CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

Page

INDEX OF PHOTOGRAPHS

Page

3 PROJECT DESCRIPTION

3.1 LOCATION

The Rumichaca Pasto Divided Highway Project, San Juan - Pedregal segment, is located in the department of Nariño, in the municipalities of Ipiales, Contadero, Iles and Imués. **Table 3.1** sets out the villages through which the project's layout is planned and **Figure 3.1** presents their location graphically. Also, **Annex 10. Cartography. Map 01 - General Location** shows the map for the project's geographic and political-administrative location.

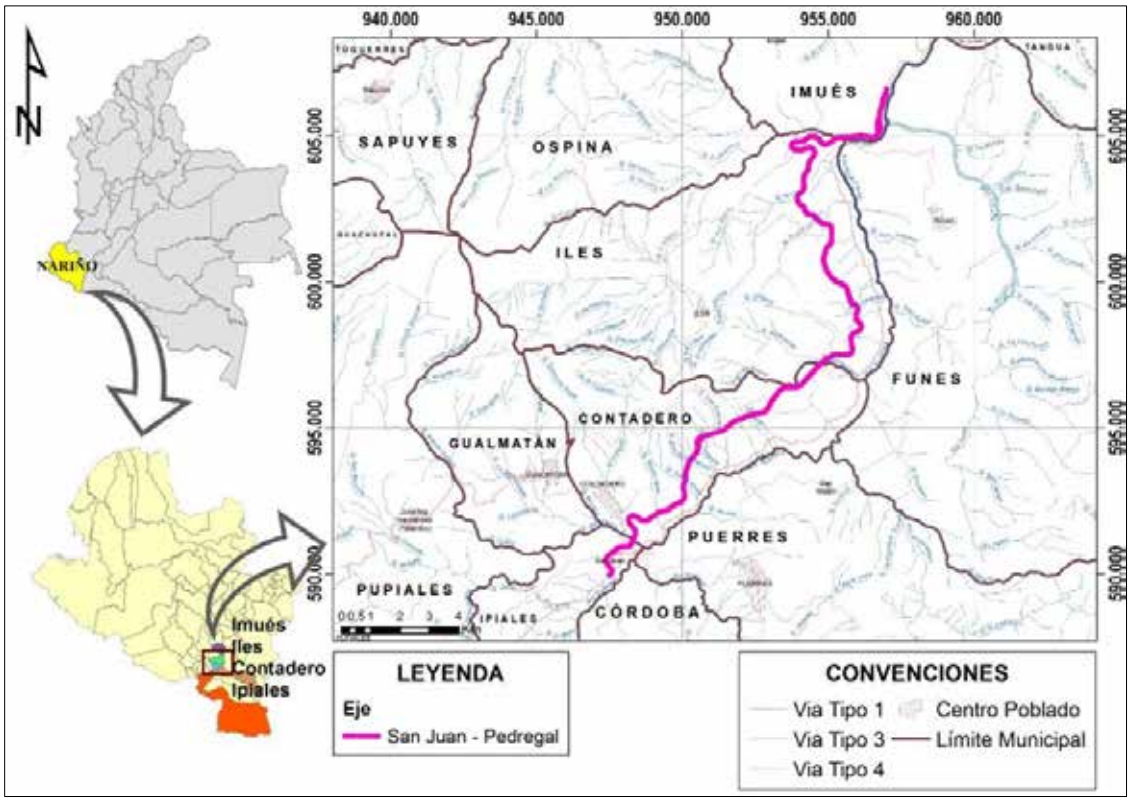
Table 3.1 Location of the project.

CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		RURAL DISTRICT	MUNICIPALITY	DEPARTMENT
	EAST	NORTH			
K15+750.00 to K16+200.00	946,552.76	589,094.31	El Rosal	Ipiales	Nariño
	946,882.49	589,446.66			
K16+200.00 to K18+700.00	946,882.49	589,446.66	San Juan		
	948,228.09	590,990.12			
K18+800.00	948,274.13	591,078.35	Boquerón		
K18+900.00 to K19+400.00	948,312.00	591,170.90	La Providencia	Contadero	
	948,284.94	591,620.17			
K19+500.00 to K20+800.00	948,221.20	591,697.22	San Francisco		
	949,094.33	592,044.06			
K20+900.00 to K22+400.00	949,176.56	592,100.80	Aldea de María		
	950,040.53	593,045.44			
K22+500.00 to K22+600.00	950,073.66	593,139.74	Las Delicias		
	950,103.49	593,235.03			
K22+700.00 to K23+300.00	950,109.99	593,334.62	El Capulí		
	950,284.69	593,900.79			
K23+400.00 to K24+500.00	950,347.31	593,978.72	El Culantro		
	950,966.20	594,777.51			
K24+600.00 to K25+500.00	951,062.47	594,804.59	Las Cuevas		
	951,830.14	595,247.18			
K25+600.00 to K27+100.00	951,926.85	595,271.30	Ip. Ospina Pérez		
	953,126.97	596,000.16			
K27+200.00 to K29+100.00	953,187.33	596,079.89	San José de Quisnamues		
	954,651.36	597,114.60			
K29+200.00 to K29+400.00	954,721.32	597,185.96	Alto el Rey	Iles	

CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		RURAL DISTRICT	MUNICIPALITY	DEPARTMENT
	EAST	NORTH			
	954,882.00	597,304.91			
K29+500.00 to K31+700.00	954,963.36	597,363.05	Urbano		
	956,003.28	598,667.15			
K31+800.00 to K33+000.00	955,950.14	598,750.34	Tablón Alto		
	955,566.46	599,805.31			
K33+100.00 to K35+400.00	955,500.04	599,879.59	Tablón Bajo		
	955,098.05	601,810.77			
K35+500.00 to K37+100.00	955,049.18	601,897.41	Tablón Alto		
	953,939.53	602,867.19			
K37+200.00 to K37+700.00	953,969.08	602,961.92	El Rosario		
	954,083.74	603,381.25			
K37+800.00 to K41+600.00	954,026.09	603,462.42	El Porvenir		
	955,263.24	604,917.62			
K41+700.00 to K44+844.00	955,358.92	604,944.24	Pilcuán	Imués	
	957,018.40	606,678.66			

Source: GEOCOL CONSULTORES S.A., 2017.

Figure 3.1 Location of the Rumichaca – Pasto Divided highway Project, San Juan - Pedregal segment.



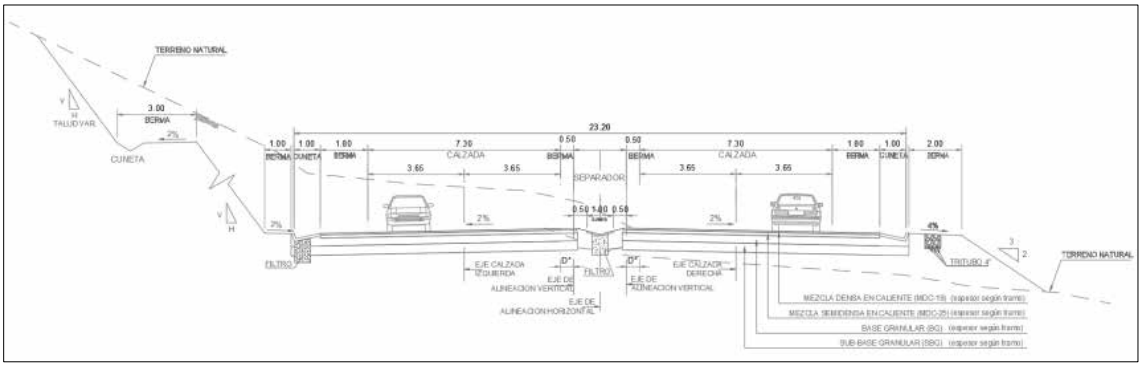
Source: GEOCOL CONSULTORES S.A., 2017.

3.2 PROJECT CHARACTERISTICS

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment, will be located from KP15 + 750 to KP44 + 909. It will consist of three sections: one section relating to the construction of a second roadway parallel to the existing one from KP15 + 750 to KP17 + 000 (1.25 km), a new road section from KP17 + 000 to KP41 + 992 (24.99 km), and the construction of a second roadway parallel to the existing road, which will span from KP41 + 992 to KP44 + 844 (2.85 km). It should be noted that sectors where the existing roadway is used will be subject to improvement. The total length of the project's layout will be 29.09 km, with a design speed of 60 km/h, two roadways (one for each direction) measuring 7.30 m wide (each), with each roadway consisting of two lanes measuring 3.65 m wide, with a median strip measuring 2.0 m wide, with internal berms measuring 0.50 m wide, with external berms measuring 1.80 m wide, and the external side of each roadway will include an additional width as a service area measuring 2.0 m in fill areas and 1.0 m in cut areas (with this for being for the installation of road signs, networks, SOS posts, etc.), giving a total road width of 23.20 m.

The project layout will be located in terrain with mountainous topography, and therefore its typical cross section will be mostly mixed (cut and fill), as presented in **Figure 3.2**.

Figure 3.2 Typical cross-section of the divided highway, with median strip.

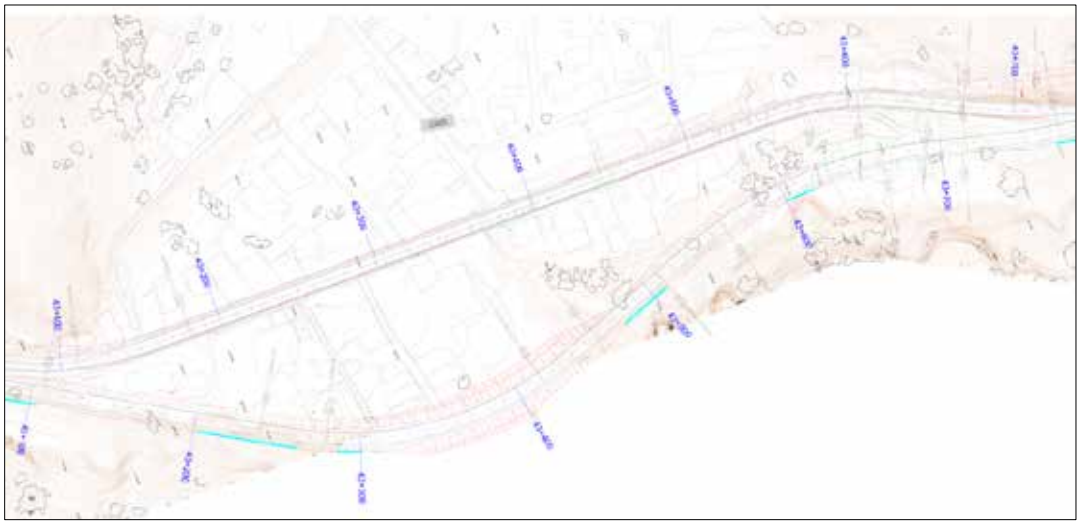


Source: Consorcio SH, 2017.

The road's layout will comprise areas in which the roadways are not parallel or are separated:

o Proposed bypass in the populated area of the Pilcuán La Recta district, municipality of Imués (see **Figure 3.3**).

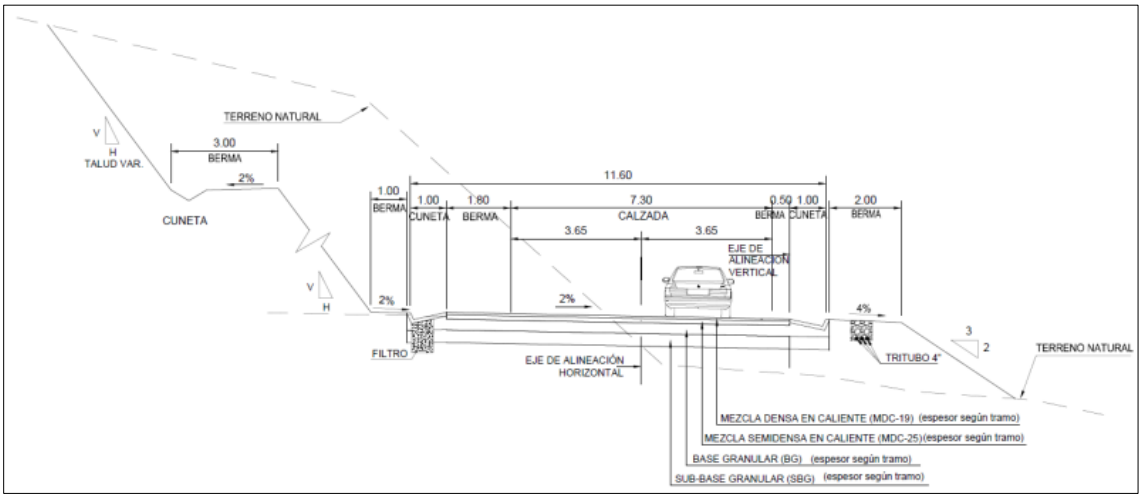
Figure 3.3 Roadways separated by the Pilcuán bypass.



Source: Consorcio SH, 2017.

The cross-section for the divided highway (with separated roadways) is set out in **Figure 3.4**.

Figure 3.4 Typical cross-section for the divided highway, with separated roadways.



Source: Consorcio SH, 2017.

The duration of the project, the schedule of activities, the estimated costs for the project, and the organizational structure for the project are presented in sections **3.2.7 Project costs, 3.2.8 Project schedule, and 3.2.9 Project organization**, in this chapter.

3.2.1 Existing infrastructure.

3.2.1.1 Types of road.

In order to characterize the existing road infrastructure, we used the classification established by the National Institute of Roads (INVIAS) as a basis. Here, infrastructure is categorized according to functionality and the condition of its surface, as set out in **Table 3.2**.

Table 3.2 Types of road according to INVIAS, as per functionality

NAME (ORDER)	DESCRIPTION
Primary (First Order)	Trunk roads, transverse roads and roads providing access to department capitals that fulfill the basic function of connecting the country's main production and consumption zones, as well as those of Colombia with other countries. Roads of this type can be divided according to the specific requirements of the project. Roads considered as Primary must be paved.
Secondary (Second Order)	These are roads that connect the municipal centers with each other and / or that come from a municipal center and connect with a Primary road. Roads considered as Secondary can be paved or gravel roads.
Tertiary (Third Order)	These are those access roads that connect the municipal centers with their rural districts or that connect rural districts to one another. Roads considered Tertiary must be gravel roads. In the event they are paved, they must comply with the geometrical characteristics stipulated for secondary roads

Source: Ministry of Transport, National Institute of Roads (INVIAS), Manual for the Geometric Design of Roads, Colombia, 2017.

The construction of the layout for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment, involves work on the following existing infrastructure:

3.2.1.2 Road infrastructure.

For purposes of carrying out activities relating to the transport of construction materials, supplies, machinery, equipment, waste and vehicles, the project requires the use of existing road infrastructure in the project's area of influence. In addition, some roads will be crossed by the project's layout. Below is a description of the road infrastructure that will be subject to use during work for the project (in its construction and operational phases):

3.2.1.2.1 Road INVIAS code 2501 – Rumichaca International Bridge – San Juan de Pasto.

This road is 82.60 km long, and its point of origin is the Rumichaca International Bridge, while its end point is the city of San Juan de Pasto. Its layout crosses the municipalities of Ipiales, Contadero, Iles, Imués, Yacuanquer, Tangua and San Juan de Pasto (see **Figure 3.5**). It is a primary road, which has flexible pavement, a roadway up to 7.30 m wide, two traffic lanes (one per direction), berms up to 1.80 m, road signs and markings, and it is located in an area with steep topography. It is generally in good condition and is under the responsibility of Concesionaria Vial Unión del Sur S.A.S., which carries out the road's periodic and preventive maintenance, as well as its operation. However, due to the characteristics relating to the area's topography, it does not allow for overtaking by the road's users, resulting in slow traffic. **Photograph 3.1** to

Photograph 3.12 provide a photographic record of this road's layouts (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.5 Layout of road INVIAS code 2501 – Rumichaca International Bridge – San Juan de Pasto.

Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.1 KP0+000. Rumichaca International Bridge.

Coordinates E 934776 N 581808.

Photograph 3.2 KP0+823. Intersection that allows access to the Ipiales bypass.

Coordinates E 935400 N 582262.

Photograph 3.3 KP8+197. Flexible pavement road section, roadway 7.30 m wide.
Coordinates E 941776 N 583913.

Photograph 3.4 KP8+674. Intersection that allows access to the Agricultural Product Collection and Supply Center.
Coordinates E 942155 N 584200.

Photograph 3.5 KP11+186. Flexible pavement road section, roadway 7.30 m wide. Coordinates E 943685 N 585979.

Photograph 3.6 KP17+969. Populated area of the district of San Juan, municipality of Ipiales. Coordinates E 947521 N 590391.

Photograph 3.7 KP35+040. Intersection that allows access to the municipal center of Iles. Coordinates E 956420 N 600217.

Photograph 3.8 KP46+489. Bridge over the Guaítara river. Coordinates E 958730 N 608627.

Photograph 3.9 KP56+327. Rumichaca - Pasto Concession Toll. Coordinates E 963084 N 612004.

Photograph 3.10 KP71+567. Flexible pavement road section, roadway 7.30 m wide. Coordinates E 970413 N 618469.

Photograph 3.11 KP79+808. Corrective maintenance activities on the road - repair. Coordinates E 976375 N 621159.

Photograph 3.12 KP83+764. City of San Juan de Pasto. Coordinates E 977581 N 623978.

Source: GEOCOL CONSULTORES S.A., 2017.

The Rumichaca - Pasto road will be subject to work for the implementation of the project, as follows:

- Construction of a second roadway, parallel to the existing one, from KP15 + 750 to KP17 + 000. The existing roadway will be improved.
- The construction of the San Juan - Pedregal segment begins at KP17 + 000, with a new road (see **Photograph 3.13** and **Photograph 3.14**). This starting point is close to the populated area of the San Juan district - municipality of Ipiales. Here, a level interchange will be built at KP17 + 300 - E 947603 N 590068 (see Annex 2. Civil II. Layout. Plan CSH-1-DI02-PL-G-G-G-0005-0-Trazado L -CD. Sheet 19).

Photograph 3.13 KP17+000. Start point of the San Juan - Pedregal segment. Coordinates E 947526 N 589979.

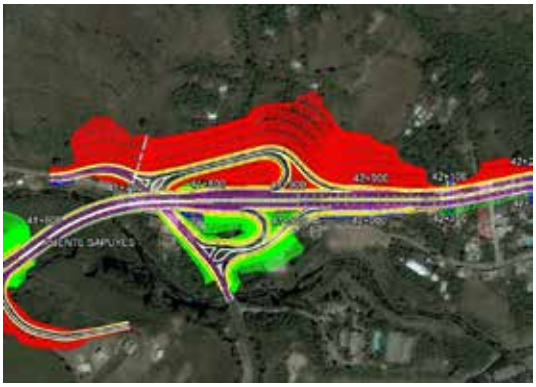
Photograph 3.14 KP17+000. Start point of the new divided highway to be built and interchange for access to the San Juan district - municipality of Ipiales. Coordinates E 947603 N 590068.

Source: GEOCOL CONSULTORES S.A., 2017.

- At KP41 + 992 (E 955471 N 604839), the new road section (San Juan - Pedregal segment) connects to the existing road (Rumichaca - Pasto). The Pilcuán grade separated interchange will be built at this point (See **Photograph 3.15, Photograph 3.16**), and will construction of the second roadway parallel to the existing one will begin (the existing road will be improved), until the San Juan Pedregal segment ends at KP44 + 844 (see Photograph 3.17). Annex 2. Civil. II. Layout. Plans **CSH-1-DI02-PL-GGG-0005-0-Layout L - CD, CSH-1-DI02-PL-GGG-0005-0-Layout L-CI** and **CSH-3-DI02-PL-GGG-0005 -0-Layout L**, sets outs the works that will be carried out on the existing Rumichaca - Pasto road.

Photograph 3.15 KP41+992. Point where Pilcuán interchange will be built Coordinates E 955471 N 604839.

Photograph 3.16 Pilcuán Interchange Coordinates E 955471 N 604839.



Photograph 3.17 KP44+844. End of the San Juan - Pedregal segment on the existing Rumichaca Pasto road Pasto.
Coordinates E 957016 N 606660

Source: GEOCOL CONSULTORES S.A., 2017.

In addition, the Rumichaca - Pasto road serves as an access for the works listed in **Table 3.3**, which will be carried out for the construction of the project:

Table 3.3 Works that it will be possible to access through the Rumichaca – Pasto road.

NAME OF STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Z1-10B	15+700	946542	589023	Right
Zodme Z1-11	15+800	946843	589280	Right
Zodme Z1-11B	16+400	947098	589500	Right
Zodme Z3-6	43+500	956878	605387	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.2 Access road to the municipal center of Iles.

This road is 16.76 km long, its point of origin is at abscissa KP35 + 040 of the Rumichaca - Pasto road, its end point is the municipal center of Iles (see **Figure 3.6**). It is a secondary road, which has a flexible pavement surface, a 6.0 m wide roadway, two traffic lanes (one per direction), and gutters made of reinforced concrete. Its layout comprises steep topography, and its slopes present instabilities that, during the rainy season, resulting in mass movement (landslides), and thus giving rise to blockages to the road. Half of its layout has road signs and markings, while the other half only has road sings. In general, and despite the instability of the slopes, the road has good service specifications. **Photographs 3.18** to **Photograph 3.21** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.6 Layout of the access road to the municipal center of Iles.

Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.18 KP0+000. Point of origin of the access road to the municipal center of Iles. Coordinates E 956420 N 600217.

Photograph 3.19 KP6+216. Landslide on the road. Coordinates E 953981 N 602027.

Photograph 3.20 KP7+732. Change in road characteristics. Flexible pavement, with a roadway up to 6.0 m wide, lacks road markings. Coordinates E 952902 N 601812.

Photograph 3.21 KP16+763. Municipal center of Iles. Coordinates E 950653 N 598997.

Source: GEOCOL CONSULTORES S.A., 2017.

The access road to Iles will be intersected by the Rumichaca-Pasto divided highway project, San Juan-Pedregal segment, and the work will be located at project chainage KP35 + 500 - E 955064 N601897, and at this point a level interchange will be built (see **Photograph 3.22**, **Photograph 3.23** and **Annex 2. Civil. II. Layout. Plan CSH-2-PL-G-G-2105-2. Sheets 12 and 13**).

Photograph 3.22 KP3+673. Viaduct relating to the access road to Iles. Point where the les interchange will be built. Coordinates E 955162 N 601702.

Photograph 3.23 KP3+372. Road section where the Iles interchange is planned. Coordinates E 955064 N601897.

Source: GEOCOL CONSULTORES S.A., 2017.

In addition, the access road to Iles allows entry to the works listed in **Table 3.4**.

Table 3.4 Works that it will be possible to enter through the Iles access road.

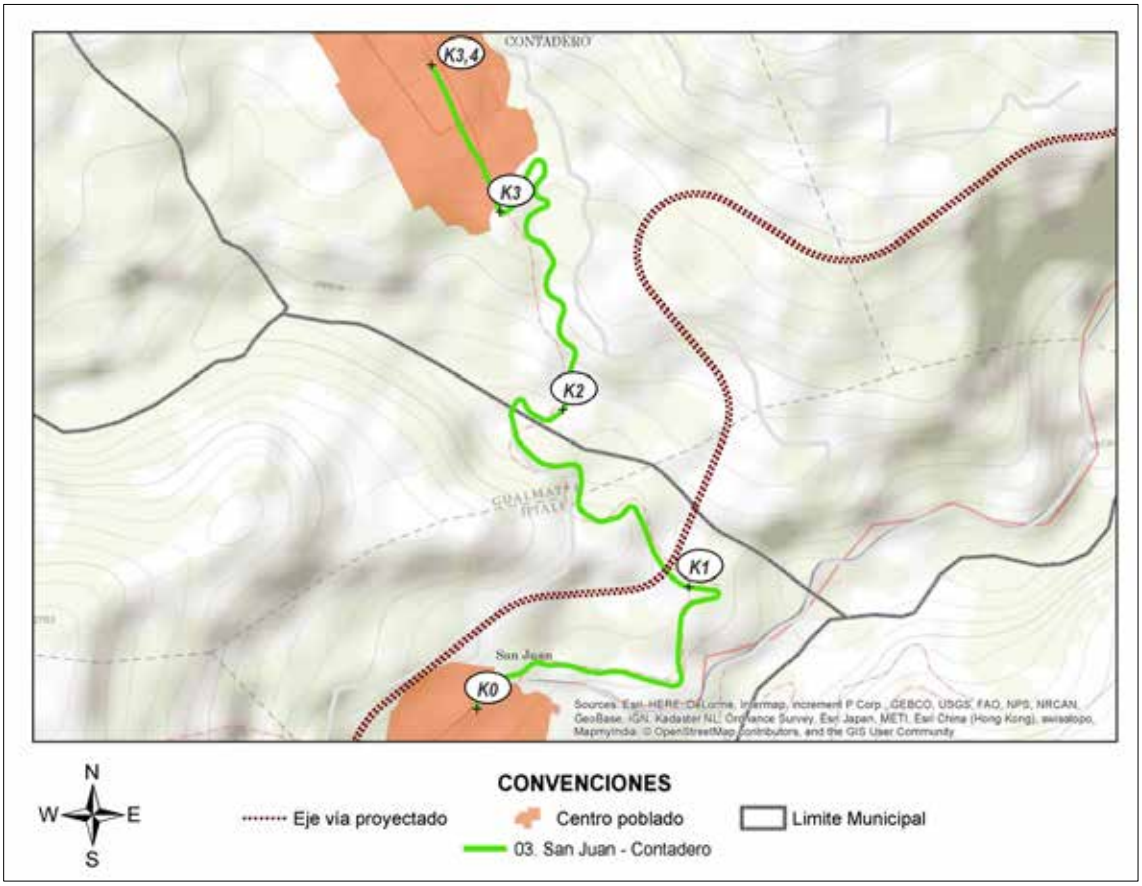
NAME OF STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z2-11	35+600	954397	601721	Left
Zodme Z2-13	35+000	954099	601178	Left
Zodme Z2-14	36+400	954312	601979	Left

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.3 San Juan – Contadero road.

