(b) Sta. 32+385 – Sta. 32+695 Bridge through Deep Creek (No. III-9)

This Creek is about than **30 m** in depth. Bridge length is **310 m**, best girder type and span arrangement is **8-span** PSCG (AASHTO girder type V, **5@ 40+35+30+30 m**). Based on geotechnical survey result, foundation type is cast-in-place pile (**1.2 m diameter**).

(2) Culverts

Pipe and box culverts are the **two (2)** type of channels proposed along the bypass alignment. Pipe culvert will be utilized for valley of stream after rain and for irrigation canals. Box culverts on the other hand is applied for road with less than **6 m** width such as barangay and farm roads. **Table 14.3-5** presents the summary of preliminary culvert design results.

Table 1.4.3-5 Summary of Preliminary Culvert Design Results

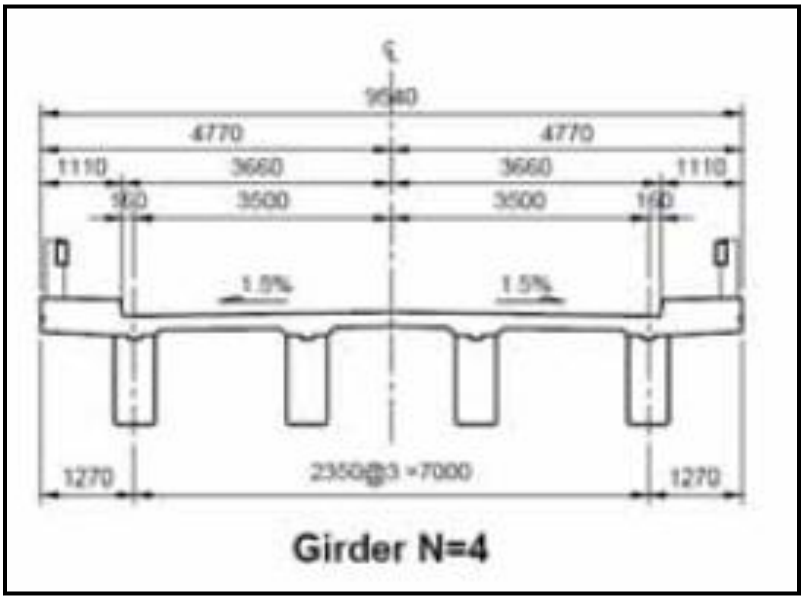
Package	Location (Sta.)	Number of Culvert (Bypass Road)		
		Pipe Culvert for Drainage	Box Culvert for River/Waterway	Box Culvert for Crossing Road
PKG-I	0+0 to 11+700	19	16	0
PKG-II	11+700 to 28+800	39	16	3
PKG-III	28+800 to 44+570	24	8	2
Total	**---**	**82**	**40**	**5**

1.4.3.2 Geometric Design

(1) Typical Cross Section

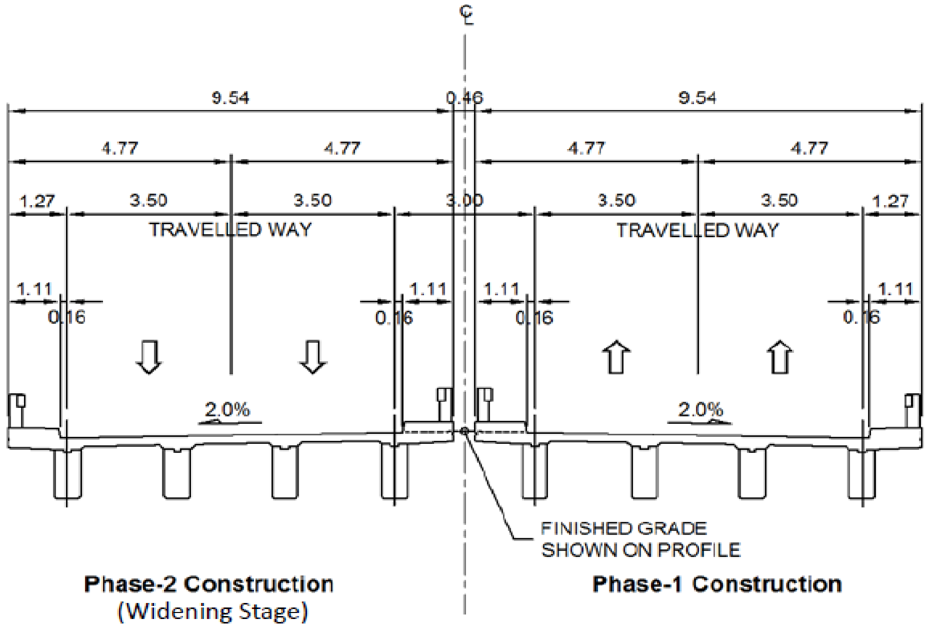
1) Bridge Structures

Type-1 DPWH Standard is the recommended cross section of the bridge and viaduct for the bypass alignment (see **Figure 1.4.3-2**). The typical cross section of the bridge is shown in **Figure 1.4.3-3**.



Source: JICA Study Team, July 2014

Figure 1.4.3-2 Recommended Cross Section for Bridge (Type-1 DPWH Standard)



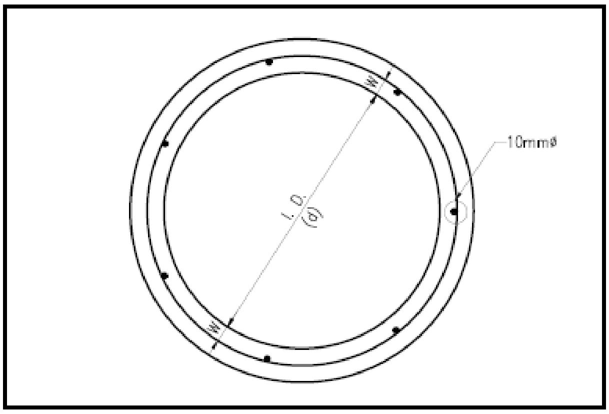
Source: JICA Study Team, July 2014

Figure 1.4.3-3 Typical Cross Section for Bridge

2) Culverts

(a) Pipe Culvert

Pipe culvert is utilized for valley of stream after rain and irrigation canal. The dimension of pipe culvert is at least **910 mm** diameter. **Figure 1.4.3-4** presents the typical cross section of reinforced concrete pipe culvert (RCPC) for the bypass alignment.



Source: JICA Study Team, July 2014

Figure 1.4.3-4 Typical Cross Section of Pipe Culvert

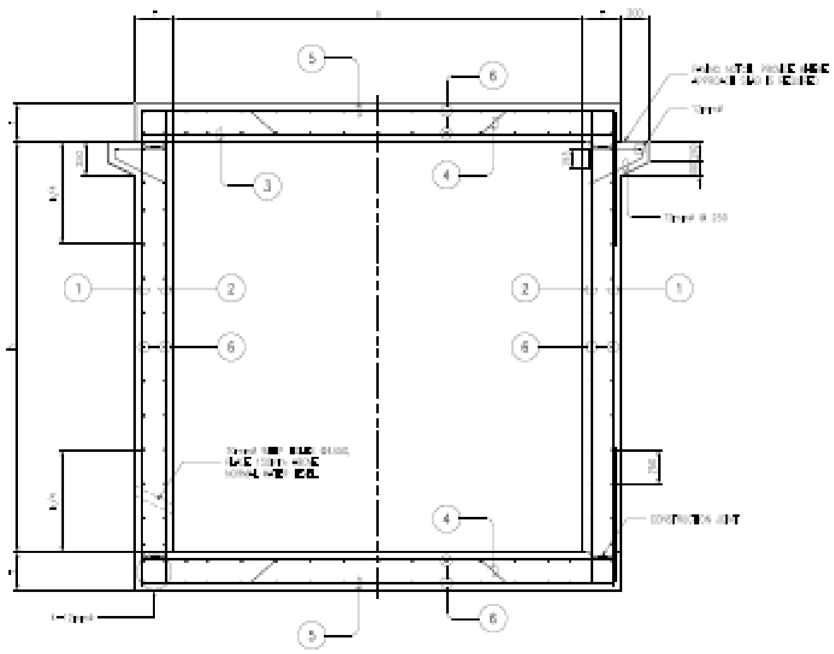
(b) *Box Culvert for Crossing Road*

Box culvert is applied for less than **6 m** width of road crossing such as barangay road and farm road.

(c) *Box Culvert for Crossing River and Waterways*

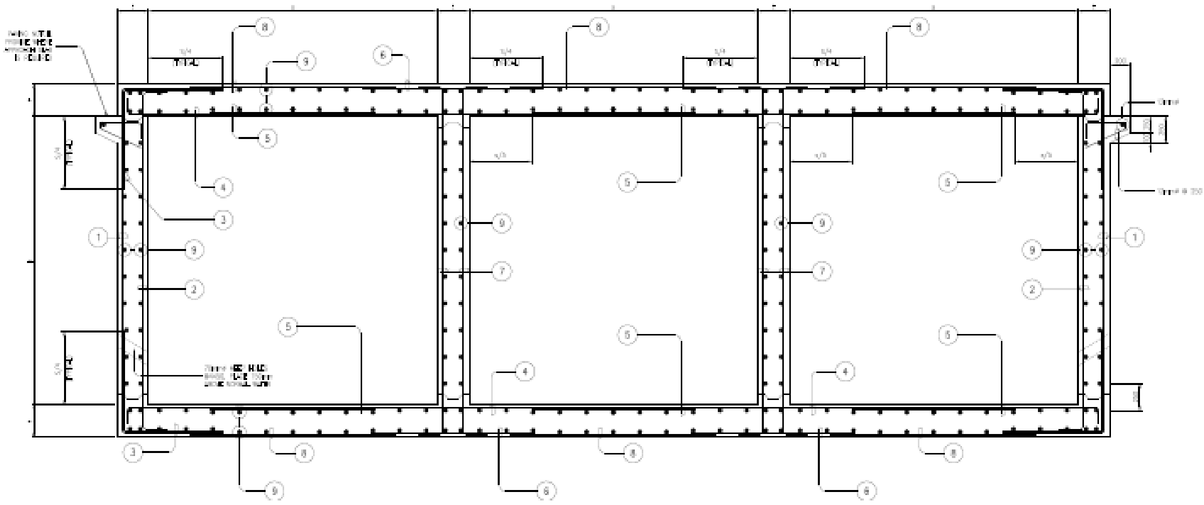
Box culvert is applied for less than **6 m** width of road crossing. Portal rigid frame type is applied less than **12 m** width and discharge volume more than **80 m^3/s**.

Typical cross section of single barrel and triple barrel reinforced concrete box culvert (RCBC) are shown in **Figures 1.4.3-5** and **1.4.3-6**, respectively.



Source: JICA Study Team, July 2014

Figure 1.4.3-5 Typical Cross Section of RCBC Single Barrel

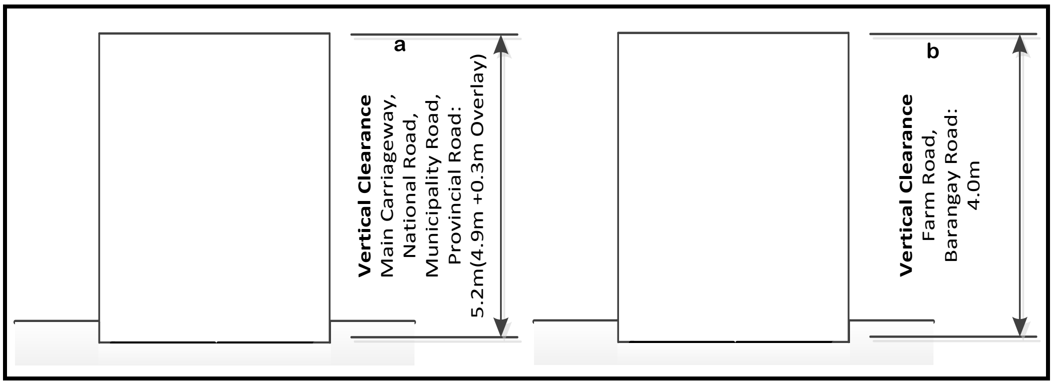


Source: JICA Study Team, July 2014

Figure 1.4.3-6 Typical Cross Section of RCBC Triple Barrel

(2) Vertical Clearance

As shown in **Figure 1.4.3-7**, the recommended vertical clearance of the main carriageway and crossing road shall be **4.0 m** (**3.8 m + overlay 0.2 m**) to **5.2 m** (**4.9 m + overlay 0.3 m**).



Source: JICA Study Team, July 2014

Figure 1.4.3-7 Vertical Clearance

Note:

a) Main Carriageway; and

b) Others: High priority crossing road

(3) Horizontal Clearance and Embedded Depth

The pier columns or walls for grade separation structures shall generally be located at a minimum of **9.0 m** from the edges of the through traffic lanes. Where the practical limits of structure cost, type of structure, volume and design speed of through traffic, span arrangement, skew and terrain make the 9.0m offset impractical, the pier or wall maybe placed closer than **9.0 m** and protected by the use of guardrail or other barrier devices. The guardrail or other devices shall be independently supported with the roadway face at least **0.60 m** from the face of pier or abutment.

The face of the guardrail or other device shall be at least **0.60m** outside the normal shoulder line. Footings shall be embedded into the ground at least **1.0m** from ground surface to the top of footing, and at least **2.0 m** from the river bed in the river. he effect of buoyancy on the structure shall be verified.

When using a spread footing type, bottom of footings shall be embedded at least **0.5 m** from the support layer. When using a pile type, bottom of pile shall be embedded at least **1.0** times diameter from the support layer.

1.4.3.3 Preliminary Design of Bridge Structures

(1) Bridges Structures (Crossing River/Waterway and Crossing Road)

Bridges crossing river/waterways for the preliminary design are listed in **Table 1.4.3-6**. The list of overpass bridges (crossing road) are shown in **Table 1.4.3-7**.

Table 1.4.3-6 List of Bridges 1/2

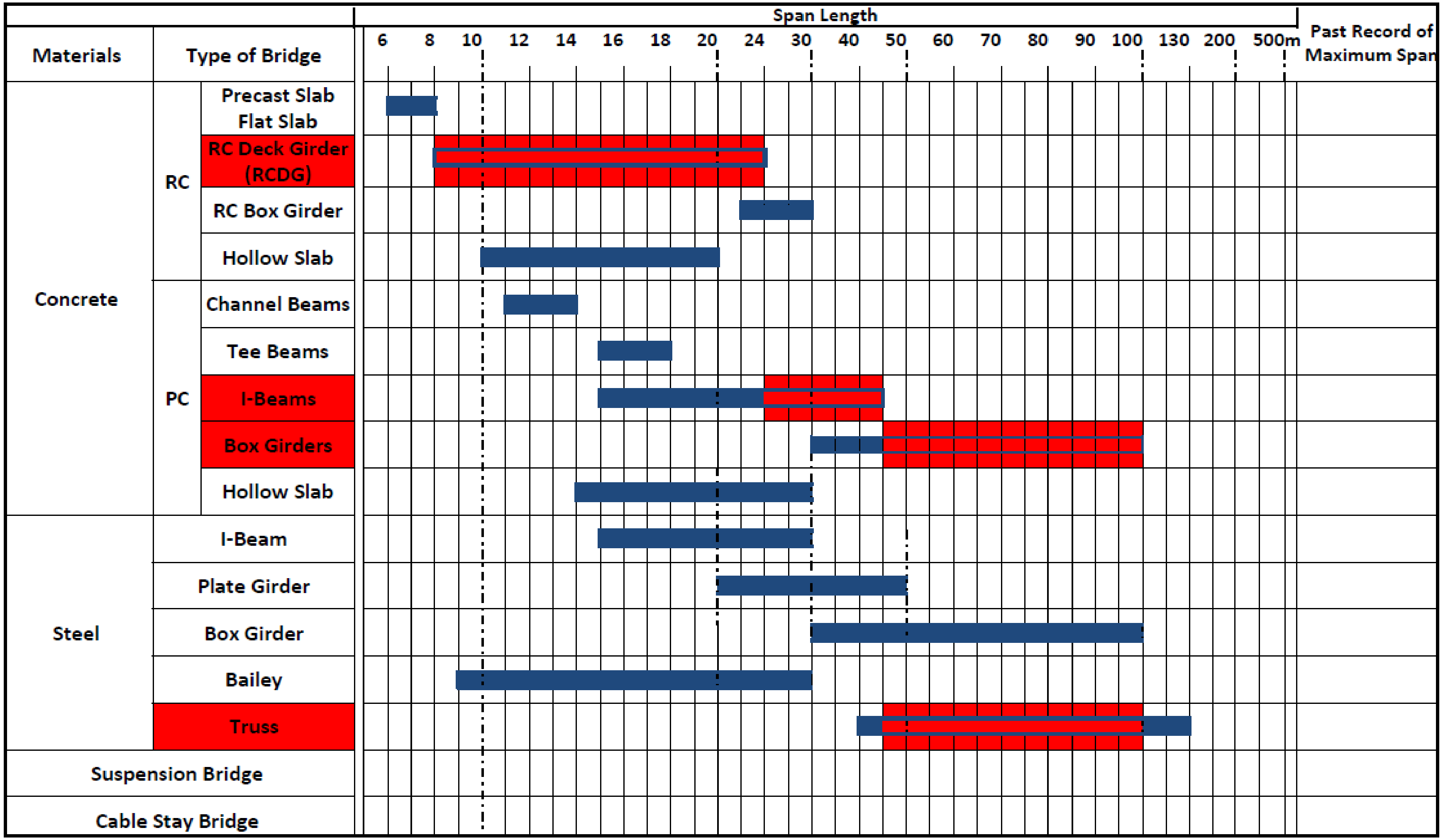
PKG	No.	Beginning Sta.	End Sta.	Bridge Length (m)	Nos. of Span	Girder Type	Angle (deg.)	Span Arrangement (m)	Type of Foundation	Apply BH. No.	Crossing Object
I	I-1	0 + 430	0 + 470	40	2	PSCG	90	40	C.I.P pile(Φ1200,L=10m)	BH1	
	I-2	0 + 940	1 + 28	88	3	PSCG	90	24 + 40 + 24	C.I.P pile(Φ1200,L=10m)		
	I-3	1 + 860	2 + 60	200	5	PSCG	90	40 + 40 + 40 + 40 + 40	C.I.P pile(Φ1200,L=10m)	BH2	
	I-4	2 + 505	2 + 635	130	4	PSCG	90	30 + 40 + 30 + 30	C.I.P pile(Φ1200,L=10m)	BH3	Bayabas Creak
	I-5	2 + 725	2 + 865	140	4	PSCG	90	30 +40 + 40 + 30	C.I.P pile(Φ1200,L=10m)		
	I-6	3 + 196	3 + 304	108	4	PSCG	90	20 + 30 + 30 + 24	C.I.P pile(Φ1200,L=10m)	BH4	
	I-7	4 + 960	5 + 100	140	2	PSCG	90	70 + 70	C.I.P pile(Φ1200,L=10m)	BH5	Lubogan River
	I-8	5 + 100	5 + 260	160	4	PSCG	90	40 + 40 + 40 + 40	Spread F.		Bato River
	I-9	6 + 27	6 + 227	200	5	PSCG	90	40 + 40 + 40 + 40 + 40	C.I.P pile(Φ1200,L=10m)	BH6	Lipadas River
	I-10	11 + 570	11 + 610	40	1	PSCG	90	40	C.I.P pile(Φ1200,L=10m)	BH8	
II	II-1	12 + 113	12 + 208	95	3	PSCG	90	30 + 35 + 30	C.I.P pile(Φ1200,L=10m)	BH8	Davao-Bukidnon Rd.
	II-2	12 + 310	12 + 430	120	3	PSCG	90	40 + 40 + 40	C.I.P pile(Φ1200,L=10m)		Talomo River
	II-3	14 + 900	14 + 940	40	1	PSCG	90	40	C.I.P pile(Φ1200,L=10m)	BH9	
	II-4	16 + 311	16 + 405	94	3	PSCG	90	24 + 35 + 35	C.I.P pile(Φ1200,L=10m)	BH10	
	II-5	16 + 982	17 + 172	190	5	PSCG	90	35 + 40 + 40 + 40 + 35	C.I.P pile(Φ1200,L=10m)		
	II-6	17 + 684	17 + 822	138	5	PSCG	90	24 + 30 + 30 + 30 + 24	C.I.P pile(Φ1200,L=10m)		
	II-7	18 + 429	18 + 724	295	8	PSCG	90	5 + 40 + 35 + 30 + 30	C.I.P pile(Φ1200,L=10m)	BH11	Malogbok Creak
	II-8	18 + 837	18 + 961	124	4	PSCG	90	24 + 40 + 3 0 + 30	C.I.P pile(Φ1200,L=10m)		Matina River
	II-9	22 + 840	23 + 40	200	5	PSCG	90	40 + 40 + 40 + 40 + 40	C.I.P pile(Φ1200,L=20m)	BH13	Davao River
	II-10	25 + 60	25 + 270	210	6	PSCG	90	40 + 40 + 40 + 30 + 30 + 30	C.I.P pile(Φ1200,L=10m)	BH15	
	II-11	26 + 57	26 + 137	80	2	PSCG	70	40 + 40	C.I.P pile(Φ1200,L=10m)		
	II-12	26 + 477	26 + 537	60	2	PSCG	90	30 + 30	C.I.P pile(Φ1200,L=10m)		
	II-13	27 + 510	27 + 630	120	3	PSCG	90	40 + 40 + 40	C.I.P pile(Φ1200,L=10m)		
	II-14	27 + 865	27 + 905	40	1	PSCG	90	40	C.I.P pile(Φ1200,L=10m)		

Table1.4.3-6 List of Bridges 2/2											
PKG	No.	Beginning Sta.	End Sta.	Bridge Length (m)	Nos. of Span	Girder Type	Angle (deg.)	Span Arrangement (m)	Type of Foundation	Apply BH. No.	Crossing Object
III	III-1	28 + 938	29 + 168	230	7	90	PSCG	30 + 30 + 35 + 40 + 35 + 30 + 30	C.I.P pile(Φ1200,L=10m)	BH16	
	III-2	29 + 195	29 + 250	55	2	90	PSCG	25 + 30	C.I.P pile(Φ1200,L=10m)		
	III-3	30 + 50	30 + 144	94	3	90	PSCG	35 + 35 + 24	C.I.P pile(Φ1200,L=10m)		
	III-4	30 + 702	30 + 867	165	5	90	PSCG	30 + 35 + 40 + 30 + 30	C.I.P pile(Φ1200,L=10m)		
	III-5	31 + 161	31 + 401	240	6	90	PSCG	40 + 40 + 40 + 40 + 40 + 40	C.I.P pile(Φ1200,L=12m)	BH17	
	III-6	31 + 512	31 +687	175	5	90	PSCG	35 + 35 + 35 + 35 + 35	C.I.P pile(Φ1200,L=12m)		
	III-7	31 + 828	31 + 918	90	3	90	PSCG	30 + 30 + 30	C.I.P pile(Φ1200,L=12m)		
	III-8	32 + 75	32 + 110	35	1	90	PSCG	35	C.I.P pile(Φ1200,L=12m)		
	III-9	32 + 386	32 + 666	280	7	90	PSCG	35 + 60 + 60 + 35 + 30 + 30 + 30	C.I.P pile(Φ1200,L=12m)		
	III-10	33 + 579	33 +657	78	3	90	PSCG	24 + 30 + 24	C.I.P pile(Φ1200,L=12m)		
	III-11	33 + 784	33 + 862	78	3	90	PSCG	24 + 30 + 24	C.I.P pile(Φ1200,L=12m)		
	III-12	34 + 617	34 + 641	24	1	90	PSCG	24	C.I.P pile(Φ1200,L=12m)		
	III-13	34 + 862	34 + 902	40	1	90	PSCG	40	C.I.P pile(Φ1200,L=12m)		
	III-14	34 + 968	35 + 48	80	2	90	PSCG	40 + 40	C.I.P pile(Φ1200,L=12m)		
	III-15	35 + 355	35 + 390	35	1	90	PSCG	35	C.I.P pile(Φ1200,L=12m)		
	III-16	35 + 455	35 + 495	40	1	90	PSCG	40	C.I.P pile(Φ1200,L=12m)		
	III-17	36 + 378	36 + 488	110	3	90	PSCG	40 + 40 + 30	C.I.P pile(Φ1200,L=12m)		
	III-18	40 + 215	40 + 255	40	1	90	PSCG	40	C.I.P pile(Φ1200,L=35m)	BH18	
	III-19	41 + 490	41 + 580	90	3	90	PSCG	30 + 30 + 30	C.I.P pile(Φ1200,L=40m)	BH19	Lacanon River
	III-20	42 + 760	42 + 800	40	1	90	PSCG	40	C.I.P pile(Φ1200,L=60m)	BH20	
	III-21	44 + 278	44 + 378	100	3	90	PSCG	30 + 40 + 30	C.I.P pile(Φ1200,L=60m)		Maduao River
			Total (m)	5131	I	1206					
					II	1806					
					III	2119					

Table1.4.3-7 List of Overpass Bridges							
PKG	**No.**	**Station**	**Crossing Object**	**Nos. of Span**	**Girder Type**	**Angle (deg.)**	**Span Arrangement (m)**
I	IO-1	3 + 820	Brgy. Rd.	2	PSCG	90	25 + 25
	IO-2	9 + 80	Brgy. Rd.	2	PSCG	90	25 + 25
II	IIO-1	18 + 820	Brgy. Rd.	2	PSCG	80	25 + 20
	IIO-2	24 + 700	Subdivision Rd. (UC)	2	PSCG	90	25 + 30
	IIO-3	25 + 470	Cabantian Rd.	2	PSCG	65	25 + 25
	IIO-4	27 + 360	Brgy. Rd.	2	RCDG	90	20 + 20
III	IIIO-1	32 + 190	Brgy. Rd.	2	PSCG	90	30 + 25
	IIIO-2	32 + 990	Acacia-Ilang Rd.	2	PSCG	75	25 + 25
	IIIO-3	33 + 465	Brgy. Rd.	2	PSCG	90	25 + 20
	IIIO-4	33 + 965	Private Rd.	2	RCDG	90	20 + 20
	IIIO-5	34 + 390	Private Rd.	2	RCDG	90	20 + 20
	IIIO-6	38 + 425	National Rd.	2	PSCG	80	25 + 20

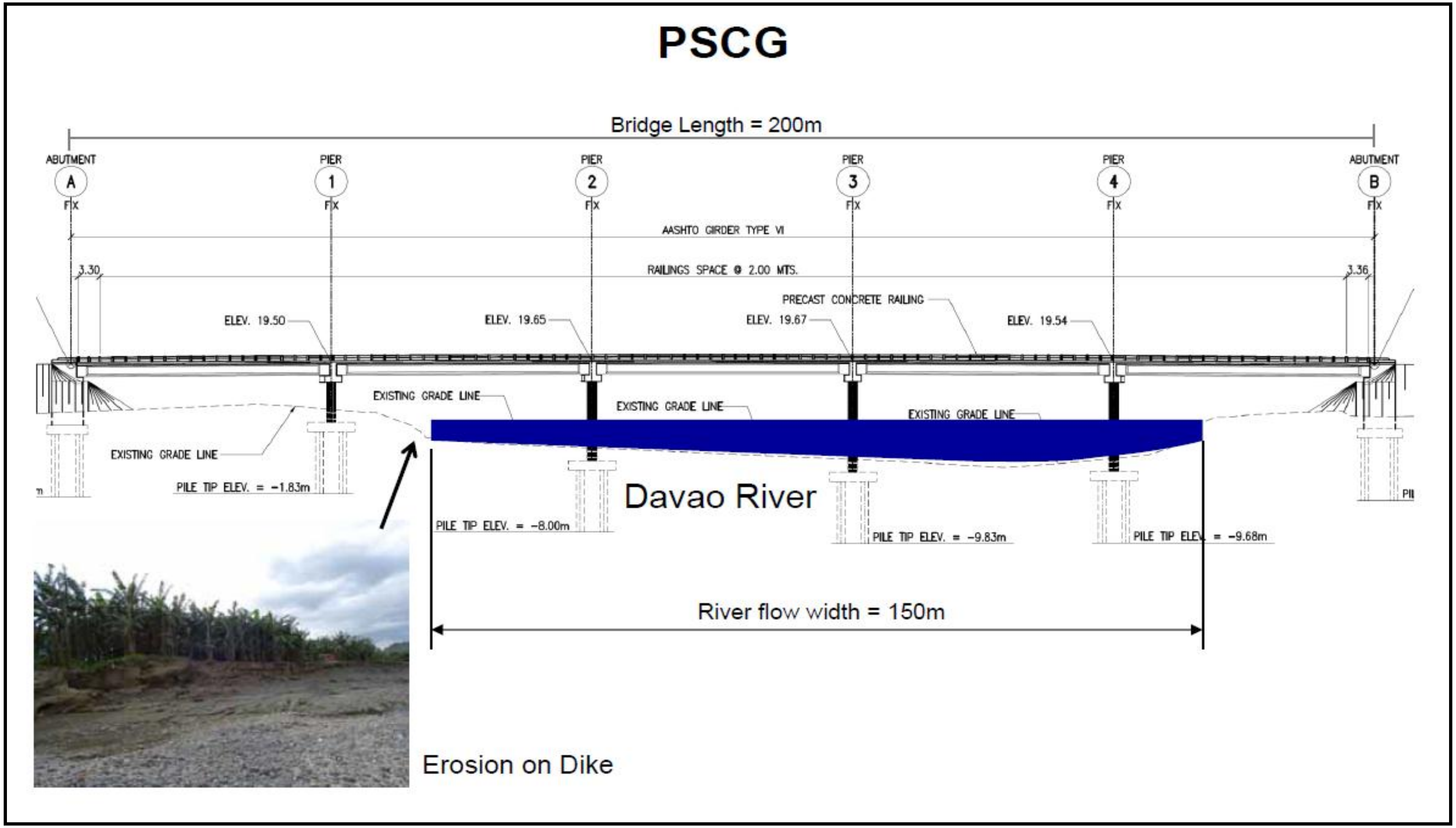
(2) Superstructures

In this study, the commonly used types of superstructure are RCDG, PSCG, and special typos are chosen such as PC box girder and Steel Truss. Shown in **Figure 1.4.3-8** are the recommended types of superstructure depending on the different span length in the Philippines. These types shall be adopted depending on the span length, economy, and site condition.



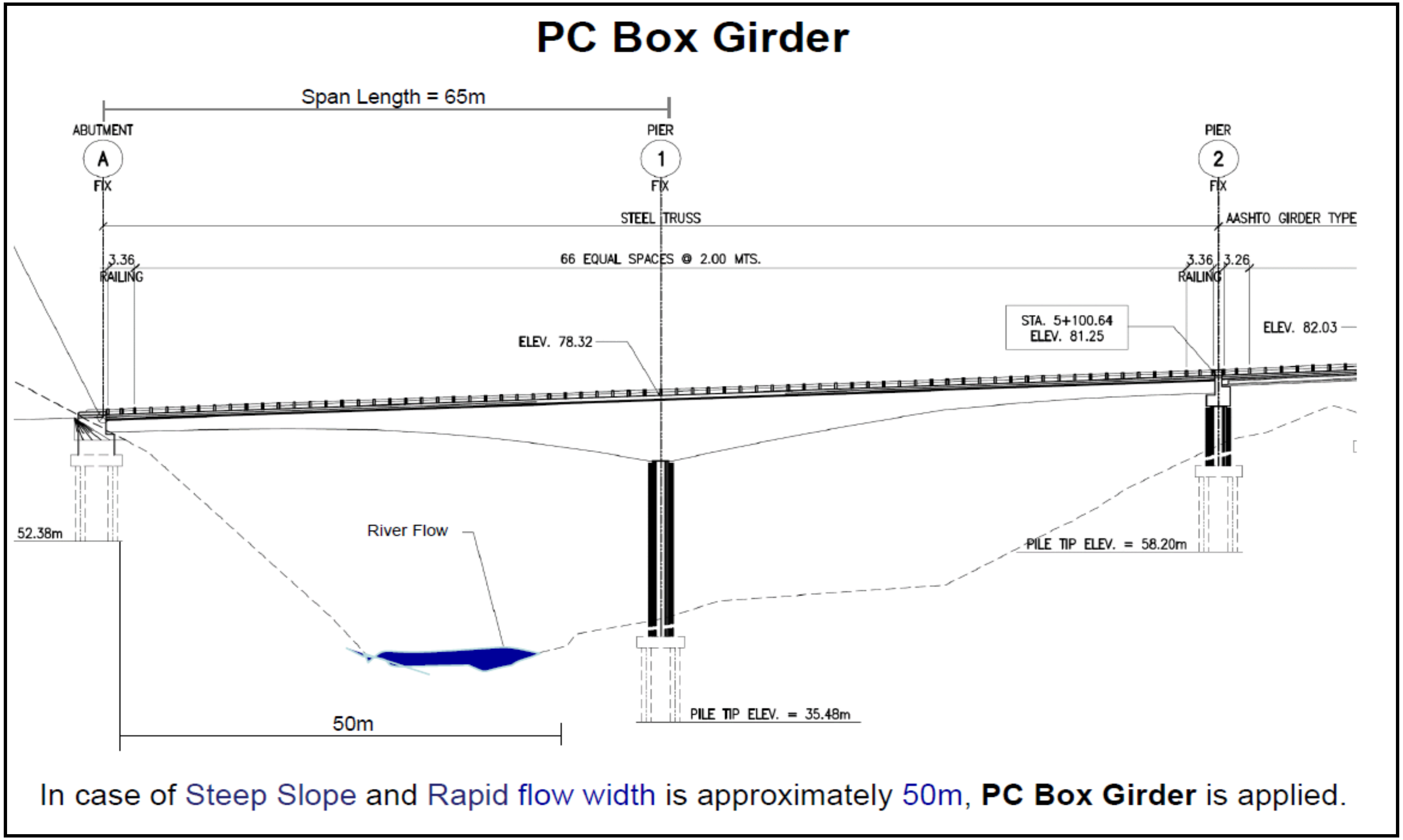
Source: JICA Study Team, July 2014

Figure 1.4.3-8 Recommended Types of Structure



Source: JICA Study Team, July 2014

Figure 1.4.3-9 Typical Plan of Pre-Stressed Concrete Girder Superstructure Type



Source: JICA Study Team, July 2014

Figure 1.4.3-10 Typical Plan of PC Box Girder Superstructure Type

Source: JICA Study Team, July 2014

Figure 1.4.3-11 Photo Showing a Typical Cantilever PC- Box Concrete Structure Type

Source: JICA Study Team, July 2014

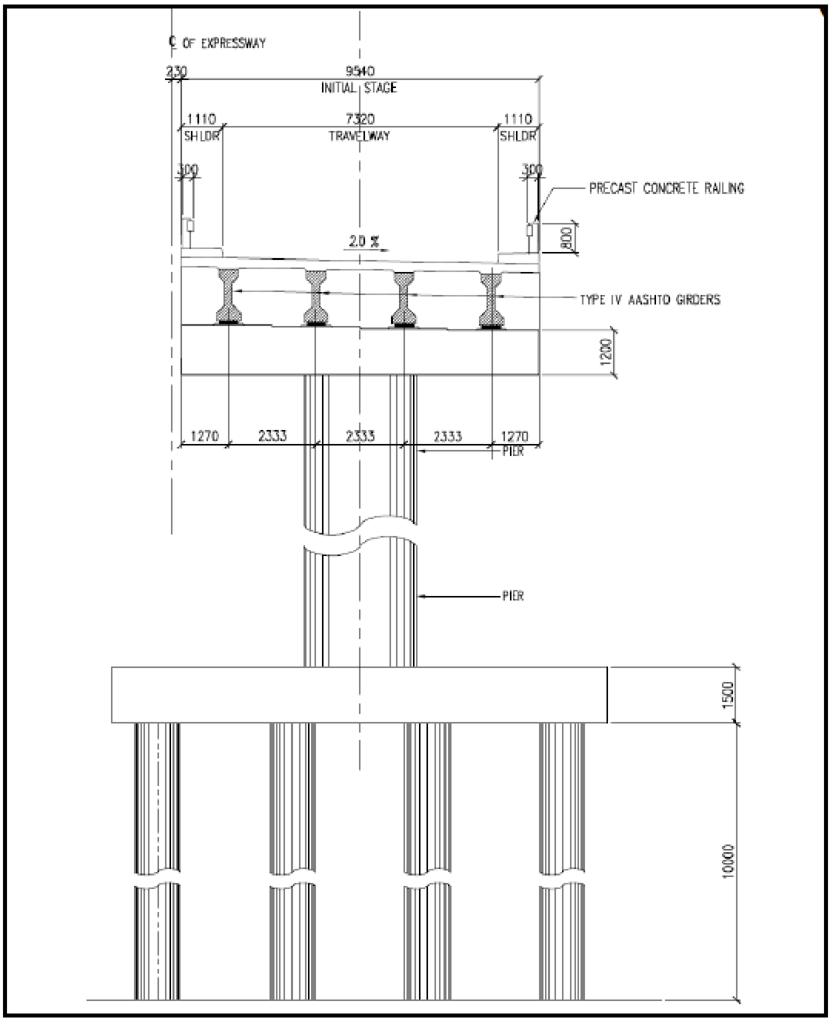
Figure 1.4.3-12 Photo of a PSCG (24 m<L<40 m)

(3) Substrucure

The following type of pier shall be adopted in accordance to the site conditions and restrictions:

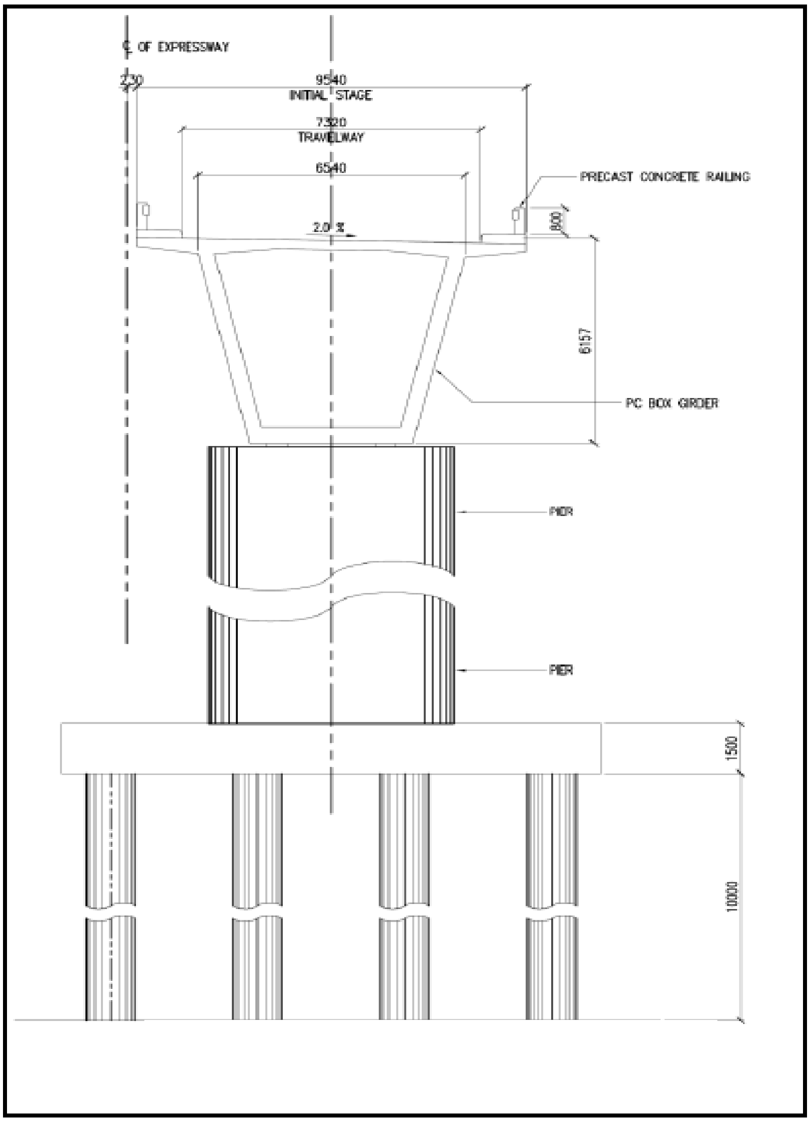
- RC column with pier-head type pier (**Figure 1.4.3-13**); and
- RC hammerhead type pier (**Figure 1.4.3-14**)

Pile bent type shall not be allowed for improvement of seismic performance.



Source: JICA Study Team, July 2014

Figure 1.4.3-13 RC Column with Pier-Head In Case of PSCG



Source: JICA Study Team, July 2014

Figure 1.4.3-14 RC Wall in Case of PC-Box

(4) Foundation

In accordance to the result of the sub-surface soil investigation, constraints factors during construction and others if any, the following types of foundation shall be selected:

a) Spread footing type; and

b) Cast in place concrete pile (**1.2 m** diameter of piles will be adopted)

Driven pile type shall not be allowed for improvement of seismic performance.

Considering the effect of scour by the flow of river, the selected arrangement of pier type of foundation is the cast in place concrete pile.

(5) Span Arrangement

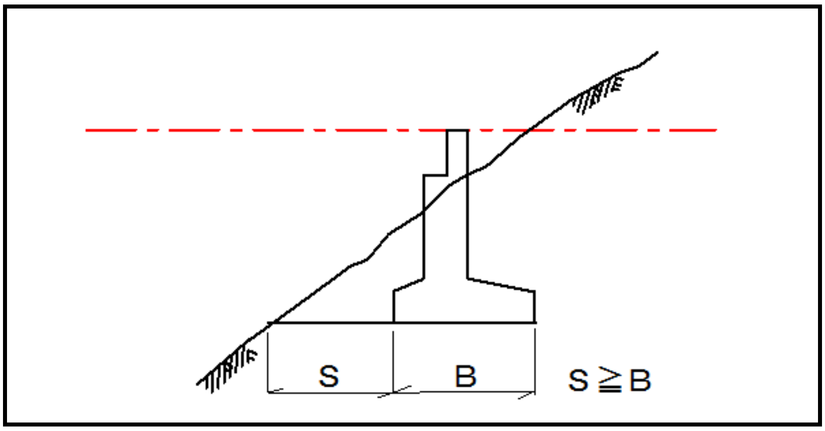
1) Bridge Length

In case the bridge is located on the deep river valleys and in mountainous areas, it is determined economically, including the many factors such as the stability of the ground, the effect of excavation, slope restoration and road construction. Therefore, it is necessary to locate the most appropriate abutment arrangement.

The following location of abutment shall be adopted in accordance to the site conditions.

a) Maximum height of abutment is **15.0 m**; and

b) Especially when abutment is located on a slope, as shown in **Figure 1.4.3-15**. Distance of toe footing to ground surface of horizontal direction (S: Space of horizontal) shall be keep more than footing length (B)



Source: JICA Study Team, July 2014

Figure 1.4.3-15 Space of Horizontal on the Slope Abutment

2) Span Arrangement

There are **three** (**3**) types of bridges that will be utilized for this Study. These include Bridge for Road, Bridge for River/Waterway, and Viaduct.

(a) Bridge for Road

Span arrangement of bridge for road shall utilize geometric design discussed in **Section 1.4.3.2** and basically these bridges are arranged as single span.

Especially, through the Davao-Bukidnon Road (No. I-10) is not only keep to existing road width but also keep the ROW (**30 m**) and it is arranged **3-span** bridge for advance to the seismic performance

(b) Bridge for River/Waterway

Span arrangement of bridge for river/waterway shall utilize the geometric design presented in **Section 1.4.3.2**. Basically, pier is not arranged in the river flow.

(c) Viaduct

Viaduct shall be defined that low effect by crossing object then long length bridge by deep valley.

Similarly, the span arrangement of viaduct shall utilize section geometric design discussed in **Section 1.4.3.2**. And basically, pier is not arranged in the river flow.

1.5 TECHNOLOGY OPTIONS

1.5.1 Design Standards/Specifications

1.5.1.1 Roadway Design Standards

The design concept is to provide a relatively high speed road that allows a safe and efficient movement of traffic as a bypass road. In accordance with Road Safety Design Manual (DPWH, 2004) as well as considering to the topographic condition, the recommended design speed is **60 kph**.

The following standard is mainly used as reference in Davao City Road.

- A Policy on Geometric Design of Highways and Streets, AASHTO 2011 6th Edition;
- Highway Safety Design Standards Part I Road Safety Design Manual, May 2004, DPWH; and
- Japan Road Association, Road Structure Ordinance, 2004

Table 1.5.1-1 Summary of Road Geometric Design Standard					
Item		**Unit**	**Standard**	**Absolute Minimum**	**Remark**
Design Speed		kph	60	-	
Design Vehicle		-	WB-15	-	
Stopping Sight Distance		m	85	-	Page 7-3, Table e7-1, AASHTO 2011
Passing Sight Distance		m	180	-	
1. Cross Section Elements					
Lane Width		m	3.5		Page 53, Table 16.1, DPWH Road Safety Design Manual
Outer shoulder Strip		m	3.0	2.5	
Number of Lanes		Nos.	2	-	
Normal Cross Slope		%	2	-	Page 7-4, AASHTO 2011
Maximum Super elevation	Flat	%	6	-	Page 53, Table 16.1, DPWH Road Safety Design Standard
	Rolling	%	8	-	
	Mountainous	%	10	-	
2. Horizontal Alignment					
Minimum Radius		m	123	-	Page 3-32, Table 3-7, AASHTO 2011, e=6%
Min. Transition Curve Length		m	50	-	JPN
Min. Radius not requiring Transition Curve		m	1,030	-	Page 3-45, Table 3-9, AASHTO 2011, cross slope, 2%)
Min. Radius not requiring Superelevation		m	2,000	-	JPN (cross slope, 2%)
		m	1,500	-	JPN (cross slope, 1.5%)
Superelevation Runoff			1/167	-	
3. Vertical Alignment					
Maximum Vertical Gradient	Flat	%	5	-	Page 7-4, Table 7-2, AASHTO 2011
	Rolling	%	6	-	
	Mountainous	%	8	-	
Minimum K value	Sag	%	18	-	Page 69, Table 16.4, DPWH Road Safety Design Manual
	Crest	%	11	-	
Minimum Radius	Sag	%	1,000	-	JPN
	Crest	%	1,400	-	
Min Vertical Curve Length		m	50	-	JPN
Max. Composition Grade		m	10.5	-	JPN
Critical Length of Grade		m	500 (6%)	-	JPN
		m	400 (7%)	-	JPN
		m	300 (8%)	-	JPN
4. Vertical Clearance					
Road		m	5.2	-	DPWH Requirement, 4.9 m (16 feet) clearance + 0.3m (Figure AC Overlay)

Source: JICA Study Team, July 2014

1.5.1.2 Tunnel Design Standard and Criteria

Discussed in the following sections are the standards to be applied to the design of the proposed Davao City Bypass Tunnel.

(1) Basic Geometric Design Standard for the Tunnel

The basic geometric design standards for the **2-lane** carriageway tunnel to be adopted are the following:

- Design Speed : 60 km/hr.;
- Carriageway width :3.5m;
- Shoulder : 1.50 m;
- Maximum super elevation of Carriageway: 5.00 %;
- Cross fall of Carriageway: 2.00 %;
- Vertical clearance : 5.00 m;
- Alternatively, the following standards will also be adopted as the Design Standards;
- Design Guidelines Criteria and Standards. For Public Works and Highways. Department of Public Works and Highways. Volume 3, Part 3-Highway Design;
- Road Safety Manual 2003 – PIAC Technical Committee on Road Safety (Permanent International Association of Road Congresses Publications); and
- Japan Standard for Mountain Tunneling. Japan Society of Civil Engineers

1.5.1.3 Structural Design Standards

(1) Codes and Specifications

The Structural Design Standards shall be in accordance with the following codes and guidelines:

- ❖ Design Guidelines Criteria and Standards for Public Works and Highways;
- ❖ L. O. I. 112, dated August 8, 1973, concerning gross weights of freight trucks and other vehicles;
- ❖ P. D. 187 as amended by P. D. 748 and Batas Pambansa Blg. 8. An act of defining the Metric System and its units, providing of its implementation and

for other purposes and MPWH Memorandum Circular No. 6 dated January e, 1983, re: Metric System (SI) Tables;

- ❖ Standard Specifications for Highways and Bridges, Revised 1995 or latest edition;
- ❖ Standard Specifications for Highway Bridges, adopted by the American Association of State Highway and Transportation Officials (AASHTO), 1977 or latest edition;
- ❖ Prestressed Concrete Institute (PCI) Design Handbook (Latest Edition);
- ❖ Manual of the American Institute of Steel Construction (AISC), 8th or latest edition; and
- ❖ Standard Specifications of American Society for Testing and Materials Joint Circular among Department of Public Works and Highways

(2) Lode Specifications

Structures shall be proportioned with the existence of the following loads and forces:

a) Dead Load;

b) Live Load;

c) Impact or Dynamic effect of the Live Load;

d) Sidewalk Live Load;

e) Seismic Load;

f) Wind Load;

g) Thermal Forces; and

h) Earth Pressure

1.5.1.4 Pavement Design Standards

The pavement design for the bypass project is in accordance with the "Guide for Design of Pavement Structures, 1993" by the American Association of the State Highway and Transportation Officials (AASHTO) and in reference also to "Design Guidelines, Criteria and Standards for Public Works and Highways" by the Department of Public Works and Highways (DPWH).

The pavement design is based on the following:

1) The results and findings of the subgrade characteristics over which the road is to be built;
2) The traffic load anticipated to traverse the proposed road alignments over the selected design life; and
3) The type of pavement to be adopted based on the technical and economic advantages

(1) Technical Approach

The design parameters used in the pavement design includes time constraints, traffic, design serviceability loss, reliability, subgrade, and material properties for pavement structure design. Discussed in the succeeding sections are the major design conditions:

1) Design Period

It is assumed that the design life of pavement consummates the **20-year** design period before rehabilitation is performed.

2) Traffic

The structural design of the pavement is based on fatigue loads. Fatigue loading is taken as the cumulative number of passes of an Equivalent Standard Axle Load (ESAL) of **8,300 kg** (**18 kips**) per axle, to which the pavement structure will be subjected throughout its design life.

(2) Recommended Pavement Structures

The recommended pavement structures for the bypass main carriageway is presented in **Table 1.5.1-2**. Shown in **Figure 1.5.1-1** shows the pavement structure of the main carriage way.

Table 1.5.1-2 Portland Cement Concrete Pavement (PCCP)

No.	Thickness	Pavement
1	300 mm	Portland Cement Concrete Pavement
2	300 mm	Crushed Aggregate Base Course

Source: JICA Study Team, July 2014

Source: JICA Study Team, July 2014

Figure 1.5.1-1 Pavement Structure of Main Carriageway

1.5.1.5 Drainage Design Standard

(1) General

The hydrological study is developed based on the project area's meteorological/hydraulic data, topographical/hydrological surveys carried out in this project. The catchment area of rivers or channels at the bypass road crossing is measured using of **1:50,000** scale topographical map published by NAMRIA. The cross sections and riverbed profiles of the rivers at bypass road crossing are obtained by project topographical survey.

Presented in **Table 1.5.1-3** are the hydrological survey items conducted for calculating the numerical value, etc. necessary to hydrological and hydraulic studies.

Table 1.5.1-3 Survey Items for Hydrological Survey				
Items		**Institutions Concerned**	**Remarks**
Meteorological Survey	General Weather Conditions (Temperature, Relative Humidity, Wind Speed and Direction, Evapo-transpiration, Sunshine Hours, Station Information, etc.)	PAGASA	
	Rainfall (Annual / Monthly / Daily rainfall, Rainfall Intensity Curve, etc.)	PAGASA	
Hydrological Survey	Annual Maximum Discharge (Peak), Annual / Monthly / Daily Discharge, Annual Maximum High water level, Station Information, etc.	BRS of DPWH	
Bibliographic Survey	Related Design Criteria / Standards / Study Reports, Topographic Maps, etc.	DPWH, Davao City, NAMRIA, JICA, etc.	
Interview Survey	Flood Situation Surrounding Related Bridge Sites	(Local Residents)	

Source: JICA Study Team, July 2014

(2) Hydraulic Design Criteria

1) Design Criteria and Standards

In general, design criteria and standards concerning hydrology and hydraulics in Philippine, are referred to the following documents:

i) DPWH Design Guidelines, Criteria and Standards for Public Works and Highways published in 1980;

ii) FHWA (Federal Highway Administration, USA), HEC (Hydraulic Engineering Circular) series; and

iii) U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-HMS, HEC-RAS and HY-8 Manuals and Technical References

These standards will be the proposed hydrologic and hydraulic design criteria which are appropriate for project requirements. Also, these standards will cover the following items:

- Hydrologic Design;
- Design Frequency or Return Period;
- Runoff Computation Methods, Runoff Coefficients;

- Rainfall Intensity;
- Level of Development in the Watersheds;
- Hydraulic Design;
- Manning's Roughness Coefficient;
- Expansion and Contraction Loss Coefficients; and
- Freeboard

The drainage design criteria for the project are shown in **Table 1.5.1-4**.

Table 1.5.1-4 Drainage Design Criteria for the Proposed Davao City Bypass Project (1/2)				
Items of Criteria		**Criteria**	**Applied Standards**	**Remarks**
Hydrologic Design		Based on the data from PAGASA	Various documents including DPWH standards	
Design frequency or return period	Rivers (Bridges)	50-year flood with sufficient freeboard to contain the 100-year flood	DPWH standards	
		25-year flood with sufficient freeboard to contain the 50-year flood	DPWH standards	
	Culverts (Box)	25-year flood with sufficient freeboard to contain the 50-year flood	DPWH standards	
	Culverts (Pipe) Esteros/Creeks Drainage pipes	15-year flood with sufficient freeboard to contain the 25-year flood	DPWH standards	
	Embankments	10-year flood	DPWH standards	
	Ditches and road surface	2-year flood	DPWH standards	
Runoff computation methods, runoff coefficients	Computation methods for waterways with catchment area of 20 km^2 or more (Davao, Lasang, Talomo, Lipadas, Matina Rivers)	Specific discharge, by drainage area rate from probable hydrological value (flood frequency analysis) and unit hydrograph method	by calculations	
Items of Criteria		**Criteria**	**Applied Standards**	**Remarks**
	Computation methods for other waterways, channels with catchment area less than 20 km^2	Rational Formula	DPWH standards, HEC	
	Runoff coefficients	**Refer to Table 1.5.1-5**	DPWH standards, HEC	

Table 1.5.1-4 Drainage Design for the Proposed Davao City Bypass Project (2/2)				
Items of Criteria		**Criteria**	**Applied Standards**	**Remarks**
Rainfall intensity-duration-frequency		Based on the data from PAGASA	by calculation	
Level of development in the watersheds		Based on the data from land use plan of Davao city	-	
Hydraulic Design	Hydraulic computation method (Bridges)	Based on the calculation by HEC-RAS	HEC	
	Hydraulic computation method (Culverts)	Based on the calculation by Rational Formula and confirmed/checked with HY-8 Software	HEC	
	Minimum size of drainage pipes	910 mm	DPWH standards	
Manning's Roughness Coefficient		**Refer to Table 1.5.1-6**	DPWH standards, HEC	
Expansion and contraction loss coefficients		(Various values)	HEC	
Freeboards		Bridge: 1 m minimum freeboard with no debris and 1.5 m minimum free board for waterways with debris load. Culverts: avoid to 2 barrel installations in debris prone areas	DPWH standards	

Source: JICA Study Team, July 2014

Table 1.5.1-5 Runoff Coefficient C	
Watershed Cover or Type of Surface	**Run-off Coefficient, C**
Concrete or asphalt pavement	0.80 – 0.90
Steep grassed areas (2:1)	0.50 – 0.70
Flat residential with about 30% of area impervious	0.40
Flat residential with about 60% of area impervious	0.60
Moderate steep residential with 50% of area impervious	0.65
Moderate steep residential with 70% of area impervious	0.80
Flat commercial with about 90% of area impervious	0.80

Source: JICA Study Team, July 2014

Table 1.5.1-6 Value of Manning's Roughness Coefficient "n"		
Glass, plastic, mechanical metal	0.010	
Dressed timber, joints flush	0.011	
Sawn timber, joints uneven	0.014	
Cement plaster	0.011	
Concrete, steel troweled	0.012	
Concrete, timber forms, unfinished	0.014	
Untreated granite	0.015	- 0.017
Brickwork or dressed masonry	-0.014	
Rubble set in cement	0.017	
Earth, smooth, no weeds	0.020	
Earth, some stones and weeds	0.025	
Natural river channels:		
Clean and straight	0.025	- 0.030
Winding, with pools and shoals	0.033	- 0.040
Very weedy, winding and overgrown	0.015	- 0.300
Clean straight alluvial channels	$0.031d^{1/6}$	
	(d=D-75 size in ft.)	

Source: JICA Study Team, July 2014

2) Hydraulic Design Criteria of Bridge

In order to design opening of the bridge waterway, the following design criteria for hydraulics are required:

- The backwater does not significantly increase the flood damage to properties upstream of the bridge;
- The velocity through the bridge does not damage the road facility or increase the damages to downstream properties.
- The existing flow distribution is maintained to the extent practicable.
- The pier and abutment are designed to minimize the flow disruption. (Contraction scour does not occur at proposed bridge site.)
- Potential local scour is within acceptable limits.
- Clearance at the structure is adequately designed to pass safety any anticipated

debris. (The elevation of bottom of bridge girder is higher than "Highest high water level + Freeboard or Navigation channel height".)

The design return period and the clearance from the bridge girder to high water level shall be compliant with authorized standards by the organizations concerned. The high water level of related rivers and the estimation of scouring shall be determined based on the HEC standards and HEC-RAS computation.

3) Hydraulic Design Criteria of Culvert

Lateral road drainage is mainly through culverts and bridges. The size of the flood opening is determined by the catchment area parameters and consideration of existing nearby structures.

The hydraulic design considered the following points:

- Head loss due to contraction at the entry of the culvert;
- Head loss at the inlet, through the culvert and outlet due to the roughness; and
- Tail water level and downstream condition

The existing topography is taken into consideration in determining the culvert slope in order to minimize excessive excavations at both ends. The type of inlet and outlet is designed according to the site conditions. The culvert cross-section is determined based on the HEC standards and HY-8 computation.

4) Hydraulic Criteria of Road Embankment

The embankment which is made of earth and sand material, and bridge super structure is very weak to overtopping and bumping, therefore planner must consider the safety countermeasures such as clearance.

The freeboard as the DPWH standards is applied for the embankment. Protection for the embankment shall be ensured using the suitable protection works. The median size of the loose riprap is determined based on the procedures provided in Design of Riprap Revetment (HEC14).

In order to protect the above mentioned criteria, the high water level (HWL) of the rivers is required. And it will be checked whether the HWL influences the bypass road. All HWL shall be shown in the design drawings.

1.5.1.6 Slope Design Standards

(1) General

Since the alignment of the proposed bypass road go through the undulating hilly terrain of **50-200 m** above sea level of **2-8 km** inland side of the Pan-Philippine Highway, many large-scale cut slopes of **20 m** or more in height are planned in the proposed bypass road.

The unconsolidated soil layers of sand and gravel are widely laying in the section which the cut slopes are planned. Appropriate slope protections of the cut slopes are needed, because the unconsolidated soil layers of sand and gravel will be easily eroded.

The slope protection is intended to protect the slopes by the vegetation or structure for ensuring the stability of the slopes, preserving of the natural environment and landscaping.

On the other hand, the excavated materials of the above-mentioned excavation sections should be used as banking materials of the embankment planned on the valleys, and the excavated materials of the tunnel section planned between the Matina River and Davao River should be also included in the banking materials. Therefore, it is necessary to design the embankment slopes in consideration of the type and characteristics of the excavated materials in the project road section.

In this section, as the cut slope design standards, the contents about "Standard Slope Gradients for Cut which is closely related to the slope protection", "Cut Slope Protection Types and Purposes", "Selection Method of Cut Slope Protection and Considerations for Application of each Cut Slope Protection" are discussed. Also, as the embankment slope design standards, the contents about Standard Slope Gradients for Embankment and Slope Protection of Embankment are mentioned.

1) Standard Gradient of Cut Slopes

The natural subsoil and rocks are composed of “heterogeneous soils (including gravel and boulder)” and “rocks which the discontinuity (consisting of joints, faults and etc.) and the weathered alteration portion are present”.

Because Philippines is a country composed of islands , located on the Circum-Pacific volcanic belt in the same way as Japan, the various geological conditions are very similar to Japan. From this, it is considered that it is appropriate to refer to “the standard slope gradient empirically determined” which is generally used in Japan when the cut slope gradient is determined.

Therefore, “Standard Slope Gradient” for Cut which is mentioned in “Road Earthwork - Guideline for Stability of Cut Slopes and Natural Slopes: June 2009 (issued by Japan Road Association) of Japan” is given in the **Table 1.5.1-7**, as the standard gradient of cut slopes of the project road.

The “Standard Slope Gradient for Cut” which is shown in **Table 1.5.1-7** can be applied in a prerequisite condition that the cut slopes may be protected by vegetation and the like, the cut height that can be applied varies by the condition of subsoil and rocks.

When the standard slope gradient in **Table1.5.1-7** is applied to the slopes design, the slope gradient of each slope stage should be decided by the condition which the cut height is the height from the bottom of each slope stage to the top of the whole of slope, because the whole slope is divided into the several slope stages by berms.

Besides, in case of the soil slopes, the applicable scope of the standard slope gradient in **Table1.5.1-7** is up to the cut height ranging **10-15 m**. When the cut height is more than the applicable scope, it is necessary the slope gradient is changed at gentle than the standard slope gradient. But, there are many cases which the standard slope gradient is applied if the cut height is within about **20 m** (within **three** slope stages).

Table 1.5.1-7 Standard Slope Gradients for Cut Sections			
Condition of Subsoil and Rocks		**Height of Cut**	**Gradient**
Hard Rock			0.3:1.0 to 0.8:1.0
Soft Rock			0.5:1.0 to 1.2:1.0
Sand	Not Dense, and Poor Particle Size Distribution		1.5:1.0 or More Gentle
Sandy Soil	Dense	5 m or less	0.8:1.0 to 1.0:1.0
		5 m to 10 m	1.0:1.0 to 1.2:1.0
	Not Dense	5 m or less	1.0:1.0 to 1.2:1.0
		5 m to 10 m	1.2:1.0 to 1.5:1.0
Sandy Soil Mixed with Gravel or Rock Masses	Dense, or Good Particle Size Distribution	10 m or less	0.8:1.0 to 1.0:1.0
		10 m to 15 m	1.0:1.0 to 1.2:1.0
	Not Dense, or Poor Particle Size Distribution	10 m or less	1.0:1.0 to 1.2:1.0
		10 m to 15 m	1.2:1.0 to 1.5:1.0
Cohesive Soil		10 m or less	0.8:1.0 to 1.2:1.0
Cohesive Soil Mixed with Rock Masses or Cobblestones		5 m or less	1.0:1.0 to 1.2:1.0
		5 m to 10 m	1.2:1.0 to 1.5:1.0

Source: JICA Study Team, July 2014

4) Standard Slope Gradient for Embankment

Standard Slope Gradient for Embankment which is mentioned in Road Earthwork - Guideline for Embankment: April 2010 (issued by Japan Road Association) of Japan is given in the **Table 1.5-1-8**, as the standard gradient of embankment slopes of the project road.

The standard slope gradient of embankment slopes is as shown in **Table 1.5-1-8**, and the height of embankment that can be applied varies by banking materials.

The height of embankment in **Table 1.5-1-8** is the height difference between top and toe of the embankment slope. Therefore the same slope gradient should be applied at top-toe of the slope without regard to the existence of berms.

<table>
<caption>Table 1.5.1-8 Standard Slope Gradients for Embankment which are Depended on Banking Materials/Height of Embankment</caption>
<tr><th>Banking Materials</th><th>Height of Embankment</th><th>Gradient</th><th>Remark</th></tr>
<tr><td rowspan="2">Well-graded sand (SW), Gravel (GW, GP),
Silty gravel (GM),
Clayey gravel (GC)</td><td>5m or less</td><td>1.5:1.0 to 1.8:1.0</td><td rowspan="8">The standard slope gradient of embankment slopes can be applied in case of some conditions. The conditions are the enough bearing capacity of foundation ground, the no-influence place of the inundation, the well-compacted embankment.

The characters in parentheses of "Banking Materials" are the group symbols of the unified soil classification of ASTM (D 2487).

The stability analysis of the embankment should be carried out, when the slope gradient is out of range of the standard slope gradients.</td></tr>
<tr><td>5m to 15m</td><td>1.8:1.0 to 2.0:1.0</td></tr>
<tr><td>Poorly graded sand (SP)</td><td>10m or less</td><td>1.8:1.0 to 2.0:1.0</td></tr>
<tr><td rowspan="2">Rock lump
(including Rock debris)
(GW, GP)</td><td>10m or less</td><td>1.5:1.0 to 1.8:1.0</td></tr>
<tr><td>10m to 20m</td><td>1.8:1.0 to 2.0:1.0</td></tr>
<tr><td rowspan="2">Silty sand (SM),
Clayey sand (SC),
Lean clay (CL), Silt (ML)</td><td>5m or less</td><td>1.5:1.0 to 1.8:1.0</td></tr>
<tr><td>5m to 10m</td><td>1.8:1.0 to 2.0:1.0</td></tr>
<tr><td>Volcanic cohesive soil(CH, MH)</td><td>5m or less</td><td>1.8:1.0 to 2.0:1.0</td></tr>
<tr><td colspan="4">Source: JICA Study Team, July, 2014</td></tr>
</table>

Further, the material classification of AASHTO (M57-80), which the materials for embankments and subgrades are targeted, is different from the unified soil classification of ASTM (D 2487) is shown in **Table 1.5.1-9**, but the rough relationships of the **two** (**2**) soil classifications are shown in **Table 1.5.1-10**.

Table 1.5.1-9 Rough Relationships Between Unified Soil Classification of ASTM And Material Classification of AASHTO		
Banking Materials	Unified Soil Classification of ASTM	Material Classification of AASHTO
Well-graded sand (SW),	SW	A-2-4, A-2-5
Gravel (GW, GP), Silty gravel (GM), Clayey gravel (GC)	GW, GP, GM, GC	A-1
Poorly graded sand (SP)	SP	A-3
Rock lump (including Rock debris) (GW, GP)	GW, GP	A-1
Silty sand (SM), Clayey sand (SC),	SM, SC	A-2-6, A-2-7
Lean clay (CL), Silt (ML)	CL, ML	A-4, A-6
Volcanic cohesive soil (CH, MH)	CH, MH	A-5, A-7
Source: JICA Study Team, July, 2014		

Note: *In AASHTO (M57-80), A-1, A-2-4, A-2-5, A-3 are defined as the embankment materials of "excellent to good" quality, and A-2-6, A-2-7, A-4, A-5, A-6, A-7 are defined as the embankment materials of "fair to poor" quality.*

5) Slope Protection of Embankment

The slope protection of embankment should be applied the planting in principle. However, such the slope protection as the grouted riprap should be applied in the inundation risk sites such of the river flood areas.

In addition, when the rock debris is used as banking materials, the slope should be overlaid by the soil blanket on embankment slope (Cohesive soil) for vegetation, except the case of slope protection of the grouted riprap. The thickness of the soil blanket on embankment slope shall be **30 cm** or more in consideration of the growth of vegetation.

The economical sowing is recommended as the planting of embankment slopes, but the stripped sodding (lined turf) is suitable when the slopes are overlaid by the soil blanket on embankment slope.

Further, the structure of the grouted riprap shall be the same structure with the case of the cut slopes (refer back to **Figure 1.5.1-5a** and **Figure 1.5.1-5b**)

1.5.2 Road Design

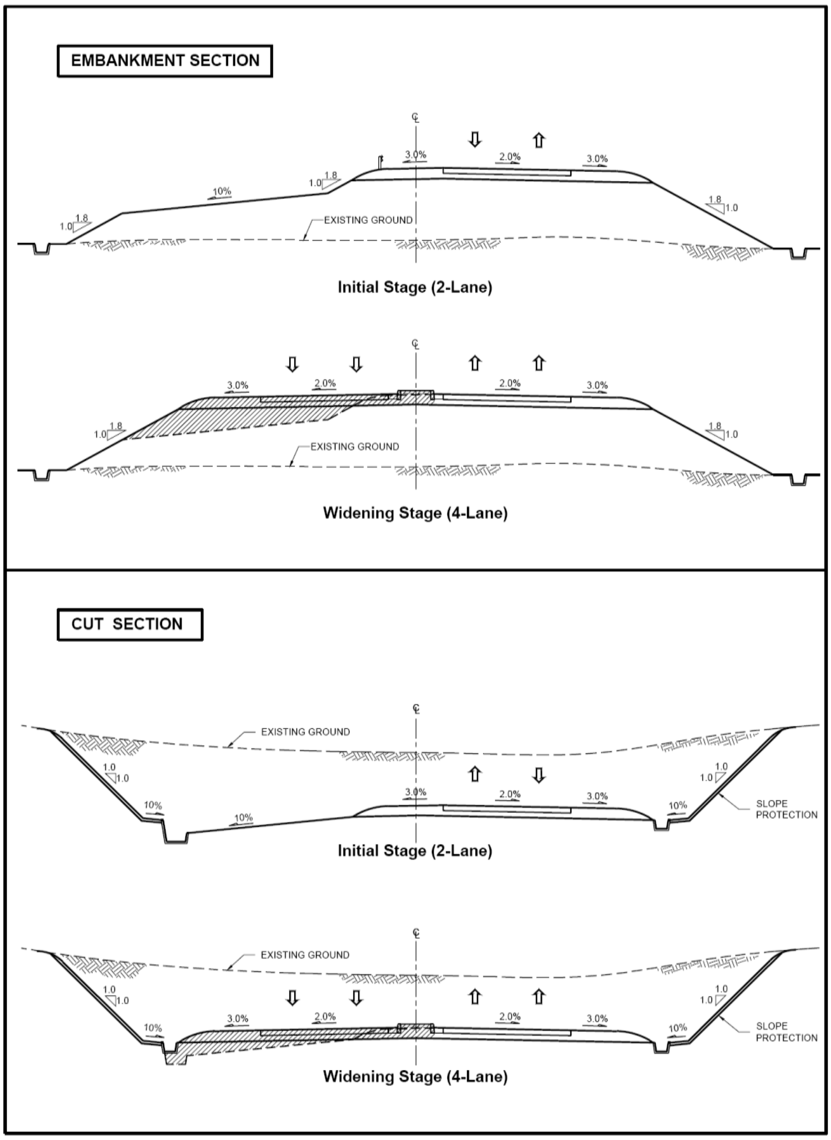
1.5.2.1 General

Road design concepts are as follows:

- Road design is based on **2-lanes**, considering **4-lanes** widening in the future;
- To minimize the road construction cost and soil disposal impact. The volume of cutting and embankment should be balanced as much as possible; and
- To consider not only the accessibility of connecting road and roadside area but also high mobility function as bypass

(1) Road Cross Section

The centerline of road cross section shows the future **4-lane** road. Initial stage is to construct the **2-lane** road at Davao City central side (at seaside) and then the widening stage is to construct additional **two** (**2**) lanes at inland side. To minimize the traffic impact during widening road works, demolish and reconstruction of slope protection facilities, it is recommended that cutting and embankment works will be done as four-lane at initial stage. **Figure 1.5.2-1** shows the typical cross section of embankment and cut at each stage.



Source: JICA Study Team, July 2014

Figure 1.5.2-1 Typical Cross Section (Initial and Widening)

(2) Control Point

This section describes the control points for preliminary design based on selected alignment.

- Based on topographical survey result, the preliminary design was conducted to minimize the bridge length, embankment and cut height and to avoid affected structures as much as possible; and

- Main changes of horizontal and vertical alignment was done using the above concept

1.5.3 Tunnel Design

The basic tunnel design standards and criteria were previously discussed in **Section 1.5.1.2** of this report.

1.5.3.1 Main Tunnel Excavation Pattern

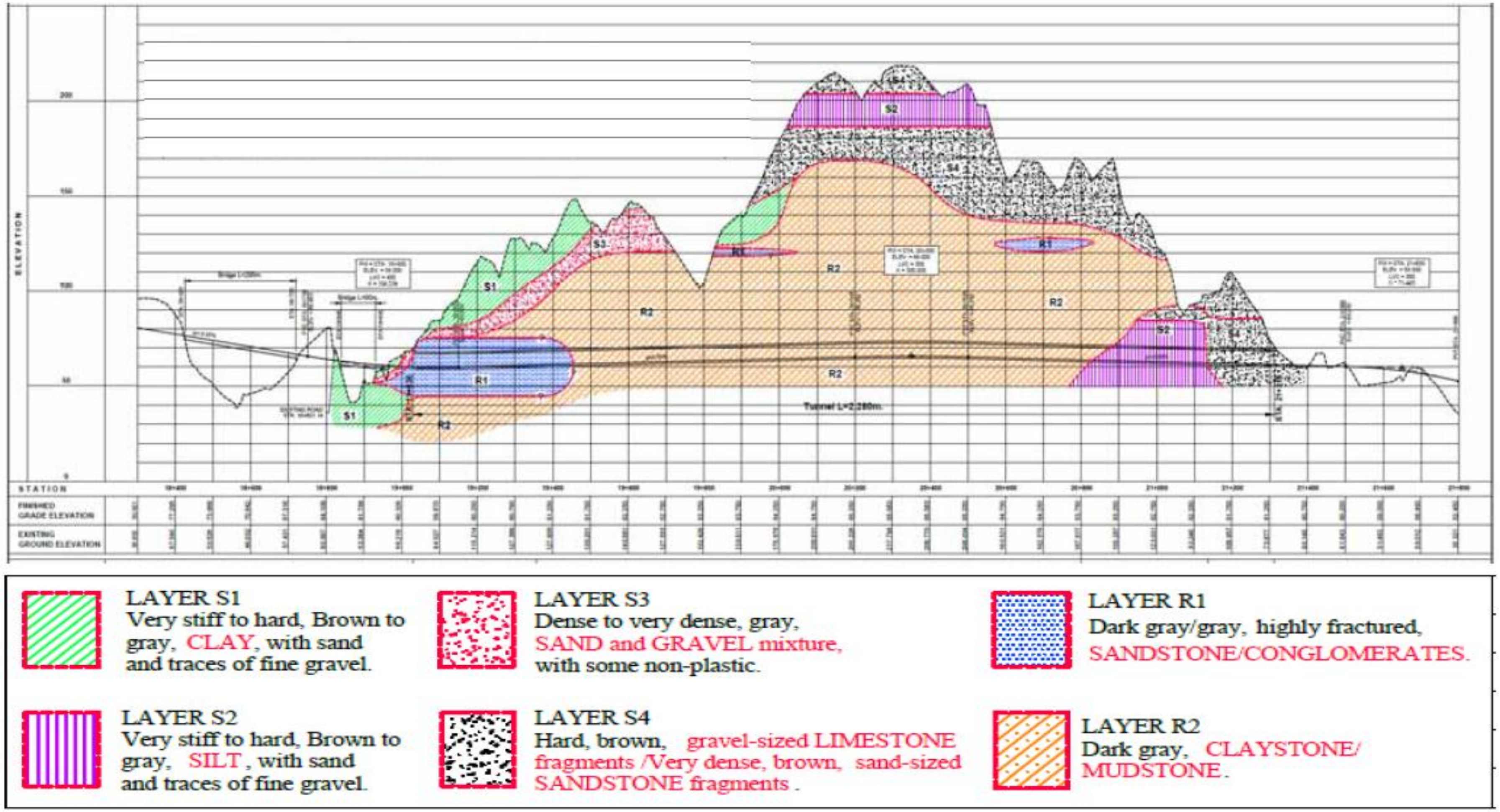
The geological profile on the tunnel route based on the geological survey undertaken is shown in **Figure 1.5.3**-1 (also shown in **Photo No. 1.3.2-3**). Different excavation patterns were suggested as section 3, C2, D1, and D2. As shown in **Table 1.5.3-1**, **four** (**4**) types of typical cross section were prepared. Based on the geological condition, the tunnel invert is necessary for the whole section due to mudstone. C2, D1 and D2 were selected.

Table 1.5.3-1 Length of Tunnel Excavation Pattern

West Side | East Side

D2	D1	C2	D1	D2	D1	D2	D2
70 m	90 m	150 m	350 m	160 m	950 m	400 m	110 m
						TOTAL= 2,280 m	

Source: JICA Study Team, July 2014



Source: JICA Study Team, July 2014

Figure 1.5.3-1 Geological Condition along the Tunnel Route

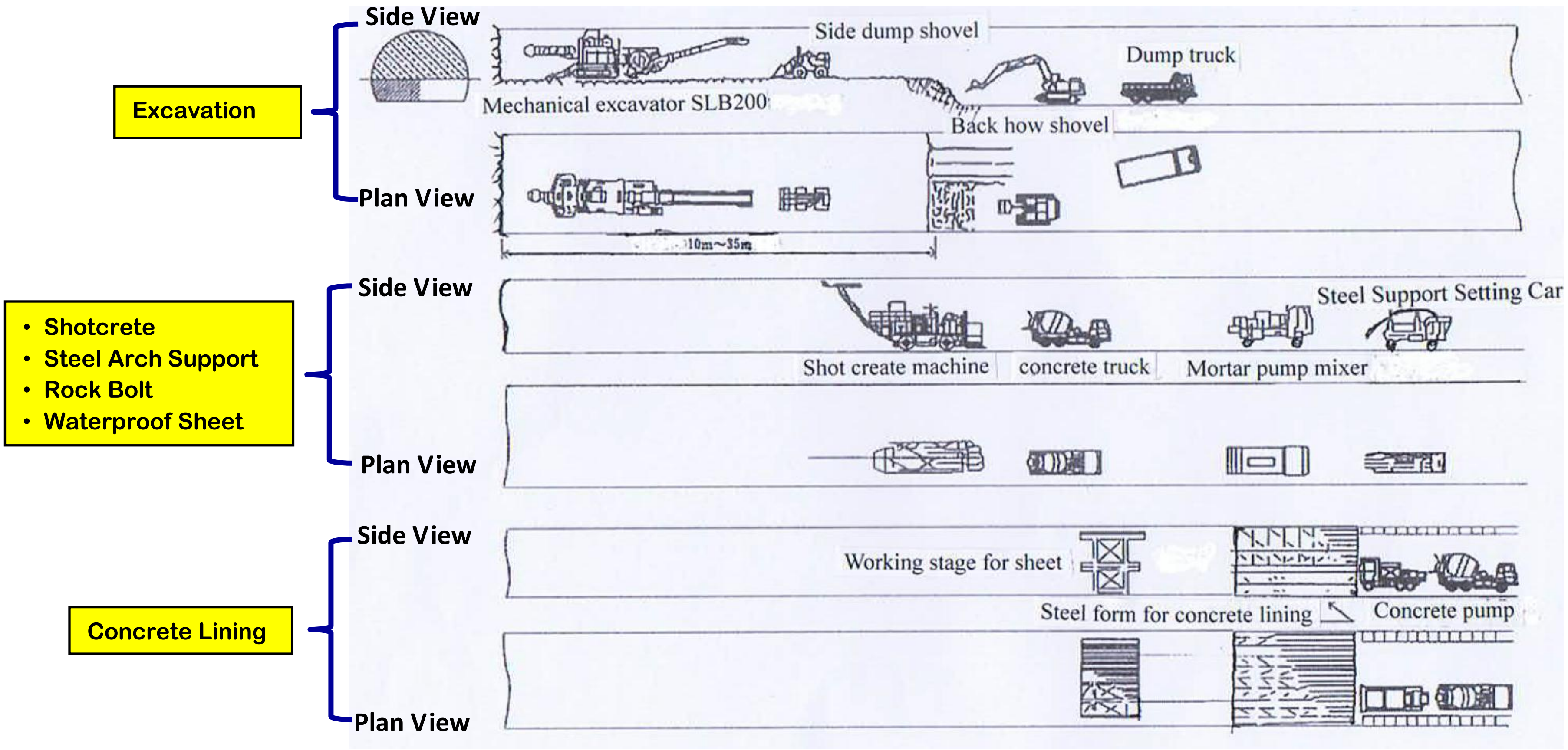
1.5.3.2 Main Tunnel Construction Methodology

(1) Excavation Method

Excavation method adopted is the conventional New Austrian Tunneling Method (NATM) based on geological survey results of tunnel route consider the blasting system or mechanical drilling system.

Mechanical drilling and blasting system for geological criteria uses Japanese bombing scheme. This scheme is economical from over 30 Mp of the uni-axial compressive strength of rock.

Geological condition along tunnel route is considered soft rock ground quality. Therefore, standard excavation method adopted is *Upper Half Advance Excavation Method* by Mechanical Excavator (Figure 1.5.3-2) for engineering safety and economic efficiency. **Blasting is not required** for this tunnel construction method.



Source: JICA Study Team, July 2014

Figure 1.5.3-2 Upper Half Advancing Excavation Method

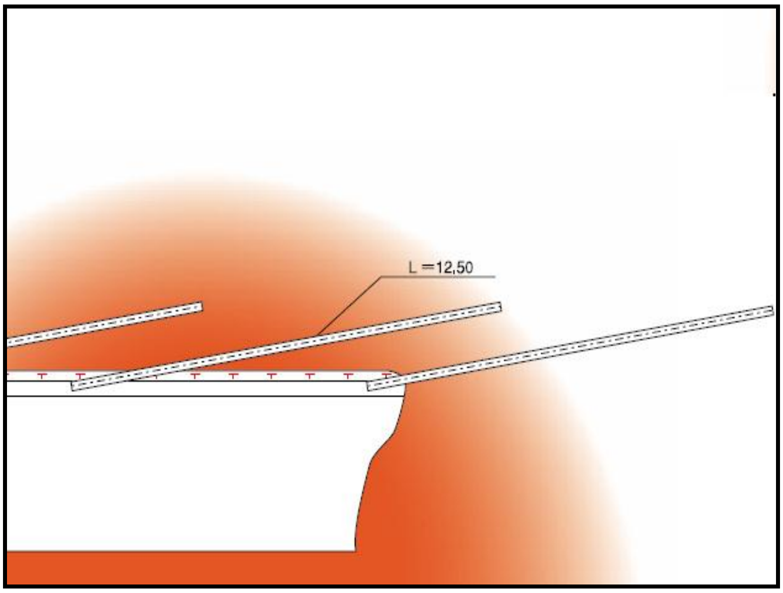
(2) Auxiliary Method for Excavation of Tunnel Entrance

1) AGF Method

All Ground Fasten (AGF) Method, one of the methods will be employed near the tunnel portal. Long steel tubes, approximately **Φ 100 mm** (**Figure 1.5.3-3**) are driven into outer circumferential part of working face. Then silicate resin is injected to form improved zone between the steel tubes to stabilize working face and to restrict frontal loosening as shown in **Figure 1.5.3-4**.

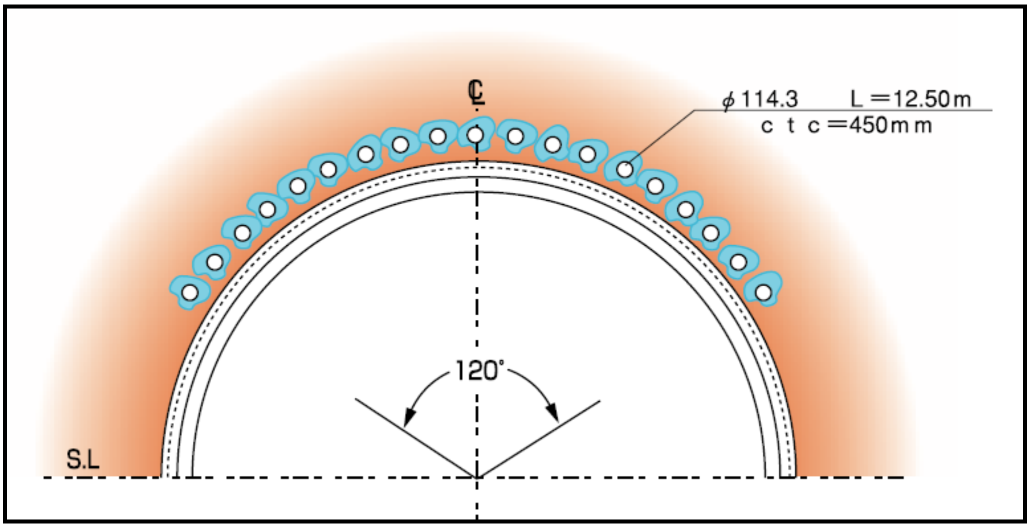
Reliable effect can be expected under various fragile conditions ranging from clayey soil to finely section can be selected depending on geological structure.

For the proposed Davao Bypass Project, sections to adopt this method are both the East and West portals and the eastern section with a minimum earth covering of **20 m**.



Source: JICA Study Team, July 2014

Figure 1.5.3-3 Long Steel Tubes Approximately Φ 100 mm



Source: JICA Study Team, July 2014

Figure 1.5.3-4 Auxiliary Construction Methodology near the Portals of the Tunnel

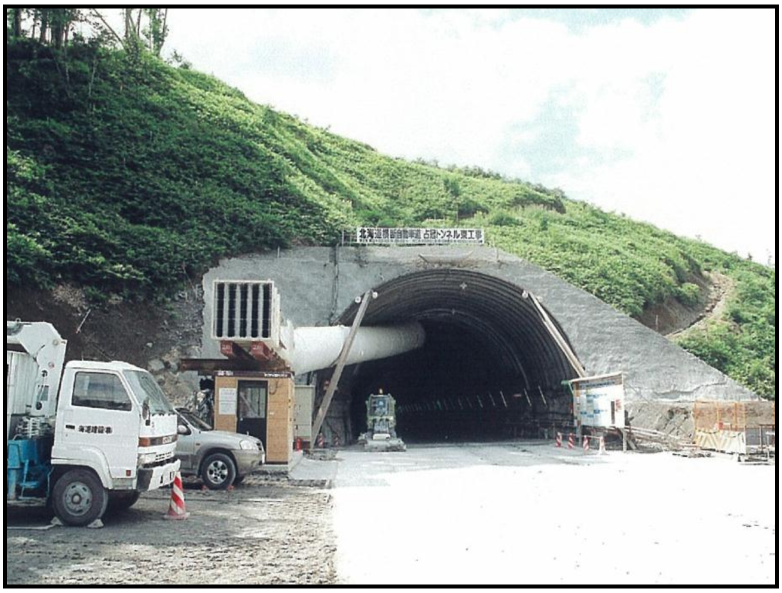


Photo No. 1.5.3-1 Tunnel entrance under construction (*Source: JICA Study Team, July 2014*)

(3) Works of Tunnel Lining Concrete

1) Steel Form

Following the tunnel excavation, shotcrete, rock bolts and secondary lining concrete as a permanent structure are undertaken. As for the assembly scheme framework, the steel panel of the framework (the arch center component) is dismantled every time for one span for concrete placing and assembled again for the next concrete placing. These repeated works for the assembling and dismantling need time resulting in the poor progress for concrete lining. The form is shrinkable by extending to up and down, left and right with the jack of hydraulic type and the movement of framework is smooth for every concrete placing. This portable scheme framework is currently used for tunnel lining. The standard length of **one** (**1**) framework is **12.0 m**.

Photo No. 1.5.3-2 Sliding Steel Form (*Source: JICA Study Team, July 2014*)

2) Lining Concrete

Challenges encountered during tunnel concrete construction management include the following items:

① Concrete finish at temperatures reaching 40°C. Resignation of the hair racks of drying shrinkage; and

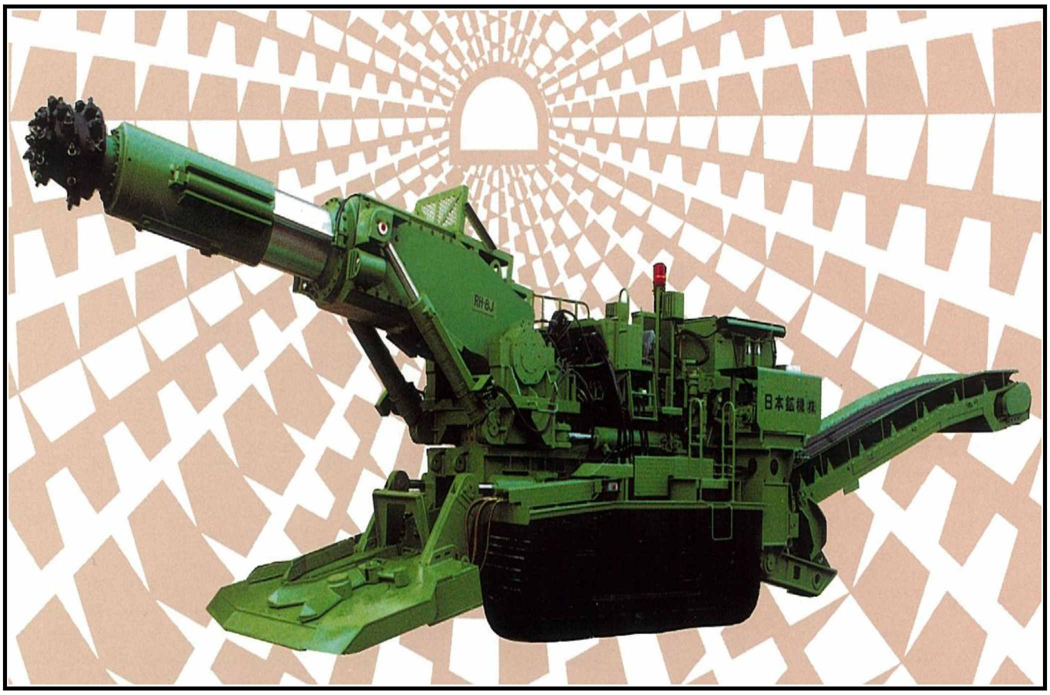
② Concrete honey real property loss due to lack of consolidation, and material separation cavity occurs due to lack of concrete back fill

To solve these problems, the Nippon Expressway Corporation (NEXCO) has developed the middle-performance lining concrete. It is proposed to the Davao Bypass Tunnel to adopt this method. It is tighter and of higher quality than the conventional concrete lining

1.5.3.3 Tunnel Excavation Equipment

The standard facilities and equipment for tunnel construction are listed in **Table 1.5.3-2**. Also called a partial face machine, a Road Header (**Figure 1.5.3-5**) is a tunneling machine that is boom mounted drum with cutting head that revolves to excavate rock or others (see **Photo No. 1.5.3-3**). Mechanical excavator and breaker machine will also be used for tunnel excavation.

Table 1.5.3-3 shows power consumption of facility and equipment for tunnel construction. Approximately **782.0 kW** is required for the works of tunnel excavation and **648.5 kW** is necessary for the works of lining concrete. Accordingly, **four (4)** units of **200 KVA** generators are necessary.



Source: JICA Study Team, July 2014

Figure 1.5.3-5 Road Header S-200 Type, Total Power 302.5 Kw

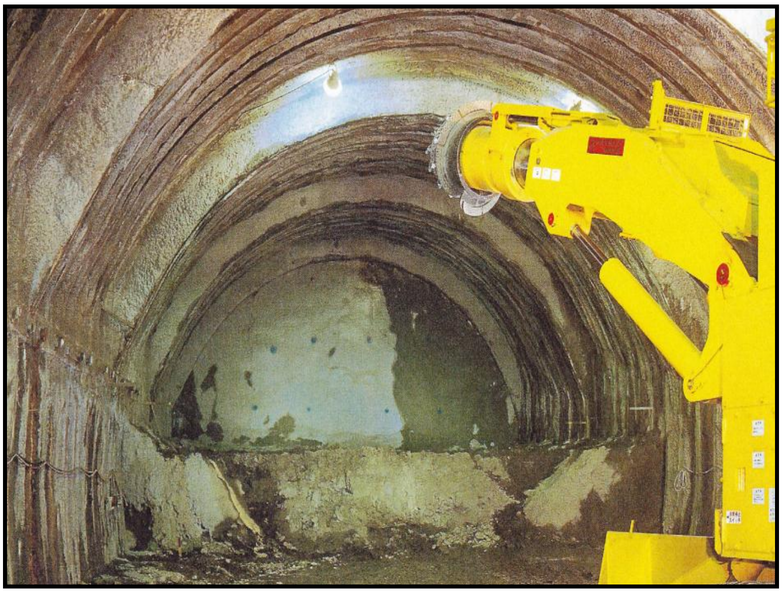


Photo No. 1.5.3-3 Photo showing excavation by a Road Header (*Source: JICA Study Team, July 2014*)

Photo No. 1.5.3-4 Shot Crete Machine (*Source: JICA Study Team, July 2014*)

Table 1.5.3-2 Typical Facilities and Equipment for Tunnel Construction				
No	**Facilities and Equipment**	**Quantity (unit)**	**Motor (kW)**	**Note**
1	Mechanical excavator S200 type	1	300.0	Road Header
2	Dump truck 20t-30t	6		Diesel
3	Side dump shovel	1		Diesel
4	Hydraulic breaker	1		Diesel
5	2-boom Jumbo	1	148.0	
6	Back hoe shovel	1		Diesel
7	Ventilation fan 150kW x 2 motor	1	300.0	Q=1,500 m^3/min
8	Shotcrete machine	1	120.0	
9	Mortar pump mixer	1	5.5	
10	Working stage for sheet	1	7.5	
11	Steel former for concrete lining	1	25.0	L=10.50m
12	Concrete pump	1	75.0	15 m^3/hr
13	Ready mixed concrete truck	4		Diesel
14	Transformer substation truck	1		Diesel
15	Lighting in tunnel	2,100 m	126.0	
16	Lighting outside of tunnel	300Wx10	3.0	
17	Batching plant for concrete	1	35.0	30 m^3/hr
18	Cement Silo 30t	1	5.5	
19	Sand gravel stock yards 200 m^3	3	16.5	
20	Water tank 30t	1	5.5	
21	Mechanical excavator S100 type	1	150	Evacuation TN
22	Shotcrete machine	1	40	
23	Battery units of Battery Locomotive	2	50	
24	Diesel generator 200KVA	4	800	Diesel
25	Electric power station 800KVA	1		
26	Dust-water equipment 40t/hr	1	40.0	Motor
27	Another facility	1	20.0	

Source JICA Study Team, July 2014

Table 1.5.3-3 Electric Power Requirement For Tunnel Construction	
Required Electric Power	**kW**
1. Excavation works	782.0
2. Shotcrete works	648.5
3. Concrete lining works	303.5

Source JICA Study Team, July 2014

1.5.3.4 Temporary Yard of Facilities and Equipment for Tunnel Construction

Mechanical excavation using both Road Header and Breaker is planned for tunnel excavation, in consideration of the restriction of using electric power. Standard area of temporary facilities and equipment's are shown in **Table 1.5.3-4**.

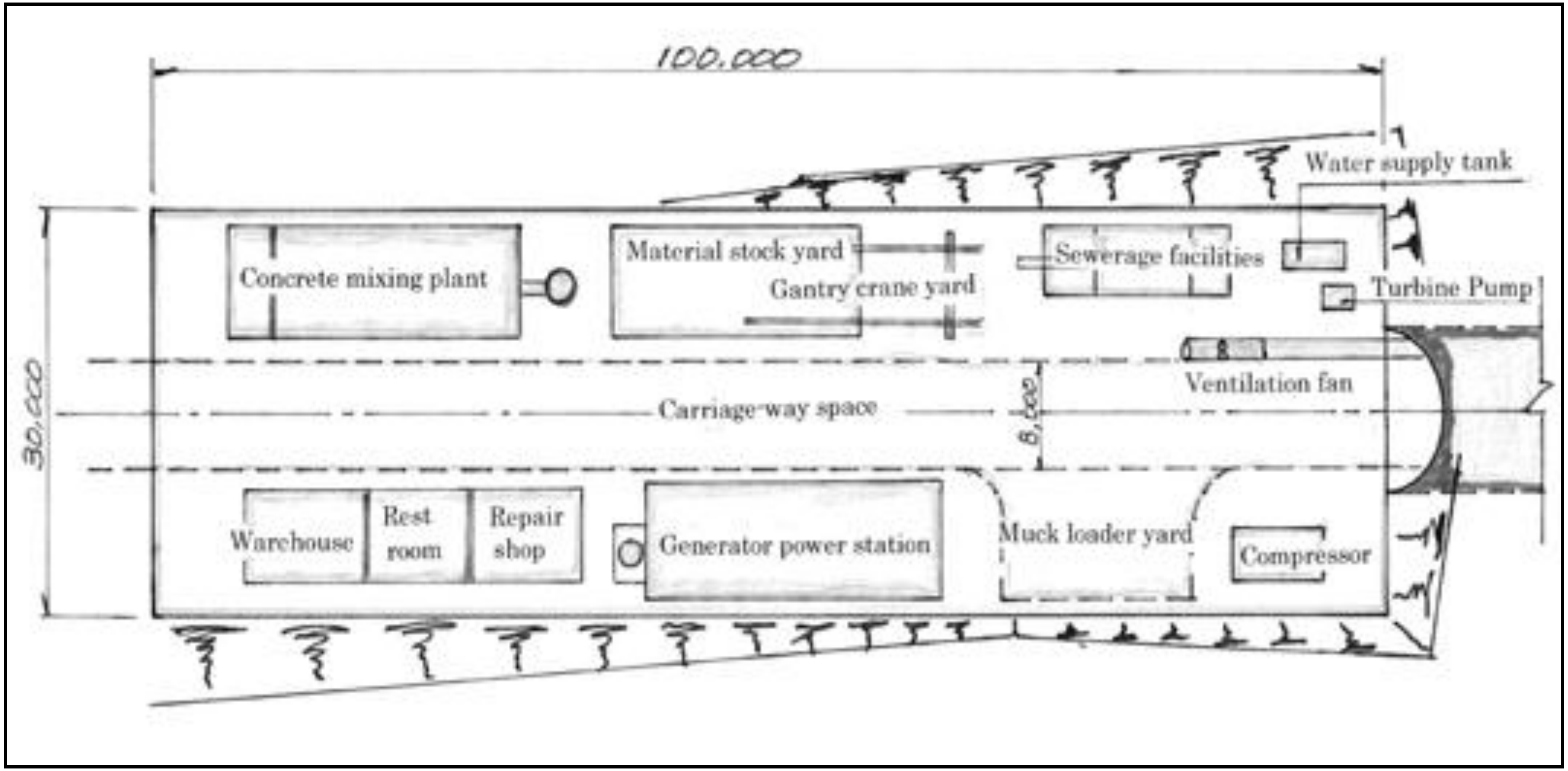
Temporary yard shall be wider than the space to be occupied by the temporary facilities and equipment. An approximate **30 m x 100 m** or **3,000 m^2** area is necessary for temporary yard. Shown in **Figure 1.5.3-6** is the typical layout plan of the temporary facilities for tunnel construction.

Photo Nos. 1.5.3-5 to **1.5.3-7** show some of the temporary facilities for the tunnel construction, while shown in **Photo Nos. 1.5.3-8** to **1.5.3-9** are some of the tunnel construction equipment

Table 1.5.3-4 Standard Area of Temporary Facilities and Equipment

Item	Size (m)	Area (m^2)	No.
Compressor Room	4.0×7.0	28.00	1
Generator Power Station	8.5×24.00	204.00	1
Repair Shop	7.2×9.0	64.80	1
Water Supply Tank	2.0×5.0	10.00	1
Turbine Pump	2.0×2.0	4.00	1
Material Stock Yard	8.0×15.0	120.00	1
Concrete Mixing Plant	8.0×20.0	160.00	1
Sewerage Facilities	5.0×15.0	75.00	1
Rest Room	7.2×9.0	64.80	1
Supervisor Office	4.5×4.5	20.25	1
Ventilation Fan	2.0×6.0	12.00	1
Muck Loader Yard	10.0×15.0	150.00	1
Warehouse	7.0×10.0	70.00	1
Gantry Crane Yard	7.0×10.0	70.00	1
Carriage-Way Space	8.0×100.0	800.00	1
Muck Stock Yard	20.0x40.0	800.00	1
Total		**2,652.85**	

Source JICA Study Team, July 2014



Source: JICA Study Team, July 2014

Figure 1.5.3-5 Typical Layout Plan of Temporary Facilities

Photo No. 1.5.3-5 Electric Power Station and Receiving Box (*Source: JICA Study Team, July 2014*)

Photo No. 1.5.3-6 Sewerage Facilities (*Source: JICA Study Team, July 2014*)

Photo No. 1.5.3-7 Generator Room for Tunnel Construction (*Source: JICA Study Team, July 2014*)

Photo No. 1.5.3-8 Dust Water Filter Equipment (*Source: JICA Study Team, July 2014*)

Photo No. 1.5.3-9 Steel Supports Setting Equipment (*Source: JICA Study Team, July 2014*)

1.6 PROJECT SIZE

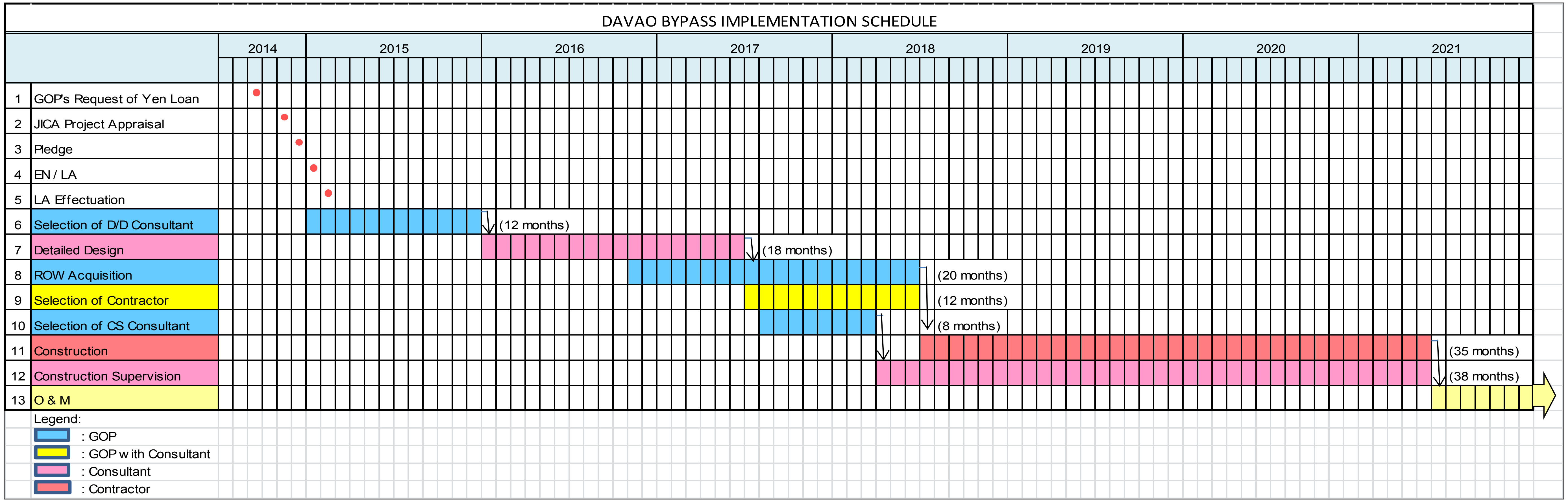
The proposed Davao City Bypass Construction Project will cover an approximate area totaling to **267.48 hectares** based on a **60 m** ROW. **Table 1.6-1** presents the estimated project size per component.

Table 1.6-1 Estimated Project Size Based on 60 m ROW

Project Component	Length (km)	Area (ha)
1. Road Section	37.17	223.02
2 Tunnel Section	2.28	13.68
3. Bridge Section	5.13	30.78
TOTAL	**44.58**	**267.48**

1.7 DEVELOPMENT PLAN, DESCRIPTION OF PROJECT PHASES, AND CORRESPONDING TIMEFRAMES

Discussed in this section are the activities involved during the Pre-Construction, Construction, Demobilization/Decommissioning, and Operation Phases. Presented in **Figure 1.7.1-1** is the target implementation schedule for the proposed Davao City Bypass Construction Project.



Source: JICA Study Team, July 2014

Figure 1.7.1-1 Implementation Schedule for the Proposed Davao City Bypass Construction Project

Activities	Duration	Implementation Date
Selection of D/D Consultant	12 months	January-December 2015
Detailed Design	18 months	January 2016-June 2017
ROW Acquisition	20 months	November 2016-June 2018
Selection of Contractor	12 months	July 2017-June 2018
Construction	35 months	July 2018-May 2021
Construction Supervision	38 months	April 2018-May 2021
O & M		June 2021 onwards

1.7.1 Description of Project Phases

1.7.1.1 Pre-Construction

Described below are the items entailed in the Pre-Construction stage of the Project:

- Transaction Documents Finalized;
- Advertisement;
- Pre-Qualification of Bidders;
- Selection of Detailed Design Consultant;
- Contract Award and Perfection;
- Detailed Engineering Design (DED); and
- ROW Acquisition Delivery by DPWH

1.7.1.2 Construction Phase

The Construction Phase covers the actual implementation of the project, which shall involve the following activities:

- Mobilization;
- Clearing, stripping, and grubbing;
- Relocation of affected basic social service facilities (i.e. power lines, water supply lines, and telecommunication lines)
- Vegetation removal;
- Ground preparation;
- Construction of temporary facilities (i.e. workers' camp, field offices, and facilities yard);
- Access road establishment;
- Actual construction of the road, bridge and tunnel sections;
- Construction of the erosion control structures; and
- Landscaping

(1) Relocation of Affected Basic Social Service Utilities

Simultaneous to initial construction works, basic social utility lines identified during the Pre-Construction Stage will be relocated to suitable location. The concerned local utility (power and water supply, and communication lines) companies are engaged to undertake the work. Early and close coordination with the concerned utility companies will be undertaken to ensure prompt restoration of affected utilities to their normal functions.

Relocation and/or improvements of the affected utilities shall be closely coordinated with concerned agencies and the Cities of Davao and Panabo.

(2) Construction of Temporary Facilities/Structures

The following facilities will be provided by the Contractor in the proximity of the construction site:

- Field office where staff meeting are held and overall construction activities are planned;
- Temporary construction facilities yard;
- Construction barracks and workers' camps where workers rest and spend their idle time;
- Motorpool and repair areas;
- Concrete batching plant; and
- Muck stock yard where excavated materials from tunnel construction will be temporarily dumped before final disposal

1.7.1.3 Demobilization/Decommissioning Phase

Demobilization/Decommissioning Phase described herein are the activities that will be undertaken immediately after completion of the Davao City Bypass Construction Project. The Contractor must ensure that the following decommissioning/demobilization activities are complied with:

- Complete closure and restoration of all temporary construction facilities/structures such bunkhouses, field offices, and facilities yard;

- Complete dismantling of portable sanitation facilities, particularly portalets provided at the construction sites;

- All constructions sites are cleared of residual solid and domestic wastes generated from the temporary sanitation facilities;

- All disconnected/disrupted basic social service facilities such as water and power supplies, and communication lines are fully restored to their normal functions;

- Affected public structures are reconstructed/restored; and

- All construction sites are cleared of residual construction spoils and debris

To ensure compliance of the Contractor, a joint site inspection at the construction sites must be undertaken involving the DPWH, ESHO of the Contractor, and the formed Multi-Partite Monitoring Team (MMT).

1.7.1.4 Operational Phase

The newly constructed Davao City Bypass shall be opened to traffic after **four** (**4**) years of construction period (refer back to **Figure 1.7.1-1**). From here onwards, operation and maintenance of the bypass will commence.

(1) Maintenance of Road Section

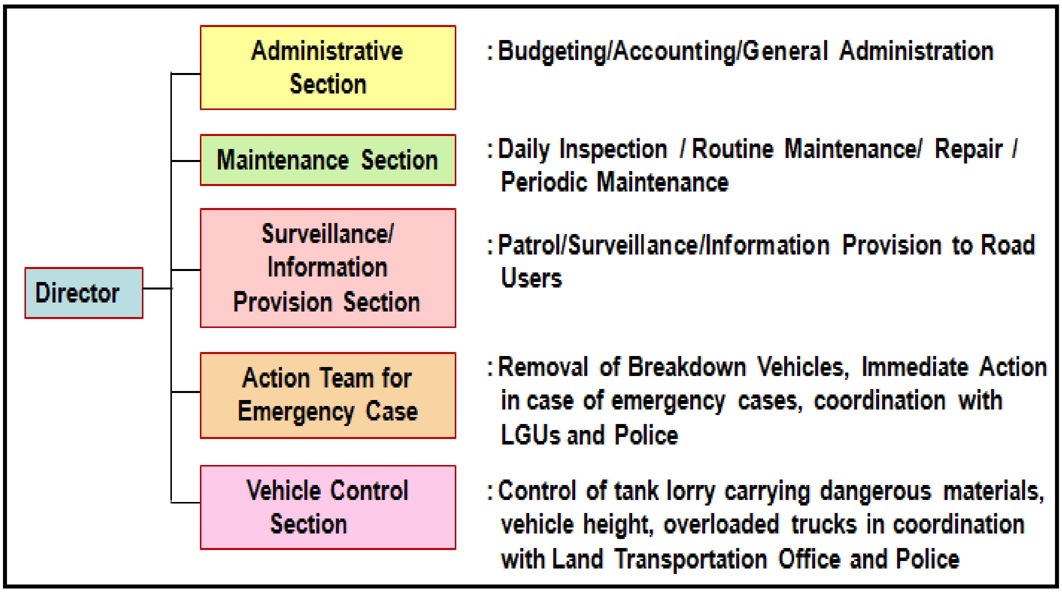
The DPWH District Engineering Office (DEO) who has jurisdiction over the newly constructed Bypass Road shall perform periodic inspection and maintenance of the road section, including all appurtenant structures based on DPWH Standard Inspection and Maintenance Manual for Roads and Bridges.

