IV. PROJECT DESCRIPTION AND ALTERNATIVES

This chapter describes project alternatives analyzed and the description of the route detailed in the selected project. The project is in the feasibility stage, so there is no detailed design to date.

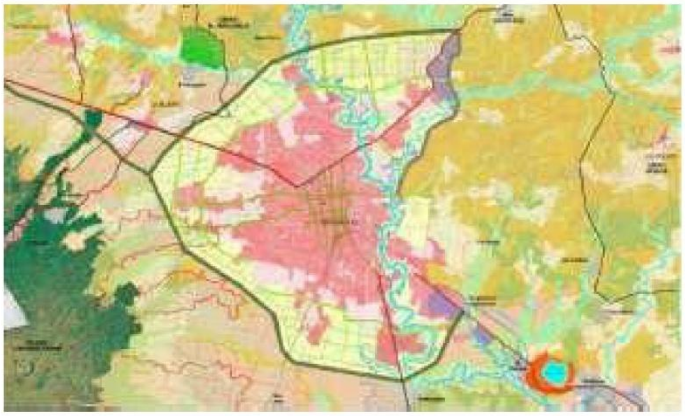
IV. 1 PROJECT ALTERNATIVE ANALYSIS

As mentioned in the previous chapter, the need and justification of the project is thanks to the Puebla Panama Plan, the Government's Five-Year Plan and the National Plan for Land Use and Development (PNODT). The project aims to connect the four main arteries coming into the City of San Miguel and decongest the downtown city area. Under this consideration, the project requires to surround the city and connect these four important pathways.

The different proposals made by the Department of Housing and Urban Development were analyzed, in documents:

- National Plan for Land Use and Development, 2004
- Territorial Development Plan for San Miguel Subregion, 2010
  The Territorial Development Plan for San Miguel Subregion (PDT) (2010) has been prepared based on the National Management and Development Plan for the San Miguel Sub region (PDT) (2010) based on the National Plan for Zoning and Development (PNODT) (2004). Component II - "Foresight" of the PDT suggests an improvement plan for the road network in the subregion of San Miguel in two stages, "Intermediate" and "Optimum".

The proposals included plans for short-term (2010 to 2014), a mid-term plan (between 2015 and 2019) and an optimal plan (between 2020 and 2024). Construction of the Bypass of San Miguel, is planned to be developed in the short term under the sub category of the primary road network. The figure below shows the plan of the Bypass.



Source: PDT, VMVDU2010

Figure No. IV. 1. San Miguel Bypass proposed in "Component III"

IV. 1.1 *Selection of the Route between North and South*

The first decision made regarding the Project was whether the route should go through the North or the South, so the first analysis was focused on the selection of the north or south option.

This analysis is shown on Table IV.1.

TABLE No. IV.l.
ANALYSIS OF NORTH/SOUTH OPTION FOR THE PROJECT ROUTE

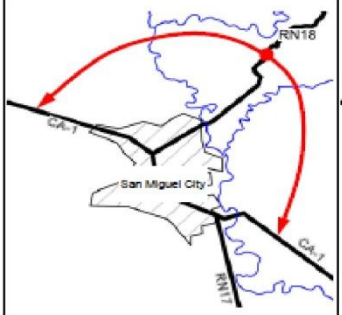
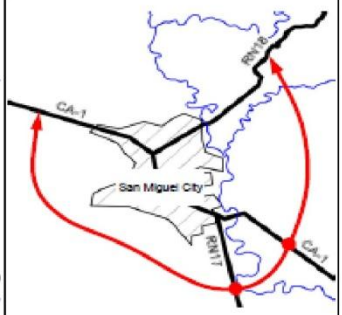
CRITERION	NORTHERN ROUTE	SOUTHERN ROUTE
Length of connection between RN18 with greater traffic demand	Shorter	Longer
Negative impact of the San Miguel Volcano (Chaparrastique Volcano)	Lower	Higher
More rugged topography, with potential erosion and / or landslide problems.	Less rugged	More rugged because of the slopes of the volcano

Source: JICA Survey Team

The northern route is more advantageous from the point of view of the connection length between CA-1 (toward San Salvador) and RN18 where there is a higher traffic demand, and also from the standpoint of the negative impact due to volcanic activities, because of the distance from this route to the volcano.

The high intensity of rainfall in the area, but especially on the steep slopes of the Volcano of San Miguel, creates problems of erosion, destruction of settlements in vulnerable areas, and floods. These processes are increased due to the lack of rules or non enforcement of rules relating to land use and risk management.

The stretch of the CA-1 (to San Salvador)-RN17-CA-1 (to La Union) is very necessary to promote trade and communication with San Salvador and the port of La Union. It's a stretch or section that may have multiple functions, such as a bypass for the city, and also alleviate some of the flooding of the volcano Chaparrastique to the City of San Miguel

	Alternative 1: Northern arc figure	Alternative 2: Southern arc figure
Options		
Accessibility between CA1 and RN18	More advantageous	Less advantageous
Greater accessibility in case of a natural disaster	Less of a negative impact	More of a negative impact (volcano)

Source: JICA Survey Team

Figure No. IV.2. Comparing the North and South Routes

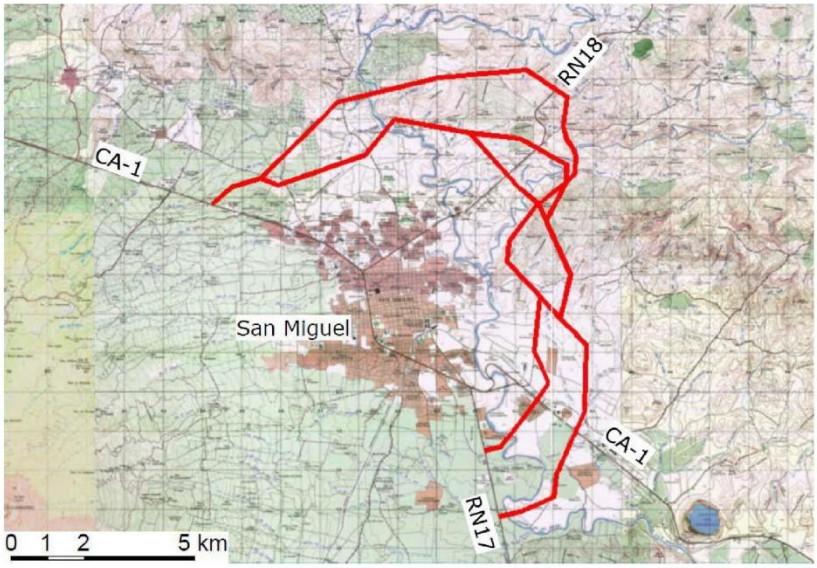
Under these considerations, we chose to analyze the option of the route to the north of the city in more detail .

IV. 1.2 *Option of Routes located at the North of San Miguel*

Two project alternatives were evaluated by the project Survey Team, which resulted in the final proposal. Following the final proposal some adjustments were made considering the economic, environmental and social criteria.

The following points were taken into account for the selection of the route between the proposed options for the north.

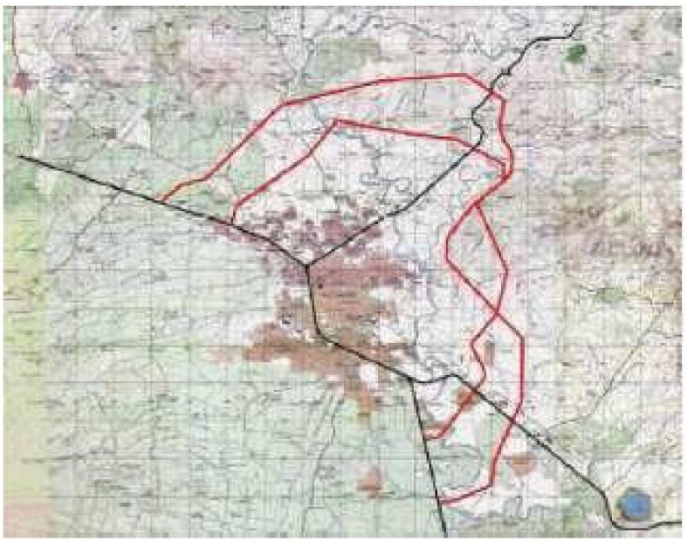
- Connection from CA-1 (to San Salvador), crossing with RN18 and CA-1 (to La Union) and to RN17.
- Conditions of the site as the result of field visits to minimize bypass passage in unsuitable zones or points .
- In the case of the VMVDU options, prioritize routes by stages, and not to optimal and intermediate plans that are for the long-development-term



Source: JICA Survey Team

Figure No. IV.3. Selected Alternatives

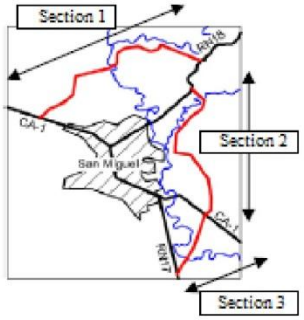
Proposals were analyzed and two were left to be analyzed in depth, corroborating them with aerial photos and field trips.



Source: JICA Survey Team

Figure No. IV.4. Two routes selected for a more detailed evaluation

An evaluation was carried out for the selected routes dividing the routes in three stretches as shown below.



•Section 1: CA-1 (to San Salvador) – RN18

•Section 2: RN18 – CA-1 (to La Unión)

• Section 3: CA-1 (to La Unión) – RN17

Source: JICA Survey Team

Figure No. IV.5. Dividing the Project into sections to assess alternatives

We compared three alternatives:

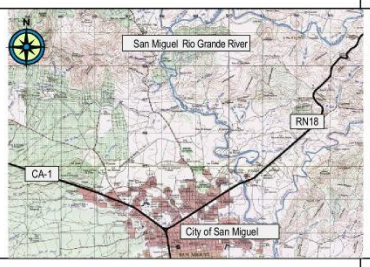
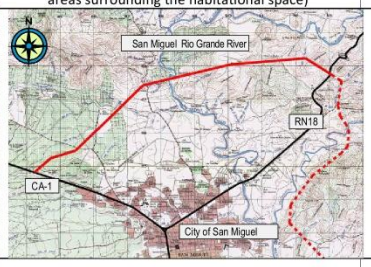
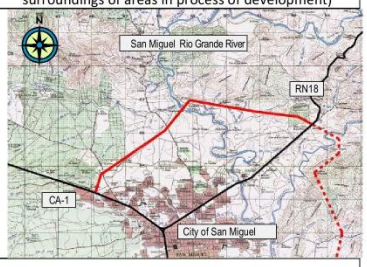
1. Not doing the project
2. Option 1: Based on the proposal made by the VMVDU, outside residential land use
3. Option 2: Based on the proposal made by VMOP, outside the land under the process of development.

The tables below show the results of the comparisons. The comparison was based on subjective scores with values ranging from 0 to 5, with 0 being the least advantageous and 5 the most advantageous, in other words 0 represents a greater amount of negative impacts and 5 fewer negative impacts. That means that the highest score has more advantages or less negative impacts compared to other options.

Following is a detail of the criteria used:

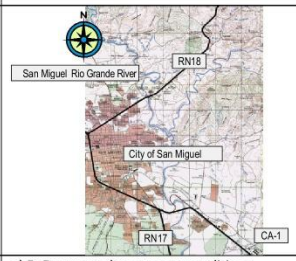
Environmental
a) Natural Environment
b) Pollution
Social
c) Social Environment
d) Land Procurement
Technical
e) Traffic Effect
f) Longitude
Economic
g) Cost of works

TABLE No. IV.2. Comparison of Alternatives by Section, CA-1 (To SAN SALVADOR) A RN18

	Option zero (Do nothing)	Option 1 (Based on VMVDU s proposal regarding the use of areas surrounding the habitational space)	Option 2 (Based on VMOP s proposal regarding use of surroundings of areas in process of development)
Map			
Biological a) Fauna b)Flora	a) 5: Does not alter present conditions b) 5: Does not alter present conditions	a) 3: (-) Affects wildlife b) 3: (-) Felling of trees, shrubs and grasses	a) 3: (-) Affects wildlife b) 4: (-) Lesser amount of trees, shrubs and grasses compared to Option 1
Physical a) Air quality b) Terrestrial physiography	a) 1: (-) Worsens pollution within the city because of increased traffic volume. Also increases noise. b) 5: Does not alter present conditions	a) 3: (+) Reduces air pollution by improving traffic flow in the city; (-) Increases air pollution in the area where the new bypass road is to be built b) 4: (-) Generates earthworks	a) 3: (+)Reduces air pollution by improving traffic flow in the city; (-) ncreases air pollution in the area where the new bypass road is to be built b) 4: (-) Generates earthworks
Socioeconomic a)Living conditions b)Acquisition of ROW c)Involuntary Resettlement	a) 1: Worsens living conditions because of increased traffic volume b) 5: No effect generated c) 5: No effect generated	a) 4 : (+) Improves living conditions by improving traffic flow; (+) Improves accessibility and movement of people and goods b)3: Effects generated c)4: Effect is generated (affecting approx. 5 families)	a) 4 : (+) Improves living conditions by improving traffic flow; (+) Improves accessibility and movement of people and goods b)3: Effects generated c) 1: Effect is generated (affecting approx. 50 families)
f) Effect	1: Worsens congestion	4: Diverts through-traffic and reduces commute time	5: Diverts through-traffic and reduces commute time
g) Technical	n.a.	4: It is technically feasible to build the bypass road	4: It is technically feasible to build the bypass road
h) Distance	2: Distance (L) is 11,620 m down the existing road	3: L = 9,990 m	4: L=7,790m
i) Cost of Works	n.a.	3: more than Option 2	4: Less than Option 1
Scorecard	30 points (except g and i)	31 points (except g and i) [38 points total]	26 points (except g and i) [34 points total]

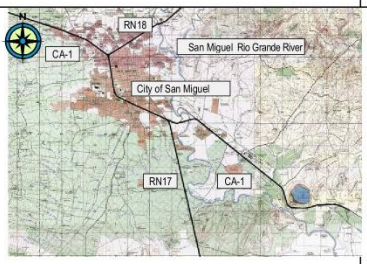
Source: JICA Survey Team

TABLE No. IV.3. COMPARISON OF ROUTES SECTION 2 RN18 – CA-1 (TO LA UNIÓN)

	Option zero (do nothing)	Option 1 (Based on VMVDU s proposal regarding the use of areas surrounding the habitational space)	Option 2 (ased on VMOP s proposal regarding use of surroundings of areas in process of development)
Map			
Biological a) Fauna b)Flora	a) 5: Does not alter present conditions b) 5: Does not alter present conditions	a) 3: (-) Affects wildlife b) 4: (-) Felling trees, shrubs and cutting grasses	a) 3: (-) Affects wildlife b) 4: (-)Felling trees, shrubs and cutting grasses
Physical a) Air quality b)Terrestrial physiography	a) 1: (-) Worsens pollution within the city because of increased traffic volume. Also increases noise b) 5: Does not alter present conditions	a) 3: (+)Reduces air pollution by improving traffic flow in the city; (-) Increases pollution in the area where the new bypass road is to be built b) 4: (-) Less of a negative impact on land physiography compared to Option 2	a) 3: (+)Reduces air pollution by improving traffic flow in the city; (-) Increases pollution in the area where the new bypass road is to be built b)2: (-) Intensive profile cutting and modification
Socioeconomic a)Living conditions b)Acquisiton of ROW c)Involuntary Resettlement	a) 1: Worsens living conditions because of increased traffic volume b) 5: No effect generated c) 5: No effect generated	a) 4 : (+) Improves living conditions by improving traffic flow; (+) Improves accessibility and movement of people and goods b)3: Effect is generated c)4: Effect is generated (affecting approx. 5 families)	a) 4 : (+) Improves living conditions by improving traffic flow; (+)Improves accessibility and movement of people and goods b)3: Effect is generated c) 2: Effect is generated(affecting approx.25 families
f) Effect	1: Worsens congestion	4: Diverts through-traffic and reduces commute time	5: Diverts through-traffic and reduces commute time
g) Technical feasibility	n.a.	4: It is technically feasible to build the bypass road (requires paying attention to river hillside pass)	3: It is technically feasible to build the bypass road (requires paying attention to high slope cuts)
h) Distance	2: Distance (L) = 11,620 m down the existing route using only RN18 y CA-1	3: L = 10,600m	4: L = 7,900m
i) Cost of Works	n.a.	4: Increases cost due to longer distance	4: Increases cost due to grading works
Scorecard	30 points (except g and i)	32 points (except g and i) [40 points total]	30 points (except g and i) [37 points total]

Source: JICA Survey Team

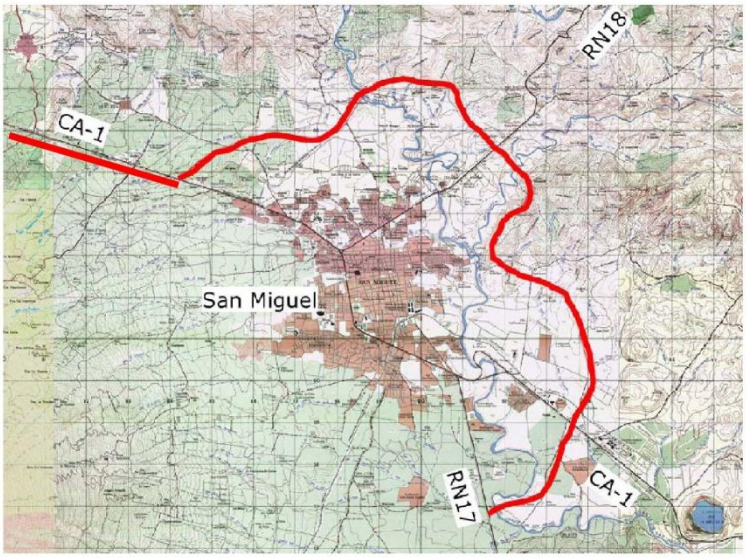
TABLE No. IV.4. COMPARISON OF ROUTES SECTION 3: CA-1 (TO LA UNIÓN) – RN17

	Option zero (Do nothing)	Option 1 (Based on VMVDU s proposal regarding the use of areas surrounding the habitational space)	Option 2 (ased on VMOP s proposal regarding use of surroundings of areas in process of development)
Map			
Biological a) Fauna b)Flora	a) 5: Does not alter present conditions b) 5: Does not alter present conditions	a) 3: (-) Affects wildlife b) 3: (-) Felling trees, shrubs and cutting grasses (more of a negative impact compared to Option 2)	a) 3: (-) Affects wildlife b) 4: (-) Felling trees, shrubs and cutting grasses
Physical a) Air quality b) Terrestrial physiography	a) 1: (-) EWorsens pollution within the city because of increased traffic volume. Also increases noise. b) 5: There is no effect	a) 3: (+) Reduces air pollution by improving traffic flow within the city; (-) Increases air pollution in the area where the new bypass road is to be built b) 4: (-) Generates earthworks	a) 3: (+) Reduces air pollution by improving traffic flow in the city; (-) Increases air pollution in the area where the new bypass road is to be built. b) 4: (-) Generates earthworks
Socioeconomic a)Living conditions b)Acquisition of ROW c) Involuntary resetle-ment	a) 1: Worses living conditions because of increased traffic volume. b) 5: There is no effect c) 5: There is no effect	a) 4 : (+) Improves living conditions by improvingl traffic flow; (+) Improves accessibility and movement of people and goods b)3: Effect is generated c)5: Effect is generated	a) 4 : (+) Improves living conditions by improving trafic flow; (+) Improves accessibility and movement of people and goods b)3: Effect is generated c) 2: Effect is generated (affecting approx 20 families)
f) Effect	1: Worsens congestion	4: Diverts through-traffic and reduces commute time	5: Diverts through-traffic and reduces commute time
g) Technical feasibility	n.a.	4: It is technically feasible to build the bypass road (flood area)	3: It is technically feasible to build the bypass road (flod area, pass through residential area)
h) Distance	2: Distance (L) = 6,710 m down the existing road (compared to Option 1)	3: L = 3,320m	4: L = 1,970 m
i) Cost of Works	n.a.	3: more than Option 2	4: less than Option 1
Scorecard	20 pints (except and y i)	28 points (except g and i) [37 points total]	27 points (except g and i) [34 points total]

Source: JICA Survey Team

IV. 1.3 Selected Route

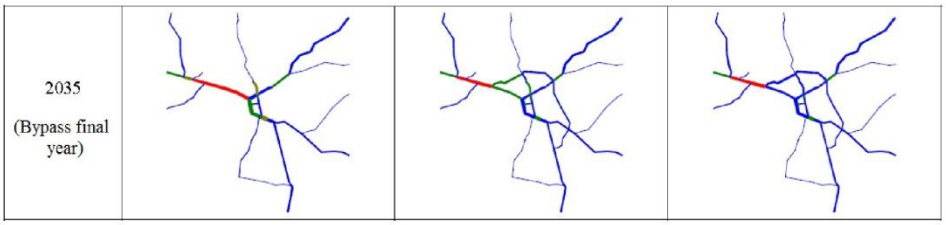
Upon analyzing alternative points with the greatest advantages, the one chosen was the one below for the feasibility study, final design and environmental assessment.



Source: JICA Survey Team

Figure No. IV.6. Selected Route

The selected route includes 3.66 km before starting the road construction section or stretch in which the expansion will be made to the Pan-American Highway, since according to the traffic study (see paragraph **III.**3.1) this stretch is the one with the highest congestion of traffic, with or without the Project, as shown in the figure below extracted from figure III.4.



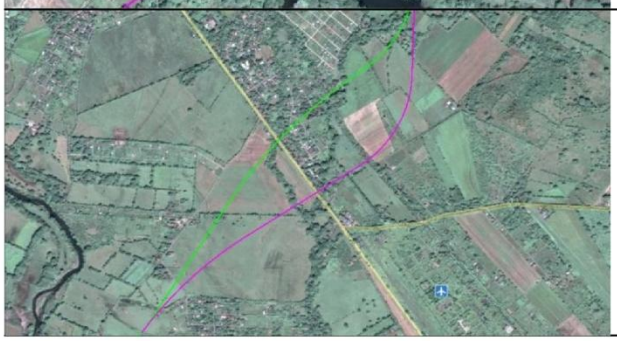
Source: JICA Survey Team

Figure No. IV.7. Results of the Traffic Study, lines show the Volume Capacity Rate (VCR) if lower than 1.00 in blue; lower than 1.20 in green; lower than 1.50 in yellow, and higher in red, the width of the connection shows the volume per PCU

If this stretch or section is not expanded, there will be traffic jams, regardless of whether the Project is implemented or not.

Additional changes are being made to the final route throughout the analysis process, as shown in the following table. The original alignment is in green and the final alignment proposed in magenta.

TABLE No. IV.5. ADDITIONAL MODIFICATIONS MADE TO THE LAYOUT OF THE PROJECT

LOCATION	DESCRIPTION
	Social impact: Path near Riverside Gardens. Alignment was modified in section close to Riverside Gardens in order not to impact the housing development there.
	Increase in costs: Crossing over Río Grande de San Miguel River, the crossing point was modified to cross over the shortest section and reduce the cost of construction of bridge
	Socioeconomic impact: Area of junction with CA-1 to La Unión was modified twice to have less of an effect on homes and not cross the bridge over El Papalón river. Several homes were found in this section that could be affected. • The dotted line is the final aligned path in this section.