This road is 3.48 km long, its point of origin is the populated area of the San Juan district in the municipality of Ipiales, and its end point is the municipal center of Contadero (see **Figure 3.7**). It is a secondary road, made up of flexible pavement, a 6.0 m wide roadway, two traffic lanes (one per direction), its layout comprises steep topography, it has road signs and markings, and in general is in a good state of service. **Photograph 3.24** to **Photograph 3.27** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.7 Layout of the San Juan – Contadero road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.24 KP0+000. Intersection on the Rumichaca - Pasto road. District of San Juan, municipality of Ipiales. Coordinates E 947725 N 590631.

Photograph 3.25 KP1+436. Flexible pavement road section, roadway 6.00 m wide. Coordinates E 947999 N 591159.

Photograph 3.26 KP2+113. Flexible pavement road section, roadway 6.00 m wide. Coordinates E 947970 N 591508.

Photograph 3.27 KP3+081 Municipal center of Contadero. Coordinates E 947773 N 591981.

Source: GEOCOL CONSULTORES S.A., 2017.

The San Juan - Contadero road will be worked on by the Rumichaca - Pasto divided highway project, San Juan - Pedregal segment, at KP18 + 700 - E 948219 N 591014 (project chainage), where the Contadero grade separated interchange will be built for the project to intersect, and this includes the planned Boquerón Bridge (See **Photograph 3.28**, **Photograph 3.29** and **Annex 2. Civil. II. Layout. Plan CSH-1-DI02-PL-G-G-G-0005-0-Layout L -CD Sheets 20 and 21**).

Photograph 3.28 KP1+104. Sector in which the Contadero interchange will be built. Coordinates E 948219 N 591014.

Photograph 3.29 KP1+104. Contador interchange, includes Boquerón Bridge. Coordinates E 948219 N 591014.

Source: GEOCOL CONSULTORES S.A., 2017.

The San Juan - Contadero road will allow access to the works listed in **Table 3.5**.

Table 3.5 Works that it will be possible to access through the San Juan – Contadero road.

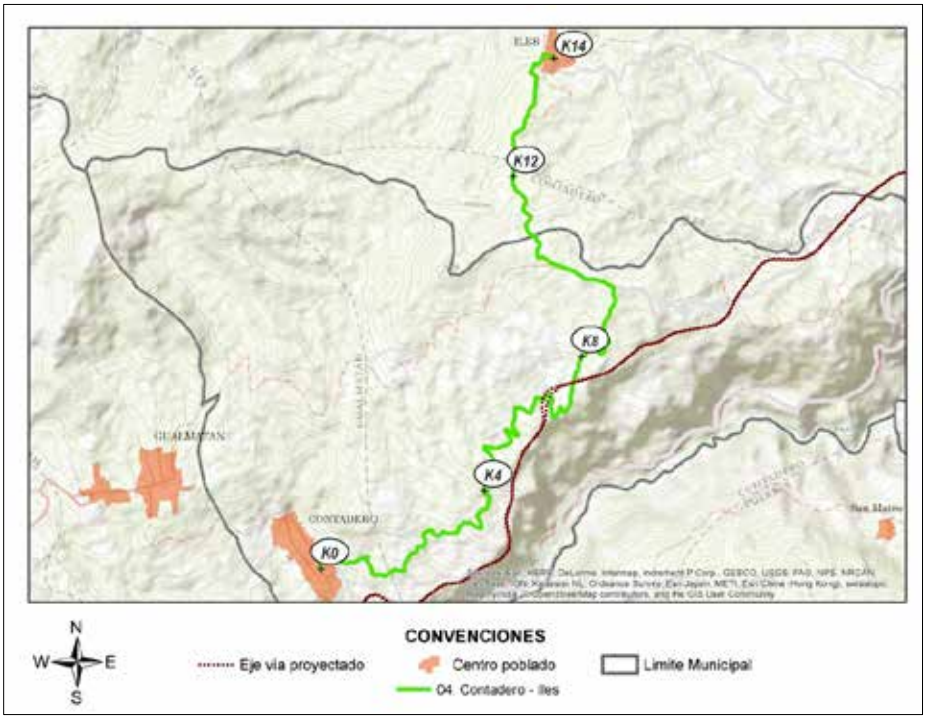
NAME OF STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z1-14B	18+600	948178	590769	Right
Zodme Z1-14C	18+800	948420	590906	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.4 Contadero – Aldea de María – Iles road.

This road is 14.01 km long, its point of origin is the municipal center of Contadero and its end point is the municipal center of Iles (see **Figure 3.8**). It is a secondary road, with its surface consisting of granular material, its roadway measures up to 4.50 m wide, it has two traffic lanes (one per direction), its layout comprises steep topography, it lacks signage, and in general it is in a good state of service. **Photograph 3.30** to **Photograph 3.33** provide a photographic record of this (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.8 Layout of the Contadero – Iles road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.30 KP0+715. Road section, granular material, roadway 4.50 m wide. Coordinates E 947856 N 592436.

Photograph 3.31 KP3+358. Road section, granular material, roadway 4.50 m wide. Near to the populated area of the Aldea of María district - municipality of Contadero. Coordinates E 949699 N 592900.

Photograph 3.32 KP5+638. Road section, granular material, roadway 3.50 m wide. Coordinates E 950140 N 594145.

Photograph 3.33 KP8+687. Road section, granular material, roadway 3.50 m wide. Coordinates E 951300 N 595176.

Source: GEOCOL CONSULTORES S.A., 2017.

The Contadero - Aldea de María - Iles road will be worked on by the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment, at chainage KP24 + 000 - E 950571 N 594552 and KP24 + 400 - E 950868 N 594559 (project chainage), with the project intersecting the road at these points. **Photograph 3.34**, **Photograph 3.35** and **Photograph 3.36** provide a photographic record of the intersection sites.

Photograph 3.34 KP6+483. Section of the Contadero - Aldea de María - Iles road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 950571 N 594552.

Photograph 3.35 KP6+623. Section of the Contadero - Aldea de María - Iles road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 950571 N 594552.

Photograph 3.36 KP7+594. Section of the Contadero - Aldea de María - Iles road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 950868 N 594559.

Source: GEOCOL CONSULTORES S.A., 2017.

This road allows access to the works listed in **Table 3.6**.

Table 3.6 Works that it will be possible to access through the Contadero – Iles road.

NAME OF STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z1-15C	21+200	949178	592483	Left
Zodme Z1-16	22+400	949938	593046	Left
Zodme Z1-16A	22+500	950136	593107	Right
Zodme Z1-16B	22+700	949849	593330	Left
Zodme Z1-17	24+100	950915	594516	Right
Zodme Z1-17B	24+400	950698	594998	Left
Zodme Z1-17C	24+600	950916	595145	Left

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.5 Ospina Pérez – Iles Road.

This road is 16.15 km long, its origin point is at chainage KP9 + 608 of the Contadero - Iles road (in the rural district of Ospina Pérez - municipality of Contadero) and its end point is the municipal center of Iles (see **Figure 3.9**). It is a tertiary road, made up of a granular material surface, with a roadway up to 4.0 m wide, two traffic lanes (one per direction), its layout comprises steep topography, it lacks signage, and in general is in an average state of service. **Photograph 3.37** to **Photograph 3.40** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.9 Layout of the Ospina Pérez – Iles Road.

Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.37 KP0+561. Road section, granular material, roadway 3.00 m wide. Coordinates E 951897 N 595858.

Photograph 3.38 KP6+332. Road intersection. To the right, it allows access to the Rumichaca - Pasto road, and to the left to the municipal center of Iles. Coordinates E 955004 N 596723.

Photograph 3.39 KP10+911. Road section, granular material, roadway 4.00 m wid. Coordinates E 954173 N 598736.

Photograph 3.40 KP15+831. Road section, granular material, roadway 4.00 m wide. Coordinates E 950747 N 598821.

Source: GEOCOL CONSULTORES S.A., 2017.

The Ospina Pérez - Iles road will be worked on by the Rumichaca - Pasto divided highway project, San Juan - Pedregal segment, at the following chainage (project chainage):

- KP27+600 - E 952924 N 595650: level intersection
- KP28+100 - E 953921 N 596323: road replacement.
- KP28+430 - E 954204 N 596620: level intersection.
- KP29+970 - E 955398 N 597503: road replacement.
- KP30+200- E 955613 N 597510: road replacement
- KP30+245 - E 955662 N 597500: road replacement.

The road will be intersected by the project at these sites. **Photograph 3.41**, **Photograph 3.42**, **Photograph 3.43** and **Photograph 3.44** provide a photographic record of the intersection sites.

Photograph 3.41 KP4+915. Section of the Ospina Pérez - Iles road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 954204 N 596620.

Photograph 3.42 KP7+813. Section of the Ospina Pérez - Iles road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 955398 N 597503.

Photograph 3.43 KP8+064. Section of the Ospina Pérez - Iles road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 955613 N 597510.

Photograph 3.44 KP8+150. Section of the Ospina Pérez - Iles road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 955662 N 597500.

Source: GEOCOL CONSULTORES S.A., 2017.

In addition, the Ospina Pérez – Iles road will allow access to the works listed in **Table 3.7**.

Table 3.7 Works that it will be possible to access through the Ospina Pérez – Iles road.

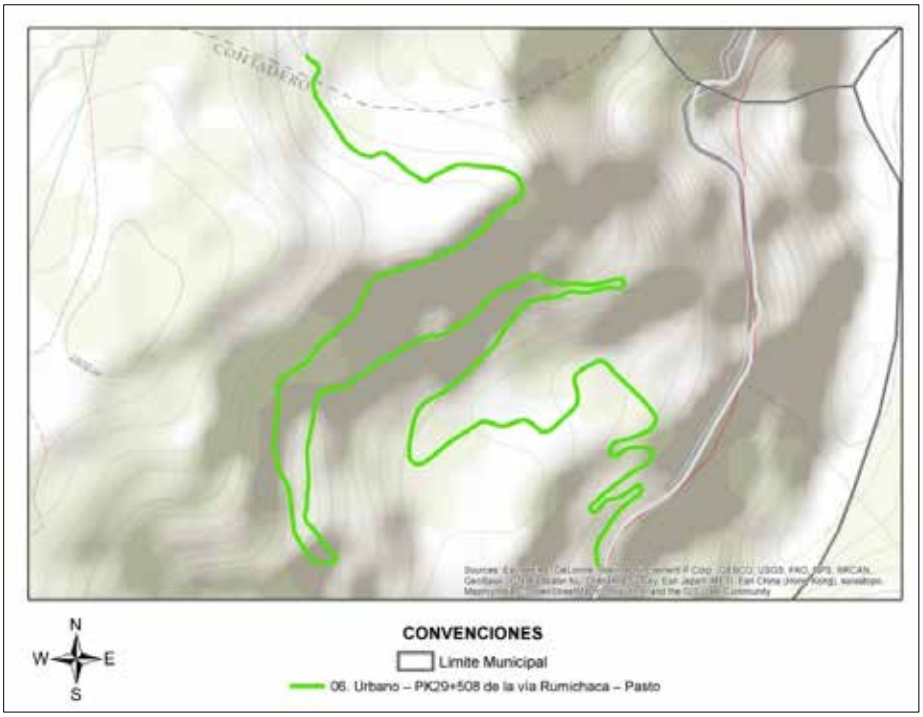
NAME OF STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z2-1B	26+500	952268	596191	Left
Zodme Z2-2	27+600	953729	595878	Right
Zodme Z2-3A	30+700	954695	598394	Left
Zodme Z2-3B	30+700	954817	598552	Left
Zodme Z2-3C	30+700	955528	598524	Left
Zodme Z2-3D	31+700	955861	598500	Left
Zodme Z2-4	30+700	954787	598824	Left
Zodme Z2-5	30+700	953875	598590	Left
Non-structural fill R2-1	30+200	955450	597384	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.6 Urbano road – KP29+508 on the Rumichaca – Pasto road.

This road is 5.4 km long, its point of origin is chainage KP6 + 332 of the Ospina Pérez - Iles road and its end point is chainage KP29 + 508 of the Rumichaca - Pasto road (see **Figure 3.10**). It is a tertiary road and consists of a granular material surface, its roadway is up to 3.50 m wide, has two traffic lanes (one per direction), its layout comprises steep topography, its slopes exhibit instabilities (resulting in mass movement during the rainy season), it lacks suitable runoff water management (and therefore is affected by the creation of gullies on its surface), it lacks signage, and in general is in a poor state. **Photograph 3.45** to **Photograph 3.48** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.10 Layout of the Urbano road - KP29+508 on the Rumichaca – Pasto road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.45 KP0+150. Road section, granular material, roadway 3.0 m wide. Coordinates E 955041 N 596594.

Photograph 3.46 KP1+706. Landslide on the road. Coordinates E 954962 N 595729.

Photograph 3.47 KP3+707. Road section with damage to surface due to lack of runoff water management.
Coordinates E 955255 N 595908.

Photograph 3.48 KP5+396. Intersection with the Rumichaca Pasto road.
Coordinates E 955672 N 595553.

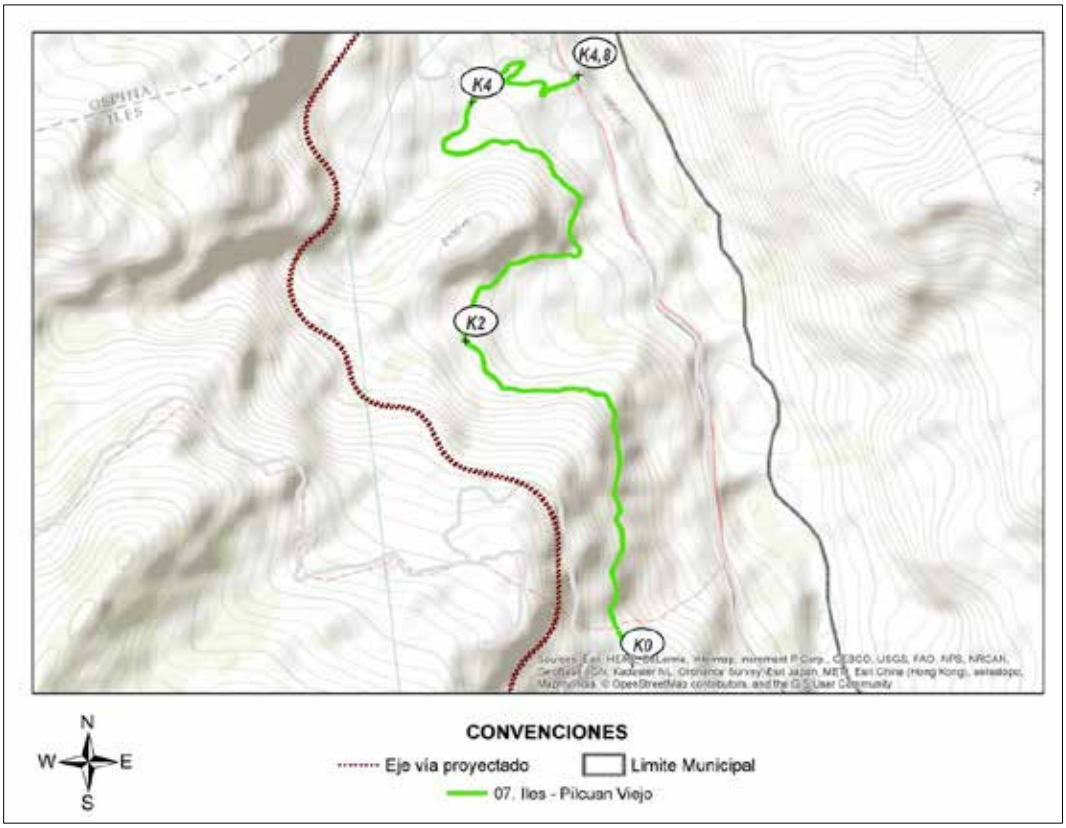
Source: GEOCOL CONSULTORES S.A., 2017.

This layout will not be intersected by the project's layout. However, it may be used to move personnel, machinery, equipment and supplies for the project.

3.2.1.2.7 Iles – Pilcuán Viejo road.

This road is 4.86 km long, its point of origin is chainage KP1 + 984 of the access road to the municipal center of Iles, and its end point is at chainage KP38 + 901 of the Rumichaca - Pasto road (see **Figure 3.11**). It is a tertiary road, made of granular material surface, with a roadway up to 3.5 m wide, two traffic lanes (one per direction), its layout comprises a steep topography, and in general it is in a good state of service. **Photograph 3.49** to **Photograph 3.52** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.11 Layout of the Iles – Pilcuán Viejo road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.49 KP0+000. Intersection. Point of origin of the Iles - Pilcuán Viejo road. Coordinates E 955427 N 601176.

Photograph 3.50 KP2+080. Road section, granular material, roadway 3.0 m wide. Coordinates E 954701 N 602639.

Photograph 3.51 KP4+293. Road section, granular material, roadway 3.5 m wide. Coordinates E 954914 N 603811.

Photograph 3.52 KP4+860 Intersection with the Rumichaca – Pasto road. Coordinates E 955183 N 603749.

Source: GEOCOL CONSULTORES S.A., 2017.

This road will allow access to the works listed in **Table 3.8**.

Table 3.8 Works that it will be possible to access through the Iles – Pilcuán Viejo road.

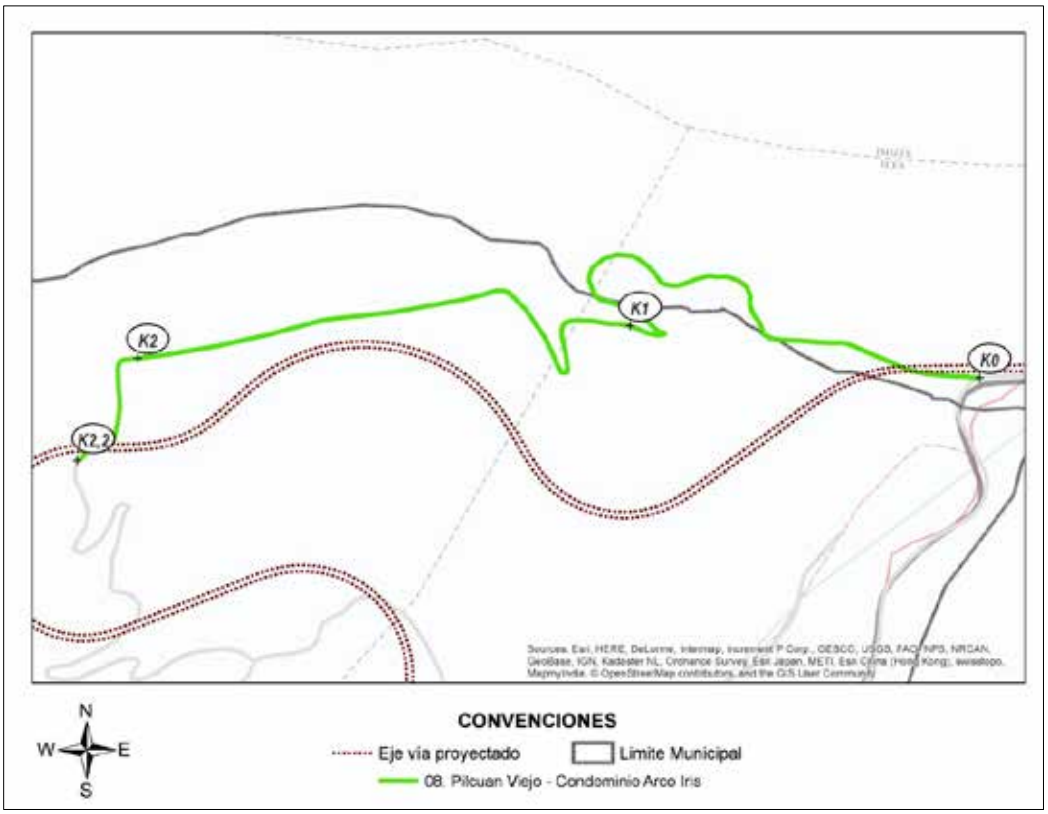
NAME OF STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z3-1B	38+100	954205	603578	Right - Left

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.8 Pilcuán Viejo – Arco Iris Condominium road.

This road is 2.25 km long, its point of origin is the populated area of the Pilcuán rural district- municipality of Imués, at chainage KP40 + 359 of the Rumichaca Pasto road, and its end point is the Arco Iris condominium (see **Figure 3.12**). It is a tertiary road, made up of a granular material surface layer, with a roadway up to 4.0 m wide, two traffic lanes (one per direction), its layout comprises undulating topography, it lacks signage, and in general is in a good state of service. **Photograph 3.53** and **Photograph 3.54** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.12 Layout of the Pilcuán Viejo –Arco Iris Condominium road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.53 KP0+000. Point of origin of the road. Coordinates E 955489 N 604929.

Photograph 3.54 KP0+635. Road section, granular material, roadway 3.00 m wide. Coordinates E 954931 N 605106.

Source: GEOCOL CONSULTORES S.A., 2017.

The Pilcuán Viejo - Arco Iris road will be worked on by the Rumichaca-Pasto Divided Highway Project, San Juan-Pedregal segment, at chainage KP41 + 700 - E 955329 N 604958 (by means of a grade separated interchange) - and KP41 + 130 - E 954016 N 604819 (by means of a level interchange) (project chainage). The road will be intersected by the project at these sites. **Photograph 3.55** and **Photograph 3.56** provide a photographic record of the sites where the project intersects with the existing road.

Photograph 3.55 KP0+165. Section of the Pilcuán Viejo - Arco Iris Condominium road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 955329 N 604958.

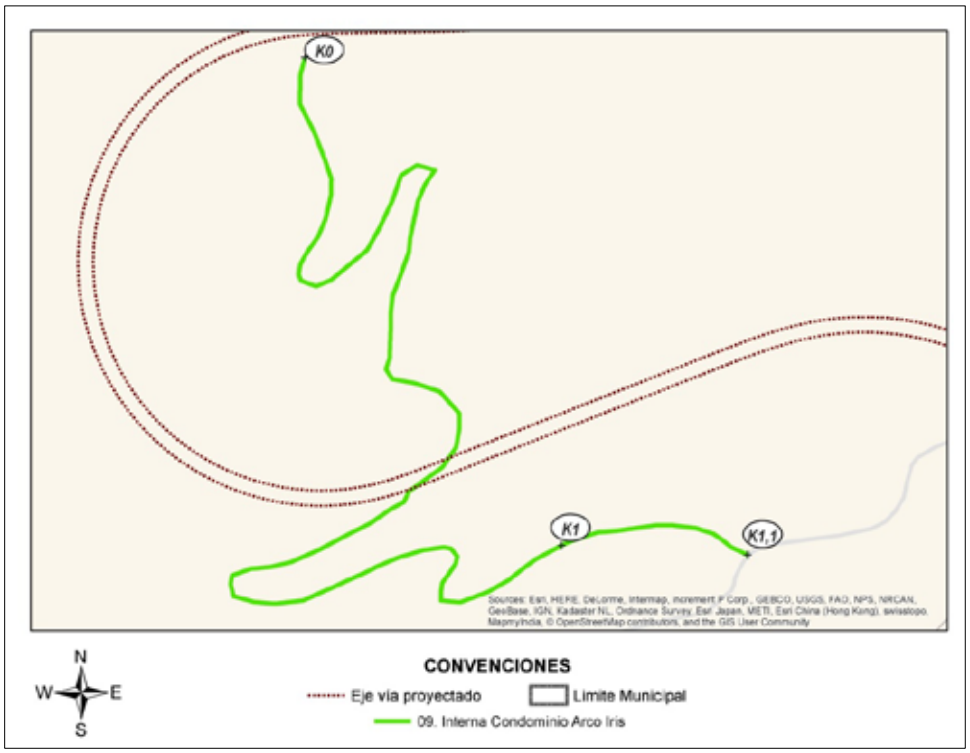
Photograph 3.56 KP2+205. Section of the Pilcuán Viejo - Arco Iris Condominium road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 954016 N 604819.