(2) Maintenance of Bridges and Culverts

Regular inspection and maintenance of the bridges (crossing river/waterway/ and crossing roads) shall likewise be undertaken by the DWPH-DEO concerned to ensure structural integrity of the facilities. Regular de-clogging and de-silting of the culverts shall be undertaken to prevent flooding, particularly at low-lying and identified flood-prone areas.

(2) Tunnel Operation and Maintenance

In order to assure safe operation inside a tunnel and to save road users' lives in case of critical incidents, the "Tunnel Management Office" must be established. The proposed structure of Tunnel Management Office is shown in **Figure 1.7.1-2**.



Source: JICA Study Team, July 2014

Figure 1.7.1-2 Proposed Organization of Tunnel Management Office

1) Major Activities

Presented below are the major activities entailed in the operation and maintenance of the tunnel.

1. Inspection;
2. Routine Maintenance: Tunnel Structure and various Facilities inside Tunnel;
3. Repair of Deteriorated Structures / Facilities;
4. Monitoring of Traffic Movement/Traffic Accident/Fire Incidents, etc. (24 hours x 365 days); and
5. Vehicle Control (tank lorry which carries dangerous materials, vehicle height, overloaded trucks)

(a) Inspection

Inspection of a tunnel must be undertaken daily by an inspection team, and check the following:

- Facilities inside the tunnel such as security cameras, lighting, jet fans, etc. are properly functioning;
- Cleanliness of the tunnel wall, facilities, etc.;
- Any cracks on concrete lining and pavement, water seepage from concrete lining, etc.;
- Drainage facility (no clogging, etc.);
- Deformation of the tunnel arch; and
- Any other problems

(b) Routine Maintenance

- Cleaning of tunnel structure and facilities (tunnel wall, road surface, facilities inside a tunnel;
- Crack Ceiling; and
- Replacement of tunnel facilities which are not functioning

(c) Monitoring of Traffic Movements by CCTV and Warning

Monitoring of the following traffic movements by CCTV:

- Reckless Driving;
- Overtaking;
- Over Speeding;
- Stopped/Parked Vehicle;
- Vehicle Breakdown;
- Obstacles Dropped from vehicle;
- Accident; and
- Fire

(d) Vehicle Control

The following vehicles should be controlled to pass through the tunnel:

- Motorbikes;
- Tricycles;
- Vehicles carrying hazardous materials;
- Overloaded trucks; and
- Vehicles of which height is higher than the limit

1.8 MANPOWER

Table 1.8-1 presents the manpower requirements for the proposed Davao City Bypass Construction Project.

Table 1.8-1 Manpower Requirements for the Proposed Davao City Bypass Construction Project

Manpower Requirement	Expertise/Skills Needed	Estimated No. of Personnel Required		Preferred Scheme for Sourcing
		Men	Women	
Construction Supervision Consultants' Staff				
12	Administrative Staff	5	7	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)
30	Technical Staff	20	10	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)
20	Administrative Staff	8	12	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)
50	Technical Staff	35	15	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)

Table 1.8-1 Manpower Requirements for the Proposed Davao City Bypass Construction Project				
Manpower Requirement	Expertise/Skills Needed	Estimated No. of Personnel Required		Preferred Scheme for Sourcing
		Men	Women	
Construction Personnel				
80	Heavy Equipment Operators	80	N.A.	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)
80	Construction Foremen	80	N.A.	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)
300	Carpenters	300	N.A.	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)
300-500	Unskilled workers (bar benders, steel men, masons, etc.)	300-500	N.A.	From outside; from the host cities/municipality (qualified and duly endorsed by the City/Municipal Mayor); from the DIA (qualified and duly endorsed by the Brgy. Chairman)

1.9 INDICATIVE PROJECT COST

The indicative cost of the proposed Davao City Bypass Construction Project is presented in **Table 1.9-1**.

Table 1.9-1 Estimated Construction Cost of the Proposed Davao City Bypass Project					
Section	**Construction Cost (Million Php)**				
	General	Main **Road**/ Cross Road	Bridge	Tunnel	**Total**
PKG-I, South	27.8 (2.4 M. Php/km)	686.4 (65.0 M.php/km)	842.0 (675.8 M.Php/km)	-	**1,556.2 (131.9 M.Php/km)**
PKG-II, Center	76.2 (4.5 M.Php/km)	1,983.1 (153.6 M.Php/km)	1,185.3 (656.3 M.Php/km)	2,800.4 (1,228.2M.Php/km)	**6,044.9 (355.6 M.Php/km)**
PKG-III, North	47.3 (3.0 M.Php/km)	1,961.8 (143.4 M.Php/km)	1,515.9 (715.4 M.Php/km)	-	**3,524.9 (223.1M.Php/km)**
Total	**151.2 (3.4 M.Php/km)**	**4,631.3 (124.7 M.Php/km)**	**3,543.1 (685.2 M.Php/km)**	**2,800.4 (1,228.2MPhp/km)**	**11,126.0 (249.5 M.Php/km)**

2 BASELINE CHARACTERIZATION AND ANALYSIS OF KEY ENVIRONMENTAL IMPACTS

2.1 THE LAND

2.1.1 Land Use and Classification

2.1.1.1 Major Land Use Classifications

The City of Davao started updating their CLUP in the last quarter of 2010. A Comprehensive Zoning Ordinance (CZO) for 2013-2022 was subsequently enacted by the City Council in 2013, incorporating as an integral part the Comprehensive Land Use Plan (CLUP) as Volume I and Sectoral Studies as Volume III. The following discussions, including illustrations are based on information provided in said CZO and CLUP.

As can be discerned in Land Use Plan (2013-2022) shown in **Figure 2.1.1-1**, the proposed Bypass alignment will traverse through **three** (**3**) **major zones** and **six** (**6**) **sub-zones** with various planned land uses that include the following:

(i) Major Urban Zone - *refers to the Poblacion area comprising the central business districts and the built-up areas including urbanizable land adjacent to the central business district. The sub-zones below shall be traversed by the Bypass at various locations:*

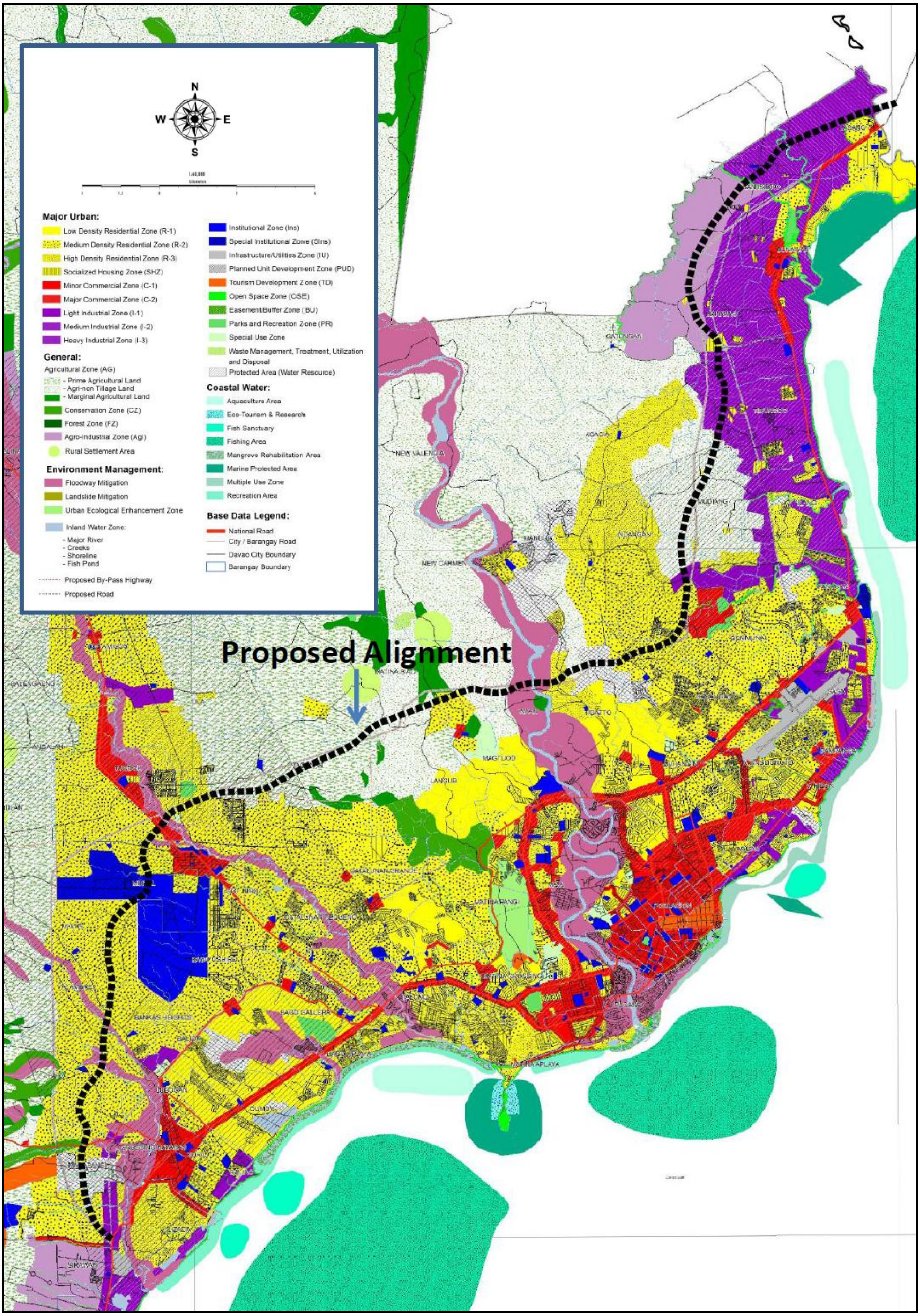
- Medium Density Residential Sub-zone (R-2) - *for housing/dwelling i.e.* ***21 to 65*** *dwelling units per hectare;*
- Minor Commercial Sub-zone (C-1) - *referred to as the Central Business sub-zone (CBD), a C-1 district principally for trade, services and business activities*;
- Medium Industrial *Sub*-zone (I-2) - *for pollutive/non-hazardous and pollutive/ hazardous manufacturing and processing establishments; and*
- *General Institutional* Sub-zone (Sins) - *Refers to areas with an established organization or foundation especially one dedicated to education, public service or culture*

(ii) Agricultural Land Zone (Ag) - *Area devoted for cultivation/fishing and pasteural activities*:

- Prime Agricultural Land (*the area for all types of agricultural activities identified and delineated in the Watershed Code and areas declared as Strategic Agriculture and Fisheries Development Zone (SAFDZ) per Republic Act No. 8435,* *otherwise known as Agriculture and Fisheries Modernization Act (AFMA)*)

- Agri-Non Tillage Land (*Those areas consisting of 12,240 identified and declared as* Environmentally *Critical Areas (ECA) in the Watershed Code of Davao City*

(iii) Agro-Industrial Zones (AgI) - *A division of an area designed primarily for integrated farm operations and related product, processing activities for farm products such as bananas, pineapple, sugarcanes, etc.*



Source: Office of the City Planning and Development Coordinator

Figure 2.1.1-1 Land Use Map of Davao City (2013-2022)

2.1.1.2 Zones Traversed by the Bypass Alignment

The beginning of the alignment in Brgy. Sirawan will traverse an area classified as ***Medium Industrial Sub-zone*** (**Figure 2.1.1-2**). Allowable uses along this zone include: (i) food based industries, (ii) leather based manufacturing, (iii) wood based industries, (iii) agriculture-based industries, (iv) Non-metallic based industries (e.g., cut stone, marble products, and other non-metallic mineral products); (v) metallic-based industries (e.g., fabricated structural iron and steel, wire and cables, household and commercial metal furniture, etc.), (vi) chemical-based industries (e.g., cosmetics, perfumes, waxes, inks, miscellaneous chemical products), (vii) plastic and rubber-based products manufacturing, and (viii) other manufacturing industries classified as medium-industrial.

From **Sta. 2+000** in Brgy. Marapangi to **Sta. 9+000** in Brgy. Mintal, the alignment will generally traverse through ***Medium Density Residential Sub-zone*** (**Figure 2.1.1-4**). Aside from dwelling units, other allowable uses within this zone are: (i) shuttle bus terminals, (ii) personal services shops, (iii) limited backyard raising of livestock (maximum of two heads) and fowl (maximum of **100** heads).

An approximate **1-kilometer** (**Sta. 9+000-10+000**) segment of the bypass in Brgy. Mintal will pass through the University of the Philippines (UP) Mindanao Campus, which is categorized as ***General Institution Sub-zone***. The only ***Commercial Sub-Zones*** to be traversed by the alignment as shown in **Figure 2.1.1-5** are in Brgy. Mintal along the Davao-Bukidnon National Highway (**Sta. 12+000**).

From the medium residential areas in Mintal, the alignment will then traverse through areas categorized as ***Prime Agricultural Land Sub-zone*** in Brgy. Tacunan (**Figure 2.1.1-6**). These areas are primarily planted to banana, which are of export quality. Other commercial fruit trees grown in the area are durian, pomelo, mango, mangosteen, lanzones, and rambutan.

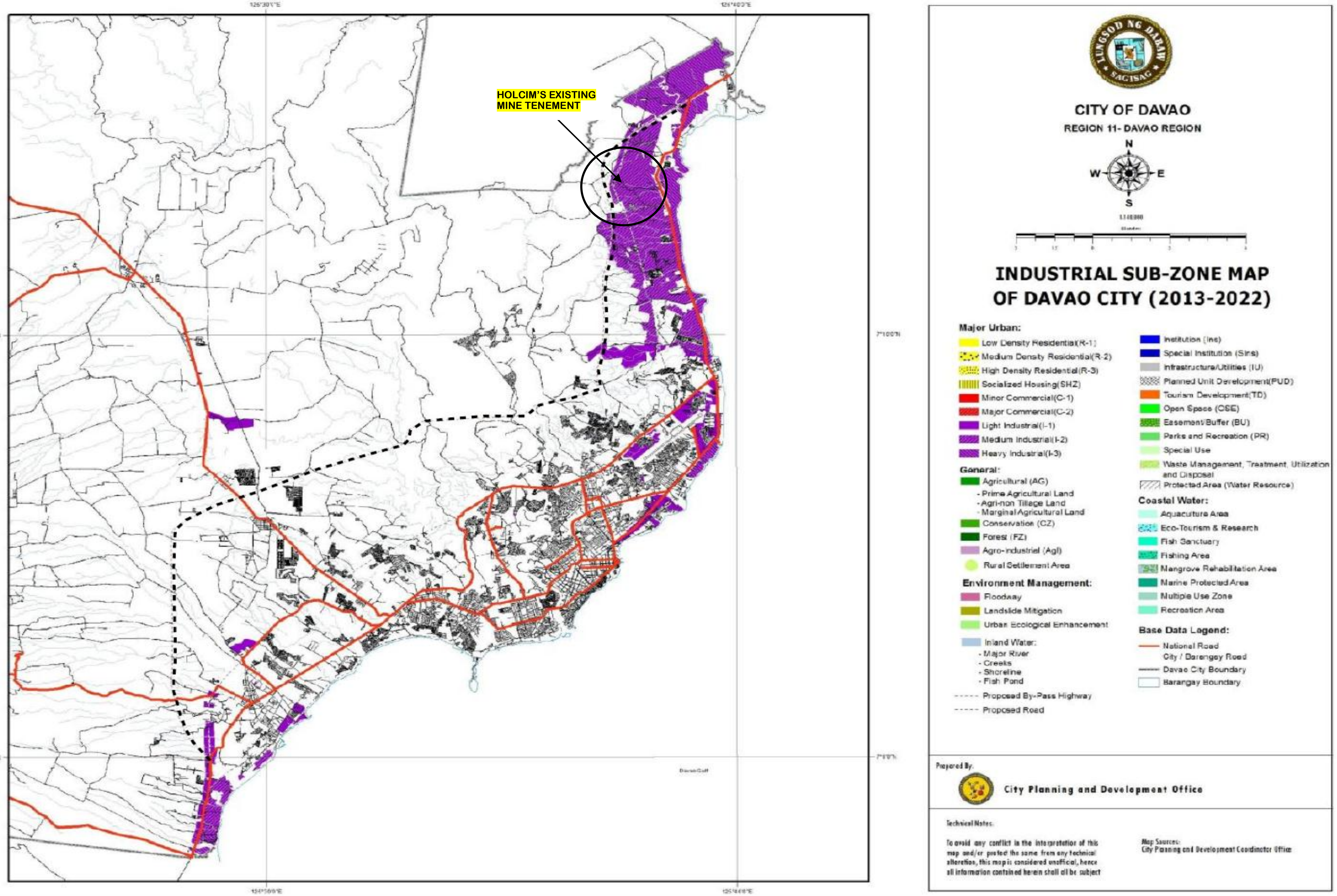
In Matina Biao, before the tunnel section at **Sta. 19+000**, the alignment will traverse areas classified as ***Agri-Non Tillage Land Sub-zone*** (refer to **Figure 2.1.1-6**). Areas after the tunnel section in **Sta. 21+300** in Brgy. Waan also belong to the same sub-zone. Allowable uses include (i) agro forest management, (ii) ecological revolution program, (iii) water management and related activities.

The areas traversed by the bypass alignment in Brgy. Cabantian from **Sta. 24+900-27+000** belong to the ***Medium Density Residential Sub-zone*** (refer to **Figure 2.1.1-4**).

The areas to be crossed in Brgy. Mudiang are also classified as ***Agri-Non Tillage Land Sub-zone***.

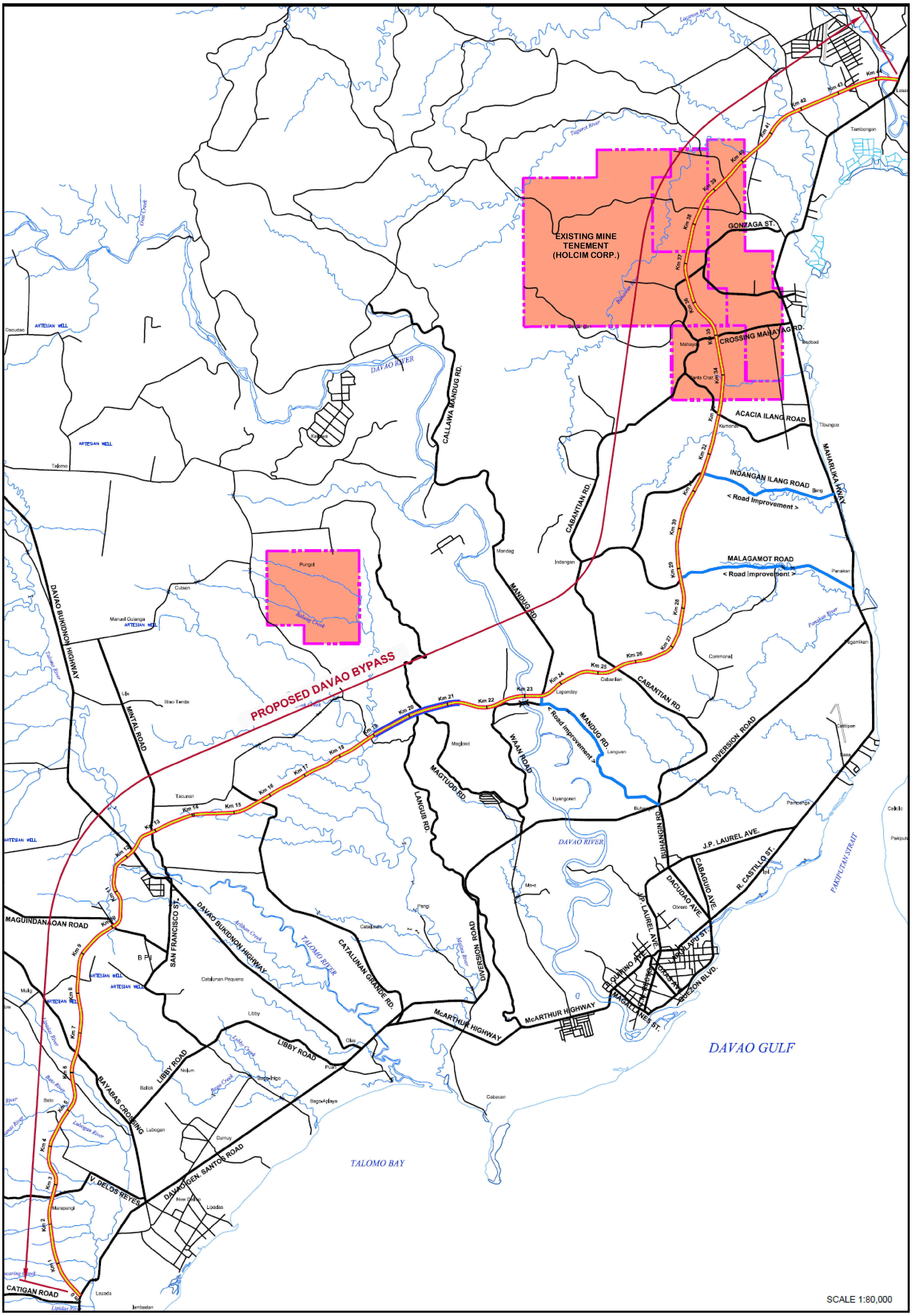
Areas traversed by the bypass alignment in Brgy. Tibungco from **Sta. 32+500-35+000** are classified as ***Medium Industrial Sub-zone***, where part of the existing mine tenement (quarry) of Holcim Cement Corporation is located (refer to **Figure 2.1.1-3**). From **Sta. 35+000-41+000**, which encompasses Brgys. Mahayag and San Isidro, the bypass alignment will traverse through areas zoned as ***Agro-Industrial Zone*** (**Figure 2.1.1-7**). Allowable uses in this zone include: (i) rice/corn mills, (ii) Flour mill, (iii) Manufacture of coffee, (iv) milk, butter, and cheese processing plants and other dairy products, (v) drying, smoking, and airing of tobacco, (vi) Jute spinning and weaving, (vii) canning and preserving of fruit and vegetable juices, (viii) sugarcane milling, sugar refining, (ix) processing, canning of fish and other seafood, and other activities classified as medium-industrial under the zoning ordinance.

The alignment will then traverse through the ***Medium Industrial Sub-zones*** in Brgy. San Isidro and Lasang. The end segment of the bypass alignment **Sta. 44+000-44+458** is located within Brgy. J.P. Laurel, Panabo City. From Lasang River to approximately **100 m** before the Davao-Agusan National Highway, the areas are dedicated to agricultural activities. The areas fronting the National Highway are intended for commercial uses.



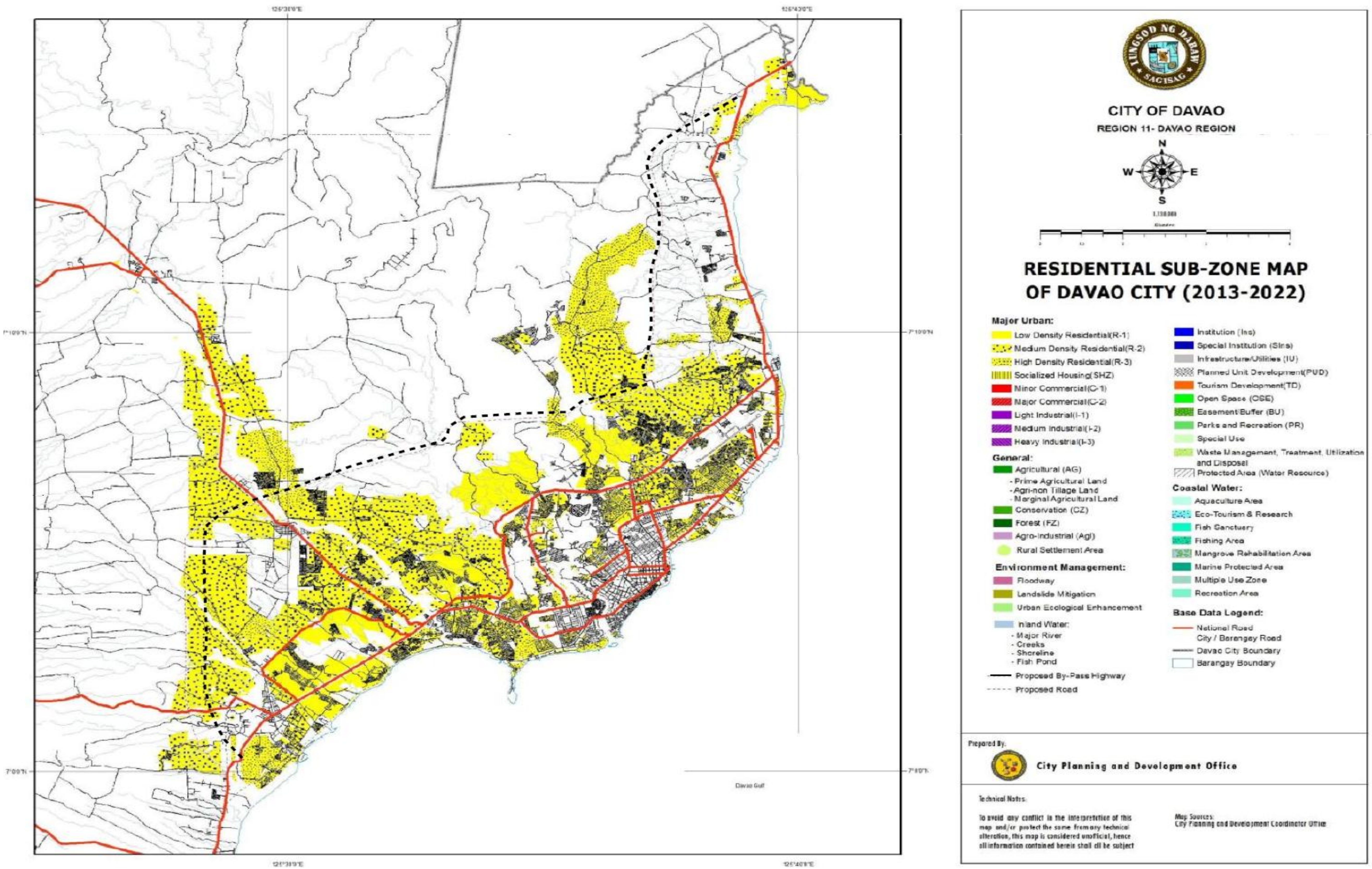
Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-2 Davao City Bypass Alignment along Medium Industrial Sub-Zones



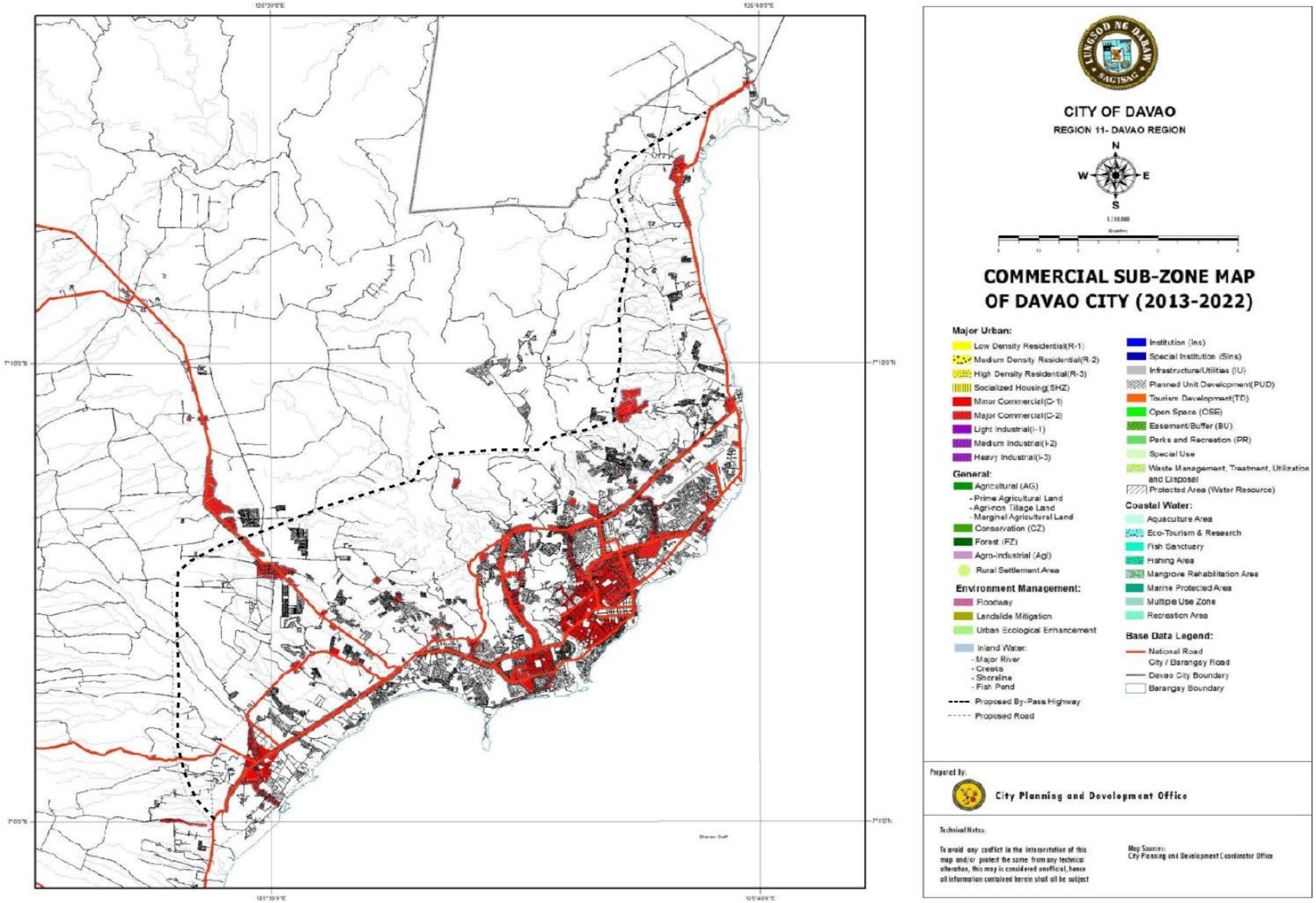
Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-3 Map Showing the Existing Holcim Mine Tenement



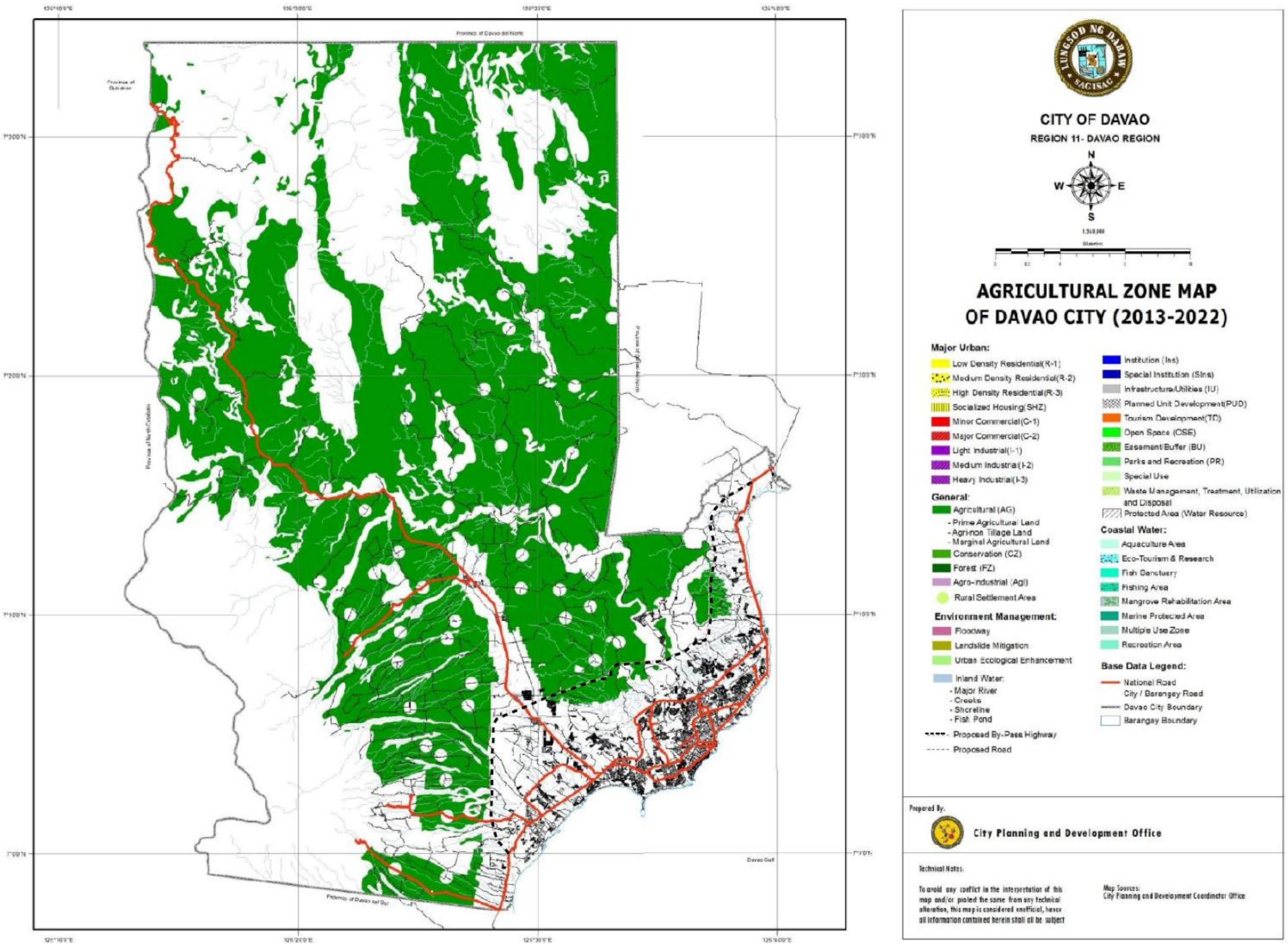
Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-4 Davao City Bypass Alignment along Medium Density Residential Sub-Zones



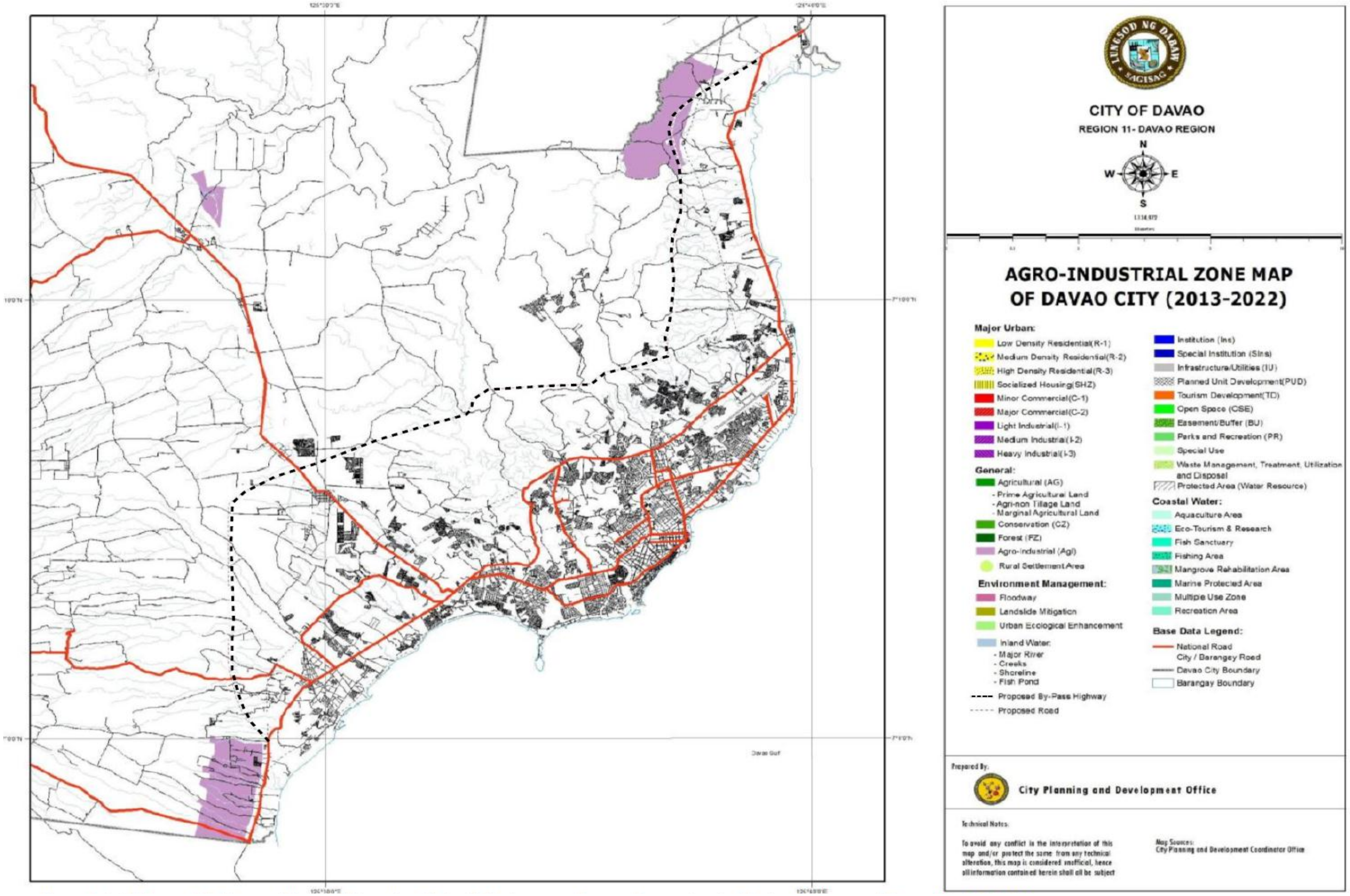
Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-5 Davao City Bypass Alignment along Commercial Sub-Zones



Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-6 Davao City Bypass Alignment Prime Agricultural Land Sub-Zones



Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-7 Davao City Bypass Alignment along Agro-Industrial Sub-Zones

2.1.1.3 Impact Analysis and Mitigation

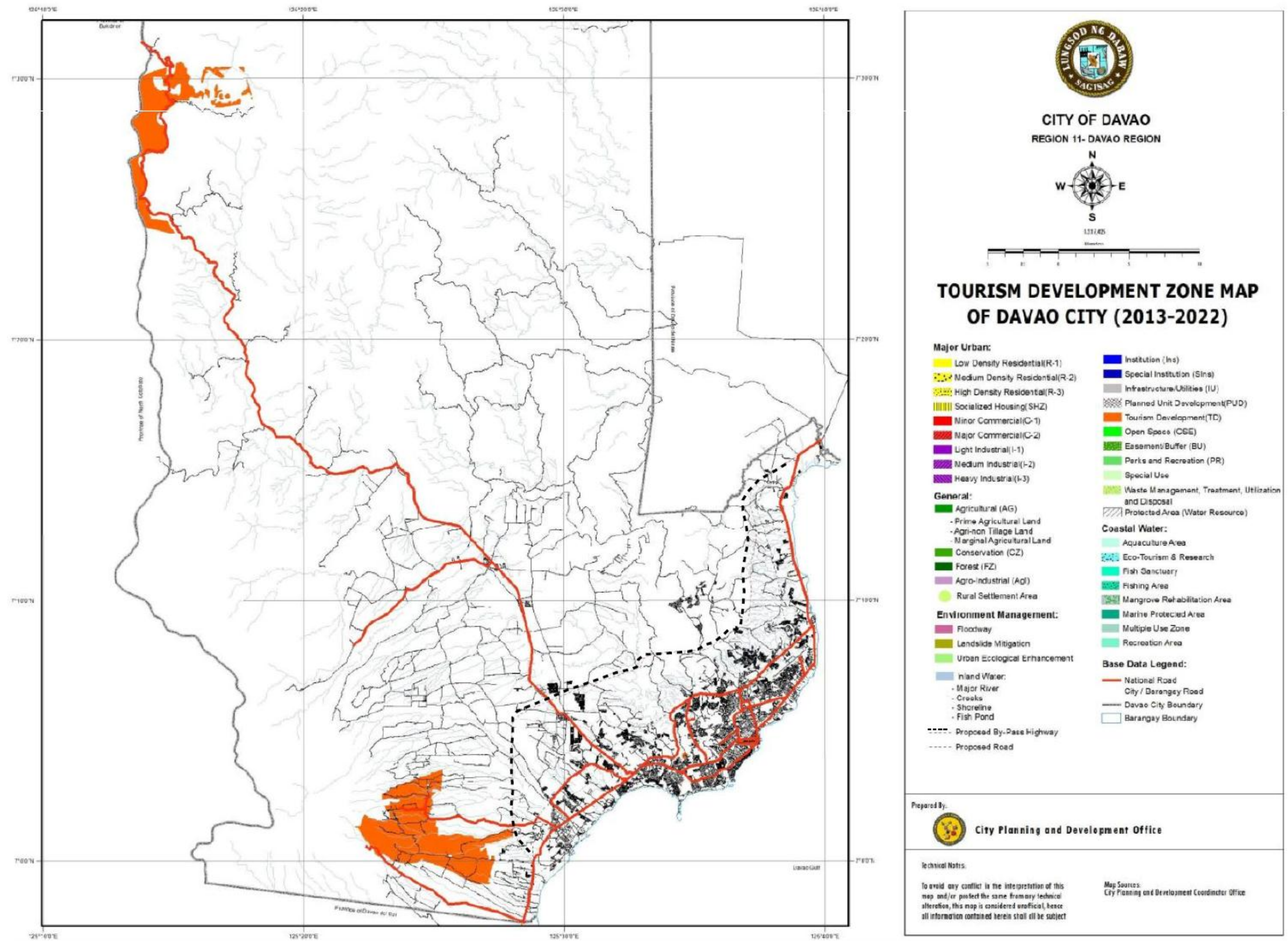
Based on the preceding section, which describes the various types of land uses traversed by the Bypass alignment, the following interpretations were drawn:

(1) Operational Phase

1) Compatibility with CLUP and CZO

As shown in the preceding maps, the bypass alignment is already incorporated in the CLUP and CZO (2013-2022) of Davao City. It may even be possible that the amendments in the planned land uses were somehow influenced by the idea of having a major highway passing through less developed areas northwest of the congested national roads of the City. This is in lieu of the fact that initial discussions have been conducted by the JICA Study Team with the key officials of Davao City, particularly the Mayor and CPDC during the early part of Feasibility Study preparation, which was sometime in the 3^{rd} quarter of 2013. But even previous to this, a bypass alignment has been identified under the JICA-Assisted High Standard Highway Master Plan of DPWH in the last quarter of 2012.

Positive Impacts. Although the proposed Davao City Bypass will not traverse through **Tourist Development Zones** (TDZ), it is deemed beneficial for this development zone in terms of providing better access to the site, particularly at the Toril Sub-District (Please refer back to **Figure 2.1.1-8**). The TDZ refers to areas where major tourism projects or tourist related activities shall be allowed provided that the structures and facilities for tourists shall be in accordance with the Department of Tourism (DOT) guidelines and standards and shall have secured special local government requirements subject to an environmental impact and vulnerability assessment.



Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-8 Davao City Bypass Alignment along Tourism Development Sub-Zones

The alignment will not cross any area classified as **Conservation Zone** (Please refer to **Figure 2.1.1-9**). This zone consists of **34,254 hectares** of identified and declared Environmentally Critical Areas (ECA) in the Watershed Code of Davao City. It also includes areas declared by laws as national parks, watershed reserves, wildlife preserves and sanctuaries including recharge areas for water requirement where rainwater or seepage actually enters the aquifers.

For the following major urban zones that will be traversed by alignment---*Medium Density Residential (R-2)*, *Medium Industrial (I-2)*, *Minor Commercial (C-1)*, and *General Institutional (G-1) Sub-zones*, and Agro-Industrial Zone (positive impacts are expected in terms of better, faster, and safer access and mobility. As gleaned from **Figure 2.1.1-10**, which shows a comparative illustration between the previous (2008) and present (2013-2022) land use plans of Davao City, major urbanization and economic development were planned, and presumably still being pursued towards the direction of areas to be serviced by the Bypass. This is particularly with regards to Medium Density Residential (R-2) and Agro-Industrial Zone (AgI).

In terms of the *Agricultural Land Zone* (AG), particularly the *Prime Agricultural Land Sub-zone* located in Brgy. Tacunan and *Agricultural Non-tillage Zones* in Brgy. Matina-Biao, Waan, and Mudiang, impacts are considered as both positive and negative; **Positive** in the sense that the Bypass can provide better and faster way, and as such more economical way of transporting products from these areas to trading centers and other distribution sites; **Negative** in the sense that there is an imminent danger of illegal conversion into other uses such as those cited in the Zoning ordinance due to its proximity to a national road. To address this, the City must **strictly and diligently implement** the **CZO**, which states that the following acts are prohibited:

<u>For the *Agri-Non Tillage Sub-zone*</u>:

(i) Any change from Agri-non Tillage Sub-zone to another general zone or sub-zone;

(ii) Agri-business and other industrial undertaking without Environmental Compliance Certificate (ECC) as provided in Presidential Decree No. 1586 establishing the Environmental Impact Statement and Proclamation No. 2146

(iii) Water drilling for industrial use except those issued with an ECC pursuant to Presidential Decree No. 1586 and Proclamation No. 2146 and the Davao City Water Resource Management Ordinance

(iv) Construction of any vertical structures for commercial, industrial, institutional, religious purposes without ECC except for research and scientific studies, educational purposes and community chapels, churches and mosque

(v) Exploitation of quarry resources and commercial sand and sand gravel resources

(vi) Monocrop agriculture activities including, but not limited to banana and pineapple plantations, provided that:

a. A Phase-Out Plan shall be granted to existing large scale monocrop agriculture in accordance with the watershed code;

b. No permit shall be issued to new applications for monocrop agricultural ventures;

c. Existing monocrop agriculture covered by the Phase-Out Plan shall not be allowed to expand upon effectivity of the Watershed Code;

(vii) Aerial spray application of all kinds of farm production inputs and crop agents;

(viii) Use of any kind of inorganic fertilizer, pesticide, herbicide and other farm production inputs and crop protection agents

For the *Prime Agricultural Land Sub-zone*

(ix) No change from Prime Agricultural Land sub-zone to any general zone and sub-zone is allowed;

(x) Monocrop agriculture shall be designated in specific areas of the Prime Agricultural Areas by the Crop Zoning Plan in consonance with the City Land Use and Zoning Plan, subject to the regulations of the Department of Environment and Natural Resources (DENR) and pertinent laws, provided that:

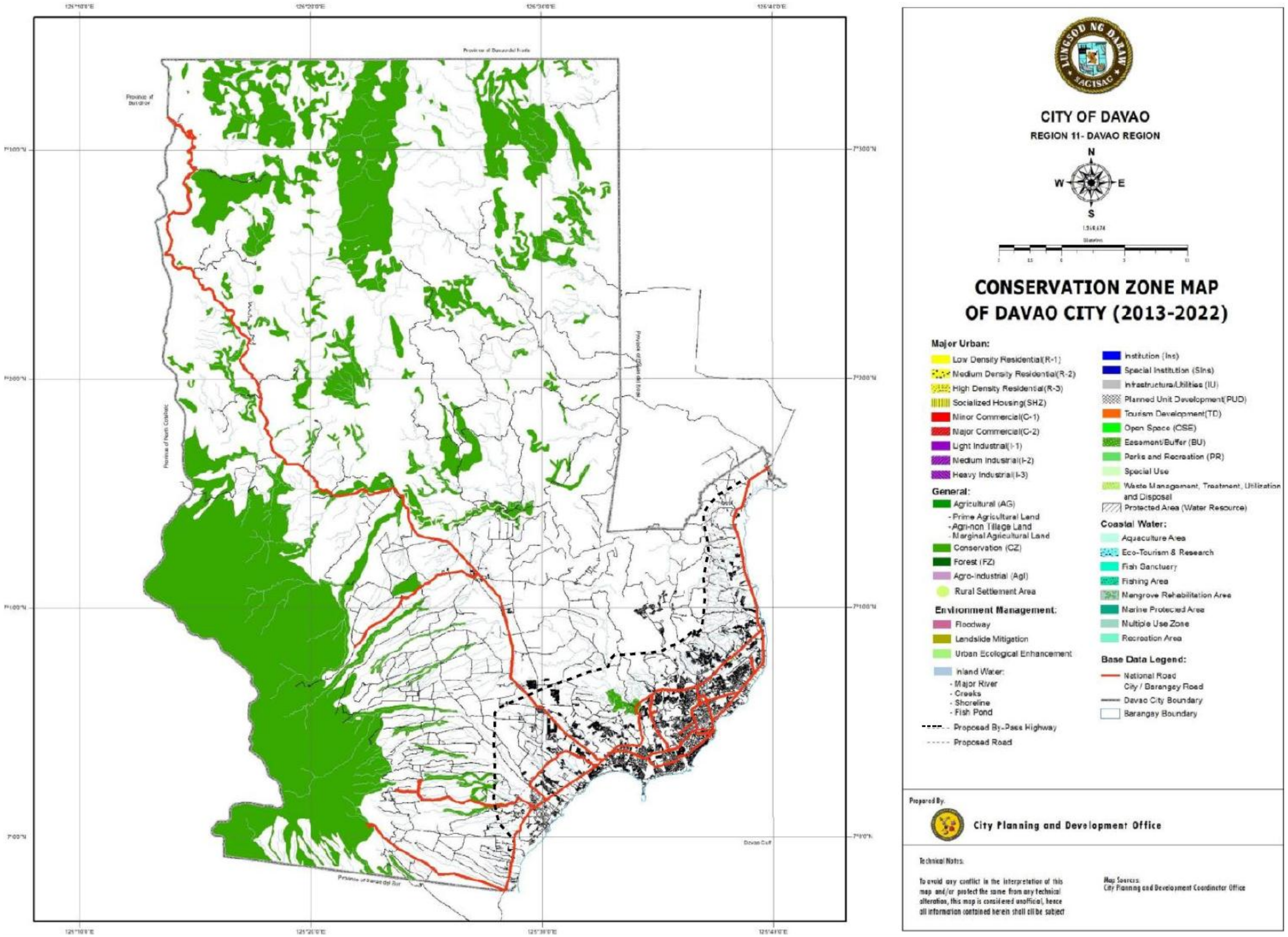
a. A **40-meter** buffer zone shall be established between the plantations and critical areas such as recharge zones critical slopes, riverbanks, rivers, springs, wells and other sources of water;

b. Monocrop agriculture including, but not limited to, banana and pineapple plantations shall maintain a buffer zone of **30 meters** between the plantation and residential houses, schools, chapels, clinics and other institutions; provided further that existing plantations, shall provide for the relocation of those inside the plantation and within the buffer zone to a suitable site at its own expense;

c. Monocrop agriculture shall now adopt a plan shifting to low chemical farm production inputs and crop protection agents and organic farming practices to replace reliance on inorganic fertilizer and other synthetic farm production inputs. No

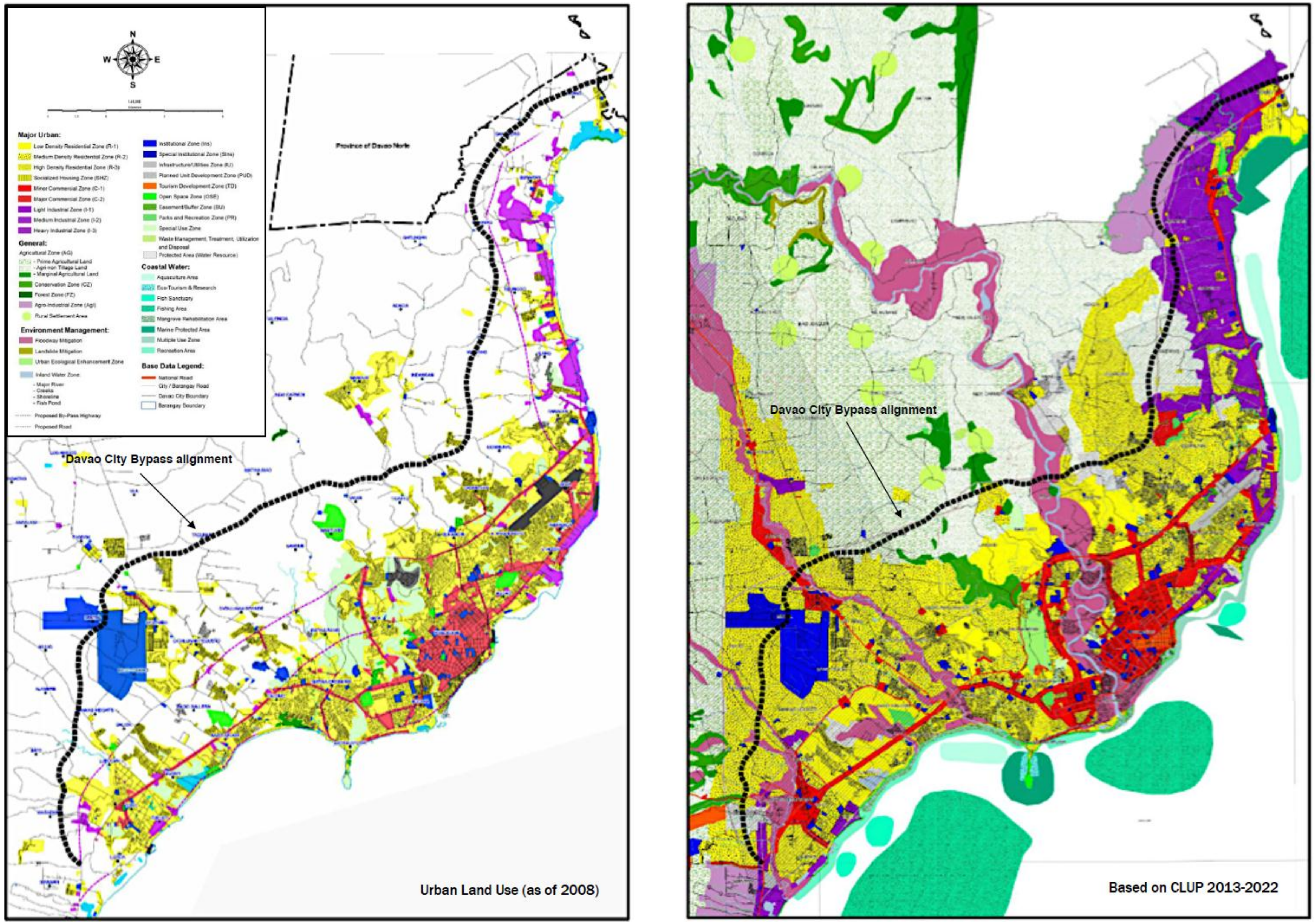
Locational Clearance and Business Permit shall be issued without the submission of this plan; and

d. Operator of mono-crop plantations shall be responsible for violations of the CZO by firms or persons with which they gave *growership agreement* or contracts



Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-9 Davao City Bypass Alignment along Conservation Zones

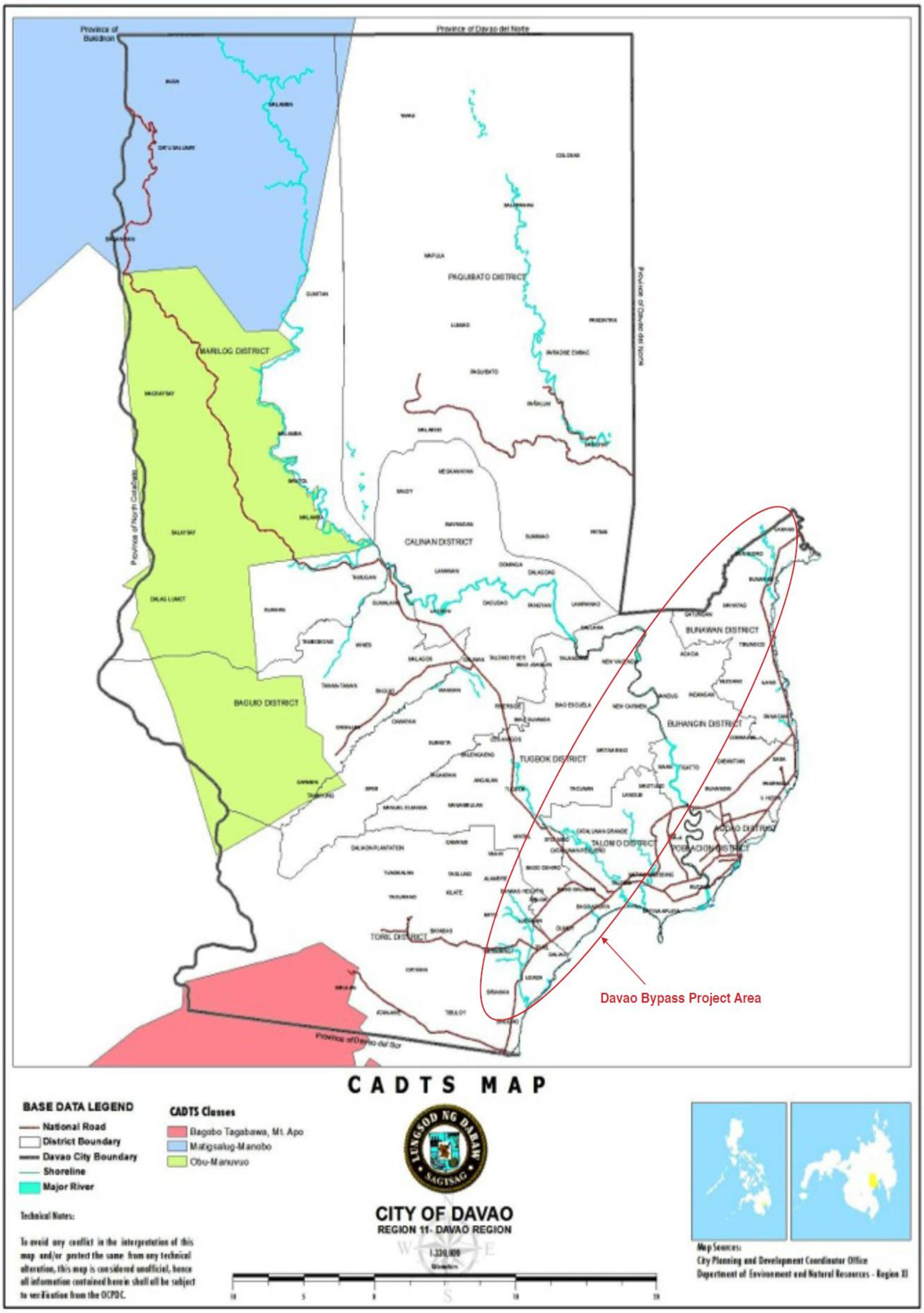


Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-10 Comparative of Illustration of Previous (2008) and Proposed (2013-2022) Land Use Plan of Davao City

2) Impact on CADT Areas

No Impact. The proposed Davao City Bypass will not traverse any area covered by Certificates of Ancestral Domain Title (CADT), as confirmed by the National Commission on Indigenous Peoples (NCIP). Please refer to **Appendix G** (**Volume II**) for the NCIP-issued Certificate of Non-Overlap (CNO), stating that based on the Field-Based Investigation (FBI) conducted, the areas to be traversed by the Davao City Bypass do not overlap with any ancestral domain. Please see also **Figure 2.1.1-11**.



Source: Comprehensive Zoning Ordinance of Davao City (2013-2022)

Figure 2.1.1-11 Areas Covered with Certificate of Ancestral Domain Titles (CADT)

2.1.2 Geomorphology and Geology

2.1.2.1 Geomorphology

(1) Morphogenetic Terrain Classifications

The morphogenetic terrain classifications for the project followed the world-recognized and accepted ITC System of Terrain Analysis and Classification using aerial photographs and other remote sensing images[1.] With this system, the following terrain mapping units (TMUs) are classified basically in terms of: (*a*) *relief-morphology relationships*; (*b*) *geomorphic processes*; (*c*) *geology/lithology*; (*d*) *soils*; (*e*) *hydrologic situations*; (f) *vegetation*; and (*g*) *land uses*.

1) Structural Peaks and Tops

These geomorphic/terrain units are characterized by the protrusions of isolated prominence of outcrops and bedrocks above the surrounding steep slopes and ridges. Many are pointed, rounded and sharp-crested mountain, hill tops and knobs occupying most prominent and highest elevations in the area. Elevations vary prominently between **70 meters** and **221 meters above** sea level.

The prominence of these geomorphic units as shown in the morphogenetic terrain map shown in **Figure 2.1.2-1a** to **2.1.2-1d**, exhibits an irregular alignment. This alignment runs following north-northwest directions where major fault zones and anticlines generally strike.

The occurrence of structural peaks and tops are fault-controlled largely by anticlinal exposures of older Tertiary marine sediments. Their sites are characterized by steeply dipping sedimentary rocks marked by severe erosions of gullies, rills and slope-wash. Thin or absence of soil cover is often noted in and around these geomorphic units. In some places, their sites are associated with minor spring zones. Forest and vegetation covers appear very limited.

2) Structural Steep Ridges and Spurs

Similar to structural peaks and tops these geomorphic/terrain units are also largely structurally-controlled. They appear very profound along western sides of Brgy. Langub, Magtuod, and New Carmen, Davao City and towards the western end of the axis of the

[1] Ref. ITC Textbook of Photo-Interpretation, vol.VII; Dr. R.A. van Zuidam, et al, 1978; ITC, Enschede, The Netherlands

by-pass tunnel. This section of the project site appears prominent with the passage of several fault zones.

The prominence of the structural ridges and spurs, especially in the vicinity of the bypass tunnel, is evolved and controlled by the dipping beds of Pleistocene shallow marine sediments. Many are steeply sloping towards the west collinear with the dip slopes of the underlying shallow marine sedimentary rocks.

Diagnostic morphologic features of these geomorphic units are: (a) deep incision of ravine-like drainage lines; (b) steeply to very steeply sloping topography with complex slope geometry; (c) mountainous and rugged relief; (d) high dissection of medium to coarse dendritic drainages. Surface weathering and rainwash erosions are common with prominent associations of surficial mass movements. Soils vary in depth which seldom exceeds **1.5 meters** below ground surface. Elevations range from **80-200 meters** above sea level.

3) Structural – Denudational Terrain

These geomorphic units have intimate association with the prominence of structural morphologies in the area. Along with the structural controls, changes of slopes in the area is visibly effectuated by the layering of different rock types and differences in soil types and distribution. These changes in slopes in the area are categorized into two terrain mapping units as described in the succeeding sections.

(a) Steeply to Moderately Sloping Terrain

The prominence of steeply to moderately sloping structural-denudational terrain appears along the western side of Brgy. Langub, where passage of major fault dominates. Their presence is essentially controlled by the geology of the underlying bedrocks which are dominated by steeply dipping Pleistocene shallow marine sediments.

Sites of the steeply to moderately sloping structural-denudational terrain are characterized by complex morphologies. Most prominent are: (a) high dissection by deep and youthful gullies and creeks; (b) rugged relief; (c) dense drainage lines; (d) complex concavo-convex slope forms; (e) poor and varied soil cover; (f) some minor springs on tributary and gully heads; (g) severe erosion; (h) open and sparse vegetation with few riparian. Elevations vary between **200** and **80 meters** above sea level.

(b) Moderately to Gently Sloping Terrain

The moderately to gently sloping structural-denudational terrain is evident between **10** and **150** meters above sea level. Their presence appears more pronounced towards the eastern section of the proposed by-pass road where mixed alluvial and fluvial actions of the Davao River are best noted. Similar to earlier structurally-controlled terrains, these slopes are guided generally by the trajectories of west-northwest faults. In similar manner, the slopes of these geomorphic sub-units dip to both east and west generally following the limbs of anticlines of the Pleistocene sedimentary rocks, which plunges generally towards the north.

Sites of the moderately and gently sloping structural-denudational terrain are characterized by varied morphologies. Most prominent are: (a) low to moderate dissection by u-shaped and rejuvenated gullies and creeks; (b) partly rugged relief; (c) complex (dendritic, parallel, trellis and rectangular) and partly deranged drainage lines; (d) complex concavo-convex slope forms; (e) varied soil cover and thickens where slopes are gentle; (f) severe erosion; (h) good vegetation with abundant riparian. Elevations vary between **180** and **40 meters** above sea level.

4) Volcanic Footslopes

These geomorphic units represent the varied volcanic landscapes and terrains evolved and developed by the downstream sedimentations, re-depositions and reworkings of volcanic materials and other ejectas from the eruptions of Mt. Apo. They appeared youthful (i.e. Recent) and most widespread in and around southern and south-western sections of the by-pass road alignment. Their sites are chiefly laid by poorly consolidated mixtures of lahar and pyroclastic materials. In some places, these materials are intersected by lava-rich pyroclastics, mudflows and rejuvenated intrusive. The formation of the volcanic footslopes at the southern end of the bypass road corridor is evident in at least **three** (**3**) levels: lower, middle, and upper.

(a) Upper Volcanic Footslopes

The prominence of the upper volcanic footslopes at the western end the road corridor between the Barangays of Mintal and Sirawan is marked by the dominance of rolling-undulating relief. Slopes steepen up to rolling-hilly and mountainous towards upper-slopes of Mt. Apo, where deep and ravine-like dissections of complex drainage lines dominate. The elevations of these geomorphic units vary between **150** and **400 meters** above sea level.

Areas of the upper volcanic footslopes are covered by generally good soils. The hydrologic situation is good with abundant availability of ground and surface waters. In many places free-flowing wells exist. Sites are good and arable lands; best suited for large plantations and industrial orchards.

(b) Middle Volcanic Footslopes

The prominence of the middle volcanic footslopes along the road corridor is marked by the dominance of undulating to gently sloping terrain. Notable portions are highly dissected by deep gullies. Soil erosions by sheet wash and slope wash are widespread. Elevations vary between **100** and **300 meters** above sea level.

Areas of the middle volcanic footslopes are covered by good volcanic soils. Water is abundant. Sites are good and highly arable lands; best suited for large agricultural plantations and industrial orchards.

(c) Lower Volcanic Footslopes

The prominence of the lower volcanic footslopes along the road corridor is characterized by gently sloping relief. Dissection by gullies, tributaries and rills is moderate to low and broadly spaced. Towards the floodplains and low-lying areas, the morphologies of the lower volcanic footslopes tend to flatten to almost horizontal. Their sites notably associate with active alluviation and fluvial processes. Elevations vary between **80** and **250 meters** above sea level.

Areas of the lower volcanic footslopes are covered by good soils. The hydrologic situation is good with abundant availability of ground and surface waters. In many places of this geomorphic unit, artesian and free-flowing wells exist. Sites are good and highly arable lands; best suited for large and industrial plantations and orchards.

5) Collapsed Pyroclastic

The prominence of collapsed pyroclastic is evident in the upstreams of Bato and Bayabas Rivers. This geomorphic unit is marked by an irregular and ring-like structure; resembling a collapsed caldera. Basically, soon after volcanic eruptions, volcanic valleys/channels may be plugged by lava and pyroclastic flows or hollowed by erosions; disturbing and distorting the volcanic drainage lines.

The prominence of collapsed pyroclastic along the road corridor appears as an erosion ring-like relict, where the central part of a basaltic mounds where hollowed by piping. The actions of piping caused the ring-like roof of the volcanic channel/mound to collapse rejuvenating the shoulders by a large amphitheater of system of branching valleys (annular drainage system). Sides and shoulders of the ring-like depression are marked by steep and cliffy slopes and round ridges. Elevations vary between **100** and **250 meters** above sea level. Topography is notably bear with minimal soil cover. S prings are present. Dissection is high.

6) Volcanic Mudflow

Downslopes of the volcanic footslopes are mixtures of fluvial actions and rejuvenation of volcanic erosions. Their prominence nearby the by-pass road alignment is marked by the dominance of slow fluvio-denudational processes, where incisions by rejuvenated volcanic gullies and slope-wash appear very profound. Relief in these areas is dominated by gently sloping terrain. Dissection by u-shaped drainage lines is moderate to low. Elevations vary between **50** and **120 meters** above sea level. Sites of Volcanic Mudflow in and around the by-pass road alignment are covered by good soils. Lands are highly arable with abundant water. In places, artesian and free-flowing wells exist.

7) Alluvial Fan Complex

Depositions by sheet floods and overbank flows appear evident at the downstream margins of several highlands rolling in the vicinity of Barangay Mahayag and San Isidro. This geomorphic unit is laid by the natural paving of non-consolidated sands and gravels. Relief varies from rolling-undulating to gentle slopes. Occurrence of denudations, aggradations and degradation is irregularly slow.

Dissection by dendritic drainage lines is low. Many of these drainage lines appear distorted, where passage of fault lines has great influence. Elevations vary between **20** and **100 meters** above sea level. Soil development is relatively poor and thin. Water is abundant. Natural vegetation and agriculture are highly possible.

8) Alluvial-Floodplain Association

This geomorphic unit evolved in the area traversed by the road corridor by the mixtures of alluvial and floodplain deposits. Their formation is evident by the associations of overbank, sheet floods and flood basins. In some areas of Barangays Lizada, Bunawan, and San Isidro, the prominent association of alluvial and floodplain deposits is marked by the presence of backswamps and ponded basins.

Sites of the alluvial-floodplain association are generally flat with irregular surface undulations. These undulations are formed by the incisions of flood channels, overbank spills and concentration of run-off gullies. River and channel actions are common. Soil development is good. Notable portions are agriculture mixed with urban orchards. Water is abundant with usual presence of artesian. Elevations vary between **10** and **80 meters** above sea level.

9) Fluvial Valley-Bottom Fills

This geomorphic unit is mapped where mixture of transported and weathered volcanic fragments and colluvio-alluvial soils filled-up and relict fluvial valley sides and channel bottom. This mixture was transported by sheetwash and slopewash. Prominence of sheet and gully erosions is evident in and around these areas.

Relief is generally gentle and flattens towards river zones, where floodplains dominate. Sites are covered by good and relatively thick soils with abundant water. Vegetation and cultivation are widespread. Their prominence in the project site is marked by low dissection of perennial gullies and rills. Some portions are marked by stagnant water. Elevations vary between **80** and **150 meters** above sea level.

10) Floodplain Complex

This geomorphic unit demarcates and separates the fluvio-alluvial environments from the coastal environments in the vicinity of the road corridor. Their prominence is obvious in the flat and low-lying areas of Barangay Tibungco, Bunawan, San Isidro, Toril and Baliok. This terrain unit is host to **km 1483+000** up to **km 1485+000** of the proposed bypass road.

Areas of the floodplain complex are characterized by flat to very gently sloping relief. Undulations are usual prominently incurred by the depositions of natural levees, abandoned channels, point bars and backswamps. River and channel actions are common with the perennial prominence of gully, sheet and rill erosions. Soil covers are generally humic in varied thickness. Water is abundant. Drainage is poor and in many places ponded. Their sites are densely vegetated and good areas for both rainfed and irrigated agriculture. Elevations vary between **5** and **20 meters** above sea level.

11) Coastal Plain

Towards the coastal environment, the project site is marked by the prominence of coastal plain. This plain is found in the northern and southern end of the road corridor, formed by the depositional environments of mixed-flats and beach-barrier. Both geomorphic units serve as the demarcation zone between the sea and fresh water environments.

The combined actions of tidal and deltaic channels are very pronounced. Floods in and around the coastal plain appear very common as evidenced by widespread water ponding in the area. Relief is generally flat with minor undulations due to human activities. Urbanization and urban agriculture are most pronounced in this unit. Soil is generally good and suitable to agriculture. In many places, aquacultures and fish-ponds are usual. Water is abundant and partly brackish in some places.

12) Fluvial – River Terraces

Portion of the road corridor associates very closely with the down streams of the Davao River at Brgy. Tigatto and Sta. **Km 1052+000**. The by-pass road section sits on the terrace deposits of the Davao River. In terms of morphology, the occurrence of the fluvial-river terraces in and around the project is best described into **two** (**2**): upper and lower terraces.

(a) Upper Fluvial Terraces (U)

The upper fluvial-river terraces are older and occupy higher grounds than the lower terraces along present water-lines of the Davao River. These terraces are relicts and water-line remnants of the present Davao River. Materials are layered streambeds and braid-plains of essentially fluviatile deposits, poorly clasted by oxide-rich clays and sandy silts, very coarse well-rounded and notably comprised of pebbles, cobbles and boulders. Features of interrupted imbrications are very profound

The prominence of upper terraces as shown in **Figures 2.1.2-1a** to **2.1.2-1d** appears constricted, elevated and unpaired only along the left-downstream side of the present Davao River and passes through the western abutment site of the proposed Davao River Bridge. This geomorphological situation substantiated with the presence of interrupted imbrications of materials suggests occurrence of an active neotectonism and fault-triggered rejuvenation in the area. Further, the present surfaces of the upper fluvial-river terraces gently incline towards the west-southwest, where dips of downthrown faulting are manifested.

No actual river actions were noted in the upper terraces during the time of this investigation. But, these areas are likely subject to lateral action of the Davao River, especially during extreme bankful floods. Normally, the frequently slow denudational processes are predominant. Other features include: (a) dissection of gullies and creeks; (b) weathered and partly poorly consolidated materials; (c) armored/stream-paved tops; (d) good and partly humic soils; (e) shallow water-table/fluvial aquifer; (f) seepage near edges; (g) good vegetation cover; (h) elevations between **15** and **30 meters** above sea level.

(b) Lower Terraces (L)

The lower fluvial-river terraces are younger and occupy lower grounds than the upper terraces along present water-lines of the Davao River. These terraces are mixed abandoned and active passages of the present Davao River.

Depositions and formation of the lower terraces are essentially stream-driven and braid-plains. Relictification of chutes, cut-offs, meander benches and island bars appears predominant; suggestive of highly dynamic and pulsative behavior of the Davao River. The present manner of relictification, pulsative shifts and migration of the Davao River from east towards west prominently supplement an active downthrown neotectonism of the north-northwest faults which cut the bypass tunnel in the project area.

Materials lack features of sedimentation layerings and/or beddings. These are notably open-worked mixtures of pebbles and very coarse sands capped and armored by silt-clasted gravels. In many places patches of island, braid and meander sand bars are common. Presence of iron-coated sediments is not visibly profound. No features of imbrications are noted.

The prominence of lower terraces appears widespread and irregularly paired along the present waterlines of Davao River. This geomorphological situation further strengthens our conception on the occurrence of an active neotectonism and fault-triggered rejuvenation of Davao River at present.

Present actions of the Davao River are actively associated by extensive flooding, erosions, bank-collapse, benching, undercuttings, overbank spills and floodplain formation. These are especially very profound towards the lower reaches, where the lateral migration of the Davao River intimately interacts with tidal events and processes of the Davao Gulf.

Normally, fast denudational and erosional processes are predominantly frequent. Surfaces are predominantly flat. Other features include: (a) active channel erosions and depositions; (b) weathering and humicification of topsoil; (c) loose and non-consolidated surficial materials and top soil; (d) highly humid, saturated, good and mostly humic soils; (e) near-surface water-table/ fluvial aquifer; (f) swampy in some places; (g) good vegetation cover; (h) elevations between **10** and **20 meters** above sea level.

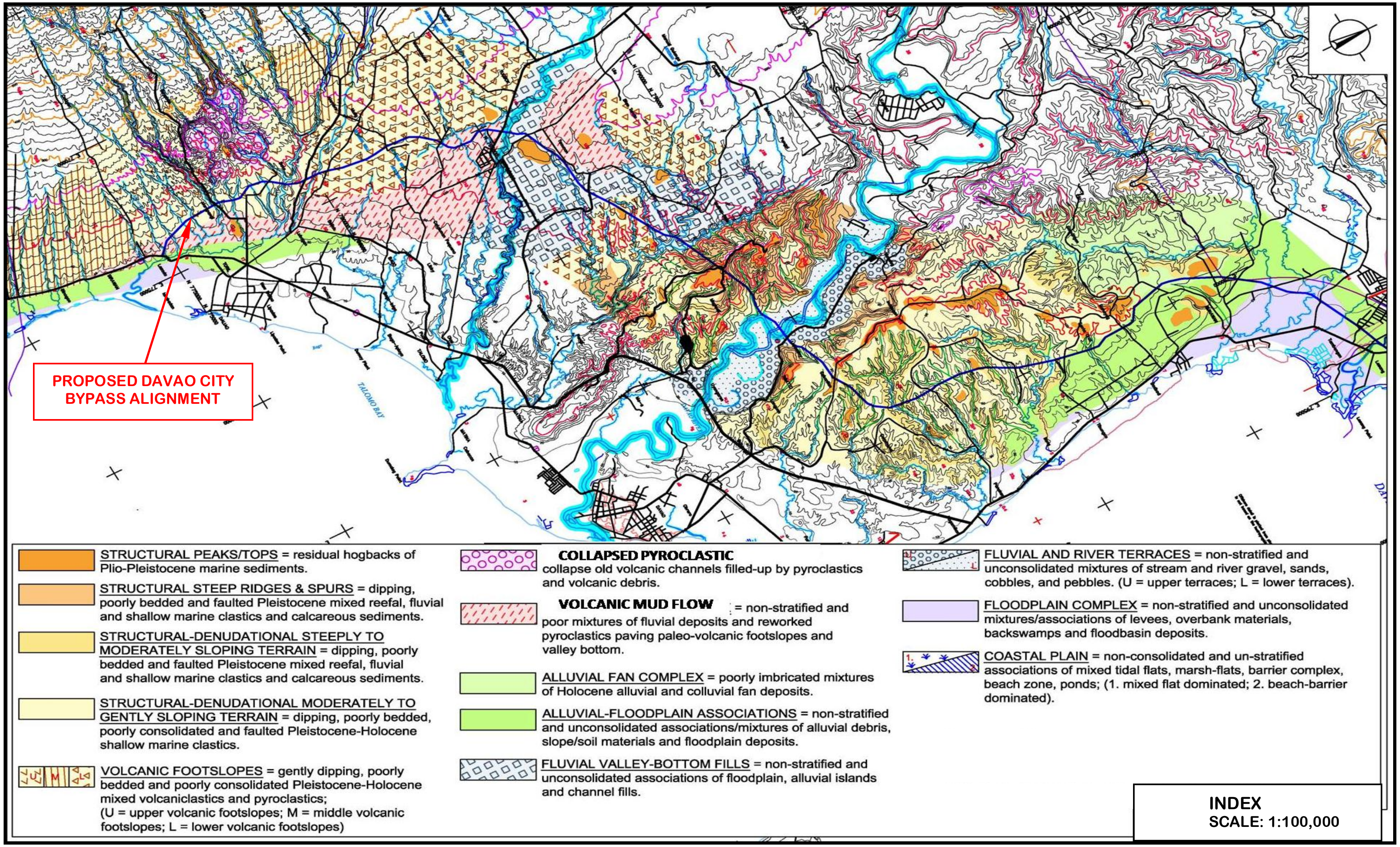


Figure 2.1.2-1a Morphogenetic Terrain Map along the Proposed Davao City Bypass Alignment

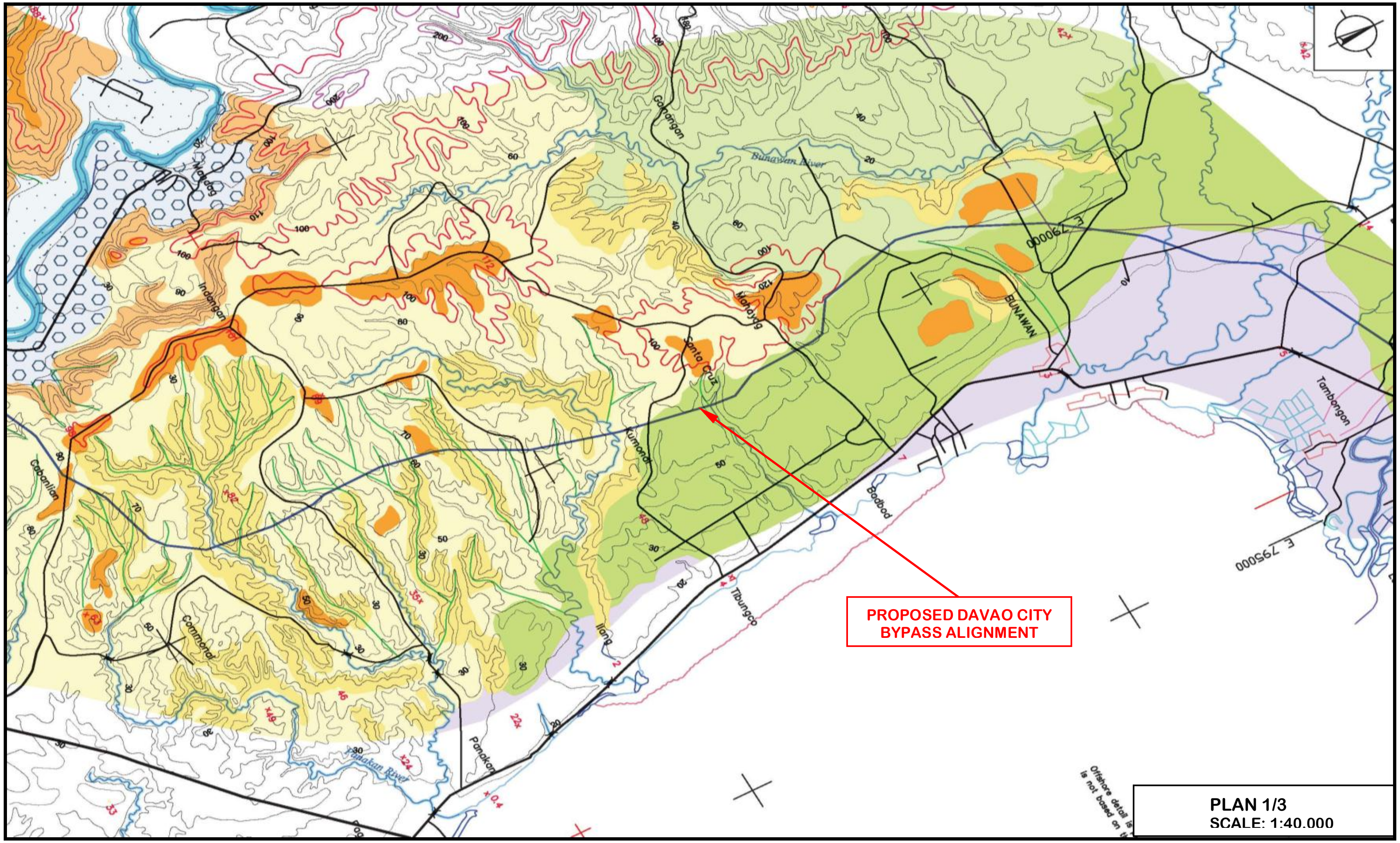


Figure 2.1.2-1b Morphogenetic Terrain Map along the Proposed Davao City Bypass Alignment

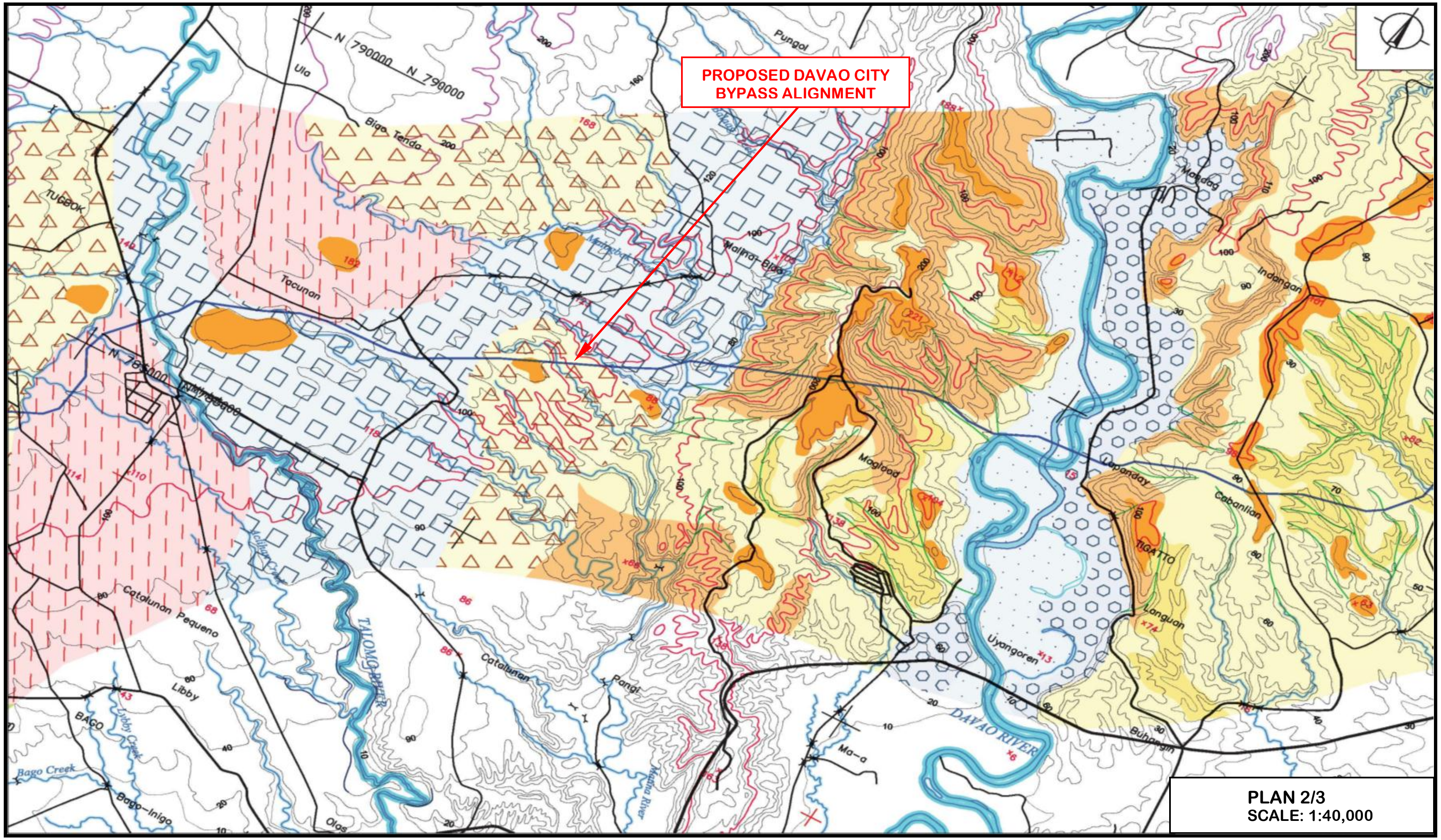


Figure 2.1.2-1c **Morphogenetic Terrain Map along the Proposed Davao City Bypass Alignment**

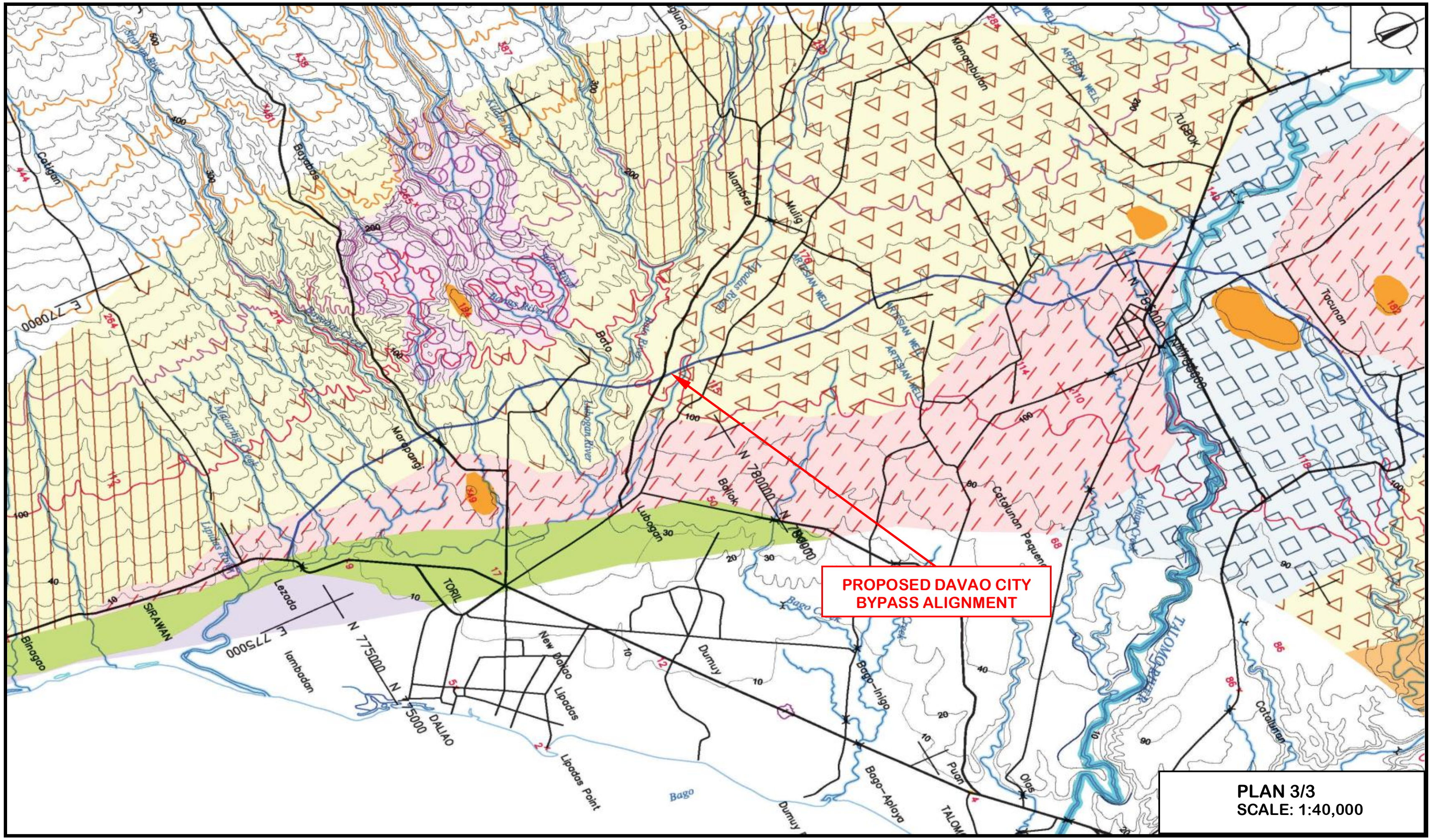


Figure 2.1.2-1d Morphogenetic Terrain Map along the Proposed Davao City Bypass Alignment

(2) Morphostructural Characterization

The terrain traversed by the road corridor has numerous features of ground instabilities. In the geomorphological point of view, these features which are shown in the morphostructural map of this report (**Figures 2.1.2-2a** to **2.1.2-2d**) are expected to trigger problems and may poise challenges in the engineering design and construction of the by-pass road. Below are geomorphic features of ground instabilities which based on the present observations requires serious attention and geotechnical considerations, namely: structures and lineaments, mass-movement zones and creeps.

1) Structures and Lineaments

The general landscape bisected by the by-pass road are cut and crisscrossed by several geologic structures and lineaments. Most prominent are faults, geologic lineaments, synclines and anticlines. In many places, the prominence and passage of structures and geologic lineaments are notably earmarked by the alignment of several structural outliers, as plotted in **Figure 2.1.2-2** to **2.1.2-2d**.

(a) Faults/Geologic Lineaments

Faults/geologic lineaments are linear fractures or fracture zones along which there has occurred displacement of blocks relative to one another and parallel to the fracture. The faults/geologic lineaments are linear features and semi-straight lines marked with scarps. These cliff-hanging scarps characterize the dip-slope displacements. In the area, these scarps appear almost vertical. Sites exhibits extensive erosional activity.

The proposed axis of the bypass road is bisected by two systems of geologic lineaments: the west-northwest (W-NW) system and the north-northeast (N-NE) system.

The west-northwest (W-NW) system appears older. This system of geologic lineament variably strikes between **45 degrees** northwest and due west. Features of displacement variably dip towards the south-southwest between **20** and **35 degrees**. Scarps of this fault system are marked with severe weathering and infillings of soil materials. Brecciation is minor. Sites are densely vegetated; suggestive of water seepages.

The north-northeast (N-NW) system appears younger based on morphological features along Davao River. This system of geologic lineament post-dates the present Davao River contributing to the current avulsion, pulsative shifts and migrations of the river. Features of movements variably strike between **30 degrees** northeast and due north.

These features dip towards northwest-west variably between **20** and **35 degrees**. Associated scarps of this geologic lineament expose poorly weathered bedrocks with minor clay and gaugy infillings. Brecciation is extensive. Sites are poorly vegetated suggesting poor subsurface water availability.

(b) Folds

Folded Tertiary-Quaternary sedimentary rocks and clastics are present in sections of the corridor. Presence of folded structures is highly discernible on several outcrops and exposures of clastic sedimentary rocks. Most observable fold structures are anticlines and synclines in the area between Barangay Waan and Langub which will be crossed by the tunnel corridor.

The anticline exhibits an upward convexity. Associated beds of the underlying Tertiary-Quaternary sedimentary rocks dip away from the axis of the anticline variably between **30** and **40 degrees**. The axis of the anticline in the project site generally elongates and plunges towards the north-northwest with shifting to the west.

Axial morphology of the anticline appear variably eroded, irregularly deranged and deeply and highly dissected by multitude of drainage patterns due to differences in resistance. Severe erosion and rugged relief are manifested on top of the anticline. Towards the dipping limbs and base, deep weathering and thick soil cover are noted. Complex denudational processes exist; suggestive that the area is very unstable subject to active neotectonism and structurally-controlled rejuvenation. No favorable place to find groundwater. Vegetation and agricultural activities appear sparse and selective.

The syncline in the project area is marked by a fold structure of the Tertiary-Quaternary sedimentary rocks, where the strata of the shallow marine sediments dip inward from both sides towards the axis. Dips vary between **20** and **30** degrees. Co-linear to the anticline, the synclinal axis elongates and plunges towards the north-northwest with profound deflection to the northeast.

Basically, reflecting a negative topography, the core of the syncline is highly eroded and dissected by deranged drainage lines. Deep weathering and complex denudational processes are manifested. Water is abundant favorable to all forms of agriculture and industrial plantations.

2) Outliers

This structural morphology of the project site is a characteristic feature of hogback and monoclonal ridges mostly underlain by folded Tertiary sedimentary rocks. Many are isolated asymmetrical elongated ridges/hills with steep slopes and high dendritic drainage pattern. Their sites are characterized by slow denudational processes. Erosions and mass movements are severe.

3) Mass Movement Zones

The by-pass road corridor will traverse an area marked with various mass-movement zones. Several features of these zones prominently cut and pass through the by-pass road. Mass-movement zones are manifold of landslides and movement of earth debris. These movements occur in varying forms, degrees and sizes depending on the set of conditions and circumstances under which they originated. Mass-movements which are manifestations of mass-wasting processes are considered important than fluvial processes in terms of the total geomorphological works performed in eroding the land.

Many of these movements are controlled by the intact strength of the bedrock and influenced by discontinuities cutting through the bedrocks. Based on the present scope of the investigation, the prominence of these discontinuities includes faults, beds, joints, fracturing, etc. The following features of mass-movement zones in the area are: scarpments, creeps, and break-of-slopes.

(a) Scarpments

Scarpments are steep slopes serving as head of the mass-movement zones. These geomorphic features exhibit a cliffy cut with strong concave and arcuate expressions against the general slopes of the landscape. Their presence is characterized by an eroded crown of old/former landslides. Their sites are lines of weakness to trigger major landslides, especially during events of high rainfall and earthquakes.

The sites of the scarpments appear badly eroded by dense dendritic drainage lines, gullies, creeks, rills and tributary heads. At present, these sites are evident of rock and debris falls. In many places these sites are largely evident of bare rocks and veneer of loose debris. No surface water was noted in the area during the investigation. Vegetation cover is very limited.

(b) Failed Slope

Failed slopes are small-scale morphological features which bulge on the ground surface. These bulges prominently exhibit convexity following the general direction of slopes. Heads of these bulges are viewed in this report as surficial manifestation of geological discontinuities.

The prominence of failed slopes in the area appears structurally-controlled cutting through the ground surface. Their occurrence resembles a cascade of small-scale rock failures. Their existence manifests an active rejuvenation of an old land-slip toe. In addition to the rejuvenation of weaknesses along geological discontinuities and the possibility of water pressure build-up in and around their sites may trigger large-scale slope failures.

(c) Creeps

Creeps are slow mass-movement processes often referred to as “creep processes” in the geomorphic literature. They are slow downslope translocations of soil and earth debris which are imperceptible except to long-term measurement. Their sites highly need engineering measures against accelerated movements.

The prominence of creep processes tends to be nearly continuous in actions and widespread to affect notable areas of the proposed by-pass road. Most occur on steeper slopes and deranged morphologies of the project site, where passage of geologic structures and lineaments is profound. The adversities of this passage appear compounded by the dominant associations of friable mixtures of loose soils and non-consolidated surficial materials.

Also, they are noted in areas of the project site where slopes are bare or poorly vegetated and overland flow erosion is limited. Their occurrence in and around these areas appeared to have been accelerated by intense actions of slope-wash, where falling and flowing of rain-water over ground surface trigger notable sediment transport processes. Here, the raindrop impact dislodges soils and surficial materials by scouring and undermining.

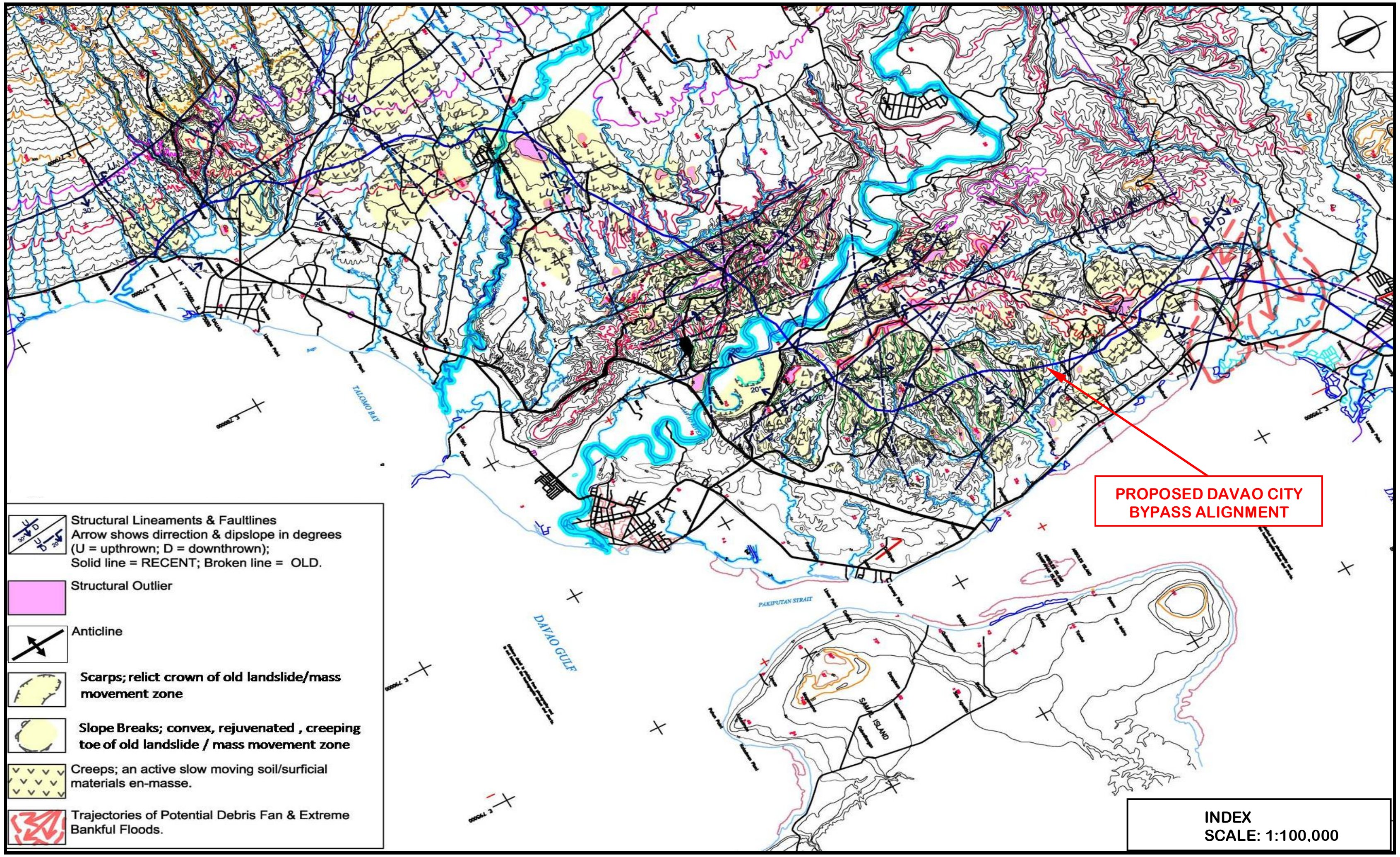


Figure 2.1.2-2a Morphostructural Map along the Proposed Davao City Bypass Alignment

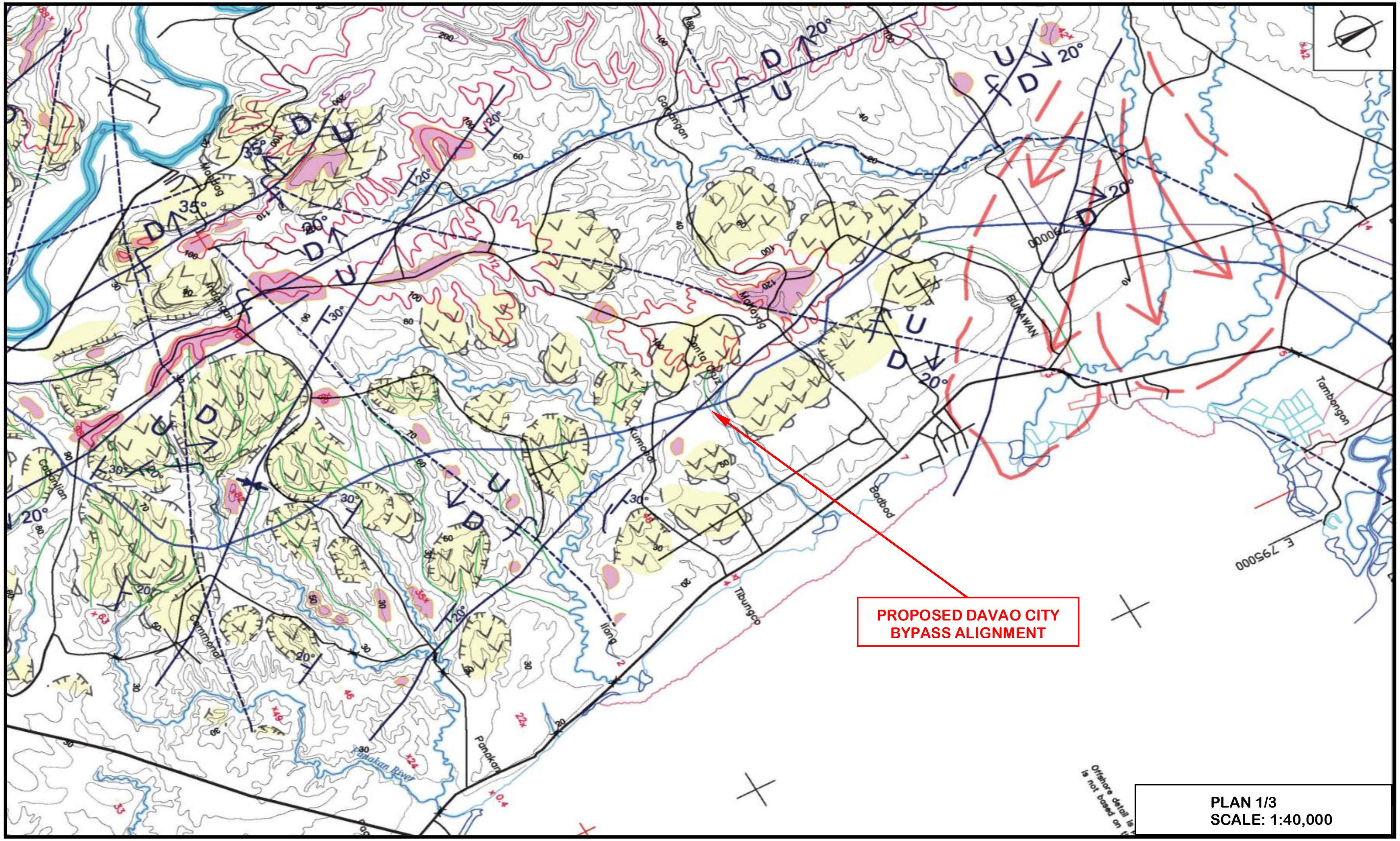


Figure 2.1.2-2b Morphostructural Map along the Proposed Davao City Bypass Alignment

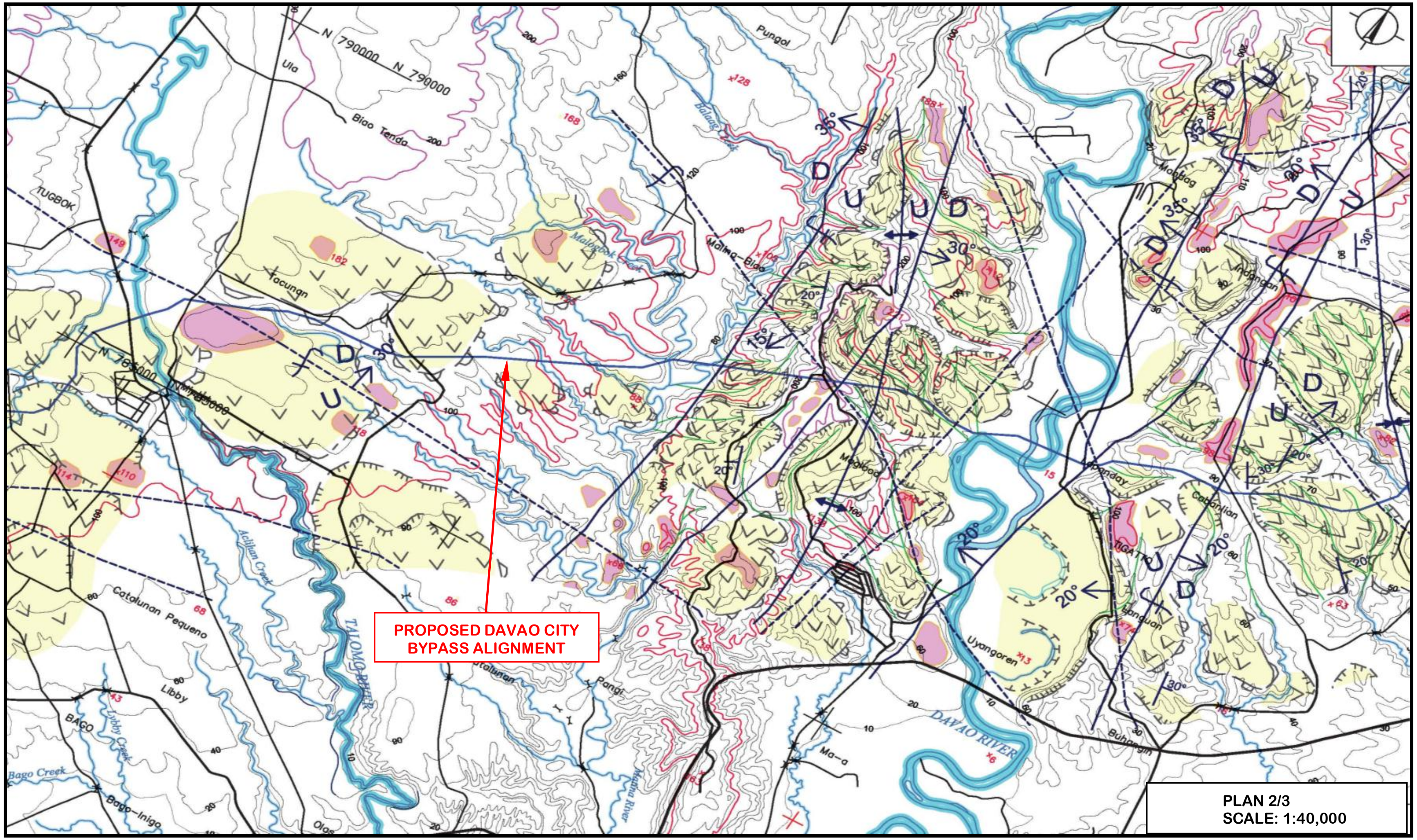


Figure 2.1.2-2c Morphostructural Map along the Proposed Davao City Bypass Alignment

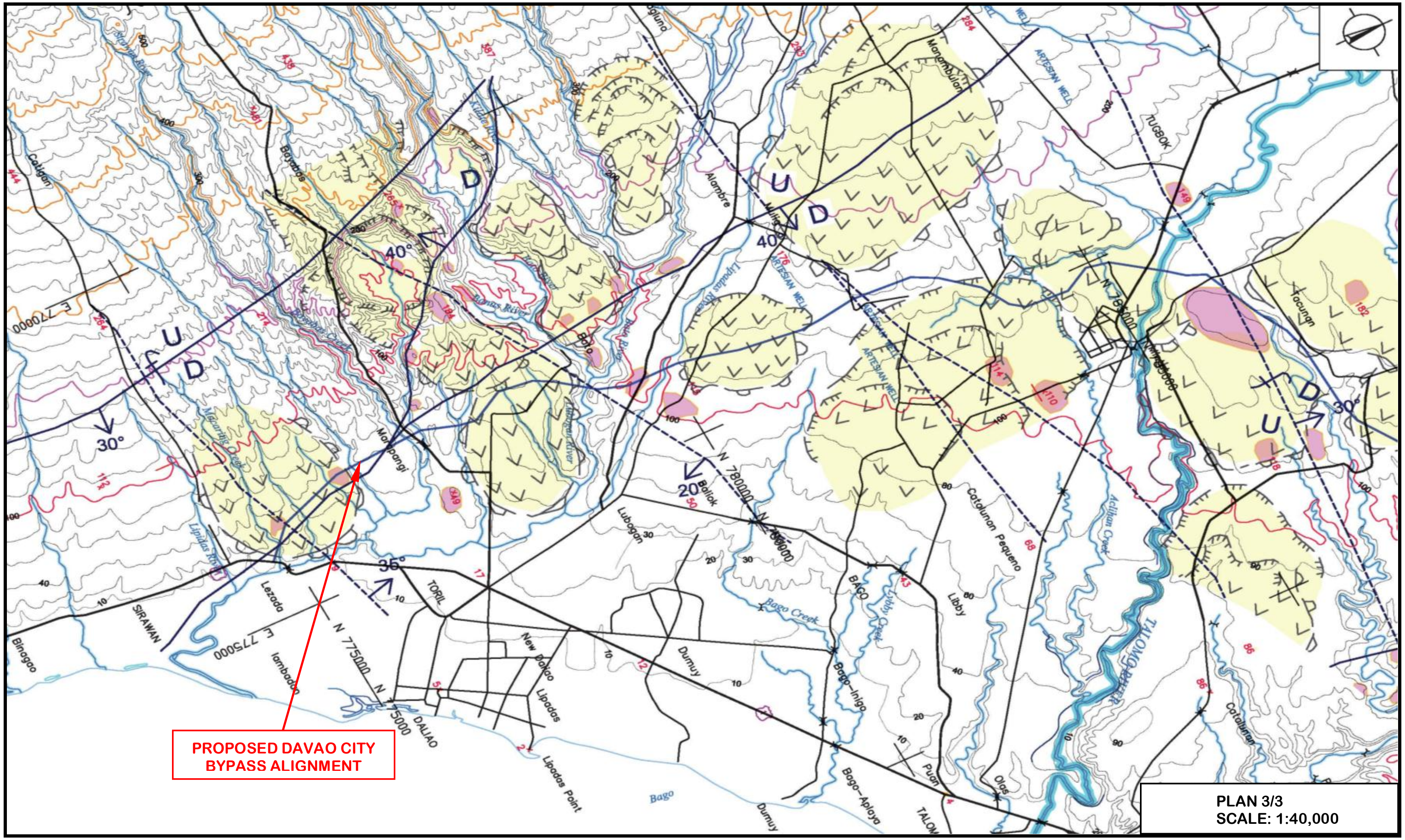


Figure 2.1.2-2d Morphostructural Map along the Proposed Davao City Bypass Alignment

(3) Classifications of Morpho Hazards and High Risk Areas

The general axis of the by-pass road alignment is densely crossed by geologic structures, lineaments and mass-movements. The geomorphic analysis and evaluation of these features together with the terrain classification, rock mass characterizations and the identification of soils/surficial materials allow the delineation of various geomorphic hazards and identification of high risk areas. The prominence of these morpho-hazards and high risk areas shown in **Figures 2.1.2-3a** to **2.1.2-3d** includes: seismic zone, rejuvenated creep zone, volcanic subsidence zone, river flood zone, karstic/cavernous zone, and trajectories of alluvial and debris fans.