Source: JICA and ECO Survey Team

The road will be developed on almost totally rural soil and land for agricultural purposes, topographically described as flat land, with slight impacts on existing households, estimating the impact on 20 to 30 houses according to the satellite images taken between 2009 and 2010. The road runs through the territories of Hamlets like El Sitio, El Zamorán, Santa Inés, El Divisadero, Hato Nuevo, Las Delicias, El Papalon and El Jute, approaching along its path some developments such as Riverside Gardens, Ana Gil Afife at the junction with the SAM10N

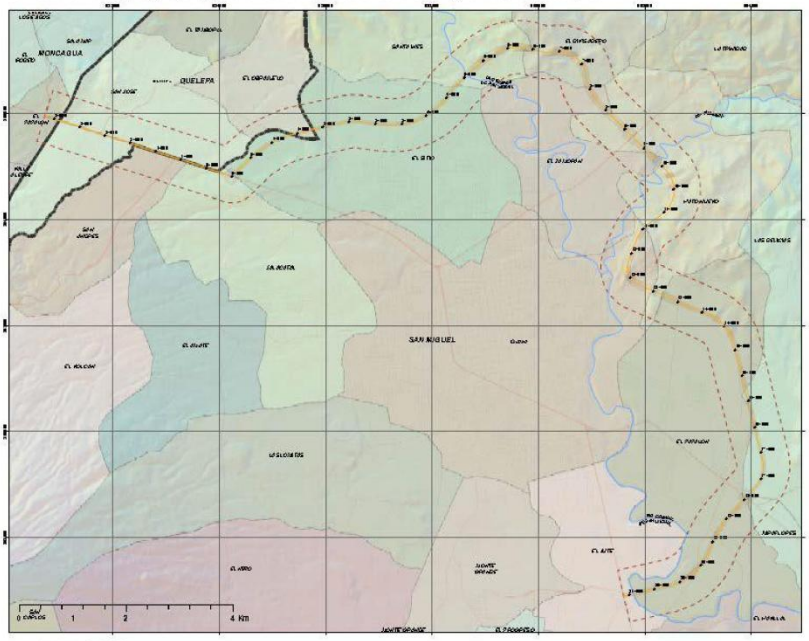
road, some Subdivisions of Canton Hato, Nuevo at the junction with the road RN18 (Military Road), other subdivisions of Canton Las Delicias, and Canton the Papalon near the intersection with Highway CA-1. Additionally, near the site where the alignment starts, we encounter the Archaeological Site of Quelepa, approximately 1.5 Km, outside the area of influence of the Project.

For the section between the CA1 to La Union and the RN17 to El Delirio, the alternative of constructing the road over a landfill was evaluated, but considering the high levels of flooding, especially when approaching the Rio Grande de San Miguel, it was determined to do this pathway as a viaduct, ie elevated on columns.

IV.2 LOCATION

The project is located in the department of San Miguel, in three municipalities: Quelepa, Moncagua and San Miguel. Appendix, level IV. 1 shows the location of the project. The Bypass Project of San Miguel is described as a special type of road of approximately 25 km in length and an operating speed of 80 km / h.

The road will run through the Municipal territories of Moncagua, El Papalon, Quelepa, Canton San Jose and El Obrajuelo, and San Miguel with the following cantons: El Sitio, El Zamorán, Sta Inés, El Divisadero, Hato Nuevo, Las Delicias , The Papalon and El Jute. The project touches some developments such as Riverside Gardens, Ana Gil Afife, at the junction with the SAM10N road, other Canton Subdivisions of Hato Nuevo, at the junction with the road RN18. It crosses other areas inhabited within the village of Las Delicias, and El Papalon. The blueprints FV-1/12 to 1/12 show the topography, structures and trees along the project pathway.



Source: MARN, 2008

Figure No. IV.8. Political and Administrative Division

TABLE No. IV.6. PROJECT LOCATION PER MUNICIPALITY AND TOWNSHIP

PROJECT ST.		CANTON	MUNICIPALITY
0+000	0+500	EL PAPALÓN	MONCAGUA
0+500	2+000	SAN JOSÉ	QUELEPA
2+000	3+600 (NORTH)	SAN JOSÉ	
2+000	3+000 (SOUTH)	SAN ANDRÉS	SAN MIGUEL
3+000	3+600 (SOUTH)	JACATAL	
3+600	5+240	EL SITIO	
5+240	5+700	EL OBRAJUELO	QUELEPA
5+700	8+600	EL SITIO	SAN MIGUEL
8+600	10+360	SANTA INÉS	
10+360	11+420	EL DIVISADERO	
11+420	12+480	EL ZAMORAN	
12+480	13+500	HATO NUEVO	
13+500	13+800	EL ZAMORAN	
13+800	15+400	HATO NUEVO	
15+400	16+860	SAN MIGUEL (CITY)	
16+860	17+020	HATO NUEVO	
17+020	19+600	EL PAPALÓN	
19+600	22+000	MIRAFLORES	
22+000	24+860	EL PAPALÓN	
24+860	25+022	EL JUTE	

Source: Project overlay atop political and administrative division map, MARN 2008

The Bypass of San Miguel is a project that started by expanding from two to four lanes the stretch from Km 128 +051 at the point where the detour of the Pan American Highway (CA-1) leads to Moncagua city heading south east on the CA-1; alternating tangents and curves it runs 3.91 Km to the point located between Km 131 +91 with coordinates Latitude 13 ° 30'9 .10 "N and Longitude 88 ° 13'14 .20 "W. The Table below shows the coordinates at the extension starting and ending sections.

TABLE No. IV.7. PROJECT LOCATION COORDINATES, ROAD EXPANSION SECTION

ST.	LATITUDE	LONGITUDE
START	88°13'14.20"W	13°30'9.10"N
FINAL	88°15'15.94"W	13°30'47.91"N

Source: JICA Survey Team

The following table provides a detail of the Project every 500 m in UTM units for the Road Construction Section or Stretch.

TABLE No. IV.8. PROJECT LOCATION MAIN COORDINATES, ROAD CONSTRUCTION SECTION

No.	LOCATION	LONGITUDE - LATITUDE	
1	Km 0+00	N13°30'53.6"	W88°15'32.9"
2	Exit to Moncagua	N13°30'47.5"	W88°15'13.7"
3	Exit to Quelepa	N13°30'36.8"	W88°14'39.8"
4	Exit to Las Placitas	N13°30'22.2"	W88°13'53.8"
5	Start of expansion section	N13°30'10.7"	W88°13'17.9"
6	Old road to Quelepa	N13°30'33.4"	W88°12'37.2"
7	Road to Canton Agua	N13°30'56.5"	W88°II'07.5"
8	Junction with Military Route Road	N13°30'32.7"	W88°09'09.1"
9	Junction with road to Canton Las Delicias	N13°28'52.8"	W88°08'39.8"
10	Junction with road to Canton Los Bajos	N13°28'10.8"	W88°08'0.1"
11	Junction with Road to La Unión (CA1)	N13°26'53.1"	W88°07'59"
12	Junction with neighborhood street	N13°26'29.5"	W88°08'16.3"
13	End of Project	N13°25'51.8"	W88°09'14.7"

Source: JICA Survey TEam

The Road Construction Section begins where the expansion stretch ends, where it turns northeast; alternating tangents and curves it travels 5.20 km to the point where it crosses over the Rio Grande de San Miguel and from here continues predominantly to the South East, alternating tangent curves and travels 4.10 km until reaching the point where it intersects with the road commonly known as Military Road (RN18) between Km 4 and 4.5 (measured from the site known as the Triangle at the entrance to the city of San Miguel from where it deviates from the CA-1 at coordinates Latitude 13 ° 30'33 .20 "N and Longitude 88 ° 09'09 .30" W. From this point the line continues to the SE and with the tangent it crosses 0.65 Km until reaching the site where it crosses over the Taisihuat river, from here it runs 7.90 km to the South East to intersect again with the CA-1 between Km 144 +500 and Km 145 +000 with coordinates Latitude 13 ° 26'59 .30 "N Longitude 88 ° 8'7 .40" W. The stretch or section of the Viaduct starts from the intersection with the CA-1, then it runs South East alternating tangents and curves running 3.00 Km to the point where it will cross the Rio Grande de San Miguel for the second time, and crossing 0.19786 km to the point where it intersects the road that leads from San Miguel to the detour of El Delirio (RN17), between Km 145 +000 and 145 +500 with coordinates Latitude 13 ° 25'46 .20 "N, Longitude 88 ° 09 '13 .20 "W.

IV.2.1 *Proiect Sections*

The project was divided into two parts or sections for the purpose of implementing the project, although both will be executed simultaneously. The sections are:

1. SECTION 1: From the starting point of the Project to highway CA1 (to La Unión)
2. SECTION 2: Viaduct. From highway CA1 (to La Unión) to RN17 (Road to El Delirio)

The description of the environment and of the entire project is presented for the entire project. Only the cost-benefit analysis and environmental management program is separated in these two sections, for purposes of a better assessment and subsequent execution of the project at the time of construction.

IV.2.2 Area to be occupied by the Project

The following figure shows the Project typical cross section, with a minimum width of 23.28 m.

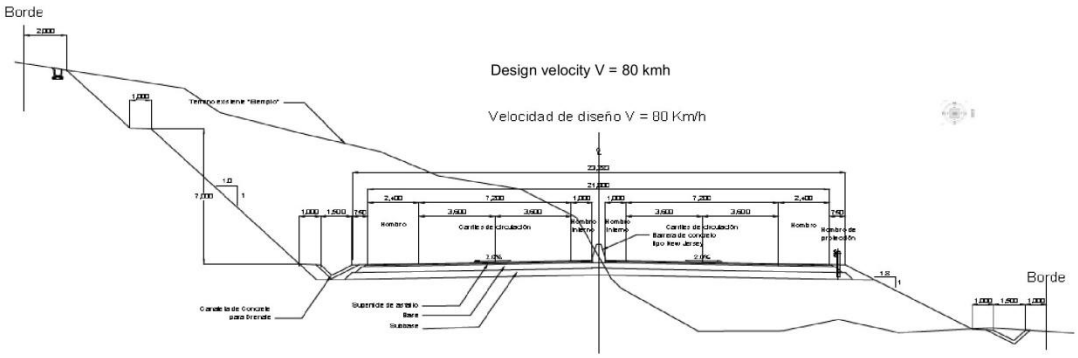


Figure No. IV.9. Project Cross-Section with a width of 23.28 m

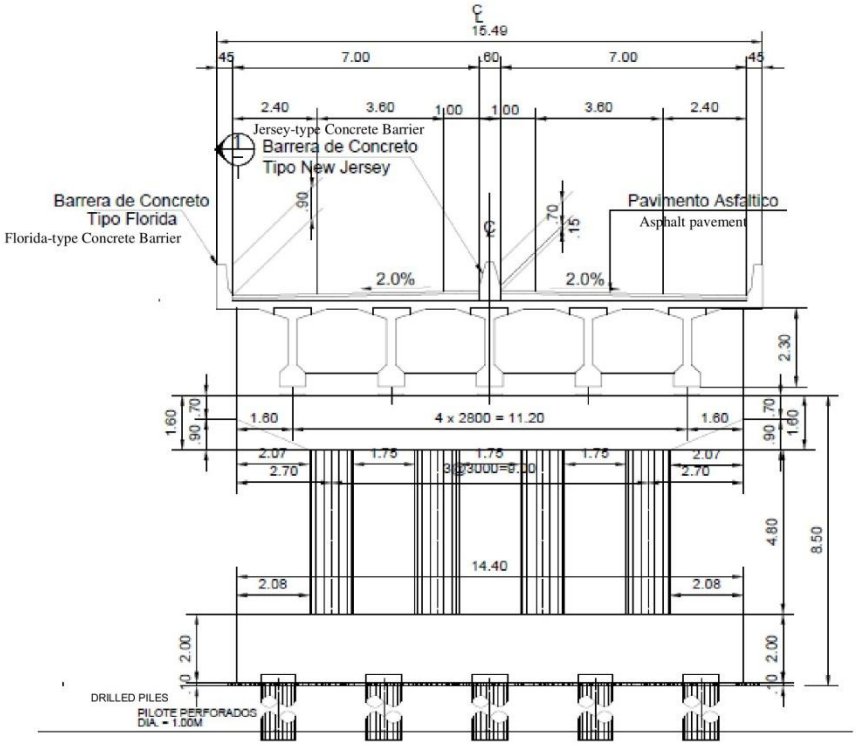


Figure No. IV.10. Viaduct cross-section, with a width of 15.49 m

The typical cross section of the road was established based on the following three types:
1. Section from start of the construction to the CA-l highway to La Union. Two lane standard carriageway with a total width of 21.80 m., with (4 x 3.60 m lane width) + (2 x2.40 m outside shoulder width) + (2 x 1.00 m inside shoulder width) + (0.6 m median width).

2. Extended Section CA-1: Overall width of 20.0 m., having a (4 x 3.65 m lane width on the main line) + (1 x 2.40 m outer shoulder width) + (0.60 m median width), without considering the longitudinal drainage works.

3.Viaduct de CA-1 stretch from the road to La Unión to road RN17 (to El Delirio) with two standard lanes with a total width of 15.49 m.

According to the typical section, the project will occupy the following areas:

TABLE No. IV.9. PROJECT AREA – SM BYPASS ROAD

PROJECT ELEMENT	DESCRIPTION	AREA TO OCCUPY (m2)
Road width and works	comprises the circulation lanes, four per side, internal shoulders, shoulders, New-Jersey type concrete barrier, and protection shoulder, width: 23.3 m.	487,199.84
Slope area	Comprises the area to be occupied by slopes under the project, including the slope itself (cut or fill), berms, drainages and embankments	431,154.25
Protection area	Area beyond the slope that serves as protection for the slope itself	650,399.80
Elements in road junctions	• Roundabout and triangles at start of opening section, station 3+860 • Roundabout and triangles, junction with road to Agua Zarca, station 8+860 • Roundabout and triangles, junction with RN18, station 13+060 • Roundabout and triangles, junction with CA-1, station 13+060 • Roundabout and triangles, junction with RN17, station 25+022	6,985.25 506.29 1,000.81 1,127.87 165.61
Bridges over 50 m long over rivers (4 bridges)*	• Two bridges over Río Grande de San Miguel, stations 8+920 and 24+540. • Bridge over Taisihuat River, station 13+770 • Bridge over El Papalón River, station 20+580	8,349.54 2,457.60 928.98
	PROJECT TOTAL	**1,590,275.84**

* The project includes the construction of additional bridges, the table includes only those over 50 m *long.*
Source: Estimate based on drawings

It is important to mention that the current road already occupies 54,600 m^2.

To set the height or level of the new road, including bridges and passage ways, the criteria of the Maximum Water Design Level, was followed. On a later date, the most convenient grade was established for the project, considering among all factors the most convenient height for filling the foundation near each bridge.

IV.3 DETAILED DESCRIPTION

The total length of the project is 25.022 m (25.02 km), of which 3.660 m belong to the extended section of the Pan-American highway and 21.360 m to the Road Construction Section. Project blue prints IV-4-1/19 to 19/19, show the plants and longitudinal profiles by sections between stations in the project. The width of the road will be 23.28 m plus the variable width of slopes, depending on the topography of the area through which the project crosses. The width of the track comprises two lanes on both sides, two internal shoulders, two lateral shoulders, and shoulder protection.

1. Expanded Section CA-1	Hot Asphalt Mix: 12cm Base Emulsified Base : 22.86 cm Granular Subbase : 30.48 cm Total thickness: 65.34cm
2. Bypass Start ~ SAM ION	Hot Asphalt Mix : 12cm Emulsified Base: 20.32 cm Granular Subbase: 27.94 cm Total thickness: 60.26cm
3. SAM10N-RN18	Hot Asphalt Mix: 12cm Emulsified Base 20.32 cm Granular Subbase: 22.86 cm Total thickness: 55.18cm
4. RN18-CA-1	Hot Asphalt Mix : 12cm Granular base: 20.32 cm Granular Subbase: 27.94 cm Total thickness : 60.26cm
5. CA-1-RN17	Hot Asphalt Mix : 12cm Emulsified Base 17.78 cm Granular Subbase: 20.32 cm Total thickness : 50.10cm

IV.3.1 *Intersection points with rivers and streets: tunnels, bridges and other.*

The alignment connects several major roads in the region which are: the Pan American Highway CA-1, the SAM ION road, the RN-18 Military Road and the road to El Delirio RN-17. The intersections with secondary roads will be resolved at level or slope with access in a single direction. The road alignment crosses the Rio Grande de San Miguel in two points, at river Taisihuat and at river El Papalon so four bridges will be built with the correct length and hydraulic capacity. The project will take up additional space for shunts, loops and overpasses.

Five intersections with major roads with level crossings overpasses will be built in the old road to Quelepa, SAM ION, Hato Nuevo, El Papalon, and El Delirio in the following locations:

TABLE No. IV.10. LOCATION OF CROSSINGS PER TYPE

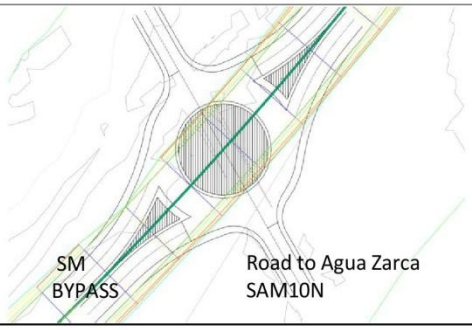
NO.	LOCATION	ST.	SECTION OF I/C	TYPE
1.	Km131deCA-1	3+860	3+680-4+040 (360 m)	Traffic circle
2.	SAM10N	8+240	8+160-8+300 (140 m)	Traffic circle
3.	Hato Nuevo	13+070	13+000-13+140 (140 m)	Traffic circle
4.	El Papalón	21+870	21+820 - 21+870(50 m)	Traffic circle
5.	El Delirio	25+022	25+095 - 25+022	Traffic circle

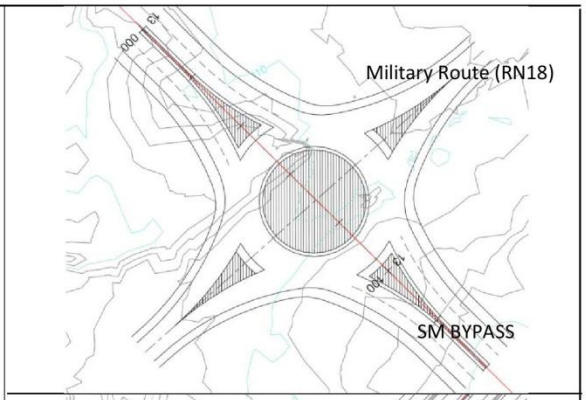
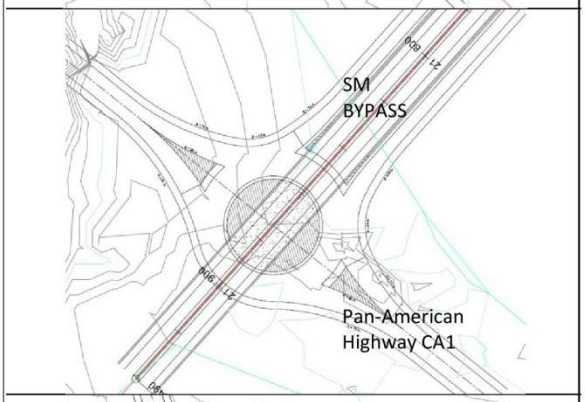
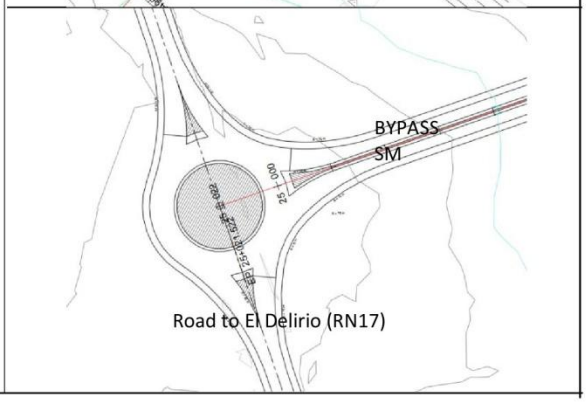
Source: JICA Survey Team

The sections in between the above mentioned crossings will be solved by means of overcrossings (boxes and bridges) without the possibility to enter vehicles in the roads that cross the project.

The following table explains in detail the main crossings along the highway.

TABLE No. IV.ll. MAIN INTERSECTIONS OF THE SAN MIGUEL BYPASS ROAD PROJECT

PASS DESCRIPTION	DETAIL
1. Roundabout at start of opening section, station 3+860. It will be solved with a roundabout and three triangles to move in a west-east direction down the current road, allowing to turn left at the round-about onto the bypass. East-west movement is down the axis of the bypass road allowing turning left at the roundabout to merge onto the current road leading to the City of San Miguel (likewise for cars coming in from the West).	
2. Junction with road to Agua Zarca (SAM10N, station 8+860 will be solved with a roundabout and two triangles. This road is used as a cattle pass and will not be interrupted.	

3. Roundabout with underpass, junction with RN18, station 13+060, It will be solved with a roundabout. The roundabout will be built on the current Military Route road (RN18) Cattle also passes down this road, so passage will not be interrupted.	
4. Roundabout with underpass, junction with CA-1, station 21+873. The point of intersection with CA-1 leading to La Unión will be solved with a roundabout. At this point there is cattle pass from North to South, which will not be affected.	
5. Roundabout, junction with RN17, station 25+022. End of Bypass road.	

Source: JICA Survey Team

IV.3.2 Bridges and Structures

Bridges will be built at river crossings. None of the crosses will change the river flow at its banks, in order not to affect the current natural river dynamics; works will take place above the maximum flood level. Due to its length it was necessary to build columns in the middle of the river, under the policy of not reducing the area of the river over 5% so as not to affect the flow of water.

The following describes in detail the bridges with a length greater than 50 m.

1. Bridge over the Rio Grande de San Miguel, Station 8 +920 to 24 +850.

The bridge over the Rio Grande de San Miguel, North Station 8 +920 will have a length of 140 m and will be located above the flow supported by three columns, two of which are outside the area of the river at the edges and the center. A wall will be built to provide support and stability at the south bank of the river. We conducted a behavioral hydraulic modeling of the river with these elements to provide a design that will impact the dynamics of the river as little as possible, and to establish the proposed bridge design based on the above.

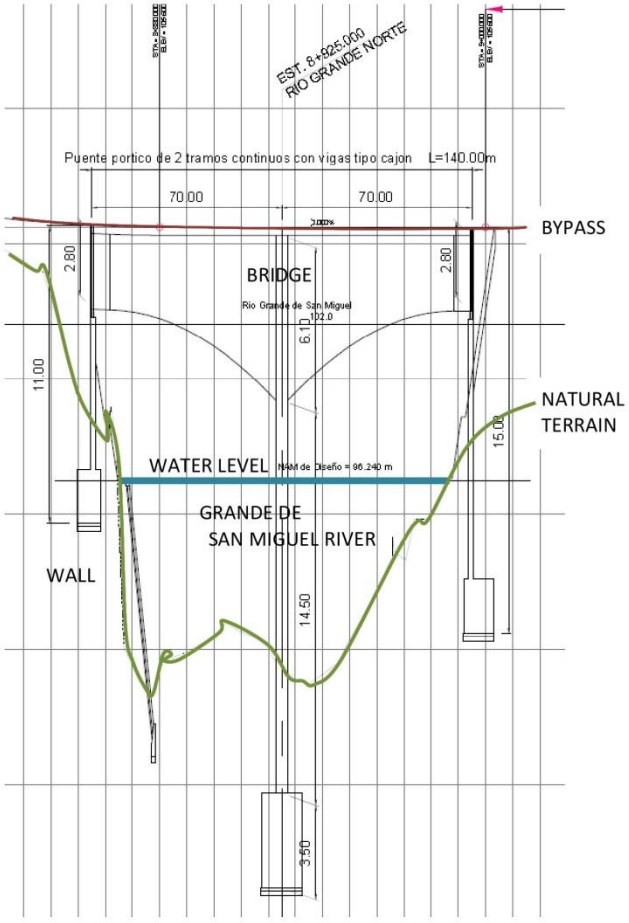


Figure No. IV.ll. Northern pass over the Grande de San Miguel River.