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.9 Arco Iris Condominium internal road.

This road is 1.14 km long, its point of origin is KP2 + 253 of the Pilcuán Viejo - Arco Iris Condominium road, and its end point is inside the condominium (see **Figure 3.13**). It is a tertiary road, composed of concrete slabs, a single roadway of a single lane, its layout comprises terrain with steep topography and it exhibits slope instability. This road will be intersected by the project at KP40 + 110 - E 953942 N 604799 and KP39 + 540 - E 953943 N 604451 (by means of level intersections) (project chainage). **Photograph 3.57** and **Photograph 3.58** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.13 Layout of the Arco Iris Condominium internal road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.57 KP0+000. Point of origin of the internal road relating to the Arco Iris condominium and the project's point of intersection. Coordinates E 953979 N 604795

Photograph 3.58 KP0+691. Section of the internal road relating to the Arco Iris Condominium. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 953943 N 604451.

Source: GEOCOL CONSULTORES S.A., 2017.

This road will allow access to the works listed in **Table 3.9**.

Table 3.9 Works that it will be possible to access through the Arco Iris Condominium's internal road.

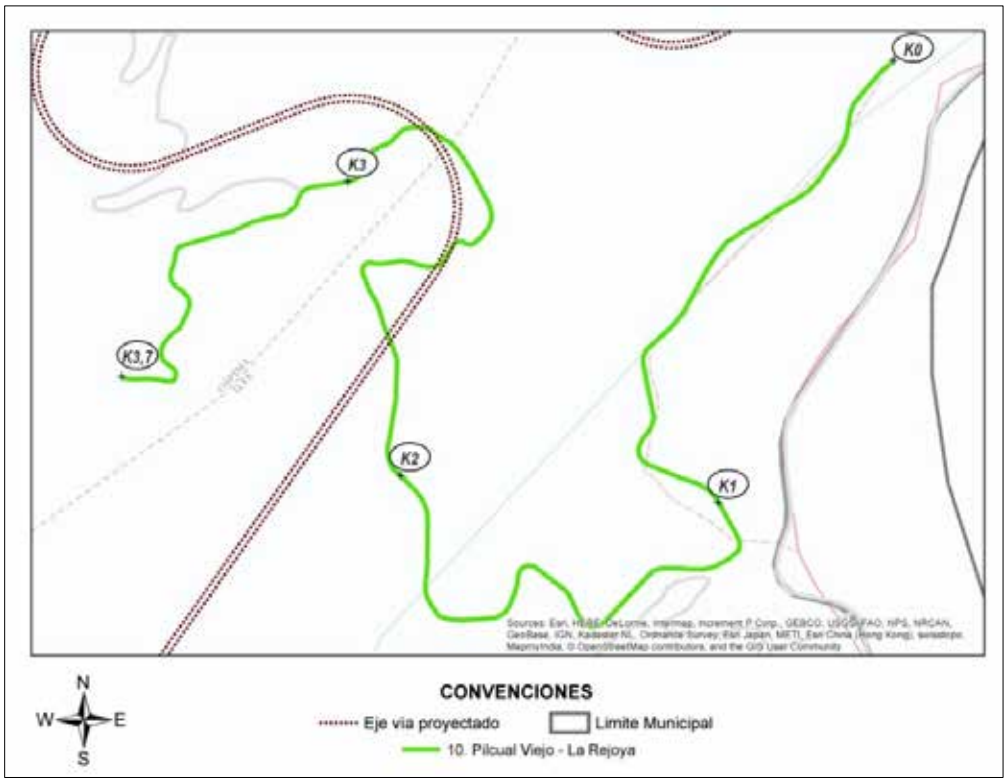
NAME OF THE STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z3-3	39+300	954208	604696	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.10 Pilcuán Viejo – La Rejoya road.

This road is 3.7 km long, its point of origin is the Pilcuán rural district - municipality of Imués, and its end point is the rural district of La Rejoya - municipality of Ospina (see **Figure 3.14**). It is a tertiary road, consisting of a granular material surface layer, a roadway up to 3.50 m wide, with a single lane, its layout comprises steep topography, and in general it is in an average state of service. This road will be intersected by the project at chainage KP38 + 700 - E 954426 N 604194 (level intersection), KP38 + 850 - E 954509 N 604341 (by means of realignment of the existing road) and KP39 + 100 - E 954520 N 604530 (by means of realignment of the existing road) (project chainage). **Photograph 3.59** to **Photograph 3.62** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.14 Layout of the Pilcuán Viejo – La Rejoya road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.59 KP2+147. Road section, granular material, roadway 3.5 m wide. Coordinates E 954626 N 603780.

Photograph 3.60 KP2+769 Section of the Pilcuán Viejo – La Rejoya road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 954426 N 604194.

Photograph 3.61 KP3+055 Section of the Pilcuán Viejo – La Rejoya road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 954509 N 604341.

Photograph 3.62 KP3+318 Section of the Pilcuán Viejo – La Rejoya road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 954520 N 604530.

Source: GEOCOL CONSULTORES S.A., 2017.

This road will allow access to the works listed in **Table 3.10**.

Table 3.10 Works that it will be possible to access through the Pilcuán Viejo – La Rejoya road.

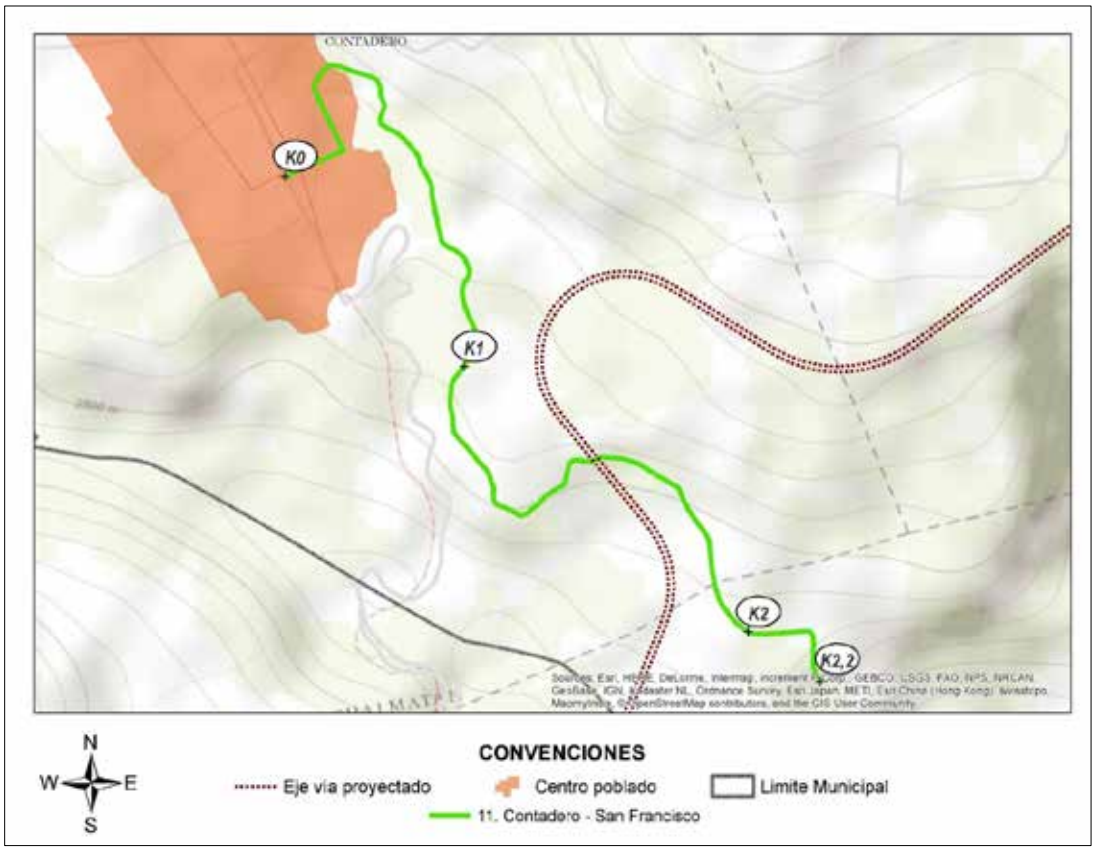
NAME OF THE STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Z3-2B	38+700	Right	954331	604024
Zodme Z3-2	38+900	954685	604146	Right
Zodme Z3-4	41+500	954933	604548	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.11 Contadero – San Francisco road.

This road is 2.23 km long, its point of origin is the municipal center of Contadero, and its end point is in the rural district of San Francisco - Contadero (see **Figure 3.15**). It is a tertiary road, made up of a granular material surface layer, a roadway up to 3.50 m wide, its layout comprises undulating topography, it lacks signage, and in general it is in a good state of service. **Photograph 3.63** to **Photograph 3.66** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.15 Layout of the Contadero – San Francisco road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.63 KP0+306. Reinforced concrete bridge with a 4.5 x 7.5 m board. Coordinates E 947761 N 592374.

Photograph 3.64 KP1+206. Road section, granular material, roadway 3.0 m wide. Coordinates E 948044 N 591646.

Photograph 3.65 KP1+711. Road section, granular material, roadway 3.0 m wide. Coordinates E 948408 N 591596.

Photograph 3.66 KP1+897. Road section, granular material, roadway 3.0 m wide. Coordinates E 948470 N 591426.

Source: GEOCOL CONSULTORES S.A., 2017.

The Contadero - San Francisco road will be worked on by the Rumichaca - Pasto Divided highway Project, San Juan - Pedregal segment, at chainage KP19 + 560 - E 948252 N 591654 (project chainage). It will be intersected by the project at this site and a level intersection is planned. **Photograph 3.67** shows the site where the project will intersect.

Photograph 3.67 KP1+540. Section of the Contadero – San Francisco road. Point of intersection for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. Coordinates E 948252 N 591654.

Source: GEOCOL CONSULTORES S.A., 2017.

This road will allow access to the works listed in **Table 3.11**.

Table 3.11 Works that it will be possible to enter through the Contadero – San Francisco road.

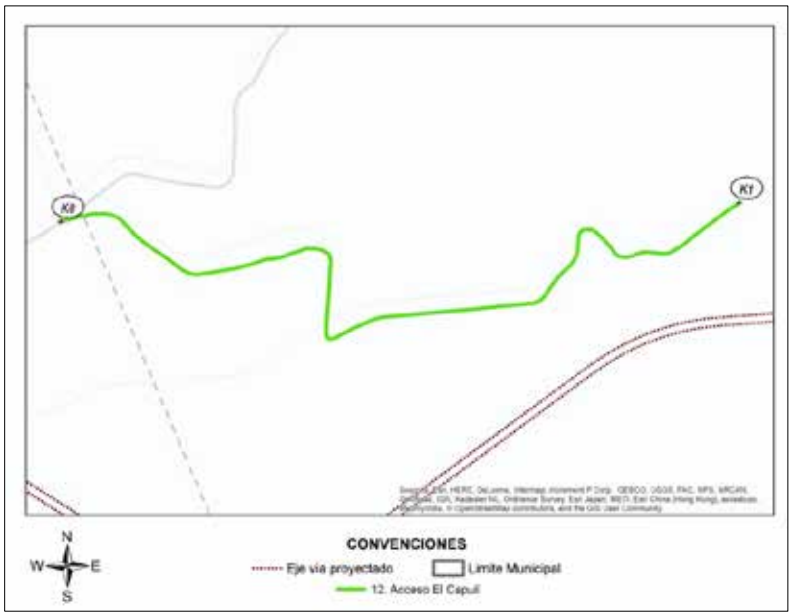
NAME OF THE STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z1-15	19+600	948094	591726	Left
Non-structural fill R1-9	18+940	948444	591702	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.12 El Capulí access road.

This road is 1.06 km long, its point of origin is chainage KP1 + 555 of the Contadero - Iles road, and its end point is the populated area of the rural district of El Capulí (see **Figure 3.16**). It is a tertiary road, made up of a granular material surface layer, a roadway up to 3.50 m wide, two traffic lanes (one per direction), its layout comprises undulating topography, it lacks signage, and in general it is in a good state of service. **Photograph 3.68** and **Photograph 3.69** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.16 Layout of the El Capulí access road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.68 KP0+028 Road section, granular material, roadway 3.5 m wide. Coordinates E 948520 N 592273.

Photograph 3.69 KP0+858. Road section, granular material, roadway 3.5 m wide. Coordinates E 949148 N 592245.

Source: GEOCOL CONSULTORES S.A., 2017.

This road will allow access to the works listed in **Table 3.12**.

Table 3.12 Works that it will be possible to enter through the El Capulí access road.

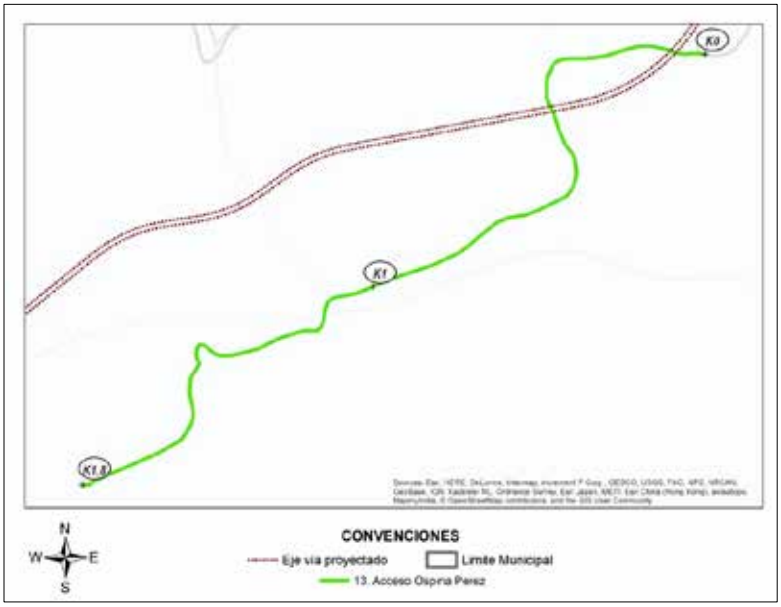
NAME OF THE STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z1-15B	20+800	948856	592284	Left

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.13 Ospina Pérez access road.

This road is 1.82 km long, its point of origin is chainage KP2 + 465 of the Ospina Pérez - Iles road, and its end point is the Ospina Pérez rural district (see **Figure 3.17**). It is a tertiary road, made up of a granular material surface layer, a roadway up to 3.50 m wide, its layout comprises undulating topography, it lacks signage and its service level is good. This road will be intersected by the Rumichaca - Pasto Divided highway Project, San Juan - Pedregal segment, at chainage KP26 + 630 - E 952879 N 595608 (by means of a level intersection) and KP26 + 370 - E 952637 N 595516 (by means of a level intersection) (project chainage). **Photograph 3.70** to **Photograph 3.73** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.17 Layout of the Ospina Pérez access road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.70 KP0+069. Section of the access road to Ospina Pérez. Point where the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment will cross the road.
Coordinates E 952879 N 595608.

Photograph 3.71 KP0+373. Section of the access road to Ospina Pérez. Point where the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment will cross the road.
Coordinates E 952637 N 595516

Photograph 3.72 KP1+181. Road section, granular material, roadway 2.5 m wide.
Coordinates E 952171 N 595065.

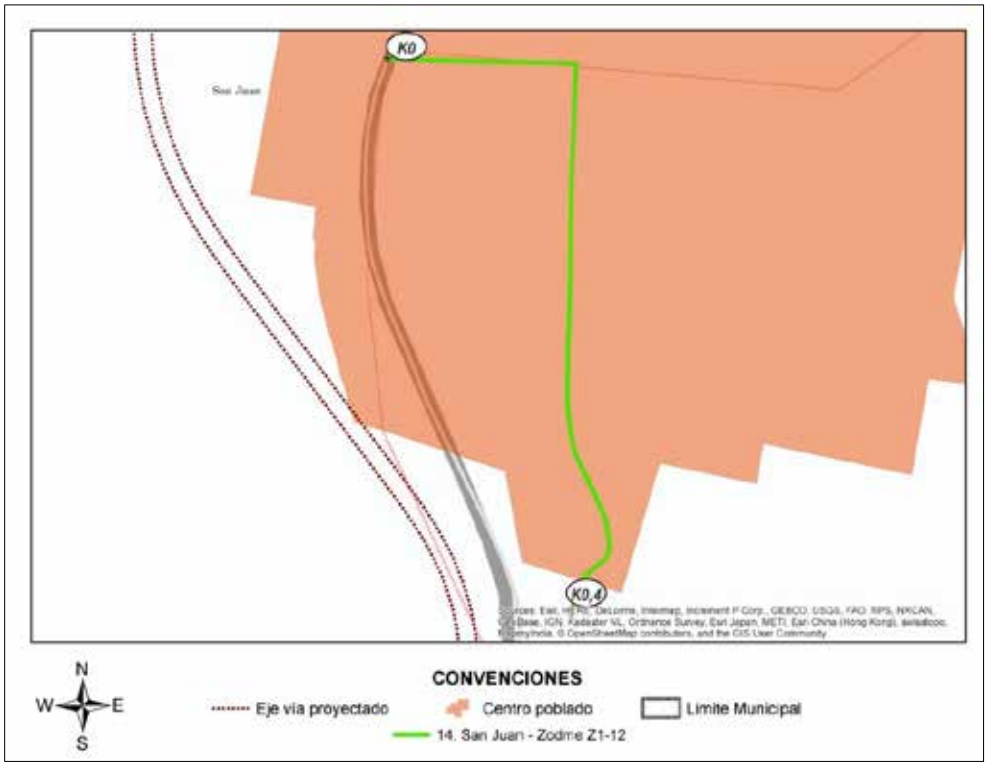
Photograph 3.73 KP1+791. Road section – path.
Coordinates E 951760 N 594774.

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.14 San Juan – ZODME Z1-12 road.

This road is 450 m long, its point of origin is chainage KP18 + 000 of the Rumichaca Pasto road, in one of the accesses to the populated area of San Juan - municipality of Ipiales (see **Figure 3.18**). It is a tertiary road, in an average state of service, composed of a granular material surface layer, and with widths up to 4.50 m. **Photograph 3.74** and **Photograph 3.75** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.18 Layout of the San Juan – Zodme Z1-12 road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.74 KP0+275. Section of the internal road relating to the San Juan village - municipality of Ipiales. Coordinates E 947635 N 590273.

Photograph 3.75 KP0+382. Road section, granular material, roadway 3.5 m wide. Coordinates E 947658 N 590169.

Source: GEOCOL CONSULTORES S.A., 2017.

This road will allow access to the works listed in **Table 3.13**.

Table 3.13 Works that it will be possible to enter through the San Juan – ZODME Z1-12 road

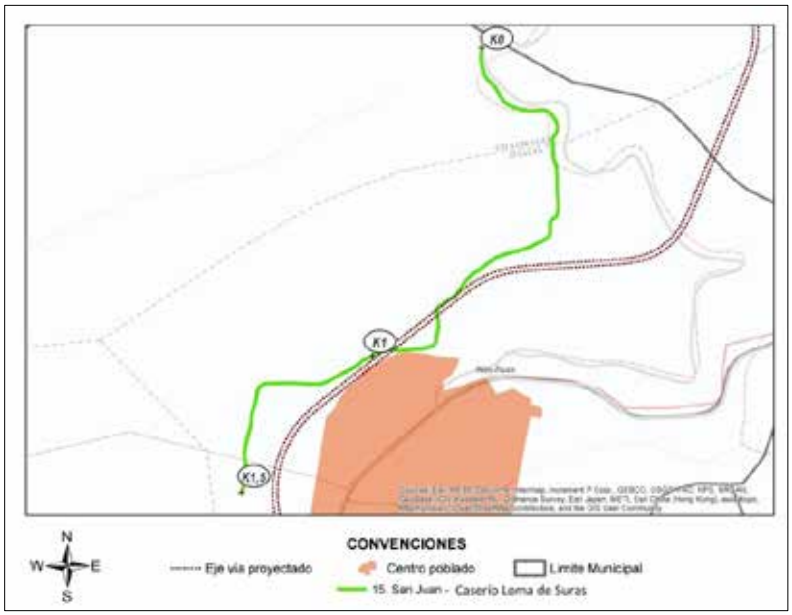
NAME	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z1-12	17+200	947725	590122	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.15 San Juan – Loma de Suras village road.

This road is 1.43 km long and its point of origin is chainage KP1 + 747 on the San Juan - Contadero road (see **Figure 3.19**). It is a tertiary road, consisting of a granular material surface layer, a roadway up to 3.50 m wide, two traffic lanes (one per direction), its layout comprises undulating topography, it lacks signage, and it is in a poor state of service. This road will be intersected by the project at KP18 + 180 - E 947725 N 590836 and KP18 + 030 - E 947624 N 590759 (project chainage). **Photograph 3.76** and **Photograph 3.77** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.19 Layout of the San Juan – Loma de Suras village road.



Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.76 KP0+747. Section of the San Juan - Loma de Suras village access road. Point where the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment will cross the road.
Coordinates E 947725 N 590836.

Photograph 3.77 KP0+914. Section of the San Juan - Loma de Suras village access road. Point where the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment will cross the road.
Coordinates E 947624 N 590759.

Source: GEOCOL CONSULTORES S.A., 2017.

In addition, this road will allow access to the works listed in **Table 3.14**.

Table 3.14 Works that it will be possible to enter through the San Juan – Loma de Suras village road.

NAME OF THE STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z1-13	KP17+600	947274	590469	Left
Zodme Z1-14	KP18+000	947551	590856	Left

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.16 Access road to El Tesoro farm.

This road is 538 m long, its point of origin is chainage KP1 + 523 of the access road to the municipal center of Iles, and its end point is El Tesoro farm (see **Figure 3.20**). It is a tertiary road, with a surface layer at the level of the natural terrain, with a roadway 2.50 m wide, a single lane, it lacks signage and its state of service is poor (see **Photograph 3.78**). The infrastructure listed in **Table 3.15** will serve as access for the project.

Figure 3.20 Layout of the El Tesoro farm access road.

Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.78 KP0+110. Section of the access road to El Tesoro farm. Coordinates E 955602 N 600781.

Source: GEOCOL CONSULTORES S.A., 2017.

Table 3.15 Works that it will be possible to enter through the El Tesoro farm access road.

NAME OF THE STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	NORTH	
Zodme Z2-8	33+800	955408	600370	Right
Zodme Z2-9	34+000	955694	600613	Right

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.2.17 Access road to El Porvenir farm.

This road is 811 m long, its point of origin is chainage KP4 + 769 of the access road to the municipal center of Iles, and its end point is El Porvenir farm (see **Figure 3.21**). It is a tertiary road, made up of a surface layer at the level of the natural terrain, a roadway up to 3.0 m wide, with stability problems on its slopes, evidence of a lack of runoff water management, it lacks signage, and in general it is in a poor state of service. **Photograph 3.79** to **Photograph 3.82** provide a photographic record of this road (the origin of the coordinates is Datum Magna Sirgas 3 West).

Figure 3.21 Layout of the El Porvenir farm access road.

Source: GEOCOL CONSULTORES S.A., 2017.

Photograph 3.79 KP0+000. Point of origin of the access road to El Porvenir farm. Coordinates E 954705 N 601626.

Photograph 3.80 KP0+633. Road section at ground level, lacks runoff water management. Coordinates E 954919 N 601336.

Photograph 3.81 KP0+683. Road section with slope instabilities. Coordinates E 954883 N 601307.

Photograph 3.82 KP0+811. House belonging to El Porvenir farm.

Source: GEOCOL CONSULTORES S.A., 2017.

This road will allow access to the works listed in **Table 3.16**.

Table 3.16 Works that it will be possible to enter through the El Porvenir farm access road.