1) Seismic Risk Zone

Faults and geologic lineaments are features that may experience slope failure in the event of an earthquake due to ground shaking. Affinity of the bypass road alignment to the geotectonic features requires full geotechnical and engineering attention. In this report, the seismic risk zone is delineated within at least one-kilometer distance from the axis of the fault/geologic lineaments found in the site. This zone is considered seismic risk area if ever they are proven to be associated with active faults. Highest in terms of possible threat are the zone of the intersection of various fault systems.

2) Rejuvenated Creep Zone

Areas where various features of mass movements appear actively rejuvenated by the actions of sheetwash and overland erosions, gullies, rills, denudations, degradations and human activities, are delineated to be rejuvenated creep zone.

Areas within the rejuvenated creep zone may subject to acute danger or susceptibility to landslides and acceleration of creeps into land-slips. This morphological situation effectuates particularly where prominence of sandy and silt-rich surficial materials is highly susceptible to piping. Earth works or any form of excavations may trigger instability of slopes and subsequent hazards in the form of mass movements. The prominence of gullies and sheetwash erosions together with poor soil and vegetation covers within the rejuvenated creep zone indicates accelerated surface mass movements, implying increased water and soil transports.

3) Volcanic Subsidence Zone

Towards the volcanic uplands of Barangay Bato and Marapangi the bypass road corridor crosses a morphologically anomalous volcanic landscape. This volcanic landscape is marked by the prominence of a ring-like structure (e.g. collapsed caldera). Located at the toe of Mt. Talomo, this morphological expression manifests a collapsed feature of volcanic paleo-channel which was possibly formed during the eruptions of Mt. Talomo. Potentiality of volcanic subsidence appears to be a major concern in and around this zone since the sub-soils are essentially made-up of very loose and non-consolidated volcaniclastics and lahars. This morphological situation together with the abundance of friable mixtures of sands and silt-rich sub-soil materials provides a potential for piping.

4) Karstic Area

This area is chiefly underlain by cavity rich Quaternary limestones. Bedrocks are deeply weathered, porous and fractured. The widespread prominence of solution cavities together with loose cavernous, calcareous and highly fossiliferous sediments makes this karstic rock mass highly unfavorable to construction of by-pass road. The construction and conduct of any forms of civil works in these rock masses require very stringent geotechnical measures and engineering attention for possible presence of cavities and sink holes.

5) River Flood Zones

The present waterlines of the Davao River and its fluvial zone are remainder of multitude flooding events and processes. Viewed from the markings along river terraces, bank-full tops and floodplains, the flood zones along the Davao River are categorized into two (2), namely: low water flood zones and high water flood zones.

(a) Lower Flood Zones

The lower flood zones are demarcated by flood marks intimately associated with the fluvial platforms and river-banks of lower river terraces. Highest flood marks are prominent between elevations **5** and **15 meters** above sea level. These flood zones are marked with coarser fluviatiles and cobble-dominated river sediments; suggestive of high-energy flooding. Common features of instability include: bank collapse, bend undercuts, bed scours, meander avulsion, etc. Their sites have poor soil cover and not favorable to long-term agriculture and habitation.

(b) Higher Flood Zones

The higher flood zones of the Davao River intimately associate with present morphologies of the upper river terraces. The higher flood zones are demarcated by highest flood marks intimately associated with the fluvial platforms and river-banks of higher terraces. Highest flood marks are prominent between elevations **20** and **30 meters** above sea level. These flood zones are marked with relatively finer fluviatiles and sand-dominated river sediments; suggestive of flashy and low-energy flooding. Common features of instability include: overbank erosion, levee scouring, chutes, splays heaving, meander benching, side-bar formations, etc. Their sites have good soil cover and highly favorable to long-term agriculture. Long-term habitation on these areas is discouraged.

6) Trajectories of Alluvial and Debris Fan

The upstream of Talomo and Bunawan Rivers characterize a highly constricted river environments. The present process of fluvial sedimentations and erosions in these areas configure a high possibility of rejuvenating association of alluvial and debris fans. The trajectories of these fans are expected to affect several sections of the proposed by-pass road particularly from Brgy. San Isidro and Bunawan and from Brgy. Tugbok and Mintal. The occurrence of these extreme events is expected during events of extreme rainfall, bankfull floods and earthquakes.

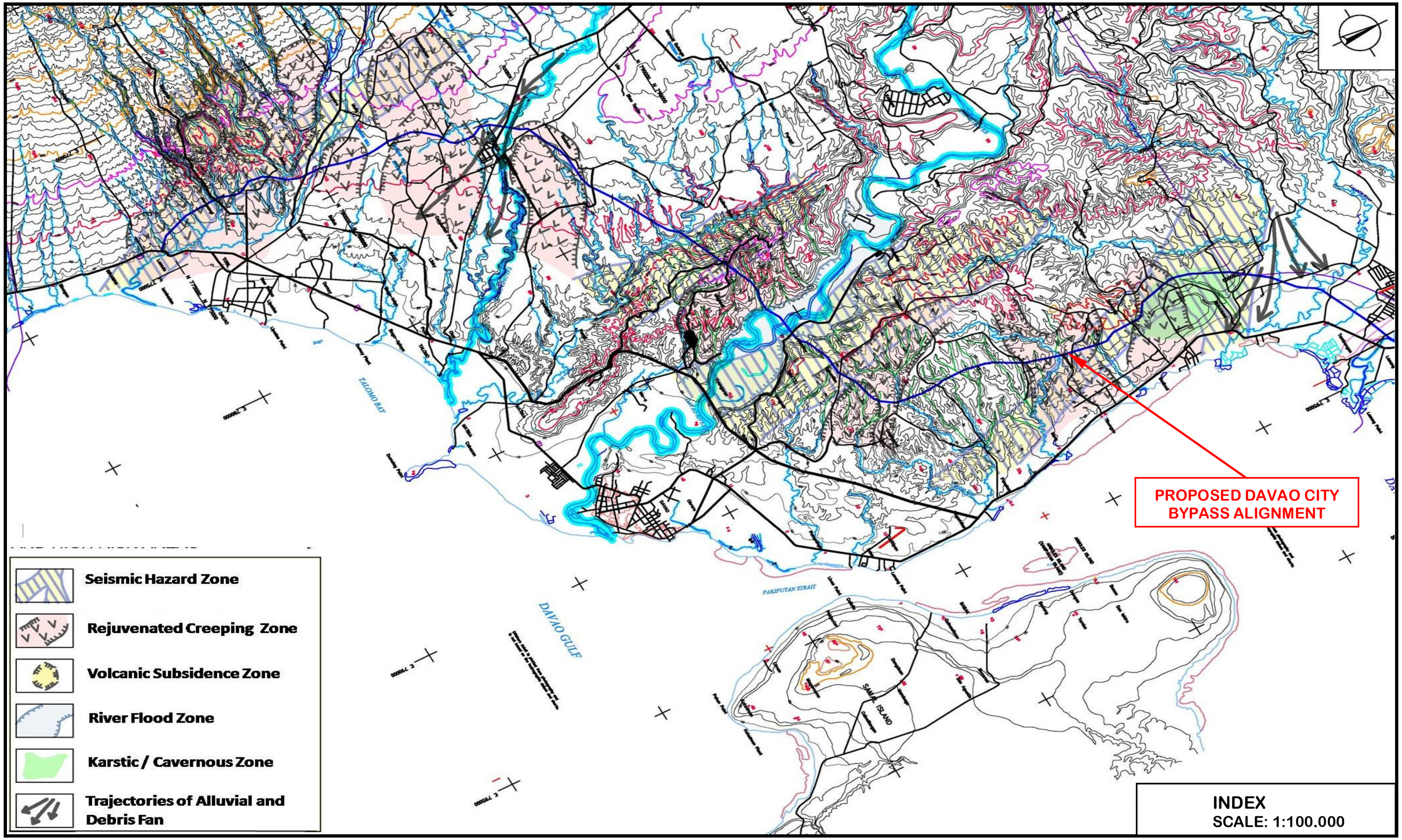


Figure 2.1.2-3a Geomorphic Hazard Map along the Proposed Davao City Bypass Alignment

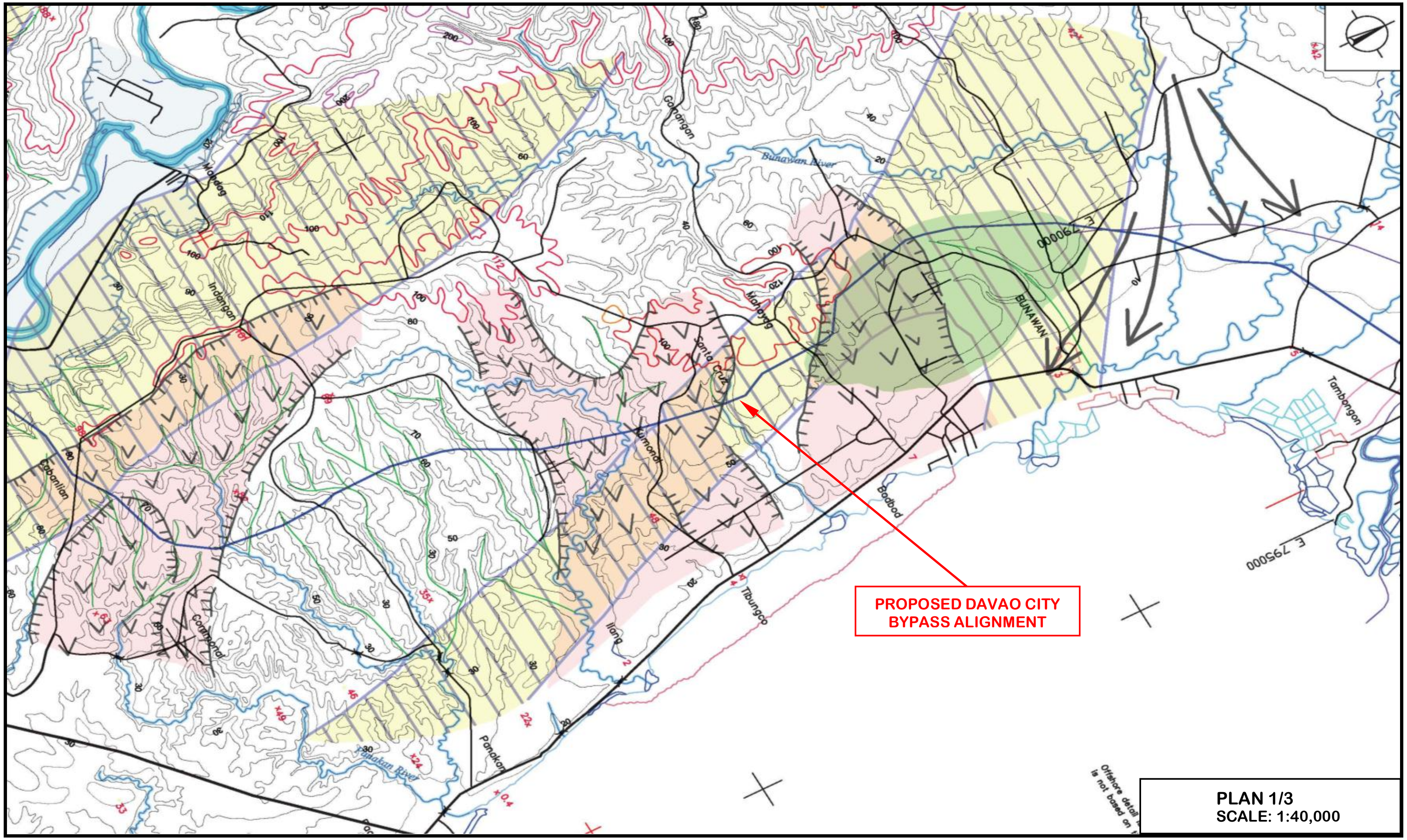


Figure 2.1.2-3b Geomorphic Hazard Map along the Proposed Davao City Bypass Alignment

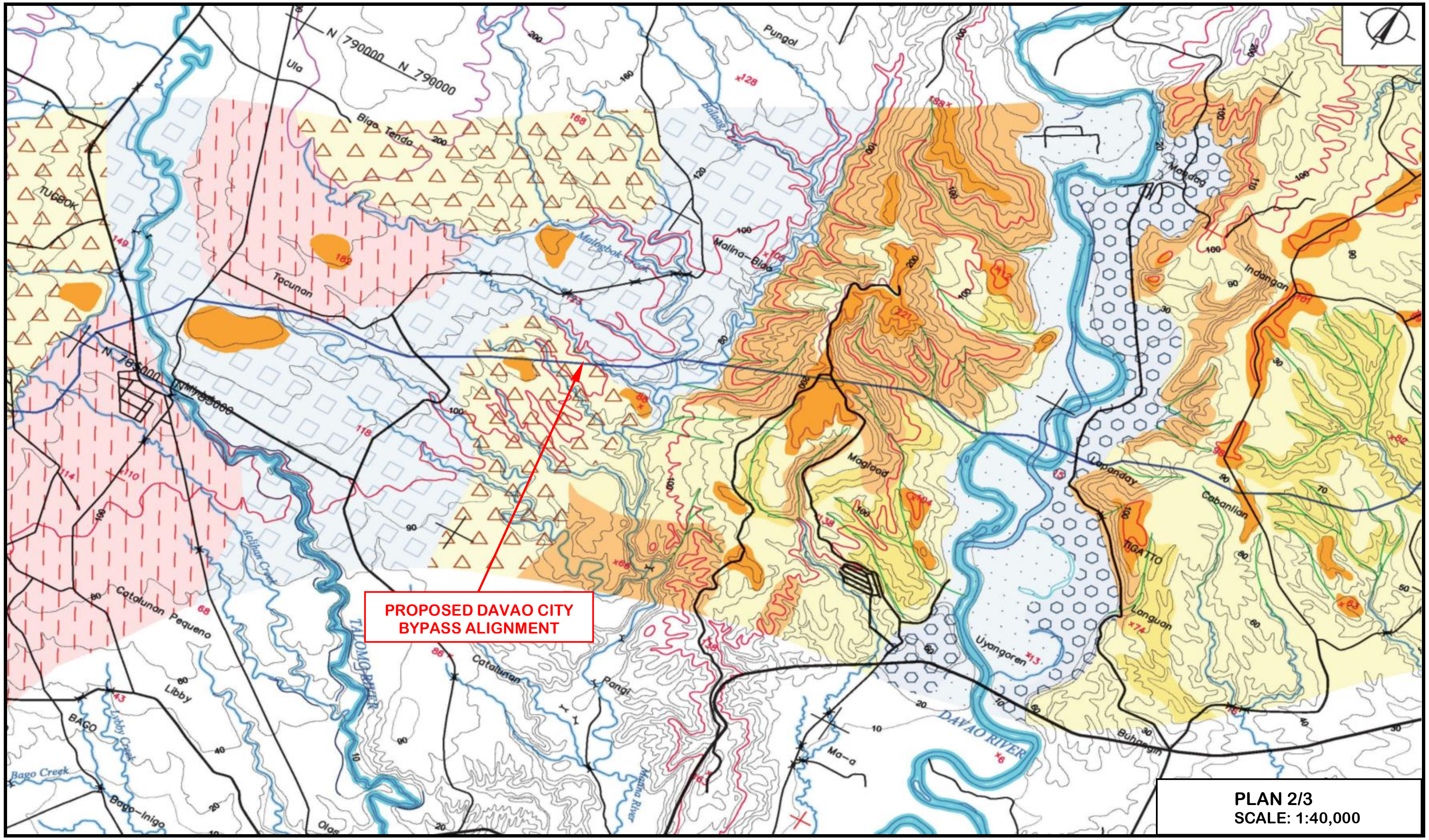


Figure 2.1.2-3c Geomorphic Hazard Map along the Proposed Davao City Bypass Alignment

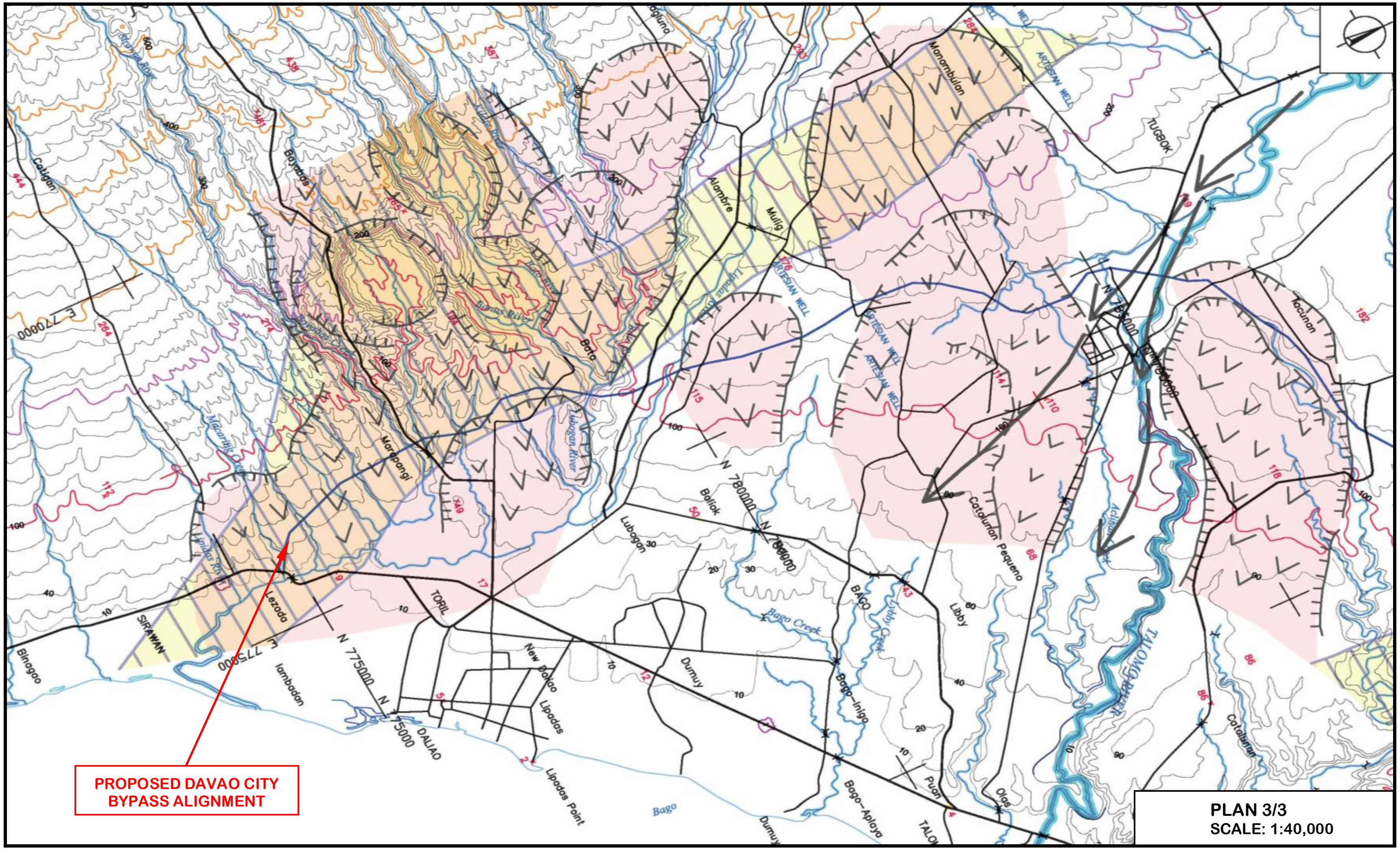


Figure 2.1.2-3d Geomorphic Hazard Map along the Proposed Davao City Bypass Alignment

2.1.2.2 Morpho Structures and Geohazards Characterization along the Tunnel Corridor

Present at the side slopes of the hill cut by the tunnel corridor are numerous features of ground instabilities. These features may trigger problems, thus have to be given due attention in the engineering design and construction of the bypass tunnel section. Below are geomorphic features of ground instabilities based on site observations.

(1) Structural Lineaments

The general landscape in the axis of the bypass tunnel corridor are cut and crisscrossed by several geologic structures and lineaments. Most prominent are faults and anticlines. In many places, the prominence and passage of structures and lineaments are notably earmarked by the alignment of several structural outliers, as plotted in **Figure 2.1.2-4**.

1) Faults

Faults are fractures or fracture zones along which there has occurred displacement of the slides relative to one another and parallel to the fracture, faults are linear features and semi-straight lines marked with scarps. These cliff-forming scarps manifest dip-slope displacements. In many places, these scarps appear almost vertical. Site exhibits extensive erosional activity.

The project site shows evidence of two fault systems: the west-northwest (W-NW) fault system and the north-northeast (N-NE) fault system.

The west-northwest (W-NW) fault system appears older. This fault system variably strikes between **45 degrees** northwest and due west. Fault features variably dip towards the south-southwest between **20** and **35 degrees**. Scarps of this fault system are marked with severe weathering and infillings of soil materials. Brecciation is minor. Sites are densely vegetated; suggestive of water seepages.

The north-northeast (N-NW) fault system appears younger and "Recent”. This fault system post-dates the present Davao River contributing to the current avulsion, pulsative shifts and migrations of the river. Faults variably strike between **30 degrees** northeast and due north. Dips towards northwest-west vary between **20** and **35 degrees**. Associated scarps of this fault system are poorly weathered with minor clay and gaugy infillings. Brecciation is extensive and poorly vegetated.

2) Anticline

The hill cut by the tunnel corridor was formed by folded Tertiary sedimentary rocks and clastics. Presence of folded structures is highly discernible on several outcrops and exposures of bedrocks. Most observable fold structure is anticline, which prominently crosses the axis of the tunnel corridor.

The anticline exhibits an upward convexity. Associated beds of the underlying Tertiary sedimentary rocks dip away from the axis of the anticline variably between **30** and **40 degrees**. The axis of the anticline generally elongates and plunges towards the north-northwest with profound swerving to the west.

Axial morphology of the anticline appear variably eroded, irregularly deranged and deeply and highly dissected by multitude of drainage patterns due to differences in resistance. Severe erosion and rugged relief are manifested on top of the anticline. Towards the dipping limbs and base, deep weathering and thick soil cover are noted.

Complex denudational processes exist; suggestive that the area is very unstable and subject to active neotectonism and structurally-controlled rejuvenation. No favorable place to find groundwater. Vegetation and agricultural activities appear sparse and selective.

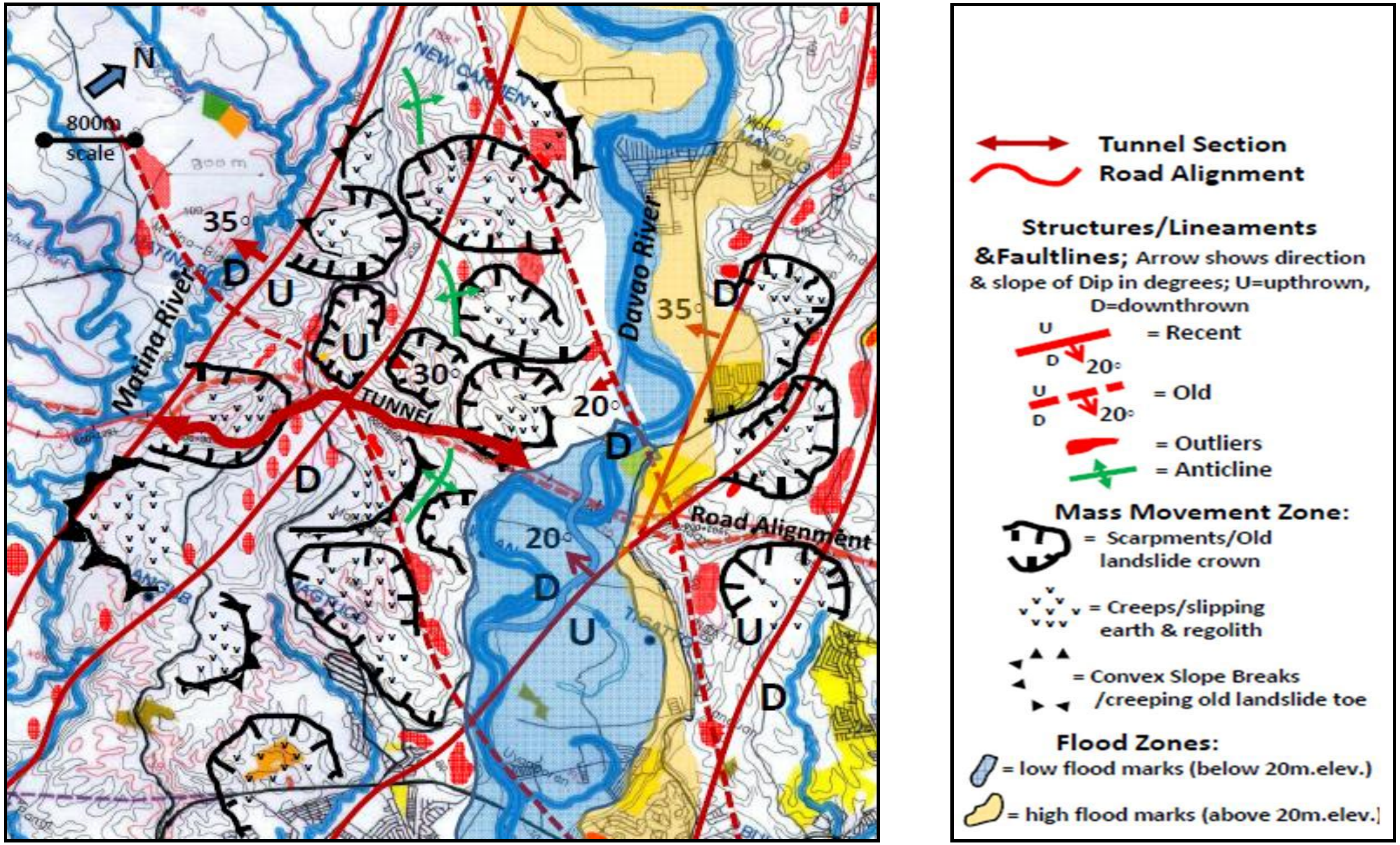


Figure 2.1.2-4 Morphostructural Hazard along the Tunnel Corridor

3) Mass Movement Zones

The side slope of the hill cut by the axis of the tunnel corridor have scars from a number of mass-movement. Mass-movement zones are manifested by landslides and movement of earth debris. These movements occur in varying forms, degrees and sizes depending on the set of conditions and circumstances under which they originated. Mass-movements which are manifestations of mass-wasting processes are considered important that fluvial processes in terms of the total geomorphological works performed in eroding the land.

Many of these movements are controlled by the intact strength of the bedrock and by the characteristics of the discontinuities cutting through the bedrocks. Based on the present scope of the investigation, the prominence of these discontinuities includes faults, beds, joints, fracturing, etc. The following features of mass-movement zones appear very profound, namely: scarpments, creeps and break-of-slopes.

(a) Scarpments

Also a common feature in the side slope of the hill cut by the tunnel corridor at the head of the mass-movement zones. They have sharp cut with concave and arcuate feature with an eroded crown of old/former landslides. They are good indicator of possible slide zones.

Shown in **Figures 2.1.2-5** and **2.1.2-6** are details of slope features in the western and eastern side of the tunnel corridor.

(b) Break-of-Slopes

Break-of-slopes are small-scale morphological features on the ground surface. They prominently exhibit convexity following the general direction of slopes. They are viewed in this report as manifestation of geological discontinuities.

The prominence of break-of-slopes appears structurally-controlled cutting through the ground surface. Their occurrence resembles small-scale rock failures. Their existence manifests an active rejuvenation of an old land-slip toe. In addition to the geometry of the discontinuity pattern, strength along the discontinuities and the possibility of water pressures within them may trigger large-scale slope failures.

(c) Creeps

Occurrence of creeps were also noted on the hill cut by the tunnel corridor with the same characteristics as those on the slopes near the road corridor.

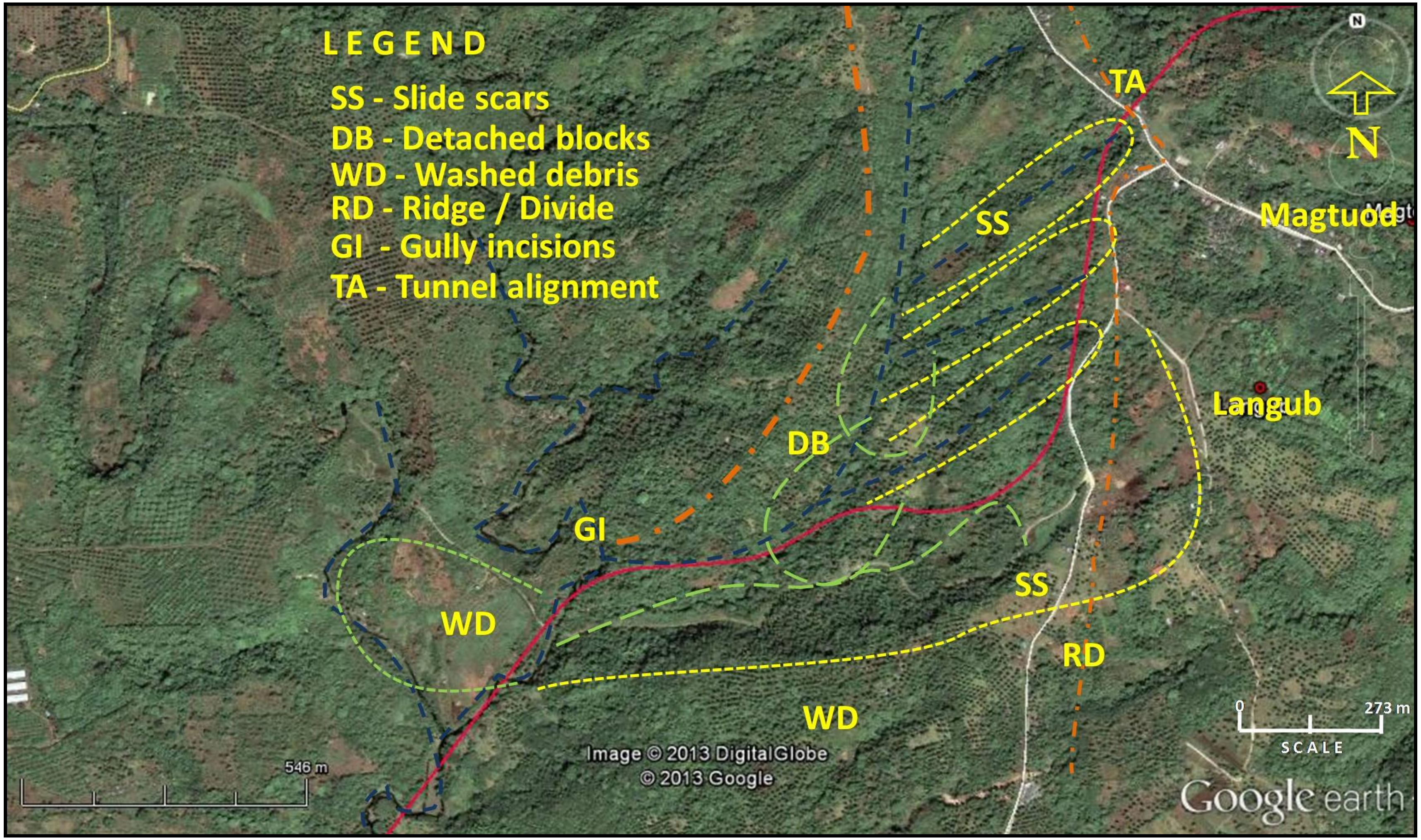


Figure 2.1.2-5 Slide Features on the Western Slopes along the Tunnel Corridor (*Base map from Google Earth*)

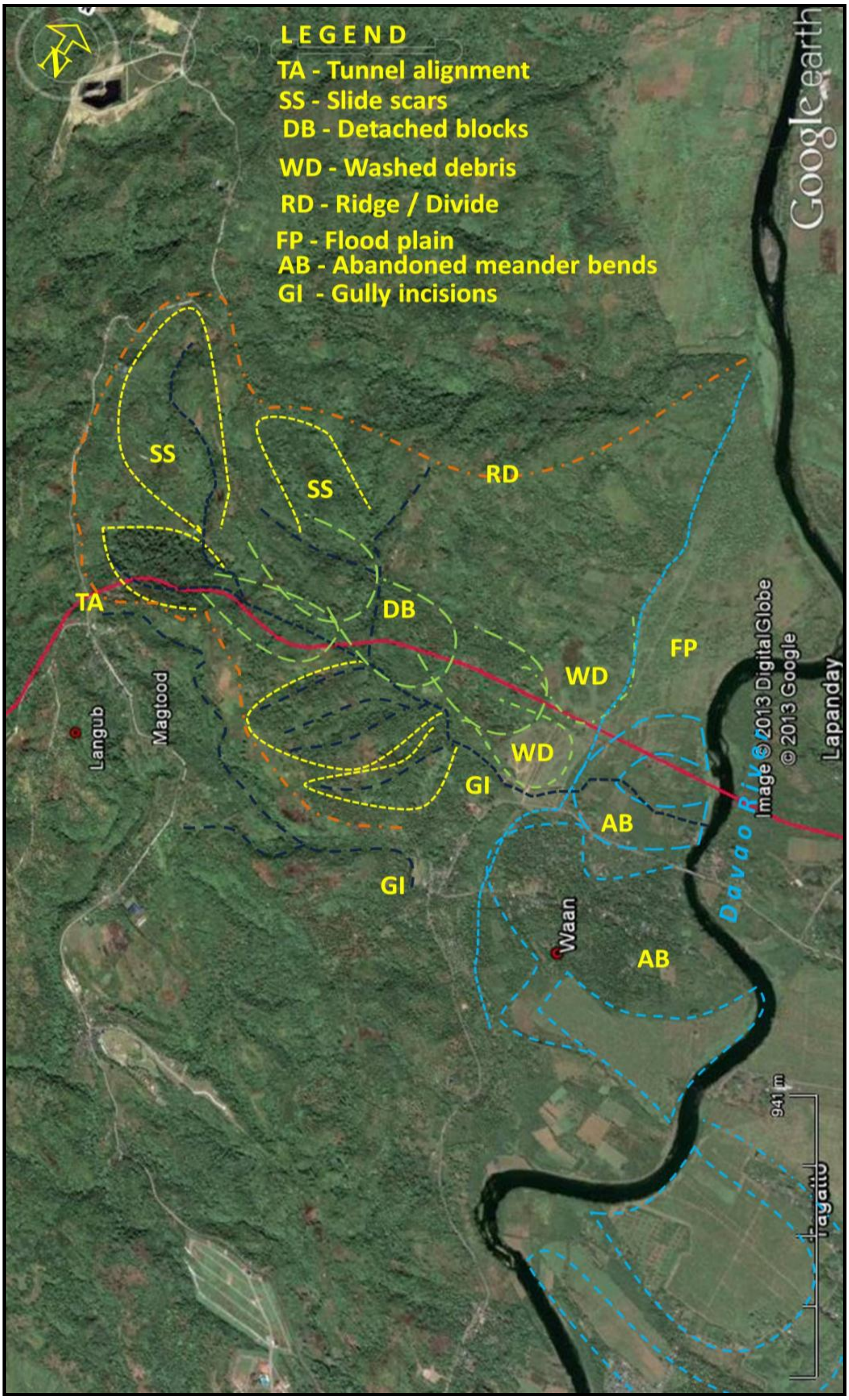


Figure 2.1.2-6 Slide Features on the Western Slopes along the Tunnel Corridor (*Base map from Google Earth*)

2.1.2.3 Geologic Framework

Based on the mapping of the Mines and Geosciences Bureau (MGB) Region XI shown in **Figures 2.1.2-7a** to **2.1.2-7d**, the rock types present along the bypass road corridor and its immediate vicinity from youngest to oldest are as follows:

(1) Quaternary Alluvium

Recently deposited loose, unconsolidated sand and gravel that blankets the river beds and coastal areas. These rivers includes Davao, Talomo and Matina Rivers.

(2) Tigatto Terrace Gravel

Dated Holocene, poorly stratified, poorly compacted layers of gravel and sand with thickness varying from **0.5** to **2.5 meters**. The gravel is rounded and equidimentional with size ranging from very fine to very course, with much boulder with diameters of up to **20 cm**. The gravel and boulders are andesitic and basaltic in composition most likely ejected from the eruptions of Mt. Apo and Mt. Talomo, the prominent volcanic peaks west of Davao City. The gravel and boulders are held by very coarse sand matrix which are sub-rounded to rounded, moderately well sorted and mainly of lithic fragments.

The sand layers are poorly compacted and consolidated, moderately sorted, fine to very coarse, sub-rounded to rounded grains. The sand is layered with thickness of **10** to **20 cm**, separated by sharp to defused borders. It is very gravelly with fine to medium, subrounded to rounded, equidimentional gravel of volcanic composition.

Photo No. 2.1.2-1 Photo showing outcrop of Tigatto Terrace Gravel

(3) Bunawan Limestone

Dated Late Pleistocene, the Bunawan Limestone are raised coralline limestone and coral breccias found in Matina Hill and Brgy. Bunawan. The limestone is porous, cream colored and probably unconformably overlay the Pleistocene Mandog Sandstone. Thickness ranges from **70** to **80 meters**.

Bunawan Limestone is the equivalent of Samal Limestone in the published geologic map of the MGB.

Photo No. 2.1.2-2 Photo showing outcrop of Bunawan Limestone

(4) Apo Volcanic Complex

The emplacement of the Apo Volcanic Complex started in the Pleistocene and composed of basalt, andesite, pyroclastic rocks. It is made up of volcanic flows and pyroclastic rocks, chiefly agglomerates and tuffs underlying the broad slopes of Apo, Boribing, Talomo and Sibulan Mountains. Mt. Apo consists of basaltic flows cut and overlain by more recent andesites. The agglomerates consist chiefly of angular fragments of basaltic andesite and pyroxene andesite cemented by a very course tuffaceous matrix. Beds of ash tuff are horizontal to moderately dipping. Flows of andesite porphyry are also present.

Based on geomorphic features, Mt. Talomo appears to be relatively older than Mt. Apo., having a more dissected and eroded terrain.

1) Apo Volcanics

Dominantly intercalated pyroclastics/volcaniclastics with lenses of volcanic flows generally occupy the broad volcanic footslopes. Repetitive eruption episodes cause deposition of ejectas that caused the spread of the footslopes.

(b) Talomo Volcanics

Talomo volcanics, made up of andesitic to basaltic volcanic flows with intercalated pyroclastics / volcaniclastics, are generally confined along the upper volcanic cone down to upper volcanic footslopes.

Photo No. 2.1.2-3 Outcrop of pyroclastic flow in Apo Volcanic Complex

<u>(5) Mandog Sandstone</u>

Dated Early Pleistocene to Late Pleistocene *Quebral* (*1994*), is composed of sandstone, shale, conglomerate that unconformably overlies the Masuhi Formation. It is exposed in Lasang and Davao Rivers with Mandog, Davao City as type locality.

The Mandog sandstone is folded and consist of poorly consolidated, thin sequence of interbedded sandstone and shale with conglomeratic portions. The latter are cross bedded, poorly sorted and polymictic, having igneous, sedimentary and metamorphic clasts. Thickness is **600** to **800 meters** (*Casasola 1956*).

The presence of nannofossil and numerous megafossils, (e.g. pelecypods and gastropods) in fine sediments and the presence of limestone, indicate sedimentation within a shallow marine environment.

Photo No. 2.1.2-4 Outcrop of sand gravel in Mandog Formation

(6) Masuhi Formation

Dated Late Miocene to Early Pliocene, the Masuhi Formation is composed of sandstone, shale, and conglomerate. The Masuhi Formation acts as the basement deposit on the area surrounding the location of the tunnel corridor; unconformably overlain by the Mandog Sandstone.

The formation outcrops along the western flank of the Davao Basin as well as within some of the basin's folds. It is composed of interbedded sandstones and shales with polymictic conglomerate beds along the western flank of the basin. In Mawad, the formation shows rhythmically interbedded sandstones and black shales with lenses of limestone bearing conglomerate, marls and coral breccia. This marine sequence was dated as Late Miocene-Pliocene. Thickness range from **200-250 m**.

Photo No. 2.1.2-5 Outcrop of mudstone in Masuhi Formation

Table 2.1.2-1 The Stratigraphic Sequence of the Rock Types Found along the Bypass Road Corridor and Surrounding Area

Formation	Description	Geologic Age
Alluvium	Loose, unconsolidated gravel, sand and clay deposits	Recent
Tigatto Terrace Gravel	Loosely stratified gravel and sand deposits	Holocene
Bunawan Limestone	Coralline limestone	Holocene
Apo Volcanic Complex		
Apo Volcanics	Intercalated pyroclastics / volcaniclastics with lenses of volcanic flows	Pleistocene
Talomo Volcanics	Volcanic flows with intercalated pyroclastics, tuff & volcaniclastics	Pleistocene
Apo-Talomo Cones	Andesitic to dacitic volcanic flows	Pleistocene
Mandog Formation	Interbedded well consolidated sandstone and shale with minor conglomerate	Early to Late Pleistocene
Masuhi Formation	Interbedded sandstone and shale with lenses of conglomerate	Late Miocene to Early Pliocene

Source: Modified from Mines and Geo-Sciences Bureau

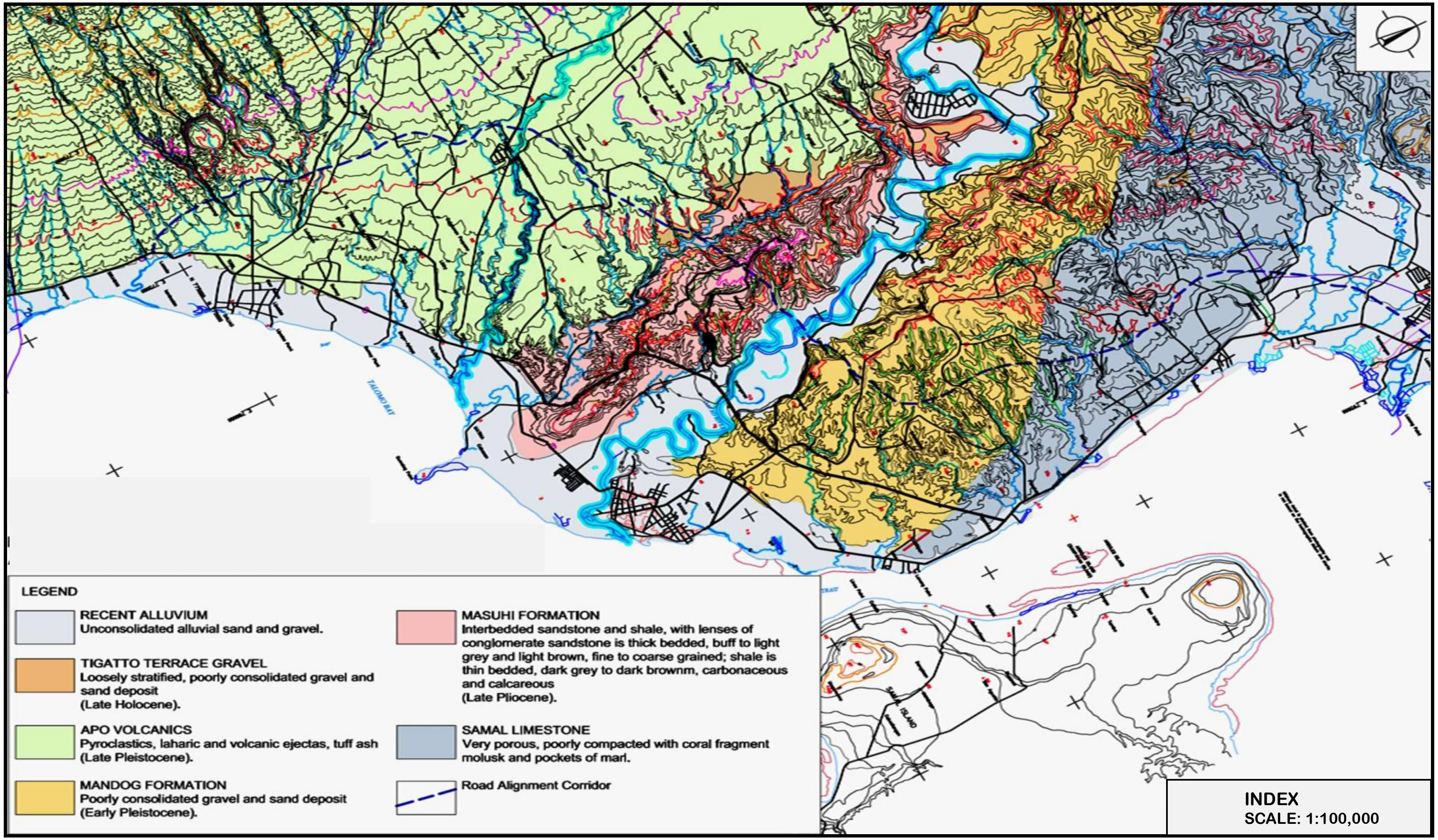


Figure 2.1.2-7a Distribution of Various Rock Types along the Proposed Davao City Bypass Road Corridor

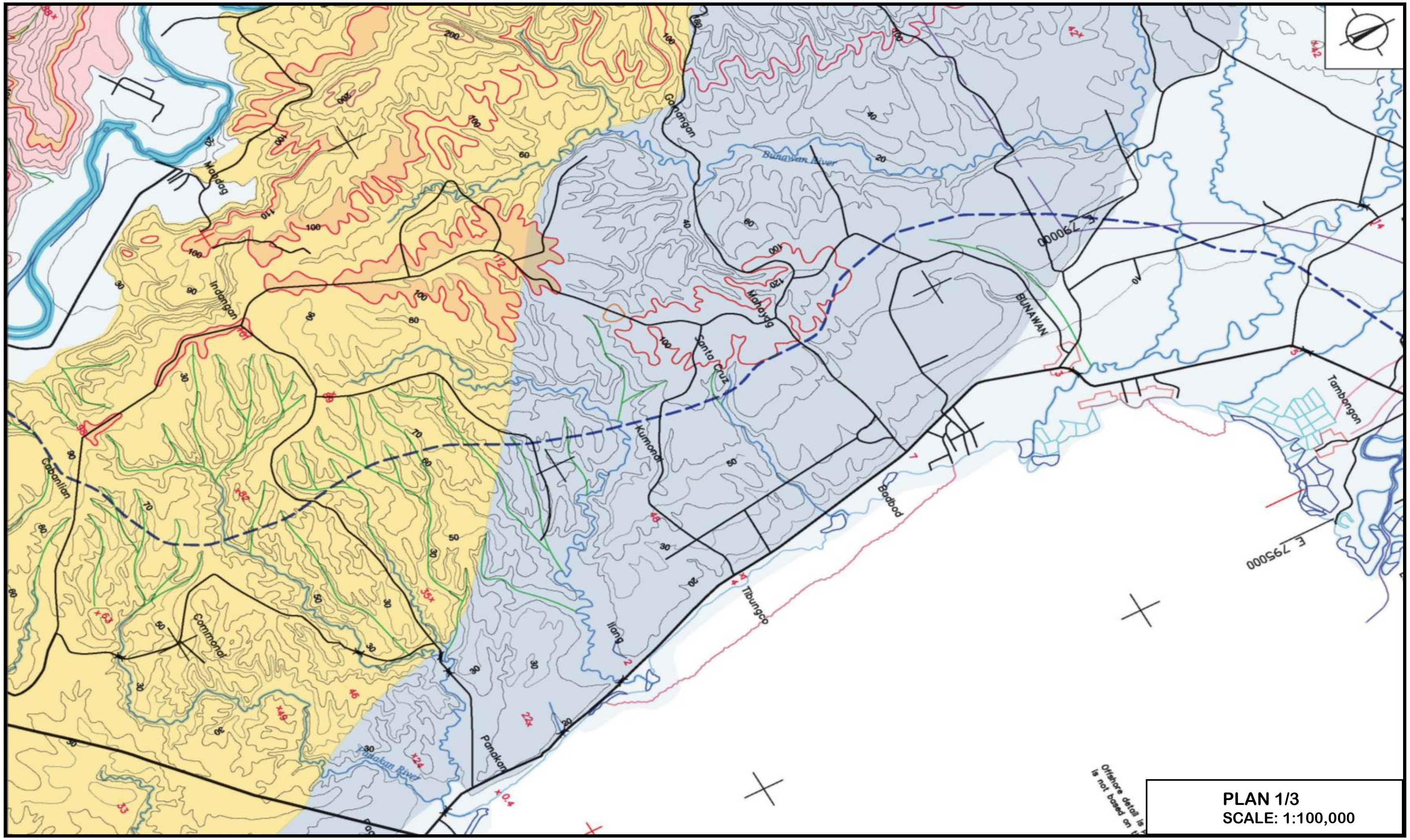


Figure 2.1.2-7b Distribution of Various Rock Types along the Proposed Davao City Bypass Road Corridor

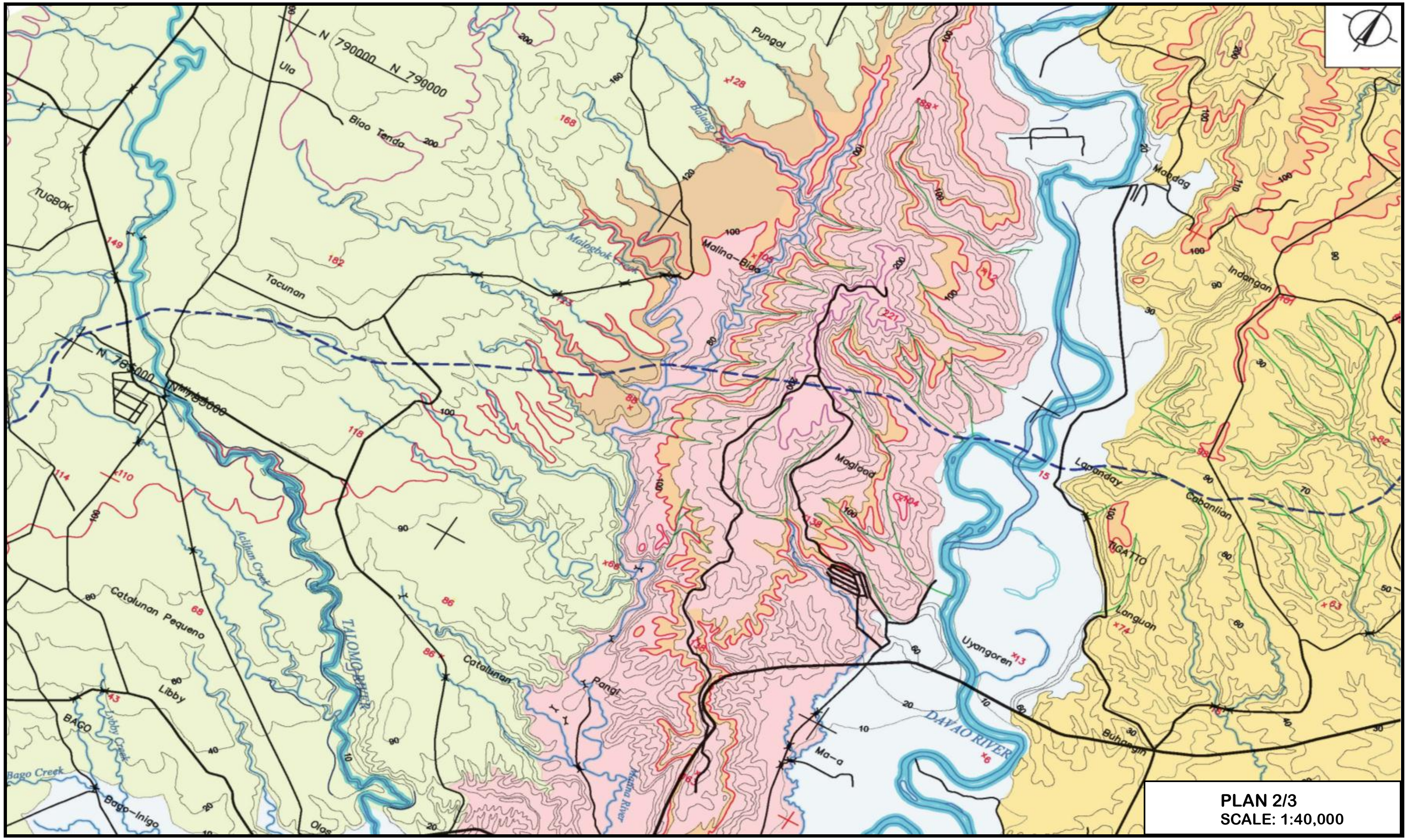


Figure 2.1.2-7c Distribution of Various Rock Types along the Proposed Davao City Bypass Road Corridor

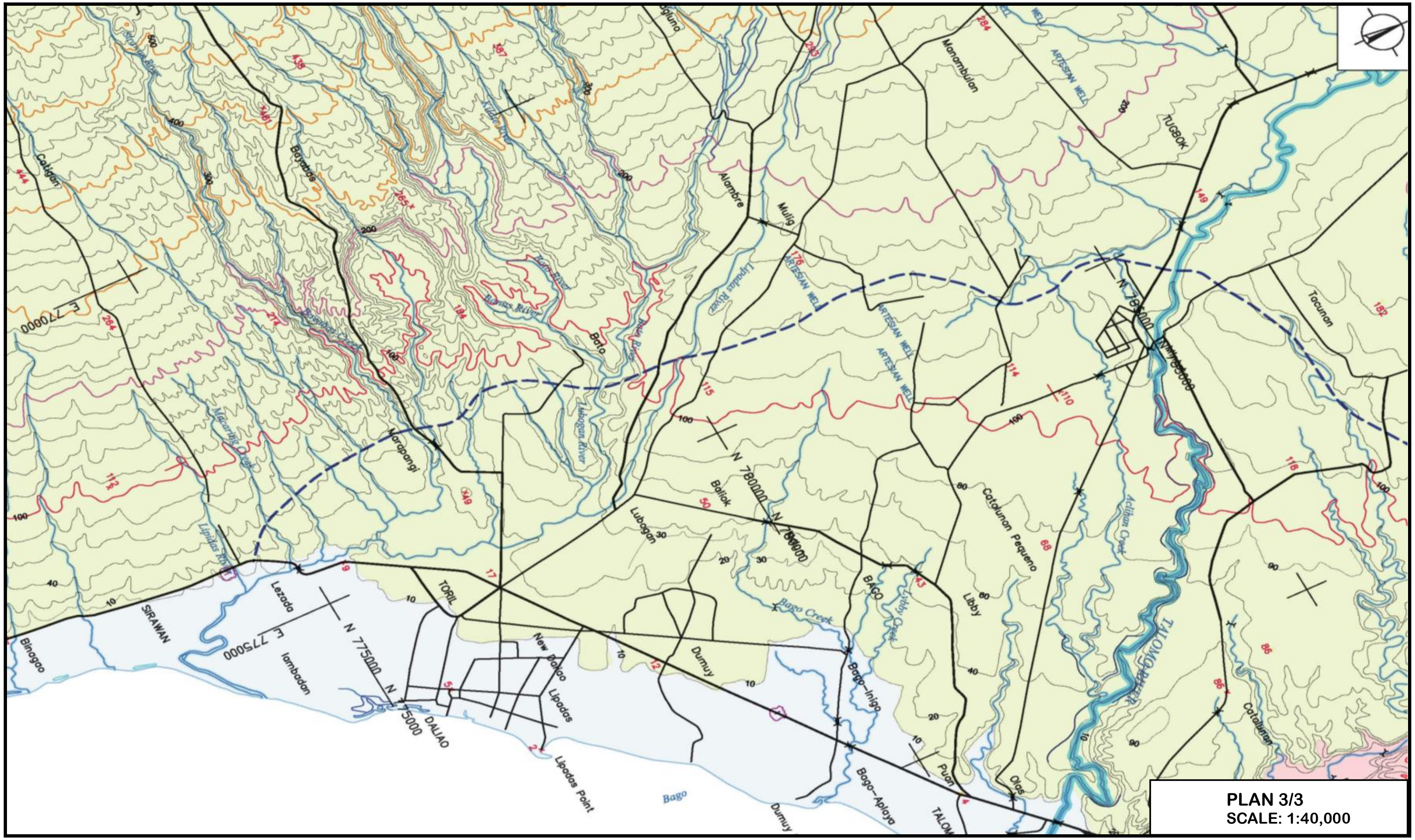


Figure 2.1.2-7d Distribution of Various Rock Types along the Proposed Davao City Bypass Road Corridor

2.1.2.4 Tectonics

The prominence of lineaments (rock discontinuities such as joints, fractures, beddings, faults) in the images covering the by-pass road corridor are related to the regional tectonic setting. In terms of tectonics, the Neogene-Quaternary evolution of the Philippine archipelago may be explained in terms of the docking of the Philippine arc with the Eurasian margin. This docking is diachronous[2.] As defined by a regional unconformity, it is dated as Middle Miocene in northern Luzon (*Maleterre, Pinet, Ringenbach*), Late Miocene in central Philippines (*Aurelio, 1992*) and Plio-Quaternary in northeastern Mindanao (*Quebral, 1994*).

The docking was followed by the generation of the Philippine Trench - Philippine Fault system which is likewise propagating southwards. Deformation related to the docking and the Philippine Fault are superposed in the Davao area.

The proposed bypass corridor is located at the southern end of the Agusan-Davao Basin, a **350 km** north-south trending elongated basin between the Pacific Cordillera and the Central Mindanao Cordillera with Butuan Bay at the northern end. The basin is filled with about **6 km** of Eocene to Holocene sediments overlying a basement complex (*Ranneft et at 1960; Cardwell et al, 1980*).

In Mindanao, the Central Cordillera, Agusan-Davo Basin and Pacific Cordillera (Diwata) are part of the Philippine arc. Arc polarity is notably to the west. The Central Cordillera is thrust westwards over the Lanao-Bukidnon Highlands. The Pacific Cordillera is thrust westwards over the Agusan Davao Basin. The basin is asymmetical with a deeper depocenter located to the east.

Part of Eurasia are the Saranggani Ridge, Davao Gulf and Pujada Peninsula which respectively correspond to the volcanic arc, forearc basin and forearc of the Saranggani arc. Arc polarity is notably to the east. Saranggani Ridge is convex to the east and is being thrust eastwards over the gulf. Thrust faults with Davao Gulf and Pujada are all east-verging. The thrusting of the different arcs in the area commonly results to the tilting of the different rock layers which are exposed the bedding of sediment rocks, jointing or fracturing and reflect as extensive linear features in the images.

[2] means same rock type or formation laid at different geologic times

(1) Geo-Structural Framework

Davao City as a whole where the proposed bypass road project is located is within a region that is tectonically, seismically and volcanically active. There are several active faults in the region as mapped by PHIVOLCS (See **Figure 2.1.2-8**). By definition, an active fault is one that has moved during the last **10,000 years**.

There are several criteria used in the determination of an active fault. These are: 1) geological (e.g. young morphology, cutting of Quaternary deposits, cutting of man-made structures), 2) historical (e.g. historical accounts of Spanish friars and explorers, folklore), and 3) seismological (i.e. instrumental data).

The active or potentially active faults within a **100 kilometer** radius of the proposed project site are as follows:

1) Philippine Fault

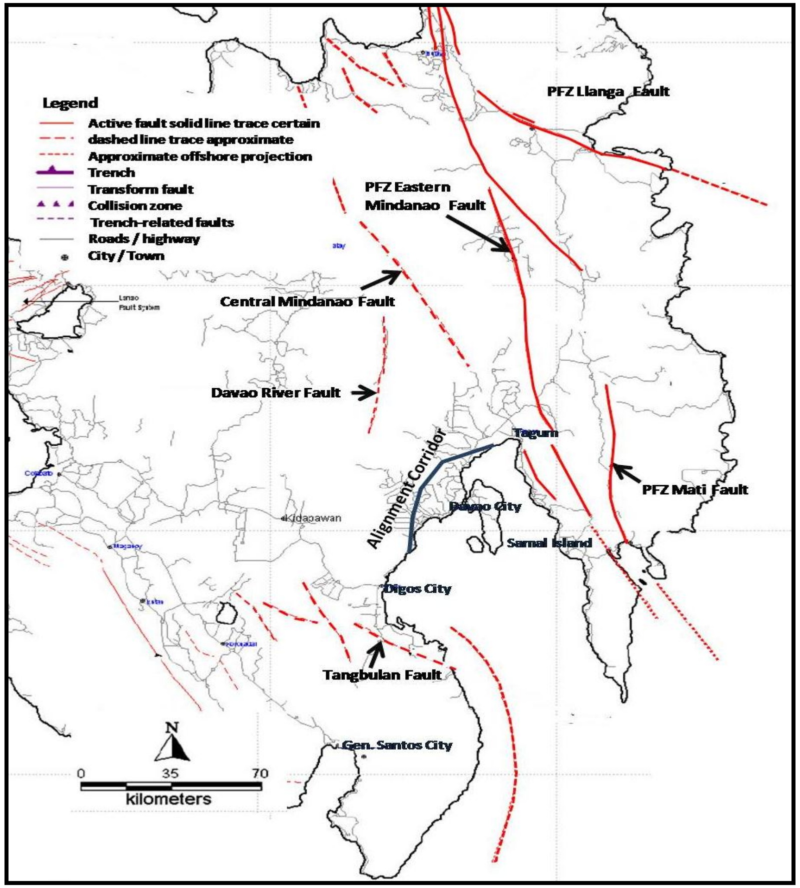
The Philippine Fault is an active left lateral strike slip fault that cuts across the entire length of the Philippine archipelago over a distance of 1**,200 kilometers**. The southern segment of the Philippine Fault cuts across eastern Mindanao. From the Surigao Peninsula - where the fault is characterized by the highly linear and narrow Tubay Valley, Malimono Ridge, Lake Mainit and Maniayao Volcano – the fault traverses across the Agusan - Davao Basin. It then enters Hijo River and cuts across the Pacific Cordillera where it exits near Mati.

Historical, seismological and geological evidence show that the Surigao, Agusan and Mati portions of the fault are active. Surigao Peninsula was even the site of a catastrophic earthquake at the start of the century. The Davao portion is less active seismically although geologic evidence shows that the portion is definitely active.

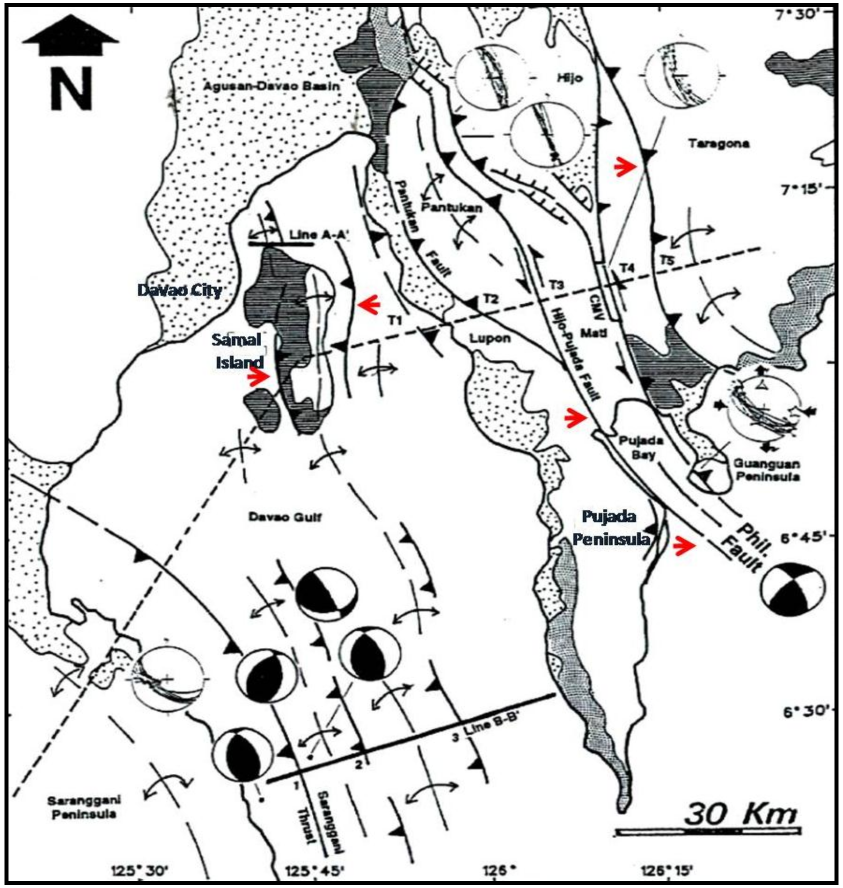
The Davao portion of the fault is therefore associated with a seismic gap where stress is building up and is not being released. Despite its low level of seismic activity, the risk of a major earthquake occurring is actually higher.

Studies done by Quebral (*1994*) revealed the Philippine fault in the southeastern Mindanao have numerous splays (refer to **Figure 2.1.2-8**) not reflected in the PHIVOLCS map. At the southeast end of Mindanao, the fault forms a horse-tail structure consistent with actively propagating fault system (*Pinet and Stephan 1990*)

Offshore seismic, bathymetric and magnetic survey under the MODEC Cruise shows the Philippine fault extends off shore and is coupled with the younging southward Philippine Trench (*Quebral et al.1996*) as shown in **Figure 2.1.2-9**.



Map Showing Active Fault and Trenches (*From PHIVOLCS*)



Structural map of the southeast Mindanao with focal mechanism, solutions, microtectonic data and location of seismic profiles shown in **Figure 2.1.2-9**. **LEGEND:** Recent (dotted) Pleistocene (dashed, Late Miocene (densely dotted). Red arrows points to fault lines not reflected in PHIVOLCS map. From Quebral 1994

Figure 2.1.2-8 Maps showing active faults in southeastern Mindanao

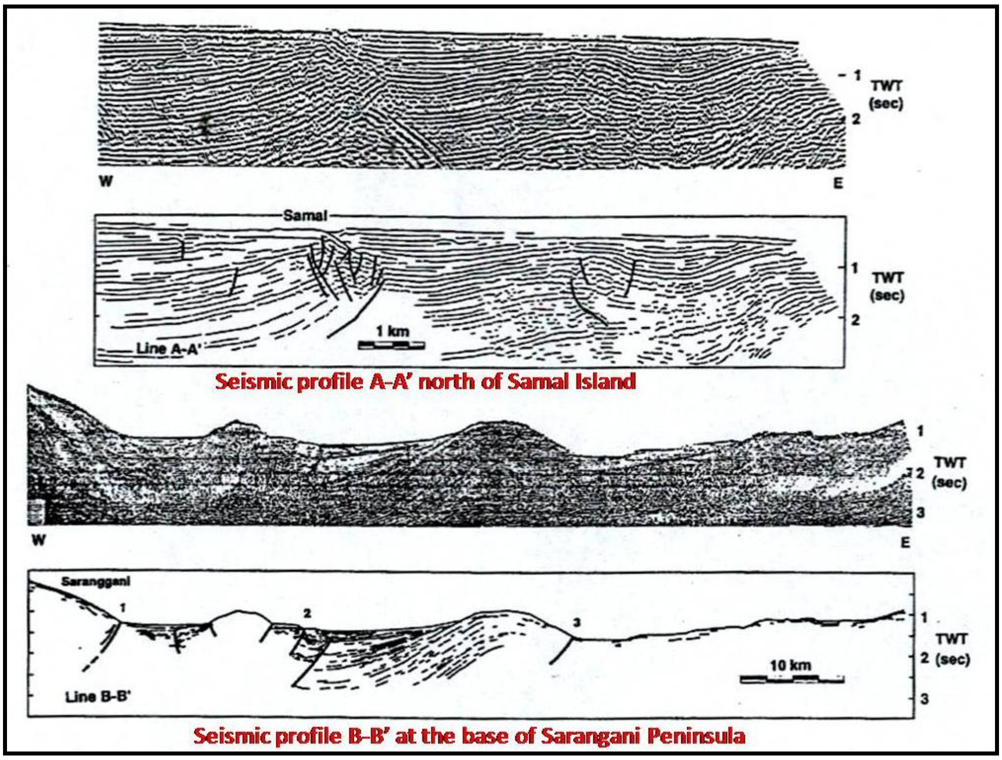


Figure 2.1.2-9 Seismic Profile Across Davao Gulf. Line A-A' located north of Samal Island (see **Figure 2.1.2-10** for location).

The thrust at the base of Sarangani Peninsula (Line B-B') is inferred from its morphology, seismicity and field data (*From Quebral 1994*).

2) Davao Gulf Reverse Faults

Bathymetric data and seismic reflection profiles across Davao Gulf show a series of submarine ridges that correspond to folds overlying thrust faults (**Figure 2.1.2-10**). Several lines of evidence show that thrusting is active:

- young submarine morphology;
- associated earthquake epicenters and thrust focal mechanism solutions;
- uplifted Quaternary coral terraces on Samal Island; and
- fanning of young reflectors, concordance between submarine morphology and underlying structures, and cutting of young reflectors on seismic reflection profiles

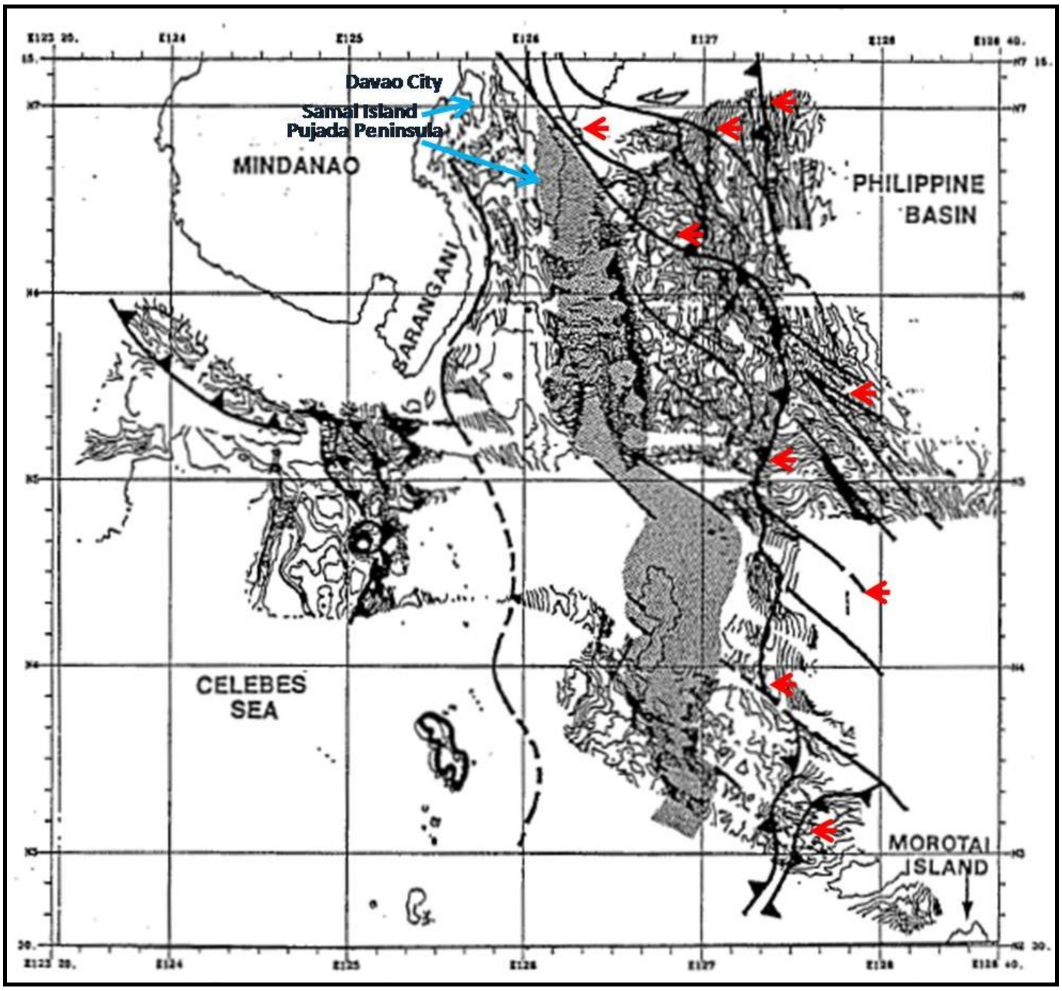


Figure 2.1.2-10 Map Showing the Offshore Extensions (pointed by red arrows) of the Geo-Structural Features in Southeast Mindanao.

Map is from the overall interpretation of bathymetric and seismic survey data from the MODEC Cruise, May 1994 of the Molucca Sea. The shaded area is the Mlangas-Pujada-Talaud unit probably formed by ophiolites slivers and melanges

(*From Rangin, Dahrin and Quebral 1994*).

Samal is one such active fault. It is a pop-up structure with a thrust fault off its east coast and a backthrust (reverse fault) off its west coast. With the fold episodically rising out of the water after major earthquakes along the faults, fringing coral reefs are uplifted to form coral terraces.

The faults within the gulf are important tectonic feature not reflected in the PHIVOLCS map. By Wells and Coppersmith empirical relation between fault length and magnitude (*1994*), these faults can generate approximately **7.2 magnitude** earthquake and relative to Davao City, a potential near-source tsunami generators. This means that there will be no lead time between a tsunami is generated and the time it reaches the coastal area around

Davao Gulf. This is in contrast to a far-source tsunami generator where lead time may be in the order of several hours. Further, a **7.2 M** earthquake can cause considerable damage to impacted area and can trigger liquefaction on susceptible sediments.

For an earthquake to be able to generate a tsunami, the event should be located offshore and should be sufficiently shallow and strong with a significant amount of vertical displacement. The reverse faults within Davao Gulf are capable tsunami generators. The coastal areas around the gulf have experienced historical events as in the 17 August 1976 Moro (Davao) Gulf earthquake with computed magnitude of **7.9** in the Richter scale. The generated tsunami was about 6 meters high that inundated the coastal areas of Southern Mindanao. It has a velocity of **720 km/hr** and rushed as far as **500 meters** inland leaving **3,564** dead, **1,502** missing , **8,256** wounded, and **12, 183** families homeless (*Cabanlit, 2010*).

3) Philippine Trench

The Philippine Trench is one of the two subduction zones that bounds the Philippines. It runs a few kilometers offshore of the eastern coastline where the West Philippine Sea plate is being consumed along the west-dipping Philippine Trench (*e.g. Hamburger et al., 1983; Ozawa et al., 2004*). The Philippine Trench is the most seismically active earthquake generator in the Philippines hosting a big percentage of earthquakes that happened in Mindanao (*Cabanlit 2010*) and has a maximum depth of **9 km** and stretches from the transform fault east of Luzon to Halmahera. It serves as the boundary between the West Philippine Sea Plate and the eastern portion of the Archipelago. Philippine Trench is propagating southward towards the Molucca Sea and extends to the Halmahera where it terminates (*Nichols et al. 1990*).

4) Central Mindanao Fault

The Mindanao Central Cordillera is thrust westwards over the Lanao-Bukidnon Highlands along a north-south trending fault that extends all to Ginoog Bay in the north. To the south, the fault does not cut through the pyroclastic apron of Mount Talomo, a major Quaternary stratovolcano. However, moderate earthquakes and focal mechanism solutions over the Bukidnon area suggests that the fault might still be active.

5) Diwata Fault

A pronounced north-south trending escarpment separates the Pacific Cordillera (Diwata Range) from the Agusan Davao Basin. The fault is not a splay of the Philippine Fault. It is a thrust fault with the cordillera being thrust westwards over the basin.

6) Saranggani Thrust

The Saranggani Ridge is asymmetrical with a steep eastern flank and a gentle western flank. The anticline, which is convex to the east, is being thrust to the east along an assumed Saranggani Thrust which is associated with earthquake epicenters and thrust focal mechanism solutions.

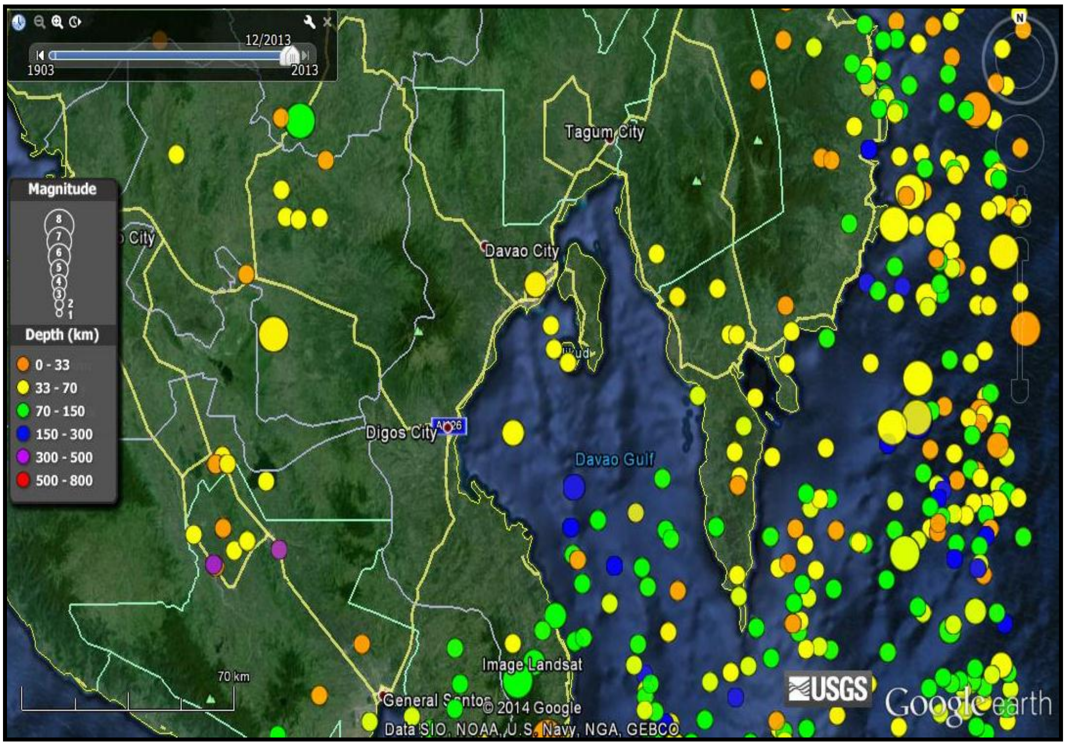
7) Daguma Fault

The Daguma Fault, characterized by a prominent NW-SE trending escarpment, separates the Daguma Range from the Cotabato Basin. The **165 kilometer** fault, characterized by a prominent NW-SE trending, NE-facing escarpment, is a normal fault with the Daguma Range being on the upthrown side and the Cotabato Basin being on the downthrown side. Normal faulting may be attributed to back arc extension of the Cotabato Trench.

There are seismic and geologic indications that the fault is active like seismic reflection profiles and the sharp morphology (*Quebral 1993*). Along its southeastern end, the fault cuts Quaternary limestone.

(2) Recent Earthquakes

Davao City is located on an area adjacent to a seismically and tectonically active zone. Earthquakes in the area are generated by local earthquake generators with epicenters clustered along the trace of the Philippine Trench and the Philippine Fault east of Davao City. The epicenters extends to the south of Davao Gulf and are relatively shallow with depth of less than **33** to **150 km**. Occurrence of high magnitude earthquakes are common. The earthquake map shoes **5M** to **7.3M**. Plotted in **Figure 2.1.2-11** and listed in **Table 2.1.2-2** are earthquakes in the area from 1903 to 2003.



(*From the National Earthquake Information Center*)

Figure 2.1.2-11 Epicenters of Recent Earthquakes with Magnitude of 5 to 7.2

Table 2.1.2-2 National Earthquake Information Center Search Results
101 earthquakes -2014-07-07 20:25:54 UTC+09:00 Showing event times using Local System Time (UTC+09:00)

Magnitude	Place	Date	Local System Time (UTC)
7.1	Mindanao, Philippines	1903-12-28 11:56:00	UTC+09:000.0 km
6.8	Mindanao, Philippines	1907-07-20 22:38:00	UTC+09:000.0 km
6.6	Mindanao, Philippines	1911-03-07 02:30:00	UTC+09:00100.0 km
7.2	Mindanao, Philippines	1918-02-07 14:20:33	UTC+09:00218.1 km
7.1	Mindanao, Philippines	1919-01-01 10:33:50	UTC+09:0035.0 km
7.1	Mindanao, Philippines	1923-03-03 01:48:44	UTC+09:0086.6 km
6.9	Mindanao, Philippines	1927-11-17 06:10:12	UTC+09:0044.0 km
7.3	Mindanao, Philippines	1928-12-19 20:37:17	UTC+09:0035.0 km
7.1	Mindanao, Philippines	1929-06-05 00:15:24	UTC+09:0035.0 km
7.1	Mindanao, Philippines	1929-06-13 18:24:38	UTC+09:0035.0 km
7.1	Mindanao, Philippines	1934-04-16 07:15:19	UTC+09:0035.0 km
7.3	Mindanao, Philippines	1949-04-30 10:23:32	UTC+09:0093.7 km
6.6	Mindanao, Philippines	1950-08-07 11:45:01	UTC+09:00128.0 km
5.7	Mindanao, Philippines	1965-06-24 16:45:15	UTC+09:0051.7 km
5.9	Mindanao, Philippines	1965-09-16 22:50:12	UTC+09:00170.4 km
5.5	Mindanao, Philippines	1965-11-16 15:45:59	UTC+09:00111.3 km
5.9	Mindanao, Philippines	1968-08-04 20:41:25	UTC+09:00102.2 km

Table 2.1.2-2 National Earthquake Information Center Search Results
101 earthquakes -2014-07-07 20:25:54 UTC+09:00 Showing event times using Local System Time (UTC+09:00)

Magnitude	Place	Date	Local System Time (UTC)
5.5	Mindanao, Philippines	1969-09-19 10:29:38	UTC+09:0094.2 km
7.3	Mindanao, Philippines	1970-01-10 21:07:08	UTC+09:0059.7 km
5.5	Mindanao, Philippines	1970-01-10 23:16:31	UTC+09:0068.1 km
7.1	Mindanao, Philippines	1970-03-31 01:46:45	UTC+09:0063.1 km
5.5	Mindanao, Philippines	1970-07-05 23:12:17	UTC+09:0054.7 km
7.4	Mindanao, Philippines	1972-12-02 09:19:54	UTC+09:0082.7 km
5.6	Mindanao, Philippines	1972-12-02 10:40:52	UTC+09:0082.8 km
5.9	Mindanao, Philippines	1975-07-11 03:29:16	UTC+09:0078.1 km
5.9	Mindanao, Philippines	1975-10-26 19:41:34	UTC+09:0060.9 km
5.9	Mindanao, Philippines	1975-10-28 03:26:42	UTC+09:0014.0 km
5.6	Mindanao, Philippines	1975-11-08 23:53:32	UTC+09:0078.2 km
5.6	Mindanao, Philippines	1976-10-26 21:51:30	UTC+09:0077.4 km
5.8	Mindanao, Philippines	1978-06-16 16:57:01	UTC+09:00142.3 km
5.6	Mindanao, Philippines	1978-08-31 19:08:11	UTC+09:0065.4 km
5.5	Mindanao, Philippines	1978-11-16 19:45:11	UTC+09:0066.9 km
6.2	Mindanao, Philippines	1979-02-12 07:22:23	UTC+09:00149.7 km
5.7	Mindanao, Philippines	1980-01-04 15:22:08	UTC+09:0042.3 km
6.3	Mindanao, Philippines	1980-02-29 20:13:27	UTC+09:0095.5 km
6.5	Mindanao, Philippines	1980-07-08 13:39:30	UTC+09:00176.4 km
5.9	Mindanao, Philippines	1981-09-03 13:29:54	UTC+09:0094.1 km
5.6	Mindanao, Philippines	1983-01-15 09:16:52	UTC+09:0042.1 km
5.6	Mindanao, Philippines	1983-04-22 16:51:50	UTC+09:0067.8 km
5.7	Mindanao, Philippines	1983-09-13 11:03:28	UTC+09:0047.7 km
5.6	Mindanao, Philippines	1984-01-09 16:18:04	UTC+09:0066.9 km
5.5	Mindanao, Philippines	1985-06-08 22:19:15	UTC+09:0087.8 km
6.4	Mindanao, Philippines	1987-05-12 10:30:31	UTC+09:0069.3 km
5.6	Mindanao, Philippines	1987-11-16 14:59:50	UTC+09:0067.2 km
5.6	Mindanao, Philippines	1989-12-16 03:57:30	UTC+09:0070.3 km
5.5	Mindanao, Philippines	1989-12-16 19:24:44	UTC+09:0031.0 km
5.5	Mindanao, Philippines	1989-12-16 19:40:20	UTC+09:0034.2 km
5.5	Mindanao, Philippines	1989-12-19 16:03:18	UTC+09:0039.5 km
5.5	Mindanao, Philippines	1989-12-19 16:27:55	UTC+09:0031.9 km
5.5	Mindanao, Philippines	1990-06-14 01:41:55	UTC+09:0079.0 km
5.6	Mindanao, Philippines	1991-04-27 02:36:54	UTC+09:0074.0 km
7.1	Mindanao, Philippines	1992-05-17 18:49:20	UTC+09:0035.5 km
7.2	Mindanao, Philippines	1992-05-17 19:15:36	UTC+09:0063.5 km
7.0	Mindanao, Philippines	1993-05-12 03:26:52	UTC+09:0062.0 km
5.5	Mindanao, Philippines	1993-05-15 10:55:41	UTC+09:0040.0 km
5.7	Mindanao, Philippines	1993-08-20 00:21:43	UTC+09:0063.7 km
5.5	Mindanao, Philippines	1993-08-20 06:52:05	UTC+09:0030.5 km
5.5	Mindanao, Philippines	1994-08-28 01:03:56	UTC+09:00100.1 km
5.6	Mindanao, Philippines	1994-09-10 13:54:10	UTC+09:0079.4 km
5.6	Mindanao, Philippines	1994-09-20 17:45:28	UTC+09:0059.2 km
5.5	Mindanao, Philippines	1994-11-06 20:52:54	UTC+09:0041.5 km
5.5	Mindanao, Philippines	1995-04-05 02:21:06	UTC+09:0097.8 km
6.4	Mindanao, Philippines	1995-04-20 17:45:13	UTC+09:00100.7 km
5.7	Mindanao, Philippines	1996-11-21 16:43:42	UTC+09:0080.4 km
5.7	Mindanao, Philippines	1998-03-11 09:37:38	UTC+09:0033.0 km
5.7	Mindanao, Philippines	2000-08-20 16:55:49	UTC+09:00174.3 km

Table 2.1.2-2 National Earthquake Information Center Search Results
101 earthquakes -2014-07-07 20:25:54 UTC+09:00 Showing event times using Local System Time (UTC+09:00)

Magnitude	Place	Date	Local System Time (UTC)
6.1	Mindanao, Philippines	2000-10-06 05:06:09	UTC+09:0031.5 km
5.6	Mindanao, Philippines	2000-10-22 10:21:44	UTC+09:0082.4 km
7.4	Mindanao, Philippines	2001-01-01 15:57:05	UTC+09:0036.0 km
6.8	Mindanao, Philippines	2001-01-01 17:54:34	UTC+09:0044.1 km
6.3	Mindanao, Philippines	2001-01-02 16:30:04	UTC+09:0024.0 km
5.5	Mindanao, Philippines	2001-01-06 07:51:53	UTC+09:0083.6 km
5.6	Mindanao, Philippines	2001-01-06 13:45:29	UTC+09:0033.0 km
5.5	Mindanao, Philippines	2001-02-22 07:50:29	UTC+09:0075.3 km
5.8	Mindanao, Philippines	2001-02-28 18:35:16	UTC+09:0060.5 km
6.3	Mindanao, Philippines	2002-01-01 20:29:24	UTC+09:00142.0 km
5.6	Mindanao, Philippines	2002-04-14 13:05:23	UTC+09:0033.0 km
5.6	Mindanao, Philippines	2002-07-29 16:13:37	UTC+09:0033.0 km
5.5	Mindanao, Philippines	2004-01-29 18:48:42	UTC+09:00209.6 km
5.8	Mindanao, Philippines	2004-05-16 20:01:15	UTC+09:0015.8 km
5.7	Mindanao, Philippines	2004-05-27 19:10:36	UTC+09:0062.9 km
5.7	Mindanao, Philippines	2004-09-01 01:25:10	UTC+09:0010.0 km
5.5	Mindanao, Philippines	2004-12-27 05:50:34	UTC+09:00127.3 km
5.5	Mindanao, Philippines	2005-01-13 09:07:22	UTC+09:0045.3 km
5.8	Mindanao, Philippines	2006-09-05 13:53:02	UTC+09:00135.2 km
5.7	Mindanao, Philippines	2007-04-25 20:52:55	UTC+09:0027.1 km
6.1	Mindanao, Philippines	2008-03-20 23:10:40	UTC+09:0045.0 km
5.7	Mindanao, Philippines	2009-05-21 14:53:53	UTC+09:0014.0 km
5.7	Mindanao, Philippines	2009-08-13 05:04:25	UTC+09:0095.7 km
5.7	Mindanao, Philippines	2009-09-18 20:53:48	UTC+09:0010.0 km
5.5	Mindanao, Philippines	2009-11-04 15:21:46	UTC+09:00116.0 km
5.6	Mindanao, Philippines	2009-12-26 14:09:28	UTC+09:0059.8 km
5.5	Mindanao, Philippines	2009-12-30 20:17:49	UTC+09:0034.0 km
5.7	Mindanao, Philippines	2010-02-26 17:37:00	UTC+09:0092.0 km
5.6	Mindanao, Philippines	2010-06-10 11:13:17	UTC+09:0015.0 km
5.9	Mindanao, Philippines	2010-12-08 15:47:15	UTC+09:0053.1 km
5.7	Mindanao, Philippines	2012-09-04 04:44:22	UTC+09:0010.0 km
5.6	Mindanao, Philippines	2012-12-10 06:45:35	UTC+09:0063.2 km
5.6	11km NNE of Banawa, Philippines	2013-06-01 23:10:10	UTC+09:0041.4 km
5.5	10km NNW of Linao, Philippines	2013-06-03 05:08:31	UTC+09:0043.9 km
5.6	7km E of Tibanbang, Philippines	2013-12-04 08:58:49	UTC+09:0030.0 km

2.1.2.5 Volcanic Hazard

Mt. Apo has an elevation of **2,938 m** and considered the highest peak in the Philippines, and has an explosive type of eruption. Mt. Apo is a basaltic to andesitic stratovolcano and is part of the Central Mindanao Arc. It has several fumaroles and sulfur deposits occur on the volcano. The volcano is classified as "dormant". The volcanic history is poorly known with unknown last eruption episode.

Given the location of the volcano relative to the location of the road corridor (**Figure 2.1.2-12**) and the terrain and topography surrounding volcano summit, hazard directly related to eruption (e.g. volcanic bombs, lava flow, pyroclastic flow, volcanic gas, etc.) will be confined within the **10 km** radius from the volcano crater and may not reach the southern end of the bypass road corridor. Depending on the height of the eruption cloud and the direction of the prevailing wind at the time of the eruption, volcanic ash and cloud may drift towards the northeasterly direction blanketing the area with ash deposited by the ash fall from the eruption cloud. The ash deposit may be remobilized into lahar flow the extent of which will depend on the thickness of the ash deposit and the intensity and duration of the rainfall. These event had previously occurred in the past as shown by the presence of thick lahar and pyroclastic deposit blanketing the area at the southern end of the bypass road.

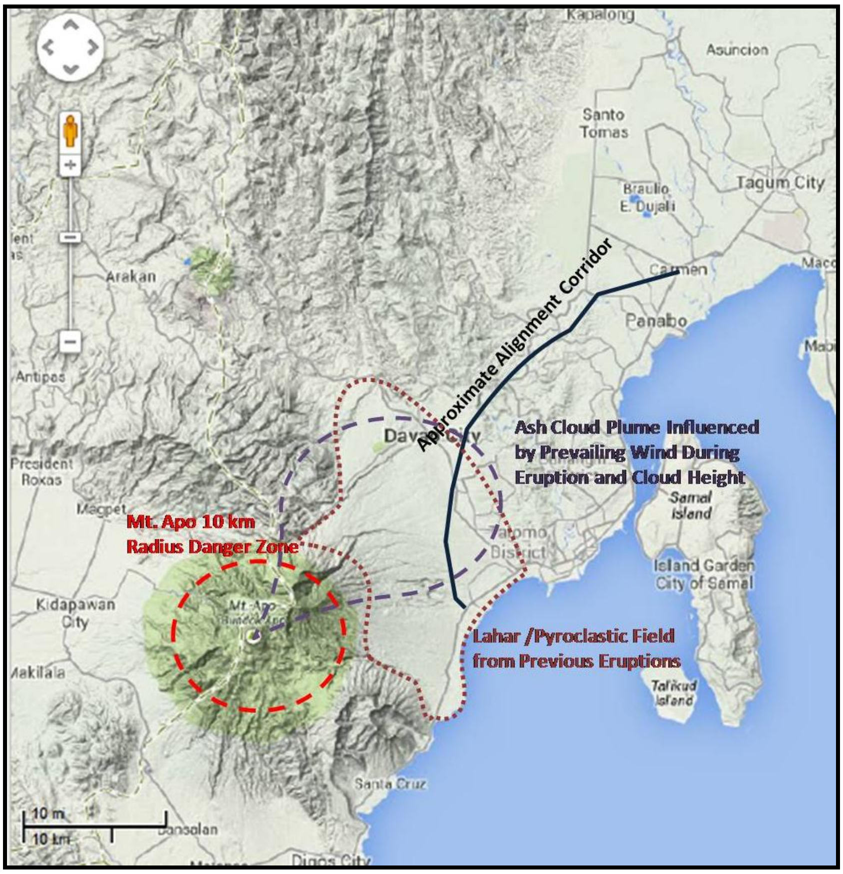


Figure 2.1.2-12 Volcanic Hazard Map Based on the Location of Mt. Apo Relative to the Road Corridor

2.1.2.6 Impact Analysis and Mitigation

(1) Pre-Construction Phase

1) Ground Shaking

Since Davao City is in the fringes of an active seismic zone with known earthquake generators capable of generating high magnitude earthquakes, it will be prudent to conduct a site specific Probabilistic Seismic Hazard Assessment (PSHA) for the project to determine the Design Based Earthquake (DBE) in terms of the maximum Peak Ground Acceleration (PGA) resulting from the movement of specific earthquake generator.

The DBE is usually defined in practice as the earthquake with a ground motion that has **10%** probability of being exceeded at least once over a period of **50 years** and a corresponding statistical return period of **475 years**. This is the current minimum seismic design criteria for structures in the Philippines.

PSHA combines the uncertainties inherent in sources of seismicity, earthquake recurrence, and ground-motion attenuation relationship in a series of probabilistic calculations.

2) Liquefaction

With the proximity of known earthquake generators and the presence of loose/unconsolidated sediments with shallow water table along the alluvial and coastal plains traversed by section of the bypass road corridor. It will be fitting to undertake a Soil Liquefaction Evaluation (SLE) using the result of the site specific PSHA. The liquefaction evaluation will need to include the following:

- Assessment of behavior of fine-grained soils;
- Assessment of the potential liquefaction susceptibility of soils specially on sections of the alignment/bridge sites with potential to liquefy following the procedure of *Seed* and *Idriss* (*1971*) and the revised relations recommended in the recent state-of-the-art papers of *Idriss* and *Boulanger* (*2004, 2006*);
- Assessment of the potential liquefaction susceptibility of soils along the road corridor for various earthquake magnitudes;
- Determination of the volumetric strain after liquefaction (degree of settlement/subsidence) using the method proposed by *Tomikatsu* and *Seed* (1987); and

- Determination of the extent of lateral movement of materials to establish the appropriate design for retaining walls to negate potential buckling during an earthquake

A specific Liquefaction Susceptibility Analysis (LSA) and PSHA in the design of the foundation for the bridges and tunnel of the project must be undertaken.

The final result is a set of site-specific quantitative prediction of liquefaction potential needed to effectively manage liquefaction hazards by incorporation of appropriate engineering mitigation into the project design.

The effects of the unstable ground shall be taken into account in the verification of seismic performance of a bridge when the ground is expected to be in an unstable state during an earthquake. Unstable ground is defined as an extremely soft soil layer in seismic design, or a sandy layer affecting the bridge due to the liquefaction and lateral spreading.

In addition to the verification of the seismic performance of a bridge with conditions indicated in soft soil layer and/or sandy layer above, the case in which the ground is assumed to be stable shall also be considered in order to ensure the seismic performance of the bridge for both stable and unstable ground conditions.

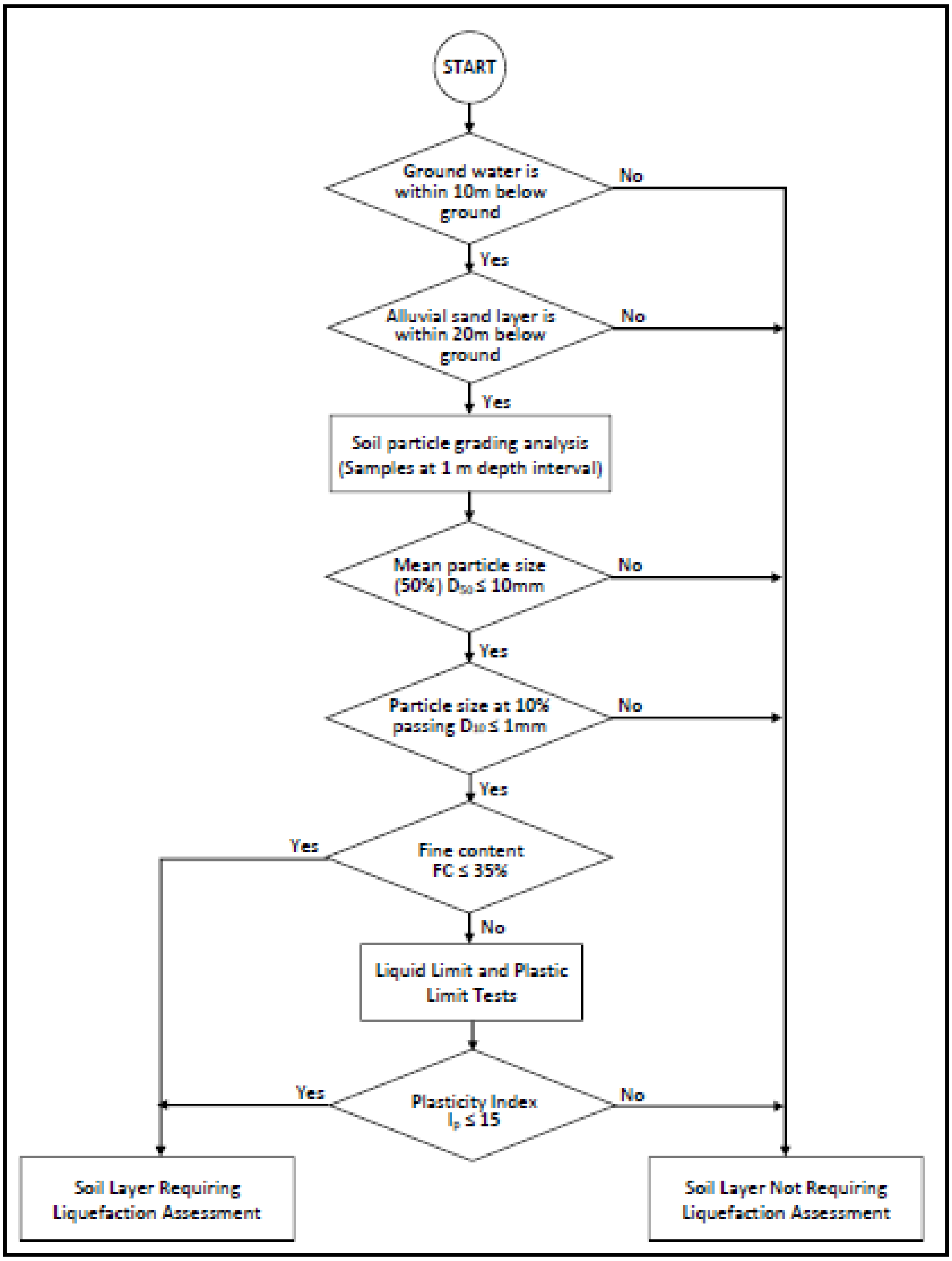
Verification of seismic performance, assessment of soil liquefaction, reduction of geotechnical parameters and verification of foundations for liquefaction-induced lateral spreading is refer to LRFD Bridge Seismic Design Specifications (*DPWH Guide Specifications, 2013, 1st Edition*).

For a clayey layer or a silt layer located within **three (3) meters** from the ground surface, and having a compressive strength of **20 kPa (kN/mm^2)** or less obtained from an unconfined compression test or an in-situ test, the layer shall be regarded as an extremely soft layer in seismic design.

(a) Sandy Layer Requiring Liquefaction Assessment

For an alluvial sandy layer, liquefaction assessment shall be conducted in accordance with the provisions specified below and shown **Figure 2.1.2-13**, since liquefaction may affect the bridge performance during an earthquake.

- Saturated soil layer with depth less than **20 m** below the ground surface and having ground water level higher than **10 m** below the ground surface;
- Soil layer containing a fine contend (FC) of **35%** or less, or soil layer having plasticity index (PI) less than **15**, even if FC is larger than **35%**;
- Soil layer having a mean particle size (D_{50}) of less than **10 mm** and a particle size at **10%** passing (D_{10}) (on the grading curve) is less than **1 mm**



Source: JICA Study Team, July 2014

Figure 2.1.2-13 Determination of Necessity for Liquefaction Assessment

According to the geotechnical survey conducted, **BH-17 to BH-20** shall be considered for soil liquefaction assessment. A more detailed geotechnical test following the specification for soil liquefaction shall be undertaken during the Detailed Engineering Design (DED) stage.

(b) Ground with Possible Lateral Movement

A pier foundation situated on a ground with a sandy layer thicker than **5 m** that is assessed as a liquefiable layer shall be verified against possible liquefaction-induced lateral spreading. In the verification, lateral movement force shall act on the pier foundation. However, the lateral movement force and the inertia force not to be considered simultaneously.

The geo-technical survey undertaken showed that **BH-18 to BH-20** shall be considered for soil liquefaction. When detailed design stage, it shall be more detailed geotechnical test and follow the specification for soil liquefaction.

Remediation objectives include increasing the soils liquefaction resistance through densification, increasing its strength, and/or improving its drainage. Enumerated below are the most common remediation measures.

1) **Surcharge -** The weight of a surcharge/buttress increases the liquefaction resistance by increasing the effective confining pressures in the foundation;

2) **Drains** - Relief of excess pore water pressure to prevent liquefaction. (Wick drains have comparable permeability to sand drains). Primarily gravel drains; sand/wick may supplement gravel drain or relieve existing excess pore water pressure. Permanent dewatering with pumps;

3) **Compaction Piles** - Densification by displacement of pile volume and by vibration during driving, increase in lateral effective earth pressure; and

4) **Deep Soil-Cement Mixing Methods -** The in situ injection and mixing of cement into weak soils is becoming more common. Recent applications include liquefaction mitigation and the strengthening of weak cohesive soils adjacent to embankments, levees and bridge abutments

3) Soil Compressibility

This impact is moderate to high in areas underlain by loose sediments. Compressible materials present at the site could be subjected to settlement due to elastic deformation (upon load application) and or compression.

To mitigate this impact, a site specific LSA must be undertaken to determine which layer will likely experience soil compressibility and by how much (in meters) for a given earthquake magnitude.

5) Fault Rupture and Creep

Fault rupture and creep commonly occur on pre-existing fault lines. The geomorphological and geological investigation had identified a number of lineament bisection the area of the road corridor.

A detailed assessment of the identified geological lineaments bisecting the critical components (e.g. tunnel, bridges, etc.) of the project must be undertaken to determine their potential to movement in the event of a high magnitude earthquake.

(a) Slope Failure at the Tunnel Section

The presence of scars from previous slides along the side slopes of the hill cut by the tunnel corridor will have to be closely investigated to ensure that there will be no future slope failure towards the tunnel openings.

The geotechnical site investigation can be augmented by a comprehensive geophysical survey essentially with the following purpose:

1) Determine the slide plane of each of the slide debris;

2) Determine the elevation difference between the tunnel roof and slide plane of each of the relict slides and or slide debris;

3) Determine the thickness of the thickness of the slide debris present near and or along the tunnel corridor;

4) Determine the water bearing horizon near and or along the tunnel corridor; and

5) Determine the thickness of the rock types / materials along the tunnel corridor

(2) Construction Phase

1) Slope Stability: (Landslide, Soil erosion and Rock Fall)

Since the alignment of the proposed bypass road go through the undulating hilly terrain of **50-200 m** above sea level of **2-8 km** inland side of the Pan-Philippine Highway, many large-scale cut slopes of **20 m** or more in height are planned in the proposed bypass road.

Slope failure, soil erosion, and rock fall may potentially occur along high cut slope sections widely underlain by unconsolidated soil layers of sand and gravel due to cut (tress release), weathering, erosion, and water infiltration. Appropriate slope protections of the cut slopes are needed, because these materials are highly erodible.

Standard Slope Gradient for Cut in the Road Earthwork - Guideline for Stability of Cut Slopes and Natural Slopes: June 2009 (issued by Japan Road Association) of Japan will be used as the standard gradient of cut slopes of the project road.

There are many cases of using the planting and the slope structures individually for slope protection. But there are cases of using the combination of planting and slope structures due to preserving of the natural environment and landscaping at the site of unstable geotechnical conditions.

Shown in **Table 2.1.2-3** are the main types and purposes of the cut slope protection for the bypass project.

Table 2.1.2-3 Main Types and Purposes of Cut Slope Protections

Classification	Types	Purposes
Planting	Sowing	The purpose is the erosion prevention for the soil slopes by Planting. This type should be used when the slope gradient is 1.0:1.0 or less (gentle).
	Vegetation Base Material Spraying	The purpose is the erosion prevention for the soil and rock slopes by Planting. This type should be used when the slope gradient is from 0.5:1.0 to 1.0:1.0.
	Vegetation Mat	The purpose is the erosion prevention for the soil and rock slopes by Planting. This type should be used when the slope gradient is 0.8:1.0 or less (gentle).
	Vegetation Sandbag	The purpose is the erosion prevention by Planting for the inside of "Grating Crib Works using Precast Blocks" mainly.
	Sodding	The purpose is the early erosion prevention for the soil slopes by Planting. This type should be used when the slope gradient is 1.0:1.0 or less (gentle).
	Planting of Sapling	The purpose is the landscaping by trees. This type should be used in the soil slopes when the slope gradient is 1.4:1.0 or less (gentle).
Slope Structures	Mortar/Concrete Spraying (Shotcrete)	The purposes are the weathering prevention, the erosion prevention and the prevention of permeation of runoff. This type should be used at the rock slopes.
	Grouted Riprap	The purposes are the weathering prevention, the erosion prevention, the prevention of permeation of runoff and the prevention of slipping of surface soils. This type should be used at the steep soil slopes.
	Concrete Pitching	The purposes are the weathering prevention, the erosion prevention, the prevention of permeation of runoff and the prevention of slipping of rocks. This type should be used at the steep rock slopes
	Grating Crib Works using Precast Blocks	The purpose is the erosion prevention at sandy soil slopes. This type should be used when the slope gradient is 1.0:1.0 or less (gentle).
	Grating Crib Works using Shotcrete	The purposes are the erosion prevention and the prevention of slipping of surface soils or rocks. This type should be used at soil and rock slopes.
	Stone/Rubble-Concrete Masonry	The purposes are the erosion prevention and the prevention of slipping of surface soils or rocks. This type should be used at the underneath of soil and rock slopes.
	Mat Gabion	The purposes are the improvement of drainage and the prevention of slipping of slopes. This type should be used at the underneath of soil slopes where the spring water is present.
	Rock Bolt Type Anchor	The purpose is the prevention of surface failure or slope failure in soil and rock slopes. This type should be used combining with Grating Crib Works and etc.
	Ground Anchor	The purpose is the prevention of slope failure or landslide. This type should be used combining with Grating Crib Works and etc.