2. Bridge over the Río Grande de San Miguel, station 24+540.

The bridge over the river Rio Grande de San Miguel, at the South, will have a length of 305 m and will be located above the channel supported by seven columns, two of them out of the area of the river along the bank of the river and five in the middle. The five columns at the center occupy less than 5% of the hydraulic area.

This is flooding area, which is why the water level in the design goes high above the river under normal conditions, and it was necessary to change the design on the viaduct in this section and raise

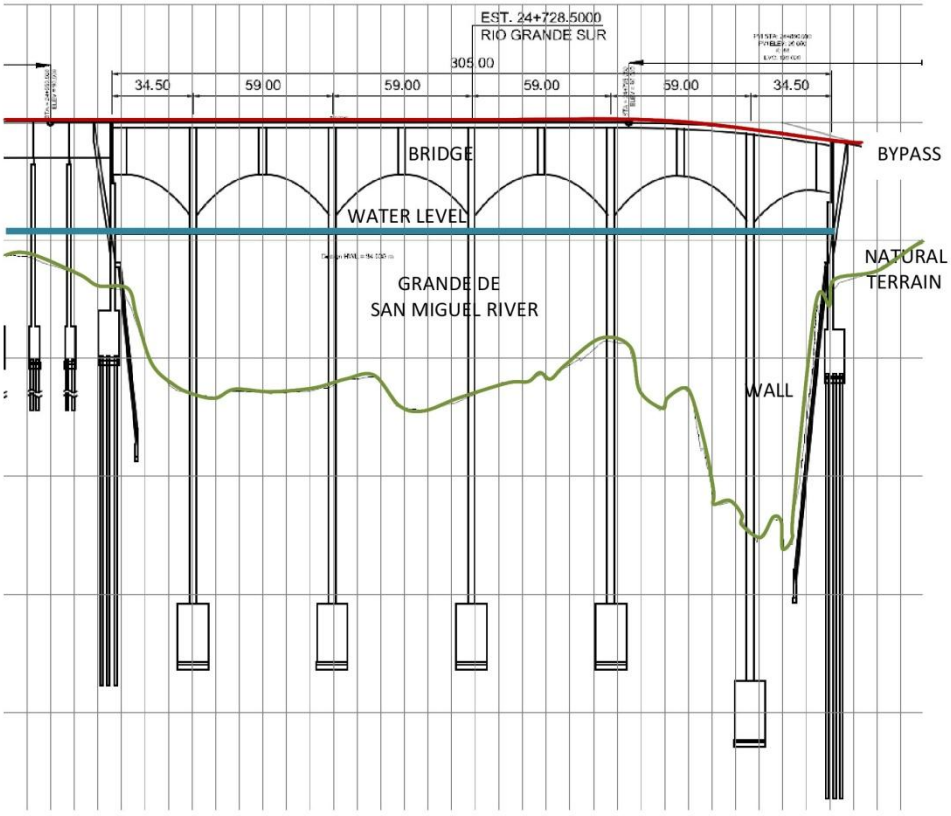


Figure No. IV.12. Southern Bridge over the Río Grande de San Miguel River.

A wall will built on the west bank to support the footing of the column of the bridge and the filling of the ramp that will go down to the RN-17 highway, the shallow foundation will be supported on deep piles leading down to the hard rock, below the level of the river bed. The construction of this wall will take place during the dry season.

3. Bridge over River Taishihuat, station13+770.

)

The bridge over River Taishihuat will have a length of 95 m and will be located above the flow supported on three columns, two of which will be located outside the river area, at the edges and one in the middle.

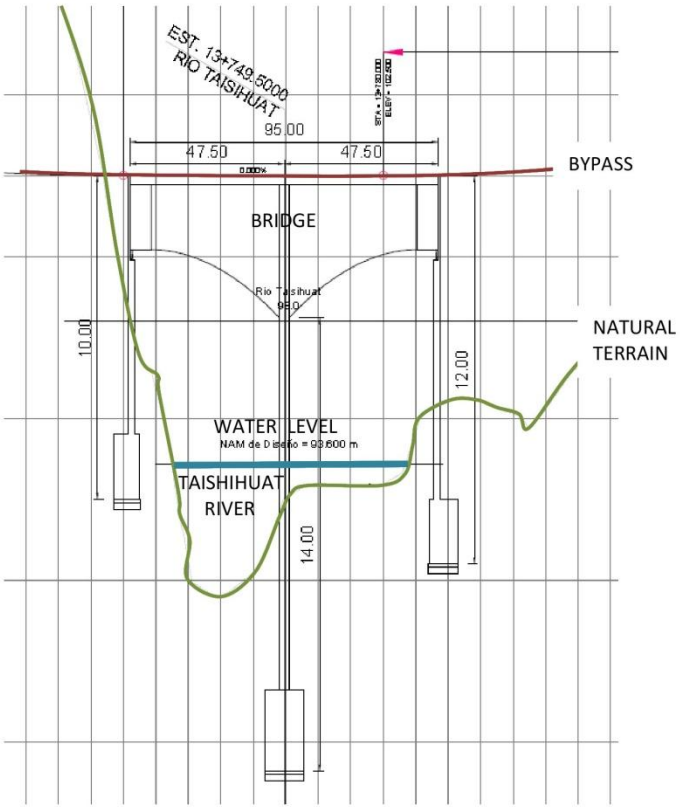


Figure No. IV.13. Schematic drawing of bridge over River Taishihuat

4. Bridge over River El Papalón, station 21+980.

The bridge over River El Papalón will have a length of 50 m supported on three columns, two of which will be located outside the river area, at the edges and one in the middle.

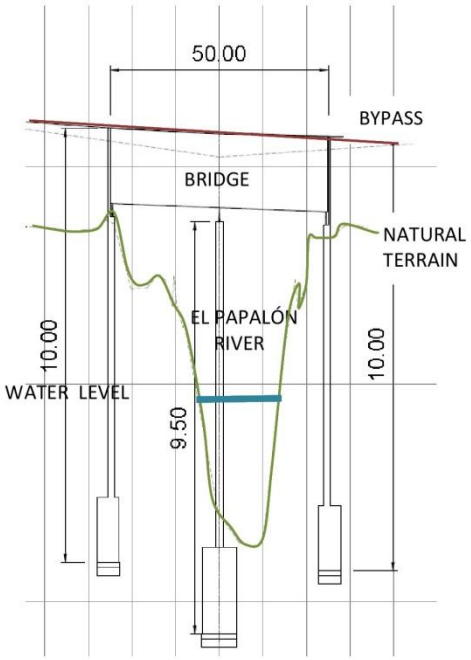


Figure No. IV.14. Detail of the bridge over River El Papalón

The construction details of the bridges can be seen in the Appendix in blueprints Pl to P3.

- *Temporary Access*

The first step in building the project will consist in providing temporary access to any structure to be built. Such access must be within the limits of the project´s right of way and must be approved by the supervisor before starting construction. When access is no longer needed, it should be removed and the surrounding areas restored to their original condition.

Temporary Access is not foreseen at the expanded section of the highway; one lane will be built first and then the other lane at the other side.

- *Bridges*

1. *Substructure*

The construction of the substructure will be divided into two stages, and therefore a close coordination with road works is necessary during this stage.

2. *Buttress*

The bridge abutments along the project are of the strip or wall type. The latter type is widely known in the country.

3. Piles

The initial step consists in drilling the piles or cast concrete shallow foundations, following with the construction of columns of piles and the beam stop.

4. Super Structure

The construction of the superstructure will start with the installation of the prestressed beams on the abutments and pedestals of the piles; later they will be connected by constructing the cast concrete diagrams in-situ and the cast concrete deck simultaneously with the approximation slabs. Finally, the casting of concrete sidewalks and installation of metal railings will be implemented, and the placement of the asphalt road surface, if specified.

5. Miscellaneous Structures

In general, special procedures for the construction of miscellaneous structures are not required, because its construction is considered standard in this country.

♦ *Viaduct*

1. Sub Structure

The construction of the substructure must be divided into two stages, and therefore being in close coordination with road works is imperative.

2. Buttress

The viaduct abutments are either of the strip or wall type. The latter type is widely known in the country.

3. Piles

The initial step consists in drilling the piles or cast concrete shallow foundations, following with the construction of columns of piles and the beam stop.

4. Super Structure

The construction of the superstructure will start with the installation of the prestressed beams on the abutments and pedestals of the piles; later they will be connected by constructing the cast concrete diagrams in-situ and the cast concrete deck simultaneously with the approximation slabs. Finally, the casting of concrete sidewalks and installation of metal railings will be implemented, and the placement of the asphalt road surface, if specified.

5. Miscellaneous Structures

In general, special procedures for the construction of miscellaneous structures are not required, because its construction is considered standard in this country.

IV.3.3 *Crossings with secondary roads and cattle pathways*

Secondary road crossings are listed in the following table. From these crossings it is not possible to incorporate into the bypass. Also included are the "boxes" to allow for the passage of livestock. The construction details are presented in the appendix, in the P4 project.

The crossings located on the enlargement stretch or section, along the current Pan American Highway, will be kept as they are now, without further works.

TABLE No. IV.12. MAIN AND SECONDARY JUNCTIONS – SAN MIGUEL BYPASS ROAD

STATION		PROPOSED STRUCTURE	LENGTH (m)	DIMENSIONS (m)	NOTE
0	+200	NOT PROPOSED			It will maintain its current use as cattle crossing.
1	+320	NOT PROPOSED			It will maintain its current use as cattle crossing.
ST. 2	+780	NOT PROPOSED			Shall be kept as it is currently
ST.4	+195/+800	NOT PROPOSED			Dirt footpath between plots with access from both sides of the future road, so construction of a pass is not warranted.
ST.5	+254	Bridge	43.00		Old road to Quelepa, used as cattle crossing
ST.5	+339	Bridge	16.00		Road to San Esteban River
ST.5	+970	Bridge	6.00		Existing road to Hacienda El Salitre
ST.7	+ 050	NOT PROPOSED			Pedestrian dirt road between plots, several points of access along the road
ST.7	+170	Underpass		4x2.5	Proposed streets of an abandoned housing
ST.7	+ 160	NOT PROPOSED			
ST.7	+ 219				
ST.7	+278.65				
ST.7	+341				
ST.7	+400				
ST.7	+460				
ST. 7	+520				
ST. 7	+600				
ST. 8	+240	Roundabout			Road to Canton Agua Zarca,
ST. 8	+250 a 450	NOT PROPOSED			Streets of Los Angeles housing developments. Only
ST. 8	+ 300				
ST. 8	+ 355				
ST. 8	+ 415				
ST. 8	+ 508	NOT PROPOSED			Narrow dirt road between plots. The project road is at-grade with the plots, therefore there will be access to the area from the road. Presently the only access is a dirt path.
ST. 9	+070	Underpass		2.5x2.5	Cattle Pass
ST. 9	+174	Bridge	16		Road to Canton Las Mesas.
ST. 9	+ 764	NOT PROPOSED			Footpath to Cerro Tablón de las Mesas with very little use, there will be access to it at station 9+866.
ST. 9	+866	Bridge	15.00		Pedestrian path and bridge
ST. 11	+226.5	Bridge over street and creek	23.00		Dirt road to plots in the area, little used, pass is enabled at foot of bridge
ST. 11	+821	Bridge	9.62		Road to Loma Quebrachada, also used as a cattle pass.
ST. 12	+457	Bridge	10.00		In this section, inner streets of various housing
ST. 12	+575 A +789	NOT PROPOSED			
ST. 12	+ 588	NOT PROPOSED			
ST. 12	+ 638	NOT PROPOSED			
ST. 12	+ 735	NOT PROPOSED			
ST. 12	+ 789	NOT PROPOSED			
ST. 12	+789 a +900	NOT PROPOSED			
ST. 12	+960 to	NOT PROPOSED			
ST. 12	+968.7	Underpass		4X2.5	Los Pasitos Creek and pedestrian pass
ST. 13	+070	ROUNDABOUT AND AT-GRADE PASS			Military Route, also used as cattle pass

ST. 13	+ 077 to +380	NOT PROPOSED			Access to several housing developments is interrupted by the new road in this section; these areas will be accessible through other streets of the Military Route, so that access will not be interrupted.
ST. 13	+164	NOT PROPOSED			
ST. 13	+322.5	NOT PROPOSED			
ST. 13	+ 423 to +537	NOT PROPOSED			
ST. 16	+522	Bridge	25.00		Road to Apacunque (Hacienda el Milagro)
ST. 17	+367.5	Bridge	17.00		Road to Apacunque and Las Delicias, and cattle pass
ST. 18	+832.5	Underpass		4X2.5	Existing road to Housing Development
ST. 19	+250	Bridge	8.00		Dirt road to Las Hojas and Apacunque, and cattle pass
ST. 19	+700	Underpass		2.5x2.5	Cattle on the Hacienda estate lands.
ST. 20	+000	Underpass		2.5x2.5	Cattle on the Hacienda estate lands.
ST. 20	+200	Underpass		6x4	Existing dirt road provides access to farm, which is divided into two parts.
ST. 20	+412	Underpass		2.5x2.5	Dirt road provides access to three plots.
ST. 20	+896.6	Underpass		2.5x2.5	Dirt road providing access to rural plots.
ST. 21	+335	Underpass		2.5x2.5	By means of underpasses at station 21 +335 and 21 +535 there will be access to lots in the rural housing development and homes built on FENADESAL grounds.
ST. 21	+348	NOT PROPOSED			
ST. 21	+ 348 to +443	NOT PROPOSED			
ST. 21	+535	Underpass		2.5x2.5	
ST. 21	+ 479	NOT PROPOSED			
ST. 21	+ 688.45	NOT PROPOSED			There is access via the road through underpass at station 21+535
ST. 21	+873	ROUNDABOUT AND AT-GRADE PASS			CA-1 TO LA UNIÓN
ST. 22	+760	NOT PRO O ED			Road to Santa María housing development is not cut off by viaduct
ST. 23	+520	NOT PROPOSED			Road to Santa María housing development is not cut off by viaduct
ST. 24	+676.9	NOT PROPOSED			Road to Santa María housing development is not cut off by viaduct
ST. 25	+021.522	ROUNDABOUT			RN-17, Road to El Delirio

Source: JICA and ECO Survey Team

At the junction with Highway CA-1 to La Union, no passage of cattle will be interrupted. Likewise, in the area of the viaduct, the land used for grazing will not be divided, from the CA-1 to station 23+500.

The road will pass over existing streets through "boxes" and bridges, that in no way will affect current existing drains in the streets and roads that cross the project. These drainage systems will not be affected or modified in any way as shown in the following figure (see project profiles in blueprints VI-January 4/19 to 19/19 project plant and profile and Environmental Measures).

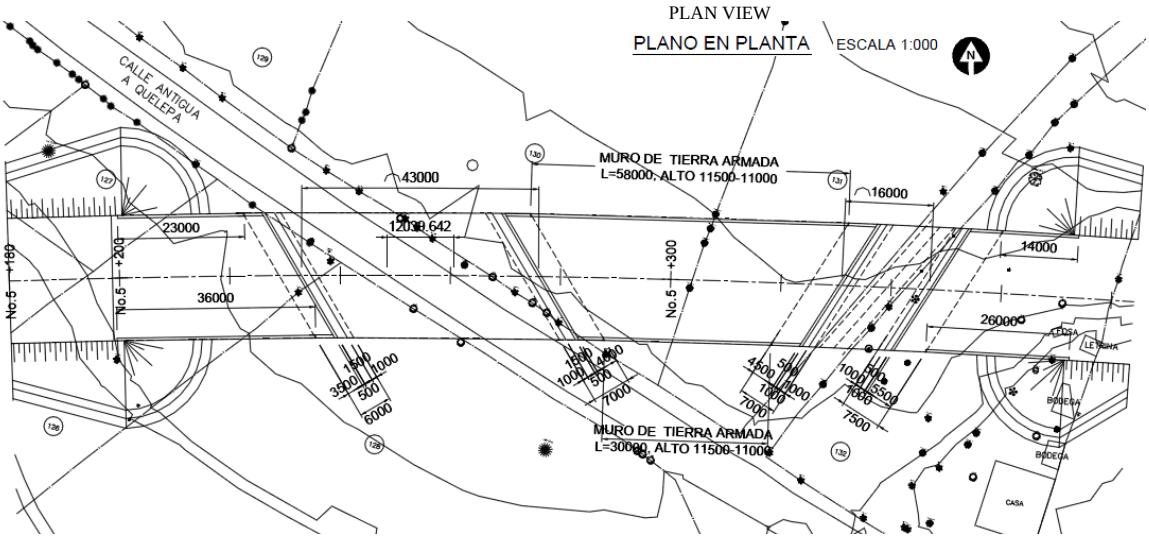


Figure No. IV.15. Detail of typical pass works over existing streets.

IV.3.4 *Hydraulic Design*

IV.3.4.1 Project Longitudinal Drainage

The road will have drains on both sides that will drain the water dripping on the pavement into existing streams, rivers, canals and waterways.

The project is still in the feasibility stage so no drains have been designed specific to the project at this stage, only some preliminary designs of drainage works and water discharges into rivers and streams that cross the project, which are presented in the drainage blueprints P4 to P6.

Water will be drained into gutters and discharge works reason why they are not expected to erode the slopes since they will discharge into existing watercourses.

The project drawings and blueprints and environmental measures, show the location of various types of piping presented in Figure IV-15: SD2, Cl, SD1 and SD3.

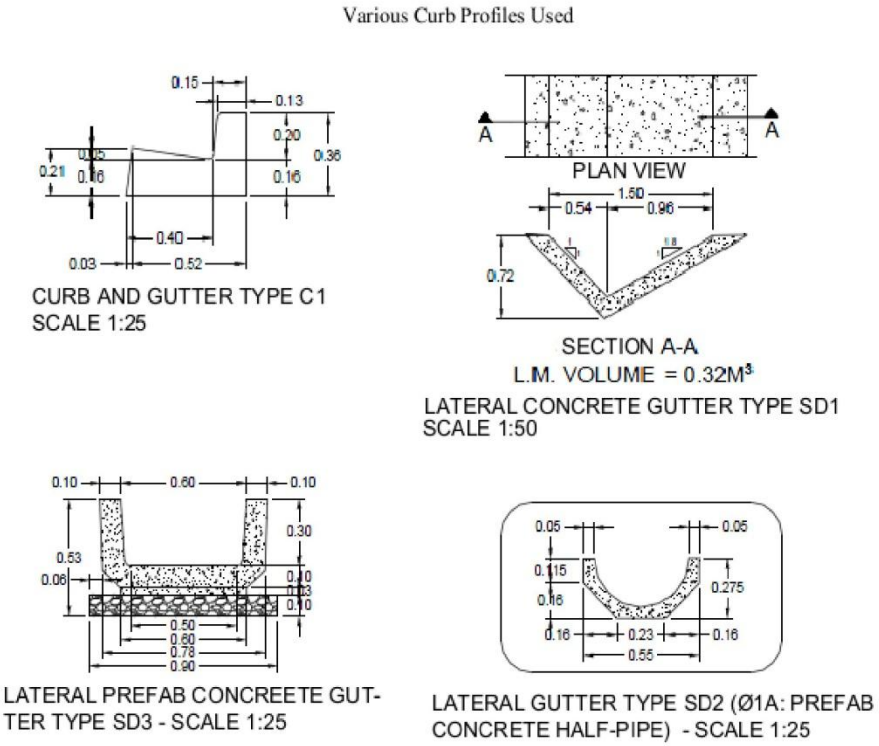


Figure No. IV.16. General detail of longitudinal drainage along the road

The project will include longitudinal drainage, vertical on slopes and discharge heads.

- *Horizontal Drainage (longitudinal)*

The horizontal drainage is comprised of ditches and shall consist of three types of concrete channels: triangular, round and square, as required by pipeline capacity. Depending on the area of concentration, 36" pipes will be located to channel water under the road, through boxes and discharge heads. Blueprint P4 of the project, shows the construction details of these elements and at the VI- January 4/19 to 19/19 project plant and profile and Environmental Measures.

- *Vertical Drainage*

Vertical drainage gutters will be built using masonry stone ditches leading to stone discharge heads as shown in blueprint P4 of project plans.

- *Collection and Discharge Works*

Blueprint P4 shows the headers to collect rainwater and discharge heads with tier energy dissipation built of stone masonry to channel streams crossing the project, according to Table IV. 13.

IV.3.4.2 Drainages

Every crossing of either permanent or non-permanent watercourses, will be channeled, none will be diverted.

At the time of preparing this EIA, the project is at its feasibility phase within which the project justification has been developed, as well as the route definition and basic engineering designs. All watercourses, permanent or not will be channeled, though none diverted.

IV.3.4.2.1 Watercourse crossings

The channeling of permanent and non-permanent streams, which will cross the new road was studied, to determine the passage works. The criteria are:

• At bridges the highway will pass over flood stage.

• The flood levels are estimated for return periods of 100 years for bridges and arches.

• Flood levels are estimated for return periods of 50 years for "boxes" and sewers.

• For permanent watercourses a hydraulic modeling was performed so that the impact of design works on river dynamics is as little as possible, so it is not anticipated to have changes in current project upstream and downstream conditions.

• For basins less than 1.5 km the rational formula was used and for watershed greater than 1.5 km2 the model HEC-HMS was used.

The annexes listed include all calculations for hydraulic works are included:

1. Annex IV. 1 HYDROLOGICAL STUDY ON PASS OVER RIO GRANDE SAN

SAN MIGUEL, SAN MIGUEL PROJECT BY PASS,

2. Annex IV.2 HYDRAULIC MODELING STUDY PASSAGE ON RIO GRANDE

DE SAN MIGUEL AND RIVER TAISIHUAT.

3. Annex IV.3 SMALL BASINS HYDROLOGICAL STUDY, BY PASS SAN MIGUEL.

Based on the analysis, we have determined the permanent and / or temporary or rapidly growing watercourse crossings, which are presented in the following table. Where the ground is drained in

a laminar way. A drain point for determining the basin was established, as is the case of C-8, C-11, C-16, C-27 and C-34, which are also included in the table.