NAME OF THE STRUCTURE	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		SIDE OF ROAD
		EAST	WEST	
Zodme Z2-10	35+600	954992	601715	Left
Zodme Z2-10A	34+700	954748	601380	Left

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.1.3 Railway lines.

There is no existing railway infrastructure in the area of influence of the Rumichaca-Pasto Divided highway Project, San Juan-Pedregal segment.

3.2.1.4 Utilities networks and assets.

Within the area of influence of the Rumichaca-Pasto Divided Highway Project, San Juan-Pedregal segment, utilities networks and assets were identified, as listed in **Table 3.17**.

Table 3.17 Identification of network operators and description.

ENTITY	DESCRIPTION
Centrales Eléctricas de Nariño S.A. E.S.P. (Cedenar)	High, medium and low voltage electricity networks. These networks carry electrical energy through the use of wiring supported by towers and poles.
Unión Temporal de Alumbrado Público de Ipiales (Utapi)	Public lighting networks that carry electrical energy through wiring supported by concrete poles.
Claro Comunicaciones S.A. E.S.P.	Mobile, landline, television and internet communication networks, using single-mode overhead and buried cables, single-mode optical fibers and thermoplastic tubes. The cables are supported by concrete poles (owned, or belonging to the Cedenar Company).
Colombia Telecomunicaciones S.A. E.S.P – Telefónica – Movistar Colombia	Communication networks via optical fibers supported by concrete poles belonging to the Cedenar Company, as well as owned poles.
Azteca Comunicaciones Colombia	Fiber optic networks supported by posts belonging to the Cedenar Company.
Empresa de Acueducto y Alcantarillado de la provincia de Obando - EmpoObando	Underground water supply networks using high-density pipes, 1" and 2" in diameter. Over ground networks using PVC and / or high-density pipes, 2" and 3" in diameter. Sanitary and rainwater sewerage networks, through concrete pipes with a diameter of 8" to 42" and box culverts made of reinforced concrete. Sewerage systems are more than 2.50 m deep.
Rural district water supply system for San Juan – municipality of Ipiales	Water supply networks attached to road sewers and/or at road junctions, over ground in several cases. 1" PVC pipes.
Rural district water supply system for Las Cruces – municipality of Ipiales	Water supply networks attached to road sewers and/or at road junctions, over ground in several cases. 1" PVC pipes.
Community Action Board for Pilcuán La Recta	Parallel water supply networks on the existing road, with 3", 4" and 6" diameter pipes. 1" diameter water supply networks, with high-density pipes. Sewerage networks with 8" concrete pipes.
Ecopetrol S.A.	Oleoducto Transandino – OTA for the transport of hydrocarbons, by means of pipes with a diameter of 16" and a depth of 1.0 m.

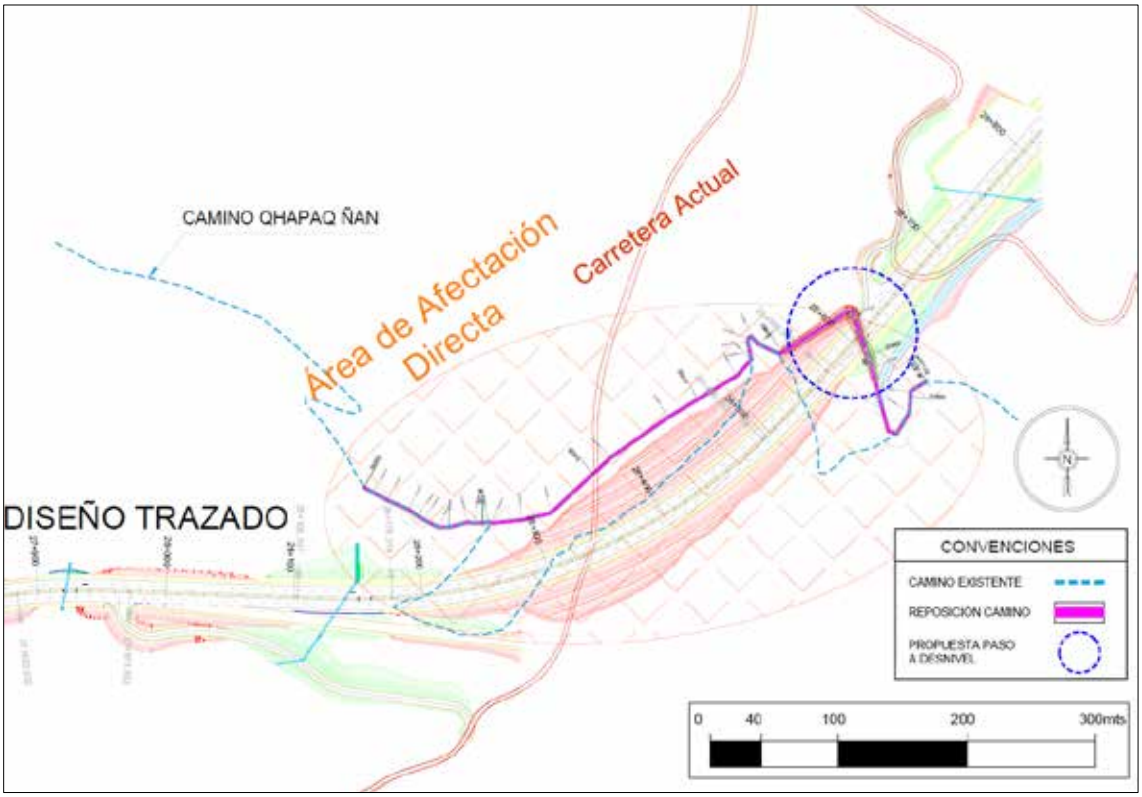
Source: Consorcio SH, 2017.

Section *3.2.3.3 Infrastructure and services affected by the project* of this chapter contains tables with the inventories and coordinates for the networks affected by the project. In addition, **Annex 2. Civil. IX. Networks** contains report **CSH-1-VD-G-G-W100-3_Networks inventory** and report **CSH-1-VD-G-G-W100-3_Networks Transfer Plan** for the Rumichaca – Pasto Divided Highway Project, San Juan – Pedregal Segment.

3.2.1.5 Urban, architectural, cultural or archaeological heritage.

The area of influence of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, comprises a historic road, i.e. section 8 of Qhapaq Ñam (Andean Road System - Inca Trail) in the rural district of San José de Quisnamues - Contadero. This road was declared as being of national importance to cultural heritage by Resolution 3317 of October 25, 2013, issued by the Ministry of Culture of the Republic of Colombia. **Figure 3.22** indicates the location of the road with respect to the project's layout.

Figure 3.22 Location of Section 8 of Qhapaq Ñam.



Source: Consorcio SH, 2017.

3.2.1.6 Protected areas.

In order to identify the presence of strategic ecosystems and/or protected areas in the road project's area of influence, the SIAC database was queried (information system for the National Environmental System (SINA)). This system is led by the Ministry of Environment and Sustainable Development in coordination with environmental research institutes (IDEAM, SINCHI, HUMBOLDT, IIAP and INVEMAR), the regional environmental authorities (Regional Autonomous Corporations and Sustainable Development Corporations), the academic community, the sectors and in general the various suppliers and users of environmental information. As a result of this query, it was found that the assessment area does not comprise any protected areas declared at national, regional or local levels (RUNAP area overlap query. SIG - SIAC).

3.2.1.7 Ethnic communities.

According to what is requested by Article 7, Law 1682 of November 22, 2013 regarding ethnic communities established as stipulated in Writ 948 of March 28, 2017 "by which an option is defined for the project known as "Divided Highway between the populated areas relating to San Juan and Pilcuán Viejo, as part of the Rumichaca - Pasto Divided Highway project," in the department of Nariño," the area of influence for the approved layout comprises: the Colonial Indigenous Reservation of San Juan, the Indigenous Area of Aldea de María, and the Indigenous Council of Iles. **Chapter 5. Section 5.3.5.3 Ethnic Communities** provides a specific description of the communities identified.

3.2.1.8 Mining rights.

Table 3.18 presents the list of mining rights for material sources nearby the area of influence of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment.

Table 3.18 Mineral rights for material sources nearby the project.

NAME OF MATERIAL SOURCE	LOCATION	ESTIMATED RESERVES (m^3)	ENVIRONMENTAL LICENSE	MINING RIGHTS	MATERIAL USES
Madeko - El Juncal	KP28+800	480,000	None reported	None reported	Granular bases and subbases
Capulí - Panavías	Iles	250,000	File No. 2201, Resolution 273 dated July 23, 2002	"Operating License No. 00342-52	Granular bases and subbases
Rosapamba Mine	KP34+400 Catambuco road	280,000	File LSC-014-10, Resolution 737 dated September 7, 2010	Resolution No. 004059 dated September 29, 2014 (Extension of Operating License)"	Granular bases and subbases
La Victoria Mine	Km 8 of Occidente Pasto road	2,942,730	File 163, Resolution 226 dated July 02, 1996	Concession Agreement for the exploration-operation of a deposit of construction materials No. JDB-14011	Granular bases and subbases, as well as concrete, asphalt aggregates
Mikel Mine	KP 38+000	225,000	File LSC-007-09, Resolution 964 dated November 23, 2009	Resolution No. GTRC-0105-09, extending Special Operating License No. 17271	Concrete, asphalt and hydraulic aggregates
Agresur	Rural district of El Porvenir, Municipality of Iles	180,000	File No. 2403, Resolution 981 dated December 28, 2006 (Contract with Panavias)	Concession Agreement for the exploration-operation of a deposit of construction materials No. EIM-142	Subbase and granular base
Panavias	Téllez River	150,000	File No. 2403, Resolution 981 dated December 28, 2006	Resolution 004059 dated September 29, 2014 (Extension of Operating License No. 00342-52) (Contract with Panavias)	Granular bases

Source: Consorcio SH, 2017.

3.2.2 Project phases and activities.

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, will comprise the phases and activities set out in **Table 3.19**.

Table 3.19 Project phases and activities.

PHASE	ACTIVITIES	DEFINITION
PRE-CONSTRUCTION	Introduction and information to the community and competent authorities	This consists of communicating the activities related to the project and the scope thereof, to the population that may be affected and to the authorities from the area of influence. It comprises the preparation of studies, as well as procedures with authorities for the permits required to implement the project.
	Land negotiation and easements	This consists of purchasing the areas where it will be necessary to establish infrastructure for the project (road layout, camps and Zodme), achieved through agreement with the owners and holders of the property, and clear mechanisms for commercial negotiation.
	Recruitment and training of personnel	The activity consists of hiring the professional, technical and operational personnel required to carry out all civil works and socio-environmental activities related to the implementation of the project. The hiring of skilled and unskilled labor will be based on the needs for each construction activity.
	Transport of construction materials, supplies, machinery, equipment and personnel	This involves the land transport of the elements necessary for the project's implementation: materials, supplies, machinery, equipment and personnel. It is carried out through the use of vans, trucks, dump trucks, low-bed trucks, all of which will travel over existing roads in the work area, taking the necessary measures to avoid accidents, and adhering to the provisions set out in current regulations.
CONSTRUCTION	Purchase of goods and services	This activity is considered preliminary, but it can also be carried out during other stages of the project. It consists of the purchase of goods and the procurement of services necessary to implement the project.
	Withdrawal of surface water	This consists of the use of water resources through the construction of the infrastructure needed for the collection and distribution of water for the project's various activities.
	Generation of solid waste by the project	Refers to the production of solid, domestic and hazardous waste during the project's various phases and activities.
	Generation of domestic and industrial liquid waste by the project	Refers to the production of liquid waste, such as domestic and industrial wastewater, during the different phases and activities carried out for the project.
	Removal of vegetation cover, clearing and cleaning	Comprises the removal of the layer of vegetation cover and cleaning of the corridor where the road will be built, as well as the right of way's lateral areas or strips. These areas are covered with stubble, weeds, crops, grasses, trees and forests, and this activity includes the removal of stumps, roots, debris and garbage, so that the right of way and the ground end up clean and free of vegetation cover, with the surface ready for the implementation of civil works. This activity also includes the removal of leftover material from the activity, taking it to Zones for the management of debris and excavation materials (Zodme).

PHASE	ACTIVITIES	DEFINITION
	Demolition and removal of existing infrastructure in the areas to be worked on	Demolition of structures located within the work corridor for the construction of the road, areas in which camps will be set up and areas where the Zones for the management of debris and excavation materials (Zodme) will be located.
	Earthworks (Excavation and Fills)	Comprises the set of activities for the excavation, scarification, leveling and compaction of the land on which the road must be formed or cemented. Includes the removal of leftover material from excavation, which will be taken to the Zodme.
	Setup and operation of camps	Comprises the setup and operation of work fronts and temporary or permanent camps, where sites for the collection and storage of construction and waste materials will be located, as will infrastructure for personnel accommodation and offices for the logistics and administration of civil works.
	Setup and operation of process plants (asphalt, concrete, crushing)	Relates to the construction and setup of infrastructure, equipment yards, crushing, concrete and mixing plants, and other infrastructure necessary for the logistics and administration of civil works. These areas will be home to activities for the management of solid and liquid waste, as well as the management of withdrawals and discharges.
	Operation and maintenance of machinery and/or equipment	The project requires the use of equipment and machinery for the implementation of civil works. It is necessary to carry out preventive and corrective maintenance in order to optimize the productivity of equipment and machinery, and to reduce the likelihood of impacts on the environment.
	Construction and operation of Zones for the management of debris and excavation materials	In order to manage leftover materials resulting from the clearing and cleaning activities and earthworks, Zones for the management of debris and excavation materials (Zodme) will be established. The management of these areas involves the loading and transport of leftover material, the controlled disposal of leftover material (in layers), the establishment of terraces and slopes, the compaction of materials, the management of runoff water, and revegetation.
	Preparation of the sub-base, base and granular base	Consists of the supply, preparation, grading and compaction of stone material (river material, granular rock material, etc.) on the ground (subsequent to clearing, cleaning and earthworks) through the use of equipment and machinery such as backhoes, loaders, bulldozers, motor graders, vibro-compactors, etc.
	Preparation of the surface course	Consists of the transport, spreading and compaction of bituminous products and asphalt mixtures that form the road's surface course.
	Foundations and pier work for bridges and viaducts	These structures are made of reinforced concrete and include the construction of foundation structures in terms of abutments, piles, piers, blocks, footings, flanges and columns that serve as support for the superstructures of bridges and viaducts.
	Construction of superstructures for bridges and viaducts	Comprises the concrete and steel construction of the upper part of bridges and viaducts. These structures are composed of beams, struts, trusses, boards, slabs, tension cables, curbs, platforms and railings, among others.
	Construction of hydraulic works (including channel use)	Consists of the construction of works (generally using concrete) for the management of runoff waters and water body crossings (streams and rivers): pipe drains, box culverts, gutters, energy dissipaters, sub-drains and drains. This is in order to guarantee the natural flow of the water.

PHASE	ACTIVITIES	DEFINITION
	Slope treatment	In order to mitigate and prevent slope instability and erosion, geotechnical and hydraulic protection works will be carried out on such slopes. These works start with slope profiling (slope ratio), the protection of the slope face by means of establishing vegetation cover, barriers, bio-matting, the construction of interceptor ditches, fences, gabions, bolting and retaining walls, among others.
	Grass laying and vegetation restoration	Consists of establishing grasses, seeds or bio-matting in the areas of the project that require revegetation, i.e. slopes, Zodme and abandoned areas, etc.
	Toll installation	Collection Booths and Toll Offices were designed for long-term operation at a low maintenance cost. The Office building is strategically located to support the roof of the Collection Booth, and in this way create a specific design for the environment, being aesthetically pleasing in terms of appearance and use. It is located at PR 11 + 100.
ABANDONMENT AND FINAL RESTORATION	Dismantling temporary facilities and camps	Involves the dismantling and removal of infrastructure relating to the camps, crushing, concrete and asphalt mixing plants, and other areas used for the project's implementation.
	Final cleaning of the areas worked on	At the end of construction activities, the construction company must remove the construction equipment, leftover material, debris and temporary works from the area, leaving the area in a suitably clean state.
	Landscape Management	Visual improvements to the areas worked on, through the implementation of works that integrate the road infrastructure with the environment. These activities are generally carried out through the use of native vegetation.

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.3 Project design.

Below are the technical characteristics of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. The specific designs are set out in **Annex 2. Civil. I. Traffic. II. Layout. III. Geology. IV. Foundations. V. Slopes. VI. Paving. VII. Drainage. VIII. Structures. X. Urban Planning**.

3.2.3.1 Layout and geometric characteristics of the roads to be built as part of the project.

3.2.3.1.1 Classification of the highway.

· **According to its functionality.**

According to the criteria defined by the INVIAS Geometric Design Manual, as a result of its functionality, the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment relates to a Primary road with two roadways.

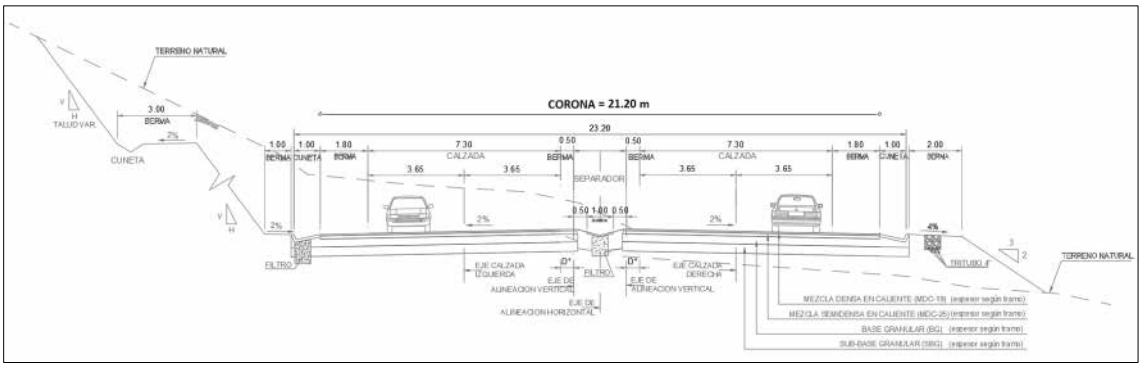
· **According to its topography.**

According to the criteria defined by the INVIAS Geometric Design Manual, the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment is a road whose topographic conditions relate to mountainous terrain.

3.2.3.1.2 Components.

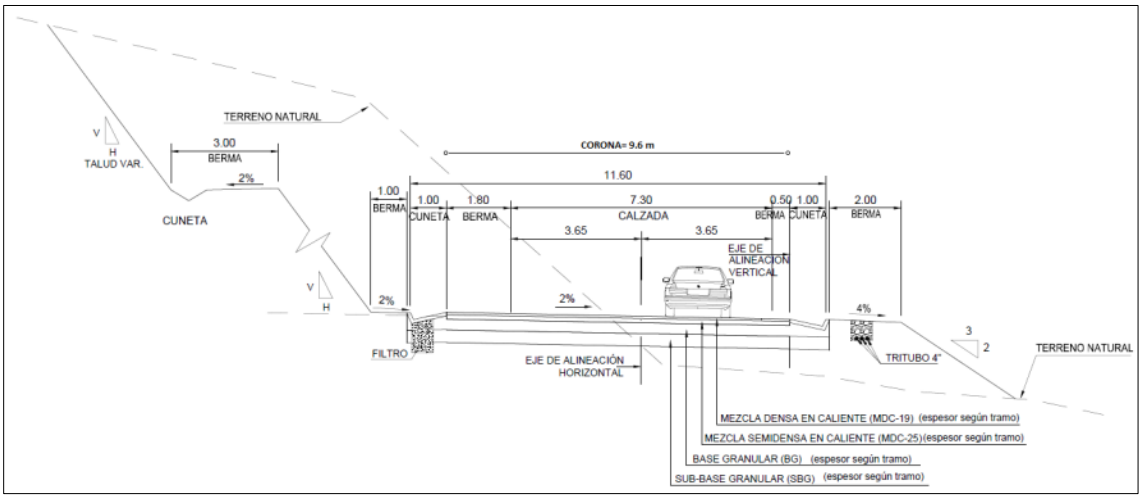
The following is a description of the characteristics reflected by the road's components, as shown in **Figure 3.23** and **Figure 3.23**.

Figure 3.23 Divided highway section – parallel roadways.



Source: Consorcio SH, 2017.

Figure 3.24 Road width – separated roadways.



Source: Consorcio SH, 2017.

As shown in **Figure 3.24,** the road's layout includes areas in which the roadways are separated:

- Bypass planned for the populated area of the district of Pilcuán La Recta, in the municipality of Imués. The existing road (Rumichaca - Pasto) is located in the northern area, while the construction of the bypass is planned for the southern area of the Pilcuán La Recta village (see **Figure 3.25**).

Figure 3.25 Roadways separated by the Pilcuán bypass.

Source: Consorcio SH, 2017.

- **Width of right-of-way area.**

Law 1228 of 2008, Article 2, issued by the Congress of Colombia, governs the minimum compulsory withdrawal or exclusion areas for roads. According to this standard, there are several rights of way depending on their configuration, as follows:

- For areas with a median strip and parallel roadways, it will be a minimum of 50.30 m, up to where the chamfer line extends.
- For areas with separated roadways, it will relate to that of a primary road consisting of a single roadway, i.e. at least 60 m for each roadway or as far as the chamfer line extends.

- **Road width.**

The road width for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment in the divided highway section with a median strip (parallel roadways), is 21.20 m. On the other hand, regarding the divided highway section with separated roadways, the road width for each roadway will be 9.6 m.

· **Roadway.**

The roadways for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, will be 7.30 m wide each.

· **Berms.**

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, will have internal berms that are 0.50 m wide and external berms that are 1.80 m wide.

· **Ditches.**

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, will have the following types of ditch:

Side ditches: Triangular cross-section, 1.0 m wide, 0.20 m deep, forming its slopes at an angle of 90°. These will be made with a concrete coating 10 cm thick and reinforced with electro-welded mesh, founded on a layer of granular material and with expansion joints every 2 or 3 m (at the discretion of the construction company).

Median ditch: Located in the roadways' median strip, triangular cross-section, symmetrical, 1.0 m wide, 0.125 m deep, forming its slopes at an angle of 152 °. These will be made with a concrete coating 10 cm thick and reinforced with electro mesh - welded, founded on a layer of granular material, and with expansion joints every 2 or 3 m (at the discretion of the construction company).

Interceptor ditch: These will be located at the foot of the embankment and at the top of the cut, will have a minimum rectangular cross-section of a 0.40 m at the base, and a height of 0.50 m.

Depending on the area that feeds into the interceptor ditches, a series of dimensions has been defined, with sufficient capacity to transport the flow. As a result, interceptor ditches of the following dimensions have been defined:

- Interceptor ditch, rectangular cross-section, base 0.40 m and height 0.50 m (minimum dimension of the interceptor ditch).
- Interceptor ditch, rectangular cross-section, base 0.60 m and height 0.50m.
- Interceptor ditch, trapezoidal cross-section, base 0.60 m, height 0.50m and slope 3H/2V.
- Interceptor ditch, trapezoidal cross-section, base 0.40 m, height 0.50m and slope 1H/1V.
- Interceptor ditch, trapezoidal cross-section, base 0.60 m, height 0.50m and slope 1H/1V.
- Interceptor ditch, trapezoidal cross-section, base 1.0 m, height 0.50 m and slope 3H/2V.

All interceptor ditches shall be covered (covered with 10 cm of concrete and electro-welded mesh), founded on a layer of granular material, and with expansion joints every 2 or 3 m (at the discretion of the construction company). There will be at least 2.0 m of separation between the foot of the embankment slope or the top of the cut slope, and the edge of the interceptor ditch.

Berm gutters: Symmetrical triangular cross-section, 1.0 m wide, 3.0 m deep, coated in concrete.

Channel gutter in access: Symmetrical triangular cross-section, 1.90 m wide, 0.20 m deep, coated in concrete, reinforced with electro-welded mesh, and founded on a layer of granular material.

Gutter pipe: Reinforced concrete pipe 400 mm in diameter.

The information on the designs for this infrastructure is provided in **Annex 2. Civil. VII. Drainage.** It is worth clarifying that these structures will be distributed throughout the project as set out in **Annex 2. Civil. VII. Drainage. Plans CSH-1-DI07-OD-G-G-0001-A, CSH-2-DI07-OD-G-G-0001-A and CSH-3-DI07-OD-G-G-0001-A**.

· **Planned slopes in cuts and embankments.**

In accordance with the characteristics found in the layout for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, the specifications and treatment of cut slopes (by section) were defined as set out in **Table 3.20**. In addition, **Annex 2. Civil. V. Slopes** sets out their design specifications.

Table 3.20 Characteristics by excavation slope sections.