Source: JICA Study Team, July 2014

(3) Operational Phase

1) Volcanic Hazard

Mt. Apo is classified dormant and have no clear eruption record in historical time. This impact is considered low. However, in the event of an eruption, the southern end of the bypass road corridor which is approximately **25 km** east of the peak of Mt. Apo will affected by ash fall and lahar. The degree of impact will be dictated by the type and scale of eruption.

Impacts of hazards due to lava flows, volcanic bombs, volcanic gases etc. will be confined to areas within the **10 km** radius eruption hazard zone.

2.1.3 Pedology and Soil Classification

2.1.3.1 Soil Types along the Bypass Alignment

The terrain traversed by the road corridor is covered by various soils and surficial materials as shown in **Figure 2.1.3-1a** to **2.1.3-1d**. Generally, these are formed by in situ weathering of different rock types. Based on the source and origin of occurrence, the soils and surficial materials are best described under the following types, namely:

(1) Regolithic-Dominated Soils

These soils are essentially made up of regolithic materials, the residual products of weathering of the underlying bedrocks. They are essentially fragmented and loosely clasted with reworked loamy clays and very clayey coarse sands. Their sites are very stony with depth which seldom exceeds **2.0 meters** below ground surface.

(2) Colluvial-Dominated Soils

These soils are principally comprised of weathered talus and transported earth debris. Mixtures of slope debris and reworked soils and rock fragments transported by gullies, slope wash and overland run-offs are essential components. Materials are generally loose and poorly clasted by loamy sands and moistened clays. Their sites are very stony with depth variably between **1.0** and **1.5 meters** below ground surface.

(3) Alluvial Complex

These soils and surficial materials are essentially loose alluvial materials with admixtures of saprolitic and regolithic soils. They are products of the alluviation, slope and sheet washes, deeper weathering and surficial wearing down of the underlying bedrocks by the combined actions of surface run-offs, overland erosions, dynamic weathering, mass-movements, creeps, talus decay, surficial saturation, bedrock alteration by thermal fluids, etc. Sites of alluvial soils are underlain by mixed volcanics, shallow marine sediments, reworked fluviatiles and reefal clastics. These soils are limy and firmly clasted by silts and sandy-clayey loam. Their sites are poorly stony and pebbly. Depth varies between **1.0** and **3.0 meters** below ground surfaces.

(4) Volcanic Soils

These soils and surficial materials are very prominent and widespread towards the southern and southwestern end of the by-pass road corridor, where volcanic deposits dominate. They are by-products of deep weathering, alteration and saprolitization of volcanic debris comprised principally of pyroclastics and other ejectas from the eruptions of volcanic centers like Mt. Apo. On higher grounds and rolling terrain, the volcanic soils appear highly fragmented, poorly clasted and poorly consolidated. Towards low-lying areas, depressions and saddles, these soils are firmly clasted by saprolites, reworked regoliths and transported alluvial soils. They are notably associated with sandy-clayey loam with patches of slightly humic topsoils particularly along sides and banks of drainage lines, creeks and rivers. Their sites are pebbly and very stony. Depth varies between **1.0** and **3.0 meters** below ground surface.

(5) Reworked Loam

These soils are friable mixtures of volcaniclastics and fluvial sands, silts and clays with usual admixtures of fine volcanic gravels and cobbles. Many are loosely clasted by highly moistened clayey volcanic ash. Materials are oxide-rich and highly pebbly. Reddish brown is the dominant soil color. Their sites are very stony on surface. Depth varies between **1.5** and **3.0 meters** below ground surface.

(6) Reworked Alluvial Loam

These soils are friable mixtures of floodplain and reworked and weathered alluvial sands, gravels, clays and silts. They are pebbly and partly humic especially at top **20 centimeters**. Presence of oxide is low. Soil color is dominantly grayish brown. Their sites are very stony on surface. Depth varies between **1.5** and **3.0 meters** below ground surface.

(7) Fluvial Deposits

These soils and surficial materials are chiefly weathered fluviatiles formed by the actions of rivers and floodplain sedimentations. They are notably non-consolidated river, stream and floodplain sediments comprised of gravel, sands, silts and minor clays. In some places, they are mixed with cobbles and boulders particularly along active waterlines and rapids. Atop river and stream terraces and levees, these soils are poorly clasted by residual clayey loam and occur as by-products of in-situ weathering with usual associations of transported floodplain sediments. Towards low-lying floodplains, backswamps and flood-basins, the fluvial soils are marked by the dominance of humic clays, silts, muds and sands. Absence of ponds and peats is highly manifested; suggestive of highly disturbed and unstable grounds.

(8) Calcareous Soils

Found in area underlain by limestone approximately from Brgy. Mahayag up to Brgy. Lasang the proposed alignment of the bypass road crosses a karstic landscape. Soil cover along this section of the bypass road alignment is essentially comprised of weathered fragments of limestone. Surface materials are friable and loose mixtures of calcareous and fossiliferous sands, clays and lime. Their sites are cavernous and evident of solution cavities and cracks. Depth varies between **0.5** and **1.0 meter** below ground surface.

(9) Fluvio-Coastal Soils

The presence of fluvio-coastal soil is partly crossed by the proposed axis of the bypass road at **Km 38+000**, **Km 34+000** and **Km 33+000**. Here, the fluvio-coastal soils are friable mixtures of floodplain and mixed-flat sediments. Materials are chiefly loose sands, silts and clays clasted by moistened humic clays. Abundance of humus and organics is becoming highly noticeable towards near-coastal and coastal zones. Materials are highly saturated; swampy in some places. Depth varies between **1.0** and **3.0 meters** below ground surface.

(10) Mixed-Tidal Flat Soils

From **Km 38+000** up to **Km 40+000**, the proposed axis of the bypass road crosses areas covered by mixed-tidal flat soils. These soils and surface materials are dominantly comprised of coastal sands, silts, clays with usual mixtures of channel gravels. Associations are usually made up of floodplain sediments, beach-barrier sands and gravels, and tidal mud and clays. Organics are abundant and in many places peaty. Surface materials are loosely clasted by organic-rich clays and mud. Most are wet and highly saturated. Their sites are often swampy and marshy. Presence of stagnant water is widespread. Water table is often near-surface. Depth seldom exceeds **3.0 meters** below ground surface.

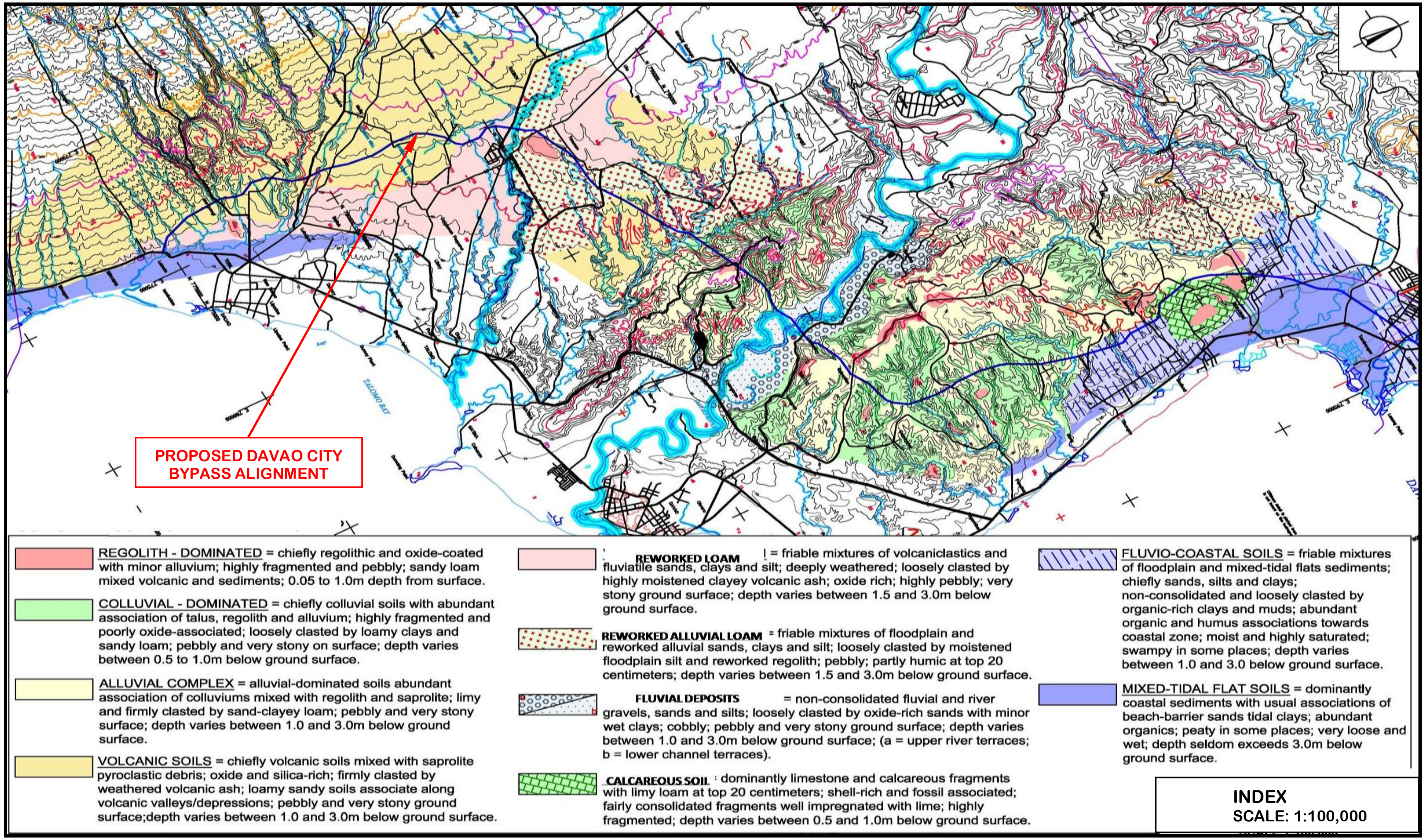


Figure 2.1.3-1a Soil Classification Map

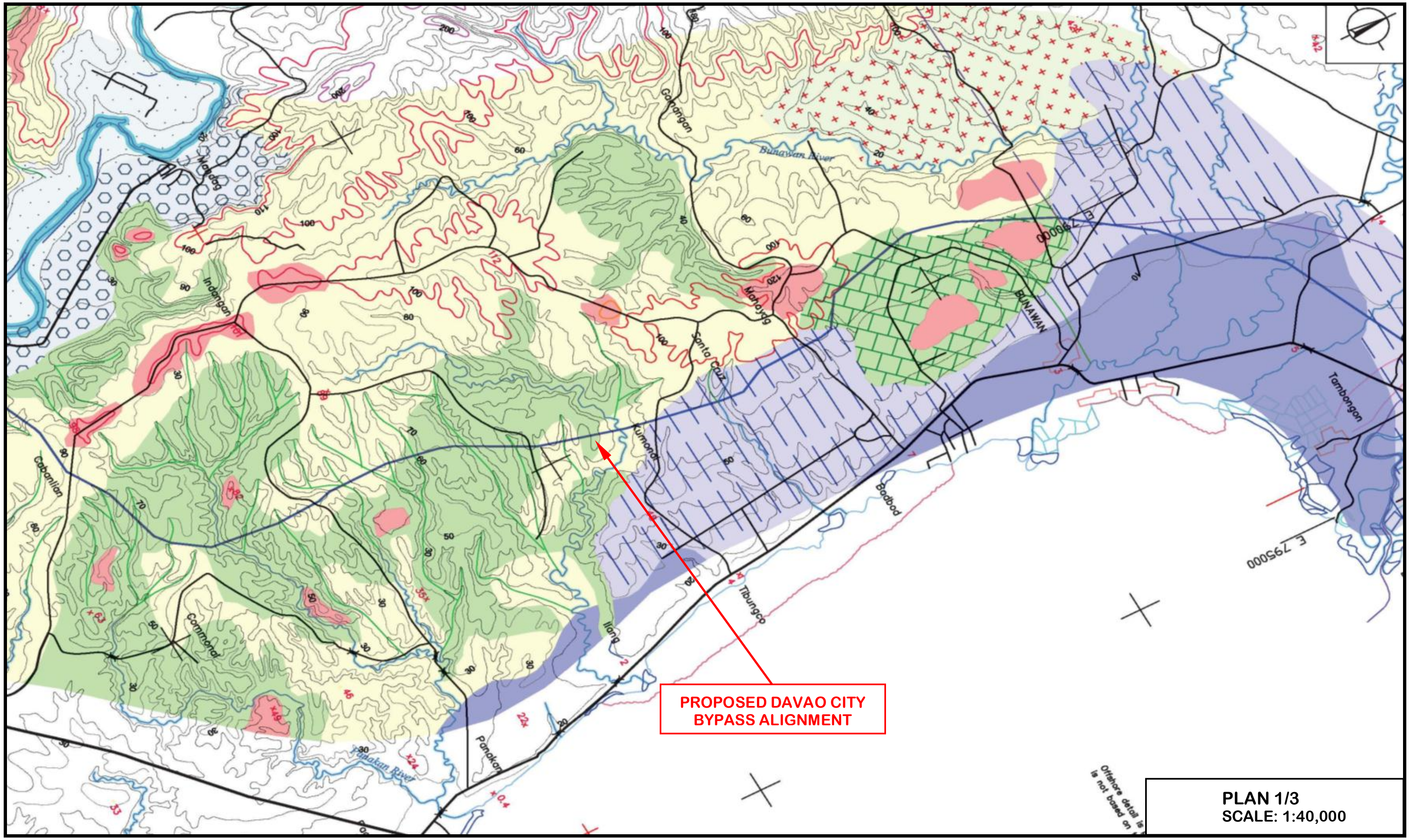


Figure 2.1.3-1b Soil Classification Map

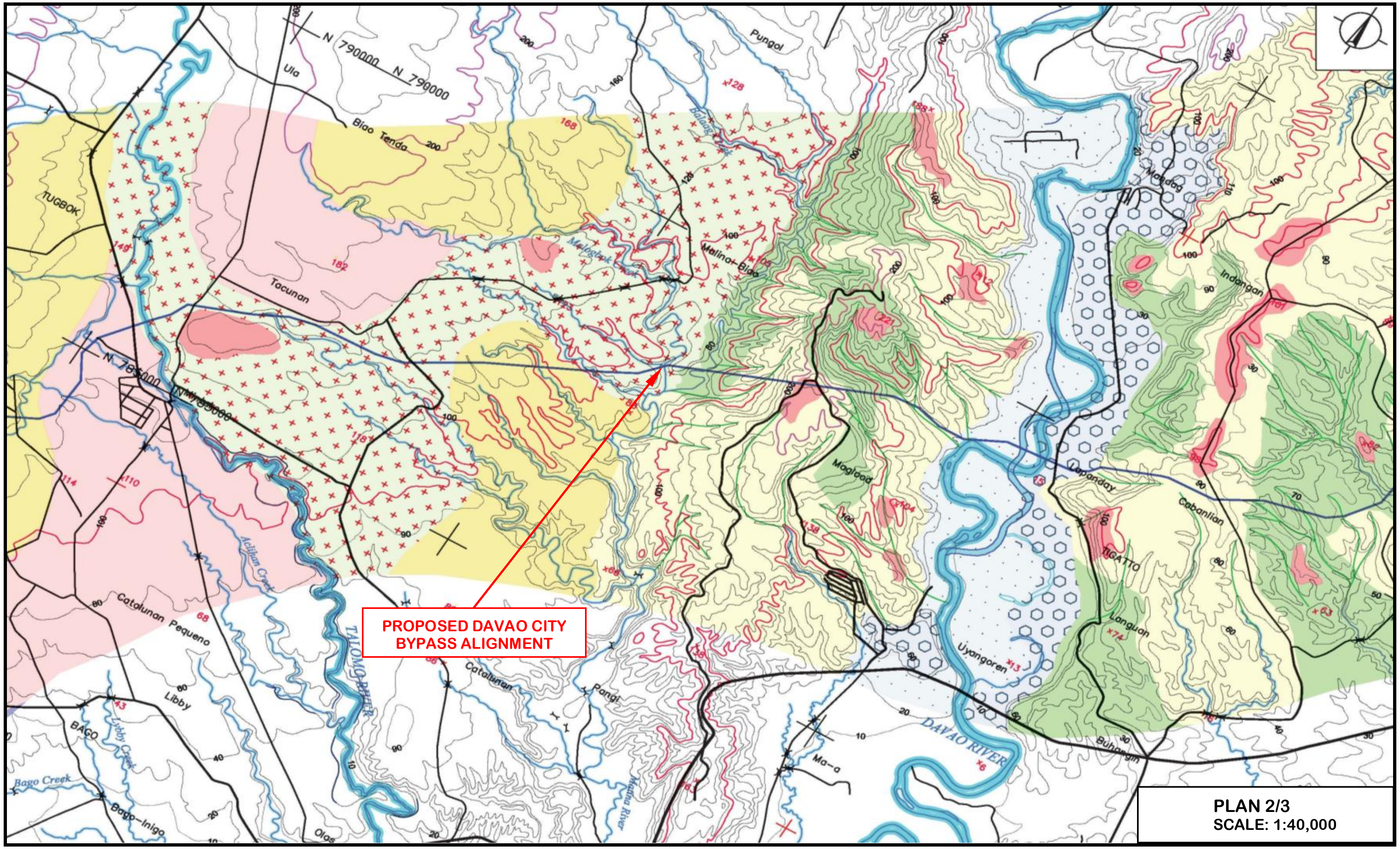


Figure 2.1.3-1c Soil Classification Map

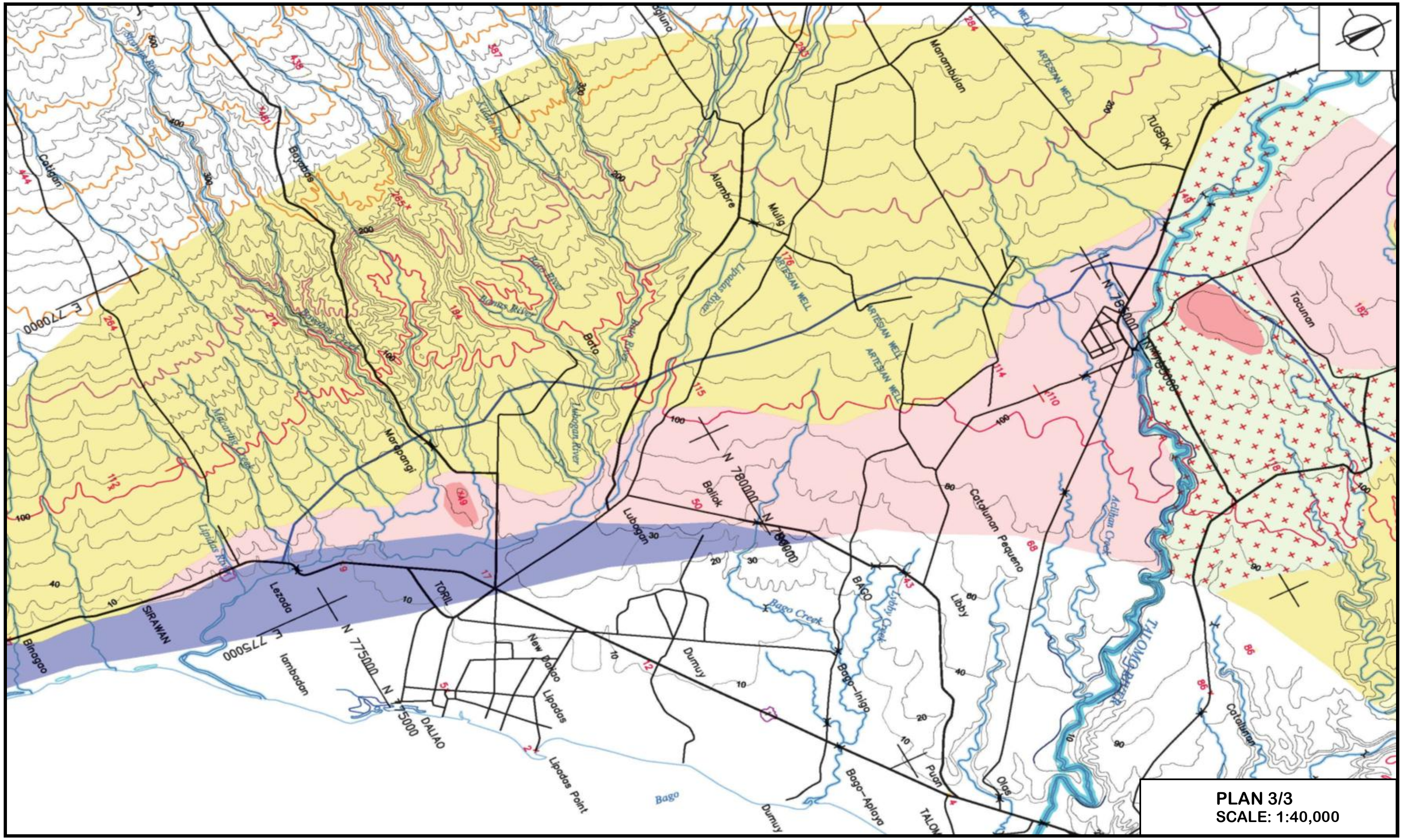


Figure 2.1.3-1d Soil Classification Map

2.1.3.2 Soil Investigation Report

(1) Investigation Items and Quantities

The soil investigation items and quantities are presented in **Table 2.1.3-1**.

Table 2.1.3-1 Investigation Items and Quantities

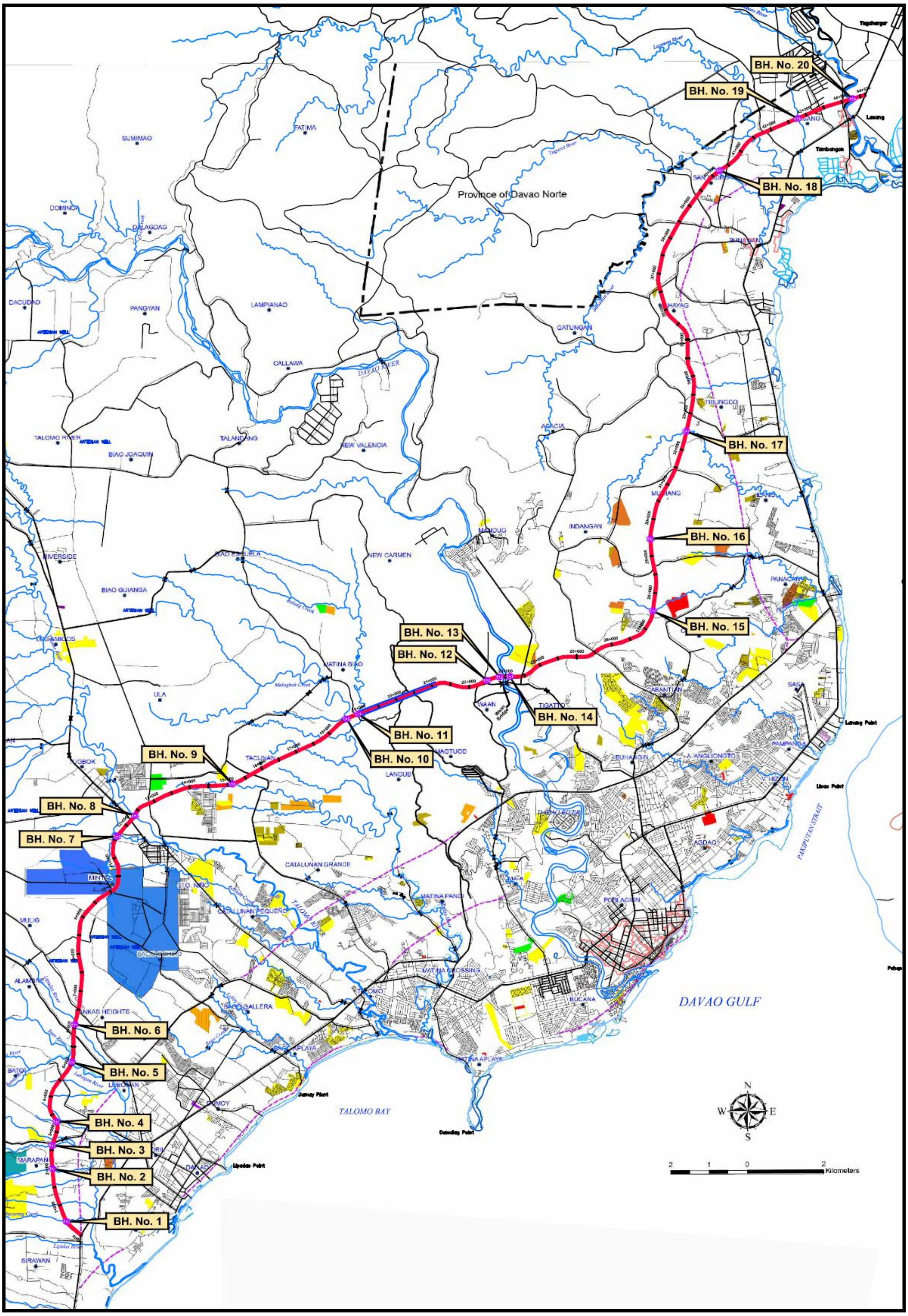
Items		Unit	Bridge Site	Tunnel Section	Low Embankment Section	Total
Boring	Number of boreholes	holes	20	8	-	28
	Total Length	m	548	585	-	1,075
Standard Penetration Test		each	548	290	-	790
Seismic Velocity Logging		each	-	137	-	137
Test pit		each	-	-	20	20
Auger Boring		each	-	-	20	20
Laboratory Test of Soil and Rock Samples	Specific Gravity of Soil	samples	60	40	40	140
	Natural Moisture Content of Soil	samples	60	40	40	140
	Grain Size Analysis of Soil	samples	60	40	40	140
	Atterberg Limits of Soil	samples	30	20	20	70
	Unit Weight (Wet Density) of Rock	samples	-	20	-	20
	Axial compression test of Rock	samples	-	20	-	20
	Auger Boring	samples	-	-	20	20

Source: JICA Study Team, July 2014

(2) Summary of Results and Findings

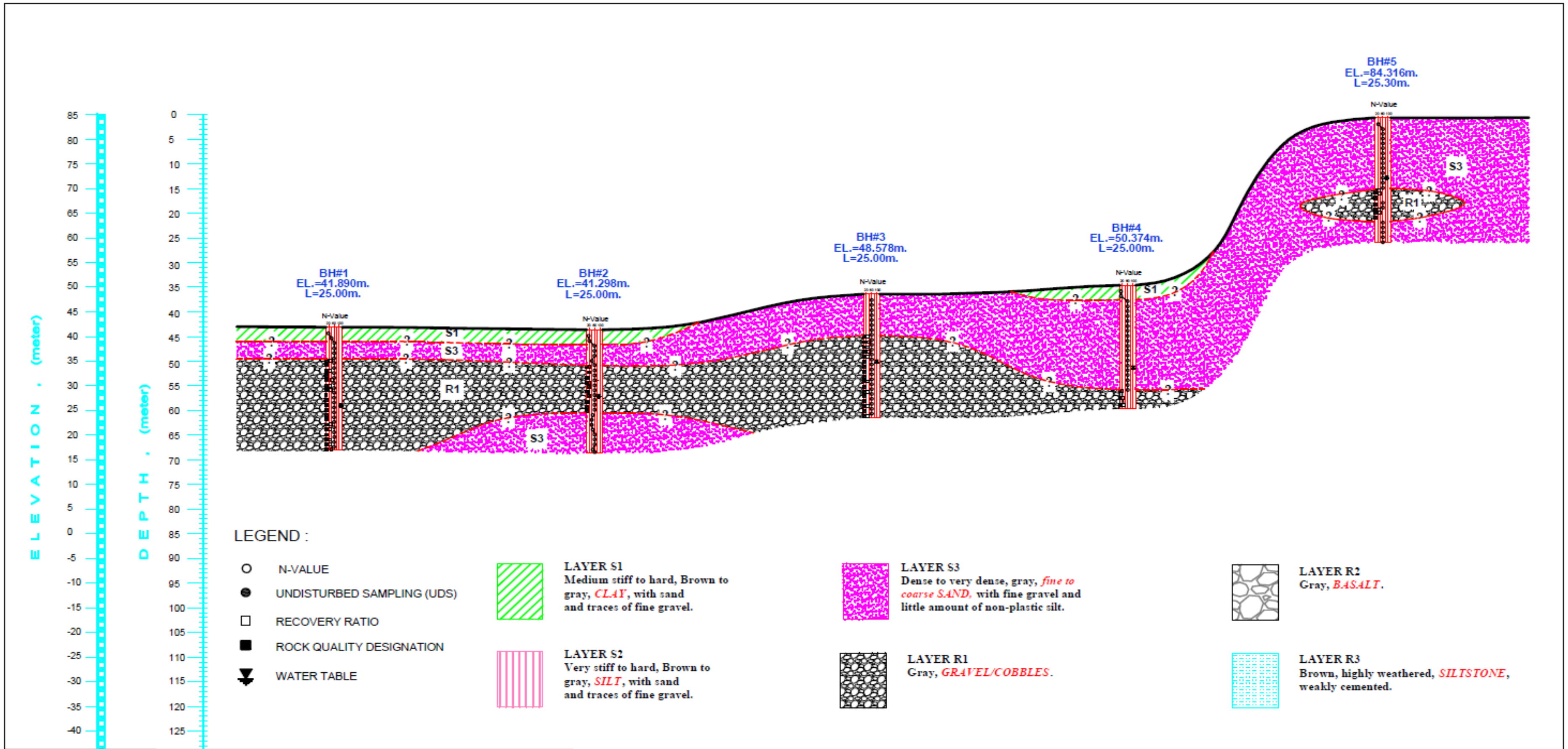
1) Bridge Site Investigation Results

Shown in **Figure 2.1.3-2** are the **20** locations of boring and Standard Penetration Test (SPT) carried out at the bridge sites. Depths of boring at BH-18, 19 and 20 are more than **35 m**. These areas have a thick presence of very soft to very loose fluvial sediments. BH-1 to BH-17 show a favorable subsurface condition. Shown in **Figures 2.1.3-3a-2.1.3-3d** are the soil profile along the bridge sites based on the geotechnical survey undertaken.



Source: JICA Study Team, July 2014

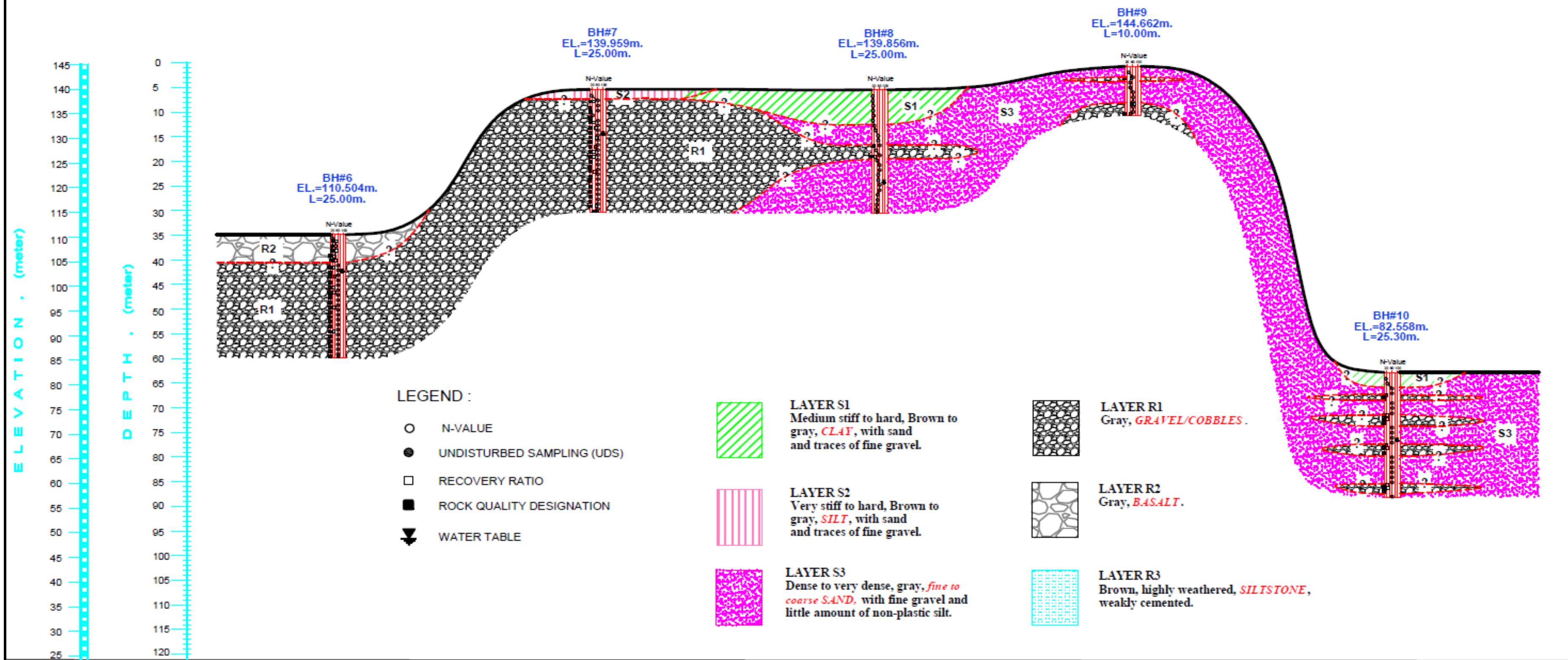
Figure 2.1.3-2 Bridge Site Boring Location Map



TITLE:	**SOIL PROFILE - A**
PROJECT: SOUTHERN MINDANAO ECONOMIC CORRIDOR IMPROVEMENT (DAVAO CITY BYPASS CONSTRUCTION) PROJECT	LOCATION: DAVAO CITY
CLIENT: CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII)	DATE: April 29, 2014 — SHEET NO.: 1 of 4

Source: JICA Study Team, July 2014

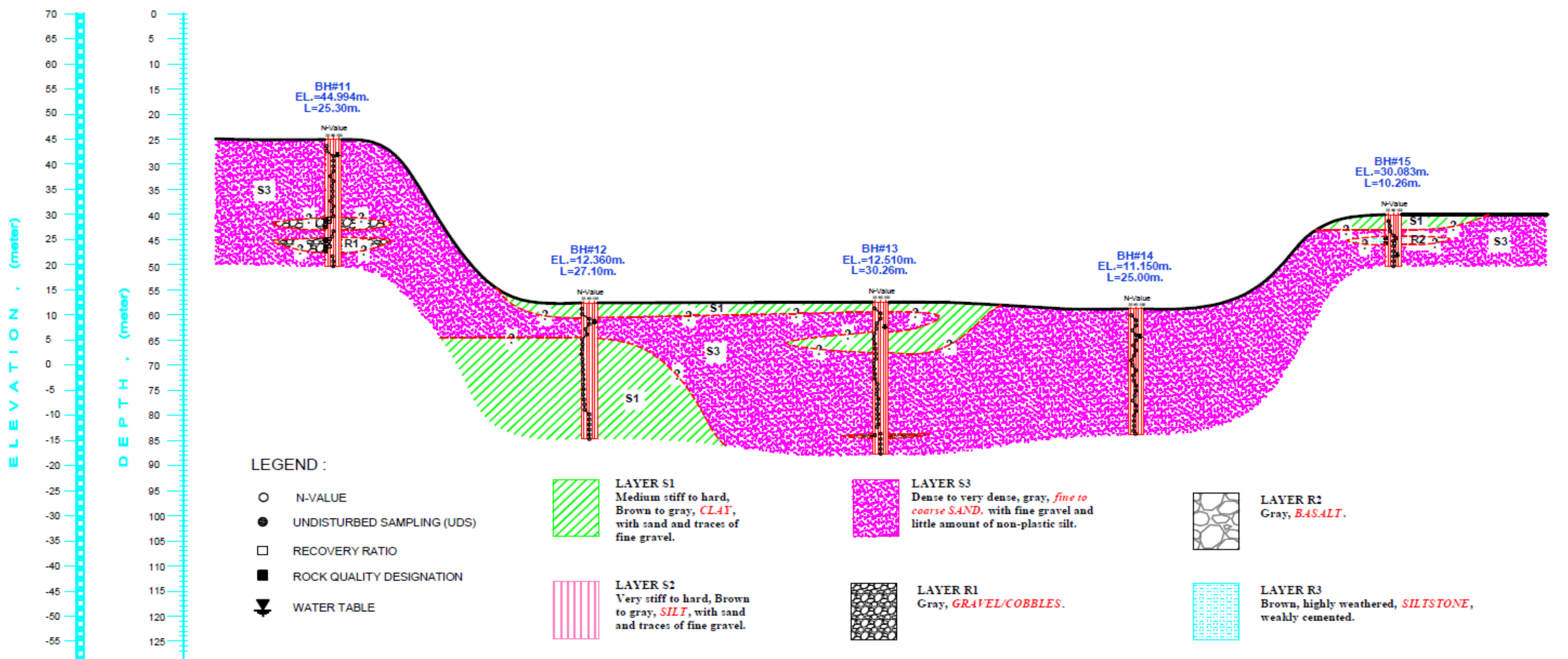
Figure 2.1.3-3a Bridge Sites Soil Profile



TITLE:	SOIL PROFILE - B		
PROJECT:	SOUTHERN MINDANAO ECONOMIC CORRIDOR IMPROVEMENT (DAVAO CITY BYPASS CONSTRUCTION) PROJECT	LOCATION:	DAVAO CITY
CLIENT:	CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII)	DATE: April 29, 2014	SHEET NO.: 2 of 4

Source: JICA Study Team, July 2014

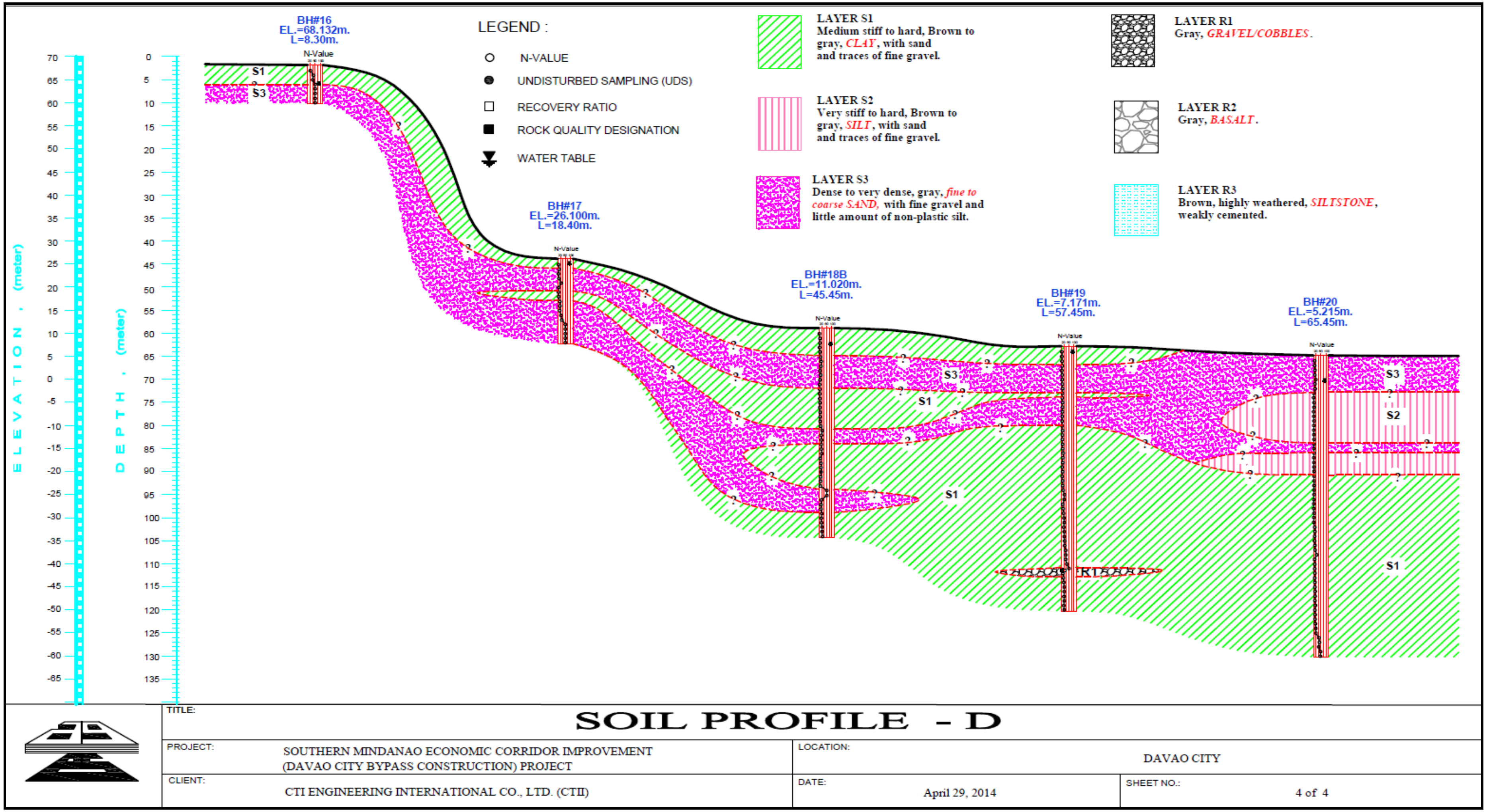
Figure 2.1.3-3b Bridge Sites Soil Profile



TITLE:	**SOIL PROFILE - C**		
PROJECT:	SOUTHERN MINDANAO ECONOMIC CORRIDOR IMPROVEMENT (DAVAO CITY BYPASS CONSTRUCTION) PROJECT	LOCATION:	DAVAO CITY
CLIENT:	CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII)	DATE: April 29, 2014	SHEET NO.: 3 of 4

Source: JICA Study Team, July 2014

Figure 2.1.3-3c Bridge Sites Soil Profile



Source: JICA Study Team, July 2014

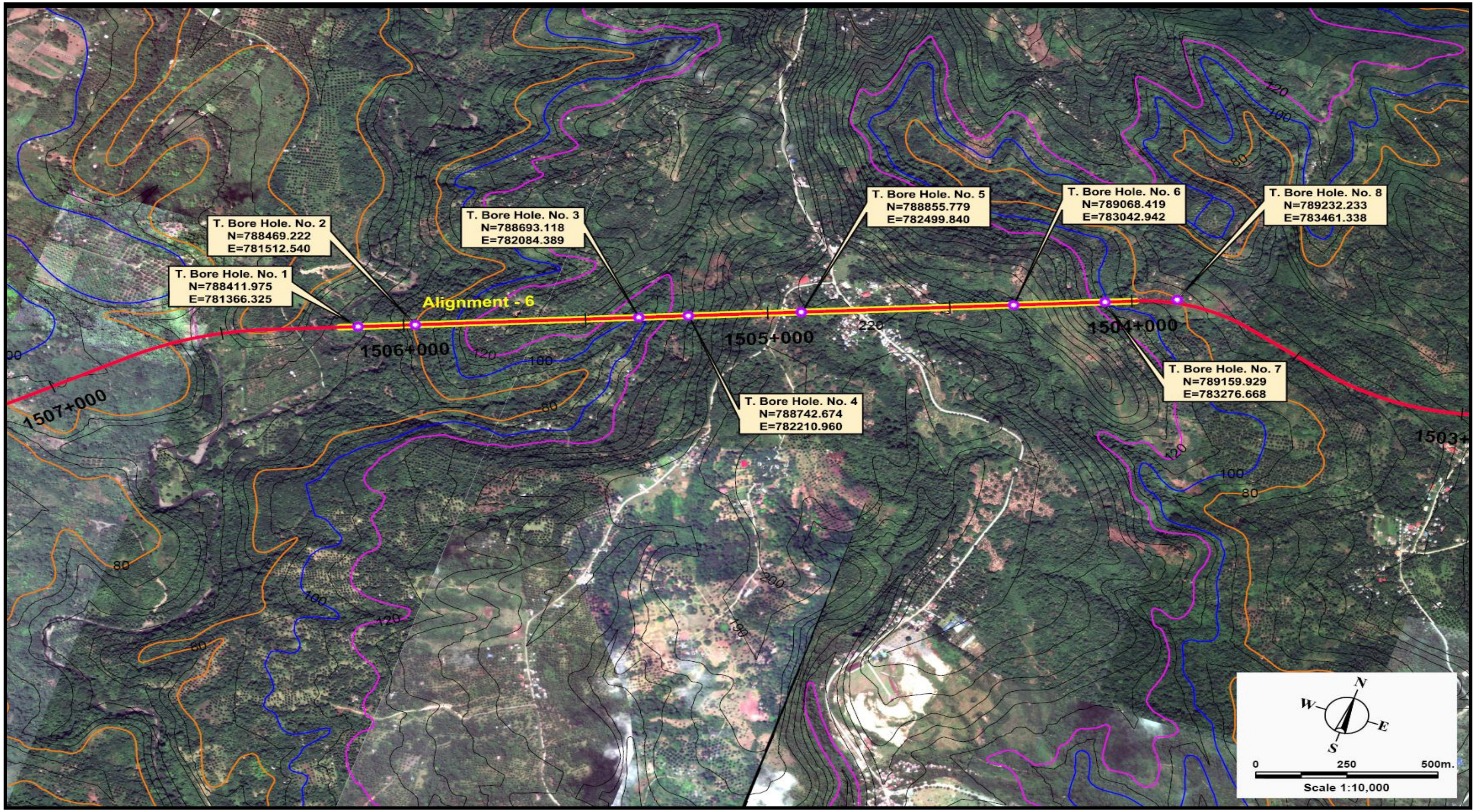
Figure 2.1.3-3d Bridge Sites Soil Profile D

2) Tunnel Section Investigation Results

Boring, standard penetration test, seismic velocity logging and laboratory test of soil were carried out at **eight** (**8**) locations along the proposed tunnel corridor shown in **Figure 2.1.3-4**. Based on the boring results the uppermost material consists of sand and clay layer, with recorded blow counts between **14<N<45** in the upper stretches of layer and hitting practical refusals towards the bottom (**60>N**).

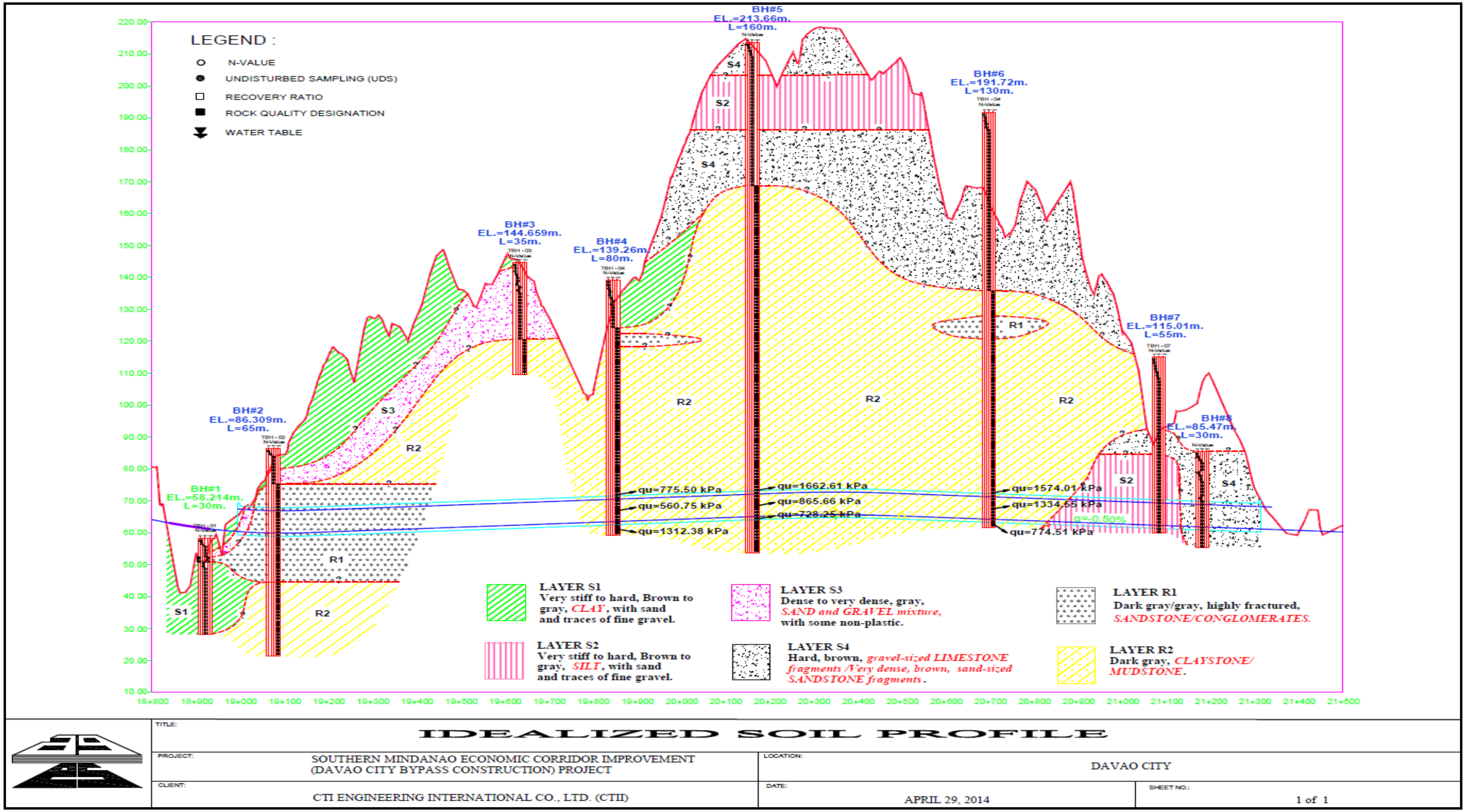
P-wave velocity of mudstone, silt, and sandstone in this area shows common figures, ranging **1,200 ~ 1,800 m/sec**. Based on P-wave test result, these layers is classified as soft rock layer. It is assumed that there is no aquifer layer between the surface and tunnel plan layer based on the result of the P-wave velocity **1,500 m/sec**. So special counter measures shall not be required for underground water of tunnel construction.

The idealized soil profile along proposed the tunnel section based on the geotechnical investigation conducted is shown in **Figure 2.1.3-5**.



Source: JICA Study Team, July 2014

Figure 2.1.3-4 Tunnel Section Boring Location Map



Source: JICA Study Team, July 2014

Figure 2.1.3-5 Idealized Soil Profile at the Tunnel Section

3) Low Embankment Section Investigation Results

Test pit (TP) and auger boring (AB) were conducted from **6+300** to **17+400** and from **35+500** to **44+600**. Laboratory test (physical test, CBR test) of soil samples taken at each location were carried out. Based on the field and laboratory test results of the **20** test pits and **20** auger holes, the excavated soils taken at the uppermost **1.2** to **2.0 meters** depth mainly consist of cohesive materials described as clay, with some content of sand. Summary of the survey results are presented in **Table 2.1.3-2.**

Table 2.1.3-2 Summary of Low Embankment Section Investigation Results (1/3)

Test Pit (TP)				Auger Boring (AB)		
TP No.	**Survey Depth (m)**	**Soil Description**	**CBR (%) @95% MDD**	**AB No.**	**Survey Depth (m)**	**Soil Description**
TP 1 6+300	0 – 1.00	Clay w/ sand & gravel	11.0	AB 1 6+800	0-1.00	Gray, CLAY, medium plastic, with sand.
TP 2 7+300	0 – 1.00	Clay	3.1	AB 2 7+800	0-0.70/ 0.70-1.00	Brown, CLAY, with sand. / Brown, CLAY, medium plastic, with sand.
TP 3 8+300	0.80 – 1.00	Clay	3.7	AB 3 8+800	0-1.00	Brown, CLAY, medium plastic, with sand.
TP 4 9+400	0.20 – 1.00	Clay	3.3	AB-4 9+800	0-1.00	Brown, sandy CLAY, medium plastic.
TP 5 10+200	0.60 – 1.00	Clay	3.1	AB 5 10+800	0-0.40	Brown, CLAY, high plastic.
TP 6 11+300	0.30 – 1.00	Clay	2.8	AB 6 11+800	0-1.00	Dark brown, silty CLAY, slightly plastic, with sand.
TP 7 12+400	0 – 1.00	Clay w/ sand	7.0	AB 7 12+800	0-1.00	Dark brown, sandy CLAY, medium plastic.
TP 8 13+300	0 – 1.00	Clay w/ sand & gravel	8.8	AB 8 13+800	0-0.20/ 0.20-0.50	Brown, CLAY, with gravel and boulders./ Gray, silty CLAY, medium plastic, with sand and fine gravel.

Table 2.1.3-2 Summary of Low Embankment Section Investigation Results (2/3)						
Test Pit (TP)				Auger Boring (AB)		
TP No.	Survey Depth (m)	Soil Description	CBR (%) @95% MDD	AB No.	Survey Depth (m)	Soil Description
TP 9 14+200	0.70 – 1.00	Clay	5.6	AB 9 14+800	0-0.90/ 0.90-1.00	Dark brown, CLAY, with some sand and fine gravel. / Gray, silty CLAY, medium plastic, with sand and fine gravel.
TP 10 15+600	0.30 – 1.00	Clay	3.6	AB 10 16+500	0-0.30/ 0.30-1.00	Brown, silty CLAY, with traces of sand. Brown, CLAY, high plastic, with sand.
TP 11 17+400	0 – 1.00	Clayey Gravel	15.0	AB 11 35+500	0-0.30/ 0.30-1.00	Dark brown, CLAY / Brown, CLAY, high plastic, with sand.
TP 12 36+000	0.60 – 1.00	Clay	4.4	AB 12 36+500	0-0.15/ 0.15-1.00	Brown, CLAY, with some fine gravel./ Brown, CLAY, high plastic, with sand.
TP 13 36+900	0.60 – 1.00	Clay	5.2	AB 13 37+400	0-0.90/ 0.90-1.00	Gray, CLAY, high plastic, with fine gravel./ Gray, CLAY, high plastic, with sand.
TP 14 37+900	0.40 – 0.95	Clay w/ limestone fragments	11.0	AB 14 38+400	0-0.30 / 0.30-1.00	Dark gray, silty CLAY, slightly plastic,with fine gravel and sand/ Brown, silty CLAY, medium plastic, with sand and fine gravel.

Table 2.1.3-2 Summary of Low Embankment Section Investigation Results (3/3)						
Test Pit (TP)				Auger Boring (AB)		
TP No.	**Survey Depth (m)**	**Soil Description**	**CBR (%) @95% MDD**	**AB No.**	**Survey Depth (m)**	**Soil Description**
TP 15 39+000	0.25 – 1.00	Clay	3.6	AB 15 39+700	0-0.15/ 0.15-1.00	Dark gray, sandy CLAY./ Brown, sandy CLAY, medium plastic.
TP 16 40+200	0.70 – 1.00	Sand & Clay	9.8	AB 16 40+700	0-0.10/ 0.10-0.90/ 0.90-1.00	Brownish gray, CLAY, with sand./ Light brown, CLAY, medium plastic, with sand./ Light brown, CLAY, medium plastic, with sand.
TP 17 41+200	0 – 1.00	Clay	5.2	AB 17 41+700	0-1.00	Brownish gray, silty CLAY, medium plastic, with sand.
TP 18 42+200	0 – 1.00	Clay	6.5	AB 18 42+700	0-0.15 / 0.15-1.00	Dark brown, silty CLAY/ Light brown, clayey SAND, slightly plastic
TP 19 43+200	0 – 1.00	Clay	5.8	AB 19 43+700	0-1.00	Brown, silty CLAY, medium plastic, with sand
TP 20 44+200	0 – 1.00	Sand & non-plastic Silt	17.0	AB 20 44+600	0-1.00	Brown, silty CLAY, medium plastic, with sand.

Source: JICA Study Team, July 2014

2.1.3.3 Change in Soil Quality/Fertility

There is no expected change in soil quality/fertility, since soil materials from cut sections will be utilized as banking materials. **Table 2.1.3-3** gives a summary of the volume soil to be cut and amount of embankment materials for filling. It can be discerned from the Table that the estimated volume of cut soil is almost twice as much as the required fill materials for embankment.

Table 2.1.3-3 Estimated Volume of Cut Soil and Embankment

	Cut Volume ($1,000\ m^3$)	Embankment ($1,000\ m^3$)
Package I	541	406
Package II	1,677	1,519
Package III	2,891	522
TOTAL	**5,109**	**2,447**

Source: JICA Study Team, July 2014

Chemical analysis of the soils identified along the bypass alignment was carried out, thus, chemical properties of the soils are not determined

2.1.3.4 Impact Analysis and Mitigation

(1) Construction Phase

Excavation works, cut and fill activities along the bypass alignment sections with rich and fertile soil materials will entail loss of topsoil. This impact however is considered minimal considering that the volume of earth materials to be cut is almost proportion to the volume of soil to be used as fill material for embankment. That is, top soil stripped from the original surface may be temporarily stockpiled and replaced on the surfaces of cut and embankment sections.

Soil quality and fertility is not expected to change. As mentioned above fill materials to be used as embankment will be obtained from materials excavated from cut sections, which are of the same physical and chemical properties.

2.1.4 Terrestrial Ecology

A total of **19** sites for plant survey and **20** sites for bird survey were investigated along the proposed Davao City Bypass Road Construction Project alignment. Sampling sites along the proposed alignment are typical rural-urban locations, ranging from relatively less disturbed riparian habitats in rural areas to highly disturbed human settlements along urban areas. The flora and fauna sampling sites are described in **Table 2.1.4-1**, while the locations are presented in **Figure 2.1.4-1**.

Table 2.1.4-1 Description of Flora and Fauna Sampling Sites 1/2

Station No.	Location	Coordinates	Description	Sampling ID	Ecological Assessment
S1	Lasang River, Brgy. Communal	N 07°08'59.3", E 125 37'07.3	Riparian Habitat near residential area	Transect 1 & Transect 2	Bird Survey
				Site 1	Mist netting for bats and birds
				Site 1	Frogs and Non-volant mammals
				Transect 1	Vegetation Survey
S2	Matina River, Brgy. Langub	N 07 06'21.7", E 125 33'02.2"	Riparian Habitat	Transect 3 & Transect 4	Bird Survey
				Site 2	Frogs and Non-volant mammals
				Transect 2	Vegetation Survey
S3	Talomo River, Brgy. Mintal	N 07 05'41.1", E 125 30'06.9"	River near residential area and public road (Fatima Bridge)	Transect 5	Bird Survey
S4	Lipadas River, Bangkas Heights	N 07 03'02.4", E 125 33'02.2"	Riparian Habitat near residential area	Transect 6 & Transect 7	Bird Survey
				Site 3	Mist netting for bats and birds
				Site 3	Frogs and Non-volant mammals
				Transect 6 & Transect 7	Bird Survey
S5	Brgy. Sirawan	N 07 00'00.35", E 125 28'55.76"	Along national road; agricultural area characterized by bananas, mango tress, coconut trees and other crops	Transect 8	Bird Survey
				Transect 4	Vegetation Survey
S6	Brgy. Marapangi	N 07 01'01.50", E 125 28'28.60"	Farm area along access road; mostly open grass field; mango plantation on the other	Transect 9	Bird Survey
				Transect 5	Vegetation Survey
S7	Brgy. Bato	N 07 01'50.20", E 125 28'30.94"	Along access road; privately owned mango farm	Transect 10	Bird Survey
				Transect 6	Vegetation Survey

Table 2.1.4-1 Description of Flora and Fauna Sampling Sites 2/2

Station No.	Station No.	Station No.	Station No.	Station No.	Station No.
S8	Brgy. Mintal	N 07 05'40.71", E 125 30'6.71	Along national road and highly residential area characterized by private owned coconut farm on one side and lanzones farm on the other.	Transect 11	Bird Survey
				Transect 7	Vegetation Survey
S9	Brgy. Tacunan	N 07 06'12.40", E 125 29'54.90"	Along National Road - residential area	Transect 12	Bird Survey
				Transect 8	Vegetation Survey
S10	Brgy. Magtuod	N 07 07'48.76", E 125 33'35.21"	Along National Road - highly residential area	Transect 13	Bird Survey
				Transect 9	Vegetation Survey
S11	Brgy. Waan	N 07 07'55.40", E 125 34'37.26"	Ranch; exemplified by open grass field/residential area	Transect 14	Bird Survey
				Transect 10	Vegetation Survey
S12	Brgy. TIgatto	N 07 08'09.07", E 125 35'22.02'	Along national road/highly residential area (subdivision)	Transect 15	Bird Survey
				Transect 11	Vegetation Survey
S13	Brgy. Cabantian	N 07 08'18.61", E 125 36'20.16"	Along national road exemplified by privately owned lot on other side	Transect 16	Bird Survey
				Transect 12	Vegetation Survey
S14	Brgy. Indangan	N 07 09'35.32", E 125 37'06.78"	Along national road	Transect 17	Bird Survey
				Transect 13	Vegetation Survey
S15	Brgy. Mudiang	N 07 10'59.99", E 125 37'25.87"	Along access road/residential area; privately owned coconut farm on other side	Transect 18	Bird Survey
				Transect 14	Vegetation Survey
S16	Brgy. Tibungco	N 07 11'47.47", E 125 37'38.06"	Along national road/highly residential area; open area on one side with observed agricultural crops on far ends (coconut trees/banana)	Transect 19	Bird Survey
				Transect 15	Vegetation Survey
S17	Brgy. Mahayag	N 07 12'49.19", E 125 37'35.09"	Along access road; highly vegetated on other side	Transect 20	Bird Survey
				Transect 16	Vegetation Survey
S18	Brgy. San Isidro	N 07 14'56.28", E 125 37'44.71"	Along access road; highly vegetated on other side (coconut trees and other vegetation)	Transect 21	Bird Survey
				Transect 17	Vegetation Survey
S19	Brgy. Lasang	N 07 16'20.40", E 125 39'50.71"	Along national road/highly residential area	Transect 22	Bird Survey
				Transect 18	Vegetation Survey
S20	Matina River, Brgy. Matina Biao (Tunnel Site)	N 07 7'29.08", E 125 32'55.88"	Riparian Habitat	Transect 23	Bird Survey
				Site 4	Mist netting for bats and birds
				Site 4	Frogs and Non-volant mammals
				Transect 19	Vegetation Survey

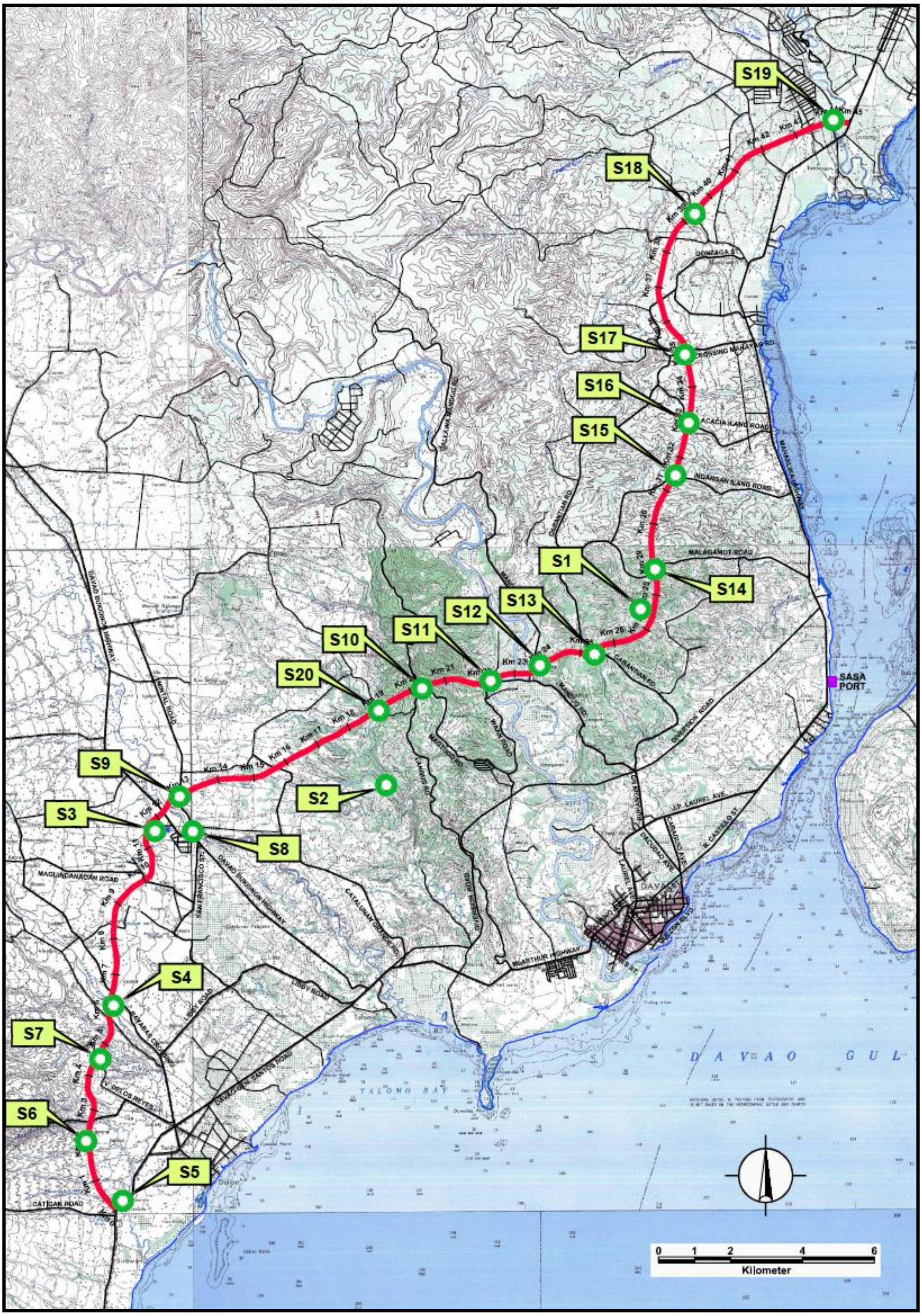


Figure 2.1.4-1 Flora and Fauna Survey Assessment Stations along the Proposed Davao City Bypass Alignment

Photo No. 2.1.4-1 Station 1 – Lasang River, Brgy. Communal

Photo No. 2.1.4-2 Station 2 – Matina River, Brgy. Langub

Photo No. 2.1.4-3 Station 3 – Talomo River, Brgy. Mintal

Photo No. 2.1.4-4 Station 4 – Lipadas River, Bangkas Heights

Photo No. 2.1.4-5 Station 5 – Brgy. Sirawan

Photo No. 2.1.4-6 Station 6 – Brgy. Marapangi

Photo No. 2.1.4-7 Station 7 – Brgy. Bato

Photo No. 2.1.4-8 Station 8 – Brgy. Mintal

Photo No. 2.1.4-9 Station 9 – Brgy. Tacunan

Photo No. 2.1.4-10 Station 10 – Brgy. Magtu-od

Photo No. 2.1.4-11 Station 11 – Brgy. Waan

Photo No. 2.1.4-12 Station 12 – Brgy. Tigatto

Photo No. 2.1.4-13 Station 13 – Brgy. Cabantian



Photo No. 2.1.4-14 Station 14 – Brgy. Indangan


Photo No. 2.1.4-15 Station 15 – Brgy. Mudiang

Photo No. 2.1.4-16 Station 16 – Brgy. Tibungco

Photo No. 2.1.4-17 Station 17 – Brgy. Mahayag

Photo No. 2.1.4-18 Station 18 – Brgy. San Isidro

Photo No. 2.1.4-19 Station 19 – Brgy. Lasang

Photo No. 2.1.4-20 Station 20 – Matina River, Brgy. Matina Biao

2.1.4.1 Flora

(1) Trees and Understory Flora

1) Summary of Flora Survey

Nineteen (**19**) vegetation transects were surveyed across barangays within the proposed alignment of the Davao City Bypass Road Construction Project. As presented in **Table 2.1.4-2**, a total of **5,487** plants were recorded, resolved into **64** families and **185** species, that are further resolved into **one** (**1**) zingiber species, **two** (**2**) aroids, **two** (**2**) fern allies, **two** (**2**) pandan species, **two** (**2**) sedges, **five** (**5**) palms, **15** grasses, **17** ferns, **18** shrubs, **26** herbs, **27** vines, and **62** trees. Representative plants from the study sites are shown in **Photo Nos. 2.1.4-21** to **2.1.4-27.**

Table 2.1.4-2 Summary of Plants Recorded along Proposed Davao City Bypass Alignment (1/6)

Family Name	Official Common Name	Scientific Name	Habit
Acanthaceae	Acanthus	*Acanthus hirsutus*	Herb
Acanthaceae	Bunlaw	*Justicia gendarussa*	Shrub
Acanthaceae	Sanchezia	*Sanchezia speciosa*	Shrub
Acanthaceae	White Funnel Acaranthus	*Ruellia metziae*	Herb
Amaranthaceae	Kulitis	*Amaranthus viridus L.*	Herb
Anarcadiaceae	Mangga	*Mangifera indica*	Tree
Annonaceae	Basikong Kalawang	*Alphonsea arborea*	Tree
Annonaceae	Ilang-Ilang	*Cananga odorata*	Tree
Apocynaceae	Calumpang	*Catharanthus pusillus*	Tree
Apocynaceae	Hingiw	*Ichnocarpus volubilis*	Vine
Apocynaceae	Pandakaki Tsina	*Tabernaemontana divaricata (Linn.) E. Br.*	Shrub
Apocynaceae	Tubli	*Derris tubli Linn.*	Vine
Araceae	Aglaonema	*Aglaonema spp.*	Herb
Araceae	Alupayi	*Homalomena pygmaea*	Aroid
Araceae	Kamay Kastila	*Syngonium podophyllum Schott.*	Aroid
Araceae	Pihau	*Schimatoglottis spp.*	Herb
Araliaceae	Malapapaya	*Polyscias nodosa (Blume) Seem.*	Tree
Arecaceae	African Oil Palm	*Elaeis guineensis*	Palm
Arecaceae	Ditaan	*Daemonorops mollis (Blanco) Merr.*	Vine
Arecaceae	Fishtail Palm	*Caryota mitis*	Palm
Arecaceae	Niyog	*Cocos nucifera L.*	Palm
Arecaceae	Palasan	*Calamus maximus L.*	Vine
Arecaceae	Pugahan	*Caryota cumingii L.*	Palms
Asclepiadaceae	Milkweed	*Ascelpias syriaca*	Herb
Asclepiadaceae	Tayom-Tayom	*Marsdenia tinctoria* R. Br.	Shrub
Asparagaceae	Pony Tail Palm	*Beaucarnea recurvata*	Palm
Asparagaceae	Song of India	*Dracaena reflexa L.*	Herb
Aspleniaceae	Asplenium	*Asplenium azoricum*	Fern
Aspleniaceae	Bird's Nest Fern	*Asplenium australasicum*	Fern
Aspleniaceae	Maidenhair Fern	*Asplenium tenerum Forst.*	Fern
Asteraceae	Dwarf Sunflower	*Helianthus gracilentus*	Herb

Table 2.1.4-2 Summary of Plants Recorded along Proposed Davao City Bypass Alignment (2/6)

Family Name	Official Common Name	Scientific Name	Habit
Asteraceae	Hagonoy	*Chromolaena odorata (L.) R.M.*	Vine
Asteraceae	Sambong	*Blumea balsamifera (L.) DC*	Herb
Asteraceae	Wedelia	*Wedelia chinensis*	Herb
Athyriaceae	Pako	*Diplazium esculentum (Retz.) Sw.*	Fern
Bignoniaceae	African Tulip	*Spathodea campanulata*	Tree
Burseraceae	Bogo	*Garuga floribunda*	Tree
Canabaceae	Anabiong	*Trema orientalis (L.) Blume*	Tree
Caricaceae	Wild Papaya	*Carica papaya*	Tree
Clusiaceae	Guyong-guyong	*Cratoxylum blancoi*	Tree
Combretaceae	Kalamansanai	*Terminalia calamansanai*	Tree
Convolvulaceae	Bulakan	*Merremia peltata L.*	Vine
Convolvulaceae	Kamkamote	*Ipomoea triloba L.*	Vine
Convolvulaceae	Kupit-Kupit	*Merrremia emarginata*	Herb
Convolvulaceae	Malakamote	*Ipomoea obscura L.*	Vine
Convolvulaceae	Spanish Flag	*Ipomoea lobata*	Vine
Costaceae	Step Ladder Plant	*Costus malortieanus*	Herb
Cyperacaea	Arat	*Scleria scrobiculata Nees*	Sedge
Davalliaceae	Solida	*Davallia solida (Forst.) Sw.*	Fern
Dioscoreaceae	Nami	*Dioscorea hispida L.*	Vine
Ebenaceae	Bolong Eta	*Diospyros pilosanthera*	Tree
Euphorbiaceae	Alim	*Melanolepis multiglandulosa*	Tree
Euphorbiaceae	Balitahan	*Bridelia glauca*	Tree
Euphorbiaceae	Cassava	*Manihot esculenta*	Shrub
Euphorbiaceae	Hamindang	*Macaranga bicolor Muell.-Arg.*	Tree
Euphorbiaceae	Kamot Pusa	*Caesalpinia latisiliqua*	Herb
Euphorbiaceae	Malabagang	*Glochidian album (Blanco) Boerl.*	Shrub
Euphorbiaceae	Matang Hipon	*Breynia rhamnoides (Retz.) Muell.-Arg.*	Shrub
Euphorbiaceae	Poinsettia	*Euphorbia pulcherrima*	Shrub
Euphorbiaceae	Soro-sampalok	*Euphorbia neriiflora*	Herb
Euphorbiaceae	Tawa-Tawa	*Euphorbia hirta*	Herb
Euphorbiaceae	Tuba-Tuba	*Jatropha curcas*	Shrub
Euphorbiaceae	Takip Asin	*Macaranga grandifolia (Blanco) Merr.*	Tree

Table 2.1.4-2 Summary of Plants Recorded along Proposed Davao City Bypass Alignment (3/6)

Family Name	Official Common Name	Scientific Name	Habit
Fabaceae	Acapulco	*Cassia alata*	Shrub
Fabaceae	Agpoi	*Phanera integrifolia subsp. cumingiana*	Vine
Fabaceae	Ascova	*Cytisus scoparius*	Shrub
Fabaceae	Balayong	*Afzelia rhomboidea*	Tree
Fabaceae	Centrosema	*Centrosema plumeiri*	Vine
Fabaceae	Hairy-leafed centrosema	*Centrosema pubescens L.*	Vine
Fabaceae	Ipil-Ipil	*Leucaena leucocephala*	Tree
Fabaceae	Kawati	*Gliricidia sepium*	Tree
Fabaceae	Makahiya	*Mimosa pudica L.*	Herb
Fabaceae	Mani-Manihan	*Desmodium capitatum*	Shrub
Fabaceae	Payang-Payang	*Desmodium pulchellum* (L.) Desv.	Shrub
Fabaceae	Prickly Narra	*Pterocarpus indicus echinus*	Tree
Fabaceae	Smooth Narra	*Pterocarpus indicus indicus*	Tree
Fabaceae	Tayom	*Indigofera suffruticosa Mill.*	Shrub
Fabaceae	Yellow Creeper	*Arachis duranensis*	Vine
Flagellariaceae	Balingwai	*Flgellaria indica L.*	Vine
Gleicheniaceae	Kilob	*Dicranopteris linearis*	Fern
Gleicheniaceae	Sticherous Fern	*Sticherous truncatus (Willd.) Nakaii*	Fern
Gnetaceae	Kuliat	*Gnetum gnemon*	Vine
Guttiferae	Paguringan	*Cratoxylon arboreum*	Tree
Lamiaceae	Dilang Baka	*Hypyis capitata Jacq.*	Herb
Lamiaceae	Gmelina	*Gmelina arborea*	Tree
Lamiaceae	Molaveng Aso	*Vitex cofassus*	Tree
Lamiaceae	Turukan	*Hyptis capitata Jacq.*	Herb
Lauraceae	Marang	*Litsea perrottettii*	Tree
Leguminosae	Brazilian Fire Tree	*Schizolobium parahyba*	Tree
Loganiaceae	Strychnos vine	*Strychnos multiflora L.*	Vine
Lycopodiaceae	Lycopodium	*Lycopodium sp.*	Fern All
Lygodiaceae	Nito	*Lygodium flexuosum (L.) Sm.*	Vine
Lygodiaceae	Nitong Hapon	*Lygodium japonicum*	Vine
Lythraceae	Luktob	*Duabanga moluccana*	Tree
Malvaceae	Balobo	*Diplodiscus paniculatus*	Tree
Malvaceae	Banalo	*Thespesia populnea*	Tree

Table 2.1.4-2 Summary of Plants Recorded along Proposed Davao City Bypass Alignment (4/6)

Family Name	Official Common Name	Scientific Name	Habit
Malvaceae	Biknong	*Kleinhovia hospita*	Tree
Malvaceae	Cacao	*Theobroma cacao*	Tree
Malvaceae	Malubago	*HIbiscus tiliaceus*	Tree
Malvaceae	Tan-ag	*Kleinhovia hospita*	Tree
Malvaceae	Walis-walisan	*Sida acuta Burm. f.*	Herb
Marantaceae	Bamban	*Donax cannaeformis*	Herb
Marattiaceae	Giant Fern	*Marattia sylvatica Bl.*	Ferns
Menispermaceae	Ligtang	*Anamirta cocculus*	Vine
Menispermaceae	Cyclea	*Cyclea merrilli*	Sedge
Moraceae	Alangas	*Ficus heteropoda Miq.*	Tree
Moraceae	Antipolo	*Artocarpus blancoi (Elmer) Merr.*	Tree
Moraceae	Basikong	*Ficus botryocarpa Miq.*	Tree
Moraceae	Dulalug	*Ficus variegate Blume var. sycomoroides (Miq.)*	Tree
Moraceae	Ficus spp.	*Ficus lanceolata*	Tree
Moraceae	Hagimit	*Ficus minahassae*	Tree
Moraceae	Hawili	*Ficus septica Burma f. var. septica*	Shrub
Moraceae	Isis	*Ficus ulmifolia*	Tree
Moraceae	Malagumihan	*Artocarpus elasticus*	Tree
Moraceae	Malatibig	*Ficus congesta var. congesta*	Tree
Moraceae	Niyug-niyugan	*Ficus pseudopalma Blanco*	Tree
Moraceae	Tangisang Bayawak	*Ficus variegata Blume var. variegata*	Tree
Moraceae	Tangisang Layugan	*Ficus latsonii*	Tree
Moraceae	Tibig	*Ficus nota (Blanco) Merr.*	Tree
Myrtaceae	Bayabas	*Psidium guajava*	Tree
Myrtaceae	Binunga	*Tristaniopsis dicorticata*	Tree
Nephrolepidaceae	Alulukdo	*Nephrolepis hirsutula*	Fern
Nephrolepidaceae	Christella	*Christella parasitica (Lindl.) Lev.*	Fern
Oleandraceae	Pakong-kalabaw	*Nephrolepis biserrta (Sw.) Schott.*	Fern
Osmundaceae	Osmunda/Royal Fern	*Osmunda banksiifolia (C. Prosl.) Kuhn.*	Fern
Pandanaceae	Bariu	*Pandanus copelandii Merr.*	Pandan
Pandanaceae	Pandan-layugan	*Pandanus exaltatus Blanco*	Pandan

Table 2.1.4-2 Summary of Plants Recorded along Proposed Davao City Bypass Alignment (5/6)

Family Name	Official Common Name	Scientific Name	Habit
Passifloraceae	Pasiflora	*Pasiflora spp.*	Vine
Piperaceae	Palo Verde	*Piper arborescens*	Tree
Piperaceae	Pamintang-aso	*Piper interruptum Opiz.*	Vine
Piperaceae	Piper	*Piper spp.*	Vine
Poaceae	Amorseco	*Andropogon aciculatos*	Grass
Poaceae	Bikal	*Dinochlea acutiflora (Munro) S. Dransf.*	Grass
Poaceae	Carabao Grass	*Paspalum conjugatum Berg.*	Grass
Poaceae	Carpet Grass	*Axonopus fissifolius*	Grass
Poaceae	Cat's Tail	*Typha orientalis*	Grass
Poaceae	Cogon	*Imperata cylindrica var. koenigii*	Grass
Poaceae	Crab Grass	*Digitaria sanguinalis*	Grass
Poaceae	Fishing Rod Bamboo	*Schizostachyum lima (Blanco) Merr.*	Grass
Poaceae	Johnson Grass	*Sorghum halapense*	Grass
Poaceae	Nut Grass	*Cyperus rotundus*	Grass
Poaceae	Paragis	*Eleusine indica (L.) Gaertn.*	Grass
Poaceae	Pusher Bamboo	*Schizostachyum fennixii*	Grass
Poaceae	Talahib	*Saacharum spontaneum L.*	Grass
Poaceae	Tambo	*Thysonolaena latifolia (Roxb. Ex Hornem.) Honda*	Grass
Poaceae	Whipping Grass	*Sporobolus indicus L.*	Grass
Polypodaceae	Kabkab/Oak-Leaf Fern	*Drynaria quercifolia (L.) Sm.*	Fern
Polypodaceae	Thai Fern	*Microsorum thailandicum*	Fern
Rhamnaceae	Salapao	*Ventilago dichotoma*	Vine
Rubiaceae	Bangkal	*Nauclea orientalis*	Tree
Rubiaceae	Dilang Butiki	*Dentella repens*	Herb
Rubiaceae	Kahoy Dalaga	*Mussaenda philippica A.Rich*	Tree
Rutaceae	Kalamansi	*Citrofortunella microcarpa*	Tree
Salicaceae	Aninguai	*Scolopia luzoniensis (Presl.) Merr.*	Vine
Sapindaceae	Kapulasan	*Nephelium mutabile*	Tree
Sapindaceae	Large Leaf Malugay	*Pometia pinnata*	Tree
Sapotaceae	Kaimito	*Chrysophyllum cainito*	Tree
Selaginellaceae	Kamariang Gubat	*Selaganella planna Hieron*	Fern Ally
Selaginellaceae	Selaginella	*Selaginella involvens (Sw.) Spreng*	Ferns

Table 2.1.4-2 Summary of Plants Recorded along Proposed Davao City Bypass Alignment (6/6)

Family Name	Official Common Name	Scientific Name	Habit
Solanaceae	Malatalong	*Solanum verbascifolim* Linn.	Shrub
Sterculiaceae	Bayok	*Pterospermum diversifolium*	Tree
Sterculiaceae	Labayo	*Commersonia platyphylla*	Shrub
Sterculiaceae	Taloto	*Pterocymbium tinctorium*	Tree
Sterculiaceae	U-us	*Sterculia glabrifolia*	Tree
Thelypteridaceae	Cristella Fern	*Christella dentata*	Ferns
Tiliaceae	Kulot-kulotan	*Triumfetta rhomboidea Jacq.*	Herb
Urticaceae	Alagasi	*Leucosyke capitellata*	Shrub
Urticaceae	Rami	*Boehmeria nivea*	Herb
Verbenaceae	Coronitas	*Lantana camara*	Herb
Verbenaceae	Kandikandilaan	*Stachytarpheta jamaicacensis*	Herb
Verbenaceae	Magilik	*Premna cumingiana*	Tree
Verbenaceae	Molave	*Vitex parviflora*	Tree
Verbenaceae	White Kandi-kandilaan	*Stachytarpheta jamaicensis Linn.*	Herb
Vitaceae	Alangingi	*Cayratia guineensis G.Don*	Vine
Vitaceae	Ayo	*Terrastigma harmandii*	Vine
Vitaceae	Kaliantan	*Leea philippinensis*	Tree
Zingiberaceae	Tagbak	*Alpinia elegans L.*	Zingiber
	Anilaw		
	Bataran Grass		
	Diliman/Hagnaya	*Stenochlaena melnei Underw.*	Fern
	Igyu	*Dysoxylum daeandrum*	Tree
	Kalokoy		
	Kulot-Kulot		
	Lupog-Lupog		
	Teramycin Plant		

2) Detailed Results of Flora Survey

(a) Transect Line 1 (S1) – Brgy. Communal (Lasang River)

Transect **1**, established at Brgy. Communal revealed a total of **252** individuals resolved into **31** species. *Centrosema pubescens* (Hairy leaf centrosema) and *Cyperus rotundus L.* (Mutha) dominated the survey with an importance value of **16.93%**, followed by *Stachytarpheta jamaicacensis* (Kandi-kandilaan), *Leucosyske capitellata* (Alagasi), *Donax acutiflora* (Bamban), and *Triumfetta rhomboidea* (Kulot-kulotan) with importance values of **14.15**, **12.56**, **11.64**, and **8.51%** respectively (refer to **Table 2.1.4-3**). This transect was established in an agricultural area planted with coconut trees that intergrade into open grassland areas.

Table 2.1.4-3 Importance Values Top 5 Flora Species Recorded in Transect 1 (Lasang River, Brgy. Communal)

Species Name	Common Name	Abundance	Frequency	Relative Abundance (%)	Relative Frequency (%)	Importance Value (%)
Centrosema pubescens	Hairy Leaf Centrosema	24	6	9.52	7.41	16.93
Cyperus rotundus	Mutha	24	6	9.52	7.41	16.93
Stachytarpheta jamaicacensis	Kandi-kandilaan	17	6	6.75	7.41	14.15
Leucosyske capitellata	Alagasi	13	6	5.16	7.41	12.56
Donax acutiflora	Bamban	20	3	7.94	3.70	11.64
Triumfetta rhomboidea	Kulot- kulotan	9	4	3.57	4.94	8.51

(b) Transect Line 2 (S2) – Brgy. Langub (Matina River)

Transect 2 in Barangay Langub established along the river bank of Matina River revealed a total of **116** species, the highest number of species recorded among **19** transects, dominated by *Imperata cylindrica* (Cogon) with an importance value of **5.54%**, followed by *Nephrolepsis hirsutula* (Alulukdo), *Centrosema pubescens L.* (Hairy Leaf Centrosema), *Syngonium podophyllum*, *Stachytarpheta jamaicacensis*, *Cyperus rotundus*, and *Nephrolepis biserrata* each with an importance value of **5%** (refer to **Table 2.1.4-4**). *Chromolaena odorata* (Hagonoy) and *Eleusine indica* (Paragrass) were also abundant in this transect both with an importance value of **4.46%**, followed by *Digitaria sanguinalis*

(Crab Grass) and *Seleria scrobiculata Nees* (Arat) with **4.0** and **3.77%** importance value, respectively.

Table 2.1.4-4 Importance Values of Top 5 Flora Species Recorded in Transect 2 (Matina River, Brgy. Langub)

Species Name	Common Name	Abundance	Frequency	Relative Abundance (%)	Relative Frequency (%)	Importance Value (%)
Imperata cylindrica	Cogon	30	10	3.24	2.29	5.54
Nephrolepsis hirsutula	Alulukdo	25	10	2.7	2.29	5
Centrosema pubescens	Hairy Leaf Centrosema	25	10	2.7	2.29	5
Syngonium podophyllum	Kamay Kastila	25	10	2.7	2.29	5
Stachytarpheta jamaicacensis	Kandi-kandilaan	25	10	2.7	2.29	5
Cyperus rotundus	Nut Grass	25	10	2.7	2.29	5
Nephrolepis biserrata	Pakong Kalabaw	25	10	2.7	2.29	5
Chromolaena odorata	Hagonoy	20	10	2.16	2.29	4.46
Eleusine indica	Paragrass	20	10	2.16	2.29	4.46
Digitaria sanguinalis	Crab Grass	20	8	2.16	1.83	4
Seleria scrobiculata	Arat	20	7	2.16	1.61	3.77

(c) Transect Line 3 (S4) – Brgy.Bangkas Heights, Lipadas River

A total of **76** species of plants were recorded in Transect **3**, established along the riparian zone of Lipadas River in Bangkas Heights (**Table 2.1.4-5**). *Nephrolepis biserrata* (Pakong kalabaw) and *Melanolepis multiglandulosa* (Alim) were the most abundant species with importance values of **9.46** and **8.54%**, respectively, followed by *Centrosema pubescens* (Hairy leaf centrosema), *Ficus ulmifolia* (Isis), *Stachytarpheta jamaicacensis* (Kandi-Kandilaan), and *Sorghum halapense* (Johnson grass) each with an importance values of **7.62 %,** followed by *Nephrolepsis hirsutula* (Alulukdo) and *Sida acuta* (Walis-walisan) at **6.83** and **6.69%,** respectively.

Table 2.1.4-5 Importance Values of Top 5 Flora Species Recorded in Transect 3 (Lipadas River, Brgy. Bangkas Heights)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Nephrolepis bisserta	Pakong Kalabaw	30	10	5.52	3.94	9.46
Melanolepis multiglandulosa	Alim	25	10	4.60	3.94	8.54
Centrosema pubescens	Hairy Leaf Centrosema	20	10	3.68	3.94	7.62
Ficus ulmifolia	Isis	20	10	3.68	3.94	7.62
Stachytarpheta jamaicacensis	Kandi-Kandilaan	20	10	3.68	3.94	7.62
Sorghum halapense	Johnson Grass	20	10	3.68	3.94	7.62
Nephrolepsis hirsutula	Alulukdo	20	8	3.68	3.14	6.83
Sida acuta	Walis-walisan	15	10	2.76	3.93	6.69

(d) Transect Line 4 (S5) – Brgy.Sirawan

Transect 4 across corn fields and mango trees in Brgy. Sirawan recorded **39** species, dominated by *Imperata cylindrica* (Cogon) and *Saccharum spontaneum* (Talahib) both with an importance value of **15.8%,** followed by *Centrosema pubescens* (Hairy Leaf Centrosema), *Chromolaena odorata* (Hagonoy) and *Eleusine indica* (Paragrass) each with an importance value of **12.83%,** and *Sporobolus indicus* and *Ficus septica* (Hawili) with an importance value of **9.72** and **8.48%,** respectively. The importance value table of the flora species recorded in Transect 3 are presented in **Table 2.1.4-6**.

Table 2.1.4-6 Importance Values of Top 5 Flora Species Recorded in Transect 4 (Brgy. Sirawan)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Imperata cylindrica	Cogon	30	10	8.90	6.90	15.80
Saacharum spontaneum	Talahib	30	10	8.90	6.90	15.80
Centrosema pubescens	Hairy leaf Centrosema	25	10	7.42	6.90	14.31
Chromolaena odorata	Hagonoy	20	10	5.93	6.90	12.83
Eleusine indica	Paragrass	20	10	5.93	6.90	12.83
Sporobolus indicus	Whipping Grass	15	7	4.45	4.82	9.27
Ficus septica Burma	Hawili	10	8	2.97	5.51	8.48

(e) Transect Line 5 (S6) – Brgy.Marapangi

Transect 5 was established several meters from the boundary of Nenita's Farm. This transect recorded **31** species dominated by *Imperata cylindrica* (Cogon) and *Paspalum conjugatum* (Carabao Grass) with importance values of **31.85%** and **25.68%**, respectively, followed by *Ipomoea triloba*. (Kamkamote) and *Cyperus rotundus* (Nut Grass) each with an importance value of **12.84%,** and *Centrosema pubescens* (Hairy Leaf Sentrosima) with **11.51%,** and *Schizolobium parahyba* (Brazilian Fire Tree) and *Axonopus fissifolius* (Carpet Grass) both with an importance value of **10.17%** (**Table 2.1.4-7**). The site is characterized by open grassland on one side and mango plantation on the other.

Table 2.1.4-7 Importance Values Top 5 Flora Species Recorded in Transect 4 (Brgy. Marapangi)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Imperata cylindrica	Cogon	30	10	18.52	13.33	31.85
Paspalum conjugatum	Carabao Grass	20	10	12.35	13.33	25.68
Ipomoea triloba	Kamkamote	10	5	6.17	6.67	12.84
Cyperus rotundus	Nut Grass	10	5	6.17	6.67	12.84
Centrosema pubescens	Hairy leaf Centrosema	10	4	6.17	5.33	11.51
Schizolobium parahyba	Brazilian Fire tree	10	3	6.17	4	10.17
Axonopus fissifolius	Carpet Grass	10	3	6.17	4	10.17

(f) Transect Line 6 (S7) – Brgy.Bato

Transect 6 was established in Brgy. Bato along a public road surrounded by privately owned mango orchard on either side. About **25** species were recorded in this transect dominated by *Centrosema pubescens* with an importance value of **19.41%,** followed by *Imperata cylindrica* (Cogon), *Axonopus fissifolius* (Crabgrass), *Chromolaena odorata* (Hagonoy), *Stachytarpheta jamaicacensis* (Kandi-kandilaan), and *Cyperus rotundus* (Nut Grass) each with an importance value of **14.09%,** and *Saccharum spontaneum* (Talahib), and *Sporobolus indicus* (Whipping Grass) both with **12.37%** (**Table 2.1.4-8**). Other dominant species are *Eleusine indica* and *Leucaena leucocephala* (Ipil-ipil) with importance values of **8.77** and **8.05%,** respectively.

Table 2.1.4-8 Importance Values of Top 5 Flora Species Recorded in Transect 6 (Brgy. Bato)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Centrosema pubescens	Hairy leaf Centrosema	15	5	10.79	8.62	19.41
Imperata cylindrica	Cogon	10	4	7.19	6.90	14.09
Axonopus fissifolius	Crab Grass	10	4	7.19	6.90	14.09
Chromolaena odorata	Hagonoy	10	4	7.19	6.90	14.09
Stachytarpheta jamaicacensis	Kandi-kandilaan	10	4	7.19	6.90	14.09
Cyperus rotundus	Nut Grass	10	4	7.19	6.90	14.09
Saacharum spontaneum	Talahib	10	3	7.19	5.17	12.37
Sporobolus indicus	Whipping Grass	10	3	7.19	5.17	12.37
Eleusine indica	Paragrass	5	3	3.60	5.17	8.77
Leucaena leucocephala	Ipil-ipil	4	3	2.88	5.17	8.05

(g) Transect Line 7 (S8) – Brgy.Bato

Transect 7 in Barangay Mintal ran across a *lanzones plantation*, where **29** species were recorded dominated by *Arachis duranensis* (Yellow Creeper) with an importance value of **23.41%**, followed by *Axonopus fissifolius* (Carpet Grass) at **14.37%** (refer to **Table 2.1.4-9**). The rest of the abundant species were *Digitaria sanguinalis* (Crab Grass) and *Chromolaena odorata* (Hagonoy) both with **13.04%**, *Paspalum conjugatum* (Carabao Grass) with **11.70**, and *Saacharum spontaneum L.* (Talahib) and *Thysonolaena latifolia* both with an importance value of **10.37%**.

Table 2.1.4-9 Importance Values of Top 5 Flora Species Recorded in Transect 7 (Brgy. Mintal)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Arachis duranensis	Yellow Creeper	20	8	12.74	10.67	23.41
Axonopus fissifolius	Carpet Grass	10	6	6.37	8.00	14.37
Digitaria sanguinalis	Crab Grass	10	5	6.37	6.67	13.04
Chromolaena odorata	Hagonoy	10	5	6.37	6.67	13.04
Paspalum conjugatum	Carabao Grass	10	4	6.37	5.33	11.70
Saacharum spontaneum	Talahib	10	3	6.37	4.00	10.37
Thysonolaena latifolia	Tambo	10	3	6.37	4.00	10.37

(h) Transect Line 8 (S9) – Brgy. Tacunan

A total of **31** species were recorded in **Transect 8,** Brgy. Tacunan among residential areas near *Durian* and *Lanzones* plantation, dominated by *Sporobolus indicus L.* (Whipping Grass), with an importance value of **22.63%,** followed by *Arachis duranensis* (Yellow Creeper) and *Saacharum spontaneum L.* (Talahib) with importance values of **20.10%** and **14.58%,** respectively (see **Table 2.1.4-10**). Other abundant species were *Chromolaena odorata* (Hagonoy), *Amaranthus viridis L.* (Kulitis), Kulot-kulot, *Dioscorea hispida L.* (Nami), and *Eleusine indica* (Paragrass) each with an importance value of **10.05%,** while *Paspalum conjugatum* (Carabao Grass) and *Imperata cylindrica* (Cogon) both have an importance value of **9.05%**.

Table 2.1.4-10 Importance Values of Top 5 Flora Species Recorded in Transect 8 (Brgy. Tacunan)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Sporobolus indicus	Whipping Grass	25	10	12.63	10	22.63
Arachis duranensis	Yellow Creeper	20	10	10.10	10	20.10
Saacharum spontaneum	Talahib	15	7	7.58	7	14.58
Chromolaena odorata	Hagonoy	10	5	5.05	5	10.05
Amaranthus viridus	Kulitis	10	5	5.05	5	10.05
	Kulot-kulot	10	5	5.05	5	10.05
Dioscorea hispida	Nami	10	5	5.05	5	10.05
Eleusine indica	Paragrass	10	5	5.05	5	10.05
Paspalum conjugatum	Carabao Grass	10	4	5.05	4	9.05
Imperata cylindrica var. koenigii	Cogon	10	4	5.05	4	9.05

(i) Transect Line 9 (S10) – Brgy. Magtu-od

Transect 9 in Brgy. Magtuod recorded a total of **34** species dominated by *Digitaria sanguinalis* (Crab Grass) with an importance value of 22.35%, followed by *Saacharum spontaneum* (Talahib) and *Cyperus rotundus* (Nut Grass) with importance values of **15.51%** and **13.67%**, respectively. The other abundant species were *Eleusine indica* (Paragrass) and *Sporobolus indicus* (Whipping Grass), both with an importance value of **12.42%.** This is followed by *Manihot esculenta* (Cassava) and *Wedelia chinensis* (Wedelia) each with an importance value of **11.17%** as indicated in **Table 2.1.4-11**.

Table 2.1.4-11 Importance Values Top 5 Flora Species Recorded in Transect 9 (Brgy. Magtu-od)						
Species Name	**Common Name**	**Abund ance**	**Freque ncy**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Digitaria sanguinalis	Crab Grass	20	8	12.35	10	22.35
Saacharum spontaneum	Talahib	15	5	9.26	6.25	15.51
Cyperus rotundus	Nut Grass	10	6	6.17	7.5	13.67
Eleusine indica	Paragrass	10	5	6.17	6.25	12.42
Sporobolus indicus	Whipping Grass	10	5	6.17	6.25	12.42
Manihot esculenta	Cassava	10	4	6.17	5	11.17
Wedelia chinensis	Wedelia	10	4	6.17	5	11.17

(j) Transect Line 10 (S11) – Brgy. Waan

About **39** species were recorded along **Transect 10** in Brgy. Waan, dominated by *Cyperus rotundus* (Nut Grass) with an importance value of **25%**, followed by *Imperata cylindrica* (Cogon) and *Digitaria sanguinalis* with importance values of **13.84%** and **12.67%**, respectively (refer to **Table 2.1.4-12**). *Paspalum conjugatum* (Carabao Grass), *Mimosa pudica* (Makahiya), and *Saccharum spontaneum* (Talahib) were also abundant in this transect, each having an importance value of **11.16%**, followed by *Centrosema pubescens* (Hairy Leaf Centrosema), *Ipomoea triloba* (Kamkamote), Kulot-kulot, *Desmodium capitatum* (Mani-manihan), and *Sporobolus indicus* (Whipping Grass), each with an importance value of **10%**.

Table 2.1.4-12 Importance Values of Top 5 Flora Species Recorded in Transect 10 (Brgy. Waan)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Cyperus rotundus	Nut Grass	25	10	13.37	11.63	25
Imperata cylindrica	Cogon	15	5	8.02	5.81	13.84
Digitaria sanguinalis	Crab Grass	15	4	8.02	4.65	12.67
Paspalum conjugatum	Carabao Grass	10	5	5.35	5.81	11.16
Mimosa pudica	Makahiya	10	5	5.35	5.81	11.16
Saacharum spontaneum	Talahib	10	5	*5.35*	5.81	11.16
Centrosema pubescens	Hairy Leaf Centrosema	10	4	5.35	4.65	10
	Kulot-kulot	10	4	5.35	4.65	10
Desmodium capitatum	Mani-manihan	10	4	5.35	4.65	10
Sporobolus indicus	Whipping Grass	10	4	5.35	4.65	10

(h) Transect Line 11 (S12) – Brgy. Tigatto

Transect 11 along human settlements in Brgy. Tigatto recorded a total of **42** species, dominated by *Saccharum spontaneum* (Talahib) with an importance value of **17.45%**, followed by *Sporobolus indicus* (Whipping Grass), *Cyperus rotundus* (Nut Grass), and *Mimosa pudica* (Makahiya) with importance values of **14.29%**, **12.69%**, and **10.58%**, respectively. The other top **five** (**5**) species as can be discerned from **Table 2.1.4-13** are represented by *Imperata cylindrica* (Cogon Grass) and *Digitaria sanguinalis* (Crab Grass) with an importance value of **9.53%.**

Table 2.1.4-13 Importance Values of Top 5 Flora Species Recorded in Transect 11 (Brgy. Tigatto)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Saacharum spontaneum	Talahib	15	9	7.98	9.47	17.45
Sporobolus indicus	Whipping Grass	15	6	7.98	6.32	14.29
Cyperus rotundus	Nut Grass	10	7	5.32	7.37	12.69
Mimosa pudica	Makahiya	10	5	5.32	5.26	10.58
Imperata cylindrica	Cogon Grass	10	4	5.32	4.21	9.53
Digitaria sanguinalis	Crab Grass	10	4	5.32	4.21	9.53

(i) Transect Line 12 (S13) – Brgy. Cabantian

Transect 12, established along a farm area in Brgy. Cabantian, recorded a total of **47** species dominated by *Imperata cylindrica* (Cogon) with an importance value of **19.08%**, followed by *Digitaria sanguinalis* (Crab Grass), *Eleusine indica* (Paragrass), *Axonopus fissifolius* (Carpet Grass), and *Paspalum conjugatum* (Carabao Gras) with importance values of **16.84%**, **13.81%**, **10.78%**, and **10%**, respectively (refer to **Table 2.1.4-14**).

Table 2.1.4-14 Importance Values Top 5 Flora Species Recorded in Transect 12 (Brgy. Cabantian)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Imperata cylindrica	Cogon	25	10	11.21	7.87	19.08
Digitaria sanguinalis	Crab Grass	20	10	8.97	7.87	16.84
Eleusine indica	Paragrass	15	9	6.73	7.09	13.81
Axonopus fissifolius	Carpet Grass	10	8	4.48	6.3	10.78
Paspalum conjugatum	Carabao Grass	10	7	4.48	5.51	10

(j) Transect Line 13 (S14) – Brgy. Indangan

Transect 13 in Brgy. Indangan was established along the national access road. Vegetation was dominated by *Imperata cylindrica* (Cogon) with an importance value of **12%**. This is followed by *Sporobolus indicus* (Whipping Grass) with **10.97%**, and

Axonopus fissifolius (Carpet Grass) and *Nephrolepis biserrata* (Pakong Kalabaw), both with an importance value of **9.66%** as indicated in **Table 2.1.4-15**. *Paspalum conjugatum* (Carabao Grass) and *Eleusine indica* (Paragrass) were also abundant both with an importance value of **9%**, followed by *Digitaria sanguinalis* (Crab Grass). *Helianthus gracilentus* (Dwarf Sunflower), and Si*da acuta* (Walis-walisan) each with an importance value of **6.66%**.

Table 2.1.4-15 Importance Values Top 5 Flora Species Recorded in Transect 13 (Brgy. Waan)

Species Name	Common Name	Abundance	Frequency	Relative Abundance (%)	Relative Frequency (%)	Importance Value (%)
Imperata cylindrica	Cogon	20	8	6.73	5.26	12
Sporobolus indicus	Whipping Grass	15	9	5.05	5.92	10.97
Axonopus fissifolius	Carpet Grass	15	7	5.05	4.61	9.66
Nephrolepis biserrata	Pakong Kalabaw	15	7	5.05	4.61	9.66
Paspalum conjugatum	Carabao Grass	15	6	5.05	3.95	9
Eleusine indica	Paragrass	15	6	5.05	3.95	9
Digitaria sanguinalis	Crab Grass	10	5	3.37	3.29	6.66
Helianthus gracilentus	Dwarf Sunflower	10	5	3.37	3.29	6.66
Sida acuta	Walis-walisan	10	5	3.37	3.29	6.66

(k) Transect Line 14 (S15) – Brgy. Mudiang

Transect 14 across a privately owned coconut plantation in Brgy. Mudiang recorded **34** species, dominated by *Digitaria sanguinalis* (Crab Grass), *Cyperus rotundus* (Nut Grass), and *Sporobolus indicus L*. (Whipping Grass) each with an importance value of **12.73%**. This is followed by *Osmunda banksiifolia* (Royal Fern), *Axonopus fissifolius* (Carpet Grass), and *Saccharum spontaneum* (Talahib) with an importance value of **12.32%**, **11.68%**, and **10.64%**, respectively. In this transect *Desmodium capitatum* (Mani-Manihan) and *Eleusine indica* (Paragrass) were also abundant, as shown in **Table 2.1.4-16** each having an importance value of **9.60%**.

Table 2.1.4-16 Importance Values Top 5 Flora Species Recorded in Transect 14 (Brgy. Mudiang)						
Species Name	**Common Name**	**Abund ance**	**Freque ncy**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Digitaria sanguinalis	Crab Grass	10	7	5.43	7.29	12.73
Cyperus rotundus	Nut Grass	10	7	5.43	7.29	12.73
Sporobolus indicus	Whipping Grass	10	7	5.43	7.29	12.73
Osmunda banksiifolia	Royal Fern	15	4	8.15	4.17	12.32
Axonopus fissifolius	Carpet Grass	10	6	5.43	6.25	11.68
Saacharum spontaneum	Talahib	10	5	5.43	5.21	10.64
Desmodium capitatum	Mani-Manihan	10	4	5.43	4.17	9.60
Eleusine indica	Paragrass	10	4	5.43	4.17	9.60

(k) Transect Line 15 (S16) – Brgy. Tibungco

Transect 15 ran across a busy public road in Brgy. Tibungco with a wide open lot on one side planted with coconut trees and bananas. This transect recorded about **41** species dominated by *Saccharum spontaneum* (Talahib) with an importance value of **13.61%**, followed by *Imperata cylindrica* (Cogon) and *Eleusine indica* (Paragrass) each with an importance value of **12.78%** (see **Table 2.1.4-17**). *Amaranthus spinosus* (Kulitis) was also abundant in this transect with an importance value of **10.46%**, followed by *Triumfetta rhomboidea* (Kulot-kulotan) and *Mimosa pudica L.* (Makahiya) both with **9.63%**, and *Euphorbia neriiflora* (Soro-sampalok) with an importance value of **8.8%**.

Table 2.1.4-17 Importance Values Top 5 Flora Species Recorded in Transect 15 (Brgy. Tibungco)						
Species Name	**Common Name**	**Abund ance**	**Freque ncy**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Saccharum spontaneum	Talahib	15	8	6.94	6.67	13.61
Imperata cylindrica	Cogon	15	7	6.94	5.83	12.78
Eleusine indica	Paragrass	15	7	6.94	5.83	12.78
Amaranthus spinosus	Kulitis	10	7	4.63	5.83	10.46
Triumfetta rhomboidea	Kulot-kulotan	10	6	4.63	5	9.63
Mimosa pudica	Makahiya	10	6	4.63	5	9.63
Euphorbia neriiflora	Soro-sampalok	10	5	4.63	4.17	8.8

(l) Transect Line 16 (S17) – Brgy. Mahayag

Transect 16 in Brgy. Mahayag recorded **62** species, dominated by *Imperata cylindrica* (Cogon) with an importance value of **11.69%**, followed by *Arachis duranensis* (Yellow Creeper) with **8.79%**, and *Axonopus fissifolius* (Carpet Grass), *Nephrolepis biserrata* (Pakong Kalabaw), and Saccharum spontaneum, each with an importance value of **8.04%** (refer to **Table 2.1.4-18**). *Donax cannaeformis* (Bamban) and *Ichnocarpus volubilis* (Hingiw Vine) were also abundant with importance values of **5.69%** and **5.14%**, respectively.