TABLE No. IV.13. STRUCTURES AT RIVER, STREAM AND OTHER WATERWAY CROSSINGS

NATURAL DRAINAGE	WORKS	STATION		Crossing with Structure			STRUCTURE			Note
				Basin	Basin (km^2)	Flow rates (m^3/s)	Proposed structure	Length (m)	Dimensions (m)	
1	1	EST. 0	+616	C- 1	2.67	35.10	Extension of arch Vault (2.6mX3.5m)	17.00		Ojo de Agua Creek - Crosses CA1 highway
2	2	EST. 1	+486	C- 2	1.85	20.80	Extension of 60 Sewer	2.50		Crosses CA1 highway - Unnamed creek
3	3	EST. 2	+036	C- 3	12.59	89.30	Extension of 2X72" Sewer	15.00		El Roble Creek - Crosses CA1 highway
4	4	EST. 2	+165	C- 3a	0.044	0.67	Extension of 36" Sewer	7.00		Crosses CA1 - El Roble Creek
5	5	EST. 2	+753	C- 4	0.78	2.05	Extension of 48" Sewer	1.00		Cannal. Crosses CA1 highway onto El Toro Creek
6	6	EST. 3	+243	C- 5	0.09	0.63	Extension of 48" Sewer	7.00		El Chile Creek - Crosses CA1 highway
7	7	EST. 3	+613	C- 6	1.23	3.06	Extension of arch Vault (1.8mX2.64m)	17.00		An arm of El Chile creek - Crosses CA1 highway
	8	EST. 5	+ 060				30 Sewer			To drain runoff off depression in the terrain, not a natural course.
8	9	EST. 5	+615	C- 7	0.81	2.06	72" Sewer	54.00		Unnamed creek
9	10	EST. 5	+840	C-8	0.19	0.62	42" Sewer	56.00		2 x 1 m existing irrigation cannal
	11	EST. 6	+ 229				30 Sewer			To drain runoff off terrain interrupted by the road, not a natural course.
	12	EST. 6	+571				30 Sewer			To drain runoff off terrain interrupted by the road, not a natural course.
10	13	EST. 6	+848	C- 9	5.94	59.30	Bridge	6.00		El Jalacatal Creek
11	14	EST. 7	+602.5	C- 10	0.31	7.55	Box	39.00	3x3	Existing gutter
12	**15**	**EST. 8**	**+920**				**BRIDGE**			**RÍO GRANDE DE SAN MIGUEL RIVER, NORTHERN PASS**
	--	EST. 8	+ 100 A +450				NO WORKS ARE PROPOSED OBRAS (See note below)			Existing unused gutter
	16	EST. 8	+ 424.5				30 Sewer			Starts at the start of the project, will drain runoff off project itself
	17	EST. 9	+ 400				Vertical Drainage			Small depression in terrain that will be drained off onto the project gutters (it is a cut area), not a natural drainage
	18	EST. 9	+ 520	C-11	0.04	0.94	30 Sewer			Small depression in terrain that will be drained off onto the project gutters (it is a cut area), not a natural drainage

NATURAL DRAINAGE	WORKS	STATION		Crossing at Structure			STRUCTURE			Note
				Basin	Basin (km^2)	Flow rates (m^3/s)	Proposed structure	Length (m)	Dimensions (m)	
	19	EST. 9	+ 600				Natural drainage			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
	20	EST. 9	+ 800				Vertical gutters			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
13	21	EST. 9	+ 866	C- 12	0.08	2.07	Bridge	15.00		Footpath and bridge
	22	EST. 10	+ 100				30 sewer			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
	23	EST. 10	+ 280				Vertical drainage			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
14	24	EST. 10	+ 394.4	C- 13	0.31	8.59	Box	77.00	3x3	Las Tinajas Creek - Basin
	25	EST. 10	+ 700				Vertical drainage			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
	26	EST. 10	+900				30 sewer			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
15	27	EST. 11	+ 247	C- 14	1.51	27.16	Bridge	23.00		El Platanillo creek - Footpath
	28	EST. 11	+ 500				Vertical drainage			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
16	29	EST. 12	+ 126	C- 15	2.60	34.90	Bridge	40.00		Unnamed creek
	30	EST. 12	+420	C-16	0.12	3.10	30 sewer			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
17	31	EST. 12	+ 968.7	C- 17	0.09	3.86	Box	35.00	4x2.5	Los Pasitos creek and footpath
	32	EST 13	+300				Vertical gutter + collection box			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
		EST 13	+500				Vertical gutter + collection box			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area). not a natural drainage
18	33	**EST. 13**	**+770**				BRIDGE			**TAISHIHUAT RIVER**
19	34	EST. 14	+ 149.6	C- 18	0.08	1.94	60" sewer	25.00		Unnamed creek
20	35	EST. 14	+ 361.9	C- 19	0.31	8.59	Box	48.00	3x3	Unnamed creek
21	36	EST. 14	+ 545.4	C- 20	0.04	1.01	Vertical gutters, col- lection box +	32.00		Dry creek, VD -1 (C-20)

NATURAL DRAINAGE	WORKS	STATION		Crossing with Structure			STRUCTURE			Note
				Basin	Basin (km^2)	Flow rates (m^3/s)	Proposed structure	Length (m)	Dimensions (m)	
							30 Sewer			
22	37	EST. 14	+823.9	C- 21	0.06	1.59	72" Sewer	85.00		Dry creek. Includes vertical drainage VD3B
		EST. 14	+935				NO WORKS ARE PROPOSED			Start of creek, modified with the road, will be drained off through gutters onto station 15+030
23	38	EST. 15	+030	C- 22	0.12	3.01	Sewer box		2.50x2.50	Unnamed creek
24	39	EST. 15	+285.1	C- 23	0.05	1.37	60" Sewer	26.00		Unnamed creek
25	40	EST. 15	+543.6	C- 24	0.04	1.12	Vertical gutter + collection box + 30 sewer	14.00		Unnamed creek, includes vertical drainage VD-1
	41	EST. 15	+896.7	C- 25	0.09	2.27	Vertical gutter + collection box + 30 sewer	15.00		Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area), not a natural drainage
	42	EST. 16	+ 060				Vertical drainage			Start of creek, will be managed with vertical drainage and gutter - Vertical drainage VD-1
	43	EST. 16	+ 160				30 sewer			High cut, sewer added, there is no natural drainage
26	44	EST. 16	+649.8	C- 26	1.62	21.50	Box	82.00	2.5x2.5	La Escondida creek
	45	EST. 16	+960				Vertical drainage + collection box + 30 sewer			Small depression in the terrain that will be drained off onto the project s gutters (it is a cut area), not a natural drainage
	46	EST. 17	+620 - 640				Vertical drainage + 30" sewer			Vertical drainage VD-1, fill cuts through small depression, managed with sewer and vertical drainage.
27	47	EST. 17	+750	C- 28	3.00	30.80	Box	62.00	6x6	Las Lajas creek
28	48	EST. 18	+220	C- 29	0.15	3.32	Box	47.00	2.5x2.5	La Gallina creek
	49	EST. 18	+ 400				Vertical drainage			Vertical draomage VD-1 because of height of cut
29	50	EST. 18	+615.2	C- 30	0.18	3.57	Box	56.50	2.5x2.5	Creek
	51	EST. 18	+780				30 sewer			Vertical drainage VD-1, the fill cuts through a small depression, managed with sewer and vertical drainage
	52	EST. 20	+131				30 sewer			Vertical drainage VD-3A, the fill cuts through a small depresion, managed with sewer and vertical drainage
	53	EST. 20	+300 A +400				Wall			Wall will be built along river so that river is not touched (se de-tail below)
	54	EST. 20	+ 557				Vertical drainage			Vertical drainage VD-1, to be drained off onto river, fill area.
30	**55**	**EST. 20**	**+580**	**C- 31**	**13.61**	**129.50**	**Bridge**	**50.00**		**El Papalon River, pass 1**

NATURAL DRAINAGE	WORKS	STATION		Crossing with Structure			ESTRUCTURA			Note
				Basin	Basin (km^2)	Flow rates (m^3/s)	Proposed structure	Length (m)	Dimensions (m)	
31	**56**	**EST. 20**	**+580**	**C- 31**	**13.61**	**129.50**	**Bridge**	**20.00**		**El Papalon River, Pass 2**
	57	EST. 20	+955	C-34	0.16	3.46	72" sewer	34.00		The gentle slope of the terrain is interrupted by fill slope, two sewers built
	58	EST. 21	+202	C-34	0.16	3.46	72" sewer	34.00		
32	**--**	**EST. 21**	**+980**	**C- 36**	**22.48**	**202.7**	**NO WORKS ARE PROPOSED (VIADUCT)**			**El Papalon River, Pass 3**
33	**59**	**EST. 24**	**+540**				**BRIDGE**			**RÍO GRANDE DE SAN MIGUEL RIVER, SOUTHERN PASS**

Source: JICA Survey Team

The project is handled as a viaduct from station 21 +873 to 24 +570, so no works like bridges, culverts, drainage boxes, etc. will be built. River El Papalón crossed once again in this stretch in the station 21 +980 as well as a flood depression at the river bank of station 23 +530 23 +830.

Basin C-27 drains into the gutters of Apacunque street, with no changes, reason why no works have been proposed. The road passes over the street with its natural drainage.

There are two points in the course of the project, where it passes close to waterways or distant watercourses, these are detailed below:

1. Canal carrying water from the San Esteban River to a hydroelectric plant from Stations 8 +300 to 8 +400, now has a drain where the pipes once stood. During the rainy season it fills with stagnant water in some places and drains into the old facilities. The land around drains in a laminar fashion to existing streets or to the river, the surrounding lots have their own drainage system so that works will not be performed at this point.

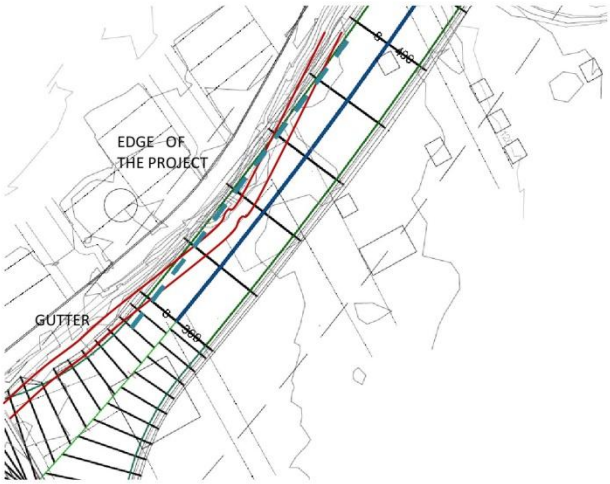


Figure No. IV.17. Detail of old gutter left behind by abandoned hydroelectric plant.

2. At station 20+300 a 20+400, the road passes next to El Papalón River, where a mud reinforced wall of 3 meters per 1.80 will be built, in order not to impact the river flow.

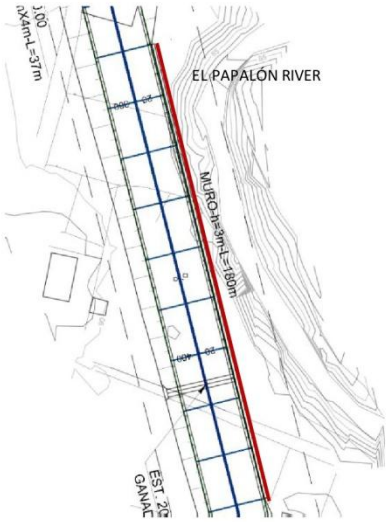


Figure No. IV.18. Area nearby El Papalón River

1. At station 21+200, the road passes over El Papalón River, and a viaduct will be built at this stretch that will pass over the river.

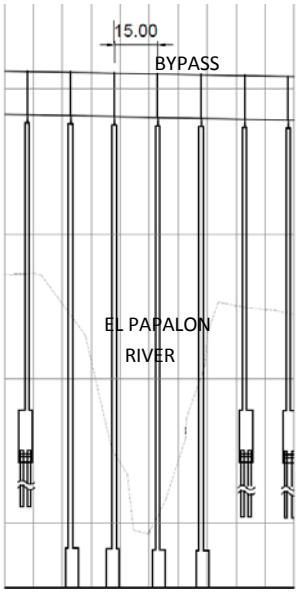


Figure No. IV.19. Area where El Papalón River crosses the viaduct.

As concluded in the evaluation of small basins we have the following additional recommendations:

Regarding the impact on upstream and downstream waterways, some corrections are to be made to the channels, both upstream and downstream with protection works such as level guards, walls, buttresses and headers, longitudinal walls, energy dissipation basins, channeling, etc. All works cause an impact that is normal regarding earthmoving: excavation, earthworks, disposal of material, construction of masonry and concrete. These impacts are minimal when compared with all the works to be made throughout the entire project, with the large volumes to consider.

IV.3.5 Crossings with Infrastructure

In order to build the various project components it will be necessary to relocate existing utilities along the right of way. There are power lines, potable water and drainage along the course of the project that might be affected temporarily during the construction of the project. At the completion of works they will be left as they are today.

1 Power transmission lines of 25 kV or less: Pan American Highway (CA-1), road to Agua Zarca (SM-10), Alas Campos development, and Joselyn Alas development, Street to Hacienda El Milagro, highway to La Union (CA-1), Road to El Delirio (RN17).
2 Po
table water pipes along the Pan Americana highway, Alas Campos development, Josselyn, Altos de Hato Nuevo, road to La Union and highway to El Delirio.
3. Unused pipelines that were used to divert water of the San Esteban River for power generation. Station 8 +340.
4. An electrical substation in Lot 8 on the Pan American Highway.
5. Vaults and piping for storm water crossing the Pan-American highway (CA1) at stations 0 +620, 1 +490, 2 +040.

6. Gutter in station 7 +600, gutters on both sides of roads: 8 +240 13 +070, 21 +810,24 +940.
7. Footbridge of School San Jose, in Quelepa, station 1 +340, owned by the Quelepa City Hall.
8. Telephone lines.

9. Public services were identified during the consulting services provided and by the information provided by the agencies and institutions involved. The relocation works will be executed by the respective utility institutions and costs will be covered by the Provisional Sum included in construction contracts where required. The lengths and exact amounts of the services will be provided by the service providers together with the Contractor.

The list of utilities to be relocated are shown on Table IV. 14.

TABLE NO. IV.14 SUMMARY OF UTILITIES TO BE RELOCATED

	UTILITIES	UNIT	AMOUNT
1.	Electricity Poles	**c/u**	**14**
2.	Telephone lines Poles, including telephone lines	**c/u**	**13**
3.	Electric energy distribution wells	**c/u**	**-**
4.	Potable water pipes /sewage	**c/u**	**-**
5	Telephone lines	**c/u**	**-**

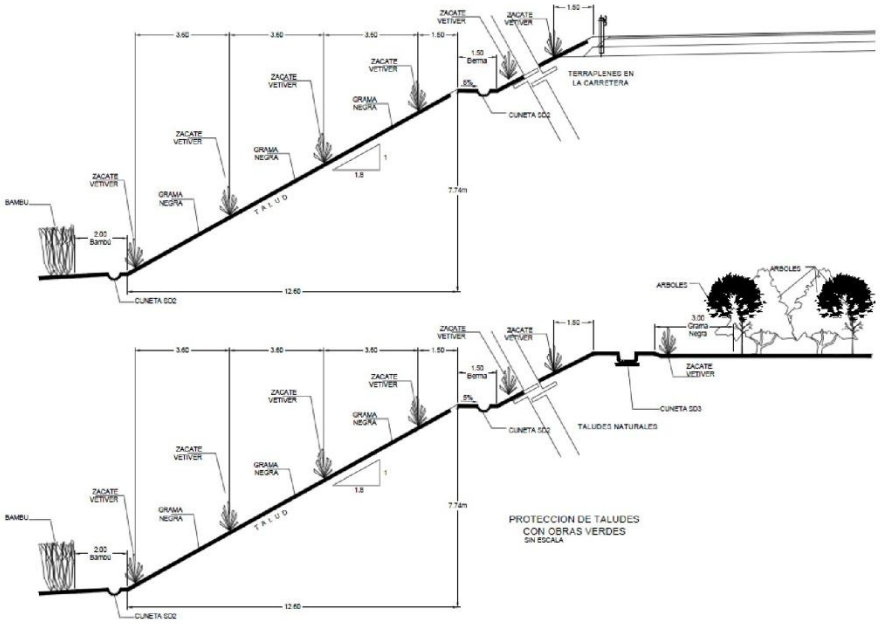
Source: JICA Survey Team

IV.3.6 Slope Management

The project will generate cut and fill slopes. The fill slopes will be protected with grass combined with a vetiver line to prevent erosion in slopes that can cause landslides at fill slopes. Regarding cut slopes in rocky sections, metal screens will be used to prevent rocks from falling on the road, and to ensure that the rocks fall on the banks of slopes. Regarding ground cut sections, concrete grids with open cells will be used, that will at the same time hold the slope with an inclination up to 2 in 1. Slopes will be planted with grass to improve the protection against erosion

Annex FV.4 shows the geotechnical study on which the design of the proposals for the management of slopes was based.
Three solutions have been proposed regarding slopes:

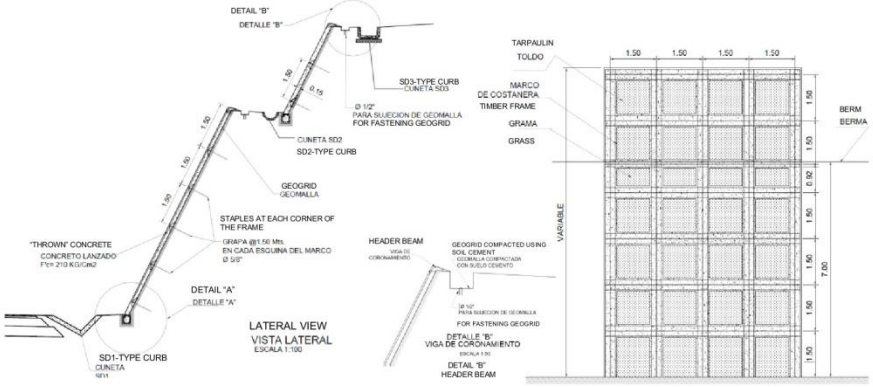
- Fill slopes
  - Leave them at the ratio of 2H: IV
  - Berms of 7 m high and 3 m wide
  - Drains at the top and bottom, with gutters, and in intermediate berms.
  - Bamboo at the bottom, for soil protection.
  - Black grass as a hedge of protection, but vetiver can also be used.
  - Trees will be planted in the buffer zone of the slopes, only at the foot of slopes.



Source: JICA Survey Team

Figure No. IV.20. Detail of fill slopes with green surface protection

- Cut slopes between Stations 3 +900 to 8 +900, and station 16+500 to station 25 +020
    - Leave them at the ratio of 1H:2V.
    - Drains at the top and bottom, with gutters.
    - Protection with a geogrid. The geogrid consists of reinforced concrete frames, cast in situ, with pins embedded in the slope, to stabilize it.



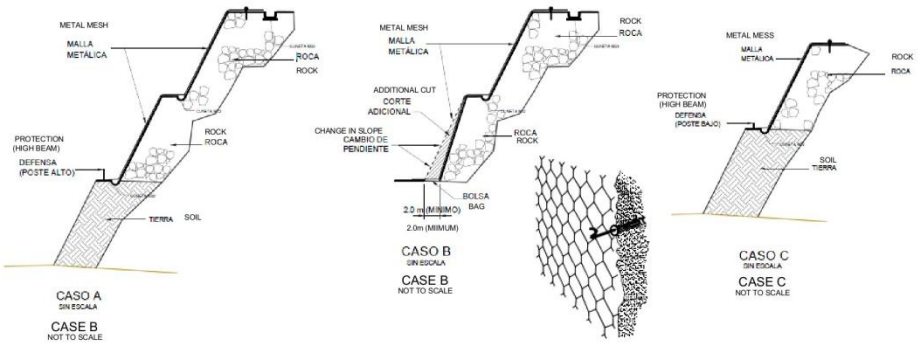
Source: JICA Survey Team:

Figure No. IV.21. Detail of Geogrid to protect slopes

- Black grass as a hedge in intermediate spaces.

♦ Cut Slopes from station 8+900 to 16+500

- Leave them at the ratio of 1H:2V
- Berms each 7 m high and 1.50 m wide
- Drains at the top and bottom, with gutters and intermediate berms.
- Stabilization with hexagonal metal mesh to avoid blocks from falling.



Source: JICA Survey Team

Figure No. IV.22. Detail of stabilization using hexagonal metal mesh

Annex IX. 1 shows the location of the measures on slopes, their height, width and area and annex No. IV.5 a shows a construction detail of the measures on the slopes.

Some sectors are considered as most important to be targeted at the time of the completion of the detailed design, in terms of construction of slopes, such as:

- From station 9+100 to 11+680
- From station 13+900 to 16+380
- From station 18+300 to 18+500

These sections include some with more than five meters in height. The following table is a breakdown of these slopes, cuts by sections are shown in blueprint IV-5 and in blueprints IV-4 we see the longitudinal profiles, Project Plant and Profile and Environmental Measures.

TABLE No. IV.15 DETAIL OF SECTIONS WITH SLOPES HIGHER THAN 5 m

No.	FROM ST.	TO ST.	MAX ALTITUDE	SECTION LENGTH	COMMENTS
CUTS					
1	9+305.5	9+752.5	26.00	447.00	Cut in rock
2	9+934	10+255.3	26.56	321.30	Cut in rock
3	10+478	11+118	32.23	640.00	Cut in rock
4	11+286	11+447	17.61	161.00	Cut in rock
5	12+774	12+797	5.28	23.00	Cut in rock
6	13+134	13+682	17.24	548.00	Cut in rock

No.	FROM ST.	TO ST.	MAX HEIGHT	SECTION LENGTH	COMMENTS
7	13+927	14+131.5	30.77	204.50	Cut in rock
8	14+182	14+344	21.41	162.00	Cut in rock
9	14+390	14+765.5	**34.83**	375.50	Cut in rock
10	15+098	15+267	16.51	169.00	Cut in rock
11	15+304	16+317	24.10	13.00	Cut in rock
12	16+774	17+075	23.53	301.00	Cut in soil
13	17+947	18+082.4	9.41	135.40	Cut in soil
14	18+313	18+558	*17.56*	245.00	Cut in soil
			FILL		
1	4+066	4+155.3	5.44	89.30	
2	4+185	4+220	5.33	35.00	
3	4+970	5+120	6.92	150.00	
4	5+168	5+230	7.80	62.00	
5	5+280	5+325.5	8.54	45.50	
6	5+350	5+426	7.90	76.00	
7	5+517	6+256	10.44	739.00	
8	7+338	7+488	6.43	150.00	
9	7+509	7+573.4	5.59	64.40	
10	7+589	7+610	7.17	21.00	
11	9+000	9+165	7.36	165.00	
12	9+183	9+209	5.72	26.00	
13	10+298.5	10+456.5	14.30	158.00	
14	11+155.5	11+234.5	10.47	79.00	
15	11+259.5	11+264.5	6.98	5.00	
16	11+695.6	11+815.3	10.82	119.70	
17	11+826	12+105.5	12.12	279.50	
18	12+150	12+261.8	11.94	111.80	
19	12+395	12+450	5.87	55.00	
20	13+798	13+852	7.92	54.00	
21	14+153	14+157	5.73	4.00	
22	14+356	14+370	8.07	14.00	
23	14+807	14+858	10.05	51.00	
24	15+015	15+053	11.70	38.00	
25	16+395	16+507	**19.19**	112.00	
26	16+535.5	16+741.5	16.37	206.00	
27	17+312	17+358	7.26	46.00	
28	17+377	17+777	8.95	400.00	
29	17+788	17+823	5.84	35.00	
30	18+174.5	18+272	6.63	97.50	
31	18+585	18+945.4	9.36	360.40	
32	19+170	19+245	6.30	75.00	
33	19+254	19+449	7.04	195.00	
34	19+972	20+197	6.76	225.00	
35	20+254	20+266	5.15	12.00	

As can be seen from the table, there are 4,356.10 m with fill slopes (17% of the project) with elevations between 5m and l9.19m maximum. There are 3745.70 m cut slopes (15% of the project) with elevations between 5 m and 34.83 maximum.

2

The guidelines for slopes were followed including for solid, high and massive rocks, well-cemented sediment or welded volcanic deposits (well consolidated lapilli tuffs of the Environmental Policy Manual of SIECA, which proposes to stabilize cuts at ¼:1 to ½:1 (horizontal: vertical), or almost vertical. It further recommends:

- High altitude excavations should be built using platforms 3-5 meters wide and 5.12 meters high.
- The geologist performing the inspection must take into account the local rock structure or angles of the dips (bedding planes of the rock) in its recommendations, which usually indicate the stable angle of the slope. Excavations on slopes of fractured or weathered rock, shall be made on hillsides with cuts of ½:1 to ¾:1.
- In the case of slopes of broken or loose rock, depending on the severity of the problem, we can resort to welded wire mesh of various types, for containment and / or retaining walls or a combination thereof, to withstand the fall of blocks on the road.