SIDE	CHAINAGE		EXCAVATION SLOPE	TREATMENT
	KP START	KP END		
LS	15+750	16+390	1H:3V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m
LS	16+430	16+700	1H:3V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m Slope mesh between KP16+520-KP16+650
LS	17+040	17+720	1H:2V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m Drains between KP17+590- KP17+670
LS	17+800	18+400	1H:2V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m
LS	19+450	20+880	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m
LS	21+000	22+540	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m Drains between KP21+080- KP21+650
LS	22+580	25+180	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m
LS	25+220	25+600	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m Drains between KP25+300- KP25+560
RS	17+000	18+380	1H:2V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m
RS	19+460	25+600	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m
-	25+600	29+640	Up to 20.00 m high: 3H:4V Heights greater than 20.00 m: Lower berm 1H:2V Rest at 3H:4V	Berms 3.00 m wide every 12.00 m in height at 3H:4V and every 15.00 m at 1H:2V
-	29+740	29+960	3H:4V	Berms 3.00 m wide every 12.00 m

SIDE	CHAINAGE		EXCAVATION SLOPE	TREATMENT
	KP START	KP END		
-	30+010	30+200	3H:4V	Berms 3.00 m wide every 12.00 m Drains in lower berm
-	30+400	31+280	Up to 20.00 m high: 3H:4V Heights greater than 20.00 m: Lower berm 1H:2V Rest at 3H:4V	Berms 3.00 m wide every 12.00 m in height at 3H/4V and every 15.00 m at 1H/2V Drains in lower berm
-	31+340	31+920	Up to 20.00 m high: 3H:4V Heights greater than 20.00 m: Lower berm and following: 1H:2V Rest at 3H:4V	Berms 3.00 m wide every 12.00 m in height at 3H: and every 15.00 m at 1H:2V
-	32+070	32+700	1H:2V Re-excavation 10.00 m above 3H:4V	Berms 3.00 m wide every 15.00 m in height Drains in lower berm and following
-	32+700	33+050	1H:2V	Berms 3.00 m wide every 15.00 m in height Drains in lower berm and following
-	33+300	33+940	1H:3V Re-excavation 15.00 m above 3H:4V	Berms 1.00 m wide at 15.00 m in height KP 33+360 a 33+410: Area slope mesh 1H:3V. KP 33+610 a 33+720: Area slope mesh 1H:3V.
-	34+030	34+460	1H:3V Re-excavation 20.00 m above 3H:4V	Berms 1.00 m wide every 15.00 m in height at 1H:3V KP 34+070 to 34+100: Area slope mesh 1H:3V. KP 34+130 to 34+200: Area slope mesh 1H:3V. KP 34+280 to 34+390: Area slope mesh 1H:3V. KP 34+390 a 34+490: Triple-twist mesh reinforced with wire grid
-	34+460	34+570	1H:3V	Berms 1.00 m wide every 15.00 m in height at 1H:3V 34+490 a 34+540: Area slope mesh 1H:3V.
-	34+590	35+620	2 Lower berms 1H:3V, Rest 1H:2V	Berms 1.00 m wide every 15.00 m in height at 1H:3V Berms 3.00 m wide every 15.00 m in height en 1H:2V From KP 34+600 a 34+690: Area slope mesh 1H:3V. From KP 34+750 a 34+880: Area slope mesh 1H:3V. From KP 34+940 a 35+150: Area slope mesh 1H:3V. From KP 35+200 a 35+620: Area slope mesh 1H:3V.
-	35+620	35+980	2 Lower berms: 1H:3V Rest 1H:2V	Berms 1.00 m wide every 15.00 m in height at 1H:3V Berms 3.00 m wide every 15.00 m in height en 1H:2V KP 35+620 a 35+710: Area slope mesh 1H:3V KP 35+810 a 35+930: Area slope mesh 1H:3V
-	36+020	36+180	1H:3V	1.00 m berms every 15.00 m in height KP 36+030 a 36+110: Triple-twist mesh reinforced with wire grid. KP 36+110 a 36+130: slope mesh
-	36+300	36+980	1H:2V	Berms 3.00 m wide every 15.00 m in height
-	37+020	37+350	1H:3V	Berms 1.00 m wide every 15.00 m in height KP 37+140 a 37+200: Area slope mesh 1H:3V KP 37+200 a 37+280: Triple-twist mesh reinforced with wire grid. KP 37+280 a 37+330: Area slope mesh 1H:3V
-	37+530	37+600	2 Lower berms: 1H:2V Rest 3H:4V	Berms 3.00 m wide every 15.00 m in height at 1H:2V Berms 3.00 m wide every 12.00 m in height at 3H:4V Drains throughout the slope

SIDE	CHAINAGE		EXCAVATION SLOPE	TREATMENT
	KP START	KP END		
-	37+700	37+945	2 Lower berms: 1H:2V Rest 3H:4V	Berms 3.00 m wide every 15.00 m in height at 1H:2V Berms 3.00 m wide every 12.00 m in height at 3H:4V Drains throughout the slope
-	38+320	38+780	1H:2V	Berms 3.00 m wide every 15.00 m in height Drains in lower berm
-	38+980	39+820	1H:2V	Berms 3.00 m wide every 15.00 m in height
-	39+880	40+140	3H:4V	Berms 3.00 m wide every 12.00 m in height Drains throughout the slope
-	40+230	40+320	3H:4V	Berms 3.00 m wide every 12.00 m in height
-	41+200	42+020	RS: Lower berm 1H:3V, rest 3H:4V LD: 3H:4V	RS: Lower berm 1.00 m wide at 15.00 m in height, rest Berms 3.00 m wide every 12.00 m in height LS: Berms 3.00 m wide every 12.00 m in height Drains between KP 41+600 and 42+100
-	42+250	43+560	From KP 42+250 to 43+000: 3H:4V From KP 43+000 to 43+560: 10.00 m above 1H:2V and rest 1H:3V	KP 42+250 to 43+000: Berms 3.00 m wide every 12.00 m in height KP 43+000 to 43+560: Berm 1.00 m wide every 15.00 m in height. KP 43+210 to 43+230: Triple-twist mesh reinforced with wire grid. KP 43+230 to 43+270: Slope mesh KP 43+450 to 43+490: Slope mesh on LS KP 43+490 to 43+540: Triple-twist mesh reinforced with wire grid on LS KP 43+450 to 43+490: Triple-twist mesh reinforced with wire grid on RS Drains throughout the slope between KP. 42+280 and 42+580 Specific drainage where water emerges between KP. 43+140 and 43+560
-	43+880	44+360	Lower berm 1H:3V, rest 1H:2V	1.00 m berm at 15.00 m in height at 1H:3V Berms 3.00 m wide every 15.00 m in height at 1H:2V Specific drainage where water emerges
-	44+660	44+840	10.00 m above 1H:2V and rest 1H:3V	1.00 m berm every 15.00 m in height

Source: Consorcio SH, 2017.

On the other hand, regarding fill slopes, the treatments and specifications are set out in **Table 3.21,** while **Annex 2. Civil. V. Slopes** provides their specific designs.

Table 3.21 Characteristics by fill slope sections.

CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
15+980	15+990	3H:2V	Stepped slope
16+470	16+500	3H:2V	Concrete Wall
16+720	16+830	3H:2V	RS. Flexible wall, 110 m in length and 14.35 m in height
17+060	17+120	3H:2V	RS. Flexible wall, 60 m in length and 12.02 m in height
17+120	17+155	3H:2V	RS. Flexible wall, 35 m in length and 6.42 m in height
17+260	17+335	-	Concrete Wall - Between roadways

CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
17+460	17+570	3H:2V	RS. Flexible wall,110 m in length and 13.63 m in height
17+570	17+580	3H:2V	RS. Flexible wall, 10 m in length and 4.09 m in height
17+650	17+820	3H:2V	Fill carried out with suitable or selected soil Stepped slope
17+650	17+820	3H:2V	Fill carried out with suitable or selected soil Stepped slope
17+820	17+880	-	Concrete Wall - Upper plastering
17+970	17+980	3H:2V	Concrete Wall
18+100	18+180	3H:2V	Scaling 2.5 m
18+380	18+420	3H:2V	Scaling 2.5 m
18+420	18+610	3H:2V	Suitable or selected soil for the top 30 meters and rockfill for the rest Stepped slope
18+610	18+690	3H:2V	Scaling 2.5m
18+960	18+970	-	Concrete Wall - Upper plastering
19+000	19+460	3H:2V	Scaling 4 m Bottom compaction Anti-pollution geotextile at bottom of scaling
20+840	21+050	3H:2V	Scaling of the entire fill 2-3 m
22+100	23+500	3H:2V	Stepped slope
23+550	23+710	3H:2V	Fill carried out with suitable or selected soil Stepped slope
24+020	24+240	3H:2V	Scaling of the entire fill 2-3 m Stepped slope
24+240	24+360	3H:2V	Fill carried out with suitable or selected soil
24+360	24+460	3H:2V	Scaling of the entire fill 2-3 m
24+802	24+812	-	Concrete Wall - Upper plastering
24+812	24+840	3H:2V	Scaling of the entire fill 2-3 m
24+840	25+220	3H:2V	Stepped slope
25+220	25+265	3H:2V	Scaling of the entire fill 2-3 m
25+280	25+285	-	Concrete Wall - Upper plastering
25+820	25+860	3H:2V	Fill carried out with suitable or selected soil Stepped Scaling 2.5 meters Settlement control. Minimum waiting period 3 months
26+000	26+210	3H:2V	Fill carried out with suitable or selected soil Stepped Settlement control. Minimum waiting period 3 months
26+600	26+780	3H:2V	Scaling 2.5 meters Replacement and foundation of the fill with selected soil or rockfill Settlement control. Minimum waiting period 3 months
27+560	27+710	3H:2V	KP 27+640 to 27+700: Stepped
27+740	27+820	3H:2V	KP 27+740 to 27+780: Stepped KP 27+800 to 27+820: Stepped
27+900	27+950	3H:2V	KP 27+940 to 27+950: Stepped
28+070	28+220	3H:2V	Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control

CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
28+580	28+980	3H:2V	KP 28+580 to 28+640: Stepped KP 28+780 to 28+970: Stepped Scaling 2.5 m Replacement and foundation of the fill with selected soil or rockfill Settlement control
29+020	29+180	3H:2V	Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control
29+360	29+540	3H:2V	Fill carried out with suitable or selected soil KP 29+400 to 29+510: Stepped
29+630	29+740	3H:2V	Fill carried out with suitable or selected soil
29+800	29+880	3H:2V	Fill carried out with suitable or selected soil Scaling 3.0 metros Replacement and foundation of the fill with selected soil or rockfill Settlement control. Minimum waiting period 3 months
29+940	30+010	3H:2V	Fill carried out with suitable or selected soil
30+200	30+420	3H:2V	Fill carried out with suitable or selected soil Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control
30+520	30+580	3H:2V	Stepped
31+280	31+600	3H:2V	Fill carried out with suitable or selected soil KP 31+340 to 31+420: Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control
32+070	33+470	3H:2V	Stepped
33+520	33+940	3H:2V	KP 33+520 to 33+530: Stepped KP 33+690 to 33+700: Stepped KP 33+920 to 33+940: Stepped
34+027	34+620	3H:2V	-
34+690	34+780	3H:2V	KP 34+690 to 34+700: Stepped KP 34+770 to 34+780: Stepped
34+924	37+349	3H:2V	-
37+940	37+945	3H:2V	From KP 37+940 to 37+945 (RS): Reinforced Earth Wall
38+280	38+330	3H:2V	Stepped
38+540	38+780	3H:2V	From KP 38+615 a 38+677: Stepped From KP 38+548 a 38+615 (RS): Reinforced Earth Wall From KP 38+677 a 38+781 (RS): Reinforced Earth Wall
39+010	39+540	3H:2V	From KP 39+006 a 39+040 (RS): Reinforced Earth Wall From KP 39+340 a 39+521 (RS): Reinforced Earth Wall
39+740	39+890	3H:2V	Scaling 3 meters Settlement control From KP 39+740 to 39+820: Stepped Upper part of the fill, up to 30 meters, with improved and selected soil, and the rest with rockfill
40+140	40+280	3H:2V	Fill carried out with suitable or selected soil Stepped

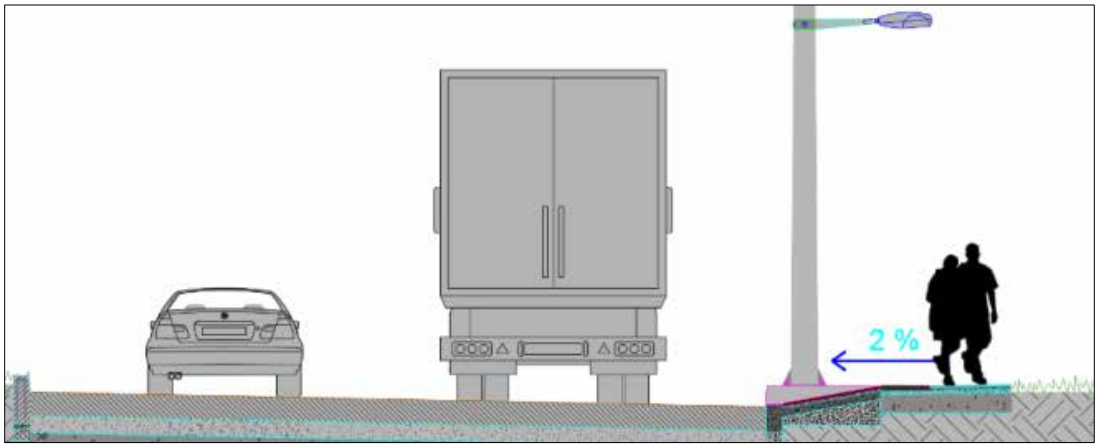
CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
40+300	41+220	3H:2V	Scaling 3 meters. Replacement and foundation of the fill with rockfill Settlement control From KP 40+340 to 40+410 and 41+170 to 41+220: Stepped Upper part of the fill, up to 30 meters, with improved and selected soil, and the rest with rockfill
42+020	42+060	3H:2V	Fill carried out with suitable or selected soil Stepped
42+260	42+430	3H:2V	Scaling 2 meters From KP 42+257 to 42+287: Reinforced Earth Wall
42+450	42+550	3H:2V	From KP 42+447 to 42+540 (RS): Reinforced Earth Wall KP 42+540 to 42+632 (RS): Concrete Wall
42+560	42+610	3H:2V	Stepped
42+880	42+970	3H:2V	From KP 42+870 to 42+966 (RS): Concrete Wall
43+060	43+131	3H:2V	From KP 43+058 to 43+060(RS): Concrete Wall From KP 43+077 to 43+136 (RS): Concrete Wall
42+930	43+390	3H:2V	From KP 43+340 to 43+370 (RS): Reinforced Earth Wall
43+550	43+910	3H:2V	From KP 43+648 to 43+910: Stepped From KP 43+560 to 43+701 (RS): Reinforced Earth Wall
43+950	44+020	3H:2V	From KP 43+950 to 44+003: Stepped From KP 44+044 to 44+060 (RS): Concrete Wall
44+330	45+130	3H:2V	From KP 44+408 to 44+620 (RS): Reinforced Earth Wall From KP 44+620 to 44+698 (RS): Concrete Wall

Source: Consorcio SH, 2017.

- **Pedestrian sidewalks and footpaths.**

In urban areas with a large population, at intersections and in certain road replacements, sidewalks will be established to promote the safety of pedestrians when traveling, as shown in **Figure 3.26**.

Figure 3.26 Sidewalks in road access areas.

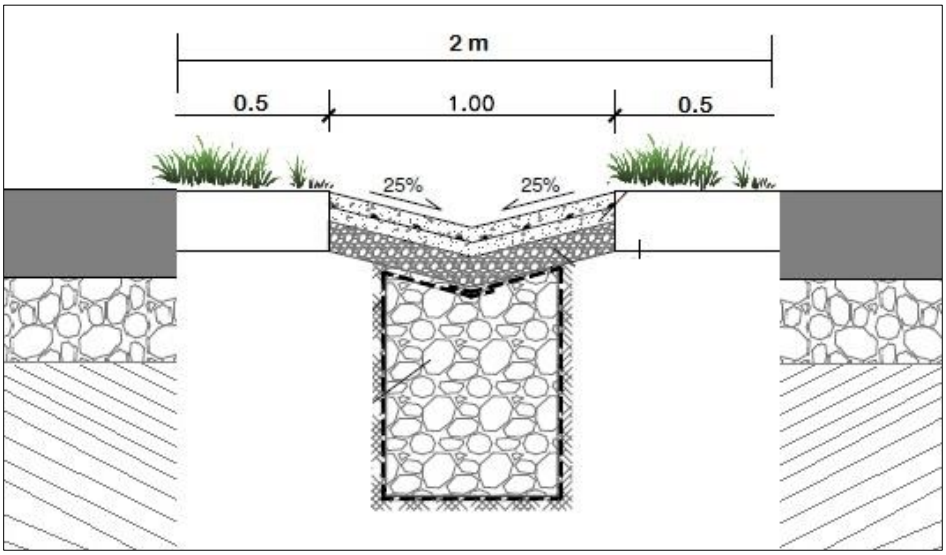


Source: Consorcio SH, 2017.

· **Median strips.**

For road sections in which the roadways are parallel, a 2.0 m wide median strip shall be constructed, with a 1.0 m wide central ditch, 0.15 m deep, covered with 0.10 m of concrete and a drainage filter beneath it, as shown in **Figure 3.27**.

Figure 3.27 Typical median strip in a road section with parallel roadways.



Source: Consorcio SH, 2017.

· **Chamfer line**

The chamfer line for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment is variable, reaching up to 110 m in areas where high cuts are anticipated. **Annex 2. Civil. II. Layout. Plans CSH-1-PL-G-G-2105-6_LAYOUT PLAN VIEW_CD**, **CSH-1-PL-G-G-2105-6_LAYOUT PLAN VIEW_CI**, **CSH-2-PL-G-G-2105-2_ LAYOUT PLAN VIEW** and **CSH-3-PL-G-G-2105-4_ LAYOUT PLAN VIEW** set out the information regarding the chamfer line.

3.2.3.1.3 Project transportation infrastructure.

· **Roads.**

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, will consist of three sections: the first from KP15 + 750 to KP17 + 000 (1.25 km), in which a second roadway will be built parallel to the existing one, while the existing roadway will be improved. The second section will relate to the construction of a flexible pavement structure for a new divided highway section from KP17 + 000 to KP41 + 992 (24.99

km), and the third section will relate to the construction of a second roadway parallel to the existing road, while also improving the existing road, and this will be carried out from KP41 + 992 to KP44 + 844 (2.85 km). The total length of the project will be 29.09 km and its design parameters are set out in **Table 3.22**, **Table 3.23** and **Table 3.24**.

Table 3.22 Project design parameters.

DESCRIPTION	PARAMETERS	UNIT
Type of road	Primary	-
Type of terrain	Steep	-
Design speed	60	km/h
Width of roadways	9.60	m
Number of lanes per roadway	2	Un
Width of lanes	3.65	m
External berm width	1.80	m
Internal berm width	0.50	m
Normal roadway pumping	2%	%
Minimum radius	113	m
Maximum banking	8	%
Minimum gradient	0.5	%
Maximum gradient	9	%
Stopping visibility distance	75	m
Minimum length of vertical curve	36	m

Source: Consorcio SH, 2017.

Table 3.23 Design parameters for interchanges and connections.

DESCRIPTION	PARAMETERS	UNIT
Type of road	Secondary	-
Type of terrain	Steep	-
Design speed	25-35	km/h
Width of roadways	5.95-9.00	m
Number of lanes per roadway	1	Un
Width of lanes	3.65-6.20	m
External berm width	1,80	m
Internal berm width	0.5-1.0	m
Normal roadway pumping	2%	%
Minimum radius	15	m

DESCRIPTION	PARAMETERS	UNIT
Maximum banking	6 %	%
Minimum gradient	0.5%	%
Maximum gradient	10 %	%
Stopping visibility distance	29	m
Minimum length of vertical curve	20	m

Source: Consorcio SH, 2017.

Table 3.24 Design parameters for turnarounds.

DESCRIPTION	PARAMETERS	UNIT
Type of road	Primary	-
Type of terrain	Steep	-
Design speed	30	km/h
Width of roadways	5,95-7,75	m
Number of lanes per roadway	1	Un
Width of lanes	3,65-5,45	m
External berm width	1.80	m
Internal berm width	0.5	m
Normal roadway pumping	2%	%
Minimum radius	18	m
Maximum banking	8%	%
Minimum gradient	0.5%	%
Maximum gradient	12 %	%
Stopping visibility distance	29	m
Minimum length of vertical curve	20	m

Source: Consorcio SH, 2017.

- **Tunnels.**

The activities relating to the Rumichaca - Pasto Divided Highway Project, San Juan Pedregal Segment, do not comprise the construction of tunnels in its layout.

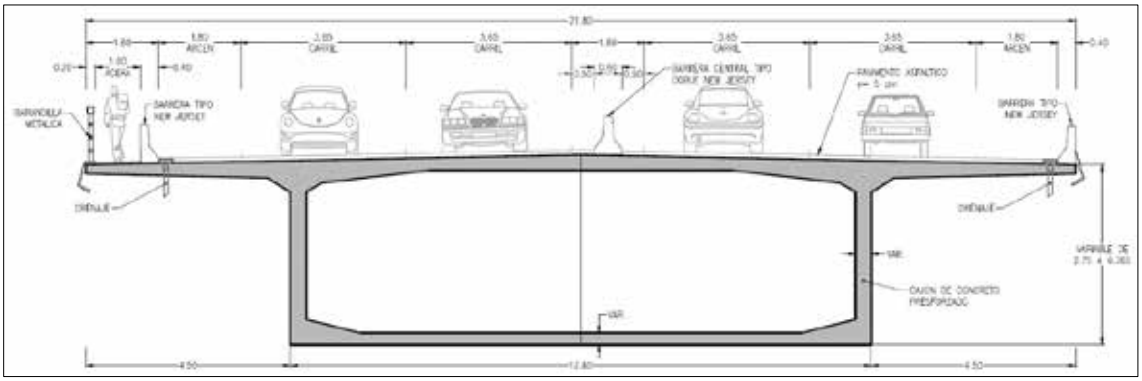
- **Bridges.**

Five (5) bridges will be built for the Rumichaca - Pasto Divided Highway Project, San Juan Pedregal Segment. The following is a general description of each of these structures. Their specific design is set out in **Annex 2. Civil. VIII. Structures**:

o Boquerón Bridge.

It will be located between chainage KP18 + 700 and KP18 + 960, and will be 260 m long, in order to cross the river of the same name. The platform will have a constant longitudinal slope of 4.17%, a total width of 21.80 m, which includes two vehicular roadways (one per direction), a 1.80 m external berm and 0.50 m internal berm, a New Jersey median strip 0.60 m wide, two New Jersey traffic barriers 0.40 m wide, a pedestrian sidewalk 1.0 m wide together with its respective railing, a progressive cantilever construction method, with single-cell concrete segments with variable heights between 2.75 m and 6.37 m, and vertical webs (see **Figure 3.28**).

Figure 3.28 Typical cross section of the Boquerón Bridge

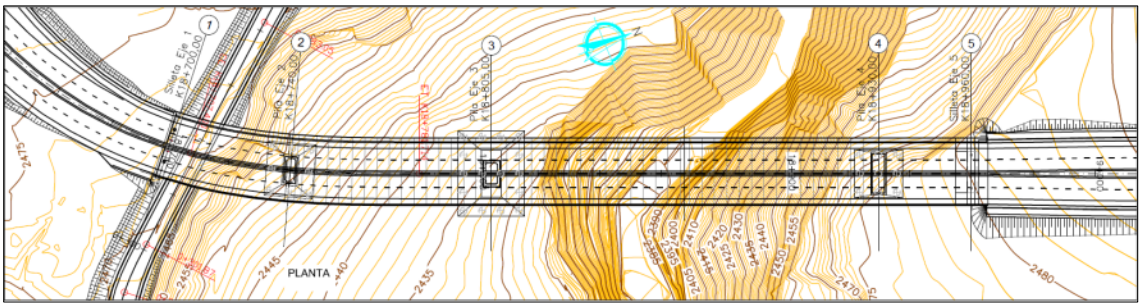


Source: Consorcio SH, 2017.

The bridge will have five (5) supports, two of them relating to outside centerlines No. 1 and No. 5 (abutments) and three intermediate centerlines in which piers will be placed, also made of reinforced concrete, all outside the channel of the river.