Table 2.1.4-18 Importance Values Top 5 Flora Species Recorded in Transect 16 (Brgy. Mahayag)						
Species Name	**Common Name**	**Abund ance**	**Freque ncy**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Imperata cylindrica	Cogon	15	7	6.47	5.22	11.69
Arachis duranensis	Yellow Creeper	10	6	4.31	4.48	8.79
Axonopus fissifolius	Carpet Grass	10	5	4.31	3.73	8.04
Nephrolepis biserrata	Pakong Kalabaw	10	5	4.31	3.73	8.04
Saacharum spontaneum	Talahib	10	5	4.31	3.73	8.04
Donax cannaeformis	Bamban	8	3	3.45	2.24	5.69
Ichnocarpus volubilis	Hingiw Vine	5	4	2.16	2.99	5.14

(m) Transect Line 17 (S18) – Brgy. San Isidro

Transect 17 in Brgy. San Isidro revealed a total of **16** species dominated by *Syngonium podophyllum* (Kamay Kastila) with an importance value of **28.52%**, followed by *Andropogon aciculatos* (Amorseco), *Dentella repens* (Dilang Butiki), *Sporobolus indicus* (Whipping Grass), and *Imperata cylindrica* (Cogon) with importance values of **12.4%**, **11.5%**, **11.32%**, and **10.23%**, respectively (refer to **Table 2.1.4-19**).

Table 2.1.4-19 Importance Values Top 5 Flora Species Recorded in Transect 17 (Brgy. San Isidro)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Syngonium podophyllum	Kamay Kastila	30	10	17.65	10.87	28.52
Andropogon aciculatos	Amorseco	10	6	5.88	6.52	12.40
Dentella repens	Dilang Butiki	14	3	8.24	3.26	11.50
Sporobolus indicus	Whipping Grass	10	5	5.88	5.43	11.32
Imperata cylindrica	Cogon	10	4	5.88	4.35	10.23

(n) Transect Line 18 (S19) – Brgy. San Lasang

Table 2.1.4-20 shows that a total of **24** species was recorded in **Transect 18** in Brgy. Lasang, which is dominated by *Saccharum spontaneum* (Talahib) with an importance value of **30.7%**, followed by *Axonopus fissifolius* (Carpet Grass), *Andropogon aciculatos* (Amorseco), *Ipomoea triloba* (Kamkamote), and *Centrosema pubescens* (Hairy Leaf Centrosema) with importance values of **23.72%**, **22.32%**, **13.67%**, and **8.37%**, respectively. This transect ran across a National Road along a residential area on one side and a privately owned banana plantation on the road.

Table 2.1.4-20 Importance Values Top 5 Flora Species Recorded in Transect 18 (Brgy. Lasang)						
Species Name	**Common Name**	**Abundance**	**Frequency**	**Relative Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Saacharum spontaneum L.	Talahib	20	10	16.81	13.89	30.7
Axonopus fissifolius	Carpet Grass	15	8	12.61	11.11	23.72
Andropogon aciculatos	Amorseco	15	7	12.61	9.72	22.32
Ipomoea triloba L.	Kamkamote	8	5	6.72	6.94	13.67
Centrosema pubescens L.	Hairy Leaf Centrosema	5	3	4.20	4.17	8.37

(o) Transect Line 19 (S20) – Brgy. Matina Biao, Matina River

A total of **93** species was recorded in Transect 19, Brgy. Matina Biao, established along the riparian zone of the boundary of Brgy. Matina Biao, dominated by *Piper arborescens* (Palo Verde) with an importance value of **7.8%** followed by *Imperata cylindrica* with **7.17%**, and *Nephrolepis biserrata* (Pakong Kalabaw), *Saccharum spontaneum* (Talahib), and *Sporobolus indicus* (Whipping Grass) each having an importance value of **6.55%** (refer to **Table 2.1.4-21**).

Paspalum conjugatum (Carabao Grass), *Cyperus rotundus* (Nut Grass), and *Wedelia chinensis* (Wedelia) each were also abundant in this transect with an importance value of **5.92%**, followed by *Axonopus fissifolius* (Carpet Grass), *Christella parasitica* (Cristella Fern), *Stachytarpheta jamaicacensis* (Kandi-kandilaan), *Mimosa pudica L.* (Makahiya), and *Sida acuta* at **5.29%**, and *Stachytarpheta jamaicacensis* (Kandi-kandilaan) with an importance value of **5.01%**.

Table 2.1.4-21 Importance Values of Top 5 Flora Species Recorded in Transect 19 (Matina River, Brgy. Matina Biao)						
Species Name	**Common Name**	**Abund ance**	**Freq uency**	**Rele Abundance (%)**	**Relative Frequency (%)**	**Importance Value (%)**
Piper arborescens	Palo Verde	40	10	5.03	2.78	7.8
Imperata cylindrica	Cogon	35	10	4.4	2.78	7.17
Nephrolepis biserrta	Pakong Kalabaw	30	10	3.77	2.78	6.55
Saacharum spontaneum	Talahib	30	10	3.77	2.78	6.55
Sporobolus indicus	Whipping Grass	30	10	3.77	2.78	6.55
Paspalum conjugatum	Carabao Grass	25	10	3.14	2.78	5.92
Cyperus rotundus	Nut Grass	25	10	3.14	2.78	5.92
Wedelia chinensis	Wedelia	25	10	3.14	2.78	5.92
Axonopus fissifolius	Carpet Grass	20	10	2.51	2.78	5.29
Mimosa pudica	Makahiya	20	10	2.51	2.78	5.29
Sida acuta Burm	Walis-walisan	20	10	2.51	2.78	5.29
Stachytarpheta jamaicacensis	Kandi-kandilaan	20	9	2.51	2.5	5.01

a) *Acanthus hirsustus*

b) *Alpinia elegans L.*

c) *Anamirta cocculus*

d) *Arachis duranensis*

e) *Breynia rhamnoides (Retz.) Muell.-Arg.*

f) *Caesalpinia latisiliqua*

Photo No. 2.1.4-21 Representative plants from the study site I

a) *Calamus maximus L.*

b) *Caryota mitis*

c) *Catharanthus pusillus*

d) *Centrosema pubescens L.*

e) *Christella dentate*

f) *Costus malortieanus*

Photo No. 2.1.4-22 Representative plants from study site II

a) *Cyperus rotundus*

b) *Daemonorops mollis (Blanco) Merr.*

c) *Dentella repens*

d) *Dioscorea hispida L.*

e) *Dracaena reflexa L.*

f) *Dysoxylum daeandrum*

Photo No. 2.1.4-23 Representative plants from study site III

a) *Ficus pseudopalma Blanco*

b) *Figellaria indica L.*

c) *Hibiscus tiliaceus*

d) *Homalomena pygmea*

e) *Indigofera suffruticosa Mill.*

f) *Ipomoea lobata*

Photo No. 2.1.4-24 Representative Plants from the study sites IV

a) *Lantana camara*

b) *Lygodium flexuosum (L.) Sm.*

c) *Lygodium japonicum*

d) *Melanolepis multiglandulosa*

e) *Merrremia emarginata*

f) *Mimosa pudica L.*

Photo No. 2.1.4-25 Representative Plants from the study sites V

a) *Piper spp.*

b) *Premna cumngiana*

c) *Pandanus exaltatus Blanco*

d) *Mussaenda philippica A.Rich*

e) *Scleria scrobiculata Nees*

f) *Selaginella involvens (Sw.) Spreng*

Photo No. 2.1.4-26 Representative Plants from the study sites VI

a) *Stachytarpheta jamaicacensis*

b) *Premna cumngiana*

c) *Tridax procumbens*

Photo No. 2.1.4-27 Representative plants from the study sites VII

(2) Evaluation of Survey Results

1) Diversity Measures

Transect 2 in Matina River, Brgy. Langub recorded the highest species diversity among vegetation transects followed by Transect 19 in Matina River, Brgy. Matina Biao. These transects are relatively far from residential areas, and are not as disturbed as the other transects. In general, species diversity across all vegetation transects is relatively high, averaging **0.94** dominated by weed plants as illustrated in **Figure 2.1.4-2.**

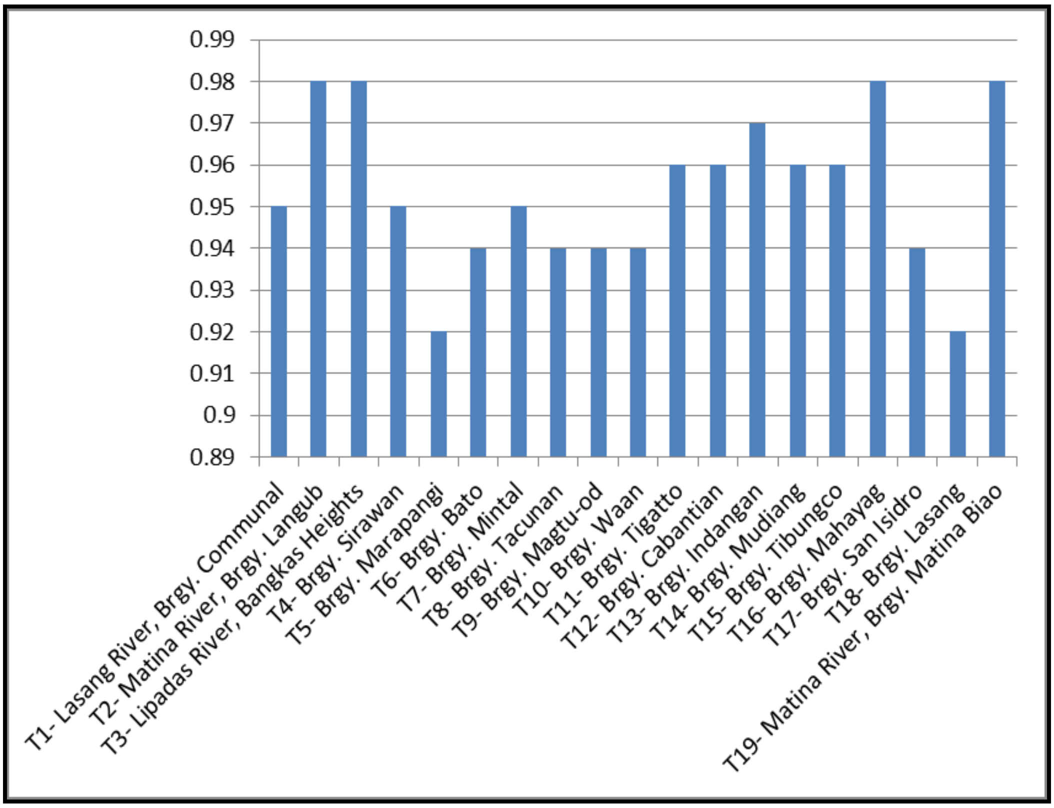


Figure 2.1.4-2 Diversity Measures of Vegetation Transects Across All Sampling Sites

2) Conservation Status and Endemicity

Out of the **185** species records of trees and understory flora, only **10** species are **Philippine endemics** – *Cananga odorata* (Ilang-ilang), *Terminalia calamansanai* (Kalamansanai), *Lygodium flexuosum* (Nito), *Diplodiscus paniculatus* (Balobo), *Artocarpus blancoi* (Antipolo), *Ficus ulmifolia* (Isis), *Ficus pseudopalma* (Niyug-niyugan), *Ficus nota* (Tibig), *Leucosyke capitellata* (Alagasi), and *Leea philippinensis* (Kaliantan).

Based on DAO 2007-01 listing, *Vitex parviflora* (Molave) and *Drynaria quercifolia* (Kabkab/Oak-leaf Fern) are categorized as **Endangered** and **Vulnerable**, respectively, while the IUCN Redlist (2014) lists *Vitex parviflora* (Molave), *Diplodiscus paniculatus* (Balobo), *Ficus ulmifolia* (Isis), *Afzelia rhomboidea* (Balayong), *Pterocarpus indicus echinus* (Prickly Narra), and *Pterocarpus indicus indicus* (Smooth Narra) as **Vulnerable**.

Table 2.1.4-22 Conservation Status of listed trees and understory flora along project site 1/7						
Family	**Official Common Name**	**Scientific Name**	**Habit**	**DAO 2007-01**	**IUCN Redlist 2013**	**Endemicity**
Acanthaceae	Acanthus	*Acanthus hirsutus*	Herbs	–	–	Not Endemic
Acanthaceae	Bunlaw	*Justicia gendarussa*	Shrub	–	–	Not Endemic
Acanthaceae	Sanchezia	*Sanchezia speciosa*	Shrub	–	–	Not Endemic
Acanthaceae	White Funnel Acaranthus	*Ruellia metziae*	Herbs	–	–	Not Endemic
Amaranthaceae	Kulitis	*Amaranthus viridus L.*	Herbs	–	Least Concern	Not Endemic
Anarcadiaceae	Mangga	*Mangifera indica*	Tree	–	–	Not Endemic
Annonaceae	Basikong Kalawang	*Alphonsea arborea*	Tree	–	–	Not Endemic
Annonaceae	Ilang-Ilang	*Cananga odorata*	Tree	–	–	Endemic
Apocynaceae	Calumpang	*Catharanthus pusillus*	Tree	–	–	Not Endemic
Apocynaceae	Hingiw	*Ichnocarpus volubilis*	Vines	–	–	Not Endemic
Apocynaceae	Pandakaki Tsina	*Tabernaemontana divaricata (Linn.) E. Br.*	Shrub	–	–	Not Endemic
Apocynaceae	Tubli	*Derris tubli Linn.*	Vines	–	–	Not Endemic
Araceae	Aglaonema	*Aglaonema spp.*	Herbs	–	Least Concern	Not Endemic
Araceae	Alupayi	*Homalomena pygmaea*	Aroids	–	–	Not Endemic
Araceae	Kamay Kastila	*Syngonium podophyllum Schott.*	Aroids	–	–	Not Endemic
Araceae	Pihau	*Schimatoglottis spp.*	Herbs	–	–	Not Endemic
Araliaceae	Malapapaya	*Polyscias nodosa (Blume) Seem.*	Tree	–	Least Concern	Not Endemic
Arecaceae	African Oil Palm	*Elaeis guineensis*	Palms	–	–	Not Endemic
Arecaceae	Ditaan	*Daemonorops mollis (Blanco) Merr.*	Vines	–	–	Not Endemic
Arecaceae	Fishtail Palm	*Caryota mitis*	Palms	–	–	Not Endemic
Arecaceae	Niyog	*Cocos nucifera L.*	Palms	–	–	Not Endemic
Arecaceae	Palasan	*Calamus maximus L.*	Vines	–	–	Not Endemic
Arecaceae	Pugahan	*Caryota cumingii L.*	Palms	–	–	Not Endemic
Asclepiadaceae	Milkweed	*Ascelpias syriaca*	Herbs	–	–	Not Endemic
Asclepiadaceae	Tayom-Tayom	*Marsdenia tinctoria R. Br.*	Shrub	–	–	Not Endemic
Asparagaceae	Pony Tail Palm	*Beaucarnea recurvata*	Palms	–	–	Not Endemic
Asparagaceae	Song of India	*Dracaena reflexa L.*	Herbs	–	–	Not Endemic
Aspleniaceae	Asplenium	*Asplenium azoricum*	Ferns	–	–	Not Endemic
Aspleniaceae	Bird's Nest Fern	*Asplenium australasicum*	Ferns	–	–	Not Endemic
Aspleniaceae	Maidenhair Fern	*Asplenium tenerum Forst.*	Ferns	–	–	Not Endemic

Table 2.1.4-22 Conservation Status of listed trees and understory flora along project site 2/7

Family	Official Common Name	Scientific Name	Habit	DAO 2007-01	IUCN Redlist 2013	Endemicity
Asteraceae	Dwarf Sunflower	*Helianthus gracilentus*	Herbs	–	–	Not Endemic
Asteraceae	Hagonoy	*Chromolaena odorata (L.) R.M.*	Vines	–	–	Not Endemic
Asteraceae	Sambong	*Blumea balsamifera (L.) DC*	Herbs	–	–	Not Endemic
Asteraceae	Wedelia	*Wedelia chinensis*	Herbs	–	–	Not Endemic
Athyriaceae	Pako	*Diplazium esculentum (Retz.) Sw.*	Ferns	–	Least Concern	Not Endemic
Bignoniaceae	African Tulip	*Spathodea campanulata*	Tree	–	–	Not Endemic
Blechnaceae	Diliman/Hagnaya	*Stenochlaena melnei Underw.*	Ferns	–	–	Not Endemic
Burseraceae	Bogo	*Garuga floribunda*	Tree	–	–	Not Endemic
Canabaceae	Anabiong	*Trema orientalis (L.) Blume*	Tree	–	Least Concern	Not Endemic
Caricaceae	Wild Papaya	*Carica papaya*	Tree	–	–	Not Endemic
Clusiaceae	Guyong-guyong	*Cratoxylum blancoi*	Tree	–	–	Not Endemic
Combretaceae	Kalamansanai	*Terminalia calamansanai*	Tree	–	–	Endemic
Convolvulaceae	Bulakan	*Merremia peltata L.*	Vines	–	–	Not Endemic
Convolvulaceae	Kamkamote	*Ipomoea triloba L.*	Vines	–	–	Not Endemic
Convolvulaceae	Kupit-Kupit	*Merrremia emarginata*	Herbs	–	–	Not Endemic
Convolvulaceae	Malakamote	*Ipomoea obscura L.*	Vines	–	–	Not Endemic
Convolvulaceae	Spanish Flag	*Ipomoea lobata*	Vines	–	–	Not Endemic
Costaceae	Step Ladder Plant	*Costus malortieanus*	Herbs	–	–	Not Endemic
Cyperacaea	Arat	*Scleria scrobiculata Nees*	Sedges	–	–	Not Endemic
Davalliaceae	Solida	*Davallia solida (Forst.) Sw.*	Ferns	–	–	Not Endemic
Dioscoreaceae	Nami	*Dioscorea hispida L.*	Vines	–	–	Not Endemic
Ebenaceae	Bolong Eta	*Diospyros pilosanthera*	Tree	EN	–	Not Endemic
Euphorbiaceae	Alim	*Melanolepis multiglandulosa*	Tree	–	–	Not Endemic
Euphorbiaceae	Balitahan	*Bridelia glauca*	Tree	–	–	Not Endemic
Euphorbiaceae	Cassava	*Manihot esculenta*	Shrub	–	–	Not Endemic
Euphorbiaceae	Hamindang	*Macaranga bicolor Muell.-Arg.*	Tree	–	–	Not Endemic
Euphorbiaceae	Kamot Pusa	*Caesalpinia latisiliqua*	Herbs	–	–	Not Endemic
Euphorbiaceae	Malabagang	*Glochidian album (Blanco) Boerl.*	Shrub	–	–	Not Endemic
Euphorbiaceae	Matang Hipon	*Breynia rhamnoides (Retz.) Muell.-Arg.*	Shrub	–	–	Not Endemic

Table 2.1.4-22 Conservation Status of listed trees and understory flora along project site 3/7						
Family	**Official Common Name**	**Scientific Name**	**Habit**	**DAO 2007-01**	**IUCN Redlist 2013**	**Endemicity**
Euphorbiaceae	Poinsettia	*Euphorbia pulcherrima*	Shrub	–	–	Not Endemic
Euphorbiaceae	Soro-sampalok	*Euphorbia neriiflora*	Herbs	–	–	Not Endemic
Euphorbiaceae	Tawa-Tawa	*Euphorbia hirta*	Herbs	–	–	Not Endemic
Euphorbiaceae	Tuba-Tuba	*Jatropha curcas*	Shrub	–	–	Not Endemic
Euphorbiaceae	Takip Asin	*Macaranga grandifolia (Blanco) Merr.*	Tree	–	–	Not Endemic
Euphorbiaceae	Teramycin Plant	*Glochidion pubicarpum Elm.*	Herbs	–	–	
Fabaceae	Acapulco	*Cassia alata*	Shrub	–	–	Not Endemic
Fabaceae	Agpoi	*Phanera integrifolia subsp. cumingiana*	Vines	–	Least Concern	Not Endemic
Fabaceae	Ascova	*Cytisus scoparius*	Shrub	–	–	Not Endemic
Fabaceae	Balayong	*Afzelia rhomboidea*	Tree	–	Vulnerable	Not Endemic
Fabaceae	Centrosema	*Centrosema plumeiri*	Vines	–	–	Not Endemic
Fabaceae	Hairy-leafed centrosema	*Centrosema pubescens L.*	Vines	–	–	Not Endemic
Fabaceae	Ipil-Ipil	*Leucaena leucocephala*	Tree	–	–	Not Endemic
Fabaceae	Kawati	*Gliricidia sepium*	Tree	–	–	Not Endemic
Fabaceae	Makahiya	*Mimosa pudica L.*	Herbs	–	Least Concern	Not Endemic
Fabaceae	Mani-Manihan	*Desmodium capitatum*	Shrub	–	–	Not Endemic
Fabaceae	Payang-Payang	*Desmodium pulchellum (L.) Desv.*	Shrub	–	–	Not Endemic
Fabaceae	Prickly Narra	*Pterocarpus indicus echinus*	Tree	–	Vulnerable	Not Endemic
Fabaceae	Smooth Narra	*Pterocarpus indicus indicus*	Tree	–	Vulnerable	Not Endemic
Fabaceae	Tayom	*Indigofera suffruticosa Mill.*	Shrub	–	–	Not Endemic
Fabaceae	Yellow Creeper	*Arachis duranensis*	Vines	–	–	Not Endemic
Flagellariaceae	Balingwai	*Flgellaria indica L.*	Vines	–	–	Not Endemic
Gleicheniaceae	Kilob	*Dicranopteris linearis*	Ferns	–	–	Not Endemic
Gleicheniaceae	Sticherous Fern	*Sticherous truncatus (Willd.) Nakaii*	Ferns	–	–	Not Endemic
Gnetaceae	Kuliat	*Gnetum gnemon*	Vines	–	Least Concern	Not Endemic
Guttiferae	Paguringan	*Cratoxylon arboreum*	Tree	–	–	Not Endemic
Icacinaceae	Anilaw	*Gonocaryum calleryanum/ Colona serratifolia*	Tree	–	–	
Lamiaceae	Dilang Baka	*Hypyis capitata Jacq.*	Herbs	–	–	Not Endemic
Lamiaceae	Gmelina	*Gmelina arborea*	Tree	–	–	Not Endemic
Lamiaceae	Molaveng Aso	*Vitex cofassus*	Tree	–	–	Not Endemic

Table 2.1.4-22 Conservation Status of listed trees and understory flora along project site 4/7						
Family	**Official Common Name**	**Scientific Name**	**Habit**	**DAO 2007-01**	**IUCN Redlist 2013**	**Endemicity**
Lamiaceae	Turukan	*Hyptis capitata Jacq.*	Herbs	–	–	Not Endemic
Lauraceae	Marang	*Litsea perrottettii*	Tree	–	–	Not Endemic
Leguminosae	Brazilian Fire Tree	*Schizolobium parahyba*	Tree	–	–	Not Endemic
Loganiaceae	Strychnos vine	*Strychnos multiflora L.*	Vines	–	–	Not Endemic
Lycopodiaceae	Lycopodium	***Lycopodium spp.*	Fern Allies	*(En/Vul)*	–	Not Endemic
Lygodiaceae	Nito	*Lygodium flexuosum (L.) Sm.*	Vines	–	–	Endemic
Lygodiaceae	Nitong Hapon	*Lygodium japonicum*	Vines	–	–	Not Endemic
Lythraceae	Luktob	*Duabanga moluccana*	Tree	–	–	Not Endemic
Malvaceae	Balobo	*Diplodiscus paniculatus*	Tree	–	Vulnerable	Endemic
Malvaceae	Banalo	*Thespesia populnea*	Tree	–	–	Not Endemic
Malvaceae	Biknong	*Kleinhovia hospita*	Tree	–	–	Not Endemic
Malvaceae	Cacao	*Theobroma cacao*	Tree	–	Least Concern	Not Endemic
Malvaceae	Malubago	*HIbiscus tiliaceus*	Tree	–	–	Not Endemic
Malvaceae	Tan-ag	*Kleinhovia hospita*	Tree	–	–	Not Endemic
Malvaceae	Walis-walisan	*Sida acuta Burm. f.*	Herbs	–	–	Not Endemic
Marantaceae	Bamban	*Donax cannaeformis*	Herbs	–	–	Not Endemic
Marattiaceae	Giant Fern	*Marattia sylvatica Bl.*	Ferns	–	–	Not Endemic
Meliaceae	Igyu	*Dysoxylum daeandrum*	Tree	–	–	Not Endemic
Menispermaceae	Ligtang	*Anamirta cocculus*	Vines	–	–	
Menispermaceae	Cyclea	*Cyclea merrilli*	Sedges	–	–	Not Endemic
Moraceae	Alangas	*Ficus heteropoda Miq.*	Tree	–	–	Not Endemic
Moraceae	Antipolo	*Artocarpus blancoi (Elmer) Merr.*	Tree	–	Least Concern	Endemic
Moraceae	Basikong	*Ficus botryocarpa Miq.*	Tree	–	–	Not Endemic
Moraceae	Dulalug	*Ficus variegate Blume var. sycomoroides (Miq.)*	Tree	–	–	Not Endemic
Moraceae	Ficus spp.	*Ficus lanceolata*	Tree	–	–	Not Endemic
Moraceae	Hagimit	*Ficus minahassae*	Tree	–	–	Not Endemic
Moraceae	Hawili	*Ficus septica Burma f. var. septica*	Shrub	–	–	Not Endemic
Moraceae	Isis	*Ficus ulmifolia*	Tree	–	Vulnerable	Endemic
Moraceae	Malagumihan	*Artocarpus elasticus*	Tree	–	–	Not Endemic
Moraceae	Malatibig	*Ficus congesta var. congesta*	Tree	–	–	Not Endemic
Moraceae	Niyug-niyugan	*Ficus pseudopalma Blanco*	Tree	–	Least Concern	Endemic

Table 2.1.4-22 Conservation Status of listed trees and understory flora along project site 5/7						
Family	**Official Common Name**	**Scientific Name**	**Habit**	**DAO 2007-01**	**IUCN Redlist 2013**	**Endemicity**
Moraceae	Tangisang Bayawak	*Ficus variegata Blume var. variegata*	Tree	–	–	Not Endemic
Moraceae	Tangisang Layugan	*Ficus latsonii*	Tree	–	–	Not Endemic
Moraceae	Tibig	*Ficus nota (Blanco) Merr.*	Tree	–	–	Endemic
Moraceae	Kalokoy	*Ficus callosa*	Tree	–	–	
Myrtaceae	Bayabas	*Psidium guajava*	Tree	–	–	Not Endemic
Myrtaceae	Binunga	*Tristaniopsis dicorticata*	Tree	–	–	Not Endemic
Nephrolepidaceae	Alulukdo	*Nephrolepis hirsutula*	Ferns	–	Least Concern	Not Endemic
Nephrolepidaceae	Christella	*Christella parasitica (Lindl.) Lev.*	Ferns	–	–	Not Endemic
Oleandraceae	Pakong-kalabaw	*Nephrolepis biserrta (Sw.) Schott.*	Ferns	–	–	Not Endemic
Osmundaceae	Osmunda/Royal Fern	*Osmunda banksiifolia (C. Prosl.) Kuhn.*	Ferns	–	–	Not Endemic
Pandanaceae	Bariu	*Pandanus copelandii Merr.*	Pandans	–	–	Not Endemic
Pandanaceae	Pandan-layugan	*Pandanus exaltatus Blanco*	Pandans	–	–	Not Endemic
Passifloraceae	Pasiflora	*Pasiflora spp.*	Vines	–	–	Not Endemic
Piperaceae	Palo Verde	*Piper arborescens*	Tree	–	–	Not Endemic
Piperaceae	Pamintang-aso	*Piper interruptum Opiz.*	Vines	–	–	Not Endemic
Piperaceae	Piper	*Piper spp.*	Vines	–	–	Not Endemic
Poaceae	Amorseco	*Andropogon aciculatos*	Grasses	–	–	Not Endemic
Poaceae	Bikal	*Dinochlea acutiflora (Munro) S. Dransf.*	Grasses	–	–	Not Endemic
Poaceae	Carabao Grass	*Paspalum conjugatum Berg.*	Grasses	–	Least Concern	Not Endemic
Poaceae	Carpet Grass	*Axonopus fissifolius*	Grasses	–	–	Not Endemic
Poaceae	Cat's Tail	*Typha orientalis*	Grasses	–	Least Concern	Not Endemic
Poaceae	Cogon	*Imperata cylindrica var. koenigii*	Grasses	–	–	Not Endemic
Poaceae	Crab Grass	*Digitaria sanguinalis*	Grasses	–	–	Not Endemic
Poaceae	Fishing Rod Bamboo	*Schizostachyum lima (Blanco) Merr.*	Grasses	–	–	Not Endemic
Poaceae	Johnson Grass	*Sorghum halapense*	Grasses	–	–	Not Endemic
Poaceae	Nut Grass	*Cyperus rotundus*	Grasses	–	–	Not Endemic
Poaceae	Paragis	*Eleusine indica (L.) Gaertn.*	Grasses	–	Least Concern	Not Endemic
Poaceae	Pusher Bamboo	*Schizostachyum fennixii*	Grasses	–	–	Not Endemic

Table 2.1.4-22 Conservation Status of listed trees and understory flora along project site 6/7						
Family	**Official Common Name**	**Scientific Name**	**Habit**	**DAO 2007-01**	**IUCN Redlist 2013**	**Endemicity**
Poaceae	Talahib	*Saacharum spontaneum L.*	Grasses	–	–	Not Endemic
Poaceae	Tambo	*Thysonolaena latifolia (Roxb. Ex Hornem.) Honda*	Grasses	–	–	Not Endemic
Poaceae	Whipping Grass	*Sporobolus indicus L.*	Grasses	–	–	Not Endemic
Polypodaceae	Kabkab/Oak-Leaf Fern	*Drynaria quercifolia (L.) Sm.*	Ferns	VUL	–	Not Endemic
Polypodaceae	Thai Fern	*Microsorum thailandicum*	Ferns	–	–	Not Endemic
Rhamnaceae	Salapao	*Ventilago dichotoma*	Vines	–	–	Not Endemic
Rubiaceae	Bangkal	*Nauclea orientalis*	Tree	–	–	Not Endemic
Rubiaceae	Dilang Butiki	*Dentella repens*	Herbs	–	–	Not Endemic
Rubiaceae	Kahoy Dalaga	*Mussaenda philippica A.Rich*	Tree	–	–	Not Endemic
Rutaceae	Kalamansi	*Citrofortunella microcarpa*	Tree	–	–	Not Endemic
Salicaceae	Aninguai	*Scolopia luzoniensis (Presl.) Merr.*	Vines	–	–	
Sapindaceae	Kapulasan	*Nephelium mutabile*	Tree	–	–	Not Endemic
Sapindaceae	Large Leaf Malugay	*Pometia pinnata*	Tree	–	–	Not Endemic
Sapotaceae	Kaimito	*Chrysophyllum cainito*	Tree	–	–	Not Endemic
Selaginellaceae	Kamariang Gubat	*Selaganella planna Hieron*	Fern Allies	–	–	Not Endemic
Selaginellaceae	Selaginella	*Selaginella involvens (Sw.) Spreng*	Ferns	–	–	Not Endemic
Solanaceae	Malatalong	*Solanum verbascifolim* Linn.	Shrub	–	–	Not Endemic
Sterculiaceae	Bayok	*Pterospermum diversifolium*	Tree	–	–	Not Endemic
Sterculiaceae	Labayo	*Commersonia platyphylla*	Shrub	–	–	Not Endemic
Sterculiaceae	Taloto	*Pterocymbium tinctorium*	Tree	–	–	Not Endemic
Sterculiaceae	U-us	*Sterculia glabrifolia*	Tree	–	–	Not Endemic
Thelypteridaceae	Cristella Fern	*Christella dentata*	Ferns	–	–	Not Endemic
Tiliaceae	Kulot-kulotan	*Triumfetta rhomboidea Jacq.*	Herbs	–	–	Not Endemic
Urticaceae	Alagasi	*Leucosyke capitellata*	Shrub	–	Least Concern	Endemic
Urticaceae	Rami	*Boehmeria nivea*	Herbs	–	–	Not Endemic
Verbenaceae	Coronitas	*Lantana camara*	Herbs	–	–	Not Endemic
Verbenaceae	Kandikandilaa n	*Stachytarpheta jamaicacensis*	Herbs	–	–	Not Endemic

Table 2.1.4-22 Conservation Status of listed trees and understory flora along project site 7/7						
Family	**Official Common Name**	**Scientific Name**	**Habit**	**DAO 2007-01**	**IUCN Redlist 2013**	**Endemicity**
Verbenaceae	Magilik	*Premna cumingiana*	Tree	–	–	Not Endemic
Verbenaceae	Molave	*Vitex parviflora*	Tree	EN	Vulnerabl e	Not Endemic
Verbenaceae	White Kandi-kandilaan	*Stachytarpheta jamaicensis* Linn.	Herbs	–	–	Not Endemic
Vitaceae	Alangingi	*Cayratia guineensis G.Don*	Vines	–	–	Not Endemic
Vitaceae	Ayo	*Terrastigma harmandii*	Vines	–	–	
Vitaceae	Kaliantan	*Leea philippinensis*	Tree	–	–	Endemic
Zingiberaceae	Tagbak	*Alpinia elegans L.*	Zingibers	–	–	Not Endemic
	Bataran Grass					
	Kulot-Kulot					
	Lupog-Lupog					

2.1.4.2 Fauna

(1) Results of Fauna Survey

1) Avifauna (Birds)

A total of **336** individuals of birds were recorded across all sampling sites, resolved into **29** species and **22** families – Ardeidae, Accipitridae, Phasianidae, Scolopacidae, Columbidae, Cuculidae, Podargidae, Apodidae, Alcedinidae, Meropidae, Capitonidae, Pycnonotidae, Corvidae, Turdidae, Slyviidae, Muscicapidae, Motacillidae, Artamidae, Sturndae, Nectariniidae, Dicaeidae, Ploceidae, and Estrildidae.

Bird surveys were dominated by *Collocalia esculenta* with a relative abundance of **22.26%**, followed by *Passer montanus* and *Pycnonotus goiavier* with a relative abundance of **11.90%** and **11.31%, respectively** (**Table 2.1.4-23**). **Four** (**4**) species – *Corvus macrorhynchos*, *Egretta garzetta*, *Batrachostomus septimus* and *Saxicola caprata* were only recorded once throughout the sampling period. The top **three** (**3**) species are widely distributed in the country, inhabiting riparian habitats, lowland areas, and residential communities. Representative birds from the study sites are shown in **Photo No. 2.1.4-28** and **Photo No. 2.1.4-29.**

No Philippine eagles were heard nor seen during the bird transect surveys along the proposed road alignment as the survey areas and immediate surroundings are highly disturbed, and Philippine eagles are largely restricted in high altitude and undisturbed primary forest habitats. In addition, presence of known prey animals of the Philippine eagle that include among others, flying foxes, flying lemurs, squirrels, paml civets, and monkeys were not observed in the study area, as most of the areas traversed by the proposed alignment are populated with limited stands of trees. No reported incidence of a Philippine eagle attacking a monkey was documented in any location along the the proposed bypass road alignment.

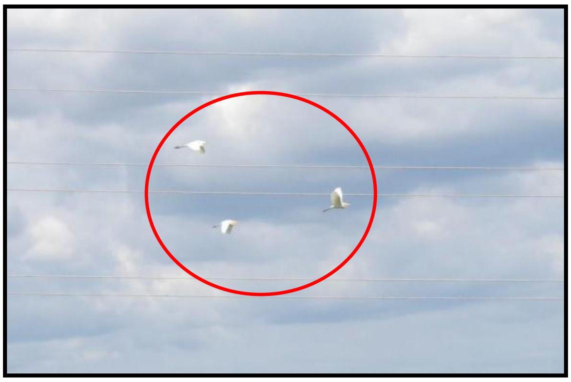
Table 2.1.4.23 Relative Abundance of Birds Recorded along the Proposed Davao City Bypass Road Project Route (1/2)

Common Name	Scientific Name	Abundance	Relative Abundance (%)
Glossy Swiftlet	*Collocalia esculenta*	76	22.26
Eurasian Tree Sparrow	*Passer montanus*	40	11.90
Yellow-vented Bulbul	*Pycnonotus goiavier*	38	11.31
Red-keeled Flowerpecker	*Dicaeum australe*	30	8.93
White-eared Brown-dove	*Phapitreron leucotis*	21	6.25
Olive-backed Sunbird	*Nectarinia jugularis*	17	5.06
Cattle Egret	*Bubulcus ibis*	15	4.46
White-collared Kingfisher	*Halcyon chloris*	15	4.46
Chestnut Munia	*Lonchura malacca*	13	3.87
Pied Fantail	*Rhipidura javanica*	12	3.57
Philippine Coucal	*Centropus viridis*	9	2.68
Pygmy Swiftlet	*Collocalia troglodytes*	6	1.79

Table 2.1.4.23 Relative Abundance of Birds Recorded along the Proposed Davao City Bypass Road Project Route (2/2)			
Common Name	**Scientific Name**	**Abundance**	**Relative Abundance (%)**
Blue-tailed Bee-eater	*Merops philippinus*	4	1.19
White-breasted Wood-swallow	*Artamus leucorynchus*	5	1.49
Brahminy Kite	*Haliastur indus*	4	1.19
Coppersmith Barbet	*Megalaima haemacephala*	4	1.19
Striated Grassbird	*Megalurus palustris*	4	1.19
Yellow Wagtail	*Motacilla flava*	4	1.19
Asian Glossy Starling	*Aplonis panayensis*	3	0.89
Grey-tailed Tattler	*Heteroscelus brevipes*	2	0.60
Red Junglefowl	*Gallus gallus*	2	0.60
Silvery Kingfisher	*Alcedo argentata*	2	0.60
Temminck's Stint	*Calidris temminckii*	2	0.60
White-bellied Munia	*Lonchura leucogastra*	2	0.60
Zebra Dove	*Geopelia striata*	2	0.60
Large-billed Crow	*Corvus macrorhynchos*	1	0.30
Little Egret	*Egretta garzetta*	1	0.30
Philipine Frogmouth	*Batrachostomus septimus*	1	0.30
Pied Buschat	*Saxicola caprata*	1	0.30
TOTAL		**336**	**100.00**

a) *Aplonis payanensis*

b) *Artamus leucorynchus*



c) *Bubulcus ibis*

d) *Calidris temminckii*

e) *Halcyon chloris*

f) *Haliastur indus*

Photo No. 2.1.4-28 Representative birds from the study sites along the proposed Davao City Bypass Road Construction Project Route

a) *Megalurus palustris*

b) *Merops philippinus*

c) *Motacilla flava*

d) *Phapitreron leucotis*

e) *Saxicola caprata*

f) *Heteroscelus brevipes*

Photo No. 2.1.4-29 Representative birds from the study sites along the proposed Davao City Bypass Road Construction Project Route

2) Herpetofauna

About **74** frog individuals were captured in four sampling locations along the proposed Davao City Bypass Road Project. Frog captures were resolved into **five** (**5**) species and **four** (**4**) families – Bufonidae, Dicroglossidae, Microhylidae, and Raniidae. The cane toad (*Bufo marinus*) dominated the entire survey with a relative abundance of **71.62%**, followed by the crab-eating frog (*Rana cancrivora*) with a relative abundance of **24.32%**.

Only **one** (**1**) individual of *Kalophrynus pleurostigma*, *Rana signata*, and *Kaloula picta* was captured throughout the survey period (**Table 2.1.4-24**). Representative frogs from the study sites are shown in **Photo No. 2.1.4-30**.

Table 2.1.4-24 Relative Abundance of Amphibians Recorded from Four (4) Stations along the Proposed Davao City Bypass Road Project Route

Family	Common Name	Scientific Name	Site				Total	Rel Abundance (%)
			1	2	3	4		
Bufonidae	Cane Toad	*Bufo marinus*	15	15	15	8	53	71.62
Dicroglossidae	Crab-eating Frog	*Rana cancrivora*	12	3	3		18	24.32
Microhylidae	Black-spotted sticky frog	*Kalophrynus pleurostigma*	1				1	1.35
Raniidae	Variable-backed Frog	*Rana signata*		1			1	1.35
Microhylidae	Slender-digit Chorus Frog	*Kaloula picta*				1	1	1.35
TOTAL			**28**	**19**	**18**	**9**	**74**	**100.00**

Note: 1 *Lasang River, Brgy. Communal; 2 – Lipadas River, Bangkas Heights; 3 – Matina River, Brgy. Langub; 4 – Tunnel Site, Brgy. Matina Biao*

a) *Bufo marinus*

b) *Kalouphrynus pleurostigma*

c) *Kaloula picta*

d) *Rana cancrivora*

e) *Rana signata*

Photo No. 2.1.4-30 Representative frogs from the study sites along the proposed Davao City Bypass Road Construction Project Route

3) Bats

A total of **50** individuals of bats were captured using mist nets in **nine** (**9**) net-nights at **three** (**3**) sampling locations, resolved into **four** (**4**) species representing only Family Pteropodidae. Bat captures were dominated by the lesser dog-faced fruit bat (*Cynopterus brachyotis*) with a relative abundance of **64%**, followed by the greater musky fruit bat (*Ptenochyrus jagori*), Geoffroy's rousette *(Rousettus amplexicaudatus*), and Dagger-toothed long-nosed fruit bat (*Macroglossus minimus*) with relative abundance of **20%**, **12%**, and **4%**, respectively (see **Table 2.1.4-25**). Representative bats from the study sites are shown in **Photo No. 2.1.4-31.**

a) *Rousettus amplexicaudatus*

b) *Macroglossus minimus*

c) *Cynopterus brachyotis (1)*

d) *Cynopterus brachyotis (2)*

e) *Ptenochirus jagori (1)*

f) *Ptenochirus jagori (2)*

Photo No. 2.1.4-31 Representative Bats from the study sites along the proposed Davao City Bypass Road Construction Project Route

Table 2.1.4-25 Relative Abundance of Bats Recorded from Four (4) Stations along the Proposed Davao City Bypass Road Project Route

Family	Common Name	Scientific Name	Site			Total	Relative Abundance (%)
			1	2	3		
Pteropodidae	Geoffroy's Rousette	*Rousettus amplexicaudatus*	6			6	12.00
Pteropodidae	Lesser Dog-faced Fruit Bat	*Cynopterus brachyotis*	22	5	5	32	64.00
Pteropodidae	Greater Musky Fruit Bat	*Ptenochyrus jagori*	5		5	10	20.00
Pteropodidae	Dagger-toothed Long-nosed Fruit Bat	*Macroglossus minimus*	1		1	2	4.00
TOTAL			**34**	**5**	**11**	**50**	**100.00**

(2) Evaluation of Survey Results

1) Diversity Measure

Highest species diversity of birds was observed along the riparian habitats of Matina River in Brgy. Langub and Brgy. Matina Biao due to the presence of remnant stands of trees and relatively dense forest cover. These sites are also relatively inaccessible with low population density. As shown in **Figure 2.1.4-3**, species diversity across all sites is low, averaging **0.71**. Species diversity of bats and frogs, based on species count and abundance is low.

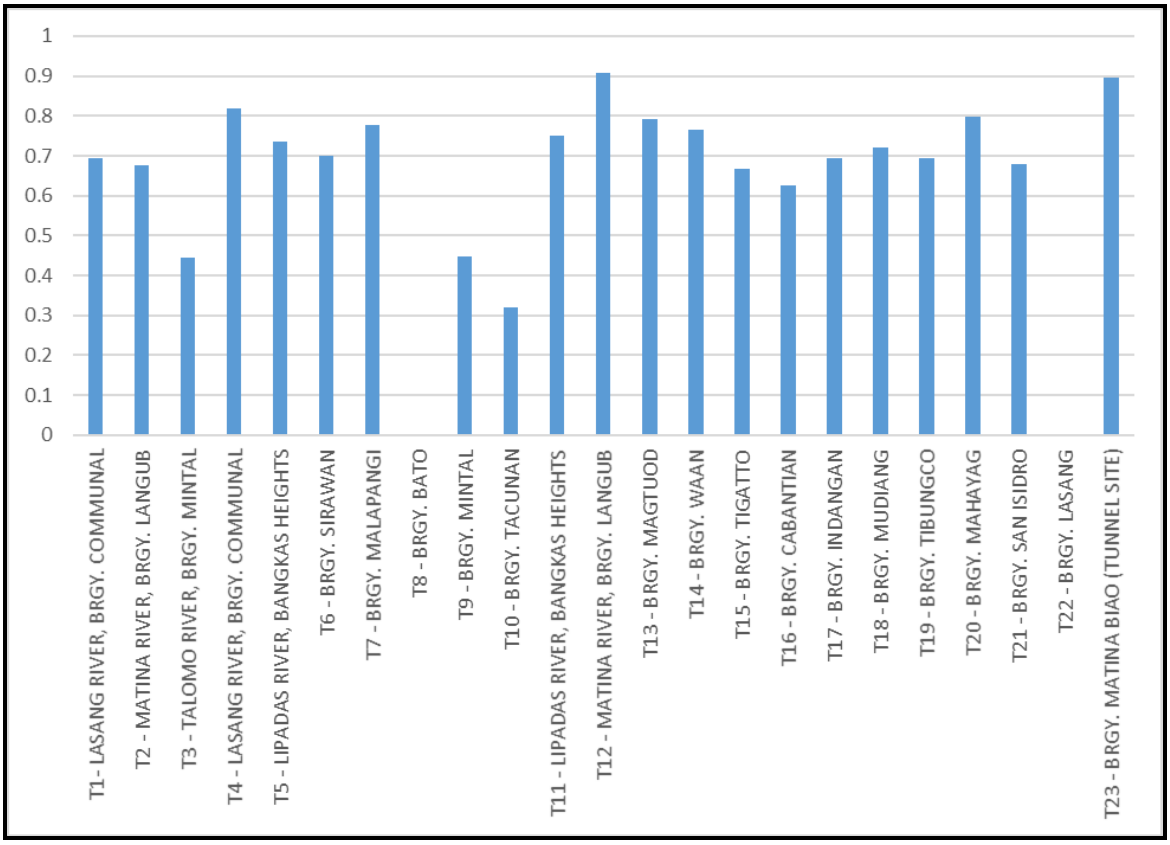


Figure 2.1.4-3 Comparison of Diversity of Avifauna Observed along the Sampling Sites

(3) Conservation Status and Endemicity

1) Birds

The **29** bird species are distributed into **19** residents, **six** (**6**) Philippine endemics, and **five** (**5**) migrant species where *Calidris temminckii* is rarely seen or observed (**Table 2.1.4-26**). Only **one** (**1**) species, the Silvery kingfisher (*Alcedo argentata*) is categorized as **Vulnerable** (*IUCN Redlist, 2014*). The other **28** species are categorized as **Least Concern**.

The Silvery kingfisher *Alcedo argentata* is mostly observed along streams in or near lowland forest. Its population is suspected to be undergoing a rapid decline as a result of habitat loss, hence, the **Vulnerable** category. All other bird species under the category "**Least Concern**" occupy extremely large range, have very large population size, and are not sufficiently decreasing in number. The Temminck's Stint (*Calidris temminckii*) is an occasional migrant to the Philippines and is rarely encountered. The species was observed along the riparian habitats of the Matina River at Brgy. Matina Biao, along with the Silvery Kingfisher (*Alcedo argentata*) flying back and forth along river banks or perching on rocks. Other than these **two** (**2**) species, no other species of exemplary status was encountered.

2) Bats and Frogs

All amphibians recorded in the surveys are categorized as "**Least Concern**" by *IUCN Redlist* (*2014*). Except for the Greater musky fruit bat (*Ptenochirus jagori*), which is a **Philippine Endemic**, the rest of the bat species are widely distributed in Southeast Asia and are also categorized as "**Least Concern**" by *IUCN Redlist* (*2014*).

Table 2.1.4-26 Residency and Conservation Status of Fauna Recorded from the Study Sites along the Proposed Davao City Bypass Road Project Route (1/2)

Family Name	Species Name	Common Name	Residency Status	IUCN Redlist (2014)
BIRDS				
Ardeidae	*Egretta garzetta*	Little Egret	Migrant	Least Concern
Ardeidae	*Bubulcus ibis*	Cattle Egret	Resident/Migrant	Least Concern
Accipitridae	*Haliastur indus*	Brahminy Kite	Resident	Least Concern
Phasianidae	*Gallus gallus*	Red Junglefowl	Resident	Least Concern
Scolopacidae	*Heteroscelus brevipes*	Grey-tailed Tattler	Migrant	Least Concern
Scolopacidae	*Calidris temminckii*	Temminck's Stint	Migrant-Rare	Least Concern
Columbidae	*Phapitreron leucotis*	White-eared Brown-dove	Endemic	Least Concern
Columbidae	*Geopelia striata*	Zebra Dove	Resident	Least Concern
Cuculidae	*Centropus viridis*	Philippine Coucal	Endemic	Least Concern
Podargidae	*Batrachostomus septimus*	Philippine Frogmouth	Endemic	Least Concern
Apodidae	*Collocalia esculenta*	Glossy Swiftlet	Resident	Least Concern
Apodidae	*Collocalia troglodytes*	Pygmy Swiftlet	Endemic	Least Concern
Alcedinidae	*Alcedo argentata*	Silvery Kingfisher	Endemic	Vulnerable
Alcedinidae	*Halcyon chloris*	White-collared Kingfisher	Endemic	Least Concern
Meropidae	*Merops philippinus*	Blue-tailed Bee-eater	Resident	Least Concern

Table 2.1.4-26 Residency and Conservation Status of Fauna Recorded from the Study Sites along the Proposed Davao City Bypass Road Project Route (2/2)

Family Name	Species Name	Common Name	Residency Status	IUCN Redlist (2014)
BIRDS				
Capitonidae	*Megalaima haemacephala*	Coppersmith Barbet	Resident	Least Concern
Pycnonotidae	*Pycnonotus goiavier*	Yellow-vented Bulbul	Resident	Least Concern
Corvidae	*Corvus macrorhynchos*	Large-billed Crow	Resident	Least Concern
Turdidae	*Saxicola caprata*	Pied Buschat	Resident	Least Concern
Sylviidae	*Megalurus palustris*	Striated Grassbird	Resident	Least Concern
Muscicapidae	*Rhipidura javanica*	Pied Fantail	Resident	Least Concern
Motacillidae	*Motacilla flava*	Yellow Wagtail	Migrant	Least Concern
Artamidae	*Artamus leucorynchus*	White-breasted Wood-swallow	Resident	Least Concern
Sturnidae	*Aplonis panayensis*	Asian Glossy Starling	Resident	Least Concern
Nectariniidae	*Nectarina jugularis*	Olive-backed Sunbird	Resident	Least Concern
Dicaeidae	*Dicaeum australe*	Red-keeled Flowerpecker	Endemic	Least Concern
Ploceidae	*Passer montanus*	Eurasian Tree Sparrow	Resident	Least Concern
Estrildidae	*Lonchura leucogastra*	White-bellied Munia	Resident	Least Concern
Estrildidae	*Lonchura Malacca*	Chestnut Munia	Resident	Least Concern
AMPHIBIANS				
Bufonidae	*Bufo marinus*	American Bullfrog	Introduced	Least Concern
Dicroglossidae	*Rana cancrivora*	Crab-eating Frog	Resident	Least Concern
Microhylidae	*Kalophrynus pleurostigma*	Black-spotted sticky frog		Least Concern
Raniidae	*Rana signata*	Variable-backed Frog	Resident	Least Concern
Microhylidae	*Kaloula picta*	Slender-digit Chorus Frog	Resident	Least Concern
BATS				
Pteropodidae	*Rousettus amplexicaudatus*	Geoffroy's Rousette	Resident	Least Concern
Pteropodidae	*Cynopterus brachyotis*	Lesser Dog-faced Fruit Bat	Resident	Least Concern
Pteropodidae	*Ptenochyrus jagori*	Greater Musky Fruit Bat	Endemic	Least Concern
Pteropodidae	*Macroglossus minimus*	Dagger-toothed Long-nosed Fruit Bat	Resident	Least Concern

(4) Habitat of Philippine Eagle

The **critically endangered** Philippine Eagle (*Pithecophaga jefferyi*) was **neither heard nor observed** along riparian habitats of the proposed bypass road project. Moreover, no traces nor signs of its mobility along these areas near the proposed bypass road were observed, as the Philippine eagle is largely **restricted in high altitude primary forest habitats**.

The Philippine Eagle is said to be found in **four** (**4**) major islands - Eastern Luzon, Samar, Leyte, and Mindanao, where the latter is believed to support a greater bulk of the species' population. Probably, the most recent effort to estimate the distribution and number of breeding pairs in Mindanao was made by *Buesser et al*. (*2003*). The report revealed an estimated of **82** to **233** breeding pairs spread in approximately **14,000 km^2** of remaining forests in Agusan del Sur, Bukidnon, Cotabato, Davao del Dur, Davao Oriental, Misamis Occidental, South Cotabato, Sarangani, and Davao City of Mindanao.

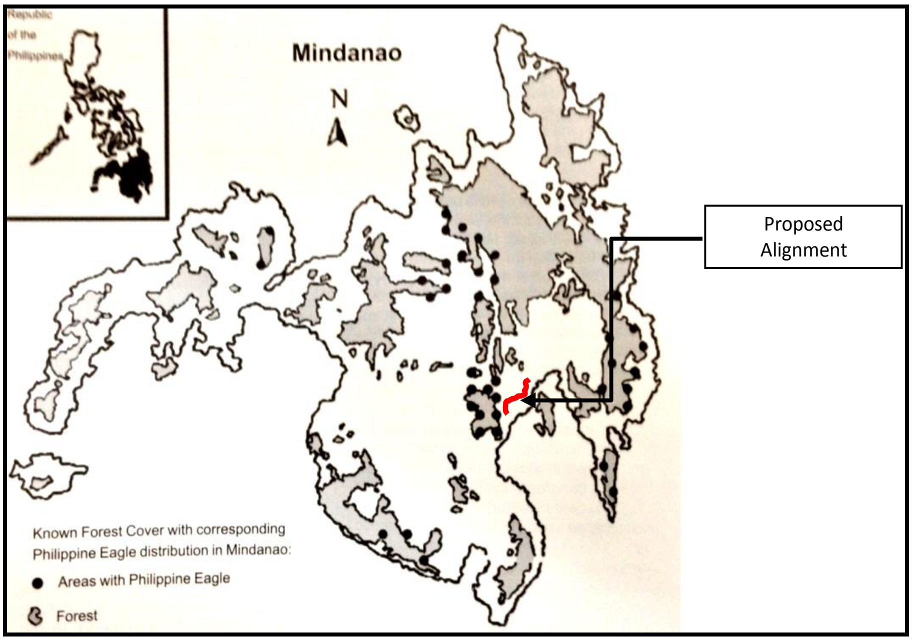
According to the Philippine Eagle Student Workbook (JICA), major habitats of *P. jefferyi* species are not distributed along or near the project area (**Figure 2.1.4-4**).

In addition, interviews were carried out with the Protected Areas and Wildlife Bureau-Department of Environment and Natural Resources, Region XII and Central Office, and with the Philippine Eagle Foundation, a known authority on distribution of Philippine eagles. The Philippine Eagle Foundation runs the only captive breeding facility for Philippine eagles in the country. The interviews indicate that nesting and activity areas of the Philippine eagle are restricted in the high altitude primary forest habitats of Mt. Apo National Park area, particularly at Brgy. Sibulan (**N 7°8'24.40", E 125°38'40.40"**), Davao City, about **7.24 miles (11.6 km)** from its nearest point in the project, and at Brgy. Salaysay (N 7°21'23.68", E 125°14'39.10") in Marilog District, about **24.7 miles (39.5 km)** from the project site (**Figure 2.1.4-5**).

Moreover, all the **interviewed specialists** concur to the prior finding that no species of *P. jefferyi* were heard nor observed along the proposed project site as it is impossible to observe the Philippine eagle in this location. The project site, generally, runs along disturbed and "open" areas, which neither serve as habitat for the Philippine eagle nor as a feeding area. The table below shows the summary of the said interview (**Table 2.1.4-27**).

And interview results from specialists are shown discussed in **Table 2.1.4-25**. According to all specialists, the habitats and hunting fields are not distributed in the project area.

Table 2.1.4-27 Result of Interview with Specialist			
No.	**Interviewee (Specialist)**	**Responses**	**Date of Interview**
1	Protected Areas Wildlife Bureau, Department of Environment and Regional Resources-Region XII	Philippine eagles cannot be observed along open areas because of vulnerability to possible threats such as poaching and inavailability of preys to feed on.	20 June 2014
2	Anna Mae Sumaya Research Staff Philippine Eagle Foundation, Malagos, Davao City	No recent sightings were reported; Philippine eagles could not possibly be found in urban areas of Davao City, such as the proposed road alignment as they are largely restricted in primary forest habitats. The Philippine Eagle Foundation in Malagos, Davao City operates a captive breeding facility for Philippine Eagles. The nearest probable nesting sites for Philippine eagles are located in Brgy. Sibulan, Davao City and Brgy. Salaysay, Marilog District; Philippine eagles are only found in primary dipterocarp forest and do not frequent the secondary growth areas. The Nearest known nesting site of the Philippine Eagle to the study area is found within the Mt. Apo National Park, this has enough preys for the eagle because of its primary forest, and thus the eagle does not visit the project area due to its more than **10 km** distance from the nesting site.	20 June 2014
3	Anson M. Tagtag Raptor Specialist, Protected Areas Wildlife Bureau, Department of Environment and Regional Resources-Region XII	Although Philippine eagles have a very restricted range, theoretically, their hunting ground may extend within 6 Km from its known territory, if the existing habitat cannot supply their food requirements, even if this 6-Km expansion zone is open or disturbed. For example, if the relatively forested tunnel area of the Bypass Road is considered for reforestation/rehabilitation in the future by the local government, it may be a potential expansion of habitat area in the future for the Philippine eagles if the reforestation is ecologically successful and it will attract the Philippine eagles and favorite prey such as macaques, squirrels, and flying lemurs.	04 August 2014



Source: JICA (the Philippine Eagle Student Workbook)

Figure 2.1.4-4 Philippine eagle distribution in Mindanao

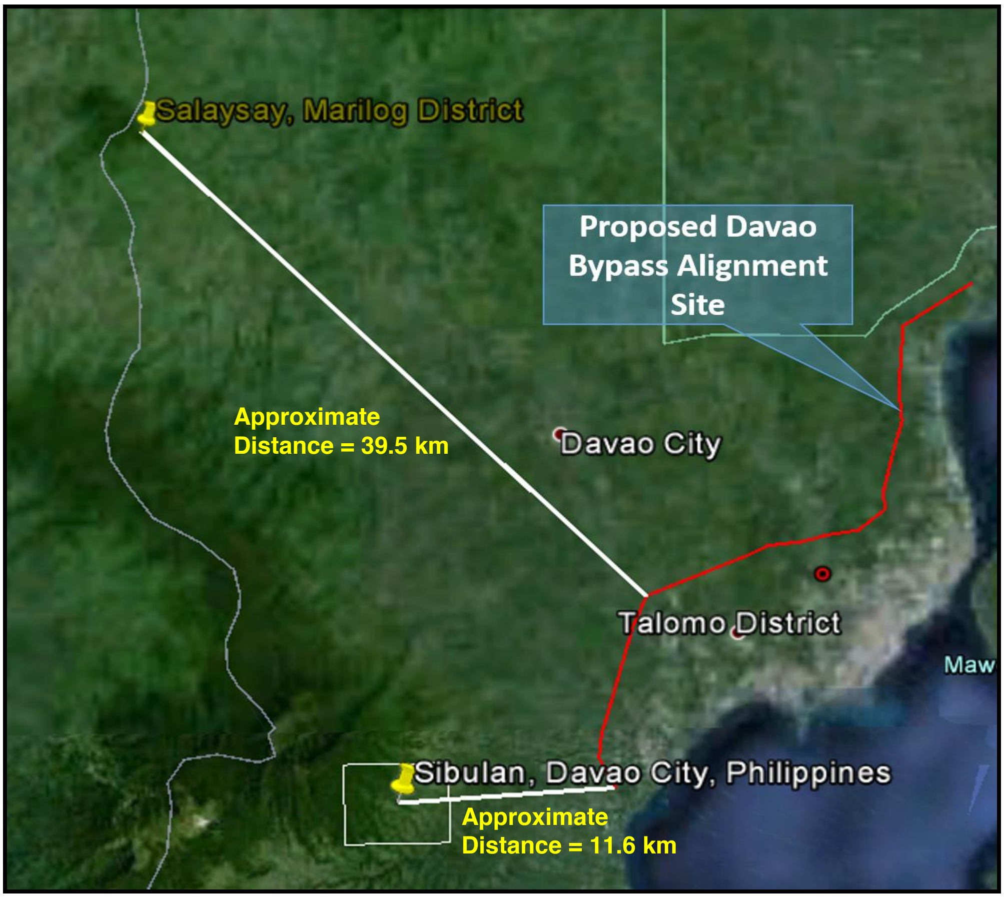


Figure 2.1.4-5 Identified Locations of Captive Breeding Sites and Nesting Center for Philippine Eagle

Photo No. 2.1.4-32 Interview with Philippine Eagle Foundation resident *Biologist*, **Ms. Anna Mae Sumaya** (left) during EIA Team's visit to the foundation last 20 June 2014. Also in the photos are from right, **Mr. Kuroki Hironori**, *Environmental Specialist* of the JICA Study Team, **Mr. Jaime A. Namocatcat PhD**., EIA Team's *Terrestrial Ecologist*, and **Mr. Ronaldo T. Manipol**, EIA Team *Deputy Team Leader*.

Photo No. 2.1.4-33 **Mr. Mr. Ronaldo T. Manipol**, of ECOSYSCORP, INC. conducting an interview with **Mr. Anson M. Tagtag** (left), *Enviromental Specialist II* (EMS II) and *Focal Person* of the Philippine Raptor Program, *Protected and Wildlife Bureau* (*PAWB*) about the profile of the Philippine Eagle. This was taken on 04 August 2014.

2.1.4.3 Impact Analysis and Mitigation

(1) Cosntruction Phase

1) Flora

(a) Removal of Natural Vegetation and Loss of Habitat

Species of plants that are likely to be removed during the construction phase of the project based on total importance values are generally weeds that inhabit roadsides, open spaces, and grassland areas presented in **Table 2.1.4-28**.

Table 2.1.4-28 Top 10 ecologically important flora along project site

Species Name	Common Name	Importance Value (%)
Imperata cylindrica var. koenigii	Cogon	172.65
Saacharum spontaneum L.	Talahib	166.78
Sporobolus indicus L.	Whipping Grass	122.55
Axonopus fissifolius	Crab Grass	111.91
Cyperus rotundus	Nut Grass	101.94
Eleusine indica (L.) Gaertn.	Paragrass	93.72
Axonopus fissifolius	Carpet Grass	93.71
Centrosema pubescens	Hairy Leaf Centrosema	93.15
Paspalum conjugatum Berg.	Carabao Grass	82.51
Chromolaena odorata (L.) R.M.	Hagonoy	54.47

From the conservation point of view, based on Philippine (DAO 2007-01) and international list (IUCN 2014) of endangered flora, these plants are not categorized being weed plants. Thus, the project does not pose serious impacts on removal of weed vegetation. However, weed plants as part of the habitat provide ecological services such as dust and erosion control.

Some **Habitats identified to have relatively denser vegetation** which may be affected by project construction are the riparian habitats of the **five** (**5**) river systems, specifically Matina River. Trees that may be potentially removed during construction phase if the road will encroach riparian habitats are *Cananga odorata* (Ilang-ilang), *Terminalia calamansanai* (Kalamansanai), *Lygodium flexuosum* (Nito), *Diplodiscus paniculatus*

(Balobo), *Artocarpus blancoi* (Antipolo), *Ficus ulmifolia* (Isis), *Ficus pseudopalma* (Niyug-niyugan), *Ficus nota* (Tibig), *Leucosyke capitellata* (Alagasi), *Leea philippinensis* (Kaliantan), *Diplodiscus paniculatus* (Balobo), *Afzelia rhomboidea* (Balayong), *Pterocarpus indicus echinus* (Prickly Narra), and *Pterocarpus indicus indicus* (Smooth Narra).

If removal of trees, especially prime species is unavoidable, a tree replacement scheme (reforestation/tree planting) is recommended during the rehabilitation of the project site prior to project operation. To avoid unnecessary cutting, site clearing and constucrion works will be limited within the required ROW of **40-60 m**. Prior to any tree cutting activities, the DPWH/Contractor shall secure "*Permit To Cut*" from the DENR-FMB Region XI. All cut trees will be surrendered to the DENR-FMB region XI for inventory.

Replacement ratio for planted trees in private and forest lands not exclusively established for tree plantations/timber production purposes (as defined in *DENR-FMB Memorandum Order No. 2012-02* attached as **Appendix D**), shall be **1:50**. Whereas, naturally growing trees in same areas, including those affected by development (such as the Davao City Bypass) projects shall have **1:100** ratio in support of the National Greening Program (NGP) and climate change initiatives of the Government.

To facilitate the implementation of tree replacements, seedling donations and identification of common tree planting sites shall be encouraged for more impact, especially in urban areas. Planted trees shall be replaced preferably with **indigenous** species, while naturally growing trees shall be **strictly replaced** with **indigenous** species. All donated seedlings shall be properly recorded and turned over to the CENRO concerned (for this project the CENRO of both Davao City and Panabo City) with jurisdiction over the area, while tree planting sites shall be delineated on the ground with the corresponding technical description and map using Global Positioning System (GPS) for ease of monitoring and evaluation purposes.

Cut trees will be considered for re-use and recycling. Vegetation spoils will be regularly hauled and disposed to sites duly-approved by the CENRO of Davao City and Panabo City.

As additional mitigation for the removal of vegetation and to improve ecological services of the entire road network during operation phase, it is recommended that a **2 or 3-layer** tree lane be established in both the right and left side of the bypass project, avoiding electrical transmission lines. This recommendation is in consonance with the DPWH

Department Order (DO) 15 issued on January 24, 2000, which concerns tree plating along the National Roads. Suggested species of trees to be planted are antipolo (*Artocarpus blancoi*) and dita (*Alstonia scholaris*), which are fast-growing indigenous species that are as good as the exotic tree species being introduced by DENR. Antipolo and dita may be interspersed with food plants for birds and bats such as bignay (*Antidesma sp*.) and several species of ficus or balete trees (*Ficus odorata*, *F. nota*, *F. minahassae*). Establishing tree lanes of indigenous species will markedly improve vegetation cover and local ecology of the Davao City Bypass Road Project.

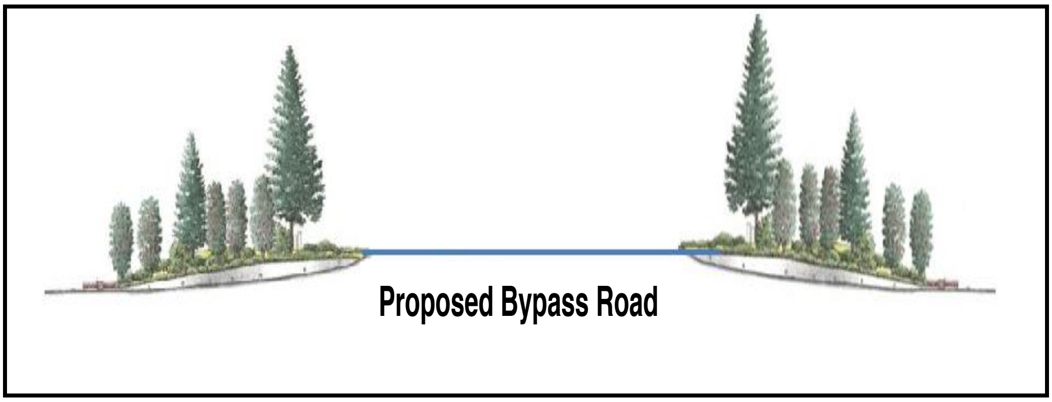


Figure 2.1.4-6 Tree lane proposed for mitigation of vegetation removal along the proposed roade alignment

(b) Impacts on Endemic and Endangered Plants

Out of the **185** species records of plants recorded from the study sites, only **10** species are **Philippine endemics**, namely:

- *Cananga odorata* (Ilang-ilang);
- *Terminalia calamansanai* (Kalamansanai);
- *Lygodium flexuosum* (Nito);
- *Diplodiscus paniculatus* (Balobo);
- *Artocarpus blancoi* (Antipolo);
- *Ficus ulmifolia* (Isis);
- *Ficus pseudopalma* (Niyug-niyugan);
- *Ficus nota* (Tibig);
- *Leucosyke* capitellata (Alagasi); and
- *Leea* philippinensis (Kaliantan);

While only **seven (7)** species are categorized as **Endangered** and **Vulnerable** based on DAO 2007-01 and IUCN Redlist (2014), summarized as follows:

- *Vitex parviflora* (Molave) – *Endangered (DAO 2007-01), Vulnerable (IUCN Redlist, 2014);*
- *Drynaria quercifolia* (Kabkab/Oak-leaf Fern) – *Vulnerable (DAO 2007-01);*
- *Diplodiscus paniculatus* (Balobo) – *Vulnerable (IUCN Redlist, 2014);*
- *Ficus ulmifolia* (Isis) - *Vulnerable (IUCN Redlist, 2014);*
- *Afzelia rhomboidea* (Balayong) - *Vulnerable (IUCN Redlist, 2014);*
- *Pterocarpus indicus echinus* (Prickly Narra) - *Vulnerable (IUCN Redlist, 2014); and*
- *Pterocarpus indicus indicus* (Smooth Narra) - *Vulnerable (IUCN Redlist, 2014)*

These species of trees are also found in the other secondary forest areas of Davao City and elsewhere in the remnant forest cover of Mindanao. While these trees are found along the proposed project site, these trees are not necessarily impacted by the project since the tree stands are located along riparian habitats that may not be encroached by road construction. If some trees will be inevitably removed, these species will be replaced by replanting along roadsides during post-construction activities. The seedlings of endangered and vulnerable trees will be sourced from the DENR-FMB (Forest Management Bureau) Region XI, or from any DENR-accredited tree nursery.

(c) Cutting of Coconut Trees and Other High-Value Commercial Fruit Trees, and Planted Trees

For coconut trees, "*Permit to Cut*" shall be secured from the Philippine Coconut Authority (PCA) Region XI prior to any tree cutting activities. Compensation for affected coconut tree shall be based on **Section 5** of **Republic Act No. 8048**, an act providing for the regulation of the cutting of coconut trees. Replacement ratio of cut coconut trees shall be **1:1**. If the applicant failed to implement replanting, fees collected by the PCA shall be used to fund the replanting activity as defined in **Section 5** of **Republic Act No. 8048**.

The PCA in coordination with the Davao City and Panabo City, shall verify if replanting was implemented, and regulate and oversee the fertilization and care of the newly planted coconut trees. On-the-spot inspections of the replanting sites shall be conducted by PCA.

All cut coconut trees shall be surrendered to PCA for inventory and proper disposal.

Replacement ratio of the planted trees to be cut in private and public lands not established as tree plantations/timber production purposes shall be 1:50, preferably indigenous species among others as *Vitex parviflora* (Molave), *Cananga odorata* (Ilang-ilang), *Pterocarpus indicus echinus* (Prickly Narra), *Pterocarpus indicus indicus* (Smooth Narra), and *Lygodium flexuosum* (Nito). Common reforestation species like *Gmelina arborea* (Gmelina), *Acacia auriculiformis* (Japanese acacia), *Acacia mangium* (Mangium), and *Swietenia mahagoni* (Common mahogany),

Compensation of planted trees and high-value commercial fruit trees such as banana, mango, durian, pomelo, mangosteen, papaya, rambutan, and lanzones shall be in accordance with the existing schedule of values from the City Agriculture Office (CAO) of Davao City and Panabo City.

(2) Fauna

1) Hindrance to Wildlife Access

Majority of birds, bats, and frogs recorded in the transect surveys are cosmopolitan species and are generally adapted to lowland and residential areas. **The faunal habitats observed to have high species diversity that may be affected** by the proposed project are the **riparian habitats of Matina River in Barangay Langub and Matina Biao**.

Thus, it is recommended to carry out appropriate mitigation measures such as replanting **2 or 3-layers** of tree lanes along the road (refer back to **Figure 2.1.4-6**). At the same time, appropriate land use management along the bypass during operation phase should be implemented by Davao City, so as not to cause unplanned development (i.e., land squatting by migrants) in areas with dense vegetation.

2.2 THE WATER

2.2.1 Hydrology

2.2.1.1 Watershed of Surface Water

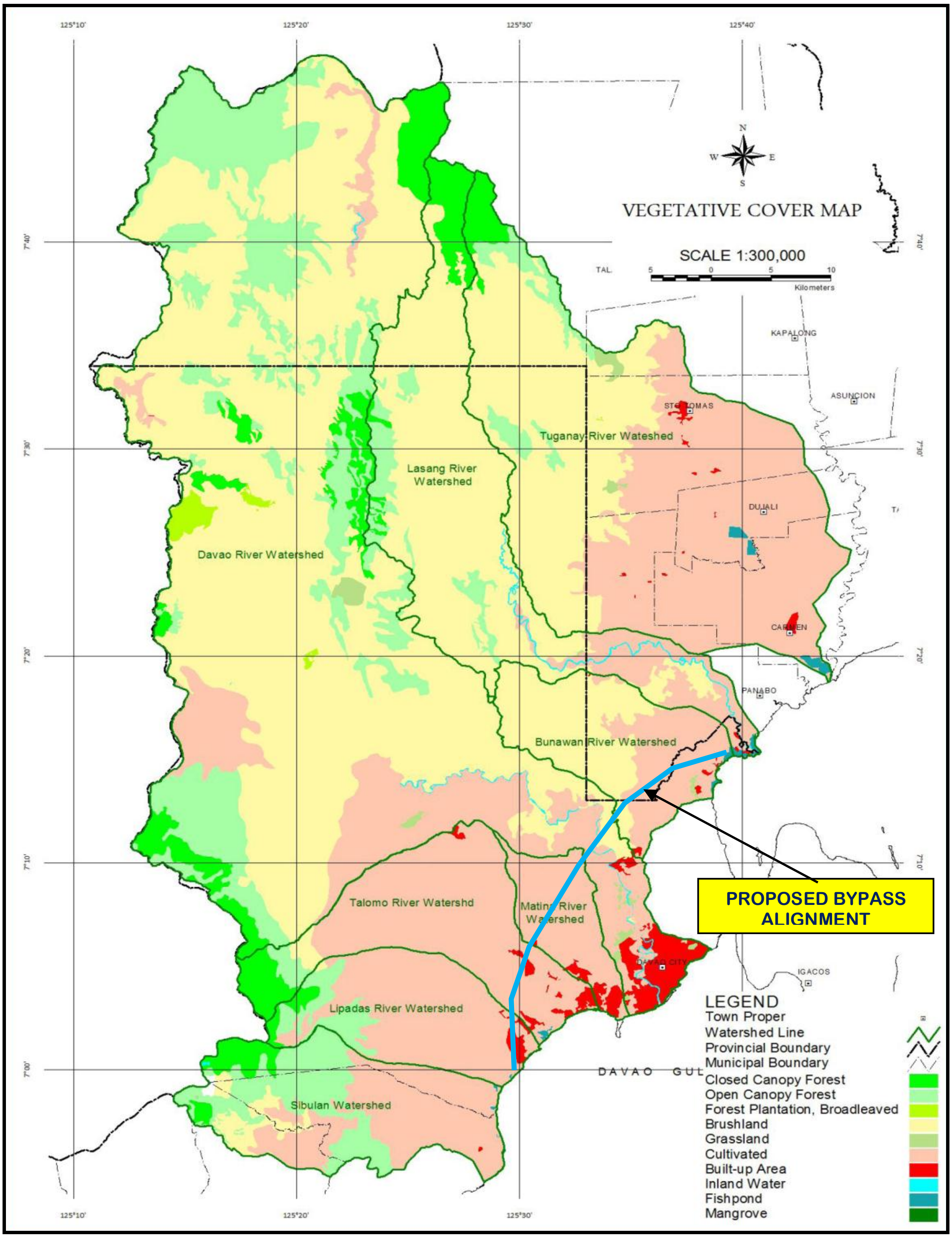
Davao City's political boundaries encompass **eight** (**8**) different watersheds shown in **Figure 2.2.1-1**. Talomo-Lipadas Watershed is a major source of drinking water. Approximately **99%** of the urban population of Davao City get their drinking water from within these river basins.

Summarized in **Table 2.2.1-1** are the area of the river basins and the area percentage within the political boundary of the Davao City.

Table 2.2.1-1 Summary of Area of the 8 River Basins within the Davao City Jurisdiction

River Basin (RB)	Hectares in Davao City	% RB within the City	Total Hectares of 8 RB
Davao River	121,385	69%	175,776
Lasang	29,132	64%	45,390
Talomo	21,578	100%	21,578
Lipadas	16,796	100%	16,796
Bunawan	18,328	73%	25,213
Tuganay	18,120	24%	74,747
Sibulan	10,782	38%	28,213
Matina	7,879	100%	7,879
Total Area	**244,000**	**62%**	**395,592**

Source: JICA Study Team, July 2014



Source: JICA Study Team, July 2014

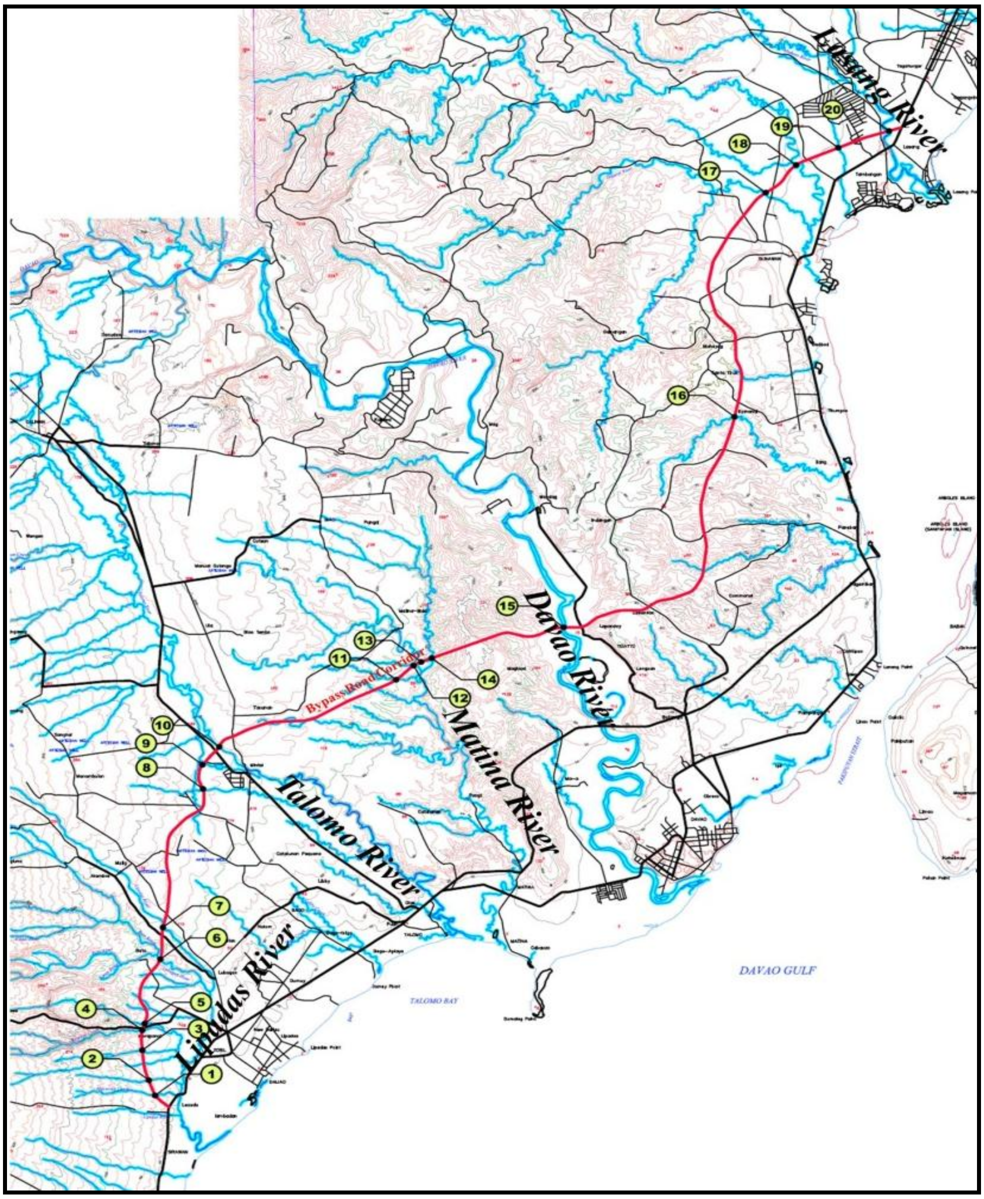
Figure 2.2.1-1 Map Showing Vegetation Cover in the 8 Watersheds within the Political Boundary of Davao City

2.2.1.2 Flooding

The major river systems that will be crossed by the bypass road corridor are Davao, Lasang, Talomo, Lipadas and Matina Rivers. In addition, a number of smaller river systems are also present as shown in **Figure 2.2.1-2**.

Flooding is a common occurrence in specific locations in Davao City. Generally, floods can be classified into these types:

- Riverine floods along the river system;
- Localized floods in urban area due to combination of cloudburst, saturated soil, poor infiltration rates and inadequate or poorly built /maintained drainage lines;
- Flooding due to typhoon and storm surge in the coastal areas;
- Subsiding coastline; and
- Flood flow impedance by high tide

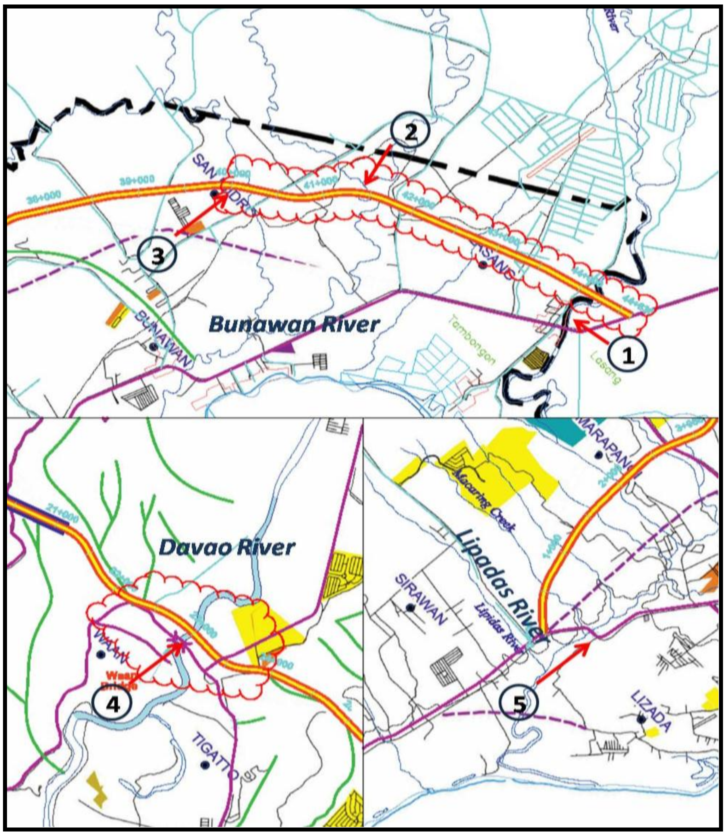


Source: JICA Study Team, 2013

Figure 2.2.1-2 Major and Minor River Systems that will be Crossed by the Davao City Bypass Alignment

For the project, the study is focused on riverine flood especially in road sections were bridges will be constructed. As part of the study, interviews of old time residents were made in pre-identified river sections the result of which is summarized in **Table 2.2.1-2** and **Figure 2.2.1-3**. Data from the interview shows flood risks on the major river system is very high.

Table 2.2.1-2 Summary Result of Interview on Flood in the Study Area		
Interview Location	**Interview Results**	**Remarks**
(1) Lasang River	*Past Flood Height*: Ground Level + 0.70 m (max) *Frequency of Overbank*: Small floods are 6 times a year Big flood is 1st time/2 years	Along the proposed bypass alignment
(2) Lacanon River	*Past Flood Height*: Ground Level + 0.80 m (max) *Frequency of Overbank*: 4 times/2013	Along the proposed bypass alignment
(3) Bunawan River	*Past Flood Height*: Ground Level + 0.30 m (max) *Frequency of Overbank*: only one (1) time (June 2011)	Along the proposed bypass alignment
(4) Davao River	*Past Flood Height*: Ground Level + 1.00 m (max) *Frequency of Overbank*: only two (2) times (December 2012)	Along the proposed bypass alignment
(5) Lipadas River	*Past Flood Height*: Ground Level + 1.60 m (max) *Frequency of Overbank*: only two (2) times (1987 & 2007)	Location away from the proposed bypass alignment (existing bridge of the National Road)
Source: JICA Study Team, 2013		



Source: JICA Study Team, 2013

Figure 2.2.1-3 Location Map of Interviews on Flood Conducted in the Study Area

2.2.1.3 Impact Analysis and Mitigation

(1) Pre-Construction Phase

Interview results conducted by the JICA Study Team in the study area showed that the proposed bypass alignment will traverse major river systems that are high flood risks (i.e. Lasang, Lacanon, Bunawan, and Davao Rivers). It was also raised during the Scoping Meeting in Brgy. Tigatto, Davao City on December 18, 2013 that the project may aggravate the existing flooding problem in the area if the drainage facilities to be constructed are insufficient and sub-standard.

The bridges, culverts, side road ditches will be designed so as not to aggravate the existing flooding condition. A hydrological study was conducted for the Drainage Design of these infrastructures based on the area's meteorological/ hydraulic data and topographical/hydrological surveys specifically conducted for the purpose of the project. The catchment area of rivers or channels that will be crossed by the bypass road were measured using the NAMRIA 1:50,000 scale topographical map. The cross sections and riverbed profiles of the rivers were based on actual topographical survey. Important items in the hydrological study for the project are presented in **Table 2.2.1-3**.

Table 2.2.1-3 Survey Items for Hydrological Survey

Items		Institutions Concerned	Remarks
Meteorological Survey	General Weather Conditions (Temperature, Relative Humidity, Wind Speed and Direction, Evapo-transpiration, Sunshine Hours, Station Information, etc.)	PAGASA	
	Rainfall (Annual / Monthly / Daily rainfall, Rainfall Intensity Curve, etc.)	PAGASA	
Hydrological Survey	Annual Maximum Discharge (Peak), Annual / Monthly / Daily Discharge, Annual Maximum High water level, Station Information, etc.	BRS of DPWH	
Bibliographic Survey	Related Design Criteria / Standards / Study Reports, Topographic Maps, etc.	DPWH, Davao City, NAMRIA, JICA, etc.	
Interview Survey	Flood Situation Surrounding Related Bridge Sites	(Local Residents)	

Source: JICA Study Team, July 2014

The design criteria and standards followed were:

i) DPWH Design Guidelines, Criteria and Standards for Public Works and Highways published in 1980;

ii) FHWA (Federal Highway Administration, USA), HEC (Hydraulic Engineering Circular) series; and

iii) U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-HMS, HEC-RAS and HY-8 Manuals and Technical References

These standards will be proposed for the hydrologic and hydraulic design criteria which are appropriate for project requirements. Also, these standards will cover the following items:

- Hydrologic Design;
- Design Frequency or Return Period;
- Runoff Computation Methods, Runoff Coefficients;
- Rainfall Intensity;
- Level of Development in the Watersheds;
- Hydraulic Design;
- Manning's Roughness Coefficient;
- Expansion and Contraction Loss Coefficients; and
- Freeboard

The drainage design criteria for the project are shown in **Table 2.2.1-4**.

Table 2.2.1-4 Drainage Design for the Proposed Davao City Bypass Project (1/2)

Items of Criteria		Criteria	Applied Standards	Remarks
Hydrologic Design		Based on the data from PAGASA	Various documents including DPWH standards	
Design frequency or return period	Rivers (Bridges)	50-year flood with sufficient freeboard to contain the 100-year flood	DPWH standards	
		25-year flood with sufficient freeboard to contain the 50-year flood	DPWH standards	
	Culverts (Box)	25-year flood with sufficient freeboard to contain the 50-year flood	DPWH standards	
	Culverts (Pipe) Esteros/Creeks Drainage pipes	15-year flood with sufficient freeboard to contain the 25-year flood	DPWH standards	
	Embankments	10-year flood	DPWH standards	
	Ditches and road surface	2-year flood	DPWH standards	
Runoff computation methods, runoff coefficients	Computation methods for waterways with catchment area of 20 km^2 or more (Davao, Lasang, Talomo, Lipadas, Matina Rivers)	Specific discharge, by drainage area rate from probable hydrological value (flood frequency analysis) and unit hydrograph method	by calculations	
Items of Criteria		**Criteria**	**Applied Standards**	**Remarks**
	Computation methods for other waterways, channels with catchment area less than 20 km^2	Rational Formula	DPWH standards, HEC	
	Runoff coefficients	**Refer to Table 2.2.1-5**	DPWH standards, HEC	
Rainfall intensity-duration-frequency		Based on the data from PAGASA	by calculation	

Table 2.2.1-4 Drainage Design for the Proposed Davao City Bypass Project (2/2)				
Items of Criteria		**Criteria**	**Applied Standards**	**Remarks**
Level of development in the watersheds		Based on the data from land use plan of Davao city	-	
Hydraulic Design	Hydraulic computation method (Bridges)	Based on the calculation by HEC-RAS	HEC	
	Hydraulic computation method (Culverts)	Based on the calculation by Rational Formula and confirmed/checked with HY-8 Software	HEC	
	Minimum size of drainage pipes	910 mm	DPWH standards	
Manning's Roughness Coefficient		**Refer to Table 2.2.1-6**	DPWH standards, HEC	
Expansion and contraction loss coefficients		(Various values)	HEC	
Freeboards		Bridge: 1 m minimum freeboard with no debris and 1.5 m minimum free board for waterways with debris load. Culverts: avoid to 2 barrel installations in debris prone areas	DPWH standards	

Source: JICA Study Team, July 2014

Table 2.2.1-5 Runoff Coefficient C	
Watershed Cover or Type of Surface	**Run-off Coefficient, C**
Concrete or asphalt pavement	0.80 – 0.90
Steep grassed areas (2:1)	0.50 – 0.70
Flat residential with about 30% of area impervious	0.40
Flat residential with about 60% of area impervious	0.60
Moderate steep residential with 50% of area impervious	0.65
Moderate steep residential with 70% of area impervious	0.80
Flat commercial with about 90% of area impervious	0.80

Source: JICA Study Team, July 2014

Table 2.2.1-6 Value of Manning's Roughness Coefficient "n"		
Glass, plastic, mechanical metal	0.010	
Dressed timber, joints flush	0.011	
Sawn timber, joints uneven	0.014	
Cement plaster	0.011	
Concrete, steel troweled	0.012	
Concrete, timber forms, unfinished	0.014	
Untreated granite	0.015	- 0.017
Brickwork or dressed masonry	-0.014	
Rubble set in cement	0.017	
Earth, smooth, no weeds	0.020	
Earth, some stones and weeds	0.025	
Natural river channels:		
Clean and straight	0.025	- 0.030
Winding, with pools and shoals	0.033	- 0.040
Very weedy, winding and overgrown	0.015	- 0.300
Clean straight alluvial channels	$0.031d^{1/6}$	
	(d=D-75 size in ft.)	

Source: JICA Study Team, July 2014

So as not to impede the river flow especially during flood events, the following will be the hydraulics criteria in the design for the opening of all bridges of the project:

- Bridge should have sufficient opening for backflow to cause increase the flood height at the upstream side of the bridge;
- The bridge opening will be sufficient so as to cause increase in velocity of flow through the bridge;
- The existing natural flow distribution is maintained;
- The pier and abutment are designed to minimize the flow disruption and effect of scouring abated (local scour is within acceptable limits); and
- Adequate clearance to allow unhindered passage of debris (elevation of the bottom of the bridge girder is higher than "Highest high water level with height of Freeboard or Navigation Channel;

The design return period, clearance from the bridge girder to high water level shall be compliant acceptable international/DPWH standards (high water level and estimation of scouring shall be determined based on the HEC standards and HEC-RAS computation)

(2) Construction Phase

Existing flooding condition at identified flood-prone areas such as Brgy. Tigatto maybe aggravated during construction of the project due to localized flooding. To avoid inundation along these areas, temporary but sufficient and effective drainage facilities must be provided at areas prone to flooding.

Vegetation spoils stripped from the riparian areas if improperly managed may impede the flow of water along the waterways, which may result to reduced stream flow. To prevent impediment of water flow, cut vegetation covers and construction spoils must be regularly hauled and disposed to sites duly approved by the DENR-FMB Region XI, and CENRO of Davao City and Panabo City.

Temporary stockpiles of vegetation spoils and construction debris will not be located anywhere near the waterways to prevent clogging caused by the improper management of these waste materials which may result to water stagnation.

If possible, stream flow regime of the waterways, particularly those along the flood risks areas will be temporarily diverted to ensure continuous flow of water especially during high precipitation periods.

(3) Demobilization/Decommissioning Phase

During demobilization/decommissioning phase, the ESHO of the Contractor must ensure that the bridge construction sites are clear of construction spoils and debris so as to avoid impediment of stream flow of the waterways. The DPWH together with the Environmental Safety and Health Officer (ESHO) of the Contractor and the MMT shall conduct a joint site inspection of all bridge construction sites to validate compliance of the Contractor.

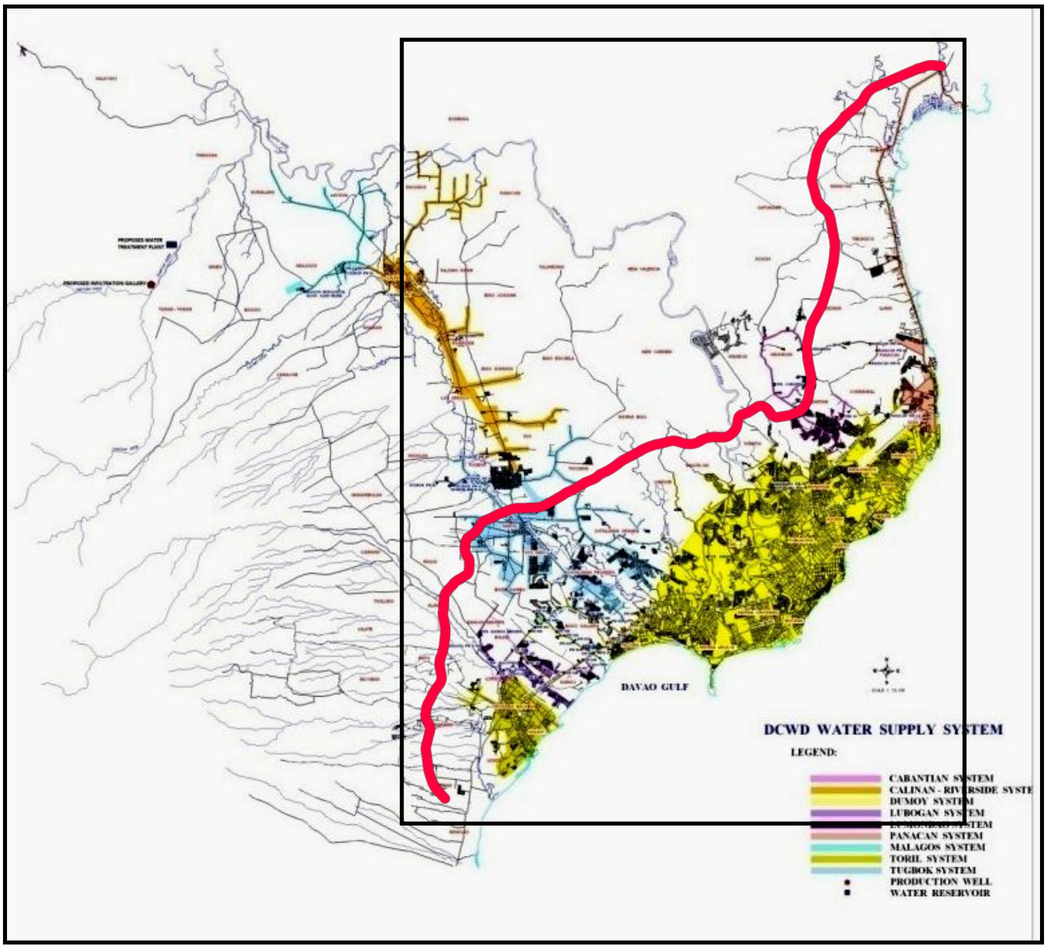
(4) Operational Phase

To ensure optimum efficiency of the drainage facilities along natural waterways and to prevent potential aggravation of the existing flood conditions along the identified flood risks areas traversed by the bypass road, the concerned District Engineering Office (DEO) of the DPWH shall undertake regular maintenance of the facilities installed. In addition, interviews with local residents regarding flood occurrence, especially after continuous and high precipitation periods will help improve future maintenance work programs.

2.2.2 Hydrogeology

2.2.2.1 Existing Groundwater Sources (Secondary Data)

The data of the groundwater in Davao City were gathered from studies done by Asian Development Bank (2012), MGB Region XI and those from Davao City Water District (DCWD). The DCWD is the country's largest district since its creation in 1973, covering about **106** barangays (about **58%** of the total **182** barangays within its jurisdiction). The DCWD manages **nine** (**9**) water supply systems, which consists of the Cabantian, Calinan, Dumoy, Lubogan, Lumandao, Malagos, Panacan, Toril and Tugbok as shown **Figure 2.2.2-1**.



Source: JICA Study Team July 2014

Figure 2.2.2-1 DCWD Service Areas

The current raw water source of DCWD is not sufficient to meet the increasing demand. The groundwater source is concentrated at Brgy. Dumoy located at the skirts of Mt. Apo and Mt. Talomo, where DCWD operates more than **30** deep wells. Also, only small amount of surface water approximately **36 liters/s** is withdrawn from the small tributary of the Davao River, the Malagos Creek.

The capacities of the **nine** (**9**) systems serving the overall DCWD service areas are summarized in **Table 2.2.2-1**. As some of the barangays are served by more than one of the water sub-systems and the total of served barangays are more than **106**, as indicated in the table. As of 2012, the number of active connections are **174,108** consisting of **167,780** domestic connections, **5,698** commercial and bulk consumers and **630** government consumers.

The capacities of the nine systems serving the overall DCWD service areas are summarized in **Table 2.2.2-1**. As some of the barangays are served by more than one of the water sub-systems and the total of served barangays are more than 106, as indicated in the table.

Although the data in **Table 2.2.2-1** is the data of 2010, as of 2012, the numbers of active connections are increased **174,108** consisting of **167,780** domestic connections, **5,698** commercial and bulk consumers and **630** government consumers.

Table 2.2.2-1 DCWD Service Area and Connections

No.	Water Supply System	Number of Barangays Served	Population Served	Number of Connections		
				Domestic	Commercial and Bulk	Government
1	Cabantian	3	30,128	6,017	30	11
2	Calinan	11	19,873	3,950	101	23
3	Lubogan	6	27,051	5,406	14	5
4	Lumandao	1	56	11	1	0
5	Dumoy	71	553,175	109,584	4,825	428
6	Malagos	3	3,973	793	2	5
7	Panacan	6	32,734	6,516	123	29
8	Toril	8	32,836	6,527	170	33
9	Tugbok	10	84,056	16,763	145	95
Total		**119**	**783,882**	**155,567**	**5,411**	**629**

Source: JICA Study Team, July 2014

The raw water will only supply **43%** of Davao City's projected population of **2.5 million** in 2030 in the capacity without expansion of the water source. There are already some problems as polluted coastal aquifers, decreasing levels of groundwater, increasing land subsidence and saltwater intrusion due to over-extraction of ground water. And these problems compel the need to tap reliable surface water as supply sources.

DCWD intends to shift from groundwater dependent to surface water first. But a move to secure the future source of water for the city is late, due to fear of groundwater contamination by pesticide from the extensive banana plantations and farms on the skirts of Mount Talomo and along the Davao River.

(1) Groundwater Resources

Most of the water wells of DCWD are placed in Dumoy, and the rest of water wells are placed in Tugbok, Panacan, Toril, Dacoville, Batulosa, Lumondado, and Riverside. These wells have an average depth of **120-150 m**.

The aquifers of groundwater in Davao City are recharged perennially by rainfall on the southern flanks of Mount Apo, Mount Tipolog and Mount Talomo. These areas are covered by highly porous pyroclastic materials and permeable highly fractured volcanics that receive and store sufficient groundwater to recharge the aquifers in the lowlands.

The aquifers in Davao City are classified based on rock types discussed below.

1) Aquifer in Igneous Rock and Volcano Clastics

Igneous rocks are poor aquifers with permeability confined along openings of fractures/fissures. Volcano clastics (e.g. pyroclastic flows, sandy tuff, tuff breccias and volcanic mud flows) are very porous and permeable, and there are natural features of very good aquifers.

2) Aquifer in Sedimentary Rock

Groundwater flow in sedimentary rocks is influenced by the physical property, composition, lithology and faces. In general, coarse grained sedimentary rocks such as conglomerates and sandstones are good aquifers. But fine grained sedimentary rocks like mudstone, siltstone, or shale are poor aquifers due to very poor hydraulic permeability.

3) Aquifer in Limestone

Limestone is excellent groundwater conveyor by the presence of cavities and caves. Coralline limestone in Davao City has a high percentage of openings that can hold high volume of groundwater. The downsides are the low filtration capacity and the property that is easy to be pollution.

4) Aquifer in Unconsolidated Sediments

The unconsolidated sediments are mainly deposits of gravel, sand, silt and clay which are laid at the valley floor, alluvial and coastal plains. These are the materials produced by weathering and erosion of the bedrock.

In general, the sand layers of unconsolidated sediments are excellent and efficient aquifers. The porosity and permeability of sand layers are commonly high, but only to be reduced by infilling of fine fraction (silt and clay, very fine sand) between interstices of grains. Therefore, the porosity of sand layers is dependent on grain size, shape and grain-size distribution.

(2) Dumoy Well Field

The Dumoy Well Field (refer to **Photo No. 1**) is in the southwest of Davao City and the main groundwater source for the DCWD. The well field is located at the foot slopes at the east of Mount Talamo blanketed by volcanic mud flow. The slopes of Mount Talamo serve as the watershed area for the deep aquifers while the shallow aquifers are recharged by the Talamo River. The Dumoy Field is approximately **8 km** wide and **13 km** in length along the coast of Talamo Bay. There are **30 wells** operated by DCWD and several private industrial wells in the area. The production of each well is range of 1**,617-4,700 liters/minute**. And the well depth ranges from **90-152 m**.

Photo No. 2.2.2-1 Photo taken at the Dumoy Well Field

(3) Panacan Wells

Panacan is located at about **5 km** northeast of Davao City where the Alluvium is underlain by the Mandug Formation and Bunawan Limestone.

In Panacan, there are **two** (**2**) operating wells with an average depth of **104 m**, and total production of the **two** (**2**) wells **is 2,000 liters/minute**.

2.2.2.2 Baseline Data

(1) Location and Physiography

The Davao City Bypass Project involves the construction of a tunnel starting from Matina Biao to the edge of Davao River across Brgy. Waan. The tunnel alignment will cut through the rugged hills of Magtuod with elevations ranging from **30** to **200 meters** above mean sea level (masl). Except for small gullies, no prominent drainage system traverses the proposed tunnel alignment.

The major drainage systems are Davao River to the east and Matina River to the west. It will be noted that most of the tributaries of Matina River join the main stream channel from the west. Tributaries on the eastern bank of Matina River are remarkably few or absent, forming an asymmetrical drainage pattern.

Eight (**8**) boring tests had been conducted along the tunnel alignment (refer back to **Figure 2.1.3-3 Section 2.1.3.2**). Aside from the lithology and other geotechnical parameters, the ground water levels in the boreholes were also measured and recorded in the boring logs. The borings ranged in depth from **30-160 meters**.

(2) Geologic Setting

1) General Geology

The proposed alignment of the Davao City Bypass road will pass through Pliocene to Recent rocks as shown in **Figure 2.2.2-2**. The rock units are arranged chronologically from youngest to oldest in **Table 2.2.2-2**. However, only the Samal Limestone, Mandug Formation and Masuhi Formation will be discussed since the proposed tunnel will only be bored through these rock units. The description of the rock units was paraphrased from the report on the geology and geomorphology of the project area by **C. Dayanghirang**.

Table 2.2.2-2 Stratigraphic Sequence in the Vicinity of the Tunnel Corridor of the Proposed Davao City Bypass Project

Formation	Description	Geologic Age
Alluvium	Loose, unconsolidated gravel, sand and clay deposits	Recent
Tigatto Terrace Gravel	Loosely stratified gravel and sand deposits	Holocene
Samal Limestone	Coralline limestone	Holocene
Apo Volcanics	Intercalated pyroclastics / volcaniclastics with lenses of volcanic flows	Pleistocene
Talomo Volcanics	Volcanic flows with intercalated pyroclastics, tuff & volcaniclastics	Pleistocene
Apo-Talomo Cones	Andesitic to dacitic volcanic flows	Pleistocene
Mandug Formation	Interbedded well consolidated sandstone and shale with minor conglomerate	Early to Late Pleistocene
Masuhi Formation	Interbedded sandstone and shale with lenses of conglomerate	Late Miocene to Early Pliocene

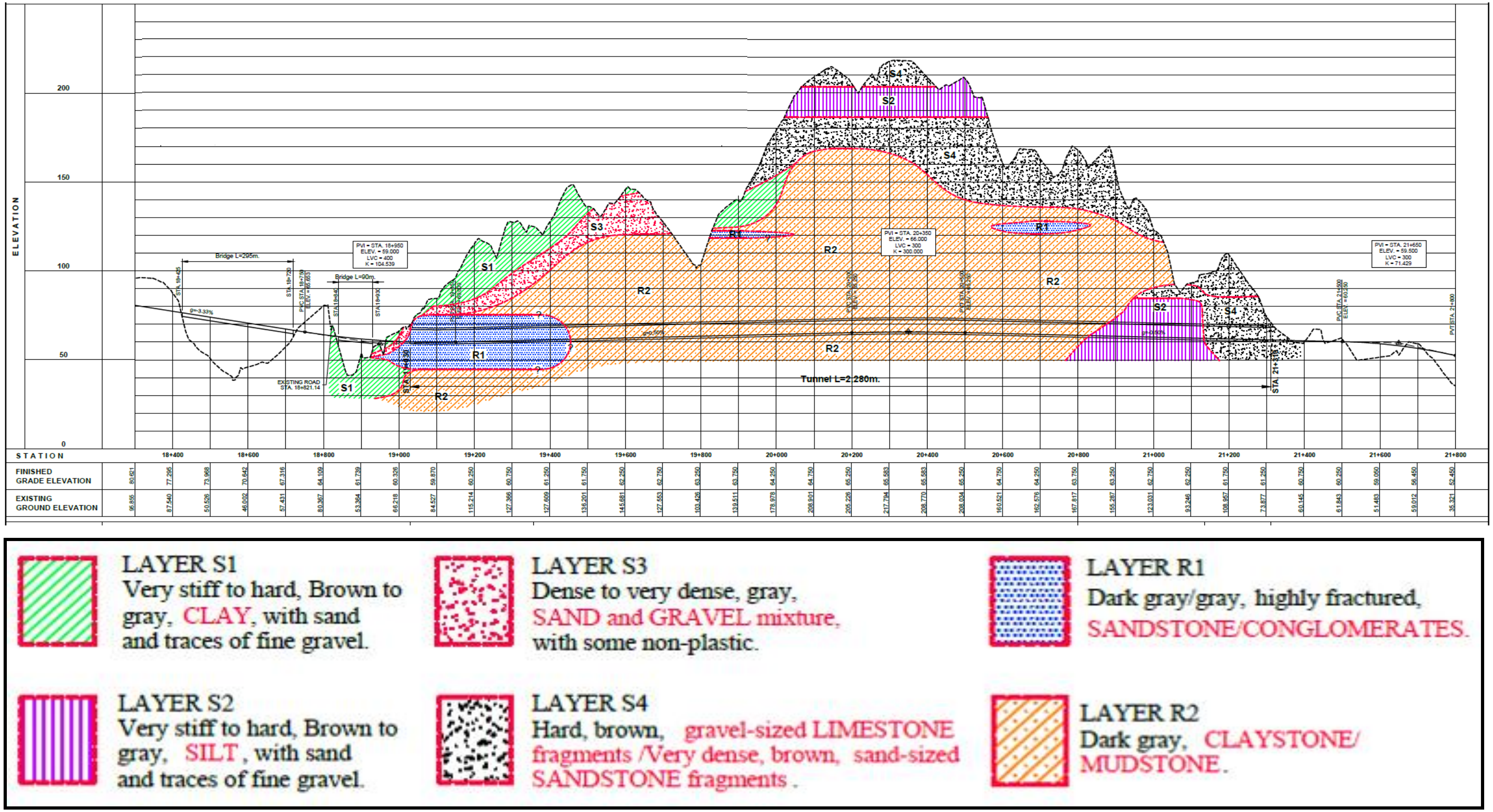


Figure 2.2.2-2 Geological Conditions at the Tunnel Section

(a) Samal Limestone

This formation consists of raised coralline limestone and breccia that are widely exposed in Langub and Magtuod. The limestone is porous, but oftentimes marly. It unconformably overlies the Mandug Formation. The thickness of this unit has been estimated to be **70** to **80 meters**.

(b) Mandug Formation

This Pleistocene formation is exposed along Lasang and Davao rivers with Mandug, Davao City as its type locality. It is composed of interbedded sandstone, shale with conglomeratic portions. The sandstone consists of fine to medium grained sand in a clayey matrix. It is poorly consolidated. Cross-bedding characterizes the conglomerate which is composed of poorly sorted pebbles derived from older igneous, sedimentary and metamorphic rocks. *Casasola* (*1956*) estimated the thickness of the formation to be **600** to **800 meters**.