IV. 3.6.1 Slopes in areas with a shallow water table

There are three slopes with cuts over 5 m where according to the geological research they could be below the water table level, the slopes are:

- Station 9+934 to 10+255.3, height 26.56 m, length 321.30 m.
- Station 10+478 to 11+118, height 32.23 m length 640.00 m.
- Station 11+286 to 11+447, height 17.61 m, length 161.00 m.

Gabions with geotextile fabric will be installed in these sections, as detailed in the following figure, performing the corresponding stability study before installation to ensure the stability of the cut slope, thanks to better information of the soil / rock layers existing in site.

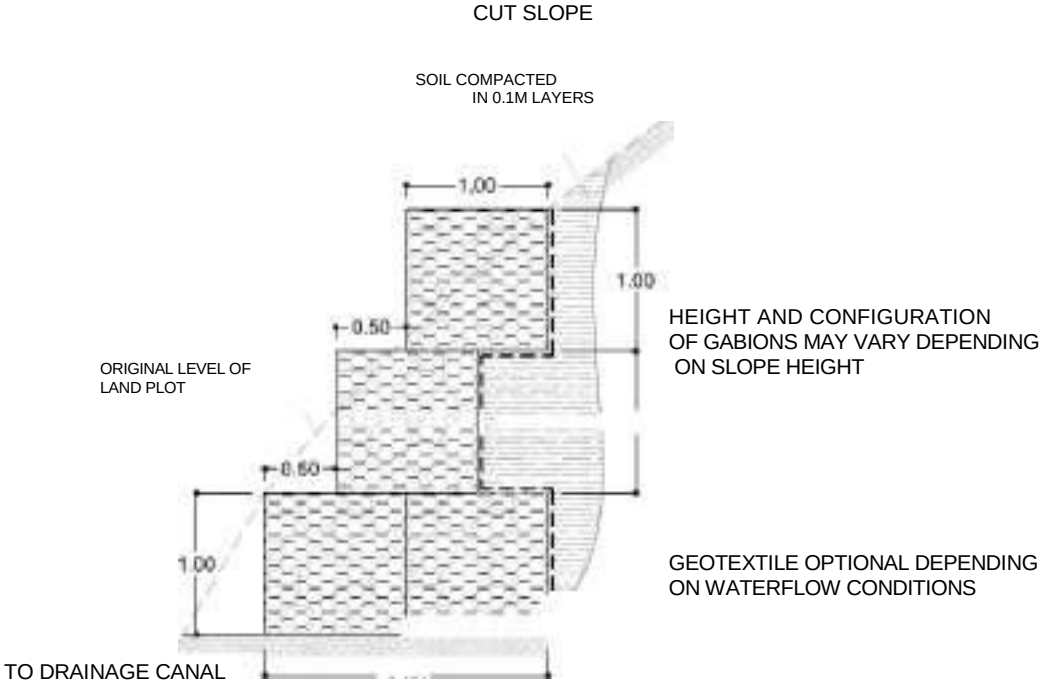


Figure No. IV.23. Gabions with geotextile fabric to drain water from slope

IV.3.6.2 Walls

In those areas where the construction of slopes is not feasible, due to the lack of space available or to protect waterways, the problem will be solved by building walls. Walls will be built of reinforced soil (type keystone). See blueprint P-l3.

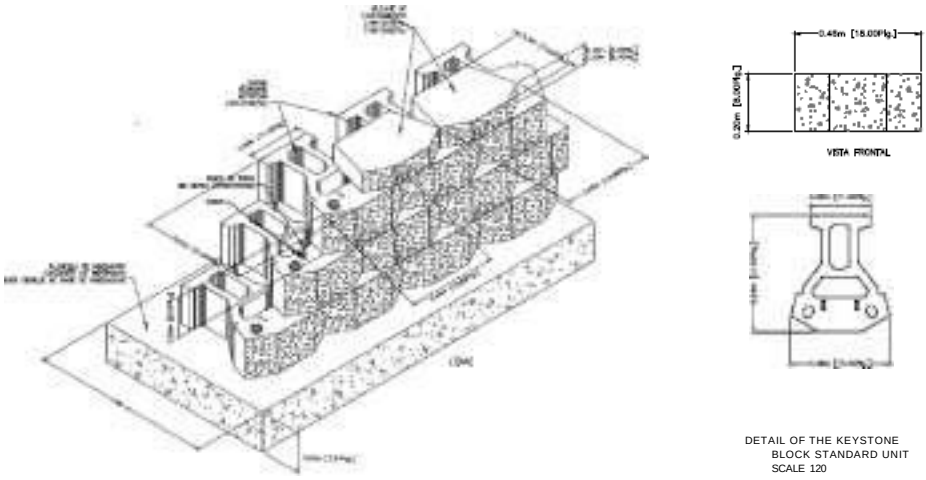


Figure No. IV.24. Detail of a keystone type wall

The following table shows the location of walls within the project.

TABLE No. IV.14 WALLS INCLUDED IN THE BYPASS OF SAN MIGUEL PROJECT

STATION	HEIGHT (m)	LENGTH (m)	SIDE
0+000	1.00	19.00	LEFT
0+617.36	1.00	81.00	LEFT
0+904	1.00	121.00	RIGHT
0+937.4	1.00	63.00	LEFT
1+998	1.00	44.00	RIGHT
2+040.9	1.00	53.00	LEFT
3+237.11	1.00	113.00	LEFT
3+469.03	1.00	161.00	RIGHT
20+260	3.00	180.00	LEFT
20+605	3.00	60.00	RIGHT
20+680	3.00	60.00	RIGHT

IV.3.7 Materials, Machinery and Equipment

The main materials used for the construction of the project are listed below:

1. Stone: gravel, sand and cement.
2. Reinforced steel for reinforced concrete and masonry.
3. Concrete blocks or clay bricks for masonry.
4. Water: for concrete, mix, cleaning, wetting of materials, etc.
5. Land suitable for compaction, if required.
6. Wood: for structures formwork, doors, warehouse.
7. Metal: bridge structure (angles, bolts, pipes).
8. Pipes: for waterway passages.
9. Miscellaneous: labels for signs, paint, plastics, and others.
10. Explosives: to open cut sections.

All materials (steel, stone, block, wood, metal, pipes, etc.) will be purchased from local suppliers or in San Miguel or the eastern part of the country. The water for making concrete will be supplied through pipes to the job site from river water or from springs and will be used for general cleaning and soil compaction works.

With regard to machinery and equipment, the general requirements below will be followed but not limited to this list.

TABLE IV. 17 MACHINERY AND EQUIPMENT TO BE USED FOR THE PROJECT

TASK	EQUIPMENT	QTTY	OPERATION	EQUIPMENT CAPACITY
	Bulldozer 15 t	1	1ha, 16 hr	
Cleaning and stump removal	Motorgrader 3.1 m	1	1ha, 6.82 hr	
	Backhoe 0.7CM	1	1ha, 3.15hr	1ha/16hr/8hr/day
	Dump truck 11 t			0.5ha/day
Excavation of sandy soils	Bulldozer 32t	2	100CM, 1.57 hr	
Transport 2km	Backhoe 1.0CM	1	100CM.1.71 hr	100CM/1.71hrx8hr/d
	Dump truck 11t			470CM / day
Excavation of soft rock	Bulldozer 32t with Cutter	1	100CM, 0.14 hr	
Transport 1 km	Backhoe 1.0CM	1	100CM, 1.32 hr	10CM/0.14hrx0.7x8h/d
	Dump truck 11t			400CM / day
	Bulldozer 32t with Cutter	2	10CM, 0.12 hr + 0.10 hr	
	Crawler drill, 150kg	1	10CM, 0.13hr	
Excavation of hard rock	Air compressor, 17CM / Min	1	100CM, 0.03 hr	
Transport 1km	Giant breaker	1	10CM, 0.13hr	
	Backhoe 1.0 CM	1	100CM, 1.71 hr	10CM/1.71hrx8hr/d
	Dump truck 11t			50CM/day
	Backhoe 0.7CM	1	100CM.2.27 hr	
	Dump truck 11 t	1	100CM, 12.14 hr	
Unclassified materials	Bulldozer 21 t	1	100CM, 0.91 hr	100CM/2.27hrx8hr/day
	Bulldozer 21 t	1	100CM, 0.71 hr	350CM / day
	Backhoe 0.7CM	1	100CM,4.72hr	
Structural excavation	Bulldozer 15t	1	100CM, 1.71 hr	100CM/4.72hrx8hr/day
	Dump truck 11t		100CM, 7.70	350CM / day
	Backhoe 0.7CM	1	1460CM, 86.80 hr	
	Dump truck 11t		1460CM.241.7 hr	
Structural fill	Bulldozer 6t	1	1460CM.241.7 hr	
	Vibrating roller 0.8-1.01	1	1460CM, 72.1 hr	
	Vibrating compactor	1	1460CM, 62.2 day	1460 CM/62.2 day
	Vibrating roller 0.8-1.01	1	1460CM, 62.2 day	15CM/day
	Motorgrader 3.1m	1	100CM, 0.31 hr	
Granular subbase	Compactor 10-20 t	1	100CM, 0.26 hr	
	Pneumatic tyre roller 8-20 t	1	100CM, 0.26hr	100CM/1.28 hrx6hr/day
	Water truck 6,000 liters	1	100CM,0.17hr	470CM / day
Emulsified asphalt base	Asphalt finalizer	1	1000 ton, 11.7 hr	
Asphalted concrete layer	Pneumatic tyre roller 10 ~ 20 t	1	1000 ton, 11.7 hr	50t/1hr/6hr/day
Hot asphalt concrete	Pneumatic tyre roller 8 ~ 20 t	1	1000 ton, 11.7 hr	300t/day
Installing 24" pipes	Truck with crane 4t	1		10m/3.3hrx8hr=24m/d
Installing 46" pipes	Truck with crane 4t	1		10m/5.9hrx8hr=14m/d
Installing 60" pipes	Truck with crane 4t	1		10m/7.2hrx8hr=11m/d
	Truck with crane 15 ~ 161	1	100CM, 2.6 hr	
Stone masonry	Concrete mixer	1	10CM,1day	10CM/5hrx5hr
	Labor	1	10CM, 2day	10CM/day
Slope protection	Perforator			

Source: JICA Survey Team

IV.3.7.1 Oils and other chemical substances

As noted in the section on wastes and residues, lubricating oils will be used during site preparation stages and construction for maintenance and also lubrication of machinery and equipment. During construction paints and waterproofing could be used.

IV.3.8 Michinoeki (Rest Station)

In order to improve road safety and reduce traffic accidents caused by long-distance travel and driving fatigue, and to increase the comfort of road users, we propose the construction of a rest station along the Bypass road of San Miguel.

A road station, is a combination of a place of rest and refreshment, which offers both the driver and passengers who make long-distance trips, a number of public services, such as first aid, parking, restaurant, fueling, and other services for the maintenance and / or repair of their vehicles.

In addition to the facilities mentioned above in the road station, the concept of "Michi-no-Eki" which was developed in Japan, and intends to provide road users, local community services, such as local products, utilities, and others. The concept of "Michi-no-Eki" is different from other road services worldwide for the following three reasons:

1. They are designed with the help of the communities and provide much stronger links with local communities and road users;

2. Create business opportunities for local residents,

3. Are the possible locations for the provision of public services such as multiple health, education and training, and cultural activities as well as a regular restaurant and commercial services.

The JICA Preparatory Survey Team will develop a road station at San Miguel Bypass, following the concept of "Michi-no-Eki".

To build the "Michi-no-Eki" the local governments, stakeholders, local communities, local private sectors must be involved in the development and implementation process.

The Japanese International Cooperation Agency in El Salvador considerd the approach of the service station and incorporated it into the Bypass Project of San Miguel as a first attempt in El Salvador to incorporate road complementary infrastructure.

Nevertheless, by the time of this Feasibility Study, this is a proposal to be developed and implemented to determine the scope along with local government entities and the MOP.

For purposes of the EIA we hereby show the tentative location and dimensions of "Michi-no-Eki". After defining all the characteristics of the rest station we will proceed to the formal statement and the relevant formalities for this project, presented as a separate project, including the request of permits:

- Line and Qualification,
- VMVDU Construction Permit,
- Municipal permits of the City Hall of San Miguel,
- Environmental Permit,
- Licence for the Works by the Ministry of Culture
- All other additional permits required

There will also be works to support the designs and to undertake the necessary measures regarding the Rest Station, such as soil studies, budgets, provision of materials, etc.

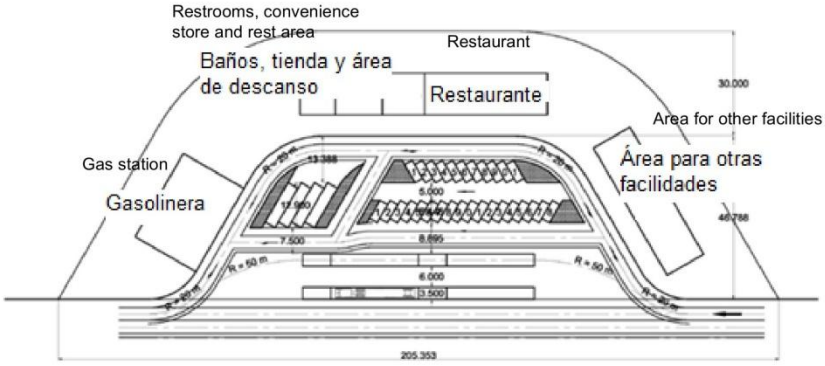
Below is a brief description of the proposed elements for the rest station.

IV.3.8.1 Description of the proposed rest station

The design of the rest station proposal consists of the following areas:

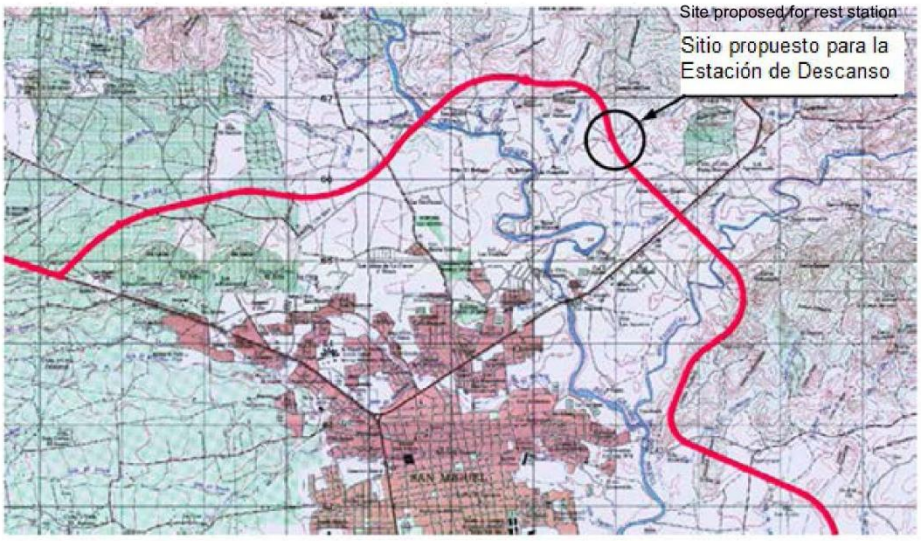
1. Parking: 30 spaces have been earmarked for parking for the Tourism sector and 4 for buses / trucks.
2. Fuel service station with an area of 500m^2.
3. Break free area of 140m^2.
4. Shopping area of 160 m^2.
5. Restaurant area of 400 m^2.
6. Rest rooms area of 120 m^2.

The estimated total area of the rest station will be of 16.000 m2 determined by the dimensions of 200.00 x 80.00, as shown in the following figure:



Source: JICA Survey Team

Figure No. IV.25. Proposed Rest Station



Source: JICA Survey Team

Figure No. IV.26. Location of Proposed Rest Station

The appropriate permissions that apply to the restaurant, gas station, store and other facilities must be obtained, including these: building permit, environmental permit from the Directorate of Hydrocarbons and Mines, the Ministry of Economy, and others in effect in accordance with the final design proposed and the mandatory requirements set out in the categorization document will be reviewed.

Michinoeki rest station is outside the project's environmental "BYPASS OF SAN MIGUEL" permit, but it is being processed with this document.

IV. 3.9 Human Resources

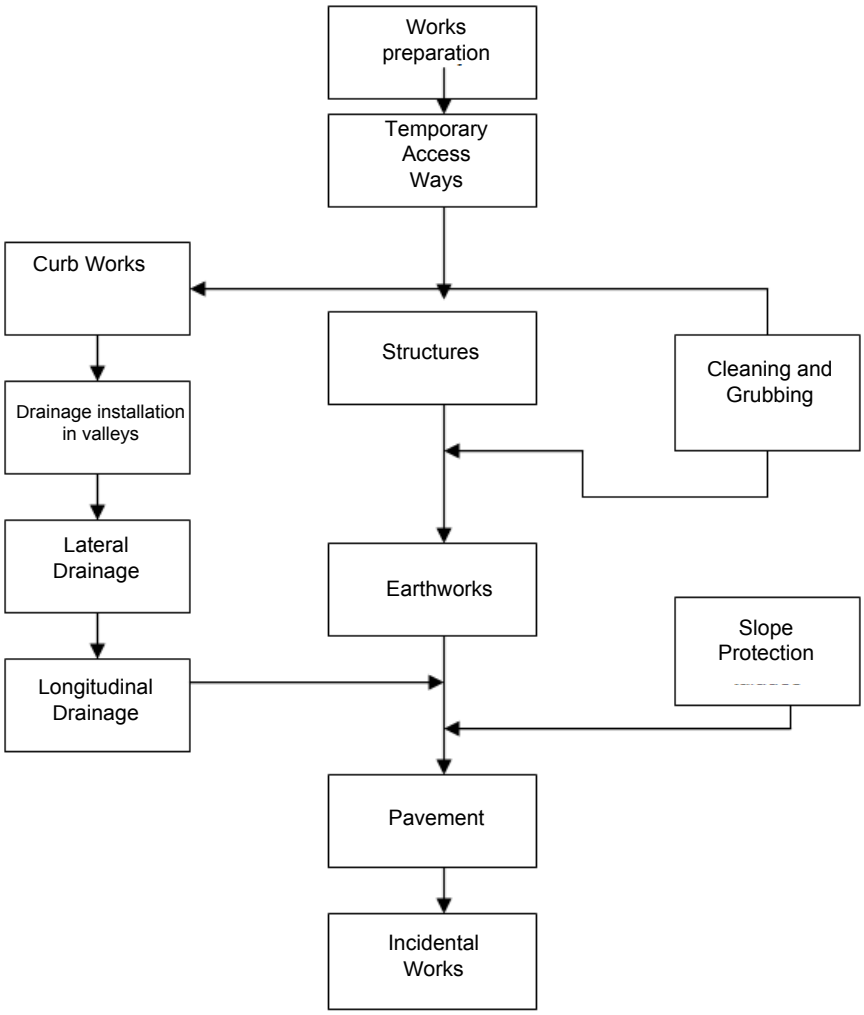
It is estimated that the project will generate 2,000 direct jobs according to the estimation in the feasibility study and more than 1,000 indirect jobs.

IV.4 WORK SCHEDULE AND PROJECT STAGES

IV.4.1 Works implementation Schedule

IV.4.1.1 Works General Flow

Figure IV.27 shows the general flow of project works. As indicated above, the highest priority regarding works is the channeling works at the deep valley in undulating terrain. In particular, the places located far from existing access points are critical path items in the Works Schedule.



Source: JICA Survey Team

Figure No. IV.27. Overall Road Construction Flow

IV.4.1.2 Proposed Construction Schedule

The bypass path including CA-1 has a length of 25,022 km, with a generally flat to undulated topography. The first section stretches 3.66 km located in the expansion of the existing CA-1 and the rest is basically a new construction, and the final stretch is about 4 km and will be a viaduct. The construction works will be implemented in one package. The basic conditions for the preparation of the construction schedule and the main features of the project, critical for the program are the following:

- *Basic Conditions*
  - Construction will begin in early 2015.
  - By the end of 2014, all rights of way will be released by the VMOP and the local or foreign qualified Contractor will have been selected.
  - First the detour for existing traffic will be built at the Road Expansion Section within the same area allocated to the right of way to build half of the road, then traffic will be moved to the new road and finally we will begin the construction for the other half, and
  - In sections where the alignment takes place in a new corridor, all the lanes will be constructed at the same time, to finally treat both sides of the connection points appropriately.

- *(2) Project Highlights*

- The North Rio Grande Bridge is the largest structure from the starting point of the Bypass to the North Rio Grande Bridge, with a length of 140 m. Other minor structures will be considered floating tasks in the Construction Schedule since they can be built simultaneously with the dirt works.
- In the section after the North Rio Grande Bridge to the intersection through Hato Nuevo, the volume to be excavated is 1.4 million m^3, with the maximum height of cuts of 30m.
- The section from the intersection of Hato Nuevo until EST16 +500, is basically a cut with a maximum height of 30m. After the bridge over River Taisihuat, the main structures are two boxes and sewers for channeling the water flow that have to be built before starting the filling works.
- The section from ST.16 +500 to the end of Km 145.2 by El Papalon, the dirt works consist mainly in fillings. There are three bridges that can be built parallel to these dirt works.
- In the final section between the CA-1 toward La Union and RN17 to El Delirio is another main project structure, consisting of a viaduct.

The number of building fronts are determined considering the total construction period and the rainy seasons.

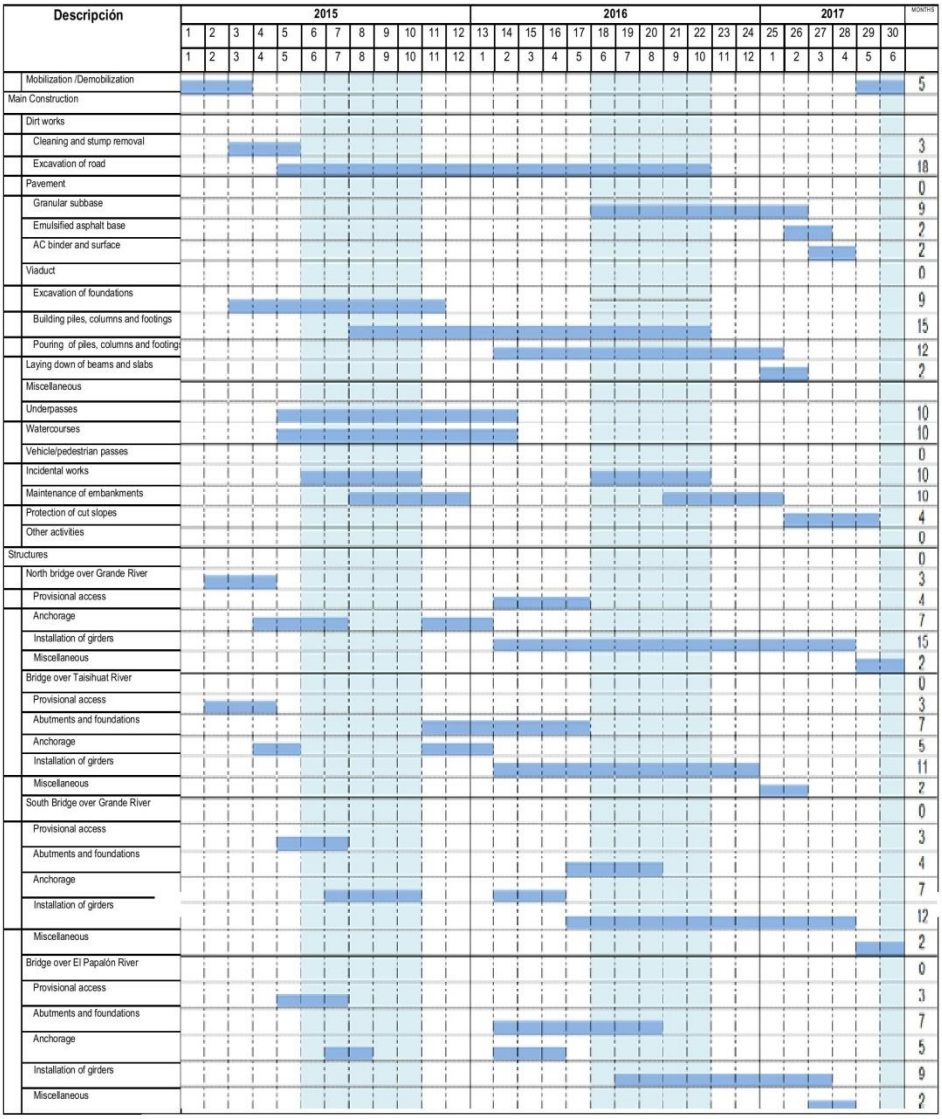
The Road Expansion Section of the CA-1, will require several construction sites with the same construction equipment for a rapid construction. To avoid a negative effect on traffic existing along the CA-1, a range of about 500 m, has been considered between fronts.
With respect to the Road Construction Section, all the sections are new construction, the four lanes can be constructed simultaneously, and a major overlap of equipment is not expected. However, as described in the previous sections, large drainage structures must be built with adequate water channeling before earthworks, at the initial stage of construction

In El Salvador, the rainy season usually occurs between the months of June and October. Thus, in order to establish aproper construction road schedule, seasonal working conditions should be taken into account.