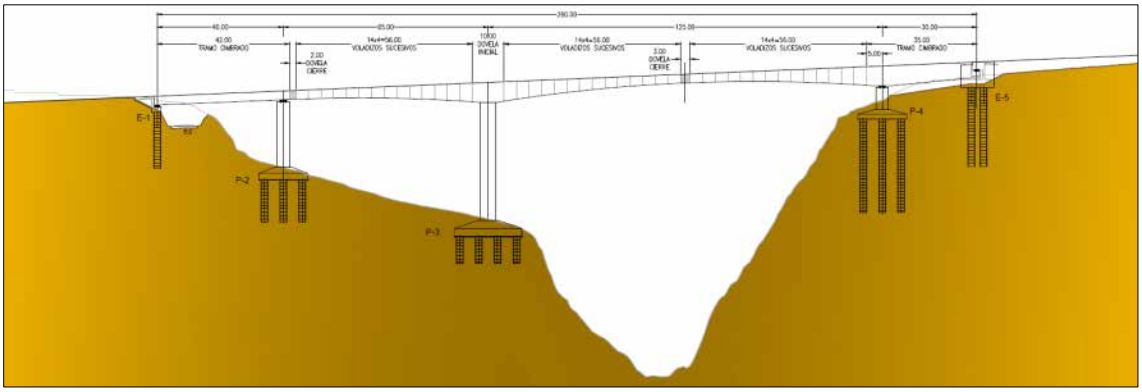
The main section, between centerlines No. 2 and No. 5, to be built using the progressive cantilever method, will have a total length of 220 m. Of this length, 125 m will relate to the main span (centerlines No. 3 to No. 4), while the lateral spans exhibit asymmetry, with the right-side (south) cantilever measuring 65 m, and 35 m on the left side (north), as shown in **Figure 3.29** and **Figure 3.29**.

Figure 3.29 Plan view of the Boquerón Bridge.



Source: Consorcio SH, 2017.

Figure 3.30 Boquerón Bridge Elevation.

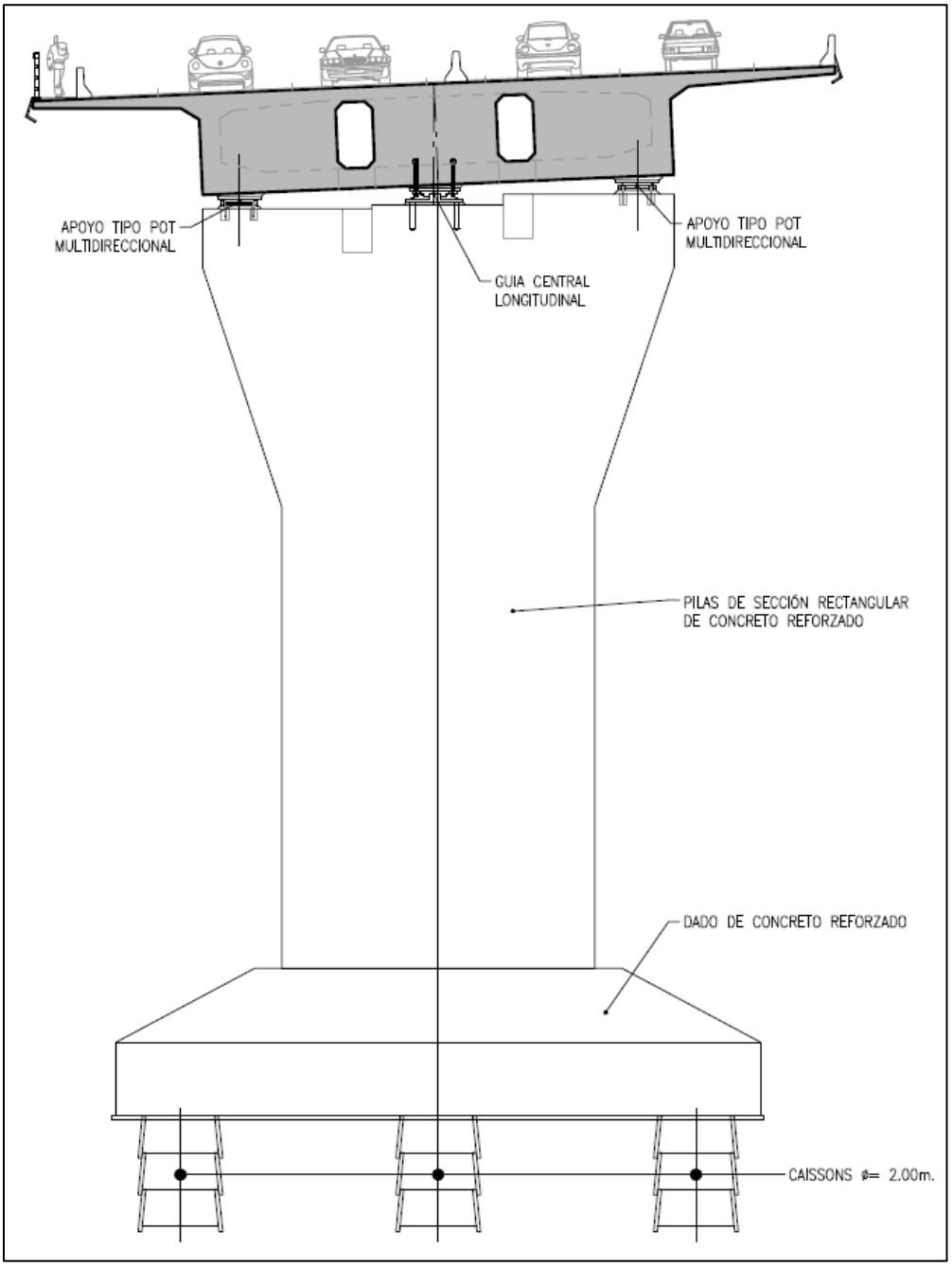


Source: Consorcio SH, 2017.

§ **Piers**

For bridge supports No. 2, No. 3 and No. 4, the plan is construct reinforced concrete hollow-section piers, on which the superstructure will be supported by means of POT devices, as shown in **Figure 3.31**. With regard to the piers relating to supports No. 2 and No. 3, they will start with a width of 8.50 m and then expand to 12.80 m, which is the same lower width as the platform's segments.

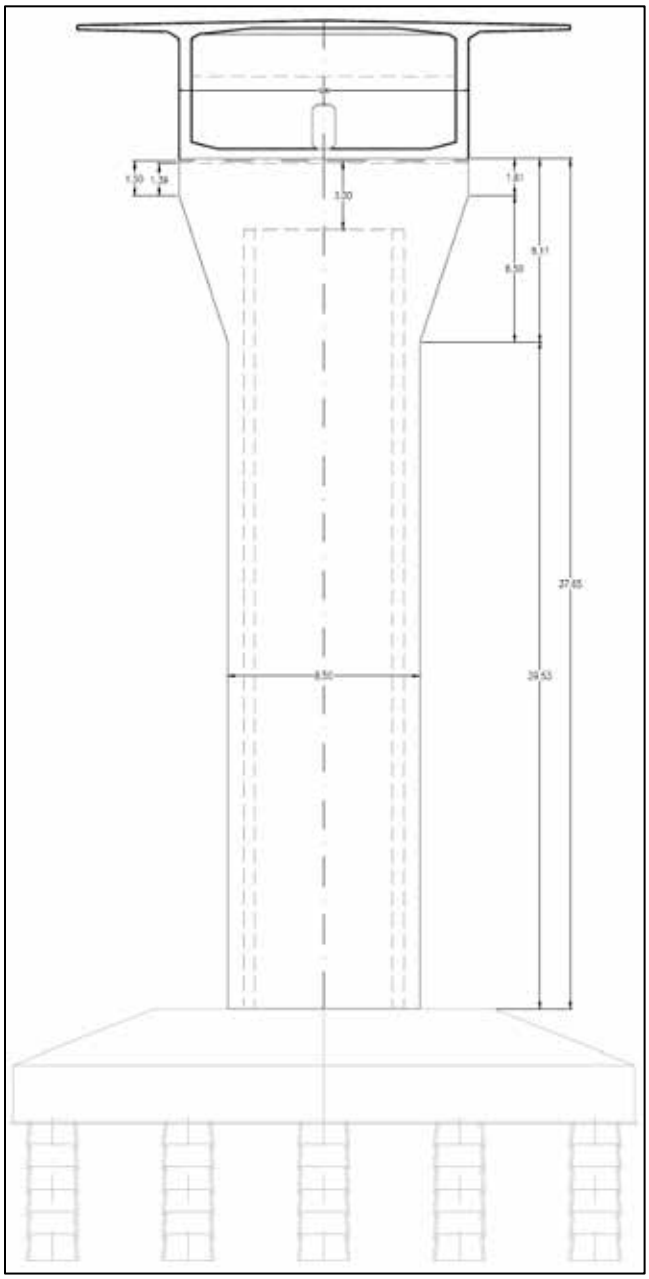
Figure 3.31 General configuration of the substructure for support 2 Boquerón Bridge.



Source: Consorcio SH, 2017.

The section walls will be 50 cm thick in the case of the column relating to centerline No. 2, and 80 cm in the case of the column relating to centerline No. 3, as presented in **Figure 3.32**.

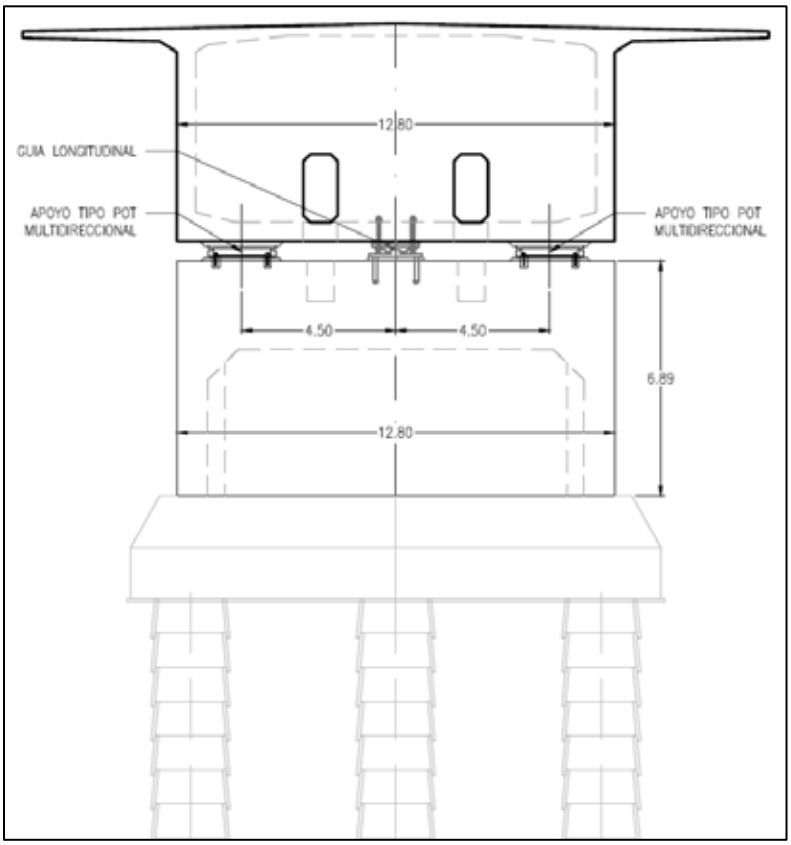
Figure 3.32 General configuration of the substructure for support 3 Boquerón Bridge.



Source: Consorcio SH, 2017.

Due to its small height, the support for centerline No. 4 will have a constant hollow rectangular section of 12.80 m, as shown in **Figure 3.33**. The section walls will be 50 cm thick.

Figure 3.33 General configuration of the substructure for support 4 Boquerón Bridge.



Source: Consorcio SH, 2017.

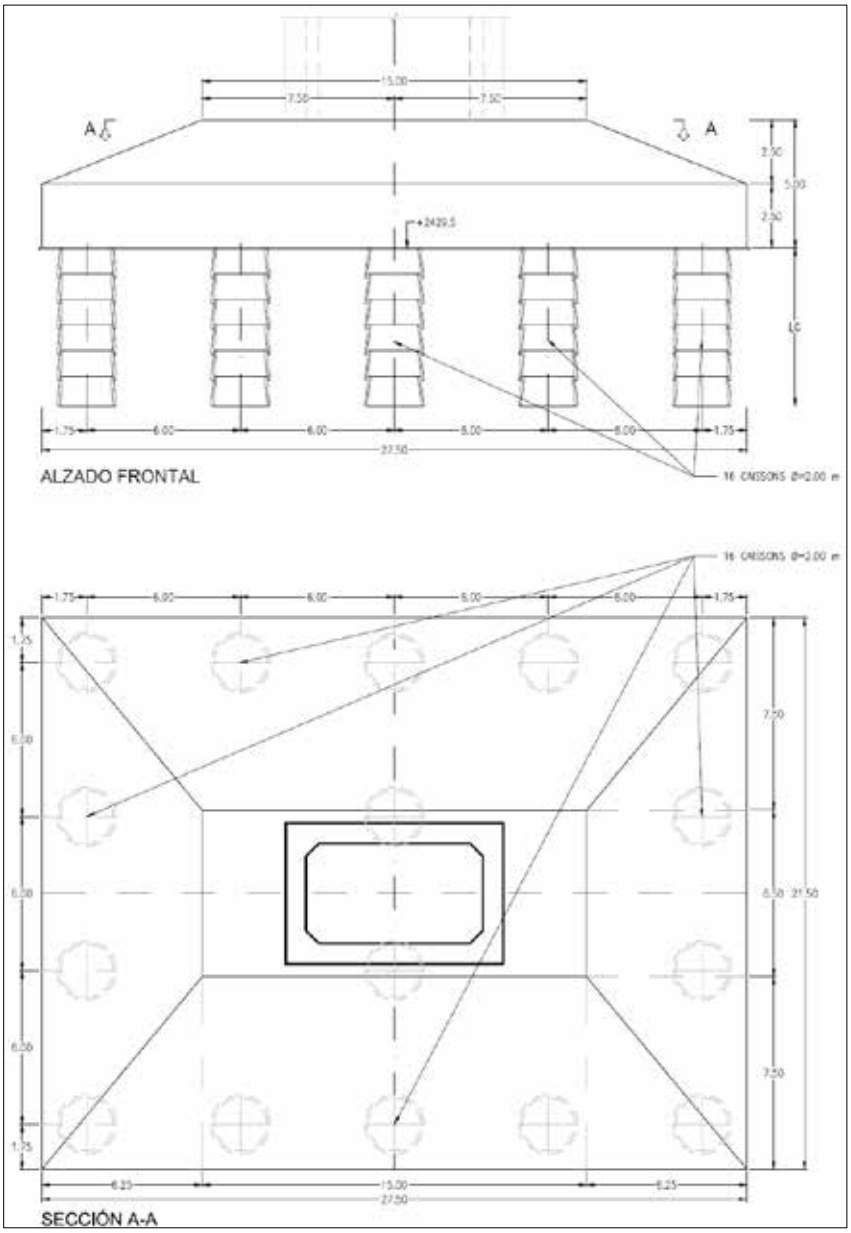
§ **Foundations.**

In compliance with the provisions of the geotechnical analysis set out in **Annex 2. Civil. IV. Foundations**, the foundations of the intermediate supports for the Boquerón Bridge will relate to concrete reinforced footings supported by caissons (excavated foundation wells) measuring 2.0 m in diameter, also made of concrete. As such, the bridge supports will be as follows:

- Pier centerline No. 2: footing of 15.50 x 17.50 x 4.00 m, supported by 8 caissons.
- Pier centerline No. 3: footing of 21.50 x 27.50 x 5.00 m, supported by 16 caissons.
- Pier centerline No. 4: footing of 15.50 x 15.50 x 3.00 m, supported by 9 caissons.

Below, **Figure 3.34** is presented as an example of the details regarding the foundation for centerline three (3) of the Boquerón Bridge. Specific designs are provided in **Annex 2. Civil. IV. Foundations. VIII. Structures**.

Figure 3.34 Elevation and plan view of the supporting foundation for pier three (3) of the Boquerón Bridge.



Sources: Consorcio SH, 2017

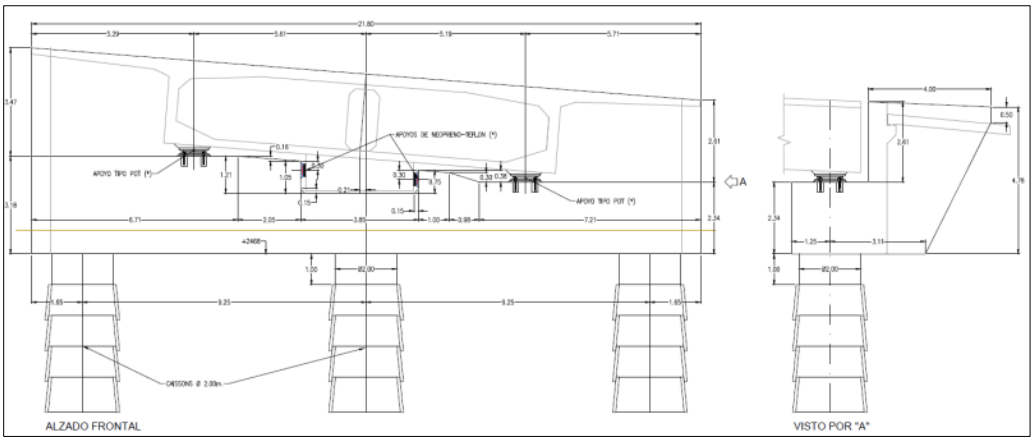
The outside supports shall consist of reinforced concrete chairs, supported on the ground by means of caissons, which are also 2.00 m in diameter:

Abutment centerline No. 1: three (3) caissons.

Abutment centerline No. 5: three (3) caissons.

Figure 3.35 presents the geometry relating to the abutment for centerline No. 1. **Annex 2. Civil. IV. Foundations. VIII. Structures** provides the specific designs.

Figure 3.35 Abutment geometry for roadway 1 of the Boquerón Bridge.

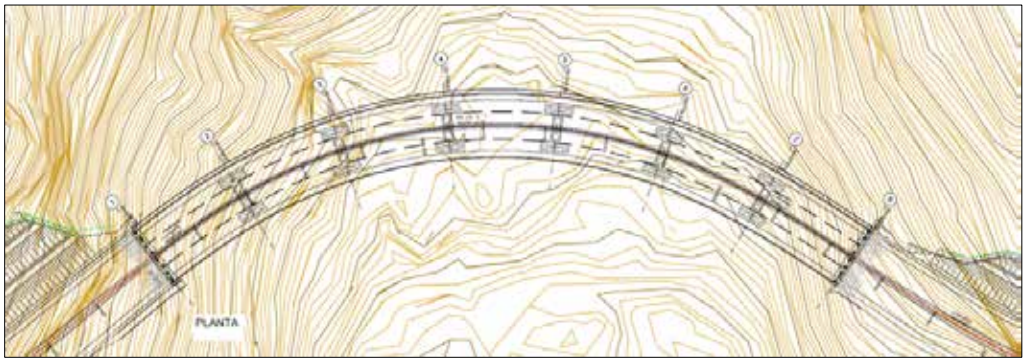


Source: Consorcio SH, 2017.

o El Tablón Alto Bridge.

It will be located between chainage KP36 + 356.5 and KP 36 + 600 and will be 243.50 m long (see **Figure 3.36**).

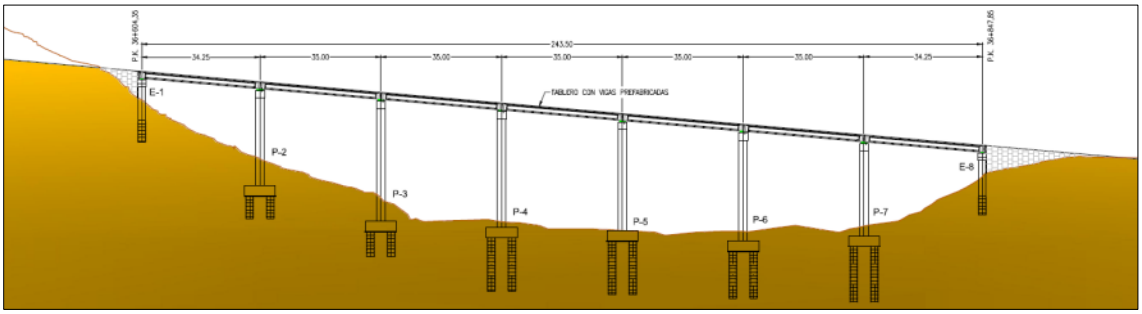
Figure 3.36 Plan view of the El Tablón Alto Bridge.



Source: Consorcio SH, 2017.

Taking into account the terrain's topography and the length of the section to be bridged, it was deemed that the most favorable option for the bridge's design comprises the use of pre-stressed beams that are 1.75 m in height. The structure will have seven spans, two outside (34.25 m) and five intermediate (35 m), as shown in **Figure 3.37**.

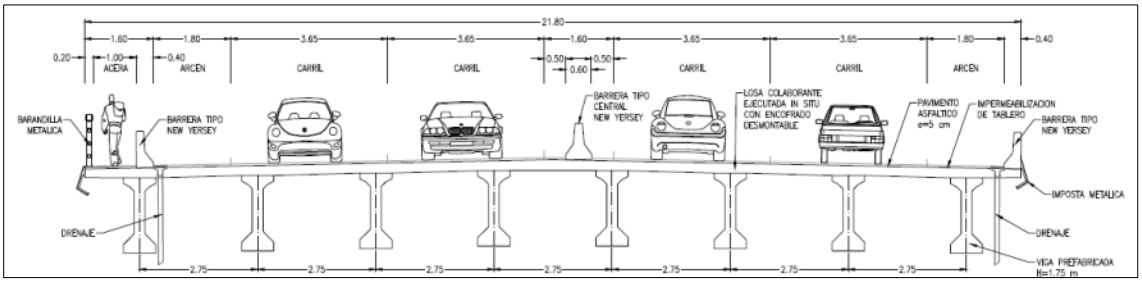
Figure 3.37 Elevation of the El Tablón Alto Bridge.



Source: Consorcio SH, 2017.

It will consist of a single platform of a total width of 21.80 m, which will include four vehicular lanes, berms measuring 1.80 m and 0.50 m on the sides of each roadway, a New Jersey median strip 0.60 m wide, two New Jersey traffic barriers 0.40 m wide, and a pedestrian sidewalk 1.00 m wide together with its respective railing (see **Figure 3.38**).

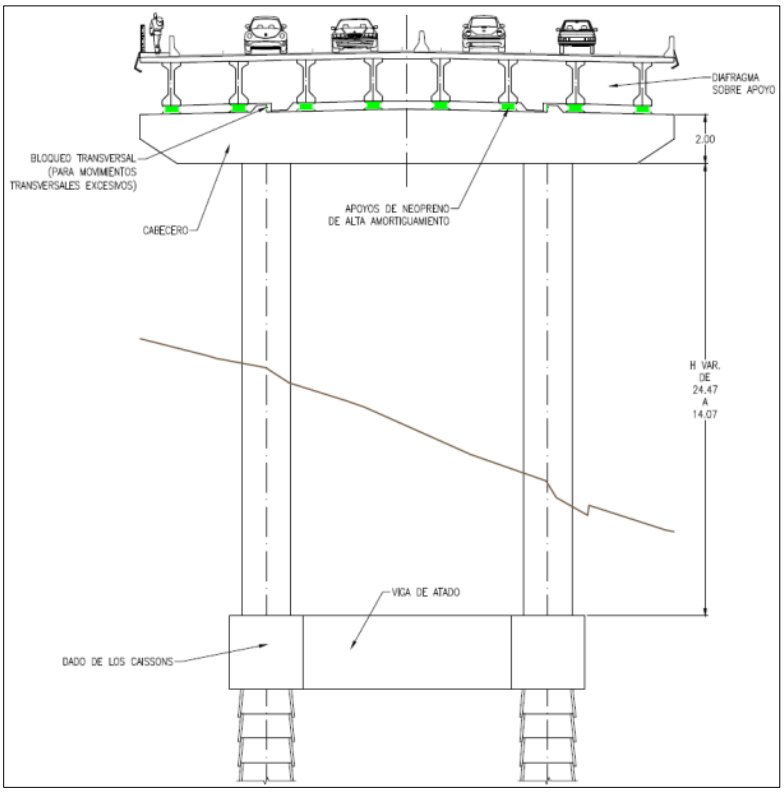
Figure 3.38 Typical cross section of the El Tablón Alto Bridge.



Source: Consorcio SH, 2017.

The piers shall consist of two rectangular hollow-section shafts (2.50 m x 2.00 m) and a wall thickness of 0.40 m. The shafts will be separated by 11.50 m and on them will rest a rectangular head measuring 2.60 m x 2.10 m (see **Figure 3.39**).