The presence of nannofossil and numerous megafossils, (e.g. pelecypods and gastropods) in the finer sediments and the presence of limestone fragments, indicate deposition within a shallow marine environment. The Mandug Formation overlies the Masuhi Formation unconformably.

c) Masuhi Formation

The Masuhi formation outcrops along the western flank of the Davao Basin. It is composed of interbedded sandstones and shales with polymictic conglomerate beds along the western flank of the basin. This marine sequence was dated as Late Miocene-Pliocene. Thickness range from **200-250 m**. The Masuhi Formation of Late Miocene to Early Pliocene age serves as the basement rock of the area surrounding the tunnel corridor.

A schematic cross section at tunnel section based on lithology from boring logs.

2) Geologic Structures

Two (**2**) northeasterly-trending faults strongly influenced the topography of the mountains under which the tunnel will be constructed. The elevated rugged terrain emerged as an uplifted block or horst between the **two** (**2**) normal faults. The easterly fault traverses the bank of Davao River where the western block rose relative to the eastern block. The Mantina Fault, on the other hand, caused the eastern block to rise relative to the western block. The displacement of the faults created what in geological terms is a horst.

Previous geologic mapping also revealed the existence of a north-trending anticline whose axis almost coincides with the highest ridge in Magtuod. This anticline plunges to the north past Matina Biao. However, in the barangay proper Magtuod, the anticline disappears or is not apparent. The anticline is asymmetric with the sedimentary beds on the western flank dipping more gently than the layers in the eastern side.

3) Geology along the Tunnel Section

The southwest portal of the tunnel will commence on a thin veneer of the Samal limestone but the greater part of the tunnel will penetrate the shale-sandstone sequence of the Masuhi Formation. The boring activities revealed the presence of various lithologic units but claystone and mudstone predominate over the sandy and gravelly sections. Based on the boring logs, the lithologic variations are illustrated in the following cross-section presented in **Figure 2.2.2-3**.

In terms of cumulative thickness, the claystone/mudstone layers comprise more than **65%** of the drilled sections. However, below TBH-06 to TBH-08, relatively thick sand sections were encountered at shallow depths although the claystone/mudstone persisted to the bottom of the boreholes. These sandy sections are situated at a higher elevation than the tunnel.

Near the southwest portal, the tunnel will likely encounter some sandy and gravelly materials. However, beyond TBH-03, the rock formations will be composed mainly of claystone and mudstone. The sandy sections above the eastern part of the tunnel are situated way above the tunnel route.

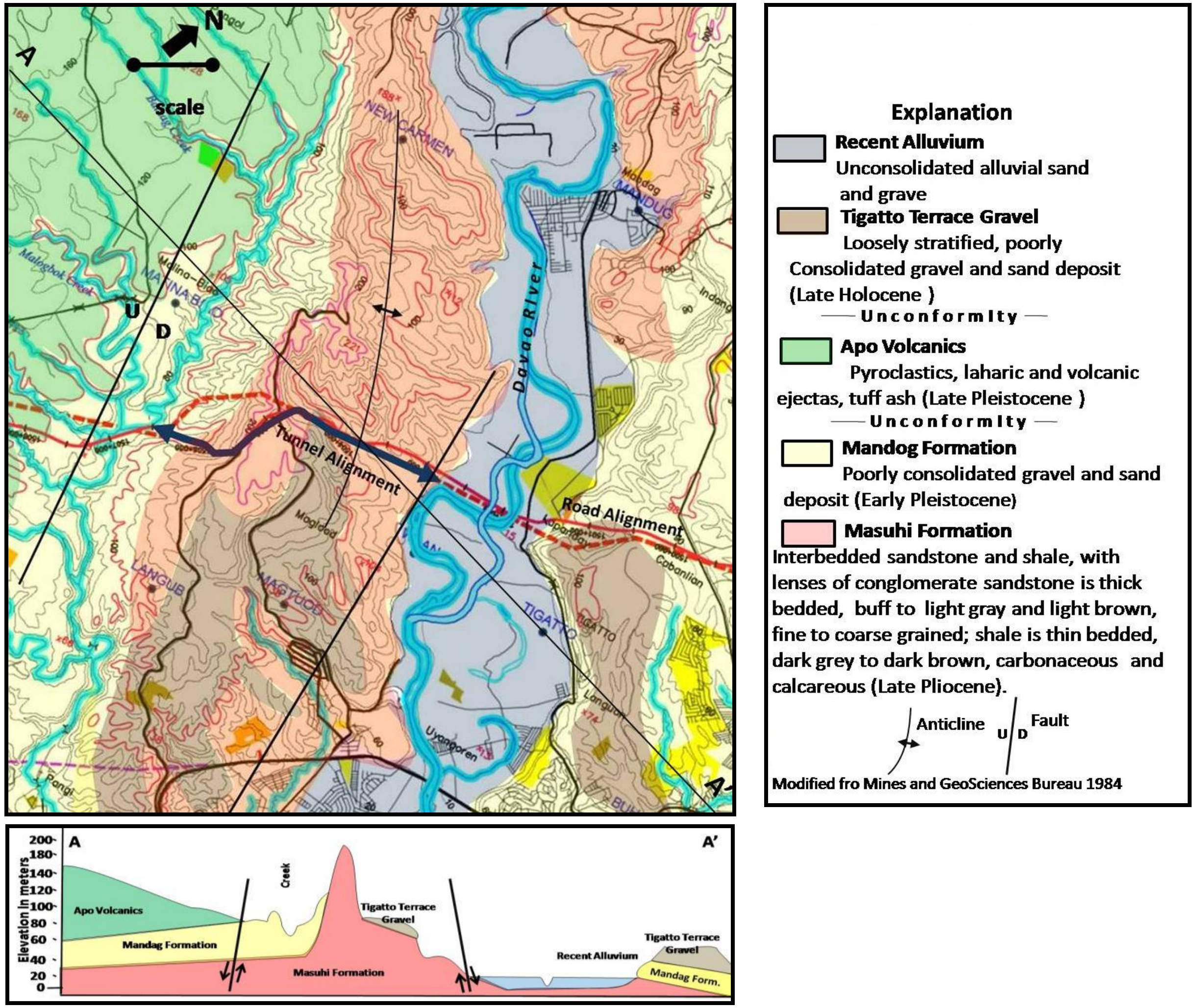


Figure 2.2.2-3 Geologic Map of the Tunnel Corridor and Vicinity

(3) Hydrogeology Assessment

1) General Statement

An aquifer performs **two** (**2**) functions, namely as a medium that transmits water and as a reservoir where ground water is stored. **Two** (**2**) important properties related to the storage function are porosity and specific yield. The porosity of a water-bearing formation is determined by that part of its volume consisting of openings or pores. It is an index of how much groundwater can be stored in a saturated medium and is usually expressed as a percentage of the bulk volume of the material.

Although the volume of water contained in an aquifer is of interest, of more concern is how much water can be actually released from storage per unit area of aquifer per unit change in head. Whereas porosity represents the volume of water an aquifer can hold, it does not indicate how much water the aquifer can yield.

When water is drained from a saturated material under the force of gravity, the material releases only part of the total volume stored in its pores. The quantity of water that a unit volume of unconfined aquifer gives up by gravity is called specific yield. Some water is retained in the pores by molecular attraction and capillarity. The smaller the grain size, the greater is the percent of retention; the coarser the grains the greater will be the specific yield.

Since the surface area of a given volume of fine particles increases as the individual grains become smaller, it follows that a larger percentage of the water in the pores of clay and silt will be held by surface tension or other adhesive forces. For this reason, finer sediments have lower specific yields compared to coarser sediments. The specific yield for unconfined aquifers range from **0.01** for clays and silts to **0.30** for clean sand and gravel.

2) Water-Bearing Characteristics of Lithologic Units

The drillers described the claystone and mudstone units as sticky and plastic although they are often tight and compact. Such lithologic units may be porous but hardly permeable. They will not transmit or allow water to flow through them. They are commonly referred to as **aquitards**. Very little ground water may be expected from these layers even if they are completely saturated.

Except for the sandy sections encountered in **TBH-06** and **TBH-07**, most of the sand layers are thin and discontinuous. They are most likely lenticular and confined within thick clay beds. The sands are fine to medium grained and often mixed with clay. Clean and well-sorted sands may be porous and permeable but the mixtures of clay can reduce its permeability considerably. Furthermore, owing to their limited thickness, these layers can contribute only a small amount of ground water.

The gravel layers consist of rounded to sub-rounded pebbles and occasional cobbles cemented with fine sand, silt and clay. In a similar manner as the poorly sorted sand, the fine cementing materials restrict the flow of water through the gravel. Therefore, ability of the gravel to transmit water is also significantly reduced.

Samal Limestone is composed of fragments of corals mixed with calcareous clay. The great amount of clay in the formation ensures that the formation will also be poorly permeable.

The hydraulic conductivity of clays and silty clays varies from about **1x10-6** to **1x10-3 cm/sec**. For clean sands, the average hydraulic conductivity is about **1x10-2 cm/sec** though it may decrease further if finer materials are mixed with the sand.

3) Ground Water Utilization

Since the Davao City Water District supplies water to the more populated areas in Magtuod and Langub, only a few shallow wells have been constructed to provide water for the unserved areas. However, these wells are located far from the proposed tunnel alignment. Furthermore, no springs have been observed although some residents report that seepages occur occasionally in the valleys, in the project area.

4) Occurrence of Ground Water

The boring logs indicated the presence of ground water in only **three** (**3**) of the **eight** (**8**) boreholes. The drillers reported no ground water in the remaining boreholes. It appears that the seepages in the valleys observed by residents are soil water that oozes out of the ground when the water is blocked by impermeable rocks.

These observations confirm the low porosity and permeability of the lithologic units penetrated by the boreholes. They suggest further that rainwater infiltration into the

Masuhi Formation is minimal and that it runs off rapidly away from the peaks and ridges towards lower grounds.

The steep slopes and the outward dip of the beds away from the anticline allows the rainwater to flow rapidly towards the lower elevations. Coupled with the thin soil cover, sparse vegetation and nearly impervious rock exposures and flash floods would occur but only a small amount of rainwater will infiltrate into the underlying rocks. In effect, ground water recharge would be extremely low in the ridges above the proposed tunnel.

This phenomenon is confirmed from the water level measurements in boreholes **TBH-04**, **TBH-06** and **TBH-07**. In TBH-06, the water level settled near the bottom of a thin sand layer. However, the thicker sand layer above it was dry. In TBH-07, the water level stood within a fairly thick sand layer whose upper section is also dry. The water level was recorded within a thin sand layer in TBH-04. These observations suggest that the aquifers are unconfined and are at best perched water table aquifers.

It can be safely concluded that the Masuhi Formation is neither a good groundwater reservoir nor will it allow water to flow through it. The Mandug Formation which occurs near the southwest portal will be slightly more permeable but the volume of water stored in the sand and gravel layers will not be substantial because of the limited saturated thickness.

2.2.2.3 Impact Analysis and Mitigation

(1) Construction Phase

The water source of the DCWD is concentrated at the Dumoy Well Field located at the skirts of Mount Apo and Mount Talomo, and other water sources are the Panacan Wells and the Malagos Creek, which a small tributary of the Davao River. These existing water sources are located approximately **2-3 km** or more from the proposed bypass alignment is not expected to be influenced by the project.

The neighboring areas of the proposed tunnel section of the bypass road are not the service area of the DCWD, and depend only to wells manage by residents and the stream water as water sources. The tunnel, even if it is **12 m** in diameter and **2.3 km** long, is still infinitesimal compared to the volume of the rocks that overlies it. However, the tunnel will function as a line sink that will draw ground water from above and at the side of the tunnel. The hydraulic conductivity of the overlying rocks is extremely low and therefore, the flow of water or seepage into the tunnel will be slow. Its radius of influence will also be small and will not extend far from the face of the tunnel. Assuming a storage coefficient in the range of **10-6**, the water released from storage will be minimal.

If the construction is limited only to the tunnel itself, the ground water regime above it will not materially change. For one, the overlying rocks do not hold much ground water. With little water in the sand layers, the rocks will be generally stable and competent. Secondly, no wells or springs with appreciable yields are present that can be adversely affected by the construction of the proposed tunnel.

Since the tunnel will very likely penetrate some sand and gravel layers at the western end, slightly more ground water will enter the tunnel during construction. However, the discharge rate or the volume of the seepage will likely be small and can be handled easily by construction of side ditches which can drain seepage to avid ponding of water. In addition, a limited amount of water that can dissipate easily may be expected from the sand and gravel layers.

Less water may be expected from the eastern side where claystone predominates over the coarser sedimentary rocks.

2.2.3 Water Quality

This section describes the baseline water quality of **five** (**5**) rivers along potential impact areas of the proposed bypass road project in terms of the water quality benchmarks prescribed for Class C Waters (primarily used for the propagation and growth of fish and other aquatic resources) under DAO 34-1990.

Five (**5**) catchment areas along the proposed bypass road project were selected for water quality sampling, namely, Lipadas River in Brgy. Communal, Davao River in Brgy. Tigatto, Matina River in Brgy Langub, Talomo River in Brgy. Mintal, and Lipadas River in Bangkal Heights designated W1 to W5, respectively. **Table 2.2.3-1** describes the water sampling stations, while **Figure 2.2.3-1** shows the location of the sites.

Most of the study sites are near human settlements and are generally used for domestic purposes such as bathing and doing laundry; specifically, Davao River and Lipadas River. Sand and gravel quarrying was observed along Davao River at Brgy. Tigatto, and Copra business with quarrying along Matina River in Brgy. Langub.

Lipadas River and Mintal River are characterized by relatively dense vegetation and tend to be less disturbed compared to the other **three** (**3**) rivers. Photo documentations of the **five** (**5**) rivers are shown in **Photo Nos. 1-5**.

Table 2.2.3-1 Technical Description of Water Quality Sampling Stations

Station ID	Location	Coordinates	Elevation
W1 – Lasang River	Brgy. Communal	N 07°08'59.3" E 125°37'07.3"	±4m, 40 masl
W2 – Davao River	Brgy. Tigatto	N 07°06'51.9" E 125°35'15.1"	±2m, 19 masl
W3 – Matina River	Brgy. Langub	N 07°06'21.7" E 125°33'02.2"	±3m, 45 masl
W4 – Talomo River	Brgy. Mintal	N 07°05'41.1" E 125°30'06.9"	±2, 119 masl
W5 – Lipadas River	Bangkal Heights	N 07°03'02.4"	±3, 120 masl

Photo. 1 W1 – Lasang River, Brgy. Communal

Photo No. 2 W2 – Davao River, Brgy. Tigatto, Davao City

Photo No. 3 W3 – Matina River, Brgy. Langub, Davao City

Photo No. 4 W4 – Talomo River, Brgy. Mintal

Photo No. 5 W5 – Lipadas River, Bangkas Heights

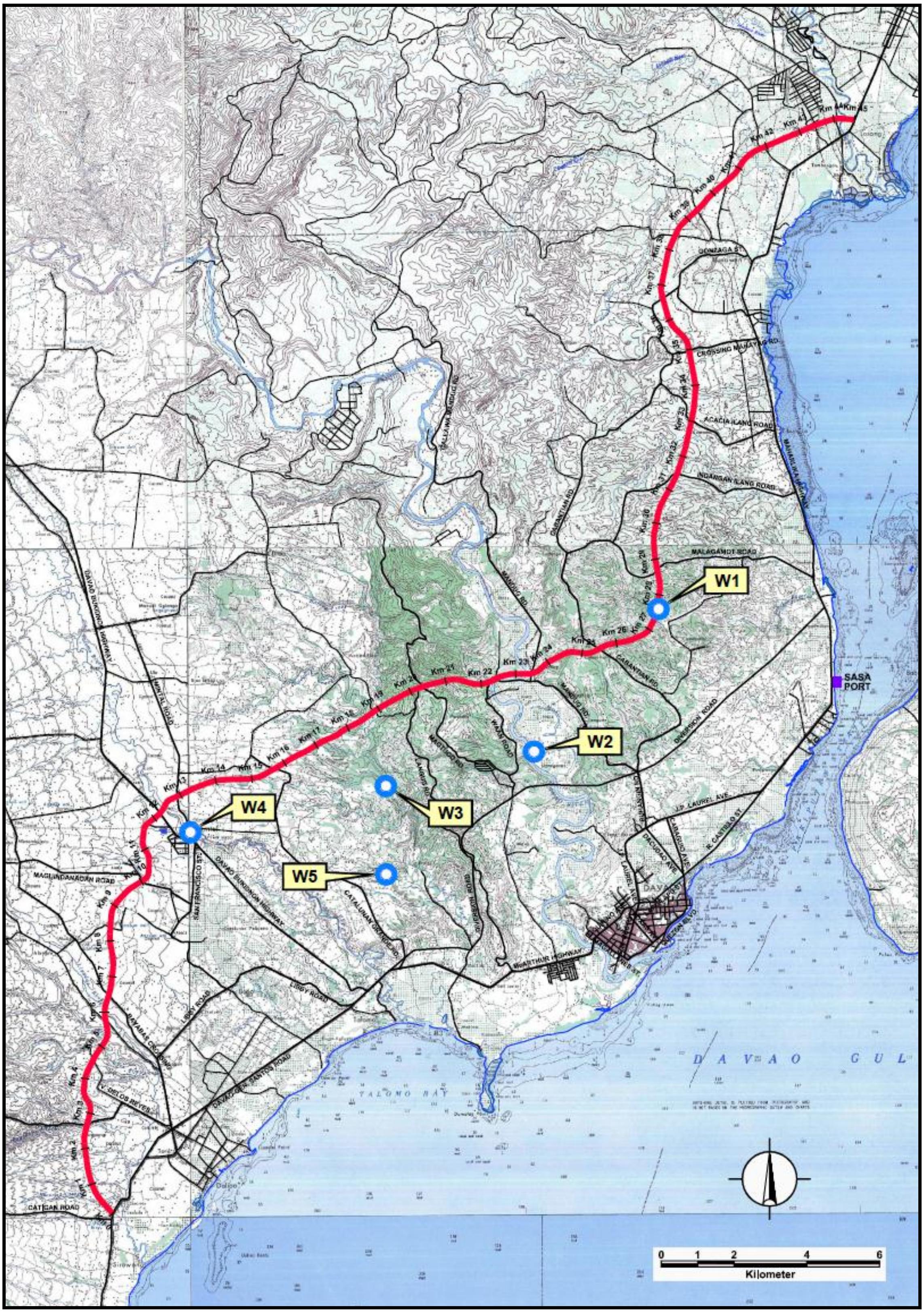


Figure 2.2.3-1 Water Quality Sampling Sites

2.2.3.1 Baseline Conditions

Results of laboratory analyses suggest that water quality parameters described in **Table 2.2.3-2** and **Annex (provide)** generally conform to the prescribed limits for Class C waters, except total coliform and fecal coliform counts. All **five** (**5**) rivers indicate very high coliform contamination, particularly in W4-Talomo River, Brgy. Mintal with **1.6×10^4 MPN/100 ml**. High coliform counts strongly indicate contamination from both human and animal sources from communities lying along each river stretch, and such activities are observed around survey points.

Among the **five** (**5**) rivers sampled, only W2-Davao River, Barangay Tigatto was recorded to have Oil-and-Grease contamination at **0.62 mg/L**, although less than the prescribed limit of **1.0 mg/L**. Oil-and-grease contamination may be attributed to inadvertent oil spills coming from dump trucks that frequent the area to haul sand and gravel (refer to **Photo No. 2**), particularly when dump trucks are washed in the river channel.

Total Suspended Solids (TSS) level was also highest in W2-Davao River, Brgy. Tigatto at **82 mg/L**, since the area is being actively quarried, while the other **four** (**4**) rivers recorded **<4 mg/L** TSS value. Biological Oxygen Demand (BOD5) values across all sites also conform to Class C limit, but BOD5 was highest in W4-Talomo River, Brgy. Mintal, suggesting organic contamination from communities living nearby (refer to **Photo No. 4**). Correspondingly, Chemical Oxygen Demand (COD) level in W2-Davao River, Brgy. Tigatto was also highest at **14.5 mg/L**. It is to be noted that COD is an effluent standard described in DAO 35-1990 for industrial and municipal wastewater effluents.

Table 2.2.3-2 Levels of Conventional Pollutants in Five (5) Rivers along Potential Impact Areas of the Davao City Bypass Road Project

PARAMETERS	DAO 34 CLASS C	SAMPLING STATIONS				
		W1	W2	W3	W4	W5
DO, mg/L	5.0	7.3	7.6	7.3	7.5	7.1
pH, @26.2°C	6.5-8.5	7.87	7.75	7.73	7.71	7.97
TSS, mg/L	(a)	ND	82.0	2.0	4.0	1.0
BOD, mg/L	7	1.1	0.5	2.0	3.9	2.7
COD, mg O_2/L	100[(b)]	9.7	6.7	8.7	14.5	9.7
Oil and Grease, mg/L	2	ND	0.67	ND	ND	ND
Total Coliforms, MPN/100 mL	1000	5.4×10^3	9.2×10^3	9.2×10^3	1.6×10^4	9.2×10^3
Fecal Coliforms, MPN/100 mL	1000	3.5×10^3	9.2×10^3	1.3×10^3	1.6×10^4	5.4×10^3

(a) Not more than 30 mg/L increase; the prescribed criterion entails that increase of measured TSS should not exceed 30 mg/L of the receiving body of water

2.2.3.2 Impact Analysis and Mitigation

(1) Construction Phase

1) Siltation

Siltation or increase in TSS levels is the major impact of the proposed project on the water quality of the **five** (**5**) rivers investigated in this report. Except W2-Davao River, Brgy. Tigatto, TSS levels in 4 other rivers are very low, averaging **<2 mg/L**.

Siltation will be mitigated by constructing silt fences or silt curtains made of geotextiles (**Photo No. 6**) in work areas near catchment basins to physically intercept loose materials generated during construction and prevent mobilization of earth materials during a heavy downpour. Piles or mounds of earth materials need to be covered with tarpaulin or sack material to prevent from being washed away during a heavy rain. Where necessary, a sedimentation pond may be constructed to divert runoff away from catchment areas.

Photo No. 6 Silt fence to mitigate downward mobilization of loose earth materials during construction works.

2) Oil and Grease Contamination

Oil-and-Grease contamination of the **five** (**5**) rivers coming from construction activities will be prevented by requiring project contractors to develop and implement a water quality management plan in all work areas of the project, such as preventing drivers from washing their trucks or articulated equipment in river channels, and requiring operators to provide an oil-spill kit for all construction vehicles, equipment, and machineries. Repair and maintenance of construction vehicles, equipment, and machineries on-site, especially near waterways must be avoided.

3) Coliform Contamination and Organic Pollution

During construction, base camps for workers will be set up in the project site. In these base camps, project contractors will be required to implement solid waste management to prevent garbage and organic pollution of the **five** (**5**) rivers, in compliance with the Philippine Ecological Solid Waste Management Act. Portable toilets will also be set up in designated work areas to prevent coliform contamination of the **five** (**5**) rivers that may potentially originate from the project, rather than allow the hired labor to use the river basins for this purpose.

Disposal of the solid and domestic wastes generated by the workers to sites duly approved by Davao City and Panabo City shall be regularly carried out.

4) Increase in pH Level

Accidental concrete spillage during construction of the bridges will cause increase in the pH level of the affected waterways. Washing of transit concrete mixers along the rivers will likewise contribute to the increase in the existing pH.

Close supervision during construction of the bridges, particularly during concrete pouring and related works must be carried to prevent incidents of concrete spillage. Net and mesh materials must also be installed at bridge construction sites to minimize effects of accidental concrete spillage into the waterways.

(2) Demobilization/Decommissioning Phase

The Contractor must ensure that all riparian areas and surrounding areas are free of residual construction spoils, particularly earth materials to prevent possible increase in siltation rate of adjacent waterways. The Contractor must also ensure that the slope and embankment protection measures implemented such as planting are well in place.

Possible contamination of waterways crossed by the bypass alignment may occur if residual domestic and solid wastes are abandoned at the construction sites adjacent the rivers and creeks. The Contractor must ensure that all temporary sanitation facilities, especially portalets are completely dismantled and all residual wastes are disposed to sites duly approved by the Davao City and Panabo City.

A joint site inspection at the construction sites shall be undertaken by the DPWH, Environmental Safety and Health Officer (ESHO) of the Contractor, and the Multi-Partite Monitoring Team (MMT) to validate compliance of the Contractor to the demobilization/ decommissioning activities.

(3) Operational Phase

The DPWH District Engineering Office (DEO) who has jurisdiction over the project site must conduct regular inspection and maintenance of the slope and embankment protection measures implemented to prevent soil erosion along these areas.

2.2.4 Freshwater Ecology

The freshwater fauna sampling sites are located in the same sampling locations as those of the water quality (please refer back to **Table 2.2.3-1** and **Figure 2.2.3-1** in **Section 2.2.3**).

2.2.4.1 Baseline Conditions

As shown in **Table 2.2.4-1**, a total of **31** individuals of freshwater fish and **one** (**1**) freshwater shell were collected across the **five** (**5**) river sampling stations along the proposed Davao City Bypass alignment. Fish captures were dominated by mosquito fish (*Gambusia affinis*) with a relative abundance of **37.5%**, followed by tilapia (*Oreochromis nilotica*), and spotted barb (*Puntius binotatus*), with a relative abundance of **25%** and **21.88%**, respectively. The low density of freshwater fishes recorded in all study sites may be attributed to overfishing and the use of electrical devices and pesticides to stun fishes, which also kills fish eggs and small fish larvae.

Representative freshwater biota are shown in **Photo No. 2.2.4-1**.

Table 2.2.4-1 Relative Abundance of Freshwater Biota Collected from the Five (5) River Stations along the Proposed Davao City Bypass Road Project

Family	Common Name	Species Name	Abundance	Relative Abundance (%)
Poecillidae	Mosquito Fish	*Gambusia affinis*	12	37.50
Cichlidae	Tilapia	*Oreochromis nilotica*	8	25.00
Cyprinidae	Spotted Barb	*Puntius binotatus*	7	21.88
Channidae	Striped snakehead	*Channa striata*	2	6.25
Gobiidae	Celebes Goby	*Glossogobius celebius*	2	6.25
Thiaridae	Suso	*Melania sp.*	1	3.13
Total			**32**	**100.00**

Oreochromis nilotica

Pontius binotatus

Channa striata

Gambusia affinis (Mosquito fish)

Glossogobius celebius

Melania sp. (Suso)

Photo No.2.2.4-1 Representative freshwater biota from the five (5) rivers along the proposed Davao City Bypass Road project

2.2.4.2 Conservation Status

The mosquito fish was introduced in the country, presumably to control fish population. Since the introduction, the mosquito fish is found all over the country in freshwater canals, streams, rivers, and creeks. Tilapia and the striped snakehead were also introduced in rivers and lakes across the country as alternative fish diet. Only the spotted barb and Celebes goby are the indigenous freshwater species recorded in the study sites. Across the country, native freshwater fishes are threatened by exotic fish introduction, displacing local population from their ecological niches. **Table 2.2.4-2** indicates that all freshwater biota recorded from study sites are categorized as **Least Concern** (*IUCN Redlist, 2014*).

Table 2.2.4-2 Conservation status of Sampled Freshwater Fauna

Family	Species Name	IUCN Redlist (2014)	Endemicity (www.FishBase.org)
Cichlidae	*Oreochromis nilotica*	Least Concern	Introduced
Cyprinidae	*Puntius binotatus*	Least Concern	Native
Channidae	*Channa striata*	Least Concern	Introduced
Poecillidae	*Gambusia affinis*	Least Concern	Introduced
Gobiidae	*Glossogobius celebius*	Least Concern	Native
Thiaridae	*Melania sp.*	Least Concern	Native

2.2.4.3 Impact Analysis and Mitigation

(1) Construction Phase

1) Increase in Siltation Rate

Excavation works and earth-moving activities along open and exposed areas will generate loose and highly erodible materials. These soil materials will likely be eroded torrential rains, causing siltation or sedimentation of rivers adjacent to the proposed bypass road.

To minimize siltation of river catchments, silt fences or silt curtains made of geotextiles should be installed in work areas near catchment basins to physically intercept loose materials generated during construction. Where necessary, a sedimentation pond may be constructed to divert runoff away from catchment areas.

2) Increase in Turbidity

Although the sampling sites exhibited a relatively low density of freshwater biota due to overfishing and utilization illegal fishing methods, still it is prudent to mitigate the potential impact of the construction activities along the riverbed for the foundation works of the bridge structures. Increase in turbidity in the water column due to piling along the riverbed would slightly increase the mortality rates among fish larvae/juveniles including other planktonic organisms. Aside from using geotextile silt screens/curtains to reduce turbidity, a work gap during piling activities should not be carried out **24-hours** a day to allow the settling of suspended sediment particles so that TSS levels would remain at acceptable level.

(2) Demobilization/Decommissioning Phase

To prevent possible increase in rate of siltation of the waterways crossed by the bypass alignment, the Contractor must ensure that all riparian and surrounding areas are cleared of residual construction spoils particularly earth materials which may be eroded during high precipitation periods and cause increased siltation rate of adjacent waterways. A joint site inspection must shall be conducted by the DPWH, ESHO of the Contractor, and the MMT to validate compliance of the Contractor to the clearing operations

The Contractor must also ensure that the protection measures for soil slopes and embankments are in place to avoid erosion.

(3) Operational Phase

The DPWH District Engineering Office (DEO) who has jurisdiction over the project site must conduct regular inspection and maintenance of the slope and embankment protection measures implemented to prevent soil erosion along these areas.

2.3 THE AIR

2.3.1 Climatology

2.3.1.1 Local Climate

Climate in Davao City and the City of Panabo, Davao Del Norte based on the Modified Coronas Classification presented in **Figure 2.3.1-1** is categorized under **Type IV**. Throughout the year, rainfall in these cities is more or less evenly distributed. Areas belonging to this climate type do not have dry season, resembling to those regions under Type II.

(1) Rainfall

As shown in the latest climatological normal data obtained from PAGASA (**Table 2.3.1-1**), the Cities of Davao and Panabo receive an annual rainfall amount of **1759.1 mm**. The highest rainfall amount of **186.7 mm** is recorded in June. In a year, the study area experiences about **174** rainy days, the most of which is observed in June with **18** days.

(2) Temperature

The annual mean temperature in the study area is **27.9°C**. A warm temperature averaging around **32.6°C** is normally felt from March to May. The average maximum temperature is **31.9°C**. Cooler weather is usually experienced in January and February, with a mean average temperature of **23.3°C**.

(3) Relative Humidity

In the study area, relative humidity is at its highest in July at **83%**. The lowest humidity of **77%** is experienced in April. The annual relative humidity in the Davao City and Panabo City is measured at **81%**.

(4) Tropical Cyclones (Typhoons)

The Philippines sit astride the typhoon belt, and the country suffers an annual onslaught of dangerous storms from July through October. These are especially hazardous for northern and eastern Luzon and the Bicol and Eastern Visayas regions, but Manila gets devastated periodically as well.

Typhoon is locally termed as “Bagyo”. Statistics from PAGASA showed that from 1948 to 2004, around an average of 20 storms and/or typhoons per year enter the Philippine

Area of Responsibility (PAR). In 1993, a record **19 typhoons** made landfall in the country making it the most in one year. Historically, the deadliest tropical cyclone to impact the Philippines was "Uring" (Tropical Storm Thelma) which caused floods that killed thousands of people in 1991.

Typhoons are categorized into **four** (**4**) types according to its wind speed by the PAGASA. All tropical cyclones, regardless of strength, are named by PAGASA.

- Tropical Depressions have maximum sustained winds of between 55 **kilometres** per hour (**30 kn**) and **64 kilometres** per hour (**35 kn**) near its center;
- Tropical Storms have maximum sustained winds of 65 kilometres per hour (**35 kn**) and **119 kilometres** per hour (**64 kn**);
- Typhoons achieve maximum sustained winds of **120 kilometres** per hour (**65 kn**) to **185 kilometres** per hour (**100 kn**); and
- Super typhoons having maximum winds exceeding **185 kilometres** per hour (**100 kn**)

(5) Wind

Two (**2**) types of air streams occur in the study area throughout the year, the northerly and southerly winds. The wind coming from the north prevails in Davao and Panabo Cities from November to April, and carries an average speed of **2 mps**. On the other hand, the southerly wind which predominates from May to October has a varying speed of **1-2 mps**.

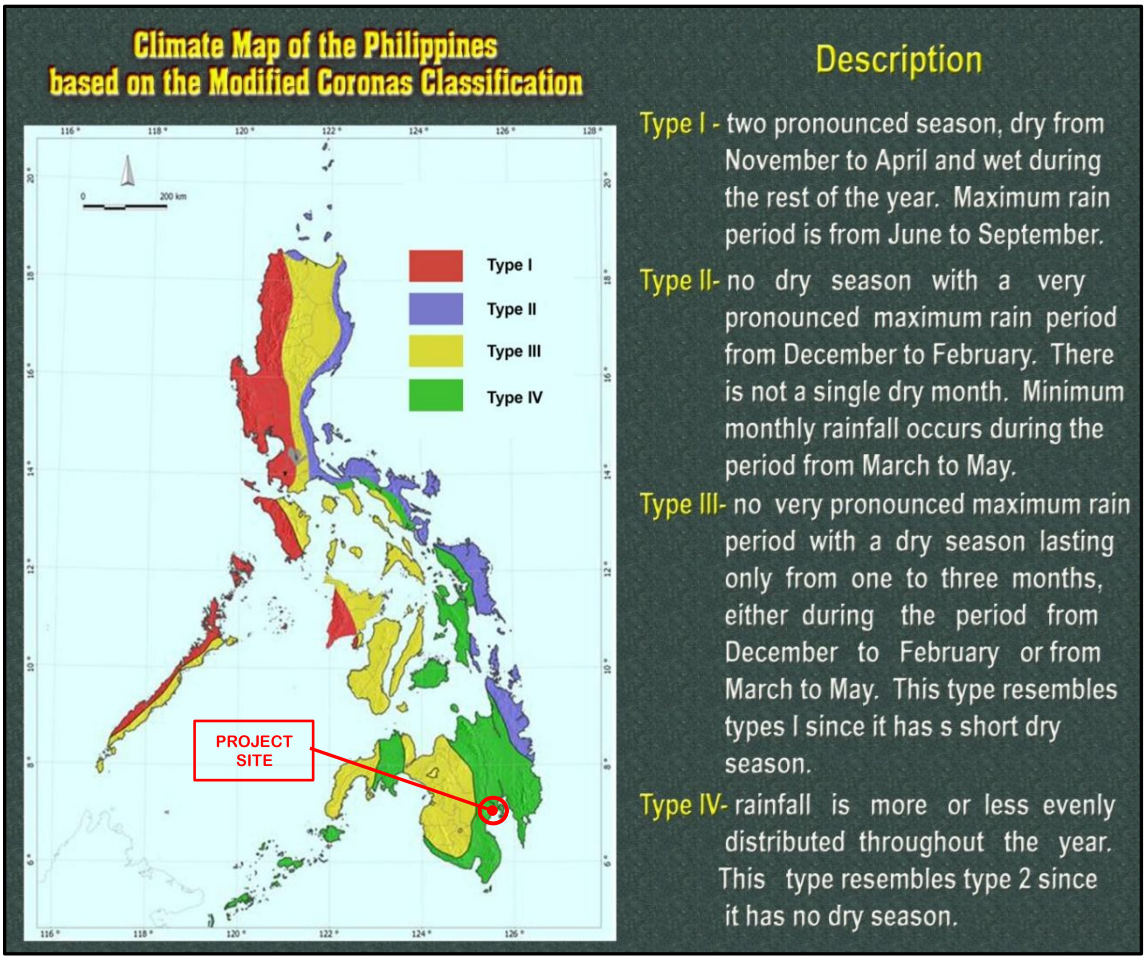


Figure 2.3.1-1 Climate Map of the Philippines Based on Modified Coronas Classification

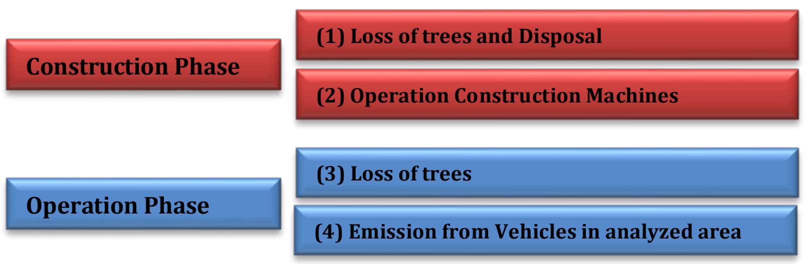
Table 2.3.1-1 Climatological Normal Values

Station Name: DAVAO CITY, DAVAO DEL SUR
Period: 1981-2010
Latitude: 07°18'00" N
Longitude: 125°50'00" E
Elevation: 18.0 m

MONTH	RAINFALL		TEMPERATURE						Vapor Pressure (MBS)	Relative Humidity (%)	Mean Sea Level Pres (mbs)	WIND		Cloud Amount (okta)	Number of Days with	
	Amount (mm)	No. Of RD	Max (°C)	Min (°C)	Mean (°C)	Dry Bulb (°C)	Wet Bulb (°C)	Dew Point (°C)				Dir. (16 pt)	Speed (mps)		Thunder storm	Light-ning
JAN	140.3	14	30.8	23.3	27.1	26.5	24.1	23.2	28.4	82	1009.9	N	2	6	3	4
FEB	109.4	12	31.2	23.3	27.3	26.7	24.1	23.1	28.2	81	1010.2	N	2	6	2	3
MAR	108.4	11	32.2	23.6	27.9	27.4	24.4	23.3	28.5	78	1010.1	N	2	5	5	5
APR	124.7	11	33	24.2	28.6	28.2	25	23.9	29.5	77	1000.4	N	2	5	8	10
MAY	158.7	16	32.6	24.6	28.6	28.2	25.5	24.6	30.8	80	1000.9	S	2	6	16	19
JUNE	186.7	18	31.8	24.2	28	27.7	25.3	24.5	30.6	82	1008.9	S	1	6	14	16
JULY	165.0	16	31.5	23.9	27.7	27.4	25.1	24.3	30.3	83	1008.9	S	1	6	13	16
AUG	170.0	15	31.7	24	27.9	27.6	25.1	24.2	30.1	82	1008.9	S	2	6	14	16
SEP	170.4	15	31.9	23.9	27.9	27.6	25.1	24.2	30.1	82	1009.1	S	1	6	15	17
OCT	174.8	16	32.3	23.9	28.1	27.7	25.1	24.2	30.1	81	1008.8	S	1	6	17	19
NOV	138.1	16	32.1	23.9	28	27.5	25	24.1	29.9	82	1008.5	N	2	6	12	15
DEC	112.6	14	31.4	23.7	27.5	27.1	24.6	23.7	29.2	81	1009.2	N	2	6	6	8
ANNUAL	**1759.1**	**174**	**31.9**	**23.9**	**27.9**	**27.5**	**24.9**	**23.9**	**29.6**	**81**	**1009.2**	**N**	**2**	**6**	**125**	**148**

2.3.1.2 Impacts of the Project on Climate Change (Philippines: Meteorology/Climatology)

Shown in **Figure 2.3.1-2** are the expected impacts of the implementation of the proposed bypass project on climate change. The analysis done by the JICA Study Team CO_2 generation rae discussed in the succeeding sections.



Source: JICA Survey Team

Figure 2.3.1-2 Analyzed Items on CO_2 Generation

(1) Tree Cutting and Disposal

Tree cutting and their disposal along the Right-Of-Way (ROW) of the proposed Davao City Bypass Project will generate greenhouse gasses such as CO2. Reduction of the carbon dioxide sink due to tree cutting is also expected.

Based on the preliminary design, the bypass road has approximate length of **44.58 km** and the average of the road width is approximately average **55 m**. A total of **245.2 ha** of agricultural area, which is mainly coconut plantations will be developed by the project. The expected negative impacts are:

Impact A: Generated CO_2 by incineration of cut trees (Incineration/burning of cut trees is not expected here. Naturally growing and planted trees to be cut will be surrendered to the CENRO of Davao City and Panabo City for inventory and will not be incinerated/burned. Likewise, cut coconut trees will be surrendered to PCA and will not be incinerated/burned.

However generated CO2 is forecasted volume is calculated on this methodology); and

Impact B: Loss of absorb CO_2 due to cutting trees

According to quantitative analysis shown in **Table 2.1.3-2**, Impact A is estimated as **35,242 t-CO_2/Year** in 2016, and Impact B shows **5,754 t-CO2/Year** in 2016 respectively during construction.

Table 2.3.1-2 Estimated CO_2 Volume by Cutting Tree									
Item	**Length of the Road (km)**	**Width of the Road (km)**	**Area (ha)**	**C Sink Unit (t/ha)**	**Lost Volume of Carbon Sink (C t)**	**Rate (CO_2-C)*1**	**Cutting Duration (Year)**	**Lost Volume of Carbon Dioxide Sink (CO_2 t)**	**Lost Volume of Carbon Dioxide Sink (CO_2 t/Year)**
Generated CO_2 due to cut coconuts *2	44.58	0.055	245.19	117.6	28,834	3.667	3	105,726	35,242
Loss of Absorb CO_2 *3	44.58	0.055	245.19	6.4	1,569	3.667	1	5,754	5,754
Source: JICA Survey Team, July 2014									

*Note-1) C-CO_2 coefficient: "C" molecular weight 12 and "CO_2" is 44. C x (44/12:3.67) = CO_2 weight;

*Note-2) Generated CO_2 volume in case of incineration the cut coconuts trees;

*Note-3) Expected absorbed CO_2 volume in case of continuation duration of the coconuts; and

*Note-4) 6.4 Ct/ha/year = 8.1-4.7/2 (Roupsard O., Lamanda N., Jourdan C., Navarro M.N.V., Mialet-Serra I., Dauzat J. & Sileye T. (2008b). Coconut carbon sequestration part 1 / highlights on carbon cycle in coconut plantations. Philippines Journal of Coconut Studies xxxiii(2) 24-37)

(2) Impact of Construction Machines Operation

The estimated generated CO_2 unit volume is given from a reference, and the quantitative analysis is carried out in accordance with these values. Results of analysis presented in **Table 2.3.1-3**, shows that a total of volume of **93,393 t-CO_2** will be generated during the year construction period, given the **31,131 t/year** generation of CO_2.

Table 2.3.1-3 Estimated CO_2 Volume by Construction Activities

Type of Structure	Unit (CO_2 t/km)	Length (km)	Generated CO_2 t	Construction Year	Generated CO_2 t/year
Embankment	2267.8	37.5	85,043	3	28,348
Bridge (PC)	1400.7	4.8	6,723	3	2,241
Tunnel	713.5	2.28	1,627	3	542
Total		**44.58**	**93,393**		**31,131**

Source: JICA Study Team, July 2014

Generated CO2 Unit: Highway Technology Research Center in Japan (2004 December)

Highway with 4 carriage way, Earth work section: 2,267.8t-CO2/km, Steel Bridge Section: 1,287 t-CO2/km, PC Bridge Section: 1400.7 t-CO2/km, Tunnel Section: 713.5 t-CO2/km

3) Impact of the Generated Greenhouse Gas during Operational Phase

Greenhouse gas around the Bypass may increase due the additional traffic volume. However the estimated total traffic volume in the project area, will remain same "With/Without Project". Only the estimated travelling speed will increase in case of "With Project" as shown in the next table.

The result of traffic analysis is shown in **Table 2.3.1-4**. Although vehicle kilometer indicates giving negative impacts "With Project Case" than "Without case", the estimated average travelling speed increase approximately **2 km/hr**, thus the exhaust CO_2 emission unit decrease "With Project" case and give positive impacts in general.

Table 2.3.1-4 Traffic Indicators With/ Without Project			
Traffic Indicator		**2023 (Operation Phase)**	**2033 (Operation Phase)**
Total Vehicle Time (Veh x hr/day)	Without Project	235,299	320,332
	With Project	216,682	297,710
	Project Impact (WO-W)	18,617	22,622
Total Vehicle km (Veh x km/day)	Without Project	5,840,688	7,100,186
	With Project	5,896,668	7,210,408
	Project Impact (WO-W)	-55,980	-110,222
Average Speed (km/h)	Without Project	25	22
	With Project	27	24
	Project Impact (W-WO)	2	2

Source: JICA Survey Team (Progress Report / Nov. 2013)

Presented in **Table 2.3.1-5** is the estimated CO_2 volume by construction activities. The estimated values are **636,936 t-CO_2/year** (in 2023) in case of "Without Project" and **605,582 t-CO_2** in case of "With Project" respectively. Additionally, **757,312 t-CO_2/year** and **736,332** in 2033 in case of "Without" and "With" respectively.

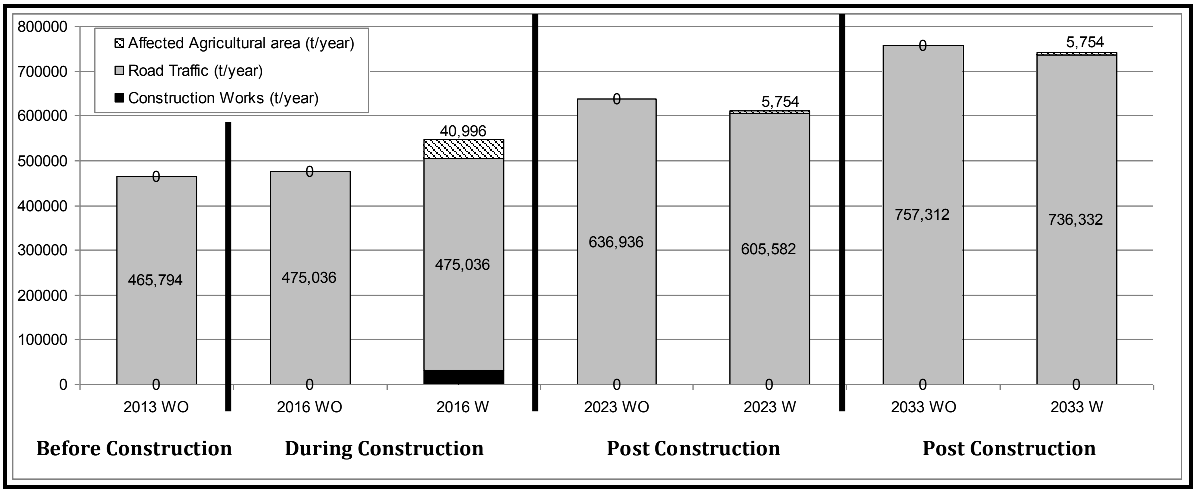
These values show that With Project has advantage **3-5 percent** of generated CO_2 after construction.

Table 2.3.1-5 Estimated CO_2 Volume by Construction Phases					
Period	**Year**	**Estimated (CO2 t/year) 365 days**			
		Road Traffic			
		Without Project	**With Project**	**Difference**	**Decrease rate (%)**
Before Construction	2013	465,794	-	-	-
During Construction	2016	475,036	-	-	-
After Construction	2023	636,936	605,582	31,354	4.92%
After Construction	2033	757,312	736,332	20,979	2.77%

Source: JICA Study Team, July 2014

(4) Compiled Result of Quantitative Analysis

The estimated comprehensive CO_2 volume is shown in **Table 2.3.1-6** and **Figure 2.3.1-3**. Although negative impacts are predicted during construction **3 years** in case of "With Project", basically positive impact is given by the project operation phase. Thus it is not likely to give significant impact on the project.



Source: JICA Survey Team, July 2014

Figure 2.3.1-3 Compiled Estimated CO_2 Volume during Construction and Operation Phase

Table 2.3.1-6 Compiled Estimated CO_2 Volume during Construction and Operation Phase

Year		Estimated (CO_2 t/Year)							2. With Project Total (CO2 t/y)	1. Without 2. With Project
		Without Project			1. Without Project Total (CO2 t/y)	With Project				
		Construction Works (t/Year)	Road Traffic (t/Year)	Affected Agriculture Area (t/Year)		Construction Works	Road Traffic	Affected Agriculture Area		
2013	Present	0	465,794	0	465,794	0	465,794	0	465,794	0
2016	During Construction	0	475,036	0	475,036	31,131	475,036	40, 996	547,162	-72,127
2023	Post Construction	0	636,936	0	636,936	0	605,582	5,754	611,336	25,600
2033	Post Construction	0	757,312	0	757,312	0	736,332	5,754	742,086	15,226

Source: JICA Survey Team, July 2014

2.3.1.3 Impact Analysis and Mitigation Measures

(1) Construction Phase

Cutting of naturally growing and planted trees along the ROW is unavoidable. To minimize the loss of trees and other vegetation covers, tree cutting activities should be limited within the required ROW. "*Permit To Cut*" shall be secured from the DENR-FMB Region XI prior to any tree cutting activities.

Loss of absorb CO_2 due to tree cutting can be mitigated by replacement of the cut trees in areas designated by the DENR-FMB RXI. For planted trees in private and forest lands not exclusively established for tree plantations/timber production purposes (as defined in *DENR-FMB Memorandum Order No. 2012-02* attached as **Appendix E** in **Volume II** of this Report), replacement ratio shall be **1:50**, while naturally growing trees in same areas, including those affected by development (such as the Davao City Bypass) projects shall have **1:100** ratio in support of the National Greening Program (NGP) and climate change initiatives of the Government.

In order to facilitate the implementation of tree replacements, seedling donations and identification of common tree planting sites shall be encouraged for more impact, especially in urban areas. Planted trees shall be replaced preferably with **indigenous** species, while naturally growing trees shall be **strictly replaced** with **indigenous** species. All donated seedlings shall be properly recorded and turned over to the CENRO concerned (for this project the CENRO of both Davao City and Panabo City) with jurisdiction over the area, while tree planting sites shall be delineated on the ground with the corresponding technical description and map using Global Positioning System (GPS) for ease of monitoring and evaluation purposes.

For coconut trees, "Permit to Cut" shall be secured from the Philippine Coconut Authority (PCA) Region XI prior to any tree cutting activities. All cut coconut trees shall be surrendered to PCA for inventory and disposal. As previously mentioned, coconut trees **shall not be incinerated and/or burned**, therefore Impact A is not expected to occur.

To minimize the effects of the exhaust gas emissions generated by the construction equipment and machineries during implementation of the project, the Contractor must strictly comply with the Periodic Maintenance Service (PMS) of all construction vehicles, equipment, and machineries.

(2) Operational Phase

Positive impact is anticipated in terms of CO_2 generation. Results of the CO_2 generation projection carried out by the JICA Study Team showed that operation of the proposed Bypass Project ("With the Project" case), approximately **4.92%** decrease rate in CO_2 is expected based on a **216,682** Total Vehicle Time (TVT) and **5,896,668** Total Vehicle Kilometer (TVK) in Year 2023. In the Year 2033, the projected decrease rate in CO_2 generation is estimated at **2.77%** based on a TVT of **297,710** and TVK of **7,210,408**.

The green belt areas along the shoulders of the newly constructed bypass road will also serve as natural filters of exhaust gas emissions generated by the vehicular traffic and will likewise provide temporary settling areas for the suspended particulate matter.

And to support the positive effect of the bypass project to the expected decrease in generation, the CENRO of the Cities of Davao and Panabo, in close coordination with their respective Traffic Management Group (TMG) shall set-up a smoke-belching monitoring station at air pollution sensitive areas. Strict implementation of penalties for violators in accordance with the Philippine Clean Air Act (R.A. 8749) and its Implementing Rules and Regulations (IRR).

2.3.2 Air Quality and Noise Level

To determine the baseline air quality and noise level along sensitive receptor areas traversed by the proposed Davao City Bypass Construction Project, sampling were carried out at **seven** (**7**) selected sites from 31 March to 01 April 2014, 01-02 August, and 04-05 August 2014.

For ambient air quality, **1-hour averaging** time was conducted at the **seven** (**7**) sampling stations. At Sta. A6 & A7, the **1-hour** sampling was carried out for the **four** (**4**) different sampling periods (morning, daytime, evening time, and nigh time). A total of **five** (**5**) **1-hour** samplings were carried out. **Two** (**2**) **1-hour** monitoring were carried out during the daytime period. The air quality parameters measured are Total Suspended Particulate (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and carbon dioxide (NO_2).

Noise level at Sta. N1-N5 were monitored within a **10-minute average** period at different hour during the daytime (0900-1800H) only. At Sta. N6 & N7, a 24-hour monitoring was carried out, covering the **four** (**4**) specified sampling periods – morning (0500-0900H), daytime (0900-1800H), evening (1800-2200H), and night time (2200-0500H). The hourly monitoring was observed within a **10-minute** averaging time.

Ambient noise levels were determined by using sound level meter, in accordance with the provision provided in the NPCC Memorandum Circular 002 (1980), which sets the median of seven maximum readings comparable to the standard and the sampling procedure outlined by *Wilson* (*1989*).

The air quality and noise level sampling stations are briefly described in **Table 2.3.2-1**, while **Figure 2.3.2-1** shows the locations of these stations with respect to the project alignment.

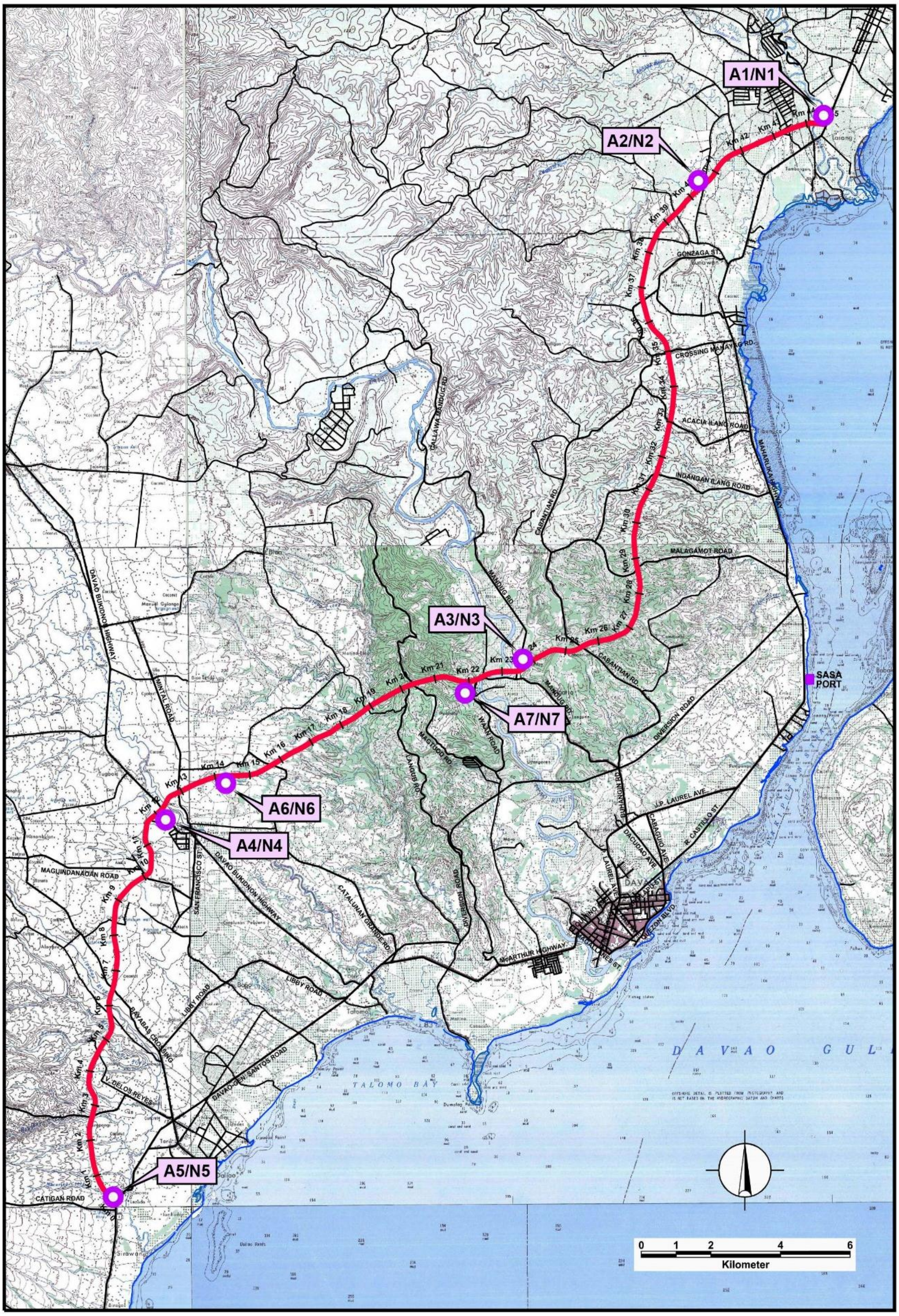


Figure 2.3.2-1 Location Map of Ambient Air Quality and Noise Level Monitoring Sites

Table 2.3.2-1 Description of Air Quality and Noise Level Sampling Stations		
Station No.	**Location**	**Coordinates**
Sta. A1 & Sta. N1	Located in front of PAICOP Compound along Davao Agusan National Road, Brgy. J.P Laurel, Panabo City (End of Alignment)	N 07° 16'25.6" E 125° 40'03.1"
Sta. A2 & Sta. N2	Located along San Isidro Road, between Piatos Chapel and Pablo M. Piatos, Sr. Elementary School, Brgy. San Isidro Bunawan, Davao City	N 07° 15'27.1" E 125° 38'05.5"
Sta. A3 Sta. N3	Located in front of Sto. Niño Chapel, along Mandug Road, Brgy. Tigatto, Davao City	N 07° 08'12.8" E 125° 35'18.5"
Sta. A4 & Sta. N4	Located in front of the University of Southeastern Philippines (USeP), along Davao-Bukidnon National Highway, Brgy. Mintal, Davao City	N 07° 05'48.7" E 125° 29'43.2"
Sta. A5 & Sta. N5	Beginning of the Alignment along Davao-Digos National Highway approximately 500 m south of Lipadas Bridge and 200 m north of Triad Road, Brgy. Sirawan, Davao City	N 07° 00'05.9" E 125° 28'52.4"
Sta. A6 & Sta. N6	Along Little Mermaid St., Elenita Heights, Brgy. Catalunan Grande, Davao City	N 07° 07'42.5" E 125°"34'24.3
Sta. A7 & Sta. N7	Waan Elementary School Grounds, Brgy. Waan, Davao City	N 07° 08'42.5" E 125° 39'34.6"

2.3.2.1 Air Quality

(1) Total Suspended Particulate (TSP)

Results of the sampling conducted presented in **Tables 2.3.2-2** and **2.3.2-3** indicate that the TSP levels observed at the **seven** (**7**) sampling sites established along the proposed bypass alignment ranged from **20.5** to **298.5 µg/Ncm**. The values observed are within the DENR National Ambient Air Quality Standards (NAAQS) for Source Specific Air Pollutants of **300 µg/Ncm** for a **1-hour** averaging time.

A relatively very low TSP concentration level of **20.5 µg/Ncm** was recorded at Sta. 6-B during the daytime sampling period. Similarly, the observed TSP concentration level at Sta. A7-2 of **29.6 µg/Ncm** is way below the DENR standard. On the other hand, the TSP concentration level recorded at Sta. A1 of **298.5 µg/Ncm**, is just slightly below the DENR standard limit. An equally high TSP level was observed at Sta. A2 (**275.9 µg/Ncm**).

(2) Gaseous Air Pollutants

1) Sulfur Dioxide (SO_2)

Based on the **1-hour** sampling period, the SO_2 concentration level recorded at the **seven (7)** sampling stations ranged between **<0.5** to **6.1 µg/Ncm**, and are very well within the standard concentration level set by the DENR for SO_2 of **340 µg/Ncm**.

Very low ground concentration levels (GCL) of **<0.5 µg/Ncm** were observed at Sta. A6-5 (night time), Sta. A7-1 (morning), Sta. A7-2 (daytime), Sta. A7-3 (daytime), and Sta. A7-4 (evening). The highest SO_2 concentration level of **6.1 µg/Ncm** was observed Sta. A1.

2) Nitrogen Dioxide (NO_2)

In terms of NO_2, the observed concentration levels observed at the sampling sites ranged from **<0.2** to **13.9 µg/Ncm**. These values are all within the DENR standard of **180 µg/Ncm** for NO_2. Sta. A3 exhibited the highest NO_2 concentration level of **13.9 µg/Ncm**, while the lowest GCL of **1.8 µg/Ncm** were observed at Sta. A6-4 (evening), Sta. A6-5 (night time), Sta. A7-4 (evening), and Sta. A7-5 (night time).

Table 2.3.2-2 Measured Ambient Concentrations of TSP, SO_2 and NO_2 along the Proposed Davao City Bypass Alignment (Sta. A1-A5)

Sta. No.	Period	Date/Time of Sampling	Weather Condition	Prev. Wind	Ave. Temp. (°C)	Concentration in µg/Ncm		
						TSP	SO_2	NO_2
A1	Daytime	31 March 2014 1600-1700H	Sunny w/ Light Air			298.5	6.1	7.8
A2	Daytime	31 March 2014 1550-1650H	Cloudy w/ Light Air			158.3	3.7	1.8
A3	Daytime	01 April 2014 1000-1100H	Sunny w/ Light Air			128.1	2.4	4.6
A4	Daytime	01 April 2014 1327-1427H	Sunny w/ Light Air	NE	30.0	275.9	3.7	13.9
A5	Daytime	01 April 2014 1600-1700H	Sunny w/ Light Air			221.1	4.3	5.1
DENR National Ambient Air Quality Standards for Source Specific Air Pollutants based on 60 minutes averaging time						**300**	**340**	**260**

Table 2.3.2-3 Measured Ambient Concentrations of TSP, SO_2 and NO_2 along the Proposed Davao City Bypass Alignment (Sta. A6 & Sta. A7)						
Station No.	**Period**	**Date/Time of Sampling**	**Weather Condition**	**Sampling Results (µg/Ncm)**		
				TSP	**SO_2**	**NO_2**
Sta. A6-1	Morning	Aug. 1, 2014 0800H-0900H	Sunny	80.1	1.8	1.9
Sta. A6-2	Daytime	Aug. 1, 2014 1110H-1210H	Cloudy	20.5	3.7	1.0
Sta. A6-3	Daytime	Aug. 1, 2014 1600H-1700H	Cloudy	136.8	1.8	0.8
Sta. A6-4	Evening	Aug. 1, 2014 1900H-2000H	Windy with slight rain	18.7	0.6	< 0.2
Sta. A6-5	Night Time	Aug. 1, 2014 2200H-2300H	Clear Sky	32.6	< 0.5	< 0.2
Sta. A7-1	Morning	Aug. 4, 2014 0630H-0730H	Sunny	173.1	< 0.5	2.6
Sta. A7-2	Daytime	Aug. 4, 2014 1100H-1200H	Cloudy	29.6	< 0.5	2.3
Sta. A7-3	Daytime	Aug. 4, 2014 1600H-1700H	Cloudy	31.1	< 0.5	0.4
Sta. A7-4	Evening	Aug. 4, 2014 1900H-2000H	Windy with brief rain shower	92.3	< 0.5	< 0.2
Sta. A7-5	Night Time	Aug. 4, 2014 2200H-2300H	Clear Sky	84.1	3.0	< 0.2
DENR National Ambient Air Quality Standards for Source Specific Air Pollutants based on 60 minutes averaging time				**300**	**340**	**260**

3) Carbon Monoxide (CO)

As shown in **Table 2.3.2-4** and **2.3.2-5**, the CO concentration levels observed at the **seven (7)** sampling stations ranged from **< 1.0** to **1.0 parts per million (ppm)**. The values recorded are very well within the DENR National Ambient Air Quality Guideline Values (NAAQGV) of **30 ppm** for CO on a **1-hour** averaging time. The minimum CO level of **<1.0 ppm** were observed at Sta. A3 and A3. The rest of the sampling stations recorded a CO level of **1.0 ppm**.

4) Carbon Dioxide (CO_2)

The recorded concentration levels of CO_2 ranged from **306** to **1348 ppm**. The highest concentration level was observed at Sta. A5, while the lowest concentration level was recorded at Sta. A6-5 during the night time sampling period. It should be noted that there is no standard established for CO_2.

Table 2.3.2-4 Measured Ambient Concentrations of CO and CO_2 along the Proposed Davao City Bypass Alignment (Sta. A1-A5)

Sta. No.	Period	Date/Time of Sampling	Weather Condition	Concentration (ppm)	
				CO	CO_2
A1	Daytime	31 March 2014 1600-1700H	Sunny w/ Light Air	1.0	890
A2	Daytime	31 March 2014 1550-1650H	Cloudy w/ Light Air	< 1.0	952
A3	Daytime	01 April 2014 1000-1100H	Sunny w/ Light Air	< 1.0	1120
A4	Daytime	01 April 2014 1327-1427H	Sunny w/ Light Air	1.0	1256
A5	Daytime	01 April 2014 1600-1700H	Sunny w/ Light Air	1.0	1348
DENR National Ambient Air Quality Standards for Source Specific Air Pollutants based on 60 minutes averaging time				**30**	**NONE**

Note: *ppm – parts per million*

Table 2.3.2-5	Measured Ambient Concentrations of CO and CO_2 along the Proposed Davao City Bypass Alignment (Sta. A6 and A7)				
Station No.	**Period**	**Date/Time of Sampling**	**Weather Condition**	**Concentration (ppm)**	
				CO	**CO_2**
Sta. 6-A	Morning	Aug. 1, 2014 0800-0900H	Sunny	1.0	321
Sta. 6-B	Daytime	Aug. 1, 2014 1110H-1210H	Cloudy	1.0	328
Sta. 6-C	Daytime	Aug. 1, 2014 1600H-1700H	Cloudy	1.0	430
Sta. 6-D	Evening	Aug. 1, 2014 1900H-2000H	Windy with slight rain	1.0	319
Sta. 6-E	Night Time	Aug. 1, 2014 2200H-2300H	Clear Sky	1.0	306
Sta. 7-A	Morning	Aug. 4-5, 2014 0630H-0730H	Sunny	1.0	412
Sta. 7-B	Daytime	Aug. 4-5, 2014 1100H-1200H	Cloudy	1.0	364
Sta. 7-C	Daytime	Aug. 4-5, 2014 1600H-1700H	Cloudy	1.0	350
Sta. 7-D	Evening	Aug. 4-5, 2014 1900H-2000H	Windy with brief rain shower	1.0	353
Sta. 7-E	Night Time	Aug. 4-5, 2014 2200H-2300H	Clear Sky	1.0	387
DENR National Ambient Air Quality Guideline Values for Source Specific Air Pollutants based on 60 minutes averaging time				**30**	**NONE**

Note: *ppm – parts per million*

Figure 2.3.2-2 shows the graphical output of the measured air pollutants along the bypass alignment at Sta. A1 to Sta. A5, while the graphical outputs of the measured air quality for Sta. A6 and Sta. A7 are shown in **Figures 2.3.2-3** and **2.3.2-4**, respectively.

Attached as **Appendix E** is the laboratory certificate of the air quality results, while **Appendix F** shows the certificate of equipment calibration.

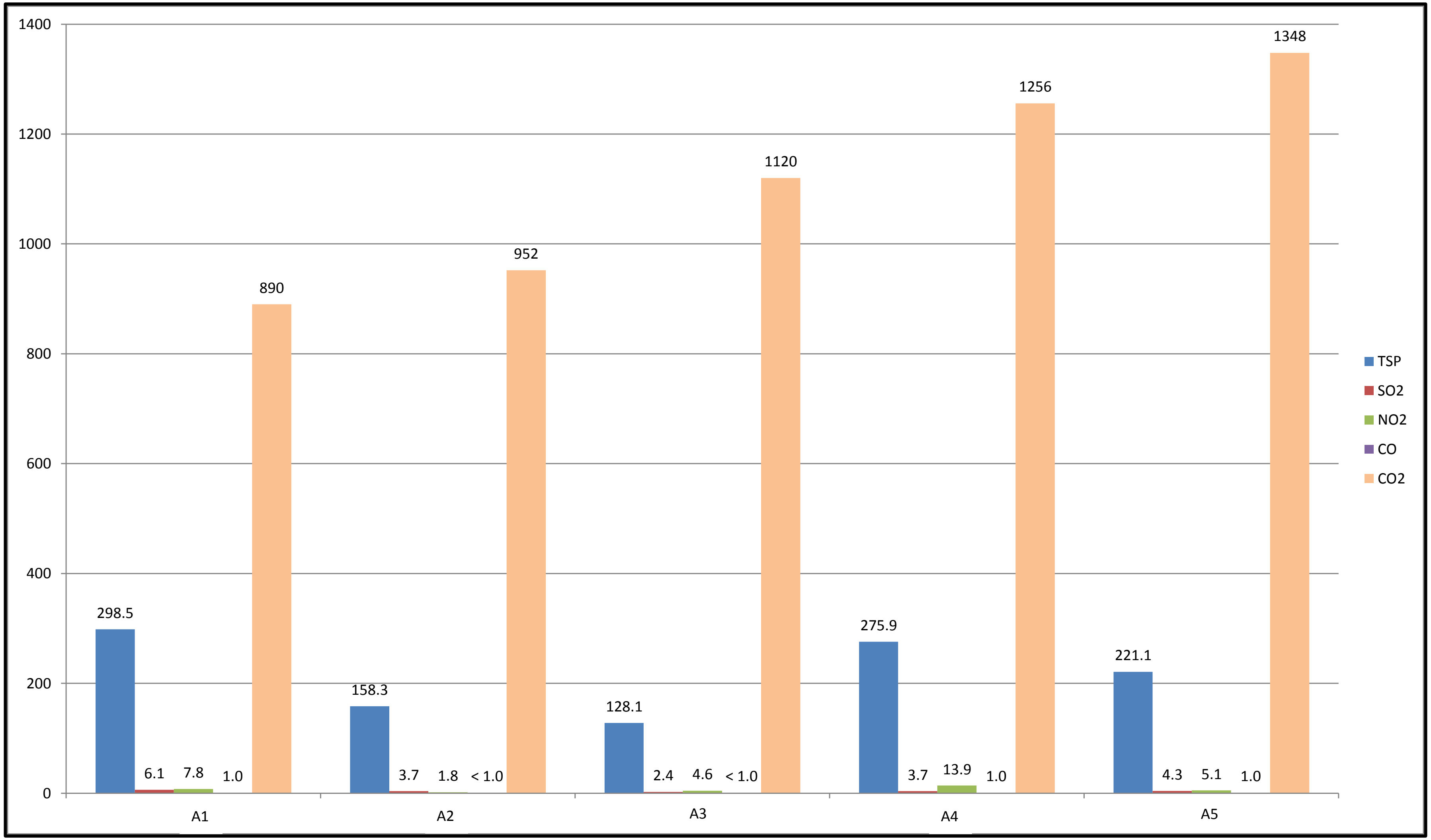


Figure 2.3.2-2 Graphical Output of the Measured Air Pollutants at Sampling Sta. A1 to Sta. A5

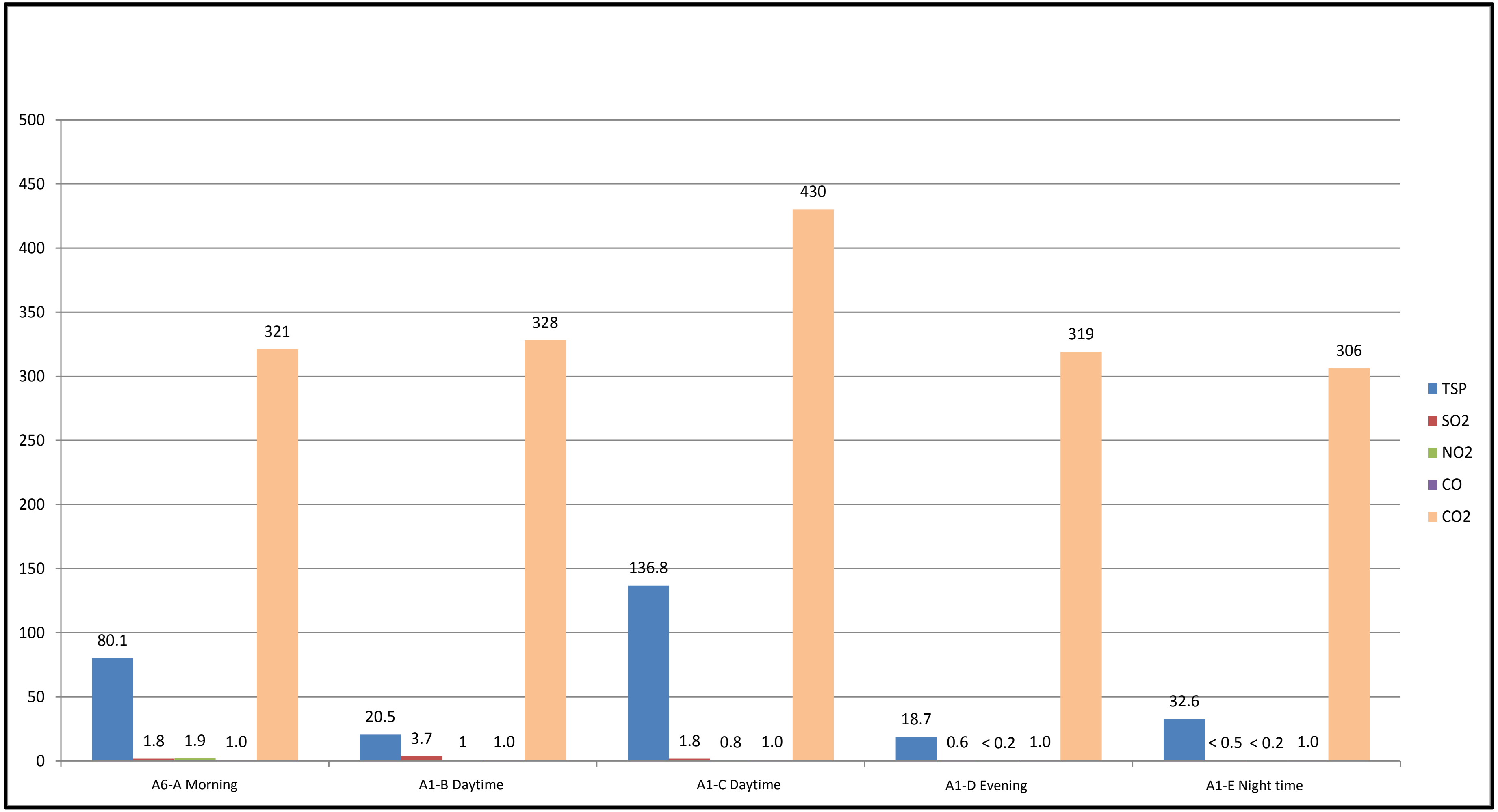


Figure 2.3.2-3 Graphical Output of the Measured Air Pollutants at Sampling Sta. A6

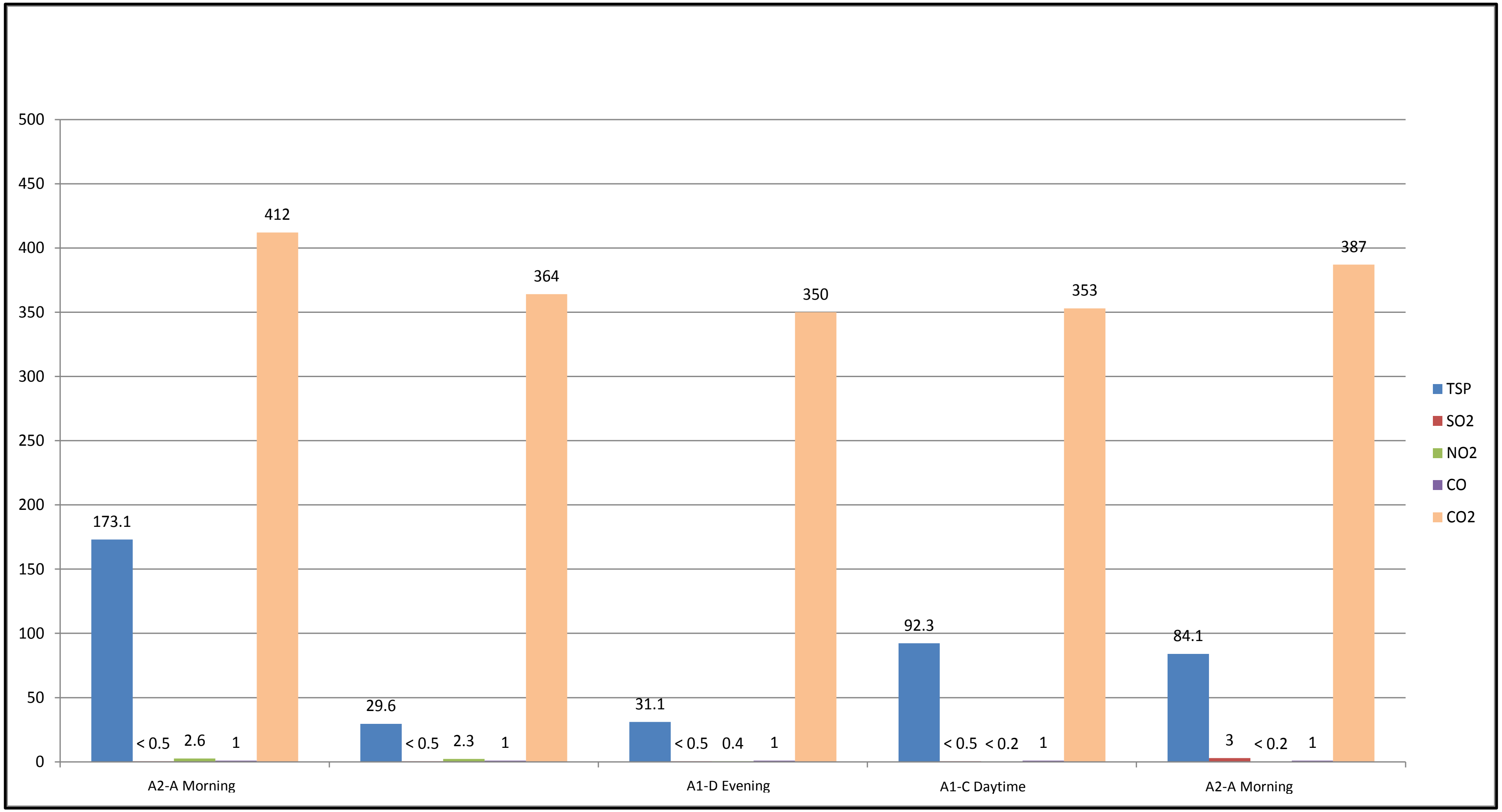


Figure 2.3.2-4 Graphical Output of the Measured Air Pollutants at Sampling Sta. A7

Photo No. 2.3.2-1 TSP level monitoring at **Sta. A1** at the end section of the alignment in front of PAICOP compound along the Davao-Agusan National Highway in Brgy. J.P. Laurel, Panabo City.

Photo No. 2.3.2-2 Ambient air quality sampling at **Sta. A2**, in front of Piatos Chapel in Brgy. San Isidro, Bunawan, Davao City.

Photo No. 2.3.2-3 SO_2 and NO_2 sampling along Mandug Road in front of the Sto. Niño Chapel, Brgy. Tigatto, Davao City

Photo No. 2.3.2-4 Air quality sampling at **Sta. A4**, in front of University of Southeastern Philippines (USeP), along the Davao-Bukidnon National Highway, Brgy. Mintal, Davao City.

Photo No. 2.3.2-5 Ambient CO and CO_2 concentration level sampling at start of the proposed bypass alignment along the Davao-Digos National Highway in Brgy. Sirawan, Davao City.

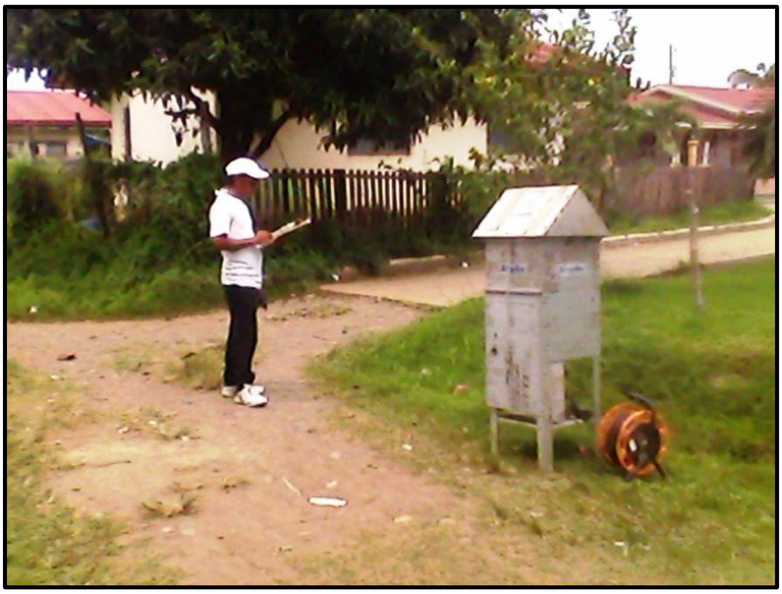


Photo No. 2.3.2-6 Morning time TSP level sampling at Sta. A6-1, Elenita Heights, Brgy. Catalunan Grande.

Photo No. 2.3.2-7 Daytime (1600-1700H) monitoring of NO_2 and SO_2 concentration levels at Sta. A6-3.

Photo No. 2.3.2-8 Morning time TSP concentration level monitoring at Sta. A7.

2.3.2.2 Noise Level

<u>(1) 10-Minute Average Daytime Monitoring</u>

Sampling results of the **10-minute average** noise level daytime monitoring along sampling Sta. N1 to N5 showed that existing noise levels exceeded the permissible DENR limit of **55 dBA** for *Class "AA"* (*a section or contiguous area which requires quietness, such as an area within **100 m** from school sites, nursery schools, hospitals, places of worships, and special homes for the aged*) and **65 dBA** for *Class "B"* (*a section or contiguous area which is primarily commercial area*) areas.

The observed daytime noise level at Sta. N2 (**72 dBA**) and Sta. N3 (**74 dBA**) which are both categorized as *AA* areas, exceeded the DENR standard of **55 dBA**. Sound generated by the passing vehicles are the identified sources of noise at the time of sampling. It is important to note that these **two** (**2**) sampling stations were established approximately **10 m** from Catholic chapels.

For the *"B"* categorized areas (Sta. N1, N4, and N5), the observed noise level ranged from **72-80 dBA**. The values recorded exceeded the DENR limit of **65 dBA** for daytime noise level standard. A relatively high noise level of **80 dBA** was observed at Sta. N4, which is located in front of the University of Southeastern Philippines (USeP) Mintal Campus along the Davao-Bukidnon National Highway. The high noise recorded can be attributed to the volume of vehicles passing along the highway and the perennial blowing of horns.

Table 2.3.2-6 below presents the complete results of the noise level monitoring conducted along the proposed bypass alignment.

Table 2.3.2-6 Ambient Noise Level Recorded along the Proposed Davao City Bypass Alignment (Sta. N1-N5)				
Station No.	**Date & Time**	**Average Noise Level (in dBA)**	**DENR Standard**	**Remarks**
N1	31 March 2014 1605-1615H	**72**	**65****	Noise coming from passing vehicles; with light wind; prevailing wind is NE;
N2	31 March 2014 1755-1805H	**72**	**55***	Noise coming from passing vehicles; with light wind; prevailing wind is NE;
N3	01 April 2014 1005-1015H	**74**	**55***	Noise coming from passing heavy equipment; with light wind; prevailing wind is SE
N4	01 April 2014 1330-1340H	**80**	**65****	Noise coming from blowing of horns and passing heavy trucks; with light wind; prevailing wind is SE
N5	01 April 2014 1705-1715H	**73**	**65****	No unusual noise at the station; with light wind; prevailing wind is NE

NOTE:

Class AA* *a section or contiguous area which requires quietness, such as an area within **100 m** from school sites, nursery schools, hospitals, places of worships, and special homes for the aged*

Class B** *a section or contiguous area which is primarily commercial area*

(2) 24-Hour Noise Level Monitoring

1) Sta. N6, Elenita Heights Brgy. Catalunan Grande

As can be discerned from **Table 2.3.2-7**, the morning noise levels observed at Sta. N6 which ranged from **60-69 dBA**, exceeded the DENR permissible limit of **50 dBA** for areas classified as *"A"* (a section or contiguous area which is used for residential purposes) areas. The highest noise level of **69 dBA** was observed between 0530-0540H. Noise sources during the sampling are crowing of roosters, sounds from stereo, and barking of dogs.

During the daytime sampling period at Sta. N6, the noise levels recorded ranged from **54-70 dBA**. All the observed levels exceeded the DENR standard of **55 dBA** for daytime noise, except the monitoring from 1010-1020H (**54 dBA**) which is slightly below the standard. The highest noise level of **70 dBA** was observed between 1620-1630H. The relatively high noise level recorded can be ascribed to the noise generated by the motor equipment and stereo sounds from adjacent houses.

The recorded evening time noise levels ranged from **53-59 dBA**. These values exceeded the DENR standard for evening time of **45 dBA**. During monitoring, slight rain was experienced which is probably the cause of a relatively high noise level of **59 dBA**, which was recorded between 2020-2030H.

Night time noise levels observed ranged from **50-57 dBA**. These values exceeded the **40 dBA** permissible limit set by the DENR for night time noise level. The highest noise level of **57 dBA** which was observed between 2220-2230H is probably from the sound generated by the television set and insect sounds

Shown in **Figure 2.3.2-5** is the graphical output of the 24-hour noise level monitoring results at Sta. N6.

Table 2.3.2-7 24 Hour Noise Level Monitoring Results at Sta. N6

Period	Time & Date	Result (dBA)	DENR Standards (A)	Weather Condition	Observation
Morning 0500-0900H	0530-0540H 02 August 2014	69	50 dBA	Fair weather with clear skies	Noise coming from Stereo Sound, crowing of roosters, birds sounds and dog barks
	0630-0640H 02 August 2014	62			
	0730-0740H 02 August 2014	60			
	0805-0815H 02 August 2014	60			
Daytime 0900-1800H	0920-0930H 04 August 2014	63	55 dBA	Fair weather with cloudy skies	Noise coming from sound of motor equipment, television sounds, barks of dogs, sound from birds, jeepney sounds crowing of roosters, sounds from stereo/radio and motorcycle vehicles,
	1010-1020H 01 August 2014	54			
	1110-1120H 01 August 2014	67			
	1220-1230H 01 August 2014	57			
	1330-1340H 01 August 2014	60			
	1430-1440H 01 August 2014	56			
	1530-1540H 01 August 2014	60			
	1620-1630H 01 August 2014	70			
	1720-1730H 01 August 2014	60			
Evening 1800-2200H	1820-1830H 01 August 2014	53	45 dBA	Windy with slight rain	Noise coming from slight rain, dog barks, insect sounds and television sound
	1920-1930H 01 August 2014	58			
	2020-2030H 01 August 2014	59			
	2120-2130H 01 August 2014	57			
Nighttime 2200-0500H	2220-2230H 01 August 2014	57	40 dBA	Clear skies	Noise coming from television sounds, insect sound, stereo sounds and crowing of roosters
	2320-2330H 01 August 2014	52			
	0020-0030H 02 August 2014	52			
	0120-0130H 02 August 2014	52			
	0220-0230H 02 August 2014	50			
	0320-0330H 02 August 2014	50			
	0430-0440H 02 August 2014	53			

Note : ***"A" A section or contiguous area which is used for residential purposes***

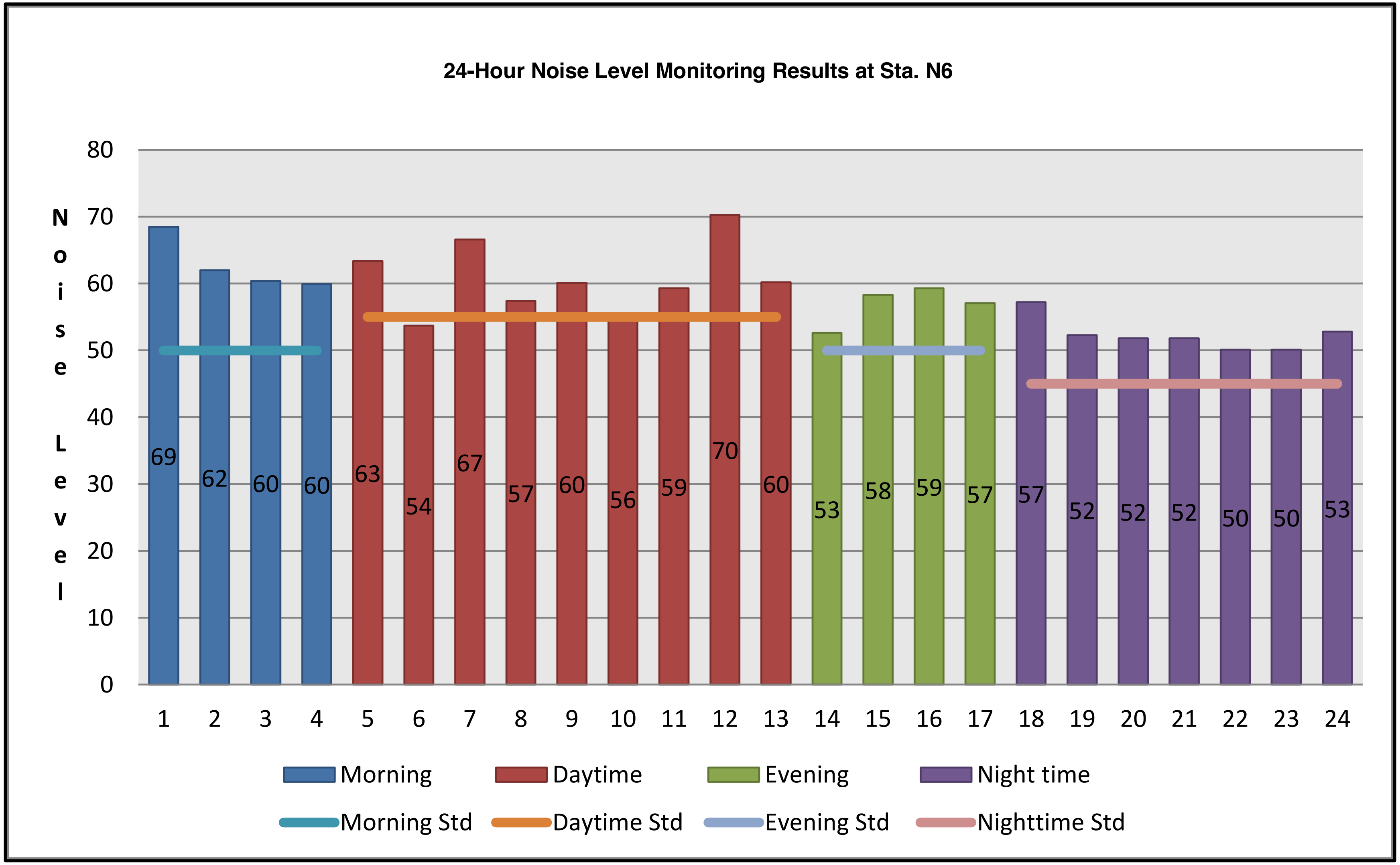


Figure 2.3.2-5 Graphical Output of the Measured 24-Hour Noise Level at Sta. N6

2) Sta. N7, Waan Elementary School Grounds, Brgy. Waan

Morning time noise levels observed at Sta. N7 ranged from **53-70 dBA**. The values gathered exceeded the allowable morning noise level of **45 dBA** set by the DENR for Class *"AA"* areas *which requires quietness, such as an area within **100-meters** from school sites, nursery schools, hospitals and special homes for the aged*. Sources of noise identified during the time of sampling include noise generated by the passing vehicles and children playing near the sampling location. The highest noise level of **70 dBA**, which was observed between 0530-0540H was most likely generated by the movements of children going to the school.

Results of the daytime sampling showed that the noise levels observed at the sampling station exceeded the DENR standard level of **50 dBA** (see **Table 2.3.2-8**). The noise level recorded ranged from **50-69 dBA**. Between 1110-1320H, an average noise level of **67 dBA** was recorded. This period is busiest, when movements of children are at the peak (having lunch break and moving to other classrooms). Sounds from children playing and xylophone sound may have also contributed to the high noise level observed.

The evening noise level observed which ranged from **68-69 dBA** likewise exceeded the DENR standard of **45 dBA**. Sounds from the Muslim instrument used by the children practicing a school dance are the main contributor of the noise pollution captured at the time of sampling. Motor sounds from the passing tricycles and motorcycles also contributed to the generated noise observed.

Noise coming from the sound of the falling rain is the primary cause of the high noise level observed during the night time (2230-2240H) sampling period at Sta. N7. The recorded noise level which ranged from **54-69 dBA** exceeded the permissible **40 dBA** limit set by the DENR for Class *"AA"* areas. Other sources of noise are sound from passing tricycles and trucks, sounds of insects and croaking of the frogs

The graphical output of the 24-hour noise level monitoring results at Sta. N7 is presented in **Figure 2.3.2-6**.

Table 2.3.2-8 24 Hour Noise Level Monitoring Results at Sta. N7

Period	Time & Date	Result (dBA)	DENR Standards (*AA*)	Weather Condition	Observation
Morning 0500-0900H	0530-0540H 05 August 2014	70	**45 dBA**	Fair weather with clear skies	Noise coming from passing vehicles like tricycles sound of birds, children passing and playing.
	0610-0620H 04 August 2014	53			
	0710-0720H 04 August 2014	65			
	0810-0820H 04 August 2014	63			
Daytime 0900-1800H	0920-0930H 04 August 2014	63	**50 dBA**	Fair weather with cloudy skies	Noise coming from children's break and playing, sounds of birds, children shouting, and sound of xylophone instrument.
	1010-1020H 04 August 2014	63			
	1110-1120H 04 August 2014	69			
	1210-1220H 04 August 2014	65			
	1310-1320H 04 August 2014	68			
	1410-1420H 04 August 2014	61			
	1510-1520H 04 August 2014	59			
	1610-1620H 04 August 2014	56			
	1710-1720H 04 August 2014	50			
Evening 1800-2200H	1810-1820H 04 August 2014	68	**45 dBA**	Windy with brief rain shower	Noise coming from children's dance practice with Muslim instrument, passing tricycles and motorcycles
	1920-1930H 04 August 2014	69			
	2020-2030H 04 August 2014	68			
	2120-2130H 04 August 2014	69			
Nighttime 2200-0500H	2230-2240H 04 August 2014	69	**40 dBA**	Clear sky	Noise coming from rain, passing tricycles, sounds coming from the insects & frogs and passing trucks
	2320-2330H 04 August 2014	58			
	0020-0030H 05 August 2014	54			
	0120-0130H 05 August 2014	56			
	0220-0230H 05 August 2014	59			
	0320-0330H 05 August 2014	54			
	0420-0430H 05 August 2014	58			

Note: ***"AA" A section or contiguous area which requires quietness, such as an area within 100-meters from school sites, nursery schools, hospitals and special homes for the aged***

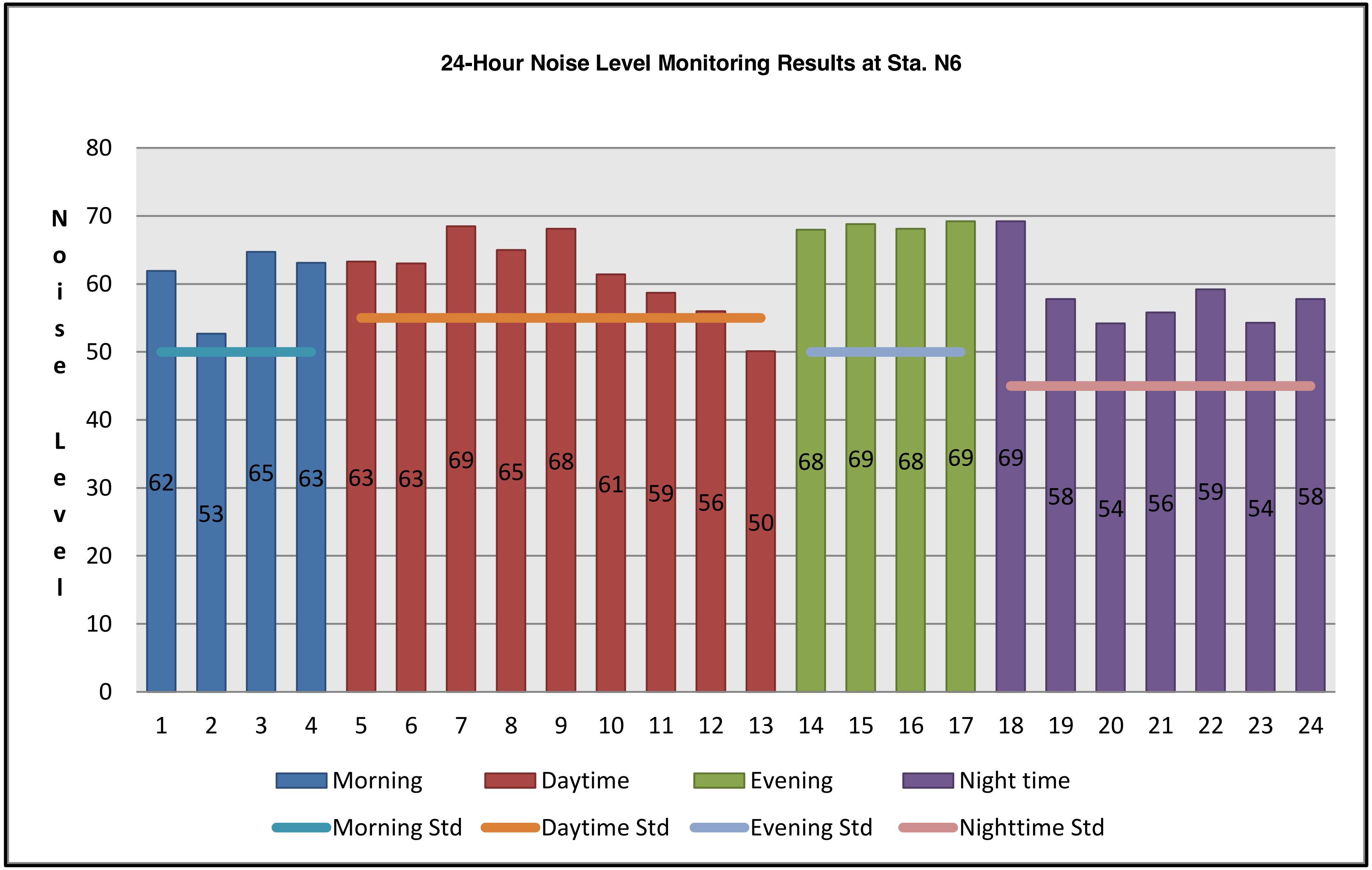


Figure 2.3.2-6 Graphical Output of the Measured 24-Hour Noise Level at Sta. N7

2.3.2.3 Impact Analysis and Mitigation

(1) Air Quality

During site clearing, vegetation stripping, grubbing, earthmoving activities and related construction works, generation of dust particles is expected to occur, especially at exposed and cleared areas.

To minimize re-suspension of particulate matters, regular spraying of water at exposed and cleared areas must be regularly undertaken using water spraying trucks. A speed limit of **20 km/hr** must be strictly enforced and observed, particularly at dust sensitive areas to lessen re-suspension of dust. Delivery trucks of earth materials, and haulers of muck soils and construction debris must be covered with sack or tarpaulin materials to minimize dust re-suspension.

Operation of various equipment and machineries during construction of the bypass road will generate exhaust gas emissions. The Contractor must strictly comply with the Periodic Maintenance Service (PMS) of all construction vehicles, equipment, and machineries to ensure that these are always in good condition.

During the Operational Phase, there will be an expected increase in level of particulate matter and gaseous emissions due to significant volume of traffic using the newly constructed bypass. To address the effects of air pollution, strict implementation of the Philippine Clean Air Act (R.A. 8749) should be carried out. Penalties for violators in accordance with its Implementing Rules and Regulations (IRR) should be strictly enforced. A monitoring station must be set-up at conspicuous areas under the supervision of representatives from the DENR Region XI, and the Cities of Davao and Panabo.

Trees to be planted by the DPWH along the greenbelt area of the newly constructed bypass will support the abatement of the effects of air pollutants emitted by the passing vehicles. Survival rate of the trees planted must be monitored by the DPWH.

(2) Noise Level

Excessive noise to be generated by the construction equipment and machineries during construction of the bypass road will cause nuisance and disturbance to adjacent residential areas, schools, and places of worships (Catholic chapels, and Mosques).

To maintain the noise levels at permissible limits, construction areas adjacent to noise sensitive receptor areas will be enclosed with metal sheets to contain the noise within construction site. Appropriate noise suppressors such as mufflers will installed to all construction equipment and machineries whenever necessary to lessen generated noise. The Contractor must also strictly comply with the PMS of all construction vehicles, equipment, and machineries.

High noise generating activities such as drilling, grubbing, and related works will be schedule during daytime only. Residents will be informed and consulted to gather consensus.

Presented in **Table 2.3.2-9** are the maximum noise standards for construction activities and the allowable working hours per area. The values presented shall be the standards during monitoring.

Table 2.3.-9 Maximum Noise Standards for Construction Activities & Allowable Working Hours per Area

Class of Activity	Maximum Noise Level	Allowable Working Hours	Areas
Class 1	90 dBA	7:00 am – 7:00 pm	AA, A, B
Class 2	85 dBA	7:00 am – 7:00 pm	AA, A, B
Class 3-4	75 dBA	7:00 am – 9:00 pm	AA, A, B

Source: Environmental Impact Assessment Hand Book, National Environmental Protection Council, 1983

Note:

Class 1 *Work which requires pile drivers (excluding manual type), file extractors, riveting hammers or combination thereof. This classification does not include work in which pile drivers are used in combination with earth augers.*

Class 2 *Work which requires rock drills or similar equipment like jack hammers or pavement breakers*

Class 3 *Work which requires air compressor (limited to those compressors which use power other than electric motors with a rated output of 15 KW or more in excludes air compressors powering rock drills, jack hammers and pavement breakers)*

Class 4 *Operation involving batching plant (limited to those with a mixer capacity of 0.5 or more cubic meters) and/or asphalt plants (limited to those with mixer capacity of 200 KG or more). Batching plants for the making or mortar are excluded.*

During its operation, high volume of traffic is expected to use the newly constructed bypass, and noise level is likely to increase. To mitigate the effects of noise level increase, especially in noise sensitive areas adjacent to the bypass installation of noise barriers must be considered.

2.4 THE PEOPLE

This section of the EIS presents the socio-economic profile of the entire City in general, with some level of detail on the project-impacted areas. For city level data, these were all obtained from the Comprehensive Land Use Plan (CLUP) 2013-2022 of Davao City prepared by the Office of the City Planning and Development Coordinator (OCPDC). Barangay level profile is augmented by information derived from the socio-economic survey conducted from middle June to July 2014.

Davao City has a total household population estimated at **1,443,890** based on the 2010 Census. This constituted **32.43%** of the total population in the Southern Mindanao Region (**4,468,563**), **5.71%** of the total population in Mindanao (**23, 375,527**); and, **1.57%** of the total Philippine population (**92,337,852**).

In terms of sex distribution there was an almost equal number of males and females with **49.9%** and **50.1%,** respectively. The dependent age group comprises **35%** of its total population, with **31.4%** and **3.6%** consisting of the young (**0-14 years old**) and old (**65** and over). The working age (**15** and over) population accounted for **64.9%** of the total population, with an almost equal share between males and females, with **32.1%** and **32.7%,** respectively. Please refer to **Table 2.4-1** for details.

Table 2.4-1 Household Population Composition by School-Age, Labor Force, Working-Age Dependent-Age Group and Sex, 2010

Age Group	Both Sexes		Male		Female		Sex Ratio
		%	No.	%	No.	%	
School Going Population							
Pre-school (3-6)	125,712	22.05	65,212	22.83	60,500	21.27	1.07
Elementary (7-12)	173,647	30.46	89,483	31.34	84,164	29.59	1.06
Secondary (13-16)	115,067	20.19	56,587	19.82	58,480	20.56	1.04
Tertiary (17-21)	155,572	27.29	74,277	26.01	81,295	28.58	1.10
Total	569,998	100.00	285,559	100.00	284,439	100.00	1.00
Labor Force (15 and over)	990,204	68.58	487,584	49.52	502,620	50.48	1.03
Working Age (15-64)	937,212	64.91	464,077	32.14	473,135	32.77	1.02
Dependent population							
Young (0-14)	453,686	31.42	233,769	51.53	219,917	48.47	1.06
Old (65 and over)	52,992	3.67	23,507	44.36	29,485	55.64	1.25
Total	1,443,890	100.00	721,353	100.00	722,537	100.00	

Source: Office of the City Planning and Development Coordinator. Comprehensive Land Use Plan of Davao City 1996-2021

2.4.1 Population and Population Density

Given the total household population and a total land area of **244,000 hectares**, Davao City's population density was estimated at **5.9** persons per hectare in 2010. Varying urbanization levels are reflected in the City's household population in urban and rural barangays. **Table 2.4-2** shows the barangay population and density in the urban and rural barangays of Davao City. Please note that out of **23** barangays that are within the Direct Impact Area, **22** are classified as **urban barangays**.

Table 2.4-2 Household Population by Urban and Rural Barangay and Average Household Size, 2010				
District/Barangay	Household Population	Number of Household	Average HH Size	Population Density
A. Urban	**1,145,963**	267,837	**4.2**	**43.00**
District I	529,375	126,262	4.1	60.83
District II	462,949	106,444	4.3	42.02
District III	153,639	35,131	4.3	22.12
B. Rural	**297,927**	66,636	**4.5**	**1.52**
District I	6,480	1,436	4.5	4.80
District II	63,890	13,925	4.5	0.89
District III	227,557	51,275	4.4	1.86
Davao City	**1,443,890**	334,473	**4.3**	**5.94**

As indicated in the CLUP 1996-2021, around **80%** of their household population are residing in urban barangays. Urban and rural barangays in the City were identified by the Office of the City Planning and Development Coordinator (OCPDC) based on National Statistics Office (NSO) guidelines.

Other socio-economic indicators are shown in **Table 2.4-3.** As presented in the said table, estimated income is small comparing with Manila City and the rate of unemployment is lower than the national average.

Table 2.4-3 Socio-economic Indicators for Davao City			
Item	Value	Year	Remarks
Population in Davao City (Persons x 1,000)	1449.3	2010	Annual Increase rate 2.7% (1990/849.4 -2000/1147.1-2010)
Average Income in Davao Region (Peso/family/year)	166,000	2009	Manila: 354,645 Peso/family/year (2009)
Average Expenditure in Davao Region (peso/family/year)	142,000	2009	Manila: 321,197 Peso/family/year (2009)
Unemployment Rate in Davao Region (%)	4.6	2011	National average : 6.4% (2011)
Annual Poverty threshold (Peso/person/year)	17,040	2009	Poverty incidence (2009) Davao City 13.2%, Davao region 31.3%
Area (km2)	2,444km2	2010	
Population Density (Persons/km2)	593	2010	

2.4.2 Literacy Rate, Profile of Educational Attainment

As reported in the CLUP, of the **1,283,078** household populations from ages **five** (**5**) years and older, a very high **97.09%** reached various levels of educational attainment. This is distributed as follows: **35.48%** went to high school education followed by **28.52%** who attended elementary education, **13.98%** (academic degree holder), **12.45%** cent (college undergraduate), and the remaining had either reached pre-school or post- secondary or baccalaureate studies.

As shown in **Table 2.4-4**, there was at least, **2.81%** of the household population who had not completed any primary school education. Of these, more males had not completed any primary school education, but more had gone to pre-school, elementary and post-secondary education than females. On the overall, more females have reached higher levels of education from high school up to post baccalaureate degree.

Table 2.4-4 Household Population 5 Years Old and Over by Highest Educational Attainment, 2010

Highest Educational Attainment	Male		Female		Both Sexes	
	No.	%	No.	%	No.	%
No Grade Completed	19,033	52.72	17,068	47.28	36,101	2.81
Pre – School	23,448	52.42	21,282	47.58	44,730	3.49
Elementary	195,273	53.35	170,724	46.65	365,997	28.52
High School	220,434	48.42	234,845	51.58	455,279	35.48
Post – Secondary	20,313	55.36	16,382	44.64	36,695	2.86
College Undergraduate	76,879	48.12	82,895	51.88	159,774	12.45
Academic Degree Holder	80,222	44.72	99,181	55.28	179,403	13.98
Post Baccalaureate	1,769	44.60	2,197	55.40	3,966	0.31
Not Stated	562	49.60	571	50.40	1,113	0.09
Total	637,933	49.72	645,145	50.28	1,283,078	100.00

2.4.3 Housing Ownership Profile/Number of Informal Settlers

Table 2.4-5 shows the 2007 data on the owner households in occupied housing units by tenure status in Davao City. As shown in the table there were **188,731** (**62.88%**) of the **300,141** households that either owned or amortized home lots. In addition, **48,337** (**16.10%**) were renting, **51,529** (**17.17%**) were occupying lands for free with consent from the owner and **7,690** (**2.56%**) households were occupying lands for free without consent from the owners.

Table 2.4-5 Owner Households in Occupied Units by Tenure Status		
Tenure Status of the Housing Unit	**Lot**	
	No.	**%**
Total Households	300,141	100.00
Owned/Being Amortized	188,731	62.88
Rented	48,337	16.10
Being Occupied for Free With Consent of Owner	51,529	17.17
Being Occupied for Free Without Consent of Owner	7,690	2.56
Not Reported	2,872	.96
Not Applicable	982	.33

2.4.3.1 Informal Settlers

Informal settlements in the City are brought about by the influx of migrants from rural areas in and around the City in search for better opportunities. Aside from having poor living conditions, they are also vulnerable to natural and human- made hazards.