Regarding asphalt concrete pavement, the construction should be done in the dry season, since the temperature and drainage conditions affect the final performance of the pavement. Concrete works can be done during the rainy season, using only the time when there is no rain.

The proposed construction schedule was developed based on the preliminary project design. The project is scheduled to be completed in a period of 30 months by mid-2017. The Survey Team assumed that construction will be performed by a qualified local or international Contractor, using good quality construction equipment and maintaining strict quality control. Following is the proposed construction schedule, which is also included in Annex IV.6 .

TABLE No. IV.18 PROPOSED CONSTRUCTION SCHEDULE



Source: JICA Survey Team

The project is comprised basically of two stages: construction (including site preparation and construction) and operation. The closing stage is not included because the project has a period longer than 50 years.

IV.4.2 Construction Stage

Site preparation and construction activities are detailed below.

IV.4.2.1 Site Preparation Activities.

Site preparation activities includes works prior to the actual construction. The activities are described below.

1. Acquisition of rights of way. Final appraisal of land and land purchases. Applying the resettlement plan presented in Chapter XI.
2. Demolition of existing structures. Demolition of walls, houses, mud walls and other structures in the course of the project. This activity will be carried out manually in the extension section, to not to affect the residents of the rest of the project and manually or by machine in the rest of the project, depending if these structures are located near others that might be disrupted.
3. Felling of trees and shrubs. Clearing works of the vegetation within the course of the project will be carried out.
4. Clearing, cleaning and uprooting:
5. Installing the work campus. The builder will be responsible for all the permissions relevant when selecting the area to install the work campus.
6. Management of quarries and borrow pits. The builder is responsible for processing all permissions when selecting the quarries and borrow pits, if they do not have the permits to operate or otherwise make the necessary modification therein.
7. Sketch outline and topographic re statement
8. Installation of traffic control (Road Expansion Section).

IV.4.2.2 Construction Activities.

1. Traffic control in Road Construction Section and intersection of streets.
2. Excavation, stripping and plant matter disposal, removal of masonry, buildings, cladding, pavement and concrete structures; Removal of existing pipelines, excavation, fillings, excavation of borrow pits; refinement of the subgrade and compaction of the same with 100% modified proctor.
3. Construction of viaduct, tunnels, bridges and level crossings: earthworks, excavation of foundations, building foundations, mounting of columns, beams and slabs.
4. Minor drainage works. Minor drainage works consist of excavations, laying of pipes and boxes, ditches, gutters and works in stone masonry.

5. Major drainage works. Major drainage works include excavations, filling works, drilling and smelting works, installation of supports, beams, railings, bridges and arches.
6. Treatment of slopes in cut: geogrid, hexagonal mesh, berms, drainages and protection coverage with vetiver and grass.
7. Application of asphalt concrete pavements. Includes sub-base layer with crushed material, soil-cement layer, primer watering, curing and bonding, hot asphalt concrete pavement, drying material
8. Horizontal Signs. As part of the road horizontal signaling a strip of continuous reflective strip will be placed on the asphalt concrete pavement. A white reflective stripe at crosswalks, marks on asphalt concrete pavement, marking of single and double arrow, labeling of a STOP and YIELD sign.
9. Vertical signs. The signage will be of a preventive and restrictive nature, informative high flag type. Lighting, traffic lights and intersections.
10. Miscellaneous. These activities are: concrete sidewalks, fences, railings, foot bridges and terminals, spillways, forged embankments, disposal.
11. Closing of the buildings, eviction final cleaning. The Builder is responsible for processing all permits for workplace lockdown .

IV. 4.3 Operational Stage: Once the project is built, the activities carried out during the operational o implementation stage are:

1. Operation: passage of vehicles and people.
2. Storm water drainage
3. Highway maintenance: Keeping track: patching, repairing of several works as gutters, barriers, and pruning of vegetation.

IV.5 MAIN PROCESSES AND TASKS

IV. 5.1 Paving Works

The proposed pavement structures, consist of a granular sub-base, asphalt emulsion treated base and asphalt concrete bond and surface layers. The preparation of the subgrade should be done before placing the sub-base, then leveled and compacted with pneumatic motor grader and bulldozer. After the distribution of the primer layer the treated asphalt emulsion base will be placed. This base is placed in a layer with a thickness of 7 cm maximum. A layer of bonding distributed on the base and the primer and surface layers will be placed with an asphalt finisher and compacted with a macadam pneumatic roller.

The structure of the shoulder is equal to the highway with the possibility of tracks for large trucks.

IV. 5.2 Intersections

The constructions proposed for the five intersections will require greater attention to address existing traffic.

IV. 5.3 Unforseen Tasks

Unforeseen works will be carried out with methods commonly used in the country

IV. 5.4 Camp buildings

A temporary storage site is required to execute the project, particularly for construction materials and machinery. The materials to be stored include: bricks, pipes, sand, gravel, cement, paint, metal, and wood, among others.

The builder will select one or more sites at his or her convenience, which can be located near the work sites or in surrounding cities, even outside the area of direct and indirect influence of the Project. The land could be owned or leased from third parties, and requires a space of about one acre (3,500 m^2).

The builder is responsible for handling all permits when selecting the area or areas for worksite installation works.

Prior to the establishment of the worksite buildings the environmental form must be submitted, according to the Document for Environmental Categorization, either based on the amount of hazardous materials and / or chemicals to be handled, their location in fragile areas or other.

Materials will be transported from this camp to the work sites, by the cadres. The following activities will be carried out in the camp:

1. **Construction and/or adaptation or temporary infrastructure:** The selected site will be adapted according to the needs of the contractor, the space required must at least lodge one office, a warehouse, restrooms and a storage yard .

2. **Management (generation and temporary disposal) of common solid wastes:** these wastes will be generated by the presence of field workers, visitors and permanent staff on the camp; wastes will be stored to ensure their proper disposal. Some special wastes are also generated: cans, paint cans, tanks with fuel or oil remains in small quantities.

3. **Hazardous materials management:** hazardous substances will be stored, such as diesel, grease and oils, whose amounts will be less than the threshold amount established as regulated by the MARN[1]. If larger volumes are handled, the builder must obtain he respective Environmental Permit [1].

4. **Supply of water and sanitary services to employees:** supply of water for field workers and permanent workers at the camp building, adequate waste water management generated due to the presence of permanent workers, or visitors

[1] Executive Agreement No No.23, D.O. No. 162, Volume No.380, September 1, 2008.

5. **Raw Material Storage:** materials and other necessary inputs will be stored.

- **Transport of materials to and from the camp:** materials will be transported from the manufacturing site to the supplier´s warehouse to the main worksite and then distributed to the various work fronts

- **Lockdown:** once activities are completed, the site will be left in similar conditions to those prevailing before the starting of works .

- The location of the CONSTRUCTION WORK SITE, has not been decided as yet; nevertheless, here are the environmental minimum requirements to be met during operation.
- As mentioned before, prior to the establishment of the camp building an environmental form must be submitted, according to the Document of Environmental Categorization.
- The minimum environmental guidelines to be met by the camp building are:
- The camps should be located away from populated areas (500 m. as minimum distance),,
- Have a topographical map with level contours at a vertical interval of 50 cm. on flat land and of 1 m. on slopes, in order to define protection structures and environmental protection and measures against erosion, noise, fumes, dust, garbage disposal, bad odors and everything that affects the hygiene, health and environment of workers on the worksite and nearby human settlement.
- Camp bedrooms and dining rooms will be located at not less than 50 meters away from service workshops and fuel station to mitigate noise, vibrations, gas emissions and dust that may affect workers.
- Camps must be surrounded by a perimeter strip of 10 m wide without vegetation, to serve as fire protector. The removal and disposal must never be done with fires or controlled burns on the site

- To deforest the camp area, a prior permit will be required and upon completion of the works the camp shall be reforest

IV.5.4.1 Adequate management of wastes (industrial, common and hazardous)

In order to prevent impacts, solid wastes will be subject to a solid wastes management plan:

Operations during the construction phase of the project, and t the camp, require the presence of workers (permanent or scheduled times) therefore domestic wastes will be generated.

Construction waste consist of: packaging materials, metal parts, scrap, debris, broken parts, lumber, plumbing parts, tires, among others

Even though major equipment maintenance activities are not performed at the camp, there are still daily activities such as applying grease or oil to the equipment, for daily maintenance, which generates wastes such as wiper rags, cotton with oil, oil containers, empty grease cans.

o **Classification and separation of solid wastes**

Will be done according to its nature, for proper disposal, deposits will be installed according to capacity, labeled, mainly near residential or work areas of temporary workers.

Classification:

- Domestic,
- Metals,
- Paper and cardboard,
- Wood,
- Plastics,
- Hazardous wastes.

Properly identified waste cans must be located within the camp according to their contents. Black containers with lids will be labeled as "common household or non-recyclable" wastes. "Recyclable Material" will be located in the same areas, and have a color code and identification depending on the materials.

These deposits will be emptied at least 3 times a week and their contents will be removed to a suitable disposal site, which will have the relevant environmental permit .

Larger materials such as scrap metal will be stored in a clearly marked and delimited place. These materials do not pollute the soil due to their characteristics.

o **Special treatment of hazardous wastes**

For proper management, at least one plastic container of suitable capacity, with a lid, and properly marked will be installed in the camp area to keep wastes labeled as follows: "Hazardous Waste" (contaminated with oil and grease).

Waste will be removed periodically and will be delivered to an authorized company for its disposal..

IV.5.4.2 Adequate disposal of excreta at the camp

The camp will have adequate health facilities or in order to properly dispose of excreta. These may be in the form of mobile toilets or installing portable toilets that discharge to a septic tank (when permitted by the facilities and potable water is available) or dry latrines without hauling water [2]; in any case it will be the responsibility of the Builder to ensure that workers have adequate sanitary facilities at the worksites.

[2] MSPAS sanitary technical standard for the installation, use and maintenance of dry latrines without hauling water.

When choosing excreta disposal into a septic tank, the quality of wastewater disposed shall comply with the technical standard that forces its users to deliver "ordinary water" to validate the features stipulated; the target for quality of the disposal of the treated water will be the standard for septic tanks of the US-EPA presented in Table No. 2.8.

TABLE IV.19 PARAMETER LIMITS FOR DISCHARGE OF ORDINARY-TYPE RESIDUAL WATERS AS PER THE US FEDERAL CODE OF REGULATIONS

No.	PARAMETER[1]	AVERAGE OF 7 DAYS	AVERAGE OF 30 DAYS
1	5-Day Biochemical Oxygen Demand (BOD5)	30 mg/l[(2)]	45 mg/l[(2)]
2	Sedimentable solids (Ssed)	Report	Report
3	Hydrogen potential (pH)	6-9[(2)]	Not requested
4	Total Suspended Solids (TSS)	30 mg/l[(2)]	45 mg/l[(2)]
5	Grease and Oils (F&O)	20.0 mg/l (daily max)'3'	15.0[(3)]
6	Total Coliform Count (TCC)	Report	Report
7	Chorides (Cl)	Report	Report

1 *Source: Special Regulations for Wastewater*
2 *Source: US Code of Federal Regulations. US Environmental Protection Agency (US-EPA) Standard 40CFR Ch.1 §133.07. Water programs. Edition of 1 July 2007.*
3 *Source: US Code of Federal Regulations. US Environmental Protection Agency (US-EPA) Standard 40CFR Ch.1 §423.15. Performance Standards for New Sources. Edition of 1 July 2007.*

A monitoring of the proper operation, consisting in the analysis of water quality and effluent infrastructure maintenance.

The Wastewater Special Regulations given in 2000, considers the regulations on the management of the waters of ordinary type to be generated in a productive activity.

Article 8 regulates the responsibility of the generator of waste water and of the suitable handling prior to disposal.

Article 15, orders the parameters to monitor water quality, relating it to current quality standards. Specifying the physical-chemical and microbiological of special type waters discharged into a receptor, which should consider the following for final disposal:

Oxygen Biochemical Demand	DBO_5
Chemical Oxygen Demand	DQO
Hydrogen potential	pH
Grease and oils	G & O
Semi settleable solids.....	Ssed
Total suspended solids.....	SST
Temperature	T°

[3] In the absence of national legislation related to the topic, use the application of environmental quality standards applied by the US-EPA

Article 18 dictates the minimum frequency of sampling and analysis, The regulation specifies the frequency and type of parameters to be monitored in waters of ordinary type, considering the flows generated, indicating them as presented in Table No.IV.20 below.

TABLE No. IV.20 FREQUENCY OF SAMPLING AND ANALYSIS

PARAMETERS	FLOWRATE M3/DAY		
	<50	>50	>100
Sedimentable Solids, pH and Flowrate	Monthly	Weekly	Daily
Grease and Oils	Annual	Semiannual	Quarterly
DBO 5,20	Quarterly	Quarterly	Quarterly
Suspended solids	Annual	Semiannual	Quarterly
Fecal coliforms	Quarterly	Quarterly	Quarterly

Daily generation of less than 100 m3 of treated water is expected, due to the number of permanent workers and visitors who will be in the camp

Source: Special Regulations for Wastewater

IV.5.4.3 Closing down of camp

Upon completion of construction the removal of all types of wastes and residues in the camp site location will be verified. If oil contaminated soil is discovered, it should be removed and properly disposed of.

IV. 5.5 Camps and other temporary facilities

The project is located around the city of San Miguel, so the installation of a construction camp is not foreseen. Skilled and unskilled labor is available. There are also many facilities for staff that come from San Salvador or other areas within the country.

If the builder requires the installation of a camp, according to convenience, he or she will obtain all permits required: the environmental permit, according to the categorization, the permit of the ministry of labor, building permit from the Department of Housing and Urban Development, and feasibility of services: water, energy and storm and sanitary sewers.

IV. 5.6 Construction and technological system

The proposed road construction method is equal to a normal road drainage structures, except that it requires a large volume of earthwork for some sections of the alignment. A conventional construction method will be adapted.

The Road Expansion Section of the CA-1 requires significant attention to maintain existing traffic flow during construction. It will require a detailed construction schedule that the Contractor must provide prior to the start of works, in order to alternate works and not require additional streets. Circulation of traffic must operate within the right of way designed. Short distances should be considered for works on the expansion stretch to not stop traffic in any sense, and residents should have access to their homes in the area of works.

The stretch of the Bypass from the start point (Station 3 +680) to the junction with the Rio Grande de San Miguel through station 8 +840, does not require a special method of construction because the topography is flat.

Access to the Project site is relatively easy from the existing highway CA-1 or RN18 because existing streets allow the access of trucks.

There are three bridges on this stretch, two for crossings with existing streets and one to cross a creek. The lower structure construction along with the earthworks will be the tasks on the critical path of the program.

The stretch of the Bypass from the Rio Grande North to the junction with the Military Road (RN18) requires better organization and a more carefully analyzed work schedule than the one of the first section of the Bypass due to undulating terrain and because the number of accesses to the alignment of the path is limited from existing roads. A total of 6 bridges for vehicular and pedestrian passage will be built.

The stretch of the Bypass from the crossing with the Military Route to Station 16 +500 requires a better organization and a work schedule more carefully analyzed, the same as the previous section. In this section, no bridges will be built but rather gutters and boxes for water flow. Furthermore, the volume of excavation in this section is about 1, 400,000 m^3 and the limited number of accesses to the work area requires a good organization of fronts.

The section from Station 16 +500 to the end of the Bypass does not require a special method of construction because the topography is flat. Access to the Project site is relatively easy from the existing highway CA-1. In this section four bridges will be built, two for vehicles and pedestrians, and two waterways. Two boxes for cattle ways are also planned.

IV.6 WATER SUPPLY, EFFLUENTS, EMISSIONS AND WASTES

Basic services required for the implementation of the Project, are directly related to the number of workers in the construction area of the project, as well as on the camp, being mainly: drinking water supply, proper disposal of ordinary wastewater and disposal of common and special solid wastes. Among the latter we can mentioned metal parts, tools, damaged and broken insulators, pieces of wire, etc., and / or hazardous materials (contaminated with hydrocarbons, oils or grease).

IV.6.1 Construction stage

IV.6.1.1 Water Supply

Construction water will be obtained from rivers, springs or existing deposits in the area (as close and accessible to the different work fronts and / or camp), using suitable pipes or barrels to transport it which will facilitate its handling.

At the camp, the estimated total water demand for domestic use and considering that workers will only be there during daytime, was estimated for a total of 2,000 people, with an allocation of 60 liters / person / day, for a total of 120 m3 / days., although most of the staff will be working on the front lines.

Water for domestic use will be provided at the camp for all workers by means of purified water drums; the Contractor will be responsible for providing and storing the water, that will allow to preserve the required quality. Workers will be responsible for getting their share of water at the various work fronts.

IV.6.1.2 Solid Waste Management

Domestic waste: common waste produced by the workers in the work fronts during the early stages of site preparation and construction.

Wastes from site preparation activities are:

1. **Domestic wastes** of project and food of workers at this stage of the project. Waste of workers will be classified according to the type of material and disposed of as described later in the document, the same as in the construction phase.

2. **Construction and machinery wastes,** Waste from construction and machinery, installation of construction camp (Warehouse and offices). In this stage will mainly be worker wastes .

3. **Vegetation wastes** from trimming, cutting, and stripping. Wood and firewood will be delivered to people who sold us the land, to be used. What is not delivered will be used as timber for the construction. Waste plant, such as roots and leaves will be distributed on the land to become part of the soil.

12. **Demolition rubble** from the demolition of existing structures in the right of way of the project. They will be taken to an authorized dump. The builder is responsible for processing all permits for disposal of the material product of demolition activities. The site for the disposal of debris must be approved by the appropriate body. Because the project is at the feasibility level the final disposal site of ruble, has not been determined, as specified above these disposal sites are dealt with by the Contractor with the corresponding permits.

During construction we have the following wastes:

1. **Domestic waste on the camp and work fronts,** in the construction phase of the project, the presence of workers (permanent or for scheduled times) generate household waste and office stationery .

2. **Demolition rubble** from the demolition of the structures still existing in the right of way of the project: floors and pavements, underground pipes, among others. They will be taken to an authorized dump.

3. **Waste from building structures**, consist of:packaging material, metal parts, scrap, debris, wood, scraps of asphalt, among others .

4. **Waste from equipment maintenance**, EVEN WHEN MAJOR EQUIPMENT MAINTENANCE ACTIVITIES will not take place at the camp. Daily activities will take place such as applying oil or grease to the equipment for their daily maintenance, generating waste as wipes or towels, cotton oil, oil containers, empty grease cans in small amounts. Hazardous waste, although in small amounts produced only from the daily preparation of machinery and equipment such as grease. Fuel will be arranged in a barrel of at least 55 gallons capacity, then that material is delivered to a recycler authorized by the competent authority for its proper disposal. To dispose of used grease , never distribute it on road surfaces under any circumstances for dust control of roads, rails or dirt roads.

5. . **Sterile soil**. Excess material of the excavation, which cannot be used for the construction. It is detailed in the Earthworks Section.

6. Organic soil. From land stripping, which will be reused in the project slope areas.

Waste should be managed separately and disposed adequately according to the needs and the type of waste. The project will have the necessary infrastructure to separate them, facilitating the management and final disposal thereof. The handling is provided as follows:

- Temporary storage of common waste

For the temporary collection of common waste produced by workers, 20 properly identified lidded containers will be placed at the operations site. Waste will be collected at least every two days and disposed of in an authorized sanitary landfill.

In construction sites: two containers will be carried on the truck used to transport field personnel, one of the containers is intended for worker common waste and the other for industrial waste from the construction. At the end of the daily shift, workers will place the collected waste in those containers and store it temporarily at the construction site.

Below are examples of properly identified containers (the shape and size of those containers will depend on the type of waste (recyclable or non-recyclable), the required resistance and the volumes generated during the different project activities; however, they must be properly identified or color coded, covered, easily reached, and easy to handle for waste removal).

- Temporary storage of hazardous waste

At the site: at least one properly identified lidded container will be used to put materials contaminated with oil, grease, hydrocarbon waste.

The table below shows a summary of the recommended management of the waste and residues produced in the project.

TABLE IV.21 RESIDUE AND WASTE MANAGEMENT

WASTE/RESIDUE	ORIGIN	MANAGEMENT	DISPOSAL
Used fuel or oil	Daily maintenance of machinery and equipment	Storage in recyclable oil container	Sold to be used as fuel
Used absorbent materials (wipes, sawdust).	Daily maintenance of machinery and equipment	Storage in sealed containers or bags marked as "hazardous waste"	Incineration using controlled combustion in sites authorized by the competent authority
Timber or firewood	Felling of forest trees and tree trunks	Storage in designated area. Firewood will be chopped and packed in bundles	Sold as timber or firewood
Leaves and branches	Felling of forest trees and tree trunks	Storage in a designated area at each working area	Put on the ground for its reincorporation
Paper	Office, packing	Storage in marked containers	Sold for recycling
Household	Food, miscellaneous	Storage in sealed containers	Garbage collection service or authorized transportation and transfer to a sanitary landfill
Glass	Containers	Storage in sealed container	Sold for reutilization

ºWASTE /RESIDUE	ORIGIN	MANAGEMENT	DISPOSAL
Plastics	Packing Material	Storage in sealed container	Sold for recycling
Removed old asphalt	Demolition of CA-1 Trunk Highway and other road crossings	Pile in open air	Crushed and reused as Trunk Highway construction material
Construction rubble	Demolition of culverts, sidewalks, pipes, etc.	Storage	Taken to an authorized rubble dump
Earthmoving sterile material	Earthmoving	Not stored	Disposed of in a specific landfill

Source: Eco Ingenieros Team

Rubble will be taken to a proper disposal site authorized by the Municipal Authorities and the MARN. Since the project is in the feasibility stage, the proposed sites for final disposal of construction rubble and sterile material are yet to be defined. Prior to the start of construction, the corresponding permits will be obtained according to the category.