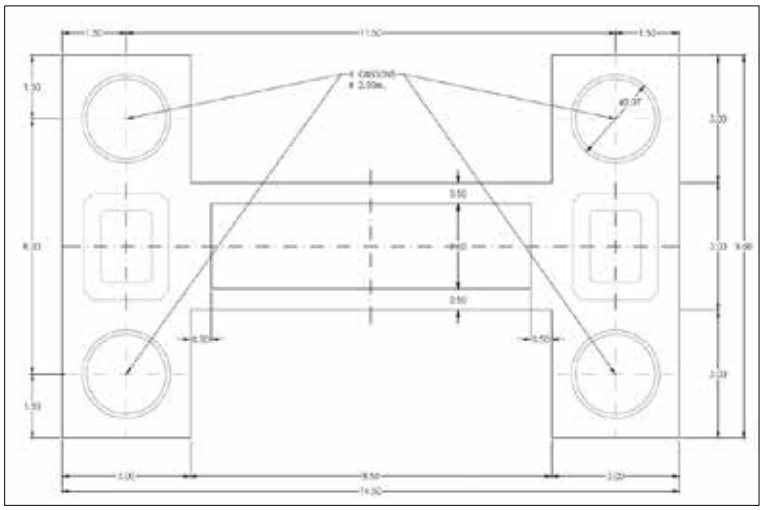
Figure 3.39 Cross section, by pier, of the El Tablón Alto Bridge.



Source: Consorcio SH, 2017.

Each shaft will be founded on a pile cap 3.00 m deep, with two (2) caissons of 2.00 m in diameter, spaced 6.00 m apart in the longitudinal direction of the bridge. The caps of both shafts will be joined together by a hollow beam measuring 3.00 m x 3.00 m and walls 0.50 m thick (see **Figure 3.40**).

Figure 3.40 Plan section of the foundations of the El Tablón Alto Bridge.



Source: Consorcio SH, 2017.

o Macal Stream Bridge.

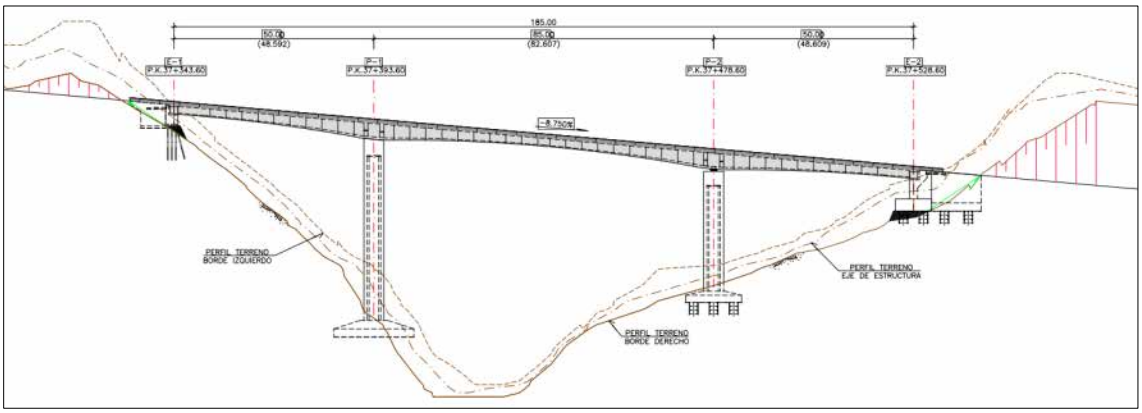
It will be located between chainage KP37 + 100 and KP 37 + 285, and will be 185 m long (see **Figure 3.41**).

Figure 3.41 Plan view of the Macal Stream Bridge.

Source: Consorcio SH, 2017.

Taking into account the terrain's topography and the length of the section to be bridged, it was deemed that the most favorable option for the bridge's design relates to the progressive cantilever construction method, with single-cell concrete segments of heights varying between 2.75 and 6.37 m, and vertical webs (see **Figure 3.42**).

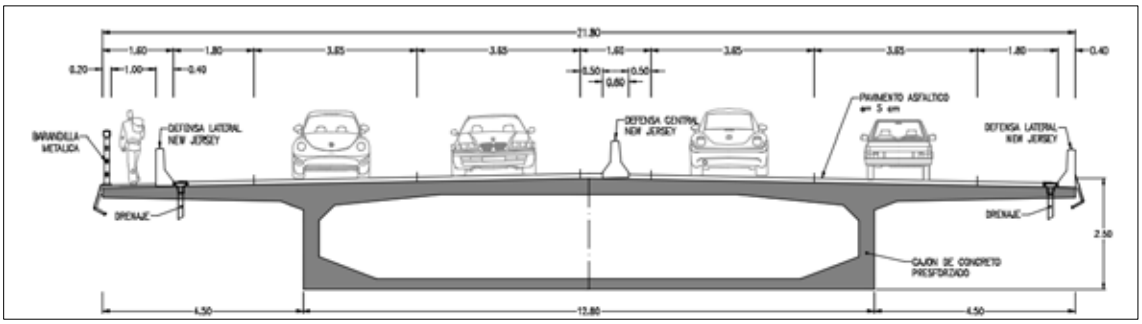
Figure 3.42 Elevation of the Macal Stream Bridge.



Source: Consorcio SH, 2017.

It will consist of a single platform of a total width of 21.80 m, which will include four vehicular lanes, berms measuring 1.80 m and 0.50 m on the sides of each road, a New Jersey median strip 0.60 m wide, two New Jersey traffic barriers 0.40 m wide, and a pedestrian sidewalk 1.00 m wide together with its respective railing (see **Figure 3.43**).

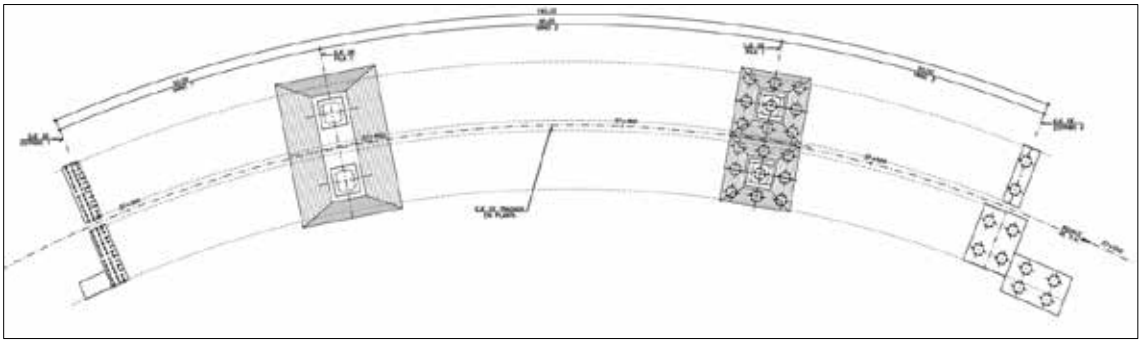
Figure 3.43 Typical cross section of the Macal Stream Bridge.



Source: Consorcio SH, 2017.

The infrastructure consists of four supports, two relating to seat-type supports and two intermediate ones formed by rectangular piers 28.98 m in height. The piers relating to centerline 2 are founded on a 20 x 28.70 m cap, and the hollow-section piers relating to support 3 measuring 2.0 x 2.5 m are founded on two 13 x 14 m blocks spaced apart 0.60 m, over nine (9) caissons (each 2.00 m in diameter) (see **Figure 3.44**).

Figure 3.44 Plan section of the foundations of the Macal Stream Bridge.

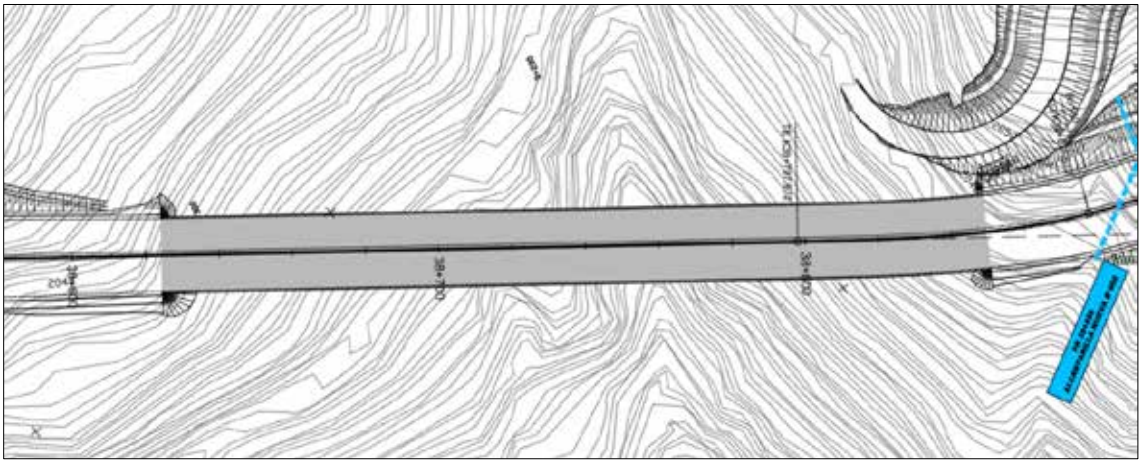


Source: Consorcio SH, 2017.

o El Porvenir rural district Bridge.

It will be located between chainage KP38 + 624 and KP 38 + 849 and it will be 225 m long, and was conceived to bridge the canyon relating to a minor stream with a canyon-bound channel. The platform will have a constant longitudinal slope of 1.0%. The bridge will have a preferred SW-NE orientation. **Figure 3.45** shows the plan view of the structure's layout. In this figure, it can be seen that the bridge is practically straight along its entire length.

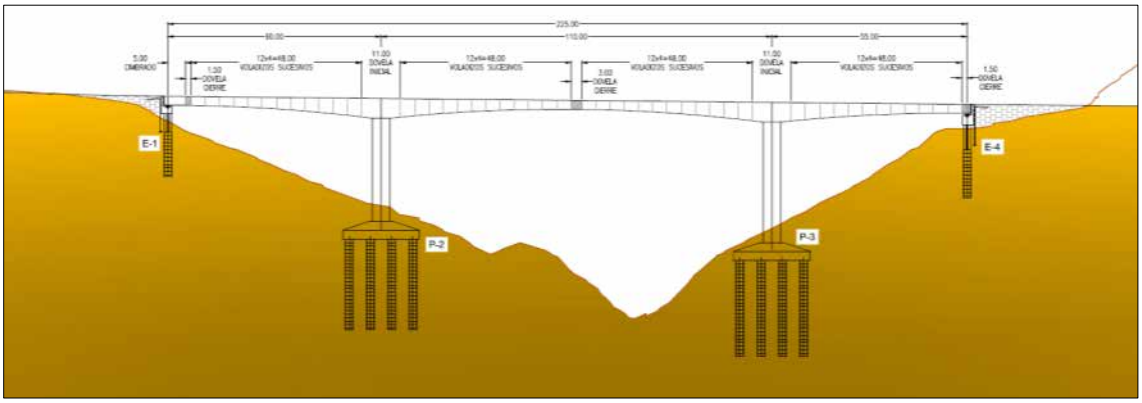
Figure 3.45 Plan view of the El Porvenir rural district Bridge.



Source: Consorcio SH, 2017.

Taking into account the terrain's topography and the length of the section to be bridged, it was deemed that the most favorable option is the design of a bridge with a reinforced concrete box section, to be constructed according to the progressive cantilever method, with single-cell concrete segments of varying heights between 2.50 and 5.50 m, and vertical webs. The structure will have three spans (60 m - 110 m - 55 m) as shown in **Figure 3.46**.

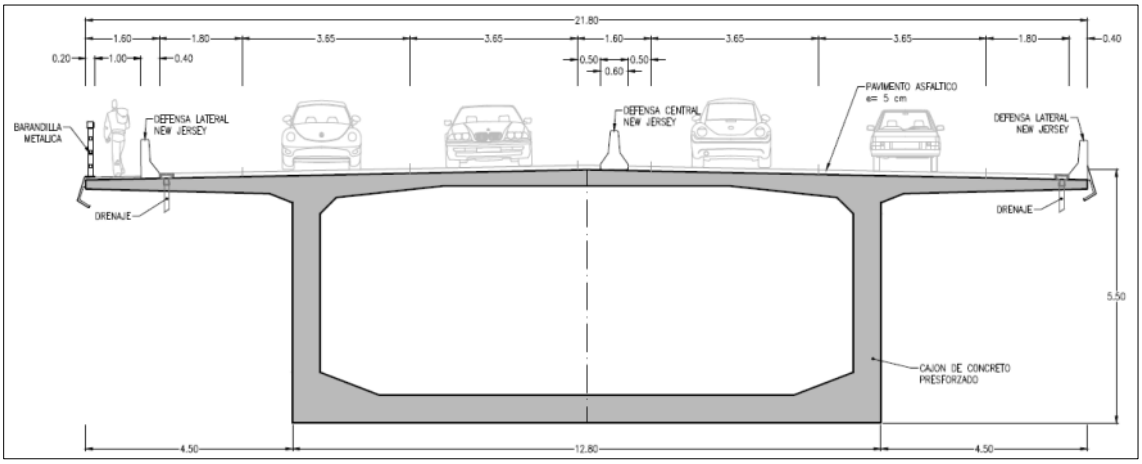
Figure 3.46 Elevation of the El Porvenir rural district Bridge.



Source: Consorcio SH, 2017.

It will consist of a single platform of a total width of 21.80 m, which will include two vehicular roadways (one in each direction), berms measuring 1.80 m and 0.50 m on the sides of each roadway, a New Jersey median strip 0.60 m wide, two New Jersey traffic barriers 0.40 m wide, and a pedestrian sidewalk 1.00 m wide together with its respective railing (see **Figure 3.47**).

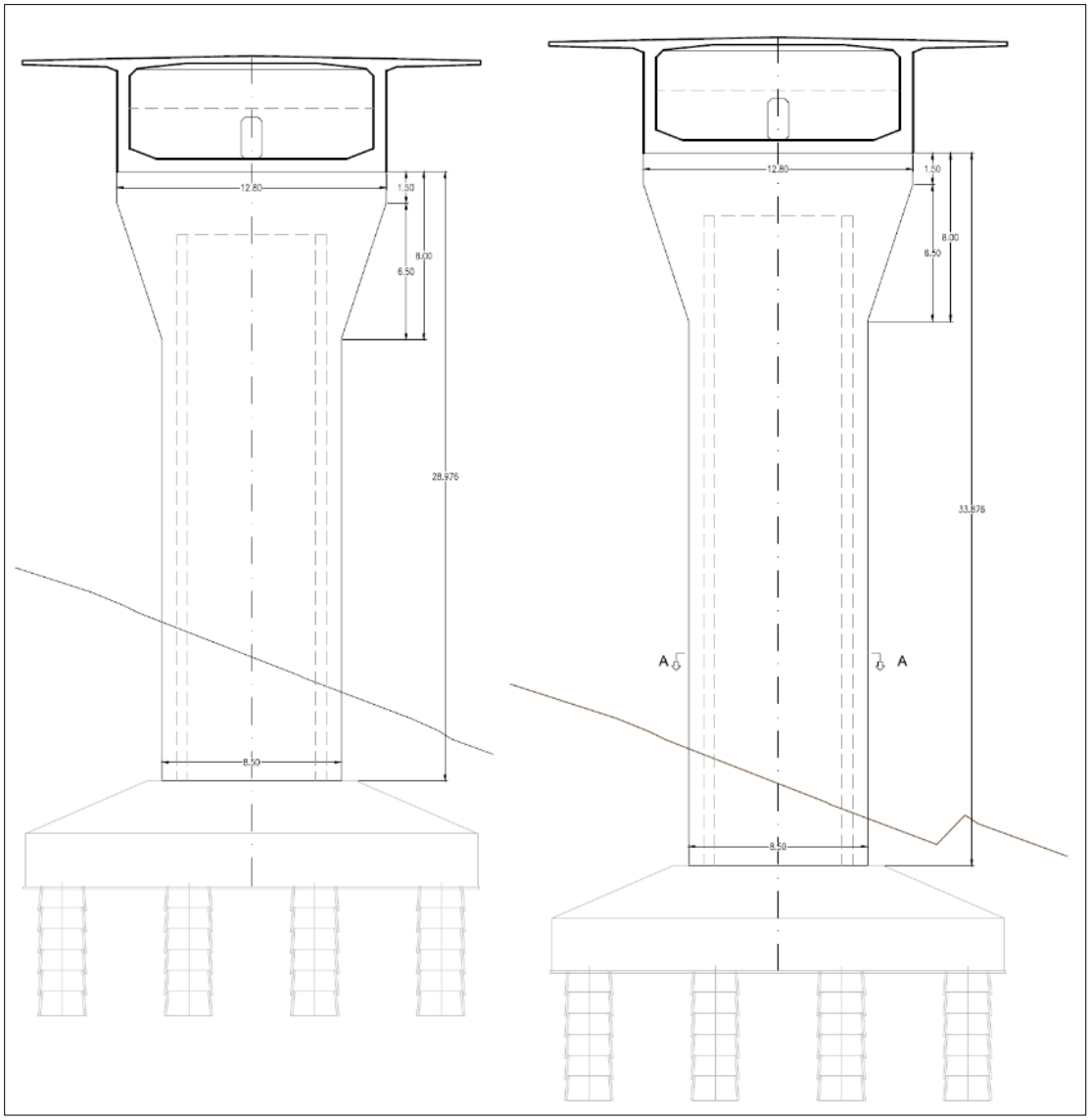
Figure 3.47 Typical cross section of the El Porvenir rural district Bridge.



Source: Consorcio SH, 2017.

The piers for supports 2 and 3 are formed by a variable hollow-section rectangular element, from 5.00 m x 8.50 m at the base, up to 5.00 m x 12.80 m at the upper head, and webs measuring 0.70 m (see **Figure 3.48**).

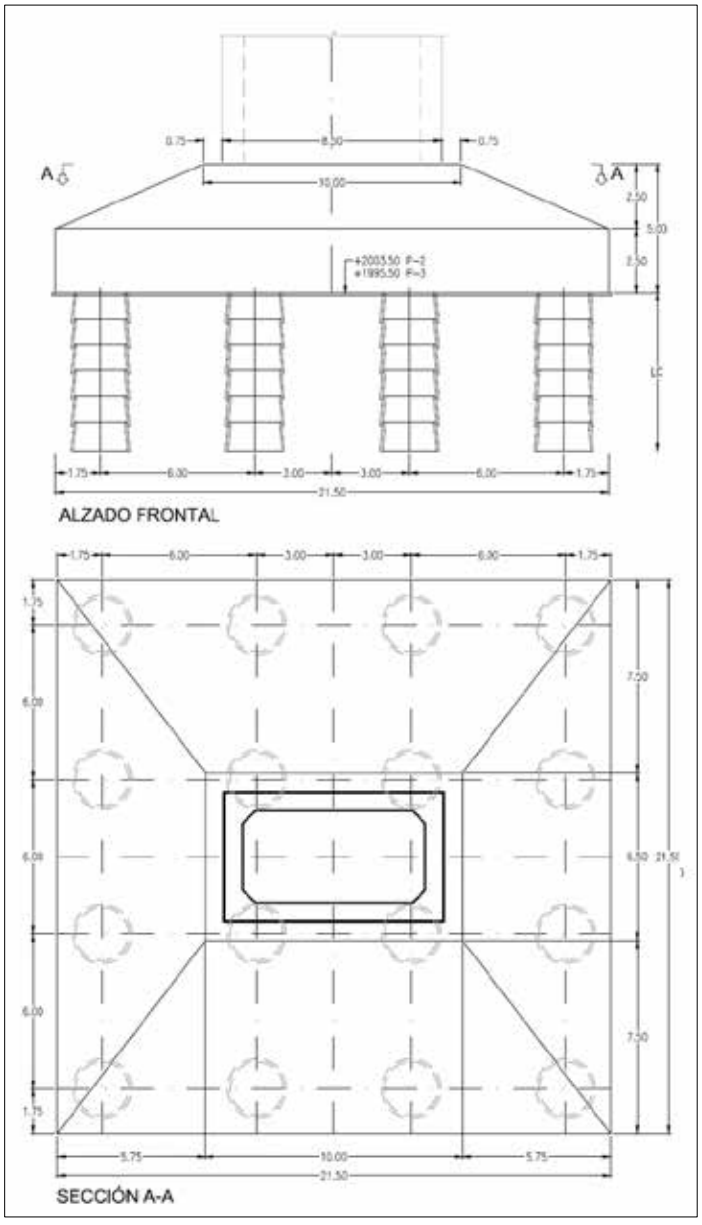
Figure 3.48 Cross section of piers 2 and 3 of the El Porvenir rural district Bridge.



Source: Consorcio SH, 2017.

Each column will be founded on a 21.50 m square footing, 5.00 m thick for piers P2 and P3, with 16 caissons of 2.00 m in diameter, spaced 6.00 m apart in the longitudinal direction of the bridge (see **Figure 3.49**).

Figure 3.49 Foundations of Piers 2 and 3 of the El Porvenir rural district Bridge.



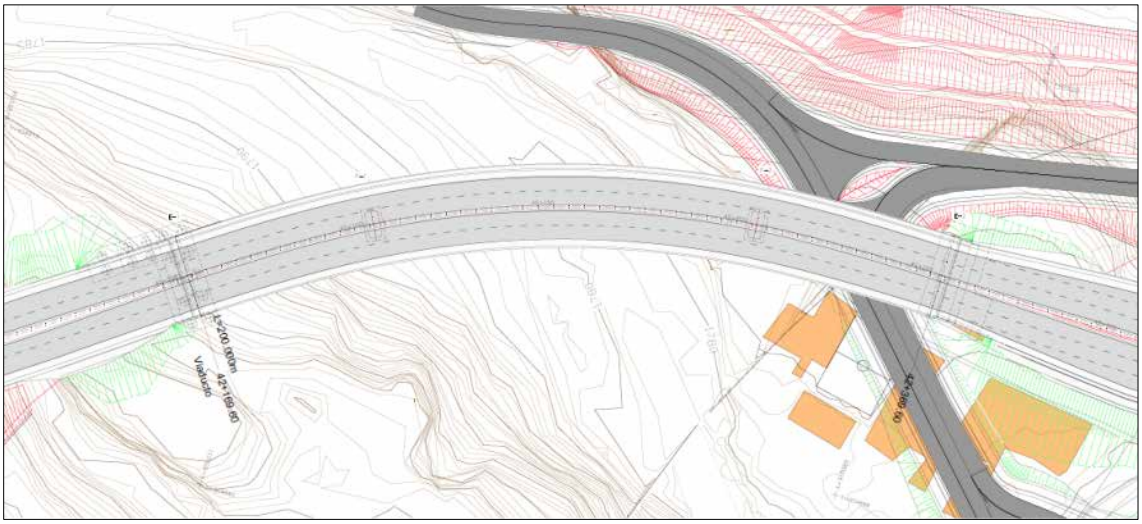
Source: Consorcio SH, 2017.

The two abutments will have POT and neoprene supports to withstand the transverse forces and POT-type supports in pier P2, while in pier P3 the platform will be embedded into the pier.

o Sapuyes River Bridge.

The Rio Sapuyes bridge, which will be located between chainage KP41 + 056.60 and KP42 + 256.60 and will be 200 m long, was conceived to bridge the channel of such stream. The bridge will have a preferred W-E orientation and, throughout its entire length, the bridge exhibits a horizontal curve. **Figure 3.50** shows the structure's layout in plan view.

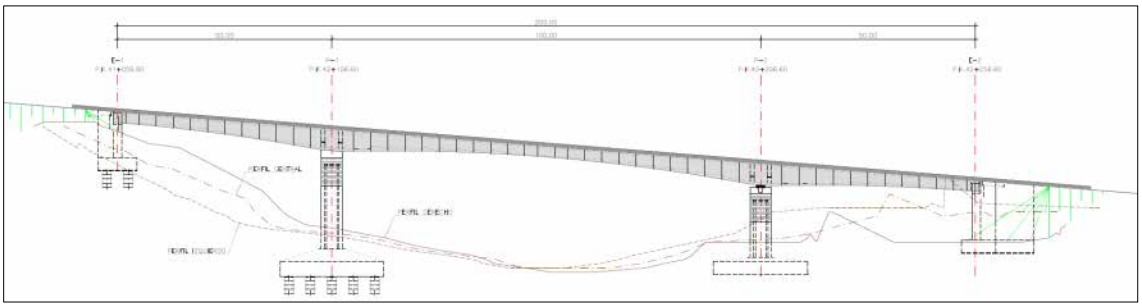
Figure 3.50 Plan view of the Sapuyes River Bridge.