An inventory of informal settlers in nine barangays of Davao City was done in 2012, initiated by the LGU's partner organizations such as the (i) Davao City Urban Poor Network (DC-UPNET), (ii) Hugpong Dabaw, (iii) Philippine Support Agencies (PHILSSA), along with Ateneo de Davao Institute of Socio-Economic Development Initiative. The results of the inventory showed that there were **16,517** settler-families in **9** barangays. Most of them occupy danger zones, followed by those dwelling in privately-owned lands. Please refer to **Table 2.4-6**. As shown in the table, Brgys. Talomo and Tigatto have the most number of informal settlers among the project-affected barangays. It is important to note here that none of the informal settlers in these areas will be affected by the Project. Based on preliminary site investigation only a few informal settlers in Brgy. Lasang will be impacted by the Project, which is not included on the list.

Various sectors have implemented various housing projects in response to the City's housing needs. Private developers in the city are active in the development of socialized, economic, aside from high-end residential subdivision projects. Aside from these, a number of urban poor community associations and non-government organizations are also able to implement land tenure security and housing projects through self-help and by accessing various socialized housing programs of key shelter agencies of the government.

Table 2.4-6 Inventory of Informal Settlers in 9 Barangays : 2012

Name of Barangays	Total Number of ISF	Landslide Prone Areas	Gov't Owned Properties	Privately Owned	Under the Bridge	Parks and Playground	Public Cemetery	Landfill/ Garbage Dump	Sidewalk	Coastline Shorelines	Canal Drainage	Riverbank Riverbed	Road Right of Way
1.Matina Aplaya	2,870		131	452					6	1,717	148	353	63
2.Matina Crossing	2,413	136	132	491	17		6	8	41		46	1,305	231
3.Matina Pangi	1,420	163	30	1,000								189	38
4.Bago Aplaya	1,694		42	1,418		4			6	1	16	147	60
5.Talomo	2,752	102	416			1		21	784	140	1,058	230	
6.Mintal	898	2	203	453			2		28		82	95	33
7.Tigatto	1,746	295	30	1,137							114	148	22
8.Indangan	673	12	1	659									1
9.Ilang	2,051			565				1	1	1,063	5	299	117
Total	**16,517**	**710**	**985**	**6,175**	**17**	**5**	**8**	**30**	**866**	**2,921**	**1,469**	**2,766**	**565**

The City Government of Davao has been actively responding to the need for housing of the underprivileged through different programs and projects. In 2007 these programs and projects were institutionalized through the approval of City Ordinance No. 014- 07 - Comprehensive Urban Shelter Services Development Code, also known as the Shelter Code of Davao City. The ordinance strengthened the LGU's tasks, as are mandated in R.A. 7279 or the Urban Development and Housing Act (UDHA) of 1992. It's main objective it to promote just, dynamic, and comprehensive land tenure security and urban services development program in cooperation with people's organization (POs), non-government organizations (NGOs), private sectors and other key shelter agencies.

In 2011, the City once again responded to the campaign of the Social Housing Finance Corporation (SHFC) for LGUs to participate in the implementation of the Localized Community Mortgage Program (LCMP)[1] . It was able to secure an approved Php50M Omnibus Commitment Line (OCL) that would secure land tenure of a significant percentage of the total housing backlog. However, midway during projects processing, the LGU decided to temporarily suspend the LCMP implementation to better prepare its own institutional capacity.

2.4.4 Water Supply

Out of its **182** barangays, **106** (**58.24%**) are served by Level III water supply system operated by the Davao City Water District (DCWD). The remaining **76** barangays are served by Level I and II water supply systems. There are **41,833** households in these **76** barangays being served by Level I and Level II water supply facilities. Please refer to **Table 2.4-7** for details. As shown in the table below, only small percentages of the households in Talomo, Bunawan, and Tugbok are served by Level I and II systems, compared to Toril.

[1] LCMP is a loan facility provided by Socialized Housing Finance Corporation (SHFC) to LGUs which will make available an initial omnibus commitment line amounting to P50M for cities and P20M for municipalities for land acquisition, site development and housing loan to qualified community association

Table 2.4-7 Project Barangays Served by Level I and Level II Water Supply Systems

District/Sub-District	Total No. of HH	Level I	%	Level II	%
District 1					
Talomo	88,903	1,477	1.7	1,099	1.2
District 2					
Buhangin	58,848	-	-	-	-
Bunawan	29,871	214	0.7	3,032	10.1
District 3					
Toril	30,623	7,126	23.3	7,997	26.1
Tugbok	20,888	690	3.3	1,344	6.4
TOTAL	229,133	9,507	4.1	12,472	5.4

Source: Davao City CLUP 2013-2022

2.4.5 Power Supply

Source of electric power supply - The Davao Light and Power Company (DLPC), which is a major provider in Davao Region distributes the power supply of Davao City. Among the other service providers, it is considered as the third largest privately-owned electric utility company in the Philippines. Davao City also has a standby diesel power plant with a capability of **46** MW for sustained operations. It is capable of supplying **19.86** per cent of electricity requirement of DLPC Despite the natural calamities and the adverse effect of climate change that hit the country. Currently, the total households served by DLPC is **213,461**, of which, **142,573** (**66.79%**) are located in the urban barangays of the city, while **70,888** (**33.21%**) are in rural areas. Based on the 2013-2022 CLUP, all project-affected barangays are fully energized.

2.4.6 Morbidity and Mortality Rates

2.4.6.1 Morbidity

Acute respiratory infection topped the list of the leading causes of diseases in Davao City for 2011-2012. Dengue cases have remarkably increased from **3,176** cases in 2008 to **7,326** in 2012, or an increase of about **130.67** percent. Respiratory diseases, pneumonia, diarrhea and healthy lifestyle-related diseases also remained prevalent. Though, malnutrition was included in the leading causes, it can be noted that it has decreased over the five year period. **Tables 2.4-8** (by Sex) and **2.4-9** shows morbidity rates for the past five (5) years.

Table 2.4-8 Ten Leading Causes of Morbidity, By Sex, 2012			
Causes	**Number**		**Total**
	Male	**Female**	
1. Acute Respiratory Infection (ARI)	7,879	8,547	16,426
2. Pneumonia	5,396	4,815	10,211
3. Dengue	3,703	3,623	7,326
4. Diarrhea & Gastroenteritis	2,968	2,553	5,521
5. Acute Respiratory Infection (AURI)	1,521	1,694	3,215
6. Urinary Tract Infection (UTI)	1,158	1,686	2,844
7. Essential Hypertension	851	1,341	2,292
8. Diseases of the Heart	922	979	1,901
9. Respiratory Tuberculosis	1,180	651	1,831
10. Malnutrition	888	890	1,778

Table 2.4-9 Ten Leading Causes of Morbidity, 2008-2011

2008		2009		2010		2011	
Causes	**Number**	**Causes**	**Number**	**Causes**	**Number**	**Causes**	**Number**
1. Pneumonia	6,052	Pneumonia	6,534	Pneumonia	8,258	Acute Respiratory Infection (ARI)	7,541
2. Acute Respiratory Infection (AURI)	5,962	Acute Respiratory Infection (AURI)	3,918	Dengue	7,425	Acute Respiratory Infection (AURI)	6,429
3. Diarrhea & Gastroenteritis	3,575	Acute Respiratory Infection (ARI)	3,261	Acute Respiratory Infection (ARI)	6,831	Pneumonia	6,335
4. Dengue	3,176	Diarrhea & Gastroenteritis	3,670	Acute Respiratory Infection (AURI)	5,228	Diarrhea & Gastroenteritis	4,662
5. Acute Respiratory Infection (ARI)	2,917	Dengue	3,435	Diarrhea & Gastroenteritis	4,205	Dengue	2,561
6. Malnutrition	1,932	Essential Hypertension	2,438	Essential Hypertension	2,198	Diseases of the Heart	2,163
7. Essential Hypertension	1,829	Malnutrition	2,147	Diseases of the Heart	2,077	Urinary Tract Infection (UTI)	1,932
8. Diseases of the Heart	1,670	Respiratory Tuberculosis	2,131	Respiratory Tuberculosis	1,819	Tonsillitis & Pharynsitis	1,631
9. Respiratory Tuberculosis	1,659	Diseases of the Heart	1,798	Urinary Tract Infection (UTI)	1,803	Respiratory Tuberculosis	1,577
10. Urinary Tract Infection (UTI)	1,383	Urinary Tract Infection (UTI)	1,768	Malnutrition	1,597	Essential Hypertension	1,214

2.4.6.2 Mortality

Cerebrovascular diseases, atherosclerosis & diseases of the heart are always in the top four causes of mortality. For the last five years, it can be observed that eight out of 10 leading causes of deaths remained prevalent (Please refer to **Tables 2.4-10** (by Sex) and **2.4-11**). Pneumonia, significantly surged from **404** deaths in 2008 to **1,049** deaths in 2012, or an increase of about **160** percent.

Table 2.4-10 Ten Leading Causes of Mortality, By Sex, 2012

Causes	Number		Total
	Male	Female	
1. Pneumonia	624	425	1,049
2. Cerebrovascular Diseases	616	403	1,019
3. Disease of the Arteries, Arterioles and Capillaris	362	500	862
4. Diseases of the Heart	525	320	845
5. Diabetes Mellitus	184	179	363
6. Renal Failure	203	112	315
7. Digestive Organs	136	158	294
8. Tuberculosis	225	54	279
9. Chronic lower respiratory diseases	158	50	208
10.Septicemia	111	75	186

Table 2.4-11 Ten Leading Causes of Mortality, 2008-2011

2008		2009		2010		2011	
Causes	**Number**	**Causes**	**Number**	**Causes**	**Number**	**Causes**	**Number**
1. Cerebrovascular Diseases	1,215	Cerebrovascular	1,243	Pneumonia	1,106	Pneumonia	1,143
2. Atherosclerosis	829	Diseases of the Heart	1,101	Cerebrovascular	1,068	Cerebrovascular	1,049
3. Diseases of the Heart	783	Atherosclerosis	966	Diseases of the Heart	873	Atherosclerosis	803
4. Unknown Diseases	419	Pneumonia	822	Atherosclerosis, Senile	775	Diseases of the Heart	779
5. Pneumonia	404	Diseases of Genito-Urinary System	575	Renal Failure	463	Renal Failure	392
6. Diseases of Genito-Urinary System	363	Diseases of Digestive System	401	Respiratory Tuberculosis	246	Diabetes Mellitus	329
7. Tuberculosis	354	Diabetes Mellitus	317	Septicemia	217	Septicemia	277
8. Assault	353	Other Diseases of the Respiratory System	236	Diabetes Mellitus	227	Respiratory Tuberculosis	250
9. Diseases of Digestive System	339	Cancer of the Digestive System	252	Malignant Neoplasm of Digestive Organ	199	Malignant Neoplasm of Digestive Organ	201
10. Diabetes Mellitus	296	Assault	251	Assault	198	Vehicular Accident	175

2.4.7 Environmental Health and Sanitation

2.4.7.1 Health

Davao City has an existing **160** Barangay Health Stations and **11** Satellite Health Stations out of its **182** barangays. This means that the BHS to population ratio is **1:9,034**, which is not conforming to the national standard of **1:5,000**. Of these, **73** are attached to other structures in the barangay either at a barangay hall or school. Some barangays without BHS are served by the BHS in the adjacent barangays.

Davao City has **16** Rural Health Units (RHU). The RHU to population ratio is calculated at **1:84,587**, which is way below the national standard of **1:20,000.** Currently, the **16** Main Health Centers or Rural Health Units are PhilHealth Accredited for Primary Care Benefit (PCB) Package, previously the Out-Patient Benefit (OPB) Package.

In terms of medical personnel there are **217** deployed in various RHUs/BHS, District Hospital and Birthing Facility. This consist of **14** doctors, **15** dentists, **68** nurses, **90** midwives, **14** Medical Technologists and **14** Sanitary Inspectors.

As shown in **Table 2.4-12**, there is a shortage of health personnel in all categories following the standard ratio of the Department of Health (DOH). That is, based on standard, the project affected sub-districts need to have **39** doctors. Currently, there are only 5 doctors, which mean that there is a deficiency of **34** doctors. To augment the number of health personnel, the city employed additional human resources and volunteer health workers. To date, there are **169** Barangay Nutrition Scholar (BNS) and **512** Barangay Health Workers (BHWs) delivering basic services to its respective barangays.

Table 2.4-12 Summary of Medical Health Personnel, by Administrative Districts, 2012

District	No. of Brgys.	Total Population	Physician	Actual Population Ration	Need (Standard 1:20,000)
1. Talomo	14	382,652	2	1:191,32	17
2. Buhangin	13	256,959	2	1:128,130	11
3. Bunawan	9	131,704	-		7
4. Toril	25	133,452	-		7
5. Tugbok	18	91,622	1	1:91,622	4
Davao City	79	966,389	5		39

In terms of medical facilities Davao City has **29** hospitals, of which **27** are privately owned while **2** are owned by the government. Most hospitals are located in the urban areas. Private Hospitals in Davao City have a total of **162** doctors, **1,476** nurses and **14** dentists with a bed capacity of **2,292**. Aside from hospitals, there are also **126** private lying-ins operating citywide.

Rural Health Units (RHUs) **-** At the RHU Level the minimum package of activity are provided. This is a mix of preventive and curative services complementary to other levels of care such as those provided in the hospital. This package includes the following:

(i) Ante Natal Care Post partum Care Immunization Family Planning Vitamin A Supplementation Growth Monitoring;

(ii) Minor Surgery Dental Services Laboratory Services Referral of cases Health Education Training;

(iii) Consultation & Treatment (Acute Respiratory Infection, Control of Diarrheal Diseases, TB, Cardiovascular Diseases); and

(iv) Surveillance Sanitation Services

Barangay Health Stations **-** The BHS also offers the same services with that of the RHU, except for the following: Dental, Laboratory, Consultation & Minor surgery considering that there is only 1 doctor, 1 dentist, & 1 medtech per RHU. To date, there is no BHS that is PHIC Accredited.

Table **2.4-13** shows a summary of the medical health facilities in the affected administrative districts.

Table 2.4-13 Summary of Medical Health Facilities, by Administrative Districts, 2012

Administrative District	No. Health Services/Facilities				
	No. of Brgys	No. of BHS	No. of RHU	Total	No. of Brgys without BHS/ RHU
1. Talomo	14	19	2	21	-
2. Buhangin	13	16	2	18	1
3. Bunawan	9	10	1	11	-
4. Toril	25	22	1	23	3
5. Tugbok	18	17	1	18	-
Davao City	82	84	7	91	4

2.4.8 Sanitation

As of 2012, out of the **308,976** households in the city, **271,577** households or **87.90** percent have sanitary toilets. However, the proportion of households with sanitary toilets is lower than DOH Target of **91%.** Most households without toilet are found in the coastal barangays of Buhangin, Toril and Agdao District and in the rural areas of Paquibato District. On the other hand, households with sanitary toilets are found in the urban barangays of Talomo, Buhangin and Poblacion District while those households with shared toilets are found in the urban barangays of Buhangin and Bunawan District. Please refer to **Table 2.4-14**.

Table 2.4-14 Number of Households in Occupied Housing Units By Type of Toilet Facilities and by Administrative District, 2012

Administrative District	Type of Toilet Facilities by Households											
	No. of Households, 2012	Water Sealed		Antipolo with Cover		Antipolo Without Cover		Share		No Toilet		Total
		No.	%	No.	%	No.	%	No.	%	No.	%	
Talomo	81,423	78,024	95.8	814	1.0	132	0.2	1,628	2.0	825	1.0	81,423
Buhangin	52,666	46,533	88.4	2,633	5.0	527	1.0	1,579	3.0	1,394	2.7	52,666
Bunawan	27,992	24,105	86.1	1,400	5.0	560	2.0	1,087	3.9	840	3.0	27,992
Toril	28,718	23,312	81.2	2,297	8.0	1,436	5.0	282	1.0	1,391	4.8	28,718
Tugbok	18,967	16,602	87.5	1,594	8.4	402	2.1	190	1.0	179	0.9	18,967
Davao City	**209766**	**188576**	**21.95**	**8,738**		**3,057**		**4,766**		**9,395**		**209766**

2.4.9 Crime Rate

In terms of index crime, of the total **7,153** crimes against persons from 2006 to 2012, more than half (**4,973** or **69.52%)** were attributed to physical injury, followed by murder (**1,448** or **20.24%**), Rape (**387** or **5.41%**) and Homicide (**345** or **4.82%**).

More crimes against property were reported than crimes against person with **17,535** cases. The number is taken from the sum of reports from 2006 to 2012. Theft topped the most common type of crime against property (**13,032** or **70.98%**) followed by Robbery (**4,969** or **27.06%**), Car napping (**337** or **1.84%**) and Cattle Rustling (**22** or **0.12%**). Most of the cases reported are in PS1 Sta. Ana (**3,065** or **30.59%**) followed by PS3 Talomo (**2,518** or **25.13%**). Please refer to **Table 2.4-15**.

Table 2.4-15 Index Crime, by Police Station,2006-2012

Police Station (PS)	2006-2012											
	Crime Against Person						Crime Against Property					
	Murder	Homicide	Physical Injury	Rape	TOTAL	% by PS	Robbery	Theft	Carnapping	Cattle Rustling	TOTAL	% by PS
PS 1, Sta. Ana	217	25	969	49	1,260	17.61%	767	4,085	32	0	4,884	27.85%
PS 2, San Pedro	193	48	509	21	771	10.78%	622	2,622	72	0	3,316	18.91%
PS 3, Talomo	391	39	1,125	70	1,625	22.72%	1,766	2,265	133	2	4,166	23.76%
PS 4, Sasa	106	28	224	28	386	5.40%	254	600	1	0	855	4.88%
PS 5, Buhangin	116	17	301	48	482	6.74%	302	456	33	0	791	4.51%
PS 6, Bunawan	69	17	402	54	542	7.58%	141	245	4	0	390	2.22%
PS 7, Paquibato	64	30	71	9	174	2.43%	11	33	0	0	44	0.25%
PS 8, Toril	107	42	438	8	595	8.32%	275	798	28	5	1,106	6.31%
PS 9, Tugbok	83	47	433	8	571	7.98%	334	749	7	10	1,100	4.01%
PS 10, Calinan	52	19	383	16	470	6.57%	169	515	19	1	704	0.49%
PS 11, Baguio	11	8	63	20	102	1.43%	16	59	7	4	86	0.48%
PS 12, Marilog	35	25	53	5	118	1.65%	52	32	1	0	85	0.05%
IDMS/WCCD	4	0	2	51	57	0.80%	3	5	0	0	8	0.00%
AVU	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%
DEU	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%
Total	1,448	345	4,973	387	7,153	100.00%	4,712	12,464	337	22	17,535	100.00%
% by Crime	20.24%	4.82%	69.52%	5.41%	100.00%		26.87%	71.08%	1.92%	0.13%	100.00%	

2.4.9.1 Women and Children Protection

Davao City have Women and Children Protection Desk (WCPD) that handles cases involving children and women. Identified cases are of three types namely: (i) Cases Against Children (CAC), (ii) Cases Against Women (CAW), and (iii) Crimes Involving Children in Conflict with the Law (CICL). Most of the cases reported are coming from PS1 Sta. Ana. Please see **Table 2.4-16**.

Table 2.4-16 WCPD Crime Report, Davao City, 2006-2011

Police Stations	2006-2011					
	CAC	Percent	CAW	Percent	CICL	Percent
PS 1, Sta. Ana	2,099	44.35%	2,624	34.50%	2,114	34.57%
PS 2, San Pedro	169	3.57%	237	3.12%	166	2.71%
PS 3, Talomo	630	13.31%	643	8.45%	853	13.95%
PS 4, Sasa	521	11.01%	1,050	13.81%	977	15.97%
PS 5, Buhangin	283	5.98%	688	9.05%	685	11.20%
PS 6, Bunawan	257	5.43%	514	6.76%	351	5.74%
PS 7, Paquibato	17	0.36%	7	0.09%	0	0.00%
PS 8, Toril	284	6.00%	658	8.65%	223	3.65%
PS 9, Tugbok	132	2.79%	375	4.93%	104	1.70%
PS 10, Calinan	229	4.84%	602	7.925	583	9.53%
PS 11, Baguio	40	0.85%	103	1.35%	37	0.60%
PS 12, Marilog	72	1.52%	104	1.37%	23	0.38%
Total	4,733	100.00%	7,605	100.00%	6,116	100.00%

2.4.9.2 Threat Groups

In 2010, PNP reported that out of **182** barangays in the city, **10** barangays were categorized as less influenced, two were influenced and **24** barangays were threatened by Armed Groups with ideological leaning (e.g. Communist Party of the Philippines (CPP)-National Democratic Front (NDF)-National People's Army (NPA))

The following barangays are being monitored due to the presence of the Moro Islamic Liberation Front (MILF) and the Moro national Liberation Front (MNLF):

Table 2.4-17 List of Barangays Affected by Threat Groups, 2010			
Administrative District	**Affected Barangays**		
	Influenced	**Less Influenced**	**Threatened**
Paquibato	Mapula	Pañalum	Malatiyas
	Lumiad	Malabog	Fatima
		Padaitan	Colosas
		Paradise Embak	Tapak
Buhangin			Acacia
			Cabantian
			Mandug
Bunawan			Mahayag
			Lasang
Toril			Baracatan
			Eden
			Marapangi
			Tagluno
			Sibulan
Marilog		Malamba	Gumitan
		Tamugan	Salumay
			Salaysay
			Magsaysay
			Dalag
Baguio			Carmen
Calinan		Dalagdag	
		Dominga	
Talomo		Magtuod	
Tugbok			Manambulan
			Talnadang
			Sanhay
			Tagakpan
Total	**2**	**10**	**24**

2.4.9.3 Sports and Recreation

The City has public and private venues and facilities for indoor and outdoor recreation as well as activities such as athletics and other sports. These are located in the Central Business District and in the outskirts of the city. The City-owned Davao City Recreational Center (Almendras Gym) has been a venue of various events such as sports tournament and assemblies. Public sports and recreational facilities are accessible to all. On the other hand, private recreational facilities are available for a fee through membership in sports club and associations. Local athletes are trained through schools and membership in Sports Clubs. **Table 2.4-18** shows a summary of existing sports and recreational facilities in the project-affected administrative units.

Table 2.4-18 Summary of Existing Sports and Recreational Facilities by Administrative District, Year 2011

Sports & Recreational Facilities	Talomo	Bunawan	Buhangin	Toril	Tugbok
Billiard Table	65	4	29	16	4
Billiard Hall	25	4	10	7	3
Bowling Alleys					
-Automatic Lanes	24				
-non-automatic					
Badminton Center	1				
Swimming Pools			8		
Tennis Court	1		2	1	1
Open Field					
Soccer Field/ soft Ball					
Covered Courts*	30	5	6	5	4
Basketball Courts*	15		2		
Open Courts*				1	1
Gymnasium			1		
Fitness gym	3		1	1	
Martial Arts Gym					
Video Games Machine	241				
Movie Houses	10				
Ornamental/ Botanical	28		7	2	6
Cockpit	1		1	1	1
Golf Course			1		
Butterfly Park	1				
Beach Resort			2		
Resort/ Mountain Resort	22			10	1
Total	**467**	**13**	**73**	**44**	**32**

2.4.9.4 Socio-economic Profile of Project-Affected Persons Based on Survey

The Davao City Bypass will traverse five (5) sub-districts with 23 barangays in Davao City and one (1) barangay in Panabo City, Davao del Norte. Details are shown in **Table 2.4-19** below. It is interesting to note that out of the 23 barangays to be traversed by the Project, 22 are classified as urban barangays. The lone rural barangay, is Matina-Biao of District 1, Tugbok Sub-District.

In accordance with the latest Comprehensive Zoning Ordinance of Davao City 2013-2022, and as defined by the National Statistical Coordination Board (NSCB) an area is classified as an urban barangay:

(i) If a barangay has a population size of 5,000 or more, or

(ii) If a barangay has at least one establishment with a minimum of 100 employees, or

(iii) If a barangay has 5 or more establishments with a minimum of 10 employees, and 5 or more facilities within the two-kilometer radius from the barangay hall.

Table 2.4-19 Areas Traversed by the Davao City Bypass Project

	No.	Barangays
DAVAO CITY		
District 1		
Toril Sub-District	7	Sirawan, Marapangi, Bato, Mulig, Alambre, Bangkas Heights, Lubogan
Tugbok Sub-District	4	Mintal, Tugbok Proper, Tacunan, Matina-Biao
District 2		
Talomo Sub-District	2	Catalunan Grande, Magtuod
District 3		
Buhangin Sub-District	5	Cabantian, Indangan, Communal, Tigatto, Waan
Bunawan Sub-District	5	Mahayag, San Isidro, Lasang, Mudiang, Tibungco
DAVAO DEL NORTE		
Panabo City	1	J. P. Laurel
Total	**24**	

Population of project-affected barangays is shown on **Table 2.4-20**. As observed from this table the most populous barangays are: Catalunan Grande, Tibungco, and Cabantian. It is important to note at this point that the Bypass alignment is located away from settlement areas where the majority of the populace resides.

Table 2.4-20 Population of Project-Affected Barangays

City	District	Sub District	Barangay	Population
Davao	First	Talomo	Catalunan Grande	30,068
			Langub	2,677
			Magtuod	3,015
	Second	Bunawan	Lasang	8,851
			San Isidro	4,260
			Mahayag	4,914
			Tibungco	36,416
			Mudiang	2,570
		Buhangin	Indangan	9,133
			Communal	7,403
			Cabantian	43,351
			Tigatto	14,533
			Waan	3,179
	Third	Tugbok	Matina Biao	1,340
			Tacunan	3,093
			Tugbok Proper	9,107
			Mintal	12,518
			Bago Oshiro	8,305
		Toril	Mulig	2,101
			Alambre	1,620
			Bangkas Heights	7,191
			Lubogan	9,719
			Bato	7,133
			Marapangi	6,128
			Sirawan	5,792
Panabo			J.P Laurel	5,816

2.4.9.5 Household Size and Household Structure

Majority of Project-Affected Persons' (PAPs) have household size between **0-3** (**45.8%**) and **4** to **6** (**36.8%**), which is consistent with data obtained from the CLUP, which gave **4.2** as the average household size of families residing in urban barangays.

Table 2.4-21 PAP's Household Size

Household Size	Number	Percent
0 to 3	92	45.77
4 to 6	74	36.82
7 to 9	24	11.94
10 and more	11	5.47
Total	**201**	**100.00**

In terms of household structure, majority has households consisting of parents and children (nuclear) living together, with **116** respondents, or **57.7%.** This is followed by those living with parents and/or siblings, or extended families, with **18.4%.** There are also a significant number of PAPs living alone (**9.5%**), and households living in one structure (joint).

Table 2.4-22 PAP's Household Structure

Household Structure	Number	Percent
Single	19	9.45
Nuclear	116	57.71
Extended	37	18.41
Joint	29	14.43
Total	**201**	**100.00**

2.4.9.6 Ethno-Linguistic Affiliation

The most common dialect spoken by PAPs is Bisaya/Binisaya. It is the mother tounge of **52.7%** of the respondents. It is followed by '*Cebuano*" with **26.9%**., then by "*Boholano*" with **5.0%**, and *Hiligaynon/Ilongo* with **4%.** The remaining **15.4%** are shared among the "*Davaweño*" and "*Tagalog*," "*Ilocano*" dialects. Please refer to **Table 2.4-23**.

Table 2.4-23 PAP's Ethno Linguistic Affiliation		
Ethno Linguistic Affiliation	**Number**	**Percent**
Bisaya/Binisaya	106	52.74
Cebuano	54	26.87
Boholano	10	4.98
Davaweño	7	3.48
Hiligaynon/ Ilongo	8	3.98
Tagalog	9	4.48
Ilocano	2	1.00
Others	5	2.49
Total	**201**	**100.00**

2.4.9.7 Residency of PAPs

More than half of the respondents (**45.3%**) stated that they have been residents of the area from the 1990's and 2000's. There are also a significant number of respondents who have been residing in the area from the **40**'s to the **60**'s (**26.9%**).

Table 2.4-24 PAP's Length of Stay		
Length of Stay	**Number**	**Percent**
1930's	3	1.49
1940's	13	6.47
1950's	20	9.95
1960's	21	10.45
1970's	33	16.42
1980's	20	9.95
1990's	34	16.92
2000's	57	28.36
Total	**201**	**100.00**

2.4.9.8 Socio-Economic Status

PAPs' standard of living and socioeconomic status is evaluated using the following indicators: (i) primary source of income, (ii) tenure on land occupied; (iii) access to basic social services ---source of lighting, water supply, toilet facilities, health and educational facilities and (iv) poverty threshold.

Table 2.4-25 presents the primary source of income of the respondents. As shown on the table, the main source of income is farming (**26.4%**), followed by own business (**22.9%**), and professional practice (**15.9%**).

Table 2.4-25 PAP's Primary Occupation

Primary Occupation	Number	Percent
Farming	53	26.37
Skilled and Unskilled	17	8.46
Professional Practice	32	15.92
Own Business	46	22.89
Agricultural Product	7	3.48
Pension	6	2.99
Others	4	1.99
None	36	17.91
Total	**201**	**100.00**

Majority of the PAPs (**79.1%**) own their land; the rest are tenants (**7.5%**), occupying land with permit (**7.0%**). Distribution of type of land tenure is presented in **Table 2.4-26**.

Table 2.4-26 PAP's Tenure on Land

Tenure	Number	Percent
Owner	159	79.10
Tenant	15	7.46
Free Occupation with Permit	14	6.97
Free Occupation Without Permit	1	0.50
Lessee	8	3.98
Others	4	1.99
Total	**201**	**100.00**

In terms of educational attainment, result shows that majority of respondents for both sexes have no formal schooling with **33.8%** for husbands, and higher for females with **49.3%**. Please see **Tables 2.4-27** and **2.4-28.**

Table 2.4-27 PAP's Educational Attainment Husband		
Educational Attainment Husband	**Number**	**Percent**
Primary	27	13.43
Secondary	40	19.90
Tertiary	37	18.41
Post Graduate	7	3.48
None	68	33.83
No Answer	22	10.95
Total	**201**	**100.00**

Table 2.4-28 PAP's Educational Attainment Wife		
Educational Attainment Wife	**Number**	**Percent**
Primary	25	12.44
Secondary	21	10.45
Tertiary	36	17.91
Post Graduate	4	1.99
Vocational	1	0.50
None	99	49.25
No Response	15	7.46
Total	**201**	**100.00**

Table 2.4-29 shows that majority of interviewed PAPs source of drinking water are from Level III (**46.8%**), Level II (**34.8%**) water supply systems. In terms of source of lighting, majority, or **78.6%** are serviced by the Davao Light and Power Corporation (DLPC); **10.5%** admitted they obtain power from illegal connections, some still utilize kerosene lamps, and the rest are either using oil lamps, and petromax (Please see **Table 2.4-30**).

For their health needs **50.3%** depend on barangay health centers. A few (**11.9%**) go to hospitals, and the rest access private clinics and hospitals (**Table 2.4-31**). In terms of sanitation, majority or **68%** use semi-flush toilet facilities, **25%** with flush facilities, and a few still using the Antipolo and open pit type (**Table 2.4-32**). For their mode of transportation, the top three answers are: (i) tricycles and pedicabs (**59.7%**), and (ii) jeep, bus, and tricycle (**15.9%**), and (iii) jeepney (**12.4%**), which accounts for **88%** of total respondents. (**Table 2.4-33**).

Table 2.4-29 PAP's Source of Water for Drinking

Water for Drinking	Number	Percent
Level 1	16	7.96
Level II	70	34.83
DCWD (Level III)	94	46.77
Spring Box	3	1.49
Illegal Connection	2	1.00
Privately owned well	3	1.49
Others	8	3.98
None	5	2.66
Total	**201**	**100.00**

Table 2.4-30 PAP's Source of Power

Source of Power	Number	Percent
Davao Light & Power Corp.	158	78.61
Kerosene Lamp	7	3.48
Petromax	1	0.50
Oil Lamp	2	1.00
Illegal Connection	21	10.45
None	12	5.97
Total	**201**	**100.00**

Table 2.4-31 PAP's Type of Health Facility		
Type of Health Facility	**Number**	**Percent**
Health Center	101	50.25
Private Clinic	16	7.96
Hospital	24	11.94
Center & Clinic	17	8.46
All	14	6.97
Others	3	1.49
None	26	12.94
Total	**201**	**100.00**

Table 2.4-32 PAP's Toilet Facility		
Toilet Facility	**Number**	**Percent**
Open Pit	4	2.00
Antipolo	4	2.00
Semi-flush	136	68.00
Flush	50	25.00
None	5	2.50
Not Applicable	1	0.50
Total	**201**	**100.00**

Table 2.4-33 PAP's Mode of Transportation		
Mode of Transportation	**Number**	**Percent**
Jeepney	25	12.44
Tricycle/Pedicab	120	59.70
Jeepney, Bus, Tricycle	32	15.92
Habal-Habal	20	9,95
Taxicab	4	1.99
Total	**201**	**100.00**

As shown in **Table 2.4-34** a relatively high percentage of the surveyed households (**66.7%**) are earning above the poverty threshold – **P 17,040** for a family of four (4) in Region XI DAVAO Region. The **20.9%** are living below the poverty food threshold. Available skills of male and female respondents are shown in **Table 2.4-35** and **Table 2.4-36**, respectively. As shown in in these tables, **23.4%** of the male respondents can be tapped for local labor requirements during construction phase. In terms of female respondents majority or **49.8%** can engage in small enterprises such as eateries during construction period to be able to augment their family income.

Table 2.4-34 Poverty Threshold Among PAPs

Poverty Threshold	Number	Percent
Above poverty threshold	134	66.67
Below poverty threshold but above food threshold	25	12.44
Below food threshold	42	20.90
Total	**201**	**100.00**

Table 2.4-35 PAP's Available Skills of Men

Available Skills of Men	Number	Percent
Labor	47	23.38
Carpentry	35	17.41
Masonry	6	2.99
Heavy equipment Operator	2	1.00
Mechanic	4	1.99
Driving	55	27.36
Utility and others	16	7.96
None	36	17.91
Total	**201**	**100.00**

Table 2.4-36 PAP's Available Skills Women		
Available Skills of Women	**Number**	**Percent**
Cook/Maintenance	100	49.75
Sewer	18	8.96
Timekeeper/Clerk	7	3.48
Seedling Nursery Caretaker	11	5.47
House help	19	9.45
Others	21	10.45
None	25	12.44
Total	**201**	**100.00**

When asked if they were in favor of the Davao Bypass project, a significant majority (**83.1%**) responded "Yes". Among the reasons cited, the following were mentioned the most number of times:

For "Yes" answer:

(i) It will bring economic development to the City;

(ii) Better accessibility; and

(iii) It will improve living conditions in the barangay

For "No" answer:

(iv) It will entail loss of land and livelihood derived from it

Table 2.4-37 PAP's In Favor of Project		
In Favor of Project	**Number**	**Percent**
Yes	167	83.08
No	34	16.92
Total	**201**	**100.00**

When asked if they have other concerns about the project, the following are the top answers:

(i) Just compensation for lost assets;

(ii) Early compensation for affected properties ad crops;

(iii) Implement livelihood programs; and

(iv) That the project be implemented soon

3 ENVIRONMENTAL RISK ASSESSMENT

3.1 ENVIRONMENTAL RISK ASSESSMENT

3.1.1 Safety Risks

3.1.1.1 Pre-Construction Phase

There is no expected safety risks during the Pre-Construction Stage of the proposed bypass project.

3.1.1.2 Construction Phase

During this phase, there is no expected safety risks in terms of explosion since construction of the tunnel section will not employ blasting activities.

3.1.1.3 Operational Phase

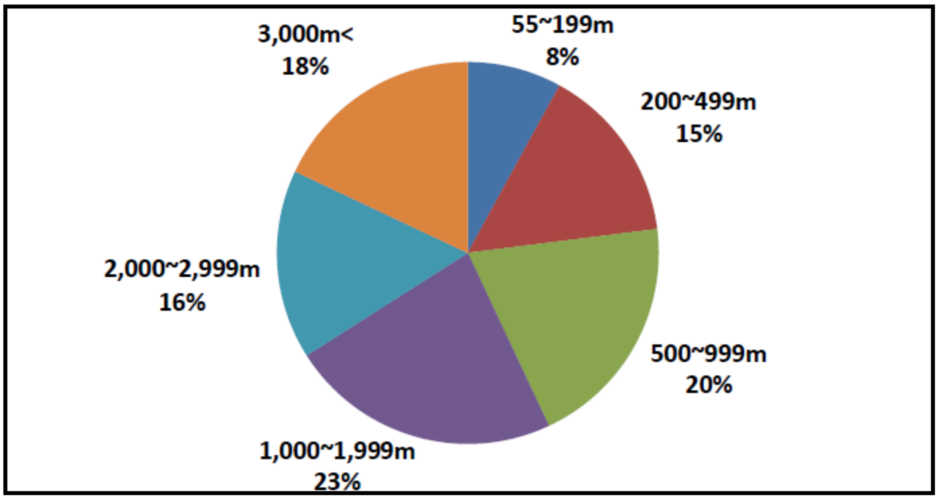
Fire is the most common accident that occurs inside a two-way tunnel in Japan. To prevent incidence of fire in the proposed tunnel section of the Davao City Bypass Project, lorries carrying oil and other flammable chemicals shall not be allowed to use the tunnel, as well as motorbikes and tricycles.

In Japan, an evacuation tunnel is provided for a tunnel with more than **3,000 m**. The Study Team proposes to provide an **evacuation tunnel** (please refer to **Figure 7.2.2-1 Chapter 7** of this EIS Report) for the Davao City Bypass tunnel, although its length is less than **3,000 m** to secure higher safety for road users during emergency cases.

(1) Fire Incident Inside the Tunnel

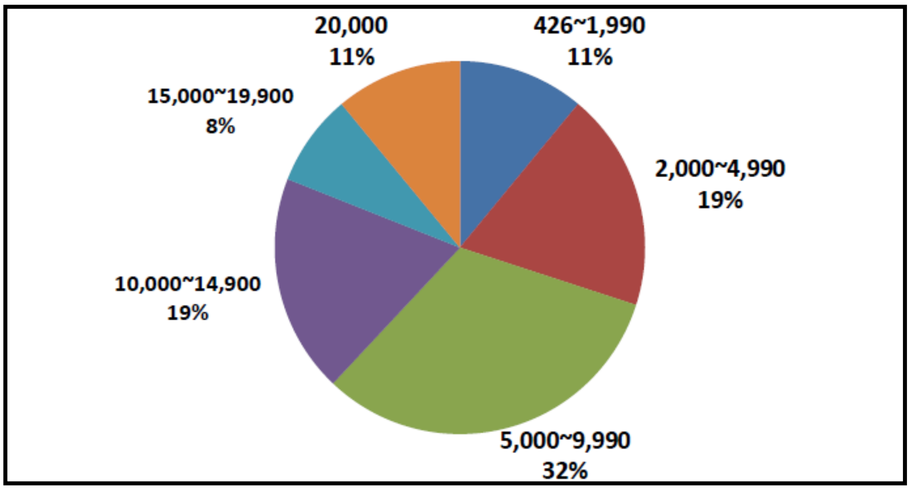
From 1960 to 2000 (**40 years**), there are about **94 reported** incidents of fire inside a **2-lane 2-way** tunnel in Japan.

Figure 3.1-1 shows that even at a short distance tunnel, fire incidents occur. As depicted in **Figure 3.1-2**, about **60%** of fire incidents occurred at a tunnel with traffic volume of less than **10,000 vehicles/day**.



Source: JICA Study Team

Figure 3.1-1 Fire Incidents vs. Tunnel Length



Source: JICA Study Team

Figure 3.1-2 Fire Incidents vs. Traffic Volume

3.1.2 Physical Risks

Failure of the structures, particularly the tunnel section of the bypass is not expected to occur, since design of the tunnel structure is based on the most advanced technology in tunnel construction in Japan.

4 IMPACTS MANAGEMENT PLAN

The Impact Mitigation Plan (IMP) presented in **Table 4.1** in this chapter are the significant impacts that may arise during the Pre-Construction, Construction, and Operational Phases of the proposed Davao City Bypass Construction Project. Also discussed in the matrices are the responsible entities who will manage the identified impacts.

This Plan shall be updated and finalized during the DED Stage so that any change in the design/configuration of the bypass alignment and its components – roadway section, tunnel section and bridge structures can be incorporated in the final IMP.

Table 4-1 Impact Management Plan (1/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE LAND						
Detailed Engineering Design (DED)	**Geology** (*Ground Shaking*)	Generation of high magnitude earthquakes, given that Davao City is in the fringes of an active seismic zone with known earthquake generators	• Conduct a site specific Probabilistic Seismic Hazard Assessment (PSHA) to determine the site specific Design Based Earthquake (DBE); and • Given the tectonic/seismic framework, ground acceleration coefficient in the area can be higher than the standard set by the NSCP especially in soft soil	DPWH and DED Consultant DPWH and the ESHO of the Contractor, in close coordination with the Multi-Partite Monitoring Team (MMT)	To be included in the project cost to be finalized during the DED	Environmental Guarantee Fund (EGF)/Quick Response Fund (QRF) and Contractor's All Risk Insurance (CARI) will be tapped for compensation of damages resulting from accidents/ untoward incidents
Detailed Engineering Design (DED)	**Geology** (*Liquefaction*)	Incidence of liquefaction given the presence of subsurface materials with potential to liquefy (e.g. loose, unconsolidated sediments with shallow water table) in the alluvial and coastal plains traversed by the road corridor	• Conduct a site specific Liquefaction Susceptibility Analysis (LSA), which will take into consideration the result of a site specific PSHA; and • Results of the LSA and PSHA shall be consideration in the design of the foundation for the bridges and tunnel of the project	DPWH and DED Consultant	To be included in the project cost to be finalized during the DED	Environmental Monitoring Fund (EMF) must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (2/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE LAND						
Detailed Engineering Design (DED)	**Geology** (*Liquefaction*)	Incidence of liquefaction during earthquake at bridge sites underlain by alluvial sandy layer	• Results of the geo-technical survey undertaken showed that **BH-17** to **BH-20** shall be considered for soil liquefaction assessment; • A more detailed geo-technical test following the specification for soil liquefaction shall be undertaken during the DED stage	DPWH and DED Consultant	To be included in the project cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
		Incidence of liquefaction-induced lateral movement, particularly at ground with a sandy layer thicker than **5 m**	• Results of the geo-technical survey undertaken showed that **BH-18** to **BH-20** shall be consider for soil liquefaction assessment; • A more detailed geo-technical test following the specification for soil liquefaction shall be undertaken during the DED stage; • Adopt remediation measures that aims to increase the soils liquefaction resistance through densification, increase its strength, and/or improving its drainage. The most common remediation measures are as follows: ➢ Surcharge; ➢ Drains; ➢ Compaction Piles; and ➢ Deep Soil-Cement Mixing Methods	DPWH and DED Consultant	To be included in the project cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (3/27)

Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE LAND						
Detailed Engineering Design (DED)	**Geology** (*Soil Compressibility*)	Compressible materials present at the site could be subjected to settlement due to elastic deformation (upon load application) and or compression, particularly at fill/embankment sections and bridge sites	• A site specific LSA must be undertaken to determine which layer will likely experience soil compressibility and by how much (in meters) for a given earthquake magnitude	DPWH and DED Consultant	To be included in the project cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Detailed Engineering Design (DED)	**Geology** (*Fault Rupture and Creep*)	Occurrence of fault rupture and creep due to presence of pre-existing fault lines in the areas traversed by the bypass route corridor	• Undertake a detailed assessment of the identified geological lineaments bisecting the critical components of the project (e.g. tunnel and bridge structures) to determine their potential to movement in the event of a high magnitude earthquake.	DPWH and DED Consultant	To be included in the project cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Tree cutting and site clearing along the 40**-60 m** RROW Tree cutting and site clearing along the riparian areas in preparation for the bridge structures Tree cutting and site clearing at the exit and entrance of the tunnel section	**Terrestrial Ecology** (*Flora*)	Loss of natural vegetation cover	• "Permit To Cut" will be secured from DENR-FMB Region XI prior to any tree cutting activities; • Site clearing and construction works shall be limited within the required **40-60 m** RROW to avoid unnecessary cutting of trees; • Cut trees will be surrendered to DENR-FMB Region XI for inventory;	DPWH and Contractor	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (4/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE LAND						
Tree cutting and site clearing along the **40-60 m** RROW Tree cutting and site clearing along the riparian areas in preparation for the bridge structures Tree cutting and site clearing at the exit and entrance of the tunnel section	**Terrestrial Ecology** (*Flora*)	Loss of secondary type of vegetation cover	• Cut trees will be considered for re-use. Cut vegetation spoils shall be disposed to sites designated by the CENRO of Davao City and Panabo City • Tree planting shall be undertaken at sites designated by the DENR-FMB Region XI. Replacement ratio of removed naturally growing trees shall be **1:100**, strictly with indigenous species among others *Vitex parviflora* (Molave), *Drynaria quercifolia* (Kabkab/Oak-leaf Fern) *Pterocarpus indicus echinus* (Prickly Narra), *Pterocarpus indicus indicus* (Smooth Narra), Cananga odorata (Ilang-ilang), *Lygodium flexuosum* (Nito), and *Diplodiscus paniculatus* (Balobo); • To facilitate the implementation of tree replacements, seedling donation and identification of common planting sites shall be encouraged. All donated seedlings shall be turned-over to CENROs of Davao City and Panabo City for proper documentation; and • Quarterly inspection of the tree planting site/s must be carried out to monitor if survival of the species introduced reached the required **85-90%**	DPWH and Contractor	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (5/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE LAND						
Tree cutting and site clearing along the **40-60 m** RROW	**Terrestrial Ecology** (*Flora*)	Loss of planted trees, agri-industrial trees such as coconut, and high-value commercial trees such as banana, mango, durian pomelo, rambutan, lanzones mangosteen, and papaya	• "Permit To Cut" will be secured from the Philippine Coconut Authority (PCA) prior to any coconut tree cutting activity; • Tree cutting will be limited to the required **40-60 m** RROW; • Compensation of coconut trees will be in accordance to existing guidelines of the PCA; and • Replacement ratio for every coconut tree cut shall be **1:1**; • Replacement ratio of planted trees shall be **1:50**, preferably indigenous species or fast growing species such as *Gmelina arborea* (Gmelina), *Acacia auriculiformis* (Japanese acacia), *Acacia mangium* (Mangium), and *Swietenia mahagoni* (Common mahogany); • Compensation of planted trees, commercial fruit-bearing trees and other cultivated agricultural crops shall be in accordance with the prevailing market values from the Department of Agriculture (DA) and concerned City Assessor's Office (CAO)	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (6/27)

Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE PEOPLE						
ROW acquisition along the bypass alignment	**Assets and Properties**	Loss of private lands	• Acquisition of private properties will be limited to the required **40-60 m** RROW; and • Prompt payment of compensation at fair market values for land (DPWH R.A. 8974)	DPWH in close coordination with the City Governments of Davao and Panabo	To be included in the Final RAP Budget	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327
		Loss of agri-industrial farm lands planted to coconut and agricultural lands grown with banana, mango, durian, and other high-value commercial crops	• Acquisition of private properties will be limited to the required **40-60 m** RROW; and • Prompt payment of compensation at fair market values for land (DPWH R.A. 8974)	DPWH in close coordination with the City Governments of Davao and Panabo	To be included in the Final RAP Budget	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327
		The propose bypass alignment will hamper the **3-year** mine development plan of Holcim Philippines in Bunawan Sub-District (i.e. Brgy. Indangan, Mudiang, Tibungco, Mahayag, and San Isidro)	• Coordination with the Holcim management have been initiated during the conduct of the Feasibility Study (FS); • Close coordination with the Holcim management will be undertaken to resolve RROW issue along Holcim's existing mine tenement area • Re-alignment of the bypass alignment shall be considered during the DED; and • During the DED suggestion raised by the Holcim representatives during the consultation meeting to consider re-alignment of the bypass section to the mined out areas will be studied	DPWH in close coordination with the Management of Holcim Philippines	To be finalized during the DED	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327

Table 4-1 Impact Management Plan (7/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE PEOPLE						
ROW acquisition along the bypass alignment	**Assets and Properties**	Encroachment of the bypass section to the UP Mindanao Campus in Brgy. Mintal	• Compensation of the affected government-owned property will be based on the inter-agency agreement between DPWH and DepEd (UP Mindanao)	DPWH and Contractor in close coordination with UP and DepEd	To be included in the Final RAP Budget	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327
	Formal Structures	Displacement of residential and commercial structures	• Limit acquisition within the **40-60 m** RROW to minimize displacement of residential and commercial structures; and • Prompt payment of compensation at replacement cost for structures (DPWH R. A. 8974)	DPWH in close coordination with the MMT	To be included in the Final RAP Budget	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327
	Informal Structures	Possible displacement of informal structures in Brgy. Lasang (along the Lasang River)	• If possible provide in-city relocation to avoid disruption of livelihood activities and social networks; • Assist the informal settler (IS) families access Community Mortgage Program (CMP) for the relocation house and lot; and • Cash compensation at replacement cost as defined in the Implementing Rules and Regulations (IRR) of R.A. 8974	DPWH in close coordination with the MMT	To be included in the Final RAP Budget	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327

Table 4-1 Impact Management Plan (8/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
I. PRE-CONSTRUCTION PHASE						
THE PEOPLE						
ROW acquisition along the bypass alignment	**Institutional Structures**	Possible displacement of institutional structures (Sto. Niño Chapel in Brgy. Tigatto and San Isidro Piatos in Brgy. Mahayag)	• Re-alignment of sections affecting institutional structures will be considered; and • Relocation and relocation/ reconstruction of affected institutional structures will be undertaken in the soonest possible time; and • Cash compensation at replacement cost as defined in the Implementing Rules and Regulations of R. A. 8974	DPWH and Contractor in close coordination with the MMT, church leaders and concerned community leaders	To be included in the Final RAP Budget	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327
	Government-Owned Structures	Possible displacement of government-owned structures (DA ROS Livestock and Poultry Development Farm, Small Ruminance Multiplier Farm) in Brgy. Bago Oshiro, Davao City	• Compensation/restoration of the affected government-owned structures will be based on the inter-agency agreement between DPWH and the concerned government agency	DPWH and Contractor in close coordination with the concerned government agency	To be finalized during the DED	EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
	Income	Loss of income of tenant farmers	• Implementation of the Livelihood Restoration and Improvement Program designed during RAP Finalization in DED stage	DPWH in close coordination with the MMT, and City Governments of Davao and Panabo	To be included in the Final RAP Budget	RAP Budget can be adjusted to accommodate changes after DED--- in accordance with DPWH D.O. 5 and 327

Table 4-1 Impact Management Plan (9/27)

Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE LAND						
Excavation works and slope cutting activities	**Geology** *(Slope Stability: Landslide, Soil Erosion, and Rock Fall)*	Occurrence of slope failure, soil erosion, and rock fall at high cut sections due to cut (stress release), weathering, erosion and water infiltration	• Planting along cut slope sections utilizing the following: ➢ Sowing when the slope gradient is 1.0:1.0 or less; ➢ Vegetation base material spraying when the slope gradient is from 0.5:1.0 to 1.0:1.0; ➢ Vegetation mat when the slope gradient is 0.8:1.0 or less (gentle); ➢ Vegetation sandbag to prevent soil erosion by planting the inside of "Grating Crib Works using Precast Blocks"; ➢ Sodding when the slope gradient is 1.0:1.0 or less (gentle) and ➢ Planting of sapling (landscaping when the slope gradient is 1.4:1.0 or less (gentle) • Construction of appropriate protection structures on different slope types such as the following: ➢ Mortar/concrete spraying (shotcrete) at rock slopes; ➢ Grouted riprap at steep soil slopes; ➢ Concrete pitching at steep rock slopes	DPWH, DED Consultant, and Contractor	To be included in the project cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (10/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE LAND						
Excavation works and slope cutting activities	**Geology** *(Slope Stability: Landslide, Soil Erosion, and Rock Fall)*	Occurrence of slope failure, soil erosion, and rock fall at high cut sections due to cut (stress release), weathering, erosion and water infiltration	• Construction of appropriate protection structures on different slope types such as the following: ➢ Grating crib works using precast blocks at sandy soil slopes when slope gradient is 1.0:1.0 or less (gentle); ➢ Grating crib works using shotcrete at soil and rock slopes; ➢ Stone/rubble-concrete masonry underneath of soil and rock slopes; ➢ Mat gabion underneath of soil slopes where the spring water is present; ➢ Rock bolt type anchor combined with grating crib works; and ➢ Ground anchor combined with grating crib works	DPWH, DED Consultant, and Contractor	To be included in the project cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
THE WATER						
Embankment works and related construction activities along flood-prone areas such as Brgy. Tigatto	**Hydrology** (*Flooding*)	Aggravation of existing flooding condition caused by localized flood	• Construction of sufficient and temporary drainage facilities to ensure unhampered flow of rain water to prevent localized flooding during high precipitation periods; and • Construction spoils and debris will be regularly hauled to sites designated by the CENRO of Davao City and Panabo City so as not to cause clogging of waterways, especially during high precipitation periods	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (11/27)						
Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE WATER						
Pile driving along river beds Construction of the bridge structures, foundation works, and related activities	**Water Quality**	Increase in turbidity	• Unavoidable but temporary in nature. Clarity of water is expected to return to normal as soon as the foundation works are completed; and • A work gap shall be observed to allow sufficient settling time of disturbed sediments	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
		Increase in oil and grease level	• Provision of oil-spill kits to all construction vehicles, equipment and machineries; • On-site maintenance of construction vehicles, equipment, and machineries will be strictly prohibited, particularly near the waterways; and • Strict compliance to the regular Periodic Maintenance Service (PMS) of all construction vehicles, equipment, and machineries to ensure optimum condition;	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Grubbing and earth-moving activities Excavation works and related construction activities of bridge structures Excavation works and related construction activities of the tunnel section		Increase in siltation rate	• Provision of geotextile silt screens/curtains to minimize siltation rate, especially during high precipitation periods; • Construction of temporary basins or siltation ponds to trap silt; and • Cover temporary stockpiles of earth materials with tarpaulin or sack materials	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (12/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE WATER						
Construction of the bridge structures, foundation works, and related activities	**Water Quality**	Increase in coliform level due to improper management of domestic and solid wastes	• Provision of temporary sanitation facilities such as portalets and trash bins to properly manage solid and domestic wastes to be generated by the at construction workers, particularly near the waterways; • Strict implementation of proper waste segregation scheme; • Regular hauling and disposal of generated wastes to sites duly-approved by Davao City and Panabo City; and • Strict implementation of daily inspection of the areas provided with temporary sanitation facilities to ensure proper waste management	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Concrete pouring and pavement works at bridge sites		Increase in pH level	• Close supervision of concrete pouring and pavement works of the bridge structures; • Installation of nets and mesh materials at bridge construction sites to minimize effects of accidental concrete spillage • Prohibit washing of transit concrete mixers along the waterways	DPWH and ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (13/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE AIR						
Site clearing, stripping, grubbing, earth-moving, and all other related activities	**Air Quality**	Possible increase in the level of TSP at the construction sites and adjacent dust sensitive-receptor areas such as residential areas, schools	• Regular spraying of water at open and exposed construction areas to minimize re-suspension of particulate matter, particularly those adjacent to dust-sensitive receptor areas; • Strict implementation of the **20 kph** speed limit, particularly at construction sites adjacent to settlement areas; • Provision of tarpaulin or sack materials to delivery trucks of earth materials and haulers of construction spoils	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Operation of various heavy equipment and machineries during site clearing, grubbing, earth-moving, and other activities entailed during construction of the bypass alignment, bridge structures, and tunnel section	**Air Quality** (*NO_2, SO_2, CO, & CO_2*)	Increase in ground concentration level of gaseous pollutants (NO_2, SO_2, Co, and CO_2)	• Strict compliance to the PMS of all construction vehicles, equipment, and machineries to ensure that these are in optimum condition	DPWH and ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Operation of various heavy equipment and machineries during site clearing, grubbing, earth-moving, and other activities entailed in the construction of the bypass alignment, bridge structures, and tunnel section	**Noise Level**	Increase in noise level at identified noise sensitive receptor areas such as residential, schools, hospitals, and places of worships	• Construction sites near noise sensitive receptor areas will be enclosed with metal sheets to keep noise level at permissible limits;	DPWH and ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget

Table 4-1 Impact Management Plan (14/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE AIR						
Operation of various heavy equipment and machineries during site clearing, grubbing, earth-moving, and other activities entailed in the construction of the bypass alignment, bridge structures, and tunnel section	**Noise Level**	Increase in noise level at identified noise sensitive receptor areas such as residential, schools, and places of worships (for Catholics, Muslims, and other religious groups)	• Installation of noise suppressors to construction equipment and machineries whenever necessary; and • Schedule high noise level generating construction activities during day time only. Affected residents will be consulted to get consensus	DPWH and ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
THE PEOPLE						
Construction of the bypass alignment	**Temporary Employment and Small-scale Business Opportunity**	Availability of temporary employment during construction period. Female members of the community, particularly wives of tenant farmers can engage in small scale business enterprises such as eateries, and supply of other goods and services	• Qualified skilled workers and laborers in the DIA will be given first priority in hiring during construction period; • Applicant workers will be required to secure certification from their respective barangays to confirm residency status in the area; and • Strict screening of female members of the community to ensure that those who will be given priority in the business concessions to be created are the directly affected persons	DPWH and the ESHO of the Contractor in close coordination with the MMT and LGUs of Davao City and Panabo City	To be included in the construction cost to be finalized during the DED	Included as an ECC condition EMF must be included in the Civil Works Budget
	Basic Social Service Facilities	Increase in demand of access to basic social service services such as health centers due to in-migration of workers	• Provision of basic social service facilities such as health care center within the work sites to reduce competition between migrant workers and local residents	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition

Table 4-1 Impact Management Plan (15/27)

Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE PEOPLE						
Excavation works and related activities during construction of the bypass	**Social Service Utilities**	Interruption of power and water supply, and telecommunication services	• Close coordination with local utility companies concerned such as the Davao Light & Power Corporation (DLPC) and the Davao City Water District (DCWD) shall be undertaken to facilitate relocation and restoration affected utilities; • Close coordination with the National Grid Corporation of the Philippines (NGCP) shall be carried out to facilitate relocation of affected transmission lines; and • Affected consumers shall be notified in advance to enable them to prepare and undertake the necessary measures. Posting of public notice at conspicuous areas such as city/barangay halls, schools, and places of worships	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Construction of the bypass	**Public Health, Sanitation, and Waste Management**	Spread of communicable diseases due to poor sanitation and improper waste management	• Provision of adequate temporary sanitation facilities such as portable toilets and trash bins at construction sites, workers' camps, motorpool areas, stock yards, facilities yards, and field offices; • Regular hauling and disposal of generated solid and domestic wastes to sites duly-approved by the City Governments of Davao and Panabo; • Strict implementation of proper	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/

			waste segregation scheme; and			untoward incidents

Table 4-1 Impact Management Plan (16/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE PEOPLE						
Construction of the bypass	**Public Health, Sanitation and Waste Management**	Spread of communicable diseases due to poor sanitation and improper waste management	• Strict implementation of the daily inspection of workers' camps, field offices, and all construction areas provided with temporary sanitation facilities to ensure proper waste management and good housekeeping	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
	Public Health, Sanitation and Waste Management	Spread of infectious diseases due to in-migration of workers infected with STDs and HIV/AIDS	• Strict medical screening of migrant workers during hiring period shall be observed; • Conduct of regular medical check-up of workers; and • Undertaking of group consultations to promote awareness among the community and workers on how to prevent transmission of STDs and HIV/AIDS	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Operation of construction equipment and machineries during implementation of the project Operation of the concrete batching plant Operation of the motorpool area and repair yard Operation of the temporary stockyard and facilities yard	**Occupational Health and Safety**	Incidence of temporary hearing problem due to long-term exposure to high noise levels	• Provision of adequate Personal Protective Equipment (PPE) such as ear muffs, especially to heavy equipment operators and other workers exposed to high noise level; and • Wearing of the provided PPE such as hard hats, safety boots, safety gloves, reflectorized vests, and other related safety gears will be strictly implemented	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (17/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE PEOPLE						
Operation of construction equipment and machineries during implementation of the project	**Occupational Health and Safety**	Incidence of upper respiratory ailments due to long-term exposure to suspended particulate matter and exhaust gas emissions	• Provision of gas/protective masks to heavy equipment operators and workers exposed to dust and gaseous air pollutants emitted by the heavy equipment and machineries; • Wearing of the provided PPE will be strictly implemented	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Operation of construction equipment and machineries during implementation of the project Operation of the concrete batching plant Operation of the motorpool area and repair yard Operation of the stockyard and temporary facilities yard		Incidence of construction related accidents Incidence of temporary skin irritation or chronic skin problems among workers caused by direct contact to hazardous materials	• Personnel shall be trained on safety procedures and educated on health standards; • Personnel will be comprehensively trained on handling of toxic materials; • Provision of medical clinic and first aid station facilities supervised by a registered nurse at the work areas and field offices; • Regular conduct of workers' medical check-up; • Formulation of an Emergency Response Plan (ERP) to quickly respond to any type of emergency situation within the construction area; and • Provision of a stand-by emergency vehicle within the construction areas at all times	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (18/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE PEOPLE						
Operation of the temporary construction facilities for the implementation of the project	**Safety of residents near the temporary construction facilities**	Incidence of untoward accidents due to negligence and unawareness	• All temporary construction facilities such as motorpool areas, concrete batching plants, material stock yard, and facilities yard, must be located at least **1 kilometer** away from the nearest settlement area; and	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget
Operation of the temporary construction facilities for the implementation of the project	**Safety of residents near the temporary construction facilities**	Incidence of untoward accidents due to negligence and unawareness	• All temporary construction facilities shall be securely enclosed and guarded to limit access to the public, especially children	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Mobilization of the construction vehicles, heavy equipment and machineries in the agricultural areas during implementation of the project	**Safety of farmers and plantation workers**	Occurrence of untoward accidents due to lack of safe farm crossings	• Provision of safe temporary crossings for farmers and plantation workers with enough consideration to farm implements; and • Designate safety personnel in areas where major construction activities will be undertaken to prevent untoward incidents	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC Condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Mobilization of the construction vehicles, heavy equipment and machineries in the settlement areas during implementation of the project	**Safety of residents in the settlement areas**	Accidents may occur due to lack of: ➢ Safety barriers; ➢ Reflectorized warning signs; ➢ Lighting; and ➢ Safe and adequate pedestrian crosswalks	• Enclose all construction sites adjacent to the settlement areas, particularly excavation sites to limit public access, especially children; • Installation of sufficient safety barriers;	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget

Table 4-1 Impact Management Plan (19/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE PEOPLE						
Mobilization of the construction vehicles, heavy equipment and machineries in the settlement areas during implementation of the project	**Safety of residents in the settlement areas**	Accidents may occur due to lack of: ➢ Safety barriers; ➢ Reflectorized warning signs; ➢ Lighting; and ➢ Safe and adequate pedestrian crosswalks	• Installation of adequate reflectorized traffic warning and safety signs written in the local dialect (Visayan) and the vernacular (Tagalog) along the entire stretch of the construction areas; • Provision of safe crosswalks and pedestrian lanes at construction areas near settlement areas, particularly schools; and • Designate well-trained traffic aides at construction sites near settlement areas and schools to assist and guide pedestrians	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	Must be included as an ECC conditionality EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Construction of at-grade intersections, overpass bridges, and underpass bridges along the roads intersected by the bypass alignment. Mobilization of the various construction equipment and machineries at the road intersections. Excavation works at the road intersections	**Safety of Motorists**	Accidents may occur due to lack of: ➢ Safety barriers; ➢ Reflectorized warning signs; ➢ Sufficient lighting; ➢ Traffic aides/flagmen; and ➢ Safety personnel	• Provision of adequate reflectorized warning and traffic safety signs written in the local dialect (Visayan) and the vernacular (Tagalog)along the entire stretch of the construction sites, particularly at major road intersections; • Installation of sufficient impact resistant concrete barriers; • Provision of sufficient lighting in all construction areas to provide illumination during night time; • Designate safety personnel and well-trained traffic aides/flagmen at critical construction areas to assist and guide motorists;	DPWH and the ESHO of the Contractor in close coordination with the MMT and the Traffic Management Group (TMG) of Davao City and Panabo City	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (20/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
II. CONSTRUCTION PHASE						
THE PEOPLE						
Construction of at-grade intersections, overpass bridges, and underpass bridges along the roads intersected by the bypass alignment. Mobilization of the various construction equipment and machineries at the road intersections. Excavation works at the road intersections	**Safety of Motorists**	Accidents may occur due to lack of: ➢ Safety barriers; ➢ Reflectorized warning signs; ➢ Sufficient lighting; ➢ Traffic aides/flagmen; and ➢ Safety personnel	• Parking time of idle construction vehicles, equipment, machineries, and vehicles along the roads will be prohibited, especially during night time	DPWH and the ESHO of the Contractor in close coordination with the MMT and the Traffic Management Group (TMG) of Davao City and Panabo City	To be included in the construction cost to be finalized during the DED	Must be included as an ECC condition EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Construction of at-grade intersections, overpass bridges, and underpass bridges along roads intersected by the bypass alignment. Mobilization of the various construction equipment and machineries at the road intersections. Excavation works at the road intersections	**Traffic**	Construction works may cause localized traffic congestion	• A sound Traffic and Management Plan (TMP) and re-routing schemes will be prepared and submitted to the Cities of Davao and Panabo for approval; and • Strict implementation of the approved TMP and re-routing schemes along major roads affected by the construction of the project	DPWH and ESHO of the Contractor in close coordination with the City Governments of Davao and Panabo, and the TMG of both cities	To be included in the construction cost to be finalized during the DED	Must be included as an ECC conditionality EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (21/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
III. DEMOBILIZATION/DECOMMISSIONING PHASE						
THE WATER						
Abandonment of construction spoils	**Hydrology**	Impediment of stream flow of affected waterways due to abandoned construction spoils and debris	• A joint site inspection shall be conducted by the representatives of DPWH, ESHO of the Contractor, and the MMT to ensure that the stream flow along the waterways is normal, and that the riparian areas and their surroundings are clear of residual construction spoils and debris	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Abandonment of residual domestic and solid wastes	**Water Quality**	Degradation of the water quality particularly coliform due to abandoned residual solid and domestic wastes	• The Contractor must ensure that: ➢ All temporary sanitation facilities provided at the construction sites are completely dismantled; and ➢ Residual domestic and solid wastes are properly disposed to sites duly-approved by the City Governments of Davao and Panabo • A joint site inspection at the construction sites must be conducted by the DPWH, ESHO of the Contractor, and the MMT to validate compliance of the Contractor	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
THE PEOPLE						
Incomplete closure of the workers' camps, field offices, temporary stock yards, and all other temporary construction facilities	**Informal Settlement**	Informal settlements at worker's camps, field offices, and other temporary construction facilities	• To ensure complete closure of the temporary construction facilities, all structures within the premises must be totally dismantled and the area is restored to its original state; and	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget

Table 4-1 Impact Management Plan (22/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
III. DEMOBILIZATION/DECOMMISSIONING PHASE						
THE PEOPLE						
Incomplete closure of the workers' camps, field offices, temporary stock yards, and all other temporary construction facilities	**Informal Settlement**	Informal settlements at worker's camps, field offices, and other temporary construction facilities	• A joint site inspection shall be conducted by the DPWH, ESHO of the Contractor, and the MMT to validate complete closure of the temporary construction facilities and restoration of the sites to their original state	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents
Incomplete dismantling of the temporary sanitation facilities at the workers' camps, field offices, and construction sites Abandonment of residual and solid domestic wastes Abandonment of muck soil materials	**Public Health, Sanitation, and Waste Management**	Spread of communicable diseases	• The Contractor must ensure that: ➢ All temporary sanitation facilities provided at the construction sites are completely dismantled; ➢ Residual domestic and solid wastes are properly disposed to sites duly-approved by the City Governments of Davao and Panabo; and ➢ Residual muck soil materials are disposed to sites duly approved by CENRO of Davao City • A joint site inspection shall be conducted by the DPWH, ESHO of the Contractor, and the MMT at the workers' camps, field offices, temporary stockyard of muck soil materials and construction sites provided with temporary sanitation facilities to validate compliance of the Contractor	DPWH and the ESHO of the Contractor in close coordination with the MMT	To be included in the construction cost to be finalized during the DED	EMF must be included in the Civil Works Budget EGF/QRF/CARI will be tapped for compensation of damages resulting from accidents/ untoward incidents

Table 4-1 Impact Management Plan (23/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
IV. OPERATIONAL PHASE						
THE LAND						
Operation of the Bypass	**Land Use**	Conversion of roadside agricultural and agro-industrial land into other uses (e.g., residential or commercial)	• Request Mayor and City Council of Davao City and Panabo City to issue ordinance prohibiting illegal conversion of such lands into other uses; and • Regular inspection and monitoring along the Bypass Road must be undertaken by the City Governments of Davao and Panabo	DPWH and LGU of Davao City	Cost of providing green belt area to be included in the construction cost to be finalized during the DED	Must be included in civil works budget
		Better access to the designated tourism development zones in Davao City	• Regular inspection and maintenance of the bypass road shall be undertaken based on standard DPWH Maintenance Works for Roads and Bridges to ensure optimum level of service to road users	DPWH District Engineering Office (DEO) who has jurisdiction over the Bypass	Standard Maintenance Budget of DPWH for Roads and Bridges	
Change in topography due to high cut and embankment sections	**Topography**	Slope failure, landslides and increased erosion rates along newly vegetated/mulched cut sections and embankments	• Regular inspection and maintenance of the vegetated cut sloes slopes until fair level of stabilization is achieved	DPWH District Engineering Office (DEO) who has jurisdiction over the Bypass	Standard Maintenance Budget of DPWH for Roads and Bridges	Must be included in the regular maintenance cost of DPWH until such time as slopes have fairly stabilized
		Slope failure and rock fall along cut sections with slope protection structures	• Regular inspection and maintenance of the slope protection structures based on DPWH Standard Maintenance for Roads and Bridges	DPWH District Engineering Office (DEO) who has jurisdiction over the Bypass	Standard Maintenance Budget of DPWH for Roads and Bridges	Must be included in the regular maintenance cost of DPWH until such time as slopes have fairly stabilized

Table 4-1 Impact Management Plan (24/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
IV. OPERATIONAL PHASE						
THE WATER						
Effectiveness of drainage structures along natural waterways	**Hydrology**	Aggravation of flooding along catchment areas of rivers to be traversed by the bypass---Davao, Lasang, Talomo, Lipadas, Matina Rivers, as well as flood-prone areas in Brgy. Tigatto	• Regular inspection and maintenance of bridges, culverts, and drainage pipes shall be undertaken to ensure optimum service of these facilities; • Ocular inspection and interview with local residents regarding aggravation and incidence of flooding, in flood-prone areas and in areas not previously flooded, respectively. This activity must be conducted particularly after high precipitation periods.	DPWH, particularly its District Engineering Office who has jurisdiction over the Bypass	Standard Maintenance Budget of DPWH for Roads and Bridges	Included as part of the regular drainage maintenance cost of DPWH
THE AIR						
Operation of the Bypass Road	**Ambient Air Quality**	Decrease in CO_2 generation due to faster and smoother traffic flow	• In support of the positive impact brought about by the project, establishment of the green belt areas (tree planting) along the roadsides of the newly constructed the bypass, will serve as natural filters for exhaust gas emissions. Likewise the trees will provide settling areas for the suspended particulate matters; • An anti-smoke-belching monitoring station shall be set-up at air pollution sensitive areas; and • Strict implementation of penalties for violators in accordance with the Philippine Clean Air Act (R.A. 8749) and its Implementing Rules and Regulations (IRR)	DPWH in close coordination with the CENROs of Davao City and Panabo City and the TMG of the respective Cities	To be finalized during the DED in close coordination with CENROs of Davao City and Panabo City	Budget for the tree planting program shall be in accordance with the DPWH D.O. 15 Series of 2000 Regular budget of DENR and Davao City CENRO

Table 4-1 Impact Management Plan (25/27)

Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
IV. OPERATIONAL PHASE						
THE AIR						
High traffic volume along the new Bypass	**Noise**	Increase in noise level in areas traversed by the Bypass alignment	• A green belt area shall be established along the road sides of the new Bypass Road in accordance with the DPWH D.O. 15, Series of 2000, which can act as noise barrier between the bypass and noise sensitive areas; and • Installation of noise barrier at identified noise sensitive receptors areas adjacent to the bypass road shall be considered	DPWH in coordination with the respective CENROs of Davao City and Panabo City	To be finalized during the DED (in close coordination with the CENROs of Davao City and Panabo City	Must be included in the civil works budget
THE PEOPLE						
Influx of in-migrants or new settlers due to improved access and accessibility	**Land Use**	Illegal conversion of roadside area into non-designated land use, such as commercial, residential, and a combination of both	• Strict adherence to Davao City Land Use Plan; • Request Mayor and City Council of Davao City and Panabo City to issue ordinance prohibiting illegal conversion of such lands into other uses; and • Regular inspection and monitoring along the Bypass Road must be undertaken by the City Governments of Davao and Panabo and • Implementation of DAO 15 Series of 2000 to provide buffer between Bypass and roadside areas, so as to discourage illegal conversion of agricultural and agro-industrial to residential, commercial, or a mix of both	Davao City Planning and Development Office and DPWH	As mentioned above, cost for establishing green belt within the R-O-W will be finalized during DED Stage.	Must be included in the civil works budget

Table 4-1 Impact Management Plan (26/27)

Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
IV. OPERATIONAL PHASE						
THE PEOPLE						
Influx of in-migrants or new settlers due to improved access and accessibility	**Social Services (water supply, health services, educational facilities, transportation and communication, etc.)**	Increase in demand for social services resulting in competition between new settlers and pre-project residents	• Strict adherence to Davao City Land Use Plan; and • Implementation of DPWH D.O. 15 Series of 2000 to provide buffer between Bypass and roadside areas, so as to discourage illegal conversion of agricultural and agro-industrial to residential, commercial, or a mix of both	Davao City Planning and Development Office and DPWH	As mentioned above, cost for establishing green belt within the ROW will be finalized during DED Stage.	Must be included in the civil works budget
Operation of the tunnel section	**Safety of motorists**	Incidence of fire inside the tunnel section	• Tank lorries carrying oils and chemicals shall be prohibited from passing through the tunnel; and • Strict implementation of the tunnel accident action flow shown in **Figure 7.2.2-1 Chapter 7** of this Report	DPWH in close coordination with TMG of Davao City	To be finalized in the DED in close coordination with the LGU of Davao City	Annual budget for proper and efficient implementation of the tunnel accident action flow must be allotted by DPWH
		Vehicular accidents involving motorbikes, overloaded trucks, and trucks over the vertical clearance limit	• Motorbikes, tricycles, overloaded trucks, vehicles over the vertical clearance restriction, and other road unworthy vehicles shall be prohibited from using bypass tunnel section	DPWH in close coordination with TMG of Davao City	To be finalized in the DED in close coordination with the LGU of Davao City	Annual budget for proper and efficient implementation of the tunnel accident action flow must be allotted by DPWH
	Health and Safety	Accidental spill of oil and other hazardous and toxic wastes	• Lorries carrying hazardous and toxic materials shall be prohibited from using the tunnel; • In case of oils and other chemical spills inside the tunnel, thorough clean-up will be immediately undertaken; and • Strict implementation of the tunnel accident action flow shown in **Figure 7.2.2-1 Chapter 7** of this Report	DPWH in close coordination with TMG of Davao City	To be finalized in the DED in close coordination with the LGU of Davao City	Annual budget for proper and efficient implementation of the tunnel accident action flow must be allotted by DPWH

Table 4-1 Impact Management Plan (27/27)						
Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee/ Financial Arrangements**
IV. OPERATIONAL PHASE						
THE PEOPLE						
Operation of the newly constructed Bypass Road	**Travel Time**	Faster, smoother, and safer travel from the southern to the northern parts of Davao City, as well as to the adjacent areas such as Panabo City	• Regular inspection and maintenance of the newly constructed bypass road, including all appurtenant structures installed in accordance with the DPWH Standard Maintenance for Roads and Bridges, shall be undertaken to provide optimum service and safe travel to road users	DPWH, particularly its District Engineering Office who has jurisdiction over the Bypass	Standard Maintenance Budget of DPWH for Roads and Bridges	Included as part of the DPWH standard maintenance cost for roads and bridges

5 SOCIAL DEVELOPMENT & IEC PLAN

Tables 5-1 and **Table 5-2** show the Social Development Framework and the Information Education and Communication Framework for the proposed Davao City Bypass Construction Project. These frameworks shall be updated and finalized during the detailed engineering design (DED) stage to reflect any adjustments/changes in the configuration of the proposed bypass road.

Table 5-1 Social Development Framework for the Davao City Bypass Construction Project (1/2)

	Concern	Responsible Community Member/ Beneficiary	Government Agency/ Non-Government Agency and Services	Proponent	Indicative Timeline	Source of Fund
1	Updating of Resettlement Action Plan (RAP)	• Barangay Chairman; and • Presidents of Homeowners Association	• DPWH; • Davao City Housing Office under the OCPDC; and • Lingap Para sa Mahirap Office	• DPWH Environment & Social Safeguards Division (ESSD)	• Detailed Engineering Design (DED) i.e., After conduct of Parcellary Survey	• Part of DED Consultancy budget
2	Relocation of informal settlers (If there are any)	• Barangay Chairman; and • Presidents of Homeowners Association	• Davao City Housing Office under the OCPDC • DSWD • DPWH • Lingap Para sa Mahirap Office • Partner Housing POs, NGOs of Davao City	• DPWH UPMO; and • DPWH Environment & Social Safeguards Division (ESSD)	• Pre-Construction Stage	• LGU for home plots or lots only • Site development cost and other basic facilities can be included in DED budget
3	Gender Responsive Livelihood Training Program • Skills training for construction work • Skills training for handicraft making • Skills training for food preparation	• Barangay Chairman; • Barangay Kagawad for Livelihood; • Presidents of Homeowners Association; and • Officers of Women's organizations	• City Cooperative Development Office • DSWD • TESDA	• DPWH Environment & Social Safeguards Division (ESSD)	• After ECC Issuance	• LGU Livelihood Office
4	Formation of/Support to Farmers Cooperatives	• Barangay Chairman; and • Presidents of City and Barangay farmers associations or organizations	• DPWH • DTI • Cooperative Development Authority (CDA)	• DPWH Environment & Social Safeguards Division (ESSD)	• Prior to RAP Implementation	• LGU Livelihood Office

Table 5-1 Social Development Framework for the Davao City Bypass Construction Project (2/2)

	Concern	Responsible Community Member/Beneficiary	Government Agency/ Non-Government Agency and Services	Proponent	Indicative Timeline	Source of Fund
5	Health and Safety	• Barangay Chairman; and • Barangay Kagawad for Health and Safety	• City Health Office; • DSWD; and • Barangay Health Centers	• DPWH District Engineering Office (DEO); and • DPWH Environment & Social Safeguards Division (ESSD)	• Pre-Construction, Construction, Operation Stage	• LGU Health Office
6	Environment and Sanitation	• Barangay Chairman; and • Barangay Kagawad for Environment and Sanitation	• LGU and CENRO; and • DENR Region XI	• DPWH DEO; and • DPWH Environment & Social Safeguards Division (ESSD)	• Pre-Construction, Construction, Operation Stage	• LGU CENRO
7	Peace and Order	• Barangay Chairman; • Barangay Kagawad for Peace and Order; and • Homeowners Association Sargent-at-Arms	• LGU • PNP	• DPWH Environment & Social Safeguards Division (ESSD); and • DPWH DEO	• Pre-Construction, Construction, Operation Stage	• LGU & PNP
8	Spiritual	• Barangay Chairman; • Parish Pastoral Council; • President Homeowners Association; • Leaders of other religious groups	• Parish Priests • LGU	• DPWH DEO; and • DPWH Environment & Social Safeguards Division (ESSD)	• Pre-Construction, Construction, Operation Stage	• LGU

Table 5-2 Information. Education, and Communication Framework for the Davao City Bypass Construction Project (1/2)					
Target Sector	**Major Topics**	**IEC Scheme/Strategy Methods**	**Information Medium**	**Indicative Timelines and Frequency**	**Indicative Cost**
LGU of Davao City and Panabo City	• Presentation of Project Status Composition: SC	• Group Meeting	• Slide Presentation • Minutes of meetings	• Quarterly during Detailed Engineering Design (DED) or as needed	• P60,000/yr
	• Presentation of Work Progress Composition	• Group Meeting	• Slide Presentation • Minutes of meetings	• Monthly during DED	• P40,000.00
Davao City Brgys. Mintal, San Isidro, Tibungco, Lasang, Mahayag, Tacunan, and Mudiang	• Creation of Project Committee on Relocation of Land Renters Composition: DPWH ESSD, City Housing Office, Lingap Para sa Mahirap, Department of Social Welfare and Development (DSWD)	• Group Meeting	• Slide Presentation • Handouts	• One Month after award to DED Consultant	• P40,000.00
	• Discussion of Memorandum of Agreement (MOA) re relocation of land renters Composition: TWG, Project Committee on Relocation of Land Renters	• Group Meeting, signing of MOA	• Slide Presentation • Handouts • MOA	• One Month after creation of Project Committees	• P20,000.00
Affected Sectors: 1. Barangay Chairman of 20 Project-affected barangays in Davao City and one in Panabo City	• Presentation of Project Status – DED Consultant	• Group Meeting	• Audio-Visual Presentation • Slide Presentation	• At the onset of the updating of Resettlement Action Plan, at least six (6) months prior to R-O-W Acquisition	• P50,000.00
2. Land and Plantation owners	• Presentation of Project Status; and • Presentation of valuation methodology and next steps for R-O-W Acquisition	• Group Meeting	• Slide Presentation • Multi-sectoral Cluster meetings	• During updating of RAP and every month thereafter until completion of R-O-W Acquisition	• P120,000.00

Table 5-2 Information. Education, and Communication Framework for the Davao City Bypass Construction Project (2/2)

Target Sector	Major Topics	IEC Scheme/Strategy Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
3. Subdivision developers and other industrial sectors (HOLCIM)	• Presentation of Project Status	• Group Meeting	• Slide Presentation • Multi-sectoral Cluster meetings	• During updating of RAP and every month thereafter until RAP is implemented	• P100,000.00
4. Land renter groups represented by Officers of Homeowners Associations	• Presentation of Project Status; and • Presentation of Project Committee on Relocation	• Group Meeting	• Slide Presentation • Multi-sectoral Cluster meetings	• During updating of RAP and every month thereafter until RAP is implemented	• P100,000.00

6 ENVIRONMENTAL COMPLIANCE MONITORING

6.1 SELF MONITORING PLAN

Table 6.1-1 shows the Self-Monitoring Plan for the Davao City Bypass Construction Project during the Pre-Construction, Construction, and Operational Phases of the project. It is very important to note that this Plan shall be updated and finalized during conduct of DED.

Table 6.1-1 Environmental Monitoring Plan (EMoP) for the Davao City Bypass Construction Project (1/4)

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling Methodology and Measurement Plan			Lead Person	Annual Estimated Cost	ENVIRONMENTAL QUALITY PERFORMANCE LEVELS (EQPL) MANAGEMENT SCHEME					
								EQPL RANGE			MANAGEMENT MEASURE		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
I. PRE-CONSTRUCTION PHASE													
THE LAND													
Terrestrial Flora	Cutting of naturally growing trees along the **40-60** ROW	Volume of trees cut	Ocular inspection	Daily during site clearing along the ROW	Along the ROW, particularly at bridge sites (riparian areas) and tunnel portals (east and west sides)	PCO of the Contractor	To be determined and finalized during DED stage	POST-ECC Agreement between DPWH, Contractor, DENR-FMB Region XI, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		Within the required **40-60 m** ROW	POST-ECC Agreement between DPWH, Contractor, DENR-FMB Region XI, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		
Terrestrial Flora	Cutting of coconut trees and planted trees along the **40-60** ROW	Volume of trees cut	Ocular inspection	Daily during site clearing along the ROW	Along the ROW, particularly at bridge sites (riparian areas) and tunnel portals (east and west sides)	PCO of the Contractor	To be determined and finalized during DED stage	POST-ECC Agreement between DPWH, Contractor, DENR-FMB Region XI, PCA, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		Within the required **40-60 m** ROW	POST-ECC Agreement between DPWH, Contractor, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		
Terrestrial Flora	Replacement of cut trees along the ROW (naturally growing trees, planted and coconut trees)	Survival rate of the species introduced	Ocular inspection	Quarterly	Designated tree planting site and/or reforestation area designated by the DENR-FMB Region XI	PCO of the Contractor	To be determined and finalized during DED stage based on current prices of seedlings	POST-ECC Agreement between DPWH, Contractor, DENR-FMB Region XI, PCA, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		**85-90%** survival rate of the species introduced as prescribed by the DENR-FMB Central Office	POST-ECC Agreement between DPWH, Contractor, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		
THE PEOPLE													
Right-Of-Way (ROW) Acquisition	Delay in compensation	Compensation for the following: • Agri-industrial, agricultural and residential lands; • Residential & commercial structures; • Coconut trees; • Banana trees and other commercial fruit bearing-trees	Consultation Meeting and/or Survey with the project affected persons (PAPs)	Monthly until ROW is fully acquired	Affected barangays	DPWH ESSD/EMA	P500,000 (can be included in the RAP updating budget)	Must be completed and settled prior to construction stage			POST-ECC Agreement between DPWH, PCA, DA, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		
II. CONSTRUCTION PHASE													
THE WATER													
Hydrology	Aggravation of flooding along flood-prone areas such as Waan and Tigatto	Flood levels	Flood level measurement during high precipitation periods Interview with local residents	Quarterly	Flood-prone areas, particularly near major river systems	DPWH Hydraulics Engineer, PCO of the Contractor	P400,000	POST-ECC Agreement between DPWH, Contractor, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		Must not exceed maximum historical flood levels prior to construction activities	POST-ECC Agreement between DPW, Contractor, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		

Table 6.1-1 Environmental Monitoring Plan (EMoP) for the Davao City Bypass Construction Project (2/4)

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter to be Monitored	Sampling Methodology and Measurement Plan			Lead Person	Annual Estimated Cost	ENVIRONMENTAL QUALITY PERFORMANCE LEVELS (EQPL) MANAGEMENT SCHEME					
								EQPL RANGE			MANAGEMENT MEASURE		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
II. CONSTRUCTION PHASE													
THE WATER													
Water Quality	Water contamination	pH, DO, Oil & Grease, BOD, Fecal Coliform/ Total Coliform, and TSS	Water Sampling in accordance with the prescribed procedures described in DAO 34-1990 and EMB-DENR Manual for Ambient Water Quality Monitoring Volume I	Semi-Annual	At **five** (**5**) sampling locations: 1. Lasang River, Brgy. Communal; 2. Davao River, Brgy. Tigatto; 3. Matina River, Brgy. Langub; 4. Talomo River, Brgy. Mintal; and 5. Lipadas River, Brgy. Bangkas Heights	PCO of the Contractor	P600,000	POST-ECC Agreement between DPWH, Contractor, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		For Class "C" freshwater pH – 6.5 to 8.5 DO – 5.0 mg/L Oil & Grease – 2.0 mg/L BOD – 7.0 mg/L TSS – not more than 30 g/L increase	POST-ECC Agreement between DPW, Contractor, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		
THE AIR													
Air Quality	Increase in particulate matter and gaseous air contaminants	TSP, NO_2, SO_2, CO_2, and CO	Air Quality sampling using the following: 1. TSP – Gravimetric Method; 2. SO_2 – Pararosaniline Method; 3. NO_2 – Griess Saltzman Reaction; 4. CO_2 & CO – Direct Reading (Gas Analyzer)	Semi-Annual Immediately based on complaints	At **seven** (**7**) sampling locations: 1. End of Bypass Alignment, in front of PAICOP Compound, Brgy. J.P. Laurel, Pabano City; 2. Along San Isidro Road, between Piatos Chapel in front of Piatos Chapel, Brgy. San Isidro, Davao City; 3. In front of Sto. Niño Chapel, Brgy. Tigatto, Davao City; 4. In front of the University of Southern Philippines (USeP), along Davo-Bukidnon National Highway, Brgy. Mintal, Davao City; 5. Beginning of Bypass Alignment, along the Davao Digos National Highway, approximately 500 m south of Lipadas Bridge, Brgy. Sirawan, Davao City; 6. Elenita Heights, Brgy. Catalunan Grande, Davao City; 7. Waan Elementary School Grounds, Brgy. Waan, Davao City;	PCO of the Contractor	P800,000	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		TSP 1 hr – 300 µ/Ncm 24 hr – 230 µ/Ncm SO_2 1 hr – 340 µ/Ncm 24 hr – 180 µ/Ncm NO_2 1 hr – 260 µ/Ncm 24 hr – 150 µ/Ncm CO 1 hr – 30 ppm 24 hr – (Every 8 hrs) 9 ppm CO_2 1 hr – None 24 hr – None	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		

Table 6.1-1 Environmental Monitoring Plan (EMoP) for the Davao City Bypass Construction Project (3/4)

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter to be Monitored	Sampling Methodology and Measurement Plan			Lead Person	Annual Estimated Cost	ENVIRONMENTAL QUALITY PERFORMANCE LEVELS (EQPL) MANAGEMENT SCHEME					
								EQPL RANGE			MANAGEMENT MEASURE		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
II. CONSTRUCTION PHASE													
THE AIR													
Noise Level	Increase in noise level at noise sensitive receptor areas	Noise level	Noise Level monitoring using a noise level meter	Semi-Annual Immediately based on complaints	At **seven** (**7**) sampling locations: 1. End of Bypass Alignment, in front of PAICOP Compound, Brgy. J.P. Laurel, Pabano City; 2. Along San Isidro Road, between Piatos Chapel in front of Piatos Chapel, Brgy. San Isidro, Davao City; 3. In front of Sto. Niño Chapel, Brgy. Tigatto, Davao City; 4. In front of the University of Souther Philippines (USeP), along Davo-Bukidnon Nationala Highway, Brgy. Mintal, Davao City; 5. Beginning of Bypass Alignment, along the Davao Digos National Highway, approximately 500 m south of Lipadas Bridge, Brgy. Sirawan, Davao City; 6. Elenita Heights, Brgy. CAtalunan Grande, Davao City; 7. Waan Elementary School Grounds, Brgy. Waan, Davao City;	PCO of the Contractor	P400,000	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		**Table 6.1-2** presents the maximum noise standards for construction activities and allowable woiking hours per area For **"AA"** categorized areas (general areas) Morning (0500-0900H) – 45 db Daytime (0900-1800H) – 50 db Evening (1800-2200H) – 45 db Night Time (2200-0500H) – 40 db For **"A"** categorized areas (general areas) Morning (0500-0900H) – 50 db Daytime (0900-1800H) – 55 db Evening (1800-2200H) – 50 db Night Time (2200-0500H) – 45 db For **"A"** categorized areas (directly facing/fronting a **4-lane** road): Morning (0500-0900H) – 50 db Daytime (0900-1800H) – 60 db Evening (1800-2200H) – 50 db Night Time (2200-0500H) – 45 db For **"B"** categorized areas (general commercial areas) Morning (0500-0900H) – 60 db Daytime (0900-1800H) – 65 db Evening (1800-2200H) – 60 db Night Time (2200-0500H) – 55 db	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		

Table 6.1-1 Environmental Monitoring Plan (EMoP) for the Davao City Bypass Construction Project (4/4)													
Key Environmental Aspects per Project Phase	**Potential Impacts Per Environmental Sector**	**Parameter to be Monitored**	**Sampling Methodology and Measurement Plan**			**Lead Person**	**Annual Estimated Cost**	**ENVIRONMENTAL QUALITY PERFORMANCE LEVELS (EQPL) MANAGEMENT SCHEME**					
								EQPL RANGE			**MANAGEMENT MEASURE**		
			Method	**Frequency**	**Location**			**Alert**	**Action**	**Limit**	**Alert**	**Action**	**Limit**
II. CONSTRUCTION PHASE													
THE AIR													
Noise Level	Increase in noise level at noise sensitive receptor areas	Noise level	Noise Level monitoring using a noise level meter	Semi-Annual Immediately based on complaints	At the same **seven (7)** sampling locations as with the air quality sampling	PCO of the Contractor	P400,000	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		For **"C"** categorized areas (light industrial areas) Morning (0500-0900H) – 65 db Daytime (0900-1800H) – 70 db Evening (1800-2200H) – 65 db Night Time (2200-0500H) – 60 db	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		
THE PEOPLE													
Temporary Employment	Competition in hiring of labor work force	Hiring of qualified workers in the DIA	Site inspection and interview	Weekly	All construction areas	Contractor	To be determined during the DED Stage and to be included in the MMT Budget	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		**N.A.**	POST-ECC Agreement between DPWH, EMB, and MMT as indicated in Annex 2-20 of the RPM for DAO 2003-30		
III. OPERATIONAL PHASE													
THE LAND													
Cut slopes and embankments	Erosion of newly stabilized slopes	Survival rate of newly vegetated slopes;	Ocular inspection	Quarterly	High cut and fill areas	DPWH DEO	Based on DPWH Standard Maintenance Cost for Roads and Bridges	Must be continuously undertaken until slopes are fairly stable and vegetation cover achieves high survival rate			Part of regular engineering maintenance activity of the DPWH District Engineering Office		
THE WATER													
Hydrology	Aggravation of flooding along flood-prone areas such as Waan and Tigatto	Flood levels	Flood level measurement during high precipitation periods Interview with local residents	Quarterly	Flood-prone areas, particularly near major river systems	DPWH Hydraulics Engineer	P100,000	Must not exceed maximum historical flood levels prior to construction of Bypass			Part of regular engineering maintenance activity of the DPWH District Engineering Office		

Note:
ESSD – Environment and Social Safeguards Division
EMA – External Monitoring Agent
PCO – Pollution Control Officer

Presented in **Table 6.1-2** are the maximum noise for construction activities and allowable working hours per area in accordance with the National Pollution Control Commission (NPCC) Circular No. 002 (May 12, 1980). The values indicated in the Table shall serve as the basis of monitoring during implementation of the project.

Table 6.1-2 Maximum Noise Standards for Construction Activities & Allowable Working Hours per Area

Class of Activity	Maximum Noise Level	Allowable Working Hours	Areas
Class 1	90 dBA	7:00 am – 7:00 pm	AA, A, B
Class 2	85 dBA	7:00 am – 7:00 pm	AA, A, B
Class 3-4	75 dBA	7:00 am – 9:00 pm	AA, A, B

Source: NPCC Memorandum Circular No. 002, May 12, 1980

Note:

Class 1 Work which requires pile drivers (excluding manual type), file extractors, riveting hammers or combination thereof. This classification does not include work in which pile drivers are used in combination with earth augers.

Class 2 Work which requires rock drills or similar equipment like jack hammers or pavement breakers

Class 3 Work which requires air compressor (limited to those compressors which use power other than electric motors with a rated output of 15 KW or more in excludes air compressors powering rock drills, jack hammers and pavement breakers)

Class 4 Operation involving batching plant (limited to those with a mixer capacity of 0.5 or more cubic meters) and/or asphalt plants (limited to those with mixer capacity of 200 KG or more). Batching plants for the making or mortar are excluded.

6.2 MULTI-SECTORAL MONITORING FRAMEWORK

The multi-sectoral monitoring framework for this Project is provided in **Table 6.2-1**. It presents the proposed list of stakeholder members of the Multi-Partite Monitoring Team (MMT), the basis for selecting them, and their proposed role and responsibilities. The measures identified during this EIA study, which is at the FS stage of the Project will be detailed during the project's Detailed Engineering Design (DED) stage (post-ECC), based on the project facility design and operational specifications.

Table 6.2-1 Multi-Sectoral Monitoring Framework (1/2)

	Members	Basis of Selection	Role and Scope of MMT Activity
1	DENR Region XI	DENR Representative (RPM of DAO 2003-30)	• Lead the MMT; • Ensure strict adherence with the policies and implementing rules and regulations governing the formation and operationalization of the MMT; • Initiate transmittal to the EMB Central Office for resolution, regional or project specific issues where consensus or decisions cannot be made at the regional level; and • Concur with and sign the MMT monitoring reports
2	PENRO of Davao Del Norte	DENR Representative (RPM of DAO 2003-30)	• Lead the Sectoral Monitoring Team (SMT) organized by geopolitical units in undertaking actual monitoring activities and act with dispatch on issues/problems that arise relative to the Davao City Bypass Construction Project; and • Concur with and sign the MMT monitoring reports
3	DPWH ESSD	Proponent (DPWH) Representative	• Co-chair the sectoral monitoring team (SMT) organized by geopolitical units in undertaking actual monitoring activities and act with dispatch on issues/problems that arise relative to the Davao City Bypass Construction Project; and • Concur with and sign the MMT monitoring reports
4	DPWH	Project Implementor	• Provide necessary budget/funds for the MMT activities; • Make available to the MMT all project information necessary to determine compliance with the environmental requirements and commitments to the extent that such information is not subject to any restrictions and confidentiality; • Coordinate with, and allow the MMT members to inspect and observe construction and operation activities of the Davao City Bypass Construction Project including the testing, calibration and operation of pollution control and in-house monitoring equipment; and • Prepare and sign the MMT monitoring reports
5	Philippine Coconut Authority	Holds sole coconut industry	• Designate a representative who shall participate in actual monitoring work; • Provide the necessary information about local policies, plans and programs affecting MMT monitoring results and standards; and • Concur with and sign the MMT monitoring reports
6	Department of Agrarian Reform	In-charge of areas under the Comprehensive Agrarian Reform Program (CARP) – if any	• Validation of tenant farmers registration; • Provide pertinent information on lands covered by CARP (if any)

Table 6.2-1 Multi-Sectoral Monitoring Framework (2/2)

	Members	Basis of Selection	Role and Scope of MMT Activity
7	LGU City Agriculturist	LGU Office in charge commercial and industrial crops	• Designate a representative who shall participate in actual monitoring work; • Provide the necessary information about local policies, plans and programs affecting MMT monitoring results and standards; and • Concur with and sign the MMT monitoring reports
8	Barangay Chairpersons	As representative of the communities affected by the Project	• Advise the MMT of any complaints, information or reports from LGUs concerning the PROJECT; • Concur with and sign the MMT monitoring reports; and • Participate in Group Meetings as provided for in the IEC Framework to provide feedback to affected communities
9	Women's Organization	For women empowerment - to improve women's access to jobs, land rights, financial services, agro-industrial inputs and infrastructure	• Participate in actual monitoring work; • Provide the necessary information such as update regarding the perceptible impact of the project on women; • Concur with and sign the MMT monitoring reports • Participate in Group Meetings as provided for in the IEC Framework to provide feedback to women's groups
10	Other duly accredited NGOs	Advocacy should be in terms of poverty alleviation through sustainable livelihood programs	• Participate in actual monitoring work; • Provide the necessary information such as update regarding the perceptible impact of the project on vulnerable sectors such as, female/elderly headed families, people with disabilities, etc.; • Concur with and sign the MMT monitoring reports • Participate in Group Meetings as provided for in the IEC Framework to provide feedback to affected vulnerable sectors;

6.2.1 The MMT Work Plan

The MMT work plan shall follow the template provided in Annex 3-4 of the Revised Procedural Manual for DAO 2003-30 as shown in **Table 6.2-2.**

Table 6.2-2 Work Plan Template

No.	Function/Activities	Performance Indicator	1st QTR	2nd QTR	3rd QTR	4th QTR
1.0	Organizational Meeting, election/designation of officers/Exec Com and *Sectoral* / Committee members	Officers elected and Committees Formed	√	√	√	√
2.0	Training-Workshop on the Preparation for the MMT Manual of Operations (MOO)	MMT MOO		√		
3.0	Training-Workshops on the preparation and use of the customized MMT Compliance Monitoring and Validation Report (CMVR)	Customized CMVR Format for MMT Trained MMT Members on preparation of CMVR		√		
4.0	Preparation of Annual Work and Financial Plan (AWFP) – fully operational MMT	AWFP			√	
5.0	Initial Compliance Monitoring and Reporting Activities	CMVR for submission to EMB				√

6.2.2 The Annual Work and Financial Plan for the MMT

The preliminary Annual Work and Financial Plan (AWFP) for the operationalization of the MMT is shown in **Table 6.2-3**. The AWFP shall be updated and finalized during conduct of DED.

Table 6.2-3 Preliminary Annual Work and Financial Plan (AWFP) for the Davao City Bypass Construction Project MMT (1/2)

No.	Cost Item Per Activity in the work plan	Unit Cost	Qty	Days/ No.	1st QTR	2nd QTR	3rd QTR	4th QTR	TOTAL
1.0	**Organizational Meetings, election/designation of officers /Exec Com and *Sectoral* / Committee members**								
1.1	Meals/venue	100	25	2	5,000	5,000	5,000	5,000	20,000
1.2	Transportation Cost/Allowance	500	25	2	25,000	25,000	25,000	25,000	100,000
1.3	Materials	300	25	2	15,000	15,000	15,000	15,000	60,000
	TOTAL				45,000	45,000	45,000	45,000	**P180,000**
2.0	**Training-Workshop on the Preparation of the MMT Manual of Operations (MOO)**								
2.1	Meals/venue	100	25	3	-	7,500	-	-	7,500
2.2	Transportation Cost/ Allowance	1200	25	3		90,000			90,000
2.3	Materials	500	25	3		37,500			37,500
2.4	Honoraria for Resource persons	5,000	2	3		30,000			30,000
	TOTAL					**P165,000**			**P165,000**
3.0	**Training-Workshops on the Preparation and use of the customized MMT Compliance Monitoring and Validation Report (CMVR)**								
3.1	Meals/venue	100	25	1		2,500			2,500
3.2	Transportation Cost/ Allowance	500	25	1		12,500			12,500
3.3	Materials	300	25	1		7,500			7,500
3.4	Honoraria for Resource Persons	5,000	2	1		10,000			10,000
	TOTAL					**P32,500**			**P32,500**

Table 6.2-3 Preliminary Annual Work and Financial Plan (AWFP) for the Davao City Bypass Construction Project MMT (2/2)									
No.	**Cost Item Per Activity in the work plan**	**Unit Cost**	**Qty**	**Days/ No.**	**1st QTR**	**2nd QTR**	**3rd QTR**	**4th QTR**	**TOTAL**
4.0	**Preparations of the next year's Annual Work and Financial Plan (AWFP) – fully operational MMT**								
4.1	Meals/venue	100	25	2			5,000		5,000
4.2	Transportation Cost/Allowance	500	25	2			25,000		25,000
4.3	Materials	300	25	2			15,000		15,000
	TOTAL						**P45,000**		**P45,000**
5.0	**Compliance Monitoring and Reporting Activities**								
5.1	Document Review Mtg. Meals/Venue	100	25	3				7,500	7,500
5.2	Document Review Mtg. Transportation Cost/ Allowance	500	25	3				37,500	37,500
5.3	Site Validation Per Diem	500	25	5				62,500	62,500
5.4	Report Preparation Mtg. Meals/venue	100	25	2				5,000	5,000
5.5	Report Preparation Mtg. Transportation Cost/ Allowance	500	25	2				25,000	25,000
	TOTAL							P137,500	**P137,500**
	GRAND TOTAL								**P560,000**

6.3 ENVIRONMENTAL MONITORING FUND AND CARI

6.3.1 Environmental Monitoring Fund

The EMF is a fund that the DPWH shall commit to establish to support the activities of the MMT as described in the AWFP to be approved by EMB. DPWH shall arrange the opening of an account in a reputable bank in the country for the EMF within ten (10) banking days after the effectivity of the EMF Agreement to finance the initial organizational activities of the MMT. Any interest earned shall accrue to the same fund. It shall replenish this amount regularly to correspond to the EMB-approved AWFP. As shown in **Table 6.2-3** above, this amount is equivalent to approximately **P560, 000**. It is important to note however that this amount may still change when the AWFP is updated and finalized during the DED Stage.

The EMF shall be exclusively utilized to cover all costs attendant to the operation of the MMT and disbursed in accordance with the guidelines stipulated in the approved Manual of Operations (MOO). The EMF shall be managed and administered by a duly elected/appointed fund manager-MMT member organization who has an acceptable and operational financial accounting system in accordance with the MOO and annual work and financial plan. A separate bank account of the EMF shall be established. The signatories shall be the designated MMT Chairperson and Vice-Chairperson.

The MMT Secretariat shall undertake the accounting of all expenses by the MMT which the Exec Com/Officers shall oversee. DPWH shall audit the expenditure/disbursement of EMF in accordance with applicable rules and guidelines. Details on the frequency of audit, procedures shall be described in the MOO.

All MMT activities shall be documented and a report following the EMB-prescribed format shall be submitted semi-annually to EMB Central Office (CO). The MMT shall document relevant data, technical references and compile monitoring reports. Storage details and custodian shall be defined upon finalization of the MOO.

6.3.2 The Contractors' All Risk Insurance (CARI)

As stipulated in Section II of the Memorandum of Agreement (MOA) between DPWH and DENR dated 27 May 1996, under the "Rights and Obligations of the DPWH", item number 10:

> "*10. **As a replacement** to EGF, the DPWH shall ensure that Contractor's All Risk Insurance (CARI) is provided to cover expenses for the following:*

indemnification/compensation of damage to life and property that may be caused by the implementation of the projects and abandonment/decommissioning of the project facilities related to the prevention of possible negative impact".

Further, another type of fund was mentioned:

"11. Quick Response Fund (QRF) to supplement CARI. This fund will be used for emergency repairs/restorations of the critically damaged infrastructure facilities after calamity in order to restore mobility and ensure safety in the affected areas."

7 EMERGENCY RESPONSE POLICY AND GENERIC GUIDELINES

7.1 GENERAL EMERGENCY RESPONSE PLAN

The organizational chart presented in **Figure 7.1** is a generic set-up of the Contractor's Emergency Preparedness and Rescue Team (EPRT). As shown in the Chart, it is headed by the Environment Safety & Health Officer (ESHO) of the Contractor who manages and supervises the **four** (**4**) teams under the organization.

Each Team of the organization is always prepared to respond to any emergency situation that may take place in the construction areas. If a fire breaks out, the fire suppression team's extinguishers and utility men will immediately respond to the scene of the incident. The search and rescue team will carry out the search and rescue operations, and will personnel will be evacuated to safer grounds. The medical team will ensure that injured personnel will be given the appropriate first-aid by the well-trained medical staff. An ambulance is always on stand-by in case more serious cases are to be taken to the nearest hospital. The logistics team shall be in-charge of sufficient supplies of food, medicines and equipment, and will also take of the continuous flow of communications between the ESHO and the teams.

A more detailed response policy and generic guidelines shall be prepared during the Detailed Engineering Design (DED) phase as part of the revised Environmental Management Plan (EMP).