In the case of tree pruning and felling, efforts will be made to deliver timber and firewood to the owners; leaf waste and small branches will be located in the area of direct influence of the project to improve the soil.

Non-recyclable waste will be taken by private transportation to the San Miguel sanitary landfill located in Las Casitas hamlet on the border with the municipality of Uluazapa

Four recycling companies were identified for the recyclable or reusable waste and residues. One of them was located on the CA-1 Highway at the entrance to the city and the other three were located at the exit, on the CA-1 Highway heading for La Unión.

Waste or residue transportation to the sites mentioned above will be done by the company responsible for the project construction.

Even though small quantities of hazardous waste, such as lubrication and fuel supply, will result from the daily maintenance of machinery and equipment, they will be disposed of in drums with a capacity of at least 55 gallons. This material will be taken to a recycling company authorized by the competent authority for proper final disposal. When disposing of used oil, it should never be used to control dust on dirt or gravel roads.

IV.6.1.3 Ordinary wastewater

If the site lacks a sewage service, septic tank or latrine, ordinary wastewater generated by personnel toilets will be managed through the construction of a septic tank or latrine, or the rental of portable toilets.

If a treatment system is in place, wastewater must comply at least with the minimum parameters required for discharge into a receiving body established in the PROPOSAL FOR SALVADORAN STANDARD NSO13.49.01:06 FOR WASTEWATER DISCHARGED INTO A RECEIVING BODY. The quality of the discharge must comply with the monitoring requirements of the Special Wastewater Regulation (MARN, 2000).

Work sites must be equipped with portable toilets, one per each 25 workers.

IV.6.1.4 Special wastewater

Taking into consideration that the activities will not generate special wastewater, the construction site will not manage and dispose of this type of water.

IV.6.1.5 Rainwater drainage

Rainwater discharges will be directed to the nearest receiving body through pipes, channels or any other infrastructure properly installed to facilitate drainage.

IV.6.1.6 Removal of vegetation

An approximate volume of 23,900 m^3 was determined when calculating the volume of timber contained by the tree vegetation in the area of direct influence.

This volume was calculated based on Saito's method to measure timber production (2004), which is summarized as follows:

HIGHER DAP = DAP (quantified) x 0.75

$$\text{AVERAGE DAP} = \frac{\text{higher D} + \text{DAP}}{2}$$

We then apply the volumetric formula of the cylinder as follows:

$$\text{Vol} = \pi \times r^2 \times h$$

Where:

$\pi \times r^2$ equal to the volume of the circle (base), and

h, height (approximate) quantified in the field per each tree, giving as a result the volume of an imaginary cylinder.

Calculation was made based on a tree census, where trees to be cut down were identified.

It has been estimated that 450 m^3 of structure demolition rubble and 15,000 m^3 of leaf waste and branches will be produced.

IV. 6.2 Operating stage

A minimum amount of common solid waste will be produced by the presence of the workers who will carry out maintenance activities throughout the project area.

Within the framework of the activities carried out in the area of direct influence, this will only occur once every three months with the presence of two workers. It will be important to teach these workers to remove from the work site the waste that they may generate. The waste will be taken to the central maintenance site where it will be managed according to the applicable procedures.

IV.6.2.1 Water supply

If water is required for the purpose of maintenance, it will be obtained from the existing rivers, springs or deposits in the area (the closest and most accessible to the different work sites and/or site), using cistern trucks or suitable drums to facilitate handling. It will be properly stored in drums or cisterns to facilitate water pumping and transfer to specific locations.

Drinking water for all workers will be provided in purified water containers by the company in charge of maintenance. Contractor will be responsible for proper water supply and storage with the required quality, while workers will be responsible for transporting their personal water supply to the different work sites.

IV.6.2.2 Waste from the operating stage

The following waste will be produced during the operation:

1. Maintenance waste will consist of: packing material, rubble and asphalt mixture leftovers, among others; this waste will be produced occasionally and in a much smaller quantity than in the construction stage. Oil or grease application to the equipment for daily maintenance generates small quantities of waste such as wipes or disposable towels, cotton impregnated with oil, oil containers, empty grease cans.

2. Vegetation waste. It is produced by the maintenance of areas surrounding the road to keep them clear of vegetation and weeds.

The quantity of this waste is variable.

IV.6.2.3 Wastewater from the operating stage.

Only ordinary wastewater will be produced by the workers. Portable toilets will be installed depending on the number of workers and duration of the works.

The maintenance activities will not produce industrial wastewater or rainwater.

IV.7 SOCIAL EFFECTS

The social effects to be produced by the project are widely described in Chapter VI. The major social effects of the project are:

1. Temporary disturbances caused by the traffic detour mainly in the expansion stretch and crossings with main Highways.
2. Relocation of families living in the future right of way.
3. Purchase of land and structures; employees working in productive and housing activities.
4. Noise, dust, smoke and vibration caused by the construction and during the operation of the road.
5. Temporary suspension of commercial activities during the construction.
6. Effect on cattle movement.
7. Temporary suspension of public services: power, water and other, due to relocation.

Upon completion of the construction, removal of all kinds of waste and residues at the work site must be verified. If the soil has been contaminated with oil, it should be removed and properly disposed of.

IV.8 DESIGN CRITERIA

The following table shows the design criteria proposed for the project. These criteria were established based on the SIECA manual, the Highway Law of the country and the VMOP standards. The typical cross section established in the Mesoamerica Project was also considered. The U.S. AASHTO manual and the Japanese manuals were also used as reference in cases where the other manuals lacked some details. The AASHTO LRFD will be used to design bridges, as indicated by the VMOP.

TABLE IV.22 DESIGN CRITERIA

ELEMENTS		**VMOP**	**PROPOSAL**	**AASHTO**
Classification		Special (4 lanes)	Rural Road	Rural and Urban Artery
Land		Flat /Undulating	Flat /Undulating	
Design speed	km/h	90	80	60~120 100-120 km/h (flat) 80~100 km/h (undulating) 60~80 km/h (mountainous)
Number of lanes	**Lanes**	4	4	Determined by volume, level of service and capacity
Pumping	**%**	3.0	2.0	1.5 to 2.0
Highest maximum elevation	**%**	-	10.0	4, 6, 8, 10 and 12%
Minimum curve radius (absolute)	m	327	252 (e=6%)	210 (e=10%)
Minimum horizontal curve length Minimum length Minimum desirable length	m	-	 240 480	 3 times the design speed 6 times the design speed
Maximum longitudinal slope Flat Rolling Hilly	%	3.5	 4 5 7	 4 5 7
Minimum K value for convex vertical curve			26	26
Concave			30	30
Minimum stopping length			48	0.6 times the design speed
Roadway width	m	3.65	3.60	3.60
Shoulder width (internal/external)	m	3.0/1.0	1.2~1.8/ 0.5~1.0	2.5/1.0
Overtake stopping minimum visibility length	m		130	130 for two-lane roads

Source: JICA Study Team

IV. 8.1 Technical specifications for road design

1. Road design and complementary works

The preliminary design of the road was prepared based on the established design criteria and taking into account the results of the studies on the natural conditions.

2. Pavement Design

The cost of the project cycle, easy maintenance, type of traffic, meteorology (rainfall, air temperature and pavement surface temperature), topography and geology, available materials, specifications and conditions of adjacent roads, were taken into consideration for the pavement design. The types of necessary works, their location and number of complementary works will be evaluated. The rainfall, topography and geology will be taken into account for the drainage design.

3. Bridges and other works

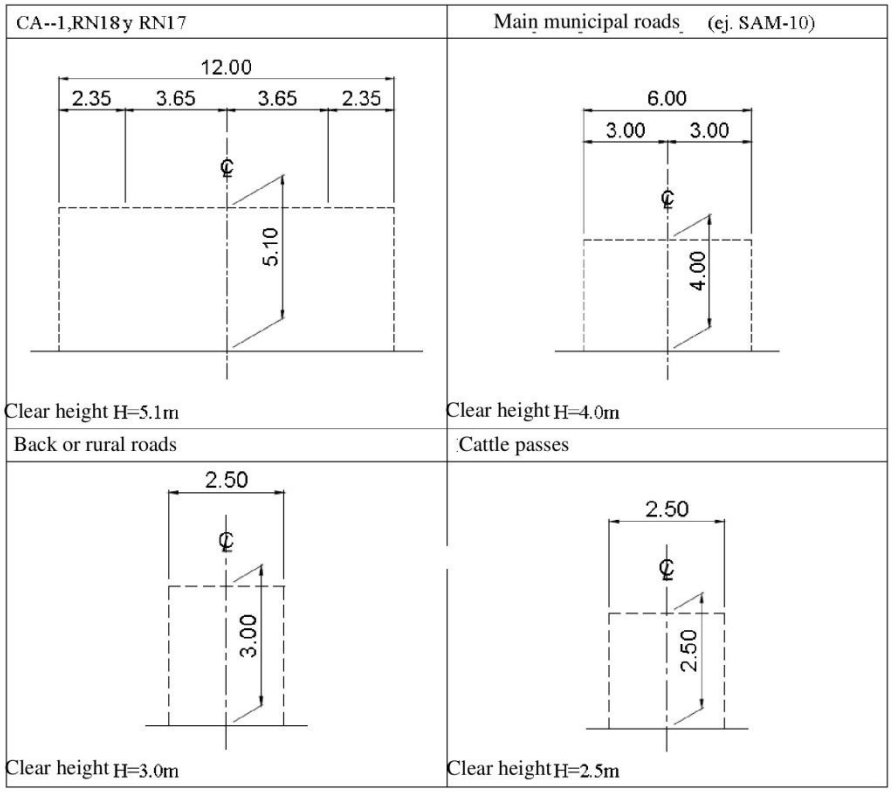
The preliminary design of the structures alongside the selected route was prepared based on the visits made and collected information. Surveys of the river and drilling sections considered in the design were prepared for the location of the main bridges. The detailed designs of these structures will be prepared in a subsequent detailed design stage.

4. Design criteria for the structures

The design standards to be applied are those established by AASHTO LRFD, Third Edition, 2004 and AASHTO LRFD design specifications, 2004 edition. Some design considerations are detailed below:

- Design load: AASHTO HL-93 for the main bridges over the Grande and Taisihuat Rivers.
- Seismic load: Technical Standard for Seismic Design of the Republic of El Salvador, Ministry of Public Works, 2001. A seismic design for the structures must be prepared since El Salvador is located in a seismic zone. Horizontal factors are determined based on the Salvadoran standard. Japanese standards for seismic design will be consulted to determine the types of earthquake-resistant structures.
- Typical cross section of the Bypass: The shoulder width will be the same as the width of the soil stretches, taking into consideration the lessons learned from the existing bridges on the main highways of the country, where a considerable number of accidents have occurred because the shoulder width is reduced in those bridges. Sidewalks have been considered on the main bridges. The construction of sidewalks on minor bridges will be discussed with the MOP, since the MOP's policy is to serve both pedestrians as well as drivers.
- Type of Bridge: Clearance length and distribution are determined according to an analysis based on the results of the topographic and geotechnical studies and the conditions of the crossings. Concrete structures are considered more beneficial from the maintenance point of view, taking into account that it was observed that metal beams of bridges in the surroundings of the project site had not received maintenance. According to the analysis carried out so far, the following types of bridges will be possibly considered in the Project.

5. Typical cross sections on roads which cross the bypass. It will be made sure that road crossing points have the minimum heights, depending on the type of road. The following table shows the widths and heights of crossing works considered for different types of roads:



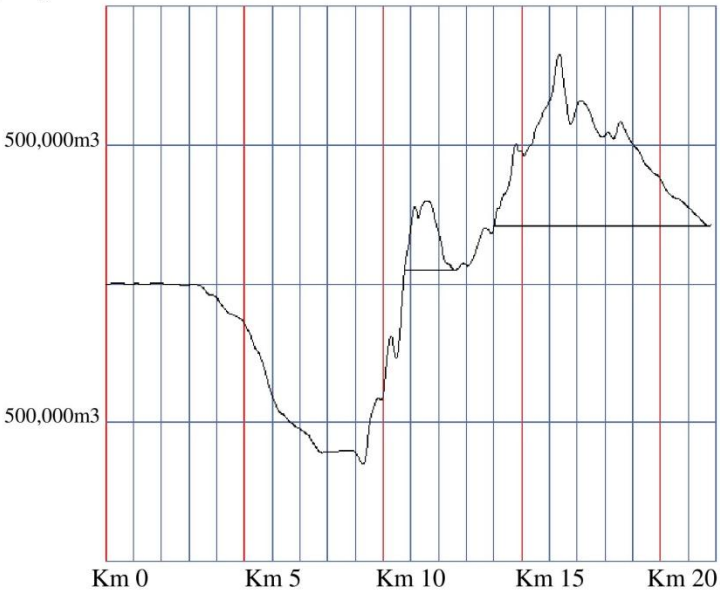
Source: JICA Study Team
Figure No. IV.28. Typical Cross Sections

IV.9 EARTHWORKS

The road construction will require the excavation of 3,508,587 m^3 and an embankment of 1,919,610 m^3. It is estimated that nearly 30% will be hard rock excavation and 40% soft rock excavation; the remaining will be common material.

Explosives will be used for hard rock excavation. Soft rock excavation will be done using a Bulldozer ripper or a backhoe in shovel configuration. Excavated materials to be transported to the embankment or waste dump site will be loaded on dumper trucks using a loader or a backhoe. Embankments with selected materials required for construction with a 1.00 m thickness for the final layer under the subgrade, will be obtained from the area near the construction site.

The following Figure shows the Project mass haul diagram. Most road sections will be built using a conventional method, including the combination of a Bulldozer, a backhoe and a dumper truck, since the hauling distance is 3-4 km. Some stretches will require the use of a moto-scraper to move earth at a relatively long distance. Annex IV.7 includes the earthworks volume calculation report.



Source: JICA Study Team

Figure No. IV.29. Project mass haul diagram

The combination of excavated materials and stone material will be required in the majority of the Project stretch to obtain suitable material for embankments.

IV. 9.1 Aggregate and borrow pits

Potential borrow pits to be used for the Project were identified.

Table IV.21 shows a detail of the borrow pits and Drawing IV.2 shows a map with their location. The Project contractor will negotiate the rental or purchase of the most convenient borrow pits, according to its work plan. If the borrow pits do not have a permit to operate, the builder will be responsible for obtaining all the corresponding permits for the selected borrow pits.

The following permits must be obtained for all of them:

- Environmental Permit
- Ministry of Economy Permit to extract material
- Felling permit
- Others which may apply based on their location

TABLE IV.23 BORROW PITS

IMAGE	DESCRIPTION
	**1. El Obrajuelo Hill** Location: West of Hacienda El Salitre. Estimated capacity: 300,000 m^3, for embankments and granular bases. The owner's authorization has been obtained. Distance from the Project: 3 km
	**2. El Marañón Hill** Location: Road to Cantón Agua Zarca. Estimated capacity: for embankments and granular bases, 100,000 m^3. The owner's authorization has been obtained. Distance from the Project: 2.5 km, dirt road.

IMAGE	DESCRIPTION
	**3. Los Rodas Quarry** Location: Road to Los Rodas site. Estimated capacity: 300,000 m^3, for granular bases and concrete aggregates. The owner's authorization has been obtained. Distance from the Project: 3 km.
	**4. Taishihuat Slope** Location: West river slope at station 13+700. Estimated capacity: not estimated; for masonry stone and aggregates. The owner's authorization is yet to be obtained. Distance from the Project: Immediate to the Project.
	**5. El Monchon or Taishihuat Hill** Location: Near station 15+000. Estimated capacity: not estimated; for masonry stone and aggregates. The owner's authorization is yet to be obtained. Distance from the Project: Immediate to the Project.
	**6. Mucinga Hill** Location: Near station 21+000. Estimated capacity: 300,000 m^3; embankments. The owner's authorization is yet to be obtained. Distance to the Project: 1 km.

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IMAGE	DESCRIPTION
	**7. El Burro Hill** Location: On the road to El Delirio (RN17). Estimated capacity: 100,000 m^3; for embankments; near the final station of the Project.

Source: Eco Ingenieros Team and geological and geotechnical study.

The information presented above is preliminary and detailed studies of each site should be carried out to determine their feasibility.

The Aramuaca Lagoon near the project (less than 12 km) was identified as the only area for the exploitation of gravel. The next closest quarry is located in Lolotique, at approximately 30 km (from the farthest point to the planned bypass); therefore, it was not considered for analysis as a potential source of material given that the hauling cost would experience a considerable increase.

None of the current sites for potential extraction of stone material shows the best characteristics for quality aggregates; however, the quarry that is currently under exploitation at the Las Rodas site (Municipal Bank) presents better conditions, and with a zoning of the area, it could be an option to be considered, bearing in mind that there could be a high percentage of rejected material during the process (possibly more than 30%). Detailed tests, including health tests, should be conducted per zone to determine the rejected material.

IV. 9.2 Sand Banks

Two places were identified as a source of fine aggregates: Aramuaca Lagoon (also a source of gravel) and Río Grande de San Miguel

There are two processed and non-processed sand deposits in the Aramuaca lagoon. The unprocessed sand was analyzed since the processed sand is too fine and previous experiences have shown that very fine sand makes it difficult to prepare and work with concrete mixtures because it quickly absorbs large quantities of water. According to standard ASTM C - 33, the granulometry of the sand from the Aramuaca Bank is 1% below the recommended range for mesh #4, and 5% and 9% above the recommended range for mesh #50 and #100, respectively. The finess modulus is within the range indicated by standard ASTM C- 33.

According to standard ASTM C - 33, the granulometry of the sand from the Río Grande Bank is 8%, 14%, 12%, 10% and 1% below the recommended range for mesh #4, #8, #16, #30 and #50, respectively. The finess modulus is 3.89, and therefore, it is also outside the highest range (3.1) suggested by standard ASTM C- 33, which implies that the sand is coarser than what the standard recommends.

The volumetric weight of the sand from the Aramuaca Bank sand is higher than the weight of the sand from Río Grande de San Miguel; therefore, mixtures made with sand from the Aramuaca bank will require a smaller amount of this material to reach the same resistance.

The specific gravity of the sand from the Grande River bank is slightly low (2.4) and its absorption is slightly high possibly due to its pumice content. The sand from the Aramuaca bank has good specific gravity and absorption, therefore, a smaller quantity of this material is required to reach a given resistance, unlike the material obtained from Río Grande de San Miguel.

The color of both types of sand indicates the presence of organic impurities below the standard color and for this reason they are considered acceptable. However, it has to be noted that according to the test, the sand from Río Grande de San Miguel has a higher quantity of organic impurities than the sand from the Aramuaca bank.

If both unauthorized sand banks are used, the constructor will be responsible for obtaining the respective permits and preparing an adjustment plan to end the project.

IV.9.3 Sites for disposal of leftover material

The leftover material for the Project is estimated in 1,588,877 m^3. The site for disposal of this leftover material is yet to be determined. The same as with the borrow pits, the project builder will have to obtain the corresponding permits for the land to be used. The following sites for disposal of leftover material were identified.

- *Municipality of San Miguel*

1. Sanitary landfill:	
Requirement:	100,000 m^3
Location:	Cantón Las Casitas.
Distance from the project:	4 km
Owner:	Mayor's Office of San Miguel.
2. San Carlos Quarry:	
Requirement:	150,000 m^3
Location:	Cantón San Carlos, El Amate.
Distance from the Project:	11 km
Owner:	Mayor's Office of San Miguel.
3. Colonia Carrillo:	
Requirement:	300,000 m^3
Location:	San Miguel
Distance from the Project:	1 km
Owner:	Private owner
Note:	Flood plain
4. Colonia La Carmensa	
Requirement:	200,000 m^3
Location:	500 m south of Don Luis de Moscoso bridge
Distance from the Project:	2 km
Owner:	Private owner

- *Municipality of Quelepa*

5. Miramonte Lot Development green area (football field)

Requirement:	20,000 m^3
Location:	Quelepa
Area:	1 mz
Owner:	Mayor's Office of Quelepa.

♦ *Municipality of Moncagua*

6. Independencia Quarter ditch.

Requirement:	40,000 m^3
Location:	Moncagua
Distance from the Project:	2 km
Owner:	Mayor's Office of Moncagua.

IV. 9.4 Use of explosives

The constructor will be responsible for the storage, transportation and proper use of explosives and must obtain the corresponding permits to carry out these activities, as listed below:

1. Permit from the Ministry of Environment and Natural Resources to import chemical substances.
2. Permit from the Ministry of Environment and Natural Resources to store chemical substances.
3. Special permit from the Ministry of National Defense to import, export, manufacture, market and store products similar to explosives, chemical substances and pyrotechnic products.
4. Certification issued by the Fire Department of El Salvador of compliance with safety measures for storing chemical substances for fire and explosion protection.
5. Authorization for sanitary installation and operation issued by the Ministry of Public Health and Social Assistance.

When the use of explosives is required for excavating and cutting slopes, all the mechanisms and procedures to ensure the minimum impact on the natural resources in the area and nearby population must be in place. The Works supervisor will establish procedures for proper handling of explosives to prevent and minimize the damage that they may cause to the environment as well as any unnecessary and catastrophic removal of material.

The following safety measures must be applied to handle explosives:

- *Transportation:*
- The area where explosives will be transported must be clear of any obstacles.
- Drivers will be trained to transport explosives.
- The minimum speed to be determined will be observed.
- Explosives must be properly packed.
- Loading and unloading operations will be carried out during the day in the absence of rain or electric storms. Explosives must be carefully unloaded and must not be hit.
- Explosives must not be transported with detonators or inflammable or corrosive materials.

- S*torage facilities:*

Explosives must be stored in a safe place, making sure that no accidental explosions which may cause personal injuries or property damage will occur. The following measures will be taken:

- The area must be supervised at all times until the blasting takes place.
- Access will be denied to unauthorized persons and the area will be protected against adverse events: lightning, natural disasters and fire.
- Explosives must be under permanent supervision.
- Explosives must be handled with care.
- Explosives must not be stored near detonators, fuel and other materials.
- Smoking or playing with fire near explosives is not allowed.
- Explosives must not be stored for long periods of time.
- In case that ammonium nitrate is used, any fire must be extinguished with water, not with extinguishers.
- The area surrounding the storage magazine must be protected and free of inflammable materials.
- Storage must be clean, organized, easy to identify and must have easy access. The oldest stock must be dispatched first.
- Signs must be posted in the storage magazine.
- Damaged products must be removed.
- The storage limit must not be exceeded; for example, stored dynamite should not exceed half the total capacity of the storage area.

t Measures to be observed in the blasting area

The blasting area comprises the blast hole and areas subject to personal injuries and property damage. The following precautions will be taken:

- Blasting area inspection: material cleanliness, previous failed blast holes.
- Proper signs must be posted.
- All blasting elements must be at hand.
- The use of metallic tools to open containers is forbidden.
- Personnel and machinery shelters must be available.
- A proper acoustic warning system must be in place.
- Detonation will be carried out by a designated person upon receipt of the supervisor's orders.
- An emergency exit must be provided and access will be denied to unauthorized persons.
- Detonators will never be triggered during storms or lightning.
- Equipment and personnel must remain at the required distance.

The area near slope cuts where rock has been found and is possible to use explosives is not populated, with the exception of stations 9+300 to 9+500 and 16+000 to 16+300, where there are houses down the slope from the site. These families will receive advance notice of any scheduled explosions.

IV.9.5 Environmental considerations for borrow pits and final disposal sites

- *Borrow pits, aggregates and sand*

The following environmental recommendations will apply to all borrow pits:

- There must be a buffer zone with the adjacent land.
- A blasting plan considering to build slopes suitable to the type of material and shoulders, must be prepared
- Rainwater will be managed with suitable channels / ditches.
- As a priority, works must be carried out from the rear of the borrow pit and not on the area immediately facing the road in order to avoid a direct visual impact as well as unstable slope cuts which may affect the road path.
- A contingency and accident prevention plan must be prepared.
- The borrow pit must have suitable terraces protected by trees or covered according to the future use agreed with the owner.
- The zones for extraction of construction materials (sand, stone or other materials to be used), located in boulders or alongside rivers or ravines must be selected with prior analysis of alternatives and their exploitation must be approved after submission of an environmental management plan and further morphological readjustment and replanting.
- Surface or stripping material removed from a borrow zone must be stored for reutilization in future restoration works.
- Whenever the quality of the material allows it, materials from cuts to make landfills or as a source of construction materials must be used in order to minimize the need to exploit other sources and decrease environmental costs.
- Waste from cuts must not be disposed of in slopes or thrown into waterways. They must be hauled to disposal sites selected in the work design and properly disposed of in order to avoid causing further landslide or erosion problems.
- Exploitation of material must be carried out outside the level of water and on the riverbank since the movement of machinery below this level produces a strong removal of material with the subsequent increase in water turbidity.
- Exploitation must be carried out in waters under bridges and aqueducts taking into account the analysis of river dynamics carried out in advance.
- Whenever it is necessary to exploit riverbanks upstream of the referred works, there should be a minimum distance of 1 km between them and the extraction riverbank and a minimum of 200 m downstream.
- If the exploitation is to be carried out within the watercourse, these works should be performed up to 1.50 m deep, avoiding the deepening of the natural riverbed and producing any additional morphological changes, in order to allow a quick recovery of such deposits. In like manner, the exploitation will take place in the widest riverbank sectors, and efforts will be made to use their entire extension.
- Special attention should be given to the protection of riverbanks since they are essential to prevent overflows during significant rises in river waters. The most recommended extraction method for exploiting riverbeds is the use of mechanical equipment such as backhoes or front loaders.
- Zones intended for storage of materials extracted from riverbeds will be located in non-protected zones covered by vegetation and away from bodies of water. Records of the extracted quantities must be kept in order to prevent overexploitation.
- The following general principles must be observed for exploiting borrow pits or banks of materials:
    - Exploitation works in one single bank must be avoided.

- o According to the stability of the rock mass, slope heights of more than ten meters will not be allowed.
- o It is strictly forbidden to exploit ditches or channels for removing material from quarries.
- o The bank method is recommended for exploitation works.
- o Topographic and geotechnical controls must be established on slopes.
- o Proper runoff water drainage systems must be established in exploitation areas and loading yards.
- o Signs must be posted in the work areas to prevent access to unauthorized personnel.
- o Loading and transportation machinery must be provided with acoustic signals for backward motion.
- o Loading and maneuver yards must be sprinkled with water to avoid the emission of dust and other particulate materials into the atmosphere.

And the other guidelines established in Central American Manual of Environmental Standards published by SIECA.

♦ *Landfills and leftover material dump areas*

During the land filling process, the material must be spread and leveled using tractors and padfoot drums or any other soil compacting method in compliance with the applicable standards in effect.

The following must be complied to reduce the potential impact of erosion on the landfill resulting from the construction activities of the project:

- The highest earthmoving activities or earthmoving from sites with the steepest slopes must be carried out during the dry season;
- The most sensitive areas must be protected with a cover;
- Landfills must be prepared applying high compacting levels;
- Landfills must have filters to avoid internal saturation of materials and hydraulic works to manage surface runoff.
- Surface runoff near landfills must be controlled with ditches and dikes to prevent materials from running off into the river.
- Areas in slope cuts subject to erosion must be planted with black grass.
- Ditches will be built at the base of slopes to channel and slow down rainwater. Ditches will be built in landfill slopes at a 5 m distance.
- During the construction, dikes will be built along the work sites to prevent that the surface runoff gets to the work areas.

The volumetric capacity of all material dump sites must be established paying particular attention to the following:

- Dump sites must not be located in wetlands, water sources, important ravines which may be obstructed and cause problems to downstream areas, which may have an impact on fragile habitats, threatened or endangered species, or ruins of cultural or historical value;

- Sites of academic or scientific interest and public and private infrastructure must not be damaged.
- The landfill must have a structural or biological stabilization system.
- Land owner's permits must be obtained to prevent any conflict over use;
- The hydrogeological characteristics of the substratum, the lithology of the surroundings as well as landscape aspects such as the camouflaging capacity of the zone, must be taken into account.
- The proximity or not to waste generating sources; and
- The nature of the effluents.
- It is critical that all sites selected as deposits or dump sites are away from populated areas, watercourses or natural and drinking water reservoirs, public service infrastructures, areas of ecological fragility, nearby farming land; any significant disturbance in the local landscape must be prevented.

Once the final closure of the dump site takes place, the site must be replanted with vegetation and leveled according to the ground contours.

IV. 10 TRAFFIC CONTROL

In general, the construction of road components will require that the Contractor(s) install conventional traffic controls. In this regard, it will be necessary to keep at least an open lane for traffic at all times, whether it is for the construction of a new road or an expansion of the existing road.

In like manner, connections with local streets will be maintained at all times in both cases, the construction of a new road or an expansion of the existing road.

The Manual on Traffic Control Devices for construction areas of the Road Network issued by the Ministry of Public Works will be complied at all times.

IV. 11 RIGHTS OF WAY

Every development project gives origin to economic, social and environmental problems. In the case of road expansion and construction, the impact caused by physical intervention of land is undeniable. The following table shows the types of impacts caused by this project.

TABLE No. IV.24 TYPES OF IMPACT

TYPE OF IMPACT	IMPACT	COMMENTS
Land	Total/ Partial	Occupation by road construction and complementary works (longitudinal drains and cross-section of drains, mitigation works, among others)
Constructions (main and complementary) and community, health, education infrastructure, and other	Total/ Partial	Displacement or loss of constructions (houses, warehouses, workshops, health units, schools, etc.)
Crops, fruit trees, timber	Total/ Partial	Loss of products from the farming activities carried out by the owners
Loss of sources of income		When the construction activities interrupt the normal activities of business and workplaces

Source: JICA Study Team (2011)

These impacts require that the project includes a Strategic Resettlement Action Plan (RAP)[4] which has been prepared for the basic guidelines that will direct the Specific Resettlement Plans to be prepared during the detailed design stage according to the constructive need of the Bypass Project in San Miguel.

The Resettlement Action Plan of the project has been prepared based on the preliminary information obtained at the level of the feasibility study; however, during the implementation stage, the Specific Resettlement Action Plans will include accurate information of each plot of land, land area, and affected construction as well as the cadastre data of the real property to be affected by the Project, among others.

The RAP must be according to JICA guidelines (2010) and the World Bank OP 4.12, which require that involuntary resettlement must be minimized, and if it cannot be avoided, all affected persons must receive compensation. [5]

The RAP will include 6 programs that must be developed during the implementation of the Resettlement Action Plan:

- Owner /Holder, public /social institutions purchase and indemnification Program;
- Housing Resettlement or Relocation Program for Owners / Holders / Occupants;
- Economic unit restitution program;
- Communications Program;
- Environmental Management Program for real property to be resettled; and
- Follow Up, Monitoring and Evaluation Program;

A complaint resolution mechanism which gives more relevance to the social aspect has been included in order that the people have a specific place where to file their complaints, inquiries, requests or clear any doubts that they may have with regard to the implementation of the work.

IV. 11.1 Property on rights of way

There are an estimated total of 588 plots of land with an estimated total of 557 owners since there are cases in which one single owner has several plots of land. 39% of the owners have plots of land in lot developments.

IV. 12 SIGNAGE

The permanent signage of the Project includes:

- Horizontal signage. A continuous reflective stripe will be placed on asphalt concrete; a white reflective stripe for pedestrian crossings, marks on asphalt concrete, single and double arrow marks as well as STOP and GIVE WAY signs.

- Vertical signage. Signage will be preventive and restrictive, elevated flag-type signage. Lighting, traffic lights and intersections.

[4] The "Resettlement Action Plan" includes the right of way acquisition process and resettlement or relocation-related programs.
[5] "Affected persons" are the persons directly affected by the Project, with the total or partial loss of their real property.

IV. 13 TOTAL INVESTMENT

A summary of the total cost of the Project is presented in the table below:

TABLE No. IV.25 PROJECT COSTS

CONCEPT	TOTAL
Direct construction cost	$ 161,659,788.69
Indirect costs (8%)	$ 12,932,783.10
VAT (13%)	$ 22,697,034.33
Total construction cost	$ **197,289,606.12**
Contingencies	$ 9,864,480.31
Final engineering design	$ 7,891,584.24
Construction supervision	$ 15,783,168.49
Land purchase and resettlement	$ 7,400,000.00
Total	$ **238,228,839.16**
Cost per kilometer	**$ 9,520,775.28**

The total Project cost is estimated in two hundred thirty eight million dollars.

IV. 14 COMMUNICATION PROCESS

A public consultation plan with prior identification of the stakeholders was prepared for the public consultation event. Annex IV.8 comprises the reports of the second and third public consultation events.

IV. 14.1 Identification of Stakeholders

A Public Consultation with the local community was carried out in San Miguel to take into account their opinions. In El Salvador, the Environment Law and its Regulation stipulate that Environmental Impact Studies must be submitted to Public Consultation since the report on the EIA must reflect the opinions of the community to be affected by the Project. On the other hand, JICA guidelines (2010) state that: "...democratic decision making is required for effective implementation of the environmental and social considerations, and it is important to respect the fundamental human rights in decision making, in addition to the participation of the stakeholders, and to ensure information transparency and accountability and efficiency." In accordance with the Salvadoran regulations and JICA guidelines, at least three Public Consultations will be carried out. The first of them will present the general information of the Project and the *scoping* draft; the second will be carried out to consult the draft terms of reference for the EIA and RAP; and the third one, will present the results of the EIA and the final report of the study.

The Project owner (in this case the VMOP) is responsible for these consultations. The following table shows the Schedule of the Public Consultations to be carried out during the present study.

TABLE No. IV.26 PUBLIC CONSULTATIONS SCHEDULE

	1st. PUBLIC CONSULTATION	**2nd. PUBLIC CONSULTATION**	**3rd. PUBLIC CONSULTATION**
Objectives	-Project Presentation -Presentation of *Scoping* draft	-Presentation of draft EIA terms of reference -Discussion to prepare the RAP	-Discussion of the draft EIA Report - Discussion of the RAP draft
Date	May 21, 2011	Beginning of July 2011	November 2011
Place	City of San Miguel	-EIA: City of San Miguel -RAP: Affected Communities	-EIA: City of San Miguel -RAP: Affected Communities
Contents	-General explanation of the Bypass Project (Project compatibility, comparison of alternatives, etc.) -Presentation of Scoping draft	-Draft of EIA terms of reference -Alternate Bypass routes -Anticipation and assessment of environmental issues	-EIA results de EIA -Environmental Management Plan -Control and Monitoring Plan -Conclusions and Recommendations
Participants	-Community Leaders	-Community leaders, population of the area affected by the Project, transportation sector, Chamber of Commerce and Industry of San Miguel, NGOs, etc.	-Community leaders, population of the area affected by the Project, transportation sector, Chamber of Commerce and Industry of San Miguel, NGOs, etc.

"Scoping" means making decisions regarding the alternatives to be studied and the scope of important topics of the assessment or any other considered important as well as the study methods.
Source: JICA Study Team (2011)

IV. 14.2 Results of the first Public Consultation

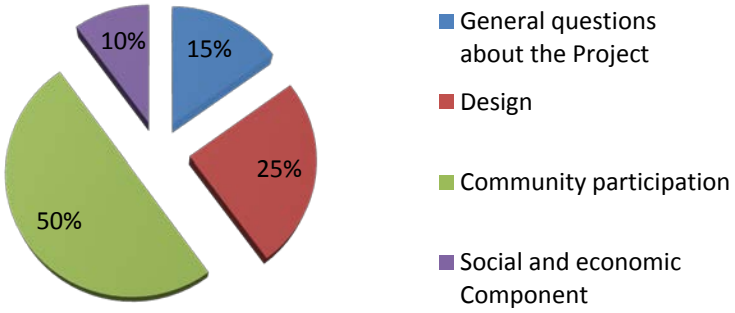
The Consultation was carried out on the Andrés Bello University campus in San Miguel on May 21, 2011, from 9:30 - 12:00 hours, with the participation of 103 guests. Purpose of the Consultation: Present the project and the expected benefits.

TABLE No. IV.27 SUMMARY OF QUESTIONS AND INQUIRIES MADE BY THE POPULATION

Type of question	**Number of questions**	**Frequency**
General information about the Project	**2**	**3**
Design	**4**	**5**
Community participation	**4**	**10**
Social and Economic Component	**2**	**2**
	12	

Source: JICA Study Team (2011)

The following chart shows that the majority of questions /comments /suggestions were made to express their gratefulness for the Study and for taking into account the citizens' opinion, followed by design considerations regarding solutions to flood plains and isolated communities during the rainy season (25%), requesting general information about the project (15%), and finally, requesting the creation of jobs in the zone, 10%.



Source: JICA Study Team (2011)

Chart No. IV. 1. Attendant Participation

IV. 14.3 Results of the second Public Consultation

The second Consultation was carried out on the Andrés Bello University campus in San Miguel on July 09, 2011, from 9:30 - 11:30 hours, with the participation of 75 guests. Purpose of the Consultation: Present the progress made in 4 specific areas:

1. Project justification: Project justification and existing development plans in support of the construction
2. Demand forecast: current status of traffic congestion, explanation of the 5 points in which the route has been divided, cost-benefit analysis and projection
3. Route selection: two routes with common boundaries were proposed and the selected route was shown using satellite photos
4. Environmental Impact Assessment: The possibility of positive and negative impacts was explained to the participants and they were also informed that an EIA, an Environmental Management Plan and a Resettlement Action Plan will be prepared.

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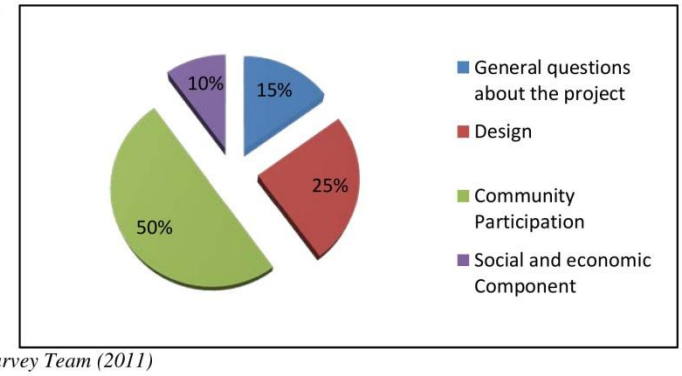
TABLE IV.28 SUMMARY OF QUESTIONS AND INQUIRIES MADE BY THE POPULATION

Type of question	**Number of questions**	**Frequency**
General information about the Project	**1**	1
Design	**11**	13
Rights of way and RAP	**1**	1
Community Participation	**7**	11
Social and Economic Component	**9**	10

Source: JICA Study Team (2011)

The following chart shows that the majority of questions/ comments/ suggestions were focused on design issues, considerations about the path of the road near San Miguel and traffic volume (36%); followed by community participation. In this regard, some participants expressed their conformity with the invitation to participate in this stage and other expressed that they were not in agreement with the Project (31%); the social and economic component is in third place (28%) with petitions for the creation of jobs in the zone and consideration of the socioeconomic effects; with regard to questions about rights of way and the RAP, there is a slight increase as compared with the first consultation (8%). It is considered that this percentage will substantially increase in

the future; and finally, 3% had doubts regarding the proposed path for the Project, which were cleared during the presentation.



Source: JICA Survey Team (2011)

Chart No. IV.2 Attendant Participation Percentages

IV. 14.4 Results of the third Public Consultation

TABLE No. IV.29 SUMMARY OF THE THIRD PUBLIC CONSULTATION

Objective	Project Overview, Presentation of Selected Route, Explanation of steps to acquire rights of way, discussion tables
Date	10:00 a.m. - 12:30 p.m., Saturday, November 12, 2011
Place	Universidad de Oriente (UNIVO) Auditorium, Quelepa Campus, San Miguel
Contents	> Project Presentation – Background – Study Progress Report – Design Criteria – Major Design Issues – Environmental and Social Issues – The Way Ahead – Questions and Answers – Work Groups (Technical Information - ROW Information, General Information).
Participants	Approx. 450 people. (Families directly and indirectly affected by the Project, Mayor of San Miguel, VMOP officials and technicians, entities of the Governor's Office and Municipality of San Miguel, businessmen of the zone, Mass Media, JICA El Salvador office representatives, JICA Study Team).
Reproduction	Brochure including a map with the Bypass route and explaining the steps for acquiring rights of way and resettlement

Source: JICA Study Team (2011)

The Open Public Consultation was carried on November 12, 2011, in the Universidad de Oriente (UNIVO) Auditorium, Sitio Jaguar de Piedra, Quelepa, San Miguel. The purpose was to present the bypass route and explain the steps for acquiring rights of way and resettlement.

Approximately 450 people attended, the majority of which were directly affected by the Project. The JICA Study Team sent an invitation to participate in the Public Consultation to all the directly affected families who were identified by the socioeconomic study carried out in August and September 2011. The Governor's Office of San Miguel provided transportation for the people who lived far from the public consultation venue to ensure their participation.

Participants received a brochure explaining the steps for acquiring ROW. Work groups were set up[6] after the presentation to receive inquiries and questions from directly and indirectly affected families. Questions and inquiries were made about legal title issues, compensation for the occupants (illegal houses), location of the complaints office, among others. The following table shows a summary of the questions and inquiries made in each work group.

TABLE No. IV.30 INQUIRIES AND QUESTIONS MADE DURING THE THIRD PUBLIC CONSULTATION

Questions and Inquiries made by the Affected Families	**JICA Study Team Countermeasures**
Technical Issues	
They requested information about the estimated width of the right of way for the Bypass.	They were informed that the final width of the section is 30 m, 15 m on each side, which belong to the State of El Salvador.
Will the bypass have lighting?	The Project is still in the design stage and the people's concerns in this regard will be considered.
They asked if a broader central divider has been considered since the brochure only shows a simple central divider.	They were informed that JICA Study Team is still considering the design of the Bypass cross-section.
The Bypass does not connect with the road to El Delirio (RN17).	An economic assessment is under way to consider the possibility of the connection.
ROW Acquisition and Resettlement	
They requested information on why the properties will be affected by the Bypass route.	The final route has not been defined yet and there may be changes in the affected zones. The Detailed Design stage will provide accurate data and each owner will be contacted with the details.
They inquired if pedestrian and animal crossings and road safety have been considered.	They were informed that JICA Study Team has considered all the activities carried out alongside the bypass route to include them in the design: cattle crossing, pedestrian crossing, signage, rules and regulations.
They wanted to know how payment for elements such as fruit trees, mud walls, outer walls, family is going to be made.	They were informed that all these elements will be considered in the valuation criteria for the payment of compensation.
They asked who will inform about the impact on their property.	They were informed that the MOP is in charge of determining and communicating the impacts.
They inquired about the possible modification of the route at different points and for various reasons: to reach certain zones and benefit the population or stay away from other areas that should not be affected.	The stakeholders were informed that there are many parameters to take into account for selecting the route and they have an impact on the costs. They were encouraged to write down their specific observations to be able to give them further consideration.

[6] Work groups were set up: 1 group to deal with technical issues; 4 groups to deal with ROW acquisition issues; and 1 group to deal with general issues of the project. More than 100 questions and inquiries were made by the participants.

Questions and Inquiries by the Affected Families	JICA Study Team Countermeasures
They inquired about legal problems with their property: lack of legal title, lack of registration with the CNR, they have built on State land, inheritance issues, mortgaged property, etc.	They were informed that the right of way acquisition process includes a process to solve different illegal situations.
They requested information to apply for resettlement programs.	The State will build a new home equal to or better than the previous one; it will also define where it will be built and will take into account the opinion of the resettled family.
They wanted to know where and how the CREA office for public consultation will open.	There are plans to open an office in San Miguel and another in San Salvador in the ROW Management Division of the MOP, during the Detailed Design stage. The people's opinions will be taken into account when deciding where they will be located.
They asked about the management of excess areas.	Excess areas will be compensated in accordance with the valuations to be made on a case by case basis.
They asked about the impact on the school of Cantón San José. (A teacher of that school)	Only the outer wall will be affected; classrooms will not be affected.
They asked for the Project start date.	It has not been defined yet since there are other processes to be concluded, such as the completion of the Feasibility Study, Project Evaluation, Agreements between the Governments of El Salvador and Japan. They will be informed in due time and well in advance.
They considered that noise and vibration of the road should not affect the classes. They request the construction of a footbridge near the School and proper vehicle access. (El Papalón School teachers)	The effect of noise and vibrations will be considered in the EIA of the Project. The construction of a footbridge as well as vehicle access to the School will be considered in the detailed design in order to assess the need.
They inquired about the Legal Power of Attorney to be granted, requested the form and how to do it in case the owner of the property is outside the country.	Third-party payments could be made provided that the owner of the property has granted a power of attorney with a special clause authorizing that type of payment. The ROW Management Division of the MOP will prepare a form for the applicants. The power of attorney granted by a person who is outside the country must be signed before an authorized Salvadoran official.
They inquired about the constructions in progress on land that is intended for the Project. Should I continue with the construction?	Since the route of the bypass is not final, constructions may be continued and the relevant compensation will be calculated when notifying the actual impact.
Who is in charge of the valuations?	Qualified experts certified by the Superintendence of the Financial System of El Salvador.
When will the valuations be notified?	Once the final design has been determined, each owner will be contacted and notified that his/her property will be affected and the respective valuation.

Source: JICA Study Team (2011)

The following can be mentioned among the most representative inquiries:

a. Inquiries with regard to property acquisition and valuation and legal procedures: to clear doubts, the Project Study Team and the MOP provided information about the procedures to acquire property and valuation methods that will be used. They also provided telephone numbers and addresses for specific inquiries. Several cases were solved through this procedure.

b. Inquiries with regard to the route and design: They explained in general, in specific inquiries made during the Public Consultation and during inquiries made on a later date, that the study is in the Feasibility stage, which means that the main goal is to make the project viable with as much information as possible and firmly justified by studies and design. On the subsequent detailed design stage, the following designs will go through a more in-depth evaluation:

- Right of way configuration
- Intersection with major roads
- Longitudinal and vertical drains
- Slope management
- Hydraulic structures
- Major and minor passage works
- Banks of materials and disposal sites
- Other works required for the Project.

c. Implementation time of each stage: The following start dates are considered: work start date, property acquisition start date, valuation process start date, site preparation, work implementation, Project end date. They explained that these dates are subject to the approval of the project feasibility study and the corresponding funding as well as the final stage start and duration.

IV. 14.5 Public Consultation according to the LMA

The public consultation for the project required under the Law on Environment (LMA, for its acronym in Spanish) was carried out during the document review process by the Ministry of Environment, before document approval was obtained. A general notice to the population was published in one of the major newspapers of the country on February 9, 10 and 11, 2012, with an invitation to participate in the consultation on the Survey documents at the Mayor's Offices of Quelepa, Moncagua and San Miguel.

IV. 15 IMPACTS ON SITES OF INTEREST

The chapter that makes a description of the environment includes a description of the sites of interest:
1. Natural: sites of biological interest, protected zones, biological corridor.
2. Cultural: archeological sites, paleontological sites or cultural wealth.
3. Social: schools, churches, health centers.
4. Other sites of interest to the population.