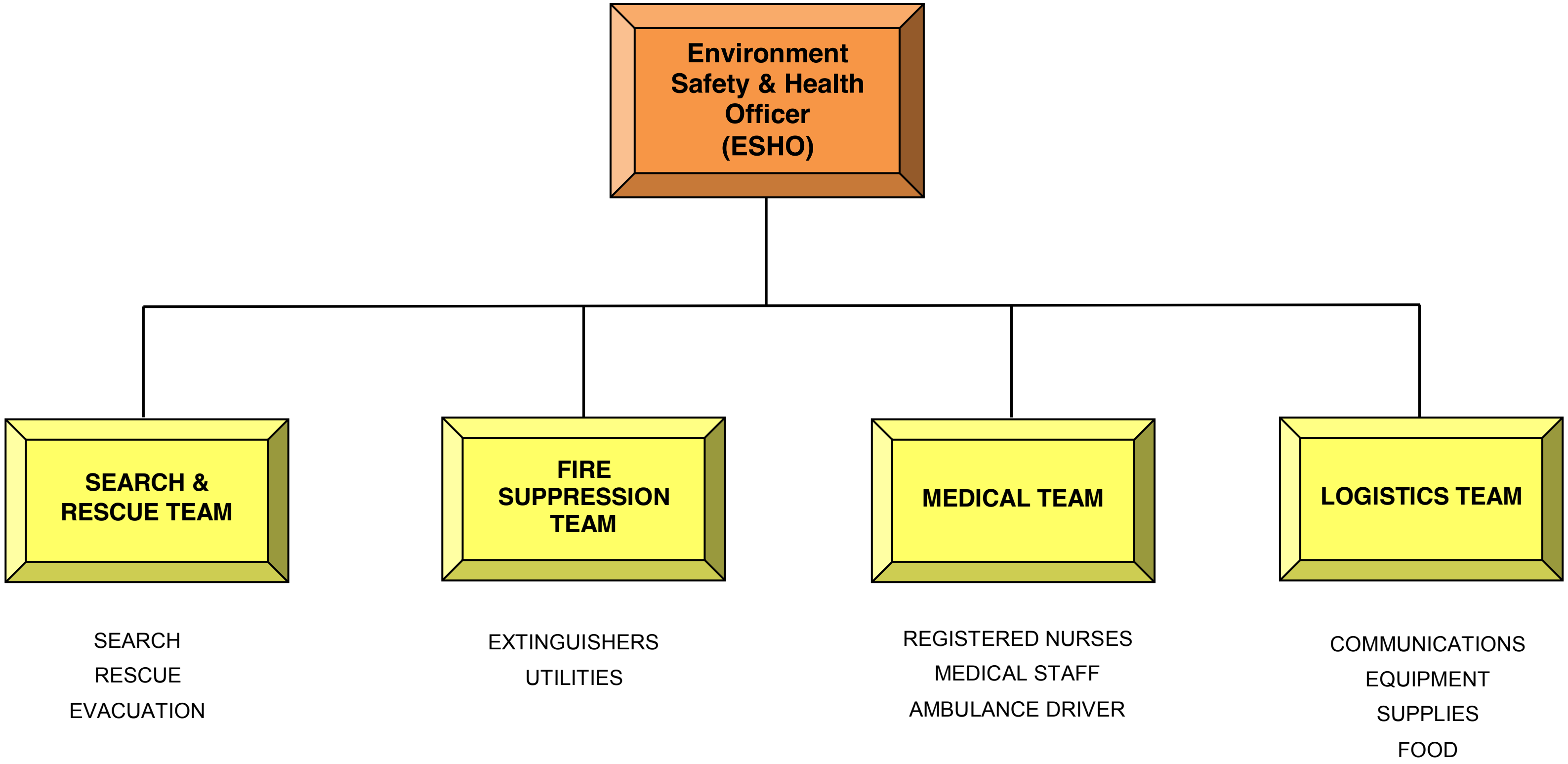


Figure 7.1-1 Emergency Preparedness and Response Team (EPRT) Organizational Set-Up

7.2 OPERATION SYSTEM FOR TUNNEL FACILITIES

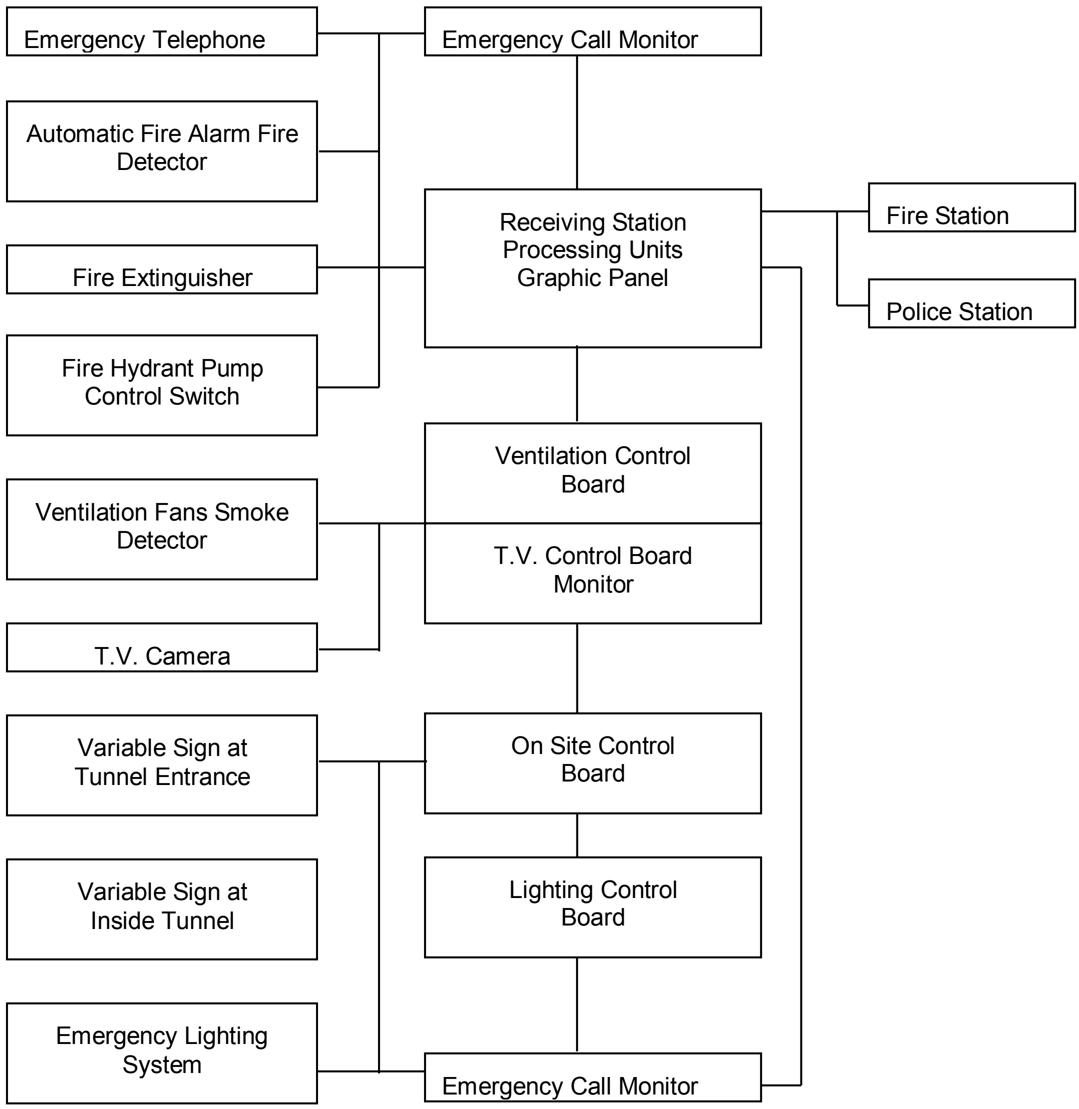
Emergency systems are designed so that all the available facilities and functions are integrated to provide an efficient and rapid response to traffic accidents in the tunnel. An accident in the tunnel is generally reported by emergency telephones and push button equipment or CCTV monitoring. Fire is automatically reported by fire detectors.

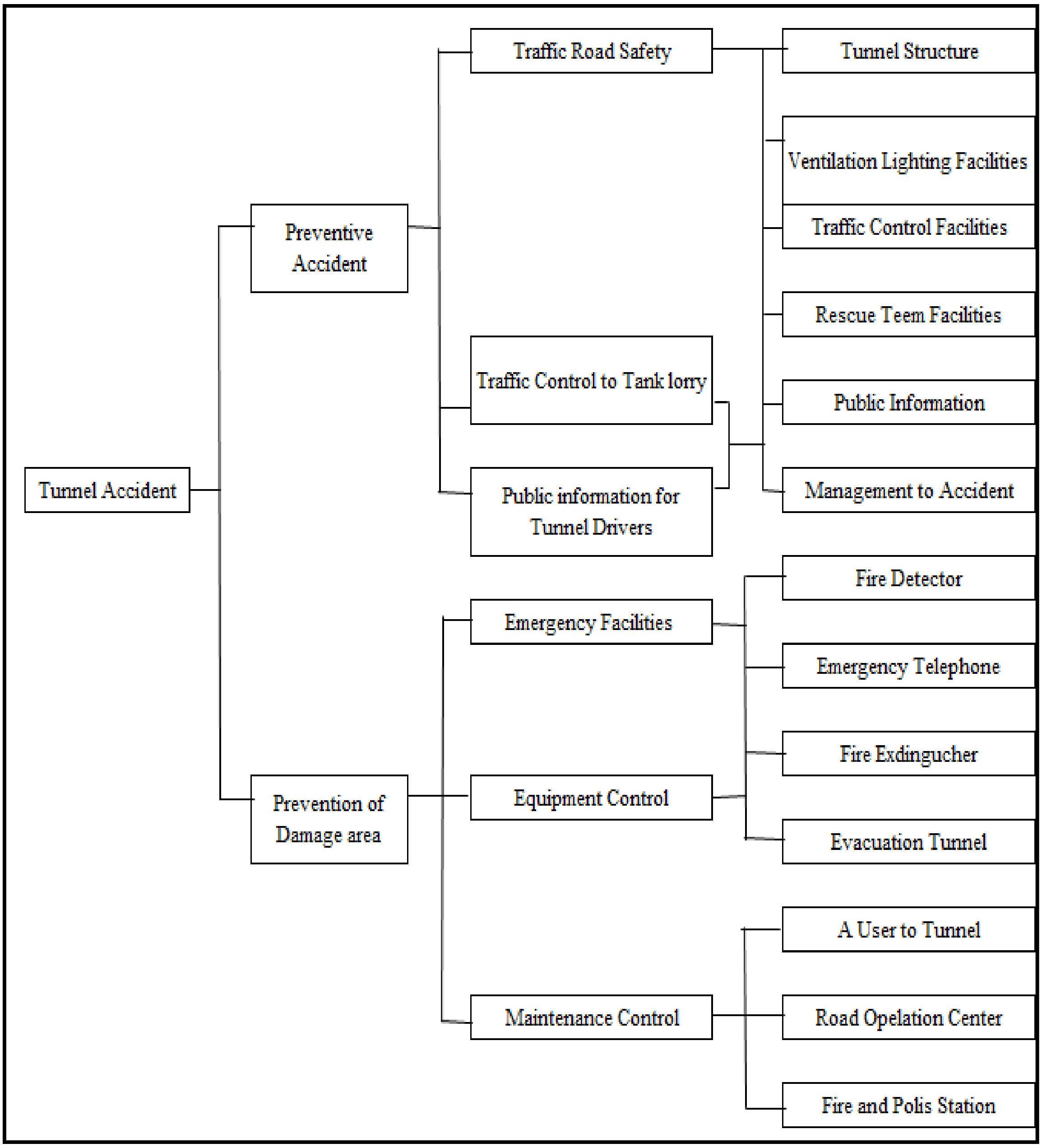
Notification of an emergency is received first by the switchboard of the central control and is transmitted to the administration office in-charge.

The schematic layout of a typical tunnel operation is shown in **Table 7.2.1-1**. On the other hand, the action flow of each accident type is shown in the **Figure 7.2.1-1.**

Table 7.2.1-1 Layout of a Typical Tunnel Operation

In Tunnel	Operation Office Central Control	Associated Organization





Source: JICA Study Team, July 2014

Figure 7.2.1-1 Component Flow of Tunnel Accident

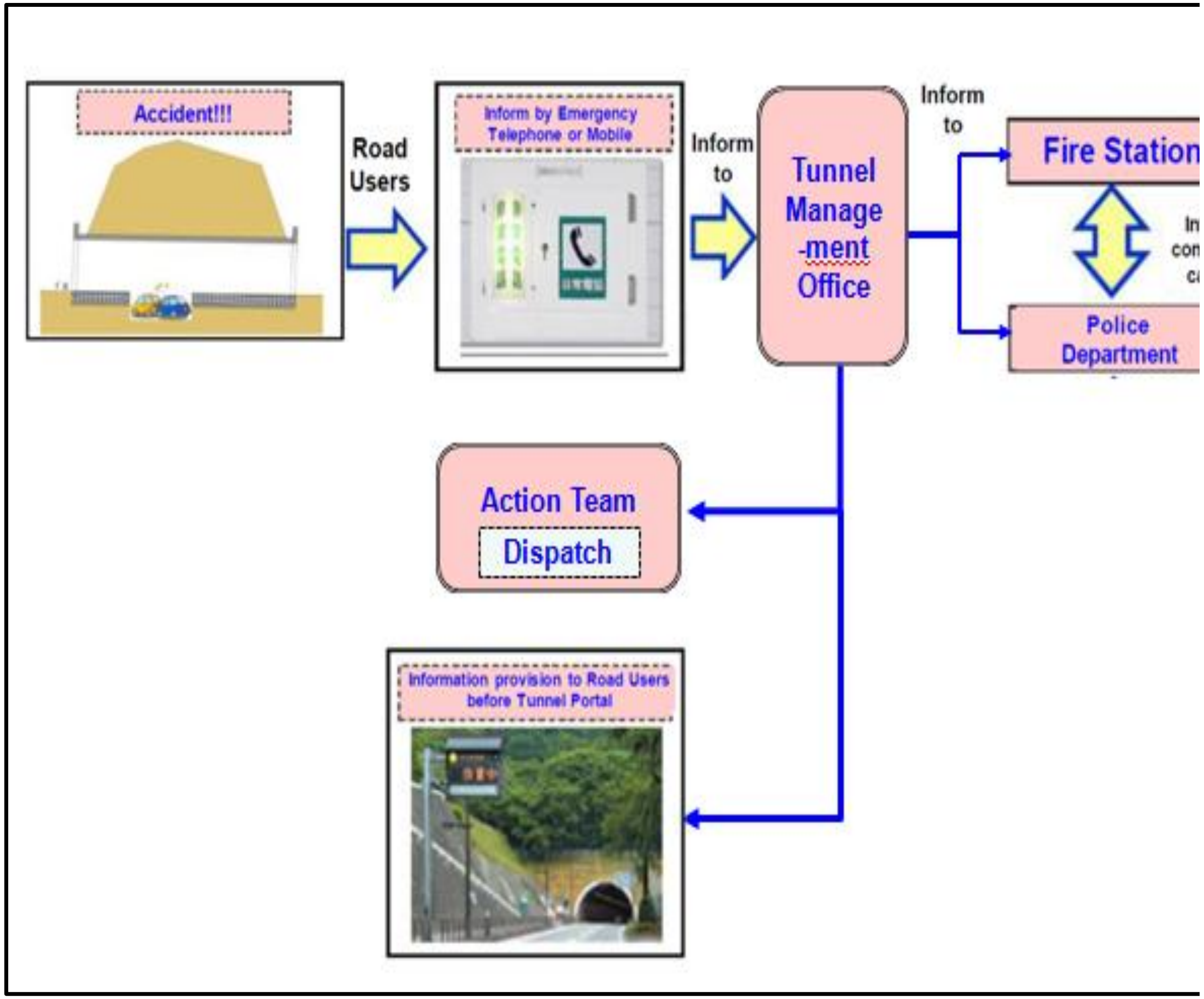
7.2.1 Action Plan During Emergency Incidents

The head of the monitoring team shall immediately decide what to do when some incidents are found or reported from road users. He must decide whether a case must be informed to Action Team, Fire Department and/or Police.

Major incidents are as follows:

- Traffic accident;
- Fire;
- Vehicle breakdown;
- Obstacle dropped from vehicles; and
- Parked/stopped (stalled) vehicles

Actions to be taken during emergency cases are illustrated in **Figure 7.2.1-2**.



Source: JICA Study Team, July 2014

Figure 7.2.1-2 Proposed Organization of Tunnel Management Office

7.2.2 Evacuation Tunnel (Emergency Tunnel)

7.2.2.1 Proposed Evacuation Tunnel

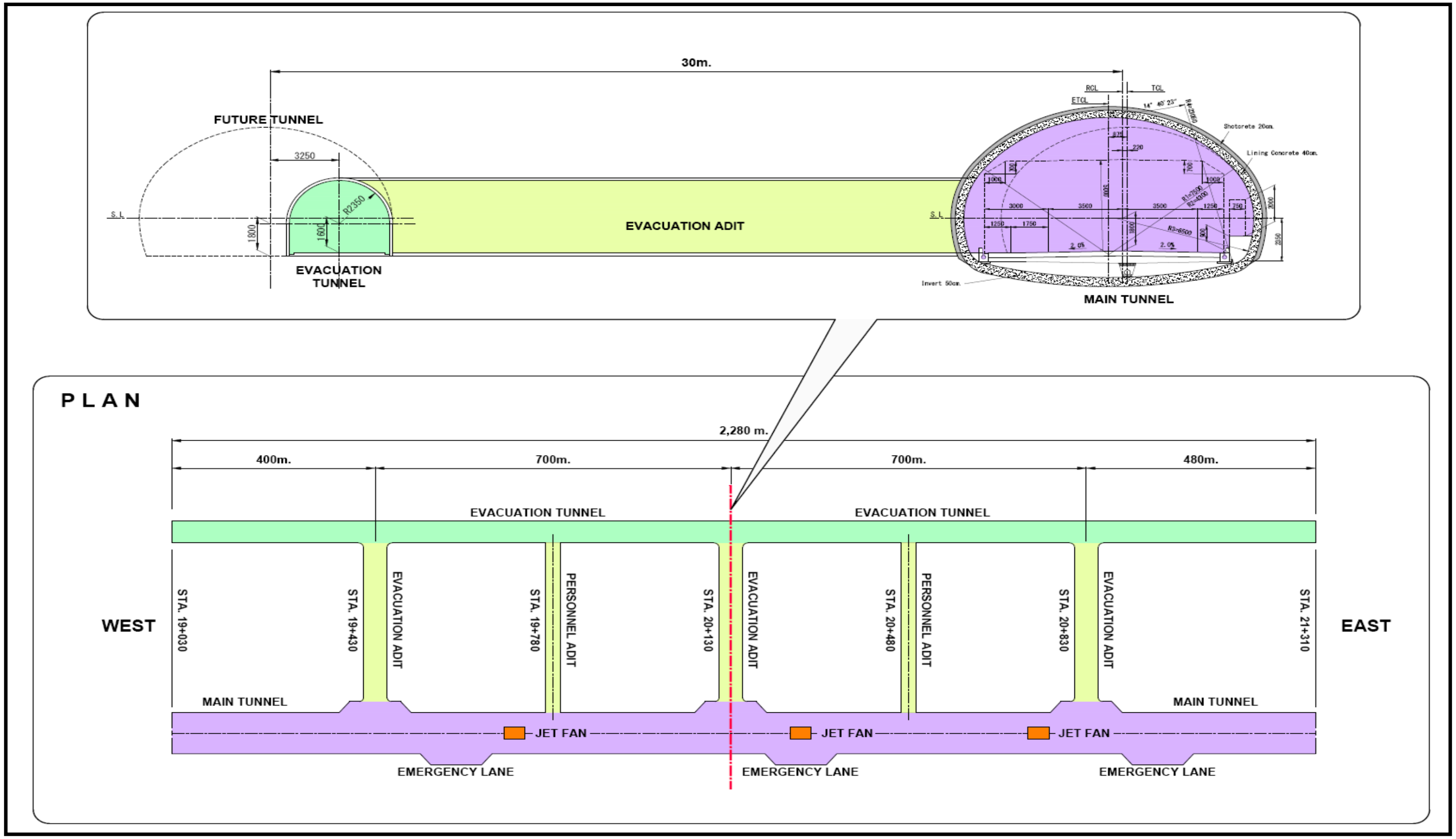
In Japan, an evacuation tunnel is provided for a tunnel with more than **3,000 m**. The Study Team proposes to provide an evacuation tunnel for the Davao City Bypass tunnel, although its length is less than **3,000 m** to secure higher safety for road users during emergency cases.

In case of accidents, road users must assess the situation and do something for evacuation from the tunnel. The facilities especially for emergency exits, user escape from accident point in the tunnel. In this case set up evacuation tunnel shall be established in **2,280 m** length of Davao Bypass tunnel. Below are photos showing the evacuation and the tunnel evacuation exit.

Shown in **Figure 7.2.2-1** is the layout plan of the proposed evacuation tunnel for the Davao City Bypass tunnel.

Photo No. 7.2.2-1 Evacuation tunnel exit. (*Source JICA Study Team, July 2014*)

Photo No. 7.2.2-2 Evacuation tunnel exit. (*Source JICA Study Team, July 2014*)



Source: JICA Study Team, July 2014

Figure 7.2.2-1 Layout Plan for Evacuation Tunnel

8 DEMOBILIZATION/DECOMMISSIONING/ REHABILITATION POLICY

The demobilization/decommissioning/rehabilitation policy referred to here is the restoration plan of the areas directly affected by the construction of the proposed Davao City Bypass Construction Project. It should be noted that a more detailed rehabilitation policy will be prepared and submitted, once the DED is completed.

Prior to abandonment of the construction areas, the Contractors must undertake and comply 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 City of Davao and City of Panabo; and
- Complete restoration/reconstruction of affected public and religious structures

9 INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

9.1 IMPLEMENTATION OF THE EMP

Implementation of the Environmental Management Plan (EMP) shall be undertaken by DPWH Region XI, and DPWH DEO of Davao City and Panabo City who has jurisdiction over the project in coordination with the following entities:

- City Government of Davao and representatives of affected Barangays (*Sirawan, Marapangi, Bato, Alambre, Bangkas Heights, Mulig, Bago Oshiro, Tugbok, Mintal, Tacunan, Magtuod, Waan, Tigatto, Cabantian, Indangan, Communal, Tibungco, Mudiang, Mahayag, San Isido, and Lasang*);
- City of Panabo and Barangay Chairperson of Brgy. J.P. Laurel;
- City Agriculture's Office (CAO), Davao and Panabo;
- City Assessor's Office, Davao and Panabo;
- Health and Sanitation Office of Davao City and Panabo City;
- Urban Poor Affairs Office (UPAO), Davao City;
- Traffic Management Group (TMG), Davao City and Panabo City;
- City Environment and Natural Resources Office (CENRO) of Davao and Panabo;
- Philippine Coconut Authority (PCA) of the Department of Agriculture (DA) Region XI;
- Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB) Region XI;
- DENR-Forest Management Bureau (DENR-FMB) Region XI;
- Bureau of Plant Industry (BPI), Davao City Office;
- Davao City Water District (DCWD),
- National Grid Corporation of the Philippines (NGCP);
- Project-affected sectors including;
  - Davao Light and Power Corporation (DLPC);
  - Holcim Corporation Davao Plant;
  - Alson's Development and Investment Corporation;

- Anflo Management and Investment Corporation;
- Banana Plantation Owners and Contract Growers;
- Coconut Plantation Owners; and
- Peoples' Organizations (POs);

In this section the above key players and their respective roles are described briefly. This Plan shall be updated upon finalization of the Detailed Engineering Design (DED) for the Project.

Shown in **Figure 9.1-1** is the simplified institutional plan for the implementation of the EMP.

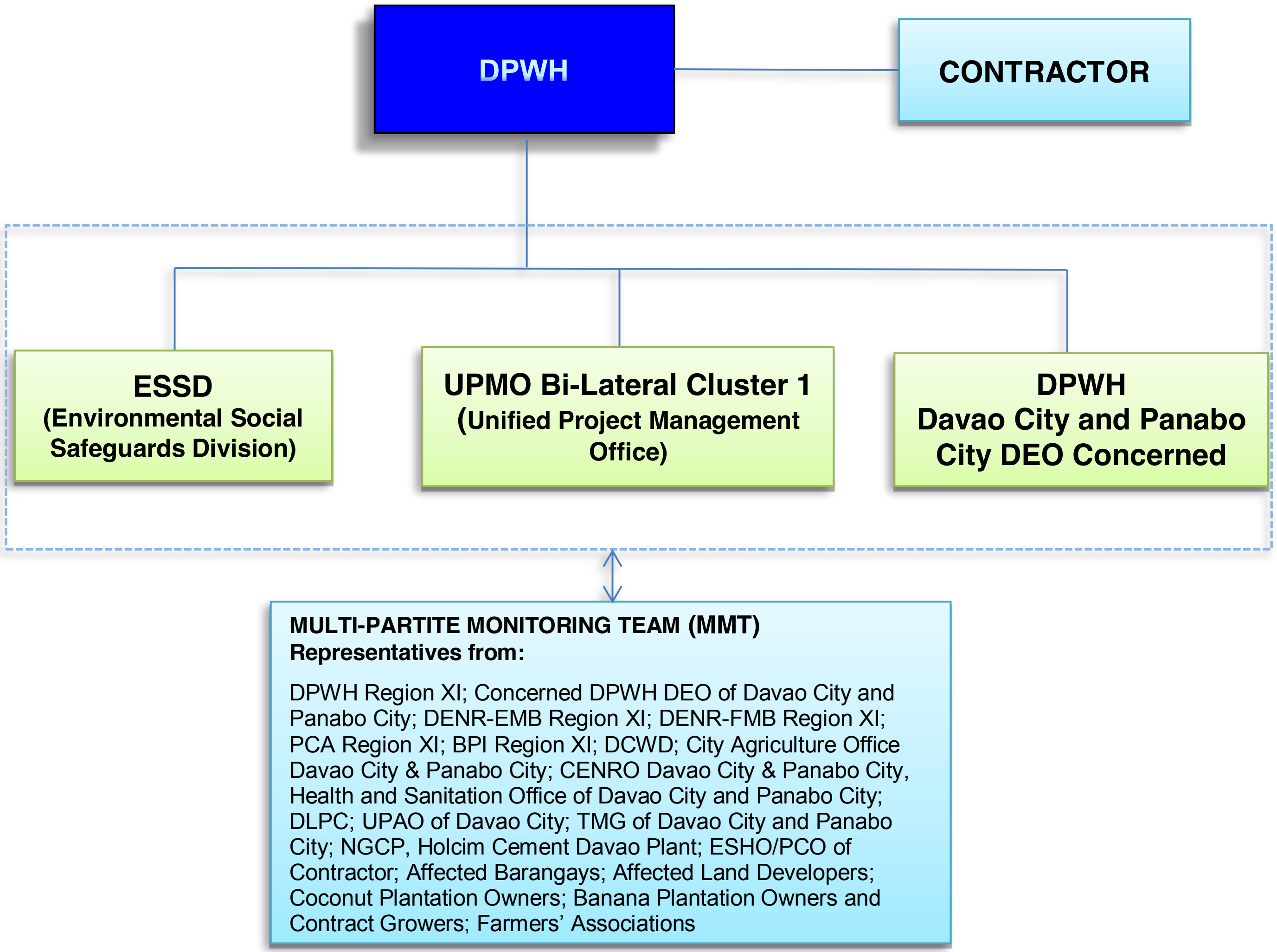


Figure 9.1-1 Simplified Institutional Plan for Implementing the EMP

9.1.1 The DPWH

The Department of Public Works and Highways as the Implementing Agency shall be responsible for providing overall policy and guidance with regards to implementation of the Project under the Project Planning Division-Planning Service (PPD-PS). It shall ensure that all the necessary provisions for implementing the Environmental Management Plan (EMP) and the Environmental Monitoring Plan (EMoP), including budgets and agreements with other concerned national and local government agencies are in place. More specific roles and responsibilities for its offices in charge of the Project and environmental and social safeguards are shown below.

9.1.1.1 The UPMO Bi-Lateral (Cluster 1)

The UPMO Bi-Lateral Cluster 1 will be the Implementing Office (IO) of DPWH for the proposed Davao City Bypass Construction Project. It 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 UPMO Bi-Lateral Cluster 1 shall include:

(i.) Ensure that compliance to all conditions stipulated in the ECC are included as provisions in the Bid Documents to be issued to prospective Contractors;

(ii.) Ensure that all engineering interventions in the approved EMP, RAP, and ECC issued are included in the Terms of Reference (TOR) of the Detailed Engineering Design;

(iii.) Execution of MOA with DENR-EMB Region XI, Davao City and Panabo City LGUs regarding formation and operationalization of the Multi-Partite Monitoring Team (MMT) for implementing the EMoP; and

(iv.) Other necessary roles upon finalization of the RAP during the DED stage

9.1.1.2 The ESSD

The Environment and Social Safeguards Division (ESSD) of the DPWH shall be responsible for:

(i.) Assisting the UPMO Bi-Lateral Cluster 1and the Contractor in the setting up of the Multi-Partite Monitoring Team (MMT);

(ii.) Overseeing the implementation of the EMP by the Contractor/s;

(iii.) Overseeing the updating of the Resettlement Action Plan (RAP) after the DED;

(iv.) Assisting in the conduct of IEC Meetings as enumerated in the IEC Framework of this EIS;

(v.) Monitoring actual payments of compensation to affected landowners, structure owners, and crops/trees owners;

(vi.) In coordination with the Davao City District Engineering Office prepare periodic supervision and monitoring reports on RAP implementation; and

(vii.) Other necessary roles upon finalization of the RAP during the DED stage

9.1.1.3 The Davao City District Engineering Office

The Davao City District Engineering Office shall be the overall responsible for ROW acquisition of needed lots. Specifically their tasks include:

(i.) Conduct negotiations with the affected land and/or structure owners, in accordance with the DPWH Land Acquisition, Resettlement, Rehabilitation and Indigenous People's Policy, or LARRIPP (3rd Ed) and Republic Act 8974 and Its Implementing Rules and Regulations;

(ii.) In coordination with ESSD, monitor progress of RAP implementation; and

(iii.) In coordination with ESSD prepare periodic supervision and monitoring reports on RAP implementation

9.1.2 The Philippine Coconut Authority

As the lead agency of the Department of Agriculture (DA) who has authority over coconut. These include:

(i.) Issue "Tree Cutting" permit of coconut trees;

(ii.) Supervise coconut tree-cutting activities;

(iii.) Guidelines in payment of affected coconut trees (Please Expound);

(iv.) Conduct on-the-spot inspections of the replanting site and regulate and oversee fertilization and care of the newly planted coconut trees;

(v.) Issue transport permits for cut coconut trees

9.1.3 Davao City and Panabo City Affected Barangays' Chairpersons

Concerned Barangay Chairpersons' roles are primarily to:

(i.) Active participation as members of the MMT and City Resettlement Implementation Committee (CRIC);

(ii.) Actively participate in the activities specified in the Social Development and Information Education and Communication Framework described in Chapter 5.

(iii.) Certify *bonafide* residents of their respective barangays in hiring of local labor during the Construction period

(iv.) Other necessary roles upon finalization of the LRIP during the DED stage

9.1.4 The MMT

The Multi-Partite Monitoring Team (MMT) shall be composed of representatives of DPWH and its Contractor and of stakeholder groups, including representatives from Davao City and Panabo City, locally accredited NGOs/POs operating in the community, DENR-EMB Region XI, DENR-FMB Region XI, PCA Region XI, and other sectors that may be identified prior to implementation. The MMT shall be tasked to undertake monitoring of compliance with ECC conditions as well as the EMP. During construction period the MMT shall submit a semi-annual monitoring report for each year.

EMB Region XI shall formulate guidelines for operationalizing area-based or cluster- based MMT. The Bureau may also develop guidelines for delegating monitoring responsibilities to other relevant government agencies as may be deemed necessary.

Significant environmental impacts stated in the IMP are not expected to persist after the construction phase, and could be addressed through the mandates of concerned LGUs. The operations of MMT may be terminated upon project completion and upon compliance with the decommissioning plan.

The MMT shall be organized through a Memorandum of Agreement between DPWH and project LGUs (represented by Barangay Chairpersons), other NGOs operating in the area. Their main roles are:

General (In accordance with the DAO 2003-30 Revised Procedural Manual):

(i.) Validate project compliance with the conditions stipulated in the ECC and the EMP;

(ii.) Validate DPWH's conduct of self-monitoring;

(iii.) Receive complaints, gather relevant information to facilitate determination of validity of complaints or concerns about the project and timely transmit to the Proponent and EMB recommended measures to address the complaint;

(iv.) Prepare, integrate and disseminate simplified validation reports to community stakeholders; and

(v.) Make regular and timely submission of MMT Reports based on the EMB-prescribed format

Specific:

(i.) Observe/participate as applicable during conduct of monitoring activities;

(ii.) Coordinate with the Pollution Control Officer (PCO) of Contractors assigned to the Project, to ensure that conditions stipulated in the ECCs are properly complied with, including the gathering of baseline data on air and water quality, and subsequent monitoring of such;

(iii.) Notify DPWH ESSD about any act or activity by the Contractors that are deemed as violations to the stipulations in the ECCs and amendments issued, and recommend immediate courses of action to avoid or mitigate any violation to said stipulations; and

(iv.) Compile monitoring data gathered by the Contractors and supervise preparation of semi-annual monitoring reports to be submitted to the DENR

9.1.5 The Contractor

The Contractor shall be jointly responsible for implementing the EMP, and liable to any and all sanctions and penalties to be incurred by DPWH in relation to non-compliance to conditions set in the ECC. It shall provide the necessary funds for implementing the EMP. As previously stated it shall be jointly (with DPWH) responsible for:

(i.) Ensuring that all engineering interventions in the approved EMP, RAP, and ECC issued are included in the Terms of Reference (TOR) of the Detailed Engineering Design;

(ii.) Be a Party to the MOA with Davao City and Panabo City regarding formation and operationalization of the Multi-Partite Monitoring Team (MMT) for implementing the EMoP; and (iii.) Other necessary roles upon finalization of the RAP during the DED stage

9.1.6 Holcim, POs and NGOs (Banana Contract Growers, Banana Plantation Owners, Coconut Plantation Owners, and Farmers' Associations)

Representatives of project-affected owners and operators of agricultural (mainly banana) and industrial (coconut) crops, as well as industrial entities shall be represented to MMT to be formed. Other pertinent Peoples' Organizations, particulary women's organizations as well as Non-Government Organizations are also recommended to be part of the MMT. The envisioned roles are:

(i.) Actively participate in ALL activities of the MMT;

(ii.) Receive complaints from Barangay Homeowners' Associations, women's organizations, and other concerned sectors;

(iii.) Gather relevant information to facilitate determination of validity of complaints or concerns about the project;

(iv.) Promptly transmit to the MMT recommended measures to address the complaint; and

(v.) Prepare, integrate and disseminate simplified validation reports and feedback to community stakeholders

SWORN STATEMENT OF ACCOUNTABILITY OF PREPARERS

This is to certify that all information in this **ENVIRONMENTAL IMPACT STATEMENT**for the **DAVAO CITY BYPASS CONSTRUCTION PROJECT** are accurate and complete to the best of our knowledge, and that an objective and thorough assessment of the Project was undertaken in accordance with the dictates of professional and reasonable judgment. Should we learn of any information which would make EISinaccurate, we shall immediately bring the said information to the attention of the DENR-EMB.

We hereby certify that no DENR-EMB personnel was directly involved in the preparation of this **EIS** for the **DAVAO CITY BYPASS CONSTRUCTION PROJECT** other than to provide procedural and technical advice consistent with the guidelines in the DAO 03-30 Revised Procedural Manual.

We hereby bind ourselves jointly and solidarily to answer any penalty that may be imposed arising from any misrepresentation or failure to state material information in this**EIS**.

In witness whereof, we hereby set our hands this 14 day of AUG 2014 at QUEZON CITY.

NAME		FIELD OF EXPERTISE	SIGNATURE
1.	ANNABELLE N. HERRERA	Environmental & Social Impact Assessment	
2.	CARLO D. DAYANGHIRANG	Geology& Geo-Hazard Assessment	
3.	MARIO P. SANDOVAL	Hydrogeology	
4.	JAIME A. NAMOCATCAT, Ph.D.	Ecology and Environmental Impact Assessment	
5.	CHARLON M. GONZALES	Meteorology/Air & Noise Quality	

SUBSCRIBED AND SWORN TO before me this 14 day of AUG 2014 2014, affiants exhibits their Community Tax Certificate information, as follows:

NAME		Community Tax Certificate Information		
		CTC NO.	Place of Issue	Date of Issue
1.	ANNABELLE N. HERRERA	CCI201209332916	Quezon City	17 January 2014
2.	CARLO D. DAYANGHIRANG	CCI201210881741	Makati City	21 January 2012
3	MARIO P.SANDOVAL	CCI201207798728	Quezon City	17 February 2014
4.	JAIME A. NAMOCATCAT, PhD.	CCI201036781694	General Santos City	14 July 2014
5.	CHARLON M. GONZALES	CCI201218194399	Valencia City, Bukidnon	06 January 2014

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Series of 2014

ATTY. DELFIN R. AGCAOILI, JR.
NOTARY PUBLIC
UNTIL DECEMBER 31, 2014
PTR NO. 2413185 / 12/4/13 / M.M.
IBP NO. 943989 / M.M.
ROLL NO. 24655 / TIN-144519868
MCLE COMPLIANCE IV-0013521
UNTIL APRIL 26, 2016

SWORN STATEMENT OF ACCOUNTABILITY OF PROPONENT

This is to certify that all the information and commitments in this **ENVIRONMENTAL IMPACT STATEMENT REPORT** for the **DAVAO CITY BYPASS CONSTRUCTION PROJECT** are accurate and complete to the best of our knowledge, and that an objective and thorough assessment of the Project was undertaken in accordance with the dictates of professional and reasonable judgment. Should I/we learn of any information, which would make this **ENVIRONMENTAL IMPACT STATEMENT REPORT** inaccurate, I shall immediately bring the said information to the attention of DENR-EMB.

I hereby certify that no DENR-EMB personnel was directly involved in the preparation of this **EIS** for the **DAVAO CITY BYPASS CONSTRUCTION PROJECT** other than to provide procedural and technical advice consistent with the guidelines in the DAO 03-30 Revised Procedural Manual.

I hereby bind myself to answer any penalty that may be imposed arising from any misrepresentation or failure to state material information in the **ENVIRONMENTAL IMPACT STATEMENT**.

In witness whereof, I hereby set my hand this ____ day of __________ at ______________________.

____

MARIA CATALINA E. CABRAL Ph.D.
Assistant Secretary
Planning & PPP-DPWH

SUBSCRIBED AND SWORN TO before me this _____ day of ____________ 200_, affiant exhibiting his/her Community Tax Certificate No. ___________________ issued at ______________________ on __________________________.

Doc. No. ___________________
Page No. ___________________
Book No. ___________________
Series of ___________________

Table V Summary of Issues, Concerns, Comments, and Suggestion During Public Scoping Meetings with the Project Affected Persons (1/6)

Queries/Concerns/Suggestions/ Comments	Responses To Queries
Plans on existing roads to be intersected by the bypass alignment	Existing roads will be maintained; The type structure to be built at the intersections shall depend on the type of road to be intersected
Schedule of project implementation;	No definite time table of project it would depend on the processing and approval of permits required
If owners of lands to be affected by the bypass alignment be compensated	Yes. The first option of the government is to negotiate with the land owners to donate the affected land. If the landowner declined to donate, the government will then offer compensation based on the present BIR zonal valuation of the property
If ALSONS' existing development project in Brgy. Cabantian was considered in the bypass alignment selection	Yes all developments along the bypass alignment were considered in the alignment selection process.
Possibility that the proposed bypass road will traverse through ALSONS existing development project in Brgy. Cabantian	Alignment will be finalized during the conduct of the DED; Representatives of the ALSONS developer were advised to write a letter to the DPWH Central Office asking for a copy of the alignment map to address the concern
Entitlements of the landowners on top of the tunnel section;	Entitlements of the landowners on top of the tunnel section will have to be consulted with the DENR-LMS (Department of Environment and Natural Resources-Land Management Services);
Compensation for affected residential structure owners or communities on the top of the tunnel section tunnel section	Resettlement of existing communities and/or compensation residential structure owners on top of the tunnel section will not be necessary since the tunnel opening will be at least 200 m below the surface. In addition, construction of the tunnel section will employ modern technologies without blasting activities
Request for a copy of the bypass alignment map	Only the DPWH is authorized to release a copy of the alignment map
Clarification on ownership of mineral resources is noted	All mineral resources found within the country is owned by state as stipulated in the constitution
Confirmation if the area (length) to be affected in Brgy. Catalunan Grande is 100 m	The length provided in the presentation is only an estimate and may be adjusted once the DED is finalized
Time frame of project completion	Implementation and completion date of the project cannot be determined yet as the project is still in the FS stage
Consideration for affected IPs who are categorized as informal settlers	A Resettlement Action Plan (RAP) will also be prepared to address the concerns of both formal and informal settlers in the affected area, especially IPs
Security cameras should be installed in the tunnel section of the bypass road	The suggestion was noted.
Structural integrity of the road should be considered with respect to potential occurrences of high intensity earthquakes	Aside from the study undertaken by the geologist of the JICA Study Team, a geo-hazard specialist who is a member of the EIA Study Team will conduct a thorough geological study along the alignment, particularly at the tunnel section to ensure stability of the structure to be constructed
If law on eminent domain will be exercised during the ROW acquisition	DPWH will first negotiate and offer the landowner compensation based on the present Bureau of Internal Revenue (BIR) zonal valuation. If the landowner refuses to settle, only then will the government exercise its power of "Eminent Domain"

Table V	Summary of Issues, Concerns, Comments, and Suggestion Raised During Public Scoping Meetings with the Project Affected Persons (2/6)
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
Locals should benefit from the project through employment and short-term business opportunities	Priority in hiring of qualified workers in the impact areas is stipulated as one of the conditions of the ECC. Qualified workers in the direct impact area (DIA) will only be required to secure endorsement from the Brgy. Chairman as a proof of residency in the area
Probable safety hazard to farmers accessing their lands adjacent to the bypass road	The type and size of culverts to be constructed at barangay road intersections will be designed in consideration with the farm implements utilized by the farmers to ensure safe and unhampered access to farmlands
If the signature of the brgy. Chairman, its officials or representatives will bind the barangay's approval to the project	No. The Scoping Matrix to be signed will only serve as proof that a public scoping took place and the issues and concerns raised are true and correct
Include budget for widening and improvements of roads to be intersected by the bypass road and other adjacent roads	The suggestion is noted. The budget for the implementation of the proposed bypass road will have a different source from the widening and improvements Barangay and Provincial Road
Supervision of the project's implementation should be handled by JICA to ensure completion of the project on the scheduled date	The suggestion is noted
Exact area to be traversed by the alignment in J.P. Laurel; A residential area will need to be resettled if alignment will traverse through the left side of J.P Laurel from Lasang	The alignment will not traverse the residential area. The bypass road will end approximately 100 m away from said area.
The terminus of the alignment is very close (approximately 200 m) to the approved flyover by the Governor crossing the proposed Circumferential Road near the Dacudao Subdivision	The issue is noted and will be referred to the JICA Study Team for further review
Close coordination with the LGUs must be carried out to consider future projects that may be affected by the bypass alignment;	A series of coordination meetings with the LGUs has been conducted since the start of the project survey. The Public Scoping Meeting which is an integral part of EIA study is another form of information campaign conducted on a barangay level;
Possible stagnation of water along natural waterways crossed by the alignment in Brgy. Mahayag due to improper management of construction spoils and debris, which may also cause dengue outbreak	The concern raised is noted. Part of the EIA study is the assessment of waterways crossed by the alignment to ensure possible water stagnation and/or pollution of affected rivers and creeks will not occur
If Piatos Elementary School in Brgy. San Isidro will be affected by the alignment	Piatos Elementary School will not be affected.
If coconut trees to be cut will be given to the land owners	Once the DPWH purchased the property for ROW purposes, everything will be included in the payment. The cut coconut trees will be turned over to DENR-FMB (Forest Management Bureau)
If there will be a disturbance compensation for the land owners	A RAP will be prepared and implemented prior to construction of the project to ensure compensation of all affected PAPs are properly settled
Classification of the bypass road, national or expressway;	The proposed bypass is a national road;
Exact areas to be traversed by the alignment must be identified the soonest possible time so as not to cause delay in the priority development projects planned by the barangay	The exact areas to be traversed by the alignment could only be identified once the parcellary survey is undertaken during the DED stage
Schedule of the final survey of the alignment	There is no definite schedule for the final survey of the alignment yet

Table V Summary of Issues, Concerns, Comments, and Suggestion Raised During Public Scoping Meetings with the Project Affected Persons (3/6)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
If which has the higher valuation between industrial agricultural lands;	Industrial lands have higher valuation compared to agricultural lands;
If a separate consultation with the affected landowners will be undertaken	A barangay level consultation meeting will be undertaken in the impact areas, wherein all the stakeholders and will be invited, including the affected land owners
If the land owners to be affected based on final alignment survey could express objection	Yes. However, the government can exercise its power of eminent domain, after which the land owner may contest it through court proceedings
Management of the remaining **30 m** ROW to prevent informal settling (if the entire 60 m ROW will be acquired at once)	There should be a concerted effort between the barangay and city officials, with the participation of the police force to discourage possible informal settlement in the remaining idle **30 m** ROW
Valuation standard to be adopted in the compensation of coconut and banana tree (industrial crops)	Compensation on coconut trees will be based on existing guidelines of the Philippine Coconut Authority (PHILCOA), while payment on banana trees will be according to the current valuation standards of the Department of Agriculture (DA)
If local road users could utilize the bypass road	Yes local road users can access the bypass road as it will be just a national road
Confirm if the proposed bypass road will pass through the existing DA ROS Livestock and Poultry farm in Brgy. Bago Oshiro	The selected bypass alignment will traverse through the DA-ROS livestock farm in Bago Oshiro. However it is not final yet and is still subject to changes
Clarification if the road to be constructed is a new road or will just use existing roads and implement widening	The proposed bypass alignment is a new road; A culvert or a flyover bridge will be constructed at road intersections to maintain existing roads
Clarification if the gymnasium inside the Davao City Treatment and Rehabilitation Center for Drug Dependents (DCTRCDD) in Bago Oshiro will be affected by the alignment	Based on the FS, the proposed bypass road alignment will affect the existing gymnasium inside the DDCTRCD but this will still be validated during the parcellary survey
If the bypass road will affect the warehouse being constructed beside RCBD	Based on the FS alignment, the warehouse will be affected but will still be validated once the parcellary survey is conducted during the Detailed Engineering Design (DED)
If blasting methodology will be adopted during construction at the tunnel section	Results of the study undertaken at the tunnel section showed that the geological profile identified in the area is categorized under the soft type, therefore blasting is not necessary during construction of the tunel
Possible occurrence of slope failure at the tunnel section area due to existence of fault lines	The structural integrity of the tunnel structure will be the utmost concern of the Design Team. The tunnel structure will be designed with consideration to the existing fault lines and other geological factors to ensure its stability to withstand high intensity earthquake occurrences
Possible loss/damage of spring water resources in the tunnel section	Part of the Environmental Impact Assessment (EIA) is to identify existence of natural water sources to assess the potential effects of the project and recommend appropriate mitigation measures
Entitlements of settlers whose application of sales patent is still in process;	This concern is noted and will be referred to the DENR-LMS;
If the landowner has rights to any natural resources or treasures that maybe extracted from his property, particularly at the tunnel section	The landowner only has surface rights to his land. According to the national law, mineral resources found within the country's land such as gold are considered as property of the state

Table V Summary of Issues, Concerns, Comments, and Suggestion Raised During Public Scoping Meetings with the Project Affected Persons (4/6)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
Compensation on affected lands with existing ownership dispute	Compensation will be settled once ownership of the land is determined
If schools to be affected by the proposed bypass alignment will be relocated	Yes. As much as possible re-alignment of bypass sections affecting educational facilities and other institutional structures will be considered. If cannot be avoided, coordination with the agency will be undertaken
Close coordination with Urban Development and Housing Authority Office (UDHAO) and Urban Poor Affairs Office (UPAO) must be undertaken to prevent violent encounters with the informal settlers during relocation	The issue is noted. The UDHAO and UPAO should be involved to ensure peaceful relocation procedure
If toll fee will be collected from the bypass road users	The bypass road is just a National Highway, not an expressway so no toll fee will be collected
Clarification on which San Isidro Labrador church will be affected by the bypass road project in Brgy. Mintal	The San Isidro Labrador Church next to along Mintal Road might be affected by the alignment
If affected informal settlers will be relocated	Affected informal settlers will be relocated. The LGU concerned will provide the relocation lot, while the DPWH will assist in the development of the relocation site;
If alternative livelihoods will be provided affected informal settlers	The RAP to be prepared and implemented prior to the construction of the proposed bypass road shall include livelihood restoration and improvement program designed for the identified Informal Settlers and PAPs
If the project is funded through a loan or grant	The feasibility study phase of the project is a grant from JICA
If the government will shoulder all the project costs for implementation;	The government may obtain the funding for the project through loan from international lending institutions such as World Bank if not from JICA;
Years of the payment term for the loan;	The standard loan term is 30 years
If JICA will supervise the implementation of the project	Yes, JICA will supervise up to the implementation of the project
Clarification if the compensation for the JICA personnel who will supervise the project's implementation will be part of the grant by the Japanese government	Compensation for JICA personnel will be part of the project cost to be loaned
If the stakeholders will be informed of the result of the EIA study	Yes the DENR-EMB will provide a copy of the EIS document to the LGUs
A suggestion was made to start the bypass alignment along the planned barangay road in Sirawan	If alignment is adjusted further south to the connect to the planned Barangay Road in Sirawan, DPWH will need to construct a bridge that will cross the Sirawan River which will be more costly
Construct the bypass parallel/adjacent to the existing transmission towers within the Nenita's Farm property	Based on the map shown by Mr. Flores and the alignment map, the proposed bypass road will basically traverse parallel to the existing transmission towers inside the Nenita's Farm property
Concern on soil erosion along the section of the alignment near the horse race track (adopt adequate soil erosion measures)	Suitable and adequate slope protection measures at sections identified as erosion-prone areas shall be considered in the design
The proposed bypass road may aggravate the existing problem of flooding in low-lying areas due to inefficient drainage systems like those installed along Davao-Tagum Road	Well engineered drainage systems will be installed along the bypass alignment to ensure that it will not aggravate the existing flood problem experienced in the adjacent low-lying areas

Table V Summary of Issues, Concerns, Comments, and Suggestion During Public Scoping Meetings with the Project Affected Persons (5/6)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
Concern on the presence of fault lines along the alignment	A geo-hazard specialist, who is a member of the JICA Study Team is undertaking the study on the existing ground hazards, particularly at the tunnel section. The findings will be included in the EIS report to be submitted to the DENR
Existing rivers and waterways crossed by the proposed alignment might be filled up with earth materials (embankment and fill materials, and construction spoils) and will be rendered useless which may cause flooding in the adjacent areas	Culverts and/or bridges will be constructed along the waterways to be crossed by the alignment; Well engineered drainage systems will installed along waterways to ensure flooding will not occur; and Mitigation measures to ensure proper management of fill and embankment materials as well as construction spoils and debris will be included in the EIA Study to be undertaken
If access points to and from barangays traversed by the alignment will be provided	All roads to be intersected by the bypass alignment will be maintained; and It will be determined during the DED if access point to and from barangays traverse by the alignment will be provided
If farm to market roads from the tribal communities in the upland areas will be provided will be included in the project	Provision of farm-to-market road in the upland tribal communities is not part of the proposed bypass road project; The concern will be referred to the Davao City LGU
A suggestion was made to conduct an extensive study for the proposed bypass project	The suggestion is noted. The EIA study will cover all the aspects of the environment for assessment and mitigation measures will be recommended to minimize the negative impacts of the project
If the proposed bypass will be implemented	Yes the proposed bypass will have to be constructed to address the present traffic congestion in the Davao City
How was the tunnel section conceptualized	The tunnel was conceptualized to avoid resettling the communities on the top of the mountain and disturbing a great number of trees that needs to be cut down
Depth of the tunnel from the surface	The proposed depth of the tunnel from the surface will be **200 m**
Bypass sections traversing flood-prone areas like Waan-Tigatto area might be submerged during occurrence of flash floods	A comprehensive hydrological study will be undertaken at flood risk areas to determine the type of structures to be constructed to prevent flooding
Width of the road way at the tunnel and highway section	The bypass road construction will be initially constructed as a **2-lane** road. The carriageway of the highway on embankment and cut sections will be **3.5 m** on each direction, with **2.5 meter** shoulders on each side, and a **2 meter** shoulder margin. The total road width is approximately **16 m**. At the tunnel section, the carriageway is **3.5 m** on each direction and a **1.25 m** shoulder on each side, with a roadway width of **9.5 m**
By tradition, Muslims does not allow mosques to be relocated	Since the alignment is not final yet, re-alignment at sections which will affect school, church, and mosques will still be considered. If re-alignment is not possible, then a series of consultation meetings will have to be undertaken with the concerned groups
Housing developments in Tigatto may have caused the occurrence of flash flood in the area due to inefficient drainage system	This concern is noted. Mitigating measures on existing flooding will be undertaken

Table V Summary of Issues, Concerns, Comments, and Suggestion During Public Scoping Meetings with the Project Affected Persons (6/6)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
By tradition, Muslims does not allow mosques to be relocated	Since the alignment is not final yet, re-alignment at sections which will affect school, church, and mosques will still be considered. If re-alignment is not possible, then a series of consultation meetings will have to be undertaken with the concerned groups
If the area on the mountain's surface at the tunnel section may still be utilized after construction of the project	The community may utilize the area on the top of the tunnel since the depth is relatively deep
If land owners refuse to allow the study team to conduct a soil test pit (insinuation of treasure hunting)	Only a sample of the soil on the area is needed for the soil test pit; Soil test pit is intended only for identifying the soil structure of the area to be traversed by the alignment; The land owner may witness the soil test pit DENR-EMB RXI representative, Mr. Benigno Rivera explained that the Brgy. Matina Biao area has limestone formation and the rock type exhibits high permeability. The soil testing is significant to determine the soil characteristics in that particular area and consider it during the design phase to prevent possible water seepage which may lead to collapse of the tunnel; DPWH-ESSD (Environmental and Social Services Division), Manila office representative Engr. Ma. Victoria O. Lofamia added that the land area to be traversed by the alignment needs to be tested to identify the soil characteristics up to a certain layer only. If identified as unsuitable for road construction, the soil will be removed and replaced by a more suitable soil for road construction
Clarification if JICA is a contractor or not	JICA is not a contractor but a Japanese Government agency funding feasibility studies on infrastructures projects
If contractors will bid for the bypass construction	There will be a national bidding of both local and international contractors. The selected contractor will construct the bypass project
Maintenance of tunnel is comparatively more expensive	All National Roads are maintained by the DPWH, which includes the proposed bypass project; Most likely, DPWH will consider the use of solar energy as a source of electricity at the tunnel section; and A possibility that the tunnel section may be tolled to mitigate the maintenance cost (cost on security cameras, source of electricity, safety, etc.)

Summary of Issues, Concerns, Comments, and Suggestion Raised During Consultation Meetings with the Project Affected Persons (1/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
Barangays *Cabantian, Indangan and Communal* Concerns/Comments	
• Who will be the point persons or offices that we can refer to the land owners that would have future concerns on their rights and other claims?	• Clarified the stages that the project will be undertaking and the purpose for inviting the possible PAPs of the bypass. The final list of PAPs will be determined during the parcellary survey which will take place after the detailed engineering design • Another consultation meeting will be conducted after the parcellary survey wherein the PAPs will be informed as to who will assist them on their concerns
• If land owners would say 'no' to the project, will the project still push through?	• As discussed, the last option that the government will take is the expropriation procedure because based on the constitution, the government can take any property for public use with just compensation • Explained the expropriation procedure
• Clarified for the benefit of the land owners that the property owner cannot say no if their property will be needed by the government for public use	• Noted
• Suggests to have an intensive information dissemination for the PAPs so that PAPs will understand that this government project is for the development of their area and that land owners would not be surprised of the processes that the government might be taking in the future map	• Explained the main purpose of conducting the meeting is to properly inform the affected community of the project and processes that the government will be taking into consideration—in line with the national laws as part of developing the project.
• Suggests that DPWH should consider compensating for the land based on the market value on the year when the government would acquire the land and not based on the value when the owner had bought their property.	• The Provincial Appraisal Committee will update the BIR Zonal value of the lands if the BIR Zonal value of the area is not updated. As part of the process, DPWH will not compensate for any land without passing through Commission on Audit (COA) and COA requires that the current prevailing market value should have supporting legal documents. • Suggests that transactions on land acquisition should be declared to BIR based on the actual transacted value to support the claims on current prevailing market value
• Requested a copy of the alignment	• During the FS stage, the alignment may still change, it would be best to request for a copy of the alignment after the detailed engineering design where it will be finalized • Avoiding speculations among the communities is also one reason why the alignment should be disclosed after the detailed engineering design
• Are lot owners not allowed to make development on their properties between now and on March 2016? • Only until March 2016 will we be able to know if our properties are affected or not?	• Private land owners have all the rights to develop their lands • Yes, after the detailed engineering design • *Note: Ambassadors for Christ is planning to extend church building*

Summary of Issues, Concerns, Comments, and Suggestion Raised During Consultation Meetings with the Project Affected Persons (2/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• Length of the road that will be traversing through Brgy. Cabantian	• Approximately 2km.
• Will the government also pay for the agricultural products on the affected lands?	• Aside from structure compensation, there will also be compensation for agricultural and industrial products on the affected land areas
• Lot owner's assurance that they can still find a similar land to develop as replacement to the land that will be lost	• There is no land for land replacement on the present law, however the team committed to do their best to recommend for this arrangement for the benefit of PAPs with small properties
• On tunnel section, will the government pay for the land even if the road will only be built passing through the mountain?	• Explained the new supreme court ruling on land ownership • If land owner wants to be paid even if they're not directly affected, the government will compensate them for their property and the land owner has to leave their area as it will become a government property or they can negotiate to be compensated a percentage only of the land since the road will be constructed 200m from the ground surface
• Emphasized a point for the benefit of the land owners that they cannot name a high value for their property if what has been declared to the BIR is actually lower than that of claimed	• Lot owners can still demand for a higher valuation if they have supporting documents to prove their claim through the expropriation procedure
• Is there a way of knowing specifically which part of their property the bypass would traverse?	• Information on the final areas where the bypass would traverse will only be determined after the detailed engineering design • Explained the process on developing the project
• Will there be another land survey between now and August? As there are some people who surveyed the area without asking permission to the land owners	• There will no longer be a land survey as FS is already finished but there will be some ground investigation to verify the number of affected crops in the area; this is for budgetary purposes
• There are some people that went inside the property doing the land survey without asking permission to the land owners	• Apologized in behalf of the JICA Team • *Note: Surveying group was already strictly instructed to ask permission to Brgy. Captains and land owners*
• Suggestion: surveyors should wear IDs so that the community would recognize them	• Noted
• How long will the land owners be paid once the project is approved?	• Addressed by DPWH: more or less two months if the documents are complete
Barangays *Lasang, Mahayag, Tibungco, San Isidro and Bunawan* Concerns/Comments	
• If property is only 300m^2 and bypass project will have to use 250m^2 of the land, can the government just buy the entire lot instead of leaving a 50m^2? • If land owners will be compensated, how much of the total value will be left for the land owners as there are some taxes that also needs to be settled during land acquisition?	• The government will buy the entire lot if a very small portion will be left for the land owners • Explained the taxes that the land owner is entitled to in land transfer • Land owners will be paying for the Capital gain tax, transfer tax will be paid by DPWH

Summary of Issues, Concerns, Comments, and Suggestion Raised During Consultation Meetings with the Project Affected Persons (3/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• Is it possible for the government to pay for the capital gain tax instead of transfer tax as capital gain tax is more expensive than transfer tax?	• The current law states that the owners are to pay for the capital gain tax, although there is already an amendment passed to the congress to suggest that the government should be the one paying for the capital gain tax, this amendment is not yet approved. • If land owner does not have budget to pay for the capital gain tax, the government can pay for it and the amount will be deducted to the payment due to the land owner
• Which zonal value will be considered for land valuation? • Very few land owners would sell their land at a very low price, how will they be able to justify this during the negotiation for land valuation? • Communities sell their land for a higher value than that of the BIR Zonal Value	• BIR Zonal Value • If land owners have complete document that would help support their claims of a high land valuation in the area • BIR Zonal value is the first option for land valuation there are other valuation that the DPWH can consider in negotiating for land valuation. Land owners can demand for a higher valuation provided that they have legal documents supporting their claims
• Tentative list of areas to be traversed by the bypass along Holcim mine site	• If Holcim already acquired ownership of the lands on the mine site, Holcim will be compensated
• There are lime stone deposits in some areas of Brgy. Mahayag, will these deposits be affected by the excavation that the DPWH will be doing in constructing the bypass? • What will happen to a land that has mineral deposits and has claims filed to the MGB? • Will alignment still change?	• Explained the extent of land ownership and the government's right to the mineral deposits • Excavations will only take place on the tunnel section of the bypass the rest of the areas will be cut and filled • DPWH will have to acquire the land area where the bypass will traverse, example: Holcim case • There are possible changes during the detailed engineering design
• The alignment will most likely affect the mine life of Holcim for the next five years, if detailed engineering design is available, Holcim can coordinate with the DPWH to design an alignment that would not affect the mine life of Holcim • Request a copy of the map so the company can impose the plan on the site development plan of Holcim and company can send the detailed technical concerns to the consultation team	• Consultation team already visited the Holcim office to set a meeting schedule and discuss the project's development plans with the company • Noted
• Land owner had bought land in Lasang and subdivided the land to the children, who will receive the land compensation?	• Whoever is the land owner stated on the land title will be the one compensated

Summary of Issues, Concerns, Comments, and Suggestion Raised During Consultation Meetings with the Project Affected Persons (4/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• Clarification on land valuation: if there are discrepancies on deed of sale are there any other basis for land valuation? • Informed that there are other land owners that the barangay have not located as some of the owners listed have migrated to other places	• The land appraiser will study cases of land valuation to determine the right market value of the land, there will be other basis for land valuation aside from the deed of sale • In case the land owners would come to the barangay office to ask matters pertaining to the project, the LGU can help explain to them regarding the plans for the project
• The property has been converted to Home Owners Association; some residents have already fully paid the lot area. However the land is still under Mr. Julapong's name (husband of the person asking), who then will be compensated in the future?	• If there is an approved subdivision plan, it will be the basis as to who will be compensated for the land. • Suggestion: to avoid future disputes on land compensation, the land owner should start sub-dividing the lot title to individuals that had fully paid their land. As for the structure, if the home owners built the structures in the area the land owner will sign a waiver of rights to structure compensation
Barangays Marapangi*, Bato, Bangkas Heights, Mulig, Alambre, Sirawan, Lubogan, and Indangan* Concerns/Comments	
• If affected land has overpass or bridge, will these constructions be affected by the proposed project? • What will happen to areas with uneven slopes?	• DPWH will only compensate for the actual diameter of the land that will be affected by the bypass road project • Uneven slopes will be cut and filled upon construction
• What benefit can the farmers get from the bypass road project? • Effect of the bypass on livelihood of local farmers	• The bypass will affect the economy of the areas that will be traversed positively by bringing development or improving urbanization and land values will have higher appraisals • The government will be providing assistance to the PAPs; a survey will be conducted to identify the types of livelihood of PAPs which will be needing such assistance from the government as mandated by the law
• The tenant had constructed a structure on the area that will be affected by the bypass, who will be held responsible for the replacement of the house/structure?	• The tenant will be paid by the gov. and the land owner will sign an agreement that he/she will not have a counterpart on the payment
• How will the farmers be compensated with the crops that were bought on credit from PCA?	• The crops that will be affected by the project will be compensated by the gov.
• Informed that the NAPOCOR suggested if it's possible to have the bypass traverse near the transmission line built on the area	• Noted
• Suggested for the bypass to traverse near the transmission line built on the area as they had acquired and are currently maintaining a right road of way	• The suggestion was already raised and noted from the previous meeting that was conducted; ECOSYSCORP will check with the JICA team whether the suggestion was noted on the realignment

Summary of Issues, Concerns, Comments, and Suggestion Raised During Consultation Meetings with the Project Affected Persons (5/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• Clarification whether the property will be affected or not as there was no survey conducted on their property	• If the land owner received an invitation to the meeting, there is a probability that their property will be affected by the project. Any future changes on the alignment will be communicated to the locals
• When is the probable date of project implementation?	• Probable date of project implementation will be on year 2017
• How wide is the proposed bypass?	• The right road of way will be approximately 50-60meters
• If locals can have a copy of the presented map that will be traversed by the bypass • Basis for land valuation on land acquisition	• The presented bypass alignment is not yet final and also to avoid presumptions from the locals, the map will only be available after the detailed engineering design • The government will first offer the BIR Zonal as basis for land valuation
• Is this project a grant from JICA or on credit?	• FS is a grant from JICA, if the government found the project feasible they will decide whether or not they will continue to ask for JICA's assistance for construction by loaning from JICA
• How true was the rumor that JICA is assisting DPWH with a purpose of locating the buried treasures in the area? • Concern: farmers with small property will lose their source of income because of the project	• The rumor was proved to be wrong because JICA is an association providing financial assistance to countries through loan just like the World Bank and Asian United Bank. Also, JICA does not pay for the land acquisition on the right of way. Only the Phil. Government can acquire rights to land acquisition for road projects. Furthermore, the construction of the bypass will be implemented by contractor/s that will be contracted by the government and JICA is not a contractor for road constructions. • Recommendation: request LGU to provide assistance to the local farmers to find similar land for farming within or around the neighboring district
Barangays *Mintal, Bago Oshiro, Tugbok Proper, Tacunan and Matina Biao* Concerns/Comments	
• What is the purpose of the bypass when there are already existing barangay roads? Furthermore, farmers with small properties will be greatly affected by this project • Why is the proposed bypass not designed as a straight road? • Modes of payments to land owners • Will there be compensation for structures and crops?	• Bypass will be constructed to help mitigate traffic congestion on major roads within the city proper and development of the rural areas • The proposed bypass was designed to avoid affecting a plenty number of residential areas, important buildings and some religious structures. Also the road is designed for fast moving vehicles • Modes of payments to the land owners whether the land is vast or small will be the same • There will be compensation to crops and structures that will be affected by the project • For farmers with small properties, study team will suggest on the RAP development for assistance in finding a replacement land for farming

Summary of Issues, Concerns, Comments, and Suggestion During Consultation Meetings with the Project Affected Persons (6/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• If representative (sister-in-law of the land owner) can answer the interview in behalf of the land owner • When will the project be implemented?	• If representative can answer questions pertaining to information of the land and other info on proof of ownership, yes. • Explained the tentative schedule of project development. Land owners will be informed of final alignment after parcellary survey
• Can land owners be compensated if the proof of ownership is only DOS? • Will the government not pay for the land on the tunnel section? (*Note: the land owner has property on the tunnel section)* • Structure was built by home owner, who will be compensated for the structure? • If land owner suggests to relocate the home owner still within the property of the land owner instead of relocating them to the relocation site	• Yes, DPWH recognizes the DOS and titled lands • Two options: 1. Disturbance fee—since road will be constructed 200m from the mountain's surface and land owners won't be affected by the construction. 2. If land owners wants to have land compensation, then land owner has to leave as the ownership will be transferred to the government • The home owner will be paid for the loss of structure and land owner will pay a waiver of rights to structure compensation • If home owner agreed to the suggestion of the land owner, then it's possible
• How did the group acquire the names of lot owners as the names listed are of those previous owners? • Suggests to submit a copy of the title to the study team for the next meeting invitation will be addressed to the current land owner	• The real land owners will be determined after the parcellary survey. There really are some records in the assessor's office wherein the current land owner's names does not reflect, but the real land owners will be most likely determined after the parcellary survey • Clarified that the preliminary list will not become a basis for compensation • Noted.
• Basis for land valuation • Who will be compensated, the previous land owner as reflected on the city assessor's office or the current land owner? • In behalf of Mr. his land and house will be affected by the project, will there also be any appraisal for the structure?	• During land appraisal, the government will consider the prevailing current market value • The current land owner will be compensated for the land • The valuation of the structures will be based on the current price of materials that will be used to build the same structure. The land valuation will be separated from the structure valuation
• Should the land owners base on the survey that was conducted whether or not they are affected by the project?	• The final list of PAPs will be determined after the parcellary survey
• A question was raised as to why the land owners were invited to the consultation meeting when they were not included in the survey?	• Land owners were invited to be informed that they are the possible affected persons of the bypass project
• Entitlements of renter, buyer and agricultural lessee • Basis for prevailing Zonal Value • Will the project still proceed despite filing an expropriation case?	• Just compensation is entitled to land owners. Renter, tenant and agricultural lessee will receive a financial assistance from the government • The zonal value will be based on the actual land use • If the court passed a writ of possession, the DPWH can already proceed with the project
• Lot was sold to a new owner; can new owner be invited to the next meeting instead of the previous land owner?	• Noted

Summary of Issues, Concerns, Comments, and Suggestion During Consultation Meetings with the Project Affected Persons (7/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• Why not align the road to areas without road access and develop existing barangay roads especially those that are leading to areas being developed for tourist attraction? • If road may be realigned to areas that may have Japanese buried treasures • Rights of Indigenous people on areas affected by the project	• The bypass will be constructed for the benefit of the majority and tunnel section may also add to tourist destinations • JICA is not related to any treasure hunting groups. The alignment may be changed but might affect a more number of land owners • There are no ancestral domain that would be affected by the project as confirmed by the NCIP Regional Office
• Why were the Japanese joining the survey?	• JICA is responsible for designing the engineering structure of the bypass
• When is the exact date of conducting the parcellary survey?	• Tentatively on March 2016
• Will the government put an embankment on natural spring water that will be affected? • Concern on Income loss	• There will be installation of culverts to maintain natural surface waters • There is no law to compensate for income loss, only for the agricultural and industrial crops
• Beginning and end point of the tunnel section • Will there be a road constructed on the top of the mountain?	• Tunnel section will start at kilometer 19 to kilometer 21 • There will be no road to be constructed on the top of the mountain, only through the mountain which will be 200meters from the mountain's surface
• Will there be compensation for the land preparation • Suggests for the government to conduct an FS on the possible time of completing land preparation and expenses on banana plantation because banana growing is more expensive compared to growing other agricultural products	• Yes, there will be compensation for the land preparation • Noted and will be considered for study
• Probable time of project construction because land owners are planning to develop their land area • Concern on compensation for opportunity loss	• Explained the tentative project development timeline • There will be no compensation for opportunity loss
• Basis for Zonal valuation	• BIR Zonal value
• What is the actual area for the bypass, 30meters or 60meters?	• The total diameter of bypass will be finalized during the detailed engineering design • The pavement will be 3.5 meters on both sides with a shoulder of 2meters
Barangays *Tigatto and Waan* Concerns/Comments	
• Clarification on the location of the tunnel section	• Tunnel section will only be on Matina Biao area
• In Brgy. Tigatto area, how far is the proposed bypass from the existing Mandug Road?	• Estimated 5-6 km from Mandug Road
• Are there any specific areas as to where the bypass will traverse?	• At present the invited land owners are the possible PAPs of the project, we can only identify the specific land areas that will be affected during the detailed engineering design on the conduct of parcellary survey
• A month after the first meeting last year, there was a survey conducted in the area, was that the parcellary survey?	• The survey conducted last year was only for the alignment of the bypass, the parcellary survey will be conducted to measure the land property that will affected by the project

Summary of Issues, Concerns, Comments, and Suggestion During Consultation Meetings with the Project Affected Persons (8/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• Which office can the land owner approach if he/she wants to suggest for their land to be traversed by the bypass?	• This can be suggested during the detailed design where the exact alignment will be finalized. However, we should note that there are safety measures that needs to be considered in conducting the detailed engineering design, example road curve shouldn't be a sharp curve for safety purposes
• How will the bypass intersect with the existing roads?	• If major roads, it will be maintained by constructing a bypass with a height of 5.2 meters • There will also be inter-changes or access road on areas intersecting national highways
• Will there be job opportunities for the locales?	• As mandated by the law all affected barangays, especially a family member of the directly affected land owners will be the priority for employment during construction
• How will this project affect the existing flood problem in Brgy. Tigatto?	• Mitigating measures for flood problems on the affected areas will be considered. There will be a study on the present condition of flood problems on directly affected communities/barangays during the FS. The data that will be gathered will be noted in designing the drainage of the bypass • The drainage design of the bypass will not be intended to control the existing flood problems in the area, rather it will be designed to prevent aggravating the existing flood problems • *Note: Some areas of Brgy. Tigatto experiences flooding during heavy rains. Flood subsides after three days according to LGU*
• If bypass will be built with a height of 5.2 meters, how will the residents be protected from flooding?	• The flood levels will be measured during the FS to identify the number of culverts that will be used for the drainage system of the bypass
• Hopefully the government will not ask the land owners to donate their land for the project as some land owners that owns only small parcels of land in the area • Who will pay for the expenses of the project?	• Donation as part of the government's way of land acquisition for development has been included for transparency. Also there are cases when land owners would offer to donate their lands to the government for development purposes • Land owners with big parcels of land will be requested first to donate some portion of their lands for the project; however, if they would not want to donate their lands, they will be compensated for the parcel of land that will be used for the project. As for those who owns a small parcel of land, they will most likely be paid by the government • The government will be paying for the right of way (land acquisition). Civil works and expenses paid to consultants will be loaned.

Summary of Issues, Concerns, Comments, and Suggestion During Consultation Meetings with the Project Affected Persons (9/9)	
Queries/Concerns/Suggestions/ Comments	**Responses To Queries**
• Who are the contractors for the project? • How long would it take for the land owners to be informed if their properties will be affected by the bypass?	• There will be bidding after the detailed engineering design. For major projects like this bypass, there will be international contractors that will be joining the bidding and these international contractors will work with Filipino sub-contractors. • The final list of land owners that will be affected by the project will be determined during the parcellary survey which will be conducted after the detailed engineering design. The detailed engineering design is estimated to be conducted on 2015 to 2016. The final list of land owners will be invited on a meeting after the parcellary survey.
Barangays *J.P Laurel Panabo City* Concerns/Comments	
• How far is the proposed bypass from the existing bridge in JP Laurel? • Is it possible for the existing building to be affected by the bypass? • Informed that the banana plantation is no longer under the land owner's property but under the name of Mr. Yengco • Who will handle the construction? • What are the entitlements intended for the land owners that will be affected by the bypass? • Suggests if the DPWH can consider widening the existing barangay road instead of creating a new one in JP Laurel • Suggests to have the affected land owner Mr. Yengco be invited on the next consultation meeting • Expressed that the project is a good plan for development	• Approximately 200m from Lasang bridge • The proposed bypass will not affect the existing building as it will only traverse on the banana plantation beside the clearing • Sketched the probable area where the bypass will traverse • Noted • There will be bidding for contractors for constructing the bypass • Explained and presented the RAP presentation • If existing road doesn't have a sharp curve, JICA might consider the suggestion especially during the detailed engineering design • Noted

Appendix C

Mrs. Resurection Mirafuentes of *Barangay Mulig*

Mr. Teofilo Hernan of *Barangay Bato*

Hon. Emud Pizzaro *Barangay Chairman of Mapapangi*

Survey photo in *Barangay Marapangi*

Appendix C

Mr. Reynaldo Abas *Barangay Kagawad of Tigatto*

Barangay Kagawad **Ms. Virginia Veron** *of Tigatto*

Barangay Kagawad **Mr. Ricardo Naval** of *Tigatto*

Brgy. Tigatto Survey photos

Mr. Charles Aban, *Rep. of Ambassadors for Christ* at *Barangay Cabantian*

Hon. Nilo Cabiles *Barangay Chairman of Cabantian*

Mr. Nelson Comaling of *Barangay Cabantian*

Consultation Photo in *Barangay Cabantian*

Appendix C

Hon. Eufemia Baquirel *Barangay Chairman of Mahayag*

Ms. Maria Elizabeth Laus, *Geologist-Holcim*

Ms. April Militar *Representative of Holcim*

Survey photo in Barangay Mahayag

Appendix C

Mrs. Rosalina Julapong of *Barangay San Isidro*

Consultation photo in Barangay J.P Laurel

Mrs. Modesta Bangayan of *Barangay Lasang*

Consultation photo in Barangay J.P Laurel

Attendance of Participants in *Barangay Mintal*

Mr. Rudy Palomaria *of Barangay Tacunan*

Mrs. Lorna Valdez of *Barangay Mintal*

Mr. Ariel Lumaad of *Barangay Tacunan*

Appendix C

Mr. Gamayot *Barangay Kagawad of Mintal*

Survey photo at *Barangay Mintal*

Survey photo at *Barangay Mintal*

Mr. Bartolome Ceniza of *Barangay Mintal*

Kagawad Eduardo G. Balaga of *Brgy. Indangan*

Mr. Nelson D. Victoriano, *in Barangay Catalunan Grande*

Senior Manager **Mr. Rannel F. Flores** of ANFLOCOR Real Estate

Brgy. Kagawad **Alfredo U. Lloren** of Brgy. Tacunan

Visayas Avenue, Diliman, 1100 Quezon City
Tel. Nos. 929-6626 to 29; 929-6633 to 35
929-7041 to 43; 929-6252; 929-1669
Website: http://www.denr.gov.ph E-mail: web@denrgov.ph

0 5 NOV 2012

MEMORANDUM ORDER
No. 2012- 02

SUBJECT : UNIFORM REPLACEMENT RATIO FOR CUT OR RELOCATED TREES

For uniformity of application of regulations pertaining to the replacement ratio for cut or relocated trees, the following specifications are hereby issued:

1. Tree cutting permits covered by exemptions under "similar activities" of Section No. 2, Item 2.2 of Executive Order No. 23 shall be governed by the Memorandum from the Executive Secretary dated 20 October 2011, or a replacement ratio of 1:100.

2. All tree cutting permits excluded in the said Memorandum dated 20 October 2011 shall be governed by the following:

   2.1 NO replacements shall be applied to planted trees within private lands and forest lands exclusively established for tree plantations/timber production purposes;

   2.2 For planted trees in private and forest lands not covered under item 2.1, tree replacement shall be 1:50 while naturally growing trees on the same areas, including those affected by development projects shall have 1:100 ratio in support of the National Greening Program (NGP) and climate change initiatives of the Government; and

   2.3 In order to facilitate the implementation of tree replacements, seedling donation and identification of common planting sites shall be encouraged for more impact, especially in urban areas. Planted trees removed shall be replaced preferably with indigenous tree species while naturally growing trees shall be strictly replaced with indigenous tree species. All donated seedlings shall be properly recorded and turned-over to the CENRO concerned with jurisdiction over the area while tree planting sites shall be delineated on the ground with the corresponding technical description and map using GPS for ease of monitoring and evaluation purposes.

3. All orders, circulars and/or instructions inconsistent herewith are hereby repealed and/or modified.

FOR GUIDANCE AND STRICT COMPLIANCE.

RAMON J.P. PAJE
Secretary

Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

DENR033870

11-8-12
NF
290.1

Let's Go Green

EI-ADMINFORM-34-REV1

ELARSI, INC.

Unit 201-202 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT	:	**BERKMAN SYSTEMS, INC.**	Lab. Report No.	:	141106
ADDRESS	:	3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila	Date Sampled	:	03-31-14 to 04-01-14
			Date Received	:	04-08-14
Nature of Sample/s	:	Ambient Air Sample	Date Analyzed	:	04-08-14 to 04-21-14
No. of Sample/s Submitted	:	Five (5)	Date Reported	:	04-22-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	TSP, µg
ES-1407524	PJ 14 199 A-1	19,200
ES-1407525	PJ 14 199 A-2	10,200
ES-1407526	PJ 14 199 A-3	8,200
ES-1407527	PJ 14 199 A-4	17,600
ES-1407528	PJ 14 199 A-5	14,200
Method		**Gravimetric / Method 501**
Detection Limit		**100**

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis. 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147A

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

ELARSI, INC.

Unit 201-202 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT : **BERKMAN SYSTEMS, INC.**
ADDRESS : 3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila
Nature of Sample/s : Ambient Air Sample
No. of Sample/s Submitted : Five (5)

Lab. Report No. : 141107
Date Sampled : 03-31-14 & 04-01-14
Date Received : 04-08-14
Date Analyzed : 04-11-14 to 04-14-14
Date Reported : 04-16-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	SO_2, µg
ES-1407529	PJ 14 199 A – 1	0.356
ES-1407530	PJ 14 199 A – 2	0.214
ES-1407531	PJ 14 199 A – 3	0.142
ES-1407532	PJ 14 199 A – 4	0.214
ES-1407533	PJ 14 199 A – 5	0.249
Method		**Pararosaniline / Method 704B**
Detection Limit		**0.030**

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis. 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY
C.R. No. 006/2011

PAB ACCREDITED TESTING LABORATORY
PNS ISO/IEC 17025:2005
LA-2009-147A

DOH ACCREDITED LABORATORY
C.A. No. 018/2012

Test results reflect the quality of the samples as received.

EI-ADMINFORM-03

REQUEST FOR ANALYSIS / CHAIN OF CUSTODY FORM

ELARSI, INC.
Unit 201-202 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 , 929-48-24 * Fax No. 441-5314 * E-mail : info@elarsi.com

Inv # ______ OR# ______ *FOR LABORATORY USE ONLY* Lab. Report No. 14106-08

Company : BSI
Address : DAVAO
Contact Person : JACQUI MANCERAS
Contact No./s ______

Submitted by: [signature] OMPOY (Printed Name/Signature) Date/Time: 04-07-14
Received by: L. HERMOSURA (Printed Name/Signature) Date/Time: 4-08-14
Checked by: R. GOFREDO (Printed Name/Signature) Date/Time: 4-8-14 6PM

Method of Transport
___ Walk-In ✓ Courier ___ Pick-up ___ Others

Sample Condition Upon Received
✓ Sealed / Container Intact
✓ Chilled Frozen
Room Temp
✓ Preserved

Container Type
✓ Plastic Bottle
✓ Glass/Sterile Glass
___ TEDLAR Bag
Others FILTER

Turn Around Time
___ Urgent/Rush (2-5 Working Days) ✓ Routine (5-10 Working Days)

Nature of Sample (PLEASE CHECK)
Water: ___ Drinking Water ___ Wastewater ___ Others ___
Metals: ___ Water ___ Air ___ Others ___
Air: ___ Stack Source Emission ✓ Ambient Air Sample ___ Work Env. Measurement ___ Others FILTERS
Solids: ___ Soil ___ Sludge ___ Sediment ___ Others ___

FOR LAB. USE ONLY — DATE OF THE FOLLOWING

Sample No. (*FOR LAB. USE ONLY*)	Sample Identification	Analyses / Parameters Requested	Date of Sampling	No. of Samples	Remarks	Certificate Sent/Reported	Worksheet Sent	CCC Sent	Sample Disposed"
	RH4-199								
EI-1407524-28	A1	TSP	MARCH 31	✓					
EI-1407529-33	A2	NO_2	APRIL 01-						
	A3			✓ w/blank					
EI-1407534-38	A4	SO_2	2014	✓ w/blank					
	A5								

*USE ONE(1) COC FOR EACH NATURE OF SAMPLE
*Unless otherwise requested, all samples will be disposed two (2) weeks after analysis.

ELARSI, INC.
Unit 201-202 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT : **BERKMAN SYSTEMS, INC.**
ADDRESS : 3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila
Nature of Sample/s : Ambient Air Sample
No. of Sample/s Submitted : Five (5)

Lab. Report No. : 141108
Date Sampled : 03-31-14 & 04-01-14
Date Received : 04-08-14
Date Analyzed : 04-08-14 to 04-10-14
Date Reported : 04-11-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	NO_2, µg
ES-1407534	PJ 14 199 A – 1	0.456
ES-1407535	PJ 14 199 A – 2	0.107
ES-1407536	PJ 14 199 A – 3	0.268
ES-1407537	PJ 14 199 A – 4	0.805
ES-1407538	PJ 14 199 A – 5	0.295
Method		**Griess-Saltzman / Method 406**
Detection Limit		**0.010**

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis. 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147A

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

Ambient Air Quality Summary of Data and Results

Project No. : **PJ-14 199**

Client : **ECOSYSCORP, INC.**

Location : **DAVAO CITY**

Station Code	A1	A2	A3	A4
Location	BRGY. J.P. LAUREL, PANABO CITY	BRGY. SAN ISIDRO, BUNAWAN, DAVAO CITY	MANDUG ROAD	MINTAI ROAD ALONG NATIONAL HIGHWAY
Date of Sampling	March 31, 2014	March 31, 2014	April 1, 2014	April 1, 2014
Time of Sampling	1600H-1700H	1550H-1650H	1000H-1100H	1327H-1427H

Total Suspended Particulates (TSP) Data				
Volume of air for TSP sampling, Ncm	64.3318	64.4381	64.0123	63.8025
TSP Weight, µg	19200	10200	8200	17600
TSP Concentration, µg/Ncm	298.5	158.3	128.1	275.9

Sulfur Dioxide (SO_2) & Nitrogen Dioxide (NO_2) Data				
Volume of air for SO_2 & NO_2 sampling, Ncm	0.0585	0.0586	0.0582	0.0580
SO_2 Weight, µg	0.356	0.214	0.142	0.214
SO_2 Concentration, µg/Ncm	6.1	3.7	2.4	3.7
NO_2 Weight, µg	0.456	0.107	0.268	0.805
NO_2 Concentration, µg/Ncm	7.8	1.8	4.6	13.9

Average Temperature, °C	30.0	29.5	31.0	32.0
Clouds (Octa)	5/8	4/8	5/8	4/8
Wind Direction	NE	NE	SE	SE
Wind Condition	BF1	BF1	BF1	BF1

Remarks:

BF	*Beaufort Force*	*BF1*	*Light Air*	*BF3*	*Gentle Breeze*
BF0	*Calm*	*BF2*	*Light Breeze*	*BF4*	*Moderate Breeze*

Ambient Air Quality Summary of Data and Results

Project No. : PJ-14 199

Client : ECOSYSCORP, INC.

Location : DAVAO CITY

Station Code	A5
Location	BRGY. SIRAWAN ALONG NATIONAL HIGHWAY
Date of Sampling	April 1, 2014
Time of Sampling	1600H-1700H

Total Suspended Particulates (TSP) Data	
Volume of air for TSP sampling, Ncm	64.2259
TSP Weight, µg	14200
TSP Concentration, µg/Ncm	221.1

Sulfur Dioxide (SO_2) & Nitrogen Dioxide (NO_2) Data	
Volume of air for SO_2 & NO_2 sampling, Ncm	0.0584
SO_2 Weight, µg	0.249
SO_2 Concentration, µg/Ncm	4.3
NO_2 Weight, µg	0.295
NO_2 Concentration, µg/Ncm	5.1

Average Temperature, °C	30.5
Clouds (Octa)	3/8
Wind Direction	NE
Wind Condition	BF1

Remarks:

BF	*Beaufort Force*	*BF2*	*Light Breeze*
BF0	*Calm*	*BF3*	*Gentle Breeze*
BF1	*Light Air*	*BF4*	*Moderate Breeze*

ELARSI, INC.

Unit 201-202 & 406 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT	BERKMAN SYSTEMS, INC.	Lab. Report No.	142696
ADDRESS	3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila	Date Sampled	08-04-14
		Date Received	08-06-14
Nature of Sample/s	Ambient Air Sample	Date Analyzed	08-06-14 to 08-08-14
No. of Sample/s Submitted	Five (5)	Date Reported	08-11-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	NO_2, µg
ES-1417100	PJ 14 606 A2 – A	0.157
ES-1417101	PJ 14 606 A2 – B	0.133
ES-1417102	PJ 14 606 A2 – C	0.024
ES-1417103	PJ 14 606 A2 – D	< 0.010
ES-1417104	PJ 14 606 A2 – E	< 0.010
Method		Griess-Saltzman / Method 406
Detection Limit		0.010

Reference
James P. Lodge, Methods for Ambient Air Sampling & Analysis, 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147B

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

ELARSI, INC.
Unit 201-202 & 406 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT	: BERKMAN SYSTEMS, INC.		Lab. Report No.	: 142696
ADDRESS	: 3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila		Date Sampled	: 08-01-14
			Date Received	: 08-06-14
Nature of Sample/s	: Ambient Air Sample		Date Analyzed	: 08-06-14 to 08-08-14
No. of Sample/s Submitted	: Five (5)		Date Reported	: 08-11-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	NO_2, µg
ES-1417095	PJ 14 606 A1 – A	0.109
ES-1417096	PJ 14 606 A1 – B	0.060
ES-1417097	PJ 14 606 A1 – C	0.048
ES-1417098	PJ 14 606 A1 – D	< 0.010
ES-1417099	PJ 14 606 A1 – E	< 0.010
Method		**Griess-Saltzman / Method 406**
Detection Limit		**0.010**

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis. 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147B

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

ELARSI, INC.
Unit 201-202 & 406 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT	:	BERKMAN SYSTEMS, INC.	Lab. Report No.	: 142695
ADDRESS	:	3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila	Date Sampled	: 08-04-14
			Date Received	: 08-06-14
Nature of Sample/s	:	Ambient Air Sample	Date Analyzed	: 08-12-14
No. of Sample/s Submitted	:	Five (5)	Date Reported	: 08-13-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	SO_2, µg
ES-1417090	PJ 14 606 A – 2A	< 0.030
ES-1417091	PJ 14 606 A – 2B	< 0.030
ES-1417092	PJ 14 606 A – 2C	< 0.030
ES-1417093	PJ 14 606 A – 2D	< 0.030
ES-1417094	PJ 14 606 A – 2E	0.177
Method		Pararosaniline / Method 704A
Detection Limit		0.030

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis. 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147B

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

ELARSI, INC.
Unit 201-202 & 406 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT	: BERKMAN SYSTEMS, INC.	Lab. Report No.	:	142695
ADDRESS	: 3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila	Date Sampled	:	08-01-14
Nature of Sample/s	: Ambient Air Sample	Date Received	:	08-06-14
No. of Sample/s Submitted	: Five (5)	Date Analyzed	:	08-12-14
		Date Reported	:	08-13-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	SO_2, µg
ES-1417085	PJ 14 606 A – 1A	0.106
ES-1417086	PJ 14 606 A – 1B	0.212
ES-1417087	PJ 14 606 A – 1C	0.106
ES-1417088	PJ 14 606 A – 1D	0.035
ES-1417089	PJ 14 606 A – 1E	< 0.030
Method		**Pararosaniline / Method 704A**
Detection Limit		**0.030**

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis. 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147B

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

ELARSI, INC.
Unit 201-202 & 406 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT	: BERKMAN SYSTEMS, INC.	Lab. Report No.	: 142694
ADDRESS	: 3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila	Date Sampled	: 08-04-14
		Date Received	: 08-06-14
Nature of Sample/s	: Ambient Air Sample	Date Analyzed	: 08-08-14 to 08-11-14
No. of Sample/s Submitted	: Five (5)	Date Reported	: 08-12-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	TSP, µg
ES-1417080	PJ 14 606 A – 2A	11,300
ES-1417081	PJ 14 606 A – 2B	1,900
ES-1417082	PJ 14 606 A – 2C	2,000
ES-1417083	PJ 14 606 A – 2D	6,000
ES-1417084	PJ 14 606 A – 2E	5,500
Method		**Gravimetric / Method 501**
Detection Limit		**100**

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis, 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147B

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

ELARSI, INC.
Unit 201-202 & 406 Rizalina Annex Bldg. 1677 Quezon Avenue, Quezon City
Tel. No. 927-77-15 Fax No. 929-4824 Email: info@elarsi.com

CLIENT	: BERKMAN SYSTEMS, INC.		Lab. Report No.	: 142694
ADDRESS	: 3rd Flr., VAG Bldg Ortigas Ave. Greenhills San Juan, Metro Manila		Date Sampled	: 08-01-14
			Date Received	: 08-06-14
Nature of Sample/s	: Ambient Air Sample		Date Analyzed	: 08-08-14 to 08-11-14
No. of Sample/s Submitted	: Five (5)		Date Reported	: 08-12-14

[REPORT OF ANALYSES]

Sample No.	Sample ID	TSP, µg
ES-1417075	PJ 14 606 A – 1A	5,100
ES-1417076	PJ 14 606 A – 1B	1,300
ES-1417077	PJ 14 606 A – 1C	8,700
ES-1417078	PJ 14 606 A – 1D	1,200
ES-1417079	PJ 14 606 A – 1E	2,100
Method		**Gravimetric / Method 501**
Detection Limit		**100**

Reference
James P. Lodge. Methods for Ambient Air Sampling & Analysis. 3rd edition

Checked By:

RENATO M. GOFREDO JR.
Chemist

Certified By:

RESSAN K. ARBUTANTE
Laboratory Manager

DENR RECOGNIZED LABORATORY C.R. No. 005/2011

PAB ACCREDITED TESTING LABORATORY PNS ISO/IEC 17025:2005 LA-2009-147B

DOH ACCREDITED LABORATORY C.A. No. 018/2012

Test results reflect the quality of the samples as received.

Calibration complies with ISO 9001
ISO/IEC 17025 AND ANSI/NCSL Z540-1

Calibration
Certificate No. 1750.01

Cert. No.: 3415-3077046

Traceable® Certificate of Calibration for Digital Calipers

Instrument Identification:

Model: 3415   S/N: 101856330   Manufacturer : Control Company

Standards/Equipment:

Description	Serial Number	Due Date	NIST Traceable Reference
Gage Block Set	99146223	9/22/13	1000267588

Certificate Information:

Technician: 57   Procedure: CAL-05   Cal Date: 8/03/13   Cal Due : 8/03/15
Test Conditions: 24.5°C 42.0 %RH 1019 mBar

Calibration Data: (New Instrument)

Unit(s)	Nominal	As Found	In Tol	Nominal	As Left	In Tol	Min	Max	±U	TUR
in		N.A.		0.0000	0.0000	Y	-0.0010	0.0010	0.0003	3.3:1
in		N.A.		0.1000	0.1000	Y	0.0990	0.1010	0.0003	3.3:1
in		N.A.		2.0000	2.0000	Y	1.9980	2.0020	0.0003	>4:1
in		N.A.		4.0000	4.0000	Y	3.9960	4.0040	0.0004	>4:1
in		N.A.		6.0000	6.0000	Y	5.9940	6.0060	0.0004	>4:1
in depth		N.A.		2.0000	2.0015	Y	1.9980	2.0020	0.0003	>4:1
in inside		N.A.		1.0000	1.0000	Y	0.9990	1.0010	0.0003	3.2:1

This Instrument was calibrated using Instruments Traceable to National Institute of Standards and Technology.

A Test Uncertainty Ratio of at least 4:1 is maintained unless otherwise stated and is calculated using the expanded measurement uncertainty. Uncertainty evaluation includes the instrument under test and is calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM). The uncertainty represents an expanded uncertainty using a coverage factor k=2 to approximate a 95% confidence level. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement. The results contained herein relate only to the item calibrated. This certificate shall not be reproduced except in full, without written approval of Control Company.

Nominal=Standard's Reading; As Left=Instrument's Reading; In Tol=In Tolerance; Min/Max=Acceptance Range; ±U=Expanded Measurement Uncertainty; TUR=Test Uncertainty Ratio; Accuracy=±(Max-Min)/2; Min = Nominal(Rounded) - Tolerance; Max = Nominal(Rounded) + Tolerance; Date=MM/DD/YY

Nicol Rodriguez
Nicol Rodriguez, Quality Manager

Wallace Berry
Wallace Berry, Technical Manager

Maintaining Accuracy:

In our opinion once calibrated your Digital Calipers should maintain its accuracy. There is no exact way to determine how long calibration will be maintained. Digital Caliperss change little, if any at all, but can be affected by aging, temperature, shock, and contamination.

Recalibration:

For factory calibration and re-certification traceable to National Institute of Standards and Technology contact Control Company.

CONTROL COMPANY 4455 Rex Road Friendswood, TX 77546 USA
Phone 281 482-1714 Fax 281 482-9448 service@control3.com www.control3.com

Control Company is an ISO 17025:2005 Calibration Laboratory Accredited by (A2LA) American Association for Laboratory Accreditation, Certificate No. 1750.01.
Control Company is ISO 9001:2008 Quality Certified by (DNV) Det Norske Veritas, Certificate No. CERT-01805-2006-AQ-HOU-ANAB.
International Laboratory Accreditation Cooperation (ILAC) - Multilateral Recognition Arrangement (MRA).

INTERNATIONAL SCIENTIFIC & INDUSTRIAL INSTRUMENTS, INC.

OFFICE ADDRESS: 24 TINDALO ST., TOWN & COUNTRY
EXECUTIVE VILLAGE, ANTIPOLO CITY, PHILIPPINES

TELEPHONE NO.
(632) 994-88-46

FAX NO. (632) 645-90-18

CERTIFICATE OF CALIBRATION

This is to certify that the instrument herein was examined and tested in compliance with the USEPA Standards on March 24, 2014.
The certicate of calibration is issued to Berkman Systems Inc., at 3rd Floor VAG Blbg., Ortigas Avenue,Greenhills, San Juan City.

KIMOTO GAS SAMPLER CALIBRATION DATA

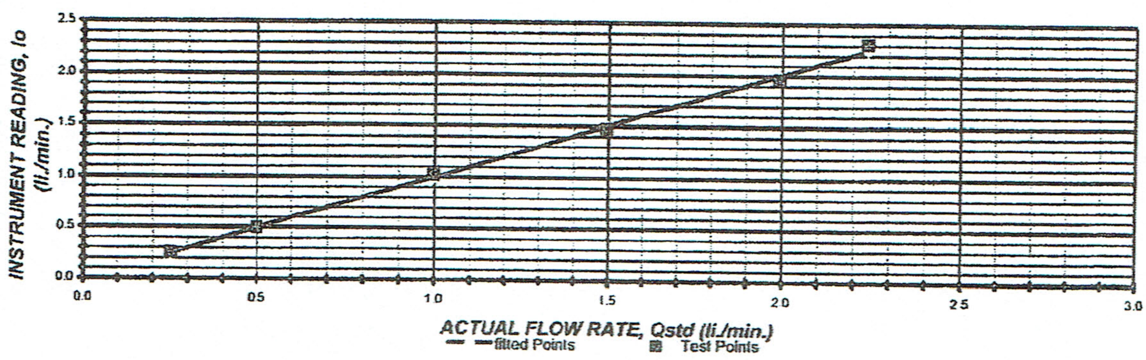
EQUIPMENT CALIBRATED : KIMOTO Gas Sampler, Model HS-7
SERIAL NO. : KHGS - 13
CALIBRATED WITH : MSA Calibrator (Soap Bubble Method)
BAROMETRIC PRESSURE (Pb 758.00 mmHg

DATE CALIBRATED : March 24, 2014
SOAP SOLUTION TEMP. (Tm) : 28.000 degC
VAPOR PRESSURE OF H_2O (Ps : 28.348 mmHg
Calibration Due Date : March 24, 2015

TRIAL NO.	TEST POINT Io (li./min)	DISPLACEMENT TIME (sec.) 1	2	3	4	5	AVERAGE TIME T av (sec.)	DISPLACED VOLUME Vd (ml.)	AVERAGE VOLUME Vav (ml.)	FLOW RATE Vm (li./min)	CORRECTED FLOW RATE Vs (li./min)	FITTED POINT Ycal	%DIFFERENCE
1	0.25	110.83	112.00	110.83	110.91	111.00	111.114	500	500	0.27	0.26	0.25	4.29
2	0.50	58.33	58.16	58.34	58.45	58.22	58.300	500	500	0.51	0.50	0.50	-0.16
3	1.00	28.66	28.55	28.54	28.45	28.59	28.558	500	500	1.05	1.02	1.00	2.15
4	1.50	19.79	19.77	19.86	19.68	19.84	19.788	500	500	1.52	1.47	1.49	-1.64
5	2.00	15.00	14.79	14.88	14.72	14.69	14.816	500	500	2.02	1.96	1.99	-1.44
6	2.25	12.22	13.00	12.33	12.40	13.00	12.590	500	500	2.38	2.31	2.24	3.11

SLOPE (m) = 0.99497
INTERCEPT (b) = 0.00231
CORRELATION COEFFICIENT (r = 0.99904
% DIFFERENCE LIMIT = +/- 5%

FLOW RATE CALIBRATION CURVE



Calibrated by: DIEGO A. VALLEJO

Certified by: NENITA M. LUMBANG

INTERNATIONAL SCIENTIFIC & INDUSTRIAL INSTRUMENTS, INC.

OFFICE ADDRESS: 24 TINDALO ST., TOWN & COUNTRY
EXECUTIVE VILLAGE, ANTIPOLO CITY, PHILIPPINES

TELEPHONE NO.
(632) 994-88-46

FAX NO. (632) 645-90-18

CERTICATE OF CALIBRATION

This is to certify that the instrument herein was examined and tested in compliance with the USEPA Standards on May 25, 2013.
The certicate of calibration is Issued to BerkmanSystems Inc., at 3rd Floor VAG Blbg., Ortigas Avenue,Greenhills, San Juan City.

HIGH VOLUME AIR SAMPLER CALIBRATION DATA

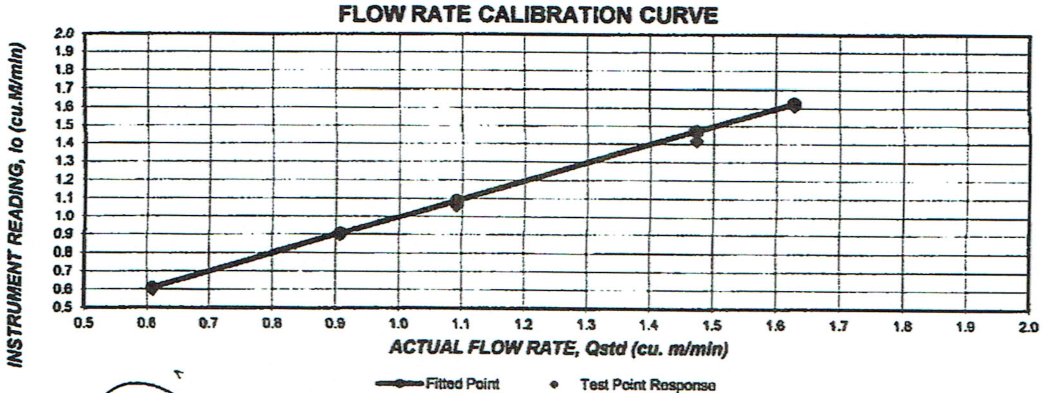
EQUIPMENT CALIBRATED	:	Staplex High Volume Air Sampler With Housing			
SERIAL NO.	:	22798N			
CALIBRATED WITH	:	Staplex High Volume Calibration Kit, Model CKHV			
SERIAL NO.	:	C-532			
DATE CALIBRATED	:	May 25, 2013			
CALIBRATION DUE DATE	:	May 25, 2014			
BAROMETRIC PRESSURE, P1	:	*758.00*	*mm Hg.*		
ROOM TEMPERATURE, T1	:	29.000	degC + 273	= 302.00	degK

Test Point N	Pressure Drop Across Orifice delta H	Corrected $Hc=\sqrt{dH \cdot \frac{P1}{Pstd} \times \frac{298}{T1}}$	From Orifice Certification cu.m./min.	Equipment Reading Io	Fitted Points Ycal	% Difference $\%D = \frac{Ycal-Io}{Ycal} \times 100$
#3	0.70 / 0.70	1.174	0.61	0.60	0.6083	1.3665
#5	1.65 / 1.65	1.802	0.91	0.90	0.9054	0.5959
#7	2.35 / 2.35	2.151	1.09	1.06	1.0893	2.5045
#10	4.40 / 4.40	2.943	1.47	1.42	1.4713	3.7544
#13	5.30 / 5.30	3.230	1.63	1.61	1.6289	0.7750

LEAST SQUARE CALCULATIONS

Slope (m)	=	0.973829
Intercept (b)	=	0.007015
Corr. Coefficient (r)	=	0.999047
%D Limit = +/- 5%		

FLOW RATE CALIBRATION CURVE



Calibrated by: DIEGO A. VALLEJO

Certified by: NENITA M. LUMBANG

Switchtek
Measurement Systems
A Division of Switchtek Construction Corporation
4th Floor Northridge Plaza, Annex A, 12 Congressional Ave.,
Bahay Toro,Quezon City, 1100, Philippines
Tel Nos.02 4267593 / 9282869 / 9287769 Fax No.4537694
email Address: switchtek@pldtdsl.net
www.switchtek.com.ph

Certificate No.: 400.01-4601-1.14
Identification: BERKMAN SYSTEMS INCORPORATED
Job: P1
Fin.acc: 32
Done......: March 5, 2014
Categories: Calibration
Cal Officer

Calibration of: Sound Level Meter
Test and Verification
Certificate of Calibration
Initials...: EBM

Men	Hours	Total cost	Type
2	1.0	-	Certificate

CERTIFICATE OF CALIBRATION - SOUND LEVEL METER

This report of calibration shall document that the instrument herein was examined and tested in compliance with ISO/IEC 17025 against NIST traceable reference standards and its co-equal standards.

Issued To: BERKMAN SYSTEMS INCORPORATED
Address: Suite 208 VAG Bldg., Ortigas Avenue, Greenhills, San Juan, Metro Manila, Philippines

UNIT UNDER TEST (UUT):

Instrument: Sound Level Meter
Brand: LUTRON
Model No: SL-4030
Serial No: I.30739
Range: 35.0 to 130.0 dB
Graduation: 0.1 dB
ID Code: No record
Date Received: March 3, 2014
Calibration Date: March 4, 2014
Calibration Due: March 3, 2015

CALIBRATOR INFORMATION:

Instrument: Sound Level Calibrator
Brand: Lutron
Serial No: I.278821
Model No: SC-942
Calibration Due: February 11, 2015
Certificate No: W014212_01
Traceability: IEC 60942 Type II A Standard
NIST and NPL

Environmental Condition:

Condition: DRY/BASIC/NEUTRAL
Relative Humidity: 49.2 ±5%,1006 hPa
Ambient Temp. (Deg C): 21.1 ±2

Calibration Method:

By comparative technique, Standard Sound Generator was introduced at the unit under test at a constant value of 94.0 dB and at a uniform frequency of 1000 Hz. Data were gathered and tabulated. Procedures of test conform to the requirements of OIML 88 Guidelines, IEC 60942 of the NIST and National Physical Laboratories.

During calibration, the unit was found to have a standard error of ±0.00 dB with a confidence level of not less than 95%. Uncertainty of measurement is ± 1.16 dB. Calculations were taken using the Standard Deviation Formula.

Results:

TRIALS	REFERENCE READING (dB)	UNIT UNDER TEST READING (dB)		ERROR IN READING (dB)	STANDARD DEVIATION	REMARKS
		AS FOUND	AS LEFT			
1	94.0	95.5	94.0	0.00	0.0000	Passed

Remarks:

All data pertain only to the unit described obtained at the time of test. This certificate is not valid w/out seal and signature. Unauthorized reproduction is prohibited.

Calibrated By: E.B. MORILLO
Date: March 4, 2014

Certified By: [illegible]
Date: March 5, 2014

Certificate of Calibration

Customer:	BERKMAN SYSTEMS, INC.	Standard No. 1:	Calibration Mix Gas
Address:	Suite 403 VAG Bldg., Ortigas Ave., Greenhills, San Juan Tel# (02) 7279832 to 33 Fax# (02) 7279831	Type:	Mix Gas (50% LEL CH4, 20.9% O2, 50 ppm CO, 5000 ppm CO_2, bal. N2)
Client PO Number:	2013-06-082 & 2013-08-092	Part Number.:	600-0129-000
Cal. Certificate Number:	2013.0831.01	Lot Number:	1453952 Cyl 13
Item Calibrated:	Multigas Monitor	Expiration:	February 2016
Model:	MultiRAE IR PGM-54	Tested Against:	CFR 49 Part 178.65 and NIST Weight Set Test
Serial Number:	080-901945		
Manufacturer:	RAE Systems	Standard No. 2:	Calibration Mix Gas
Origin:	USA	Type:	Isobutylene, 100 ppm, 34L steel cylinder
Ambient Temprature:	28.0 oC ± 2	Part Number.:	600-0002-000
Humidity:	72% RH ± 5%	Lot Number:	1436080 Cyl 117
Date of Calibration:	31-Aug-13	Expiration:	February 2016
Calibration Due:	30-Aug-14	Tested Against:	CFR 49 Part 178.65 and NIST Weight Set Test
User Calibration:	As needed. Bump Test required every prior to usage.		

CALIBRATION METHOD & RESULTS:

The LEL, CO2, CO and VOC Sensors of the Unit Under Test were subjected to BUMP and SPAN calibration procedures using known concentration test gas (50% LEL methane, 20.9% oxygen, 5000 ppm carbon dioxide, 50 ppm carbon monoxide, 100 ppm isobutylene with nitrogen balance). The objective is to find out the LEL , CO, CO2 & VOC sensors' response to the standard's methane, carbon dioxide, carbon monoxide and isobutylene component. Procedures of test and calibration conform to the requirements and guidelines traceable to NIST.

After calibration, the UUT's LEL, CO2, CO and VOC sensors responses were all in tolerance with the standard and PASSED both Bump and Span calibration.

CALIBRATION DATA:

SENSORS	UNIT UNDER TEST (UUT)					
Reference Reading	As received	Raw Value	Accuracy	After Calibration	Expiry	STATUS
Combustible (50% LEL)	N/A	835	±5% of	50	03 / 14	Passed
CO2 (5000 ppm)	N/A	2618	±5% of	4910	10 / 15	Passed
CO (50 ppm)	N/A	404	±5% of	50	03 / 14	Passed
Isobutylene (100 ppm)	N/A	356	±5% of	100		Passed

RECOMMENDATION:

To verify instrument accuracy, always perform a routine Fresh Air and Bump Test procedures prior to every use. Should it become necessary, perform user Span Calibration to avoid sensitivity loss due to sensor drift. Replace these sensors on or before its expiration date or as soon as they fail any of the abovementioned tests and calibration procedure.

REMARKS:

All data pertain only to the unit described obtained at the time of test. This certification is not valid without seal and is not to be reproduced other than in full. Unauthorized reproduction is prohibited.

NEIL M. JERVOSO
08/31/13

Calibrated by: Eldrin S. Gamboa

Certified by: Eric R. Gamboa

METROWIDE COMMODITIES CORPORATION

Exclusive Distributor of RAE Systems Products
Tel. No. (02) 9393141 Fax No. (02) 9388247

Republic of the Philippines
OFFICE OF THE PRESIDENT
National Commission on Indigenous Peoples
Region XI
E. Valeroso Bldg., E.B. Lopez St., Sandawa Plaza, SIR Matina, Davao City
Tel. Nos. 298-0495 • 298-2957 Tel. Fax 298-2942
Website: www. ncip.gov.ph

Control No. 2014-08-26

CERTIFICATE OF NON-OVERLAP

TO WHOM IT MAY CONCERN:

THIS IS TO CERTIFY that **DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS** has applied for the issuance of Certification Precondition for the DAVAO CITY BYPASS CONSTRUCTION PROJECT which shall traverse from Toril Sub-District to Tugbok, Buhangin, Bunawan, and Talomo Sub-Districts joining the Davao-Agusan Road in Panabo City and upon the conduct of Field-Based Investigation (FBI) by the FBI Team of NCIP Davao City headed by Mr. Cristito D. Ingay, with findings that the subject area does not overlap with any ancestral domain.

Further, this Certification is issued to Department of Public Works and Highways (DPWH) as precondition to the application within the above described area on the conditions that

> *DPWH shall undertake to comply with the salient provisions of Republic Act 8371, otherwise known as the Indigenous Peoples' Right Act of 1997 and with NCIP Administrative Order No. 03, Series of 2012, FPIC Guidelines, in the event that there is, in fact, an overlap in whole or in part of any ancestral domain/land of the Indigenous Cultural Communities/Indigenous Peoples. Moreover, the NCIP reserves the right to cancel or suspend this certification precondition in compliance with the above-mentioned rules and regulations.*

FINALLY, this **CERTIFICATION** is issued upon the request of DPWH as a requirement for the issuance of permit for DAVAO CITY BYPASS CONSTRUCTION PROJECT.

Issued this 4th day of August 2014 at Davao City, Philippines.

LILIBETH D. MALABANAN, MD
Regional Director

Concurred:

ATTY. LEONOR T. ORALDE-QUINTAYO
Chairperson
Commissioner–Southern & Eastern Mindanao

NCIP RXI – RECORDS
CERTIFIED TRUE COPY
Aug. 13, 2014