Source: Consorcio SH, 2017.

The platform will have a constant longitudinal slope of 7.50%. Adapting to the terrain's topography, the most appropriate option was deemed to be a concrete hollow-section bridge, to be constructed in accordance with the progressive cantilever method. There are three spans: one central span (100 m) and two 50 m side spans, as shown in **Figure 3.51**.

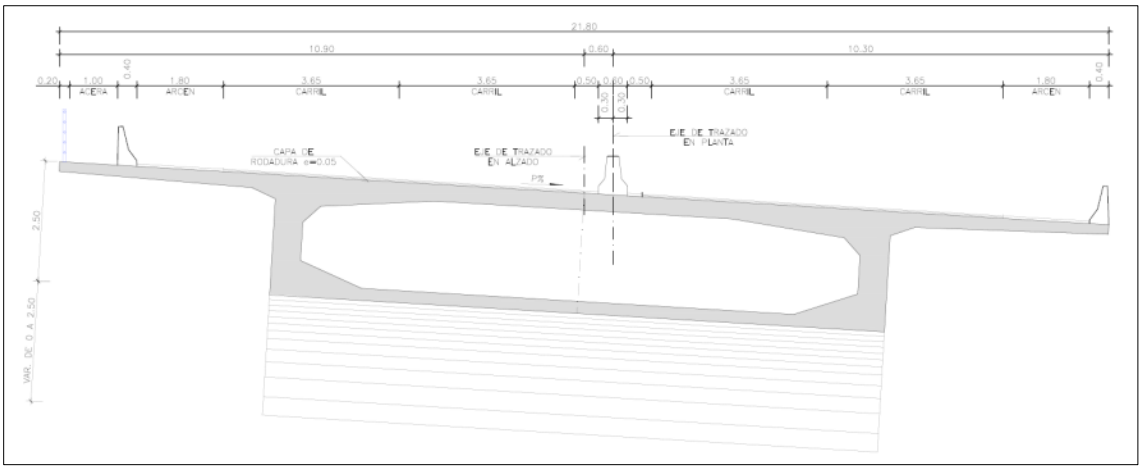
Figure 3.51 Elevation of the Sapuyes River Bridge.



Source: Consorcio SH, 2017.

It will consist of a single platform with a total width of 21.80 m, which will include two vehicular roadways (one in each direction), berms measuring 1.80 m and 0.50 m on the sides of each roadway, a New Jersey median strip 0.60 m wide, two New Jersey traffic barriers 0.40 m wide, and a pedestrian sidewalk 1.00 m wide together with its respective railing (see **Figure 3.52**).

Figure 3.52 Typical cross section of the Sapuyes River Bridge.



Source: Consorcio SH, 2017.

The platform will have a variable-depth box section, with a maximum depth of 5.00 m in piers P-1 and P-2, and a minimum depth of 2.50 m in the center of the span and on the abutment support. As a result, with two Ts implemented through cantilevers from piers 1 and 2, this will complete the three spans that will make up the viaduct.

Each T implemented from the piers will be formed by a segment referred to as "O," which will be placed on piers, which will be 10 m long, and which, during execution of the cantilevered progress, will be embedded in a temporary block in pier 2. The embedding for pier 1 will be final as it is the fixed point of the structure.

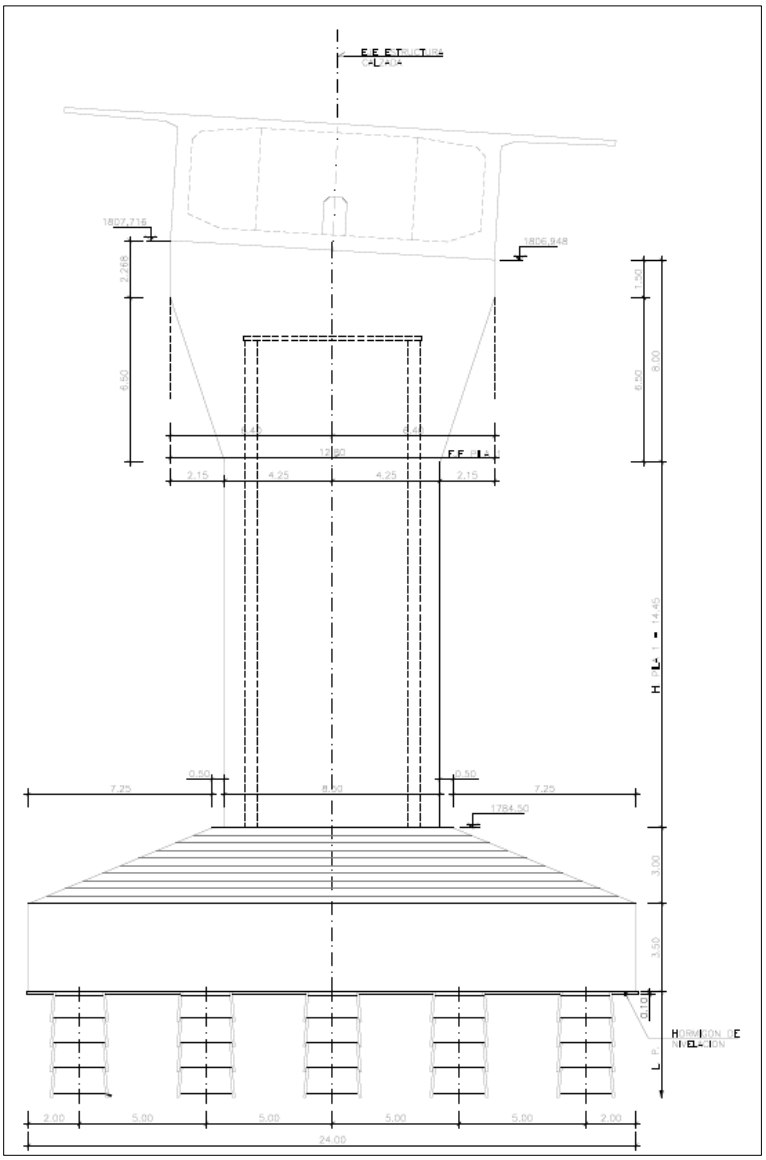
The box section will have webs with a constant thickness of 0.60 m. The base of the section's core will have a constant width of 12.80 m. The thickness of the lower platform has been projected at 0.6 m, on piers varying linearly up to 0.25 m. The webs' intersection with the upper slab of the platform will have haunches of a certain thickness, necessary so that the segment's tendons can be suitably anchored.

The pre-stressing of the segments (pre-stressed type A) will consist of twelve 29 T15 tendons per web. All tendons will be anchored on each segment front. The continuity pre-stressing (pre-stressed type B) will consist of six 31T15 tendons per web. Span 1 and span 3's pre-stressing will consist of two 19T15 tendons per web (pre-stressed type C).

The platform will rest on Pier 2 and on the abutments on neoprene-teflon devices (POT), while Pier 1 will be embedded since, as has already been mentioned, it will constitute the fixed point of the structure.

The piers will be made of reinforced concrete and will be rectangular in shape. Both piers will be hollow, and their dimensions will be 8.5 x 5.0 m, with a thickness of 0.80 m (see **Figure 3.53**).

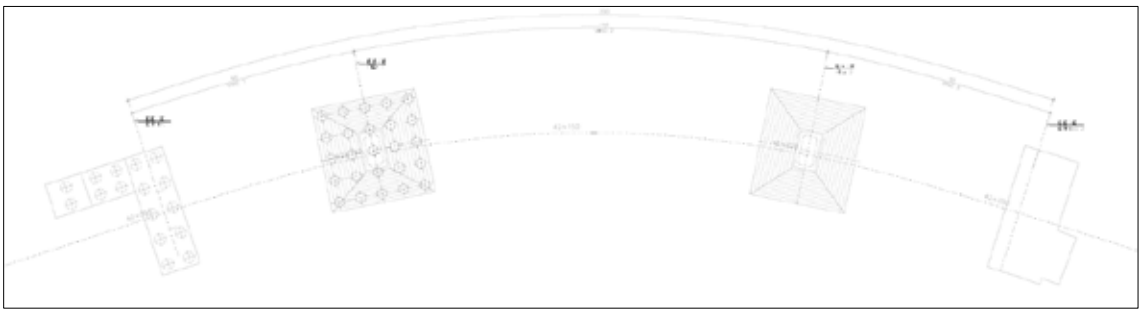
Figure 3.53 Cross section of pier 1 of the Sapuyes River Bridge.



Source: Consorcio SH, 2017.

Foundations for pier 2 are direct by footing, and caisson piles form the foundations for pier 1. Moreover, the abutments will be made of reinforced concrete (closed type). The foundations for the abutments are caisson piers. The viaduct will have an expansion joint in both abutments. **Figure 3.54** presents the plan section for the foundations of the Sapuyes River Bridge.

Figure 3.54 Plan section of the foundations of the Sapuyes River Bridge.



Source: Consorcio SH, 2017.

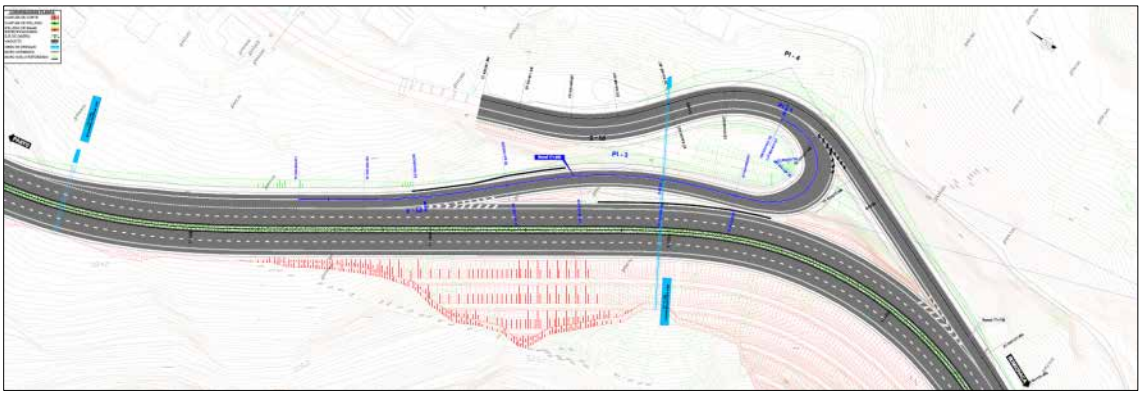
· **Level or grade separated intersections.**

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment comprises the construction of four (4) intersections, accounted for by interchanges, and these are presented below:

o San Juan connection interchange.

This infrastructure will consist of a level intersection. The entry branch for this interchange will leave the main roadway at KP17 + 100, at coordinates E 947512.77 N 589942.90, and it will have a deceleration lane 70 m in length. It will connect to the current road through a 9% descent slope and it was designed with two branches that will connect the right side of the new road with the existing road in a straight stretch before reaching the central point. The horizontal alignment of this branch will be separated from the new roadway enough to connect the exit branch from San Juan at a minimum curve radius of 15 m. This second branch will have a 9% climb ramp, and will connect to the new roadway with an acceleration lane 120 m in length (see **Figure 3.55**).

Figure 3.55 Interchange connecting with San Juan - KP17+300.

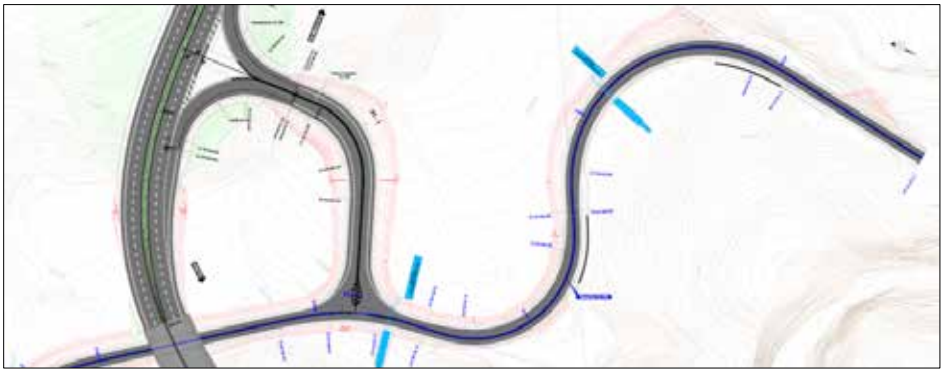


Source: Consorcio SH, 2017.

o Contadero connection interchange.

This infrastructure will comprise a grade separated interchange that is located at KP18 + 600 - coordinates E 948258.12 N 590769.31. The existing road between San Juan and Contadero will be modified at ground level to pass under the Boquerón Bridge (see section ***3.2.3.1.3 Project transportation infrastructure Bridges. Boquerón Bridge*** in this chapter) and will continue until ending about 400 m from the crossing under the viaduct. The connection will be completed with a branch that will connect to the previous road through a T-intersection located about 70 m north of the crossing under the viaduct. Connected to this second branch will be the exit lanes and incorporation to the new road's left roadway, thus supplementing the connection to San Juan's surrounding area with the interchange planned for KP17 + 100. These lanes that connect with the new platform will have a minimum radius of 30 m, and will have a deceleration lane 70 m in length, and an acceleration lane 120 m in length (see **Figure 3.56**).

Figure 3.56 Interchange connecting with Contadero – KP18+700.



Source: Consorcio SH, 2017.

o Iles road connection.

Regarding the crossing for the access road to the municipal center of Iles (see ***section 3.2.1.2.2 Access road to the municipal center of Iles*** *in this chapter*), the plan is to build a connection located at KP35 + 600 (see **Figure 3.57**).

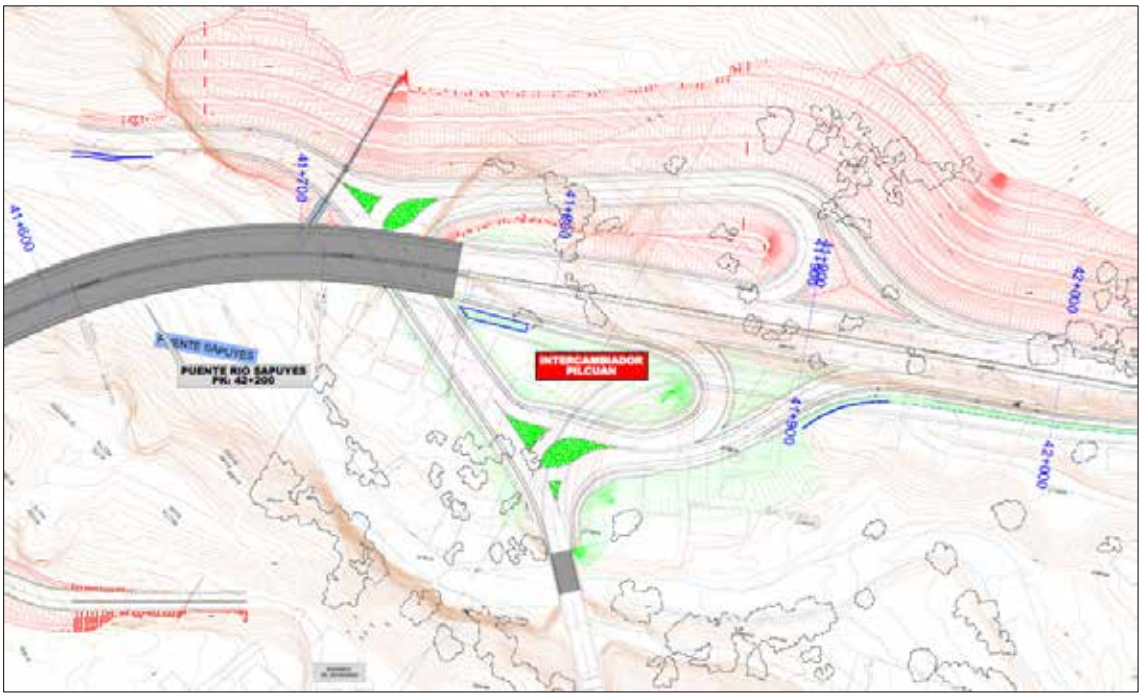
Figure 3.57 Connection to Iles road.

Source: Consorcio SH, 2017.

o Pilcuán connection interchange.

At KP41 + 700, at coordinates E 955463.26 N 604835.03, in the area surrounding Pilcuán Viejo, there will be a grade separated interchange (through the Sapuyes River Bridge, see section ***3.2.3.1.3 Project transportation infrastructure. Bridges. Sapuyes River Bridge*** in this chapter) that will provide for all movements and will even allow turnarounds (see **Figure 3.58**).

Figure 3.58 Interchange for Pilcuán – KP41+700.



Source: Consorcio SH, 2017.

This interchange will include the replacement of the access road to the northern housing developments and will streamline movements, connecting it with the existing road to Rumichaca. In addition, it will serve to connect the branches of the interchange, thus providing for all movements and ensuring local connectivity and mobility as a result of the new road's implementation. Connecting the urban areas of Pilcuán and the housing developments to the north with the new road will provide this area with significant potential future development since this corridor is a backbone of great importance to the Department of Nariño.

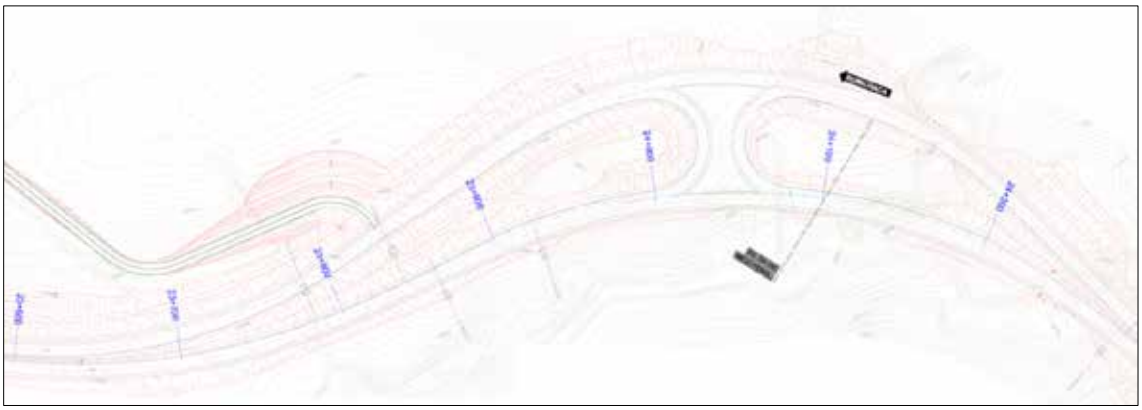
- **Turnarounds.**

In order to enable changes of direction for traffic in the Rumichaca - Pasto Divided Highway Project, San Juan Pedregal Segment, a series of level turnarounds has been designed within the road's median strips, and therefore it becomes necessary to separate the roadways in this area. Below is a description of these turnarounds:

o Turnaround KP24+050.

In this sector there will be a turnaround in both directions. The first of them allows for a change of direction, so that, when traveling upwards towards Pedregal, in the right roadway, one can change destination and continue towards Ipiales in the left roadway. On the other hand, the second allows for the change of direction in such a way that vehicles travelling toward Ipiales in the left roadway can change their route towards Pedregal and travel in the right roadway (direction of ascending chainage) (see **Figure 3.59**).

Figure 3.59 Turnaround KP24+050.

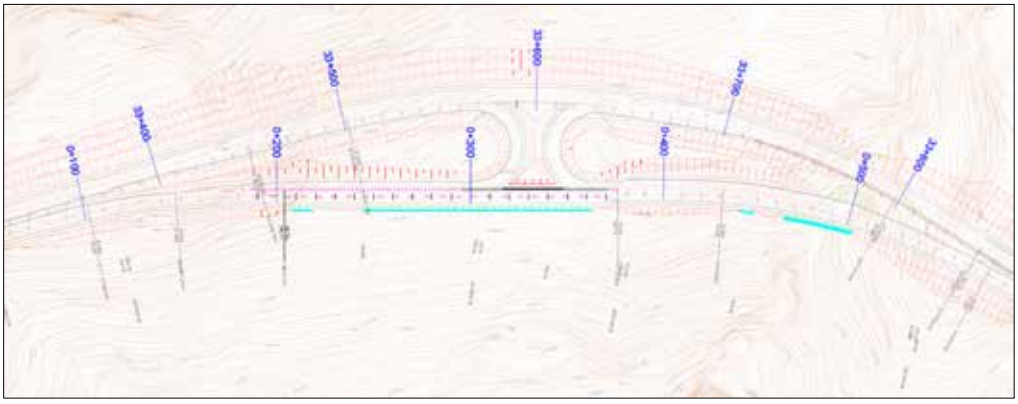


Source: Consorcio SH, 2017.

o Turnaround KP33+600.

In this sector there will be a turnaround in both directions. The first of them allows for a change of direction, so that, when traveling downwards towards Pedregal, in the right roadway, one can change destination and continue towards Ipiales in the left roadway. On the other hand, the second allows for the change of direction in such a way that vehicles travelling toward Ipiales in the left roadway can change their route towards Pedregal and travel in the right roadway (direction of ascending chainage) (see **Figure 3.60**).

Figure 3.60 Turnaround KP33+600.



Source: Consorcio SH, 2017.

o Turnaround KP38+250.

In this sector there will be a turnaround in both directions. The first turnaround allows for a change of direction, so that, when traveling downwards towards Pedregal, in the right roadway, one can change destination and continue towards Ipiales in the left roadway. On the other hand, the second allows for the

change of direction in such a way that vehicles travelling toward Ipiales in the left roadway can change their route towards Pedregal and travel in the right roadway (direction of ascending chainage) (see **Figure 3.61**)

Figure 3.61 Turnaround KP38+250.

Source: Consorcio SH, 2017.

- **Tolls and operational control centers.**

o Works in urban centers.

To cross the populated area of Pilcuán - municipality of Imués, the roadways will be separated, creating the Pilcuán bypass from KP43 + 100 to KP43 + 750, as presented in **Figure 3.62**.

Figure 3.62 Pilcuán bypass.

Source: Consorcio SH, 2017.

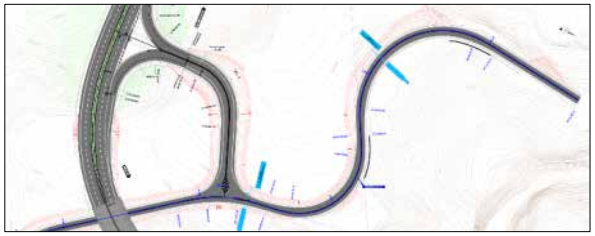
· **Linear works crossed.**

The layout of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, comprises the crossing of roads and utilities: water supply networks, sewage networks, an oil pipeline network, electricity networks, and information and communication technology networks (see section *3.2.3.3 Infrastructure and services affected by the project.* in this chapter).

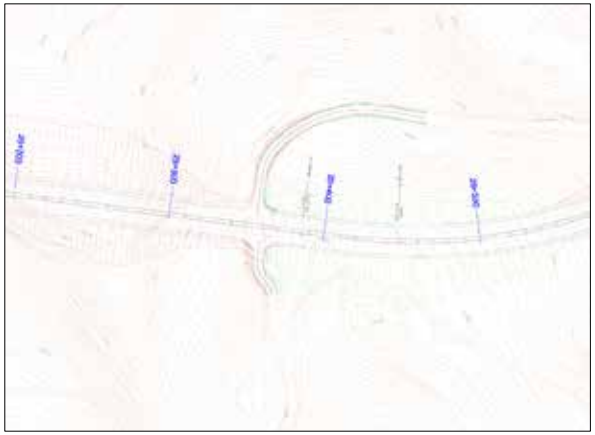
Below, **Table 3.25** lists the existing roads that will be crossed by the project.

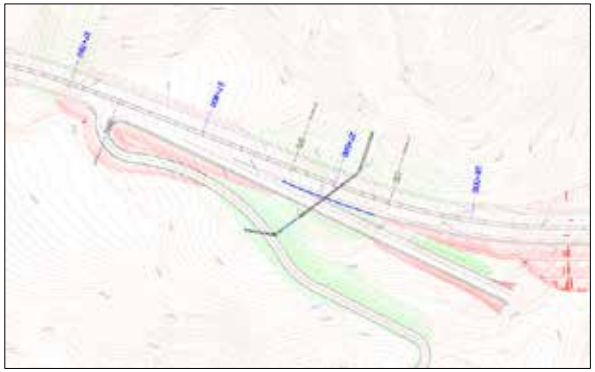
Table 3.25 List of existing roads crossed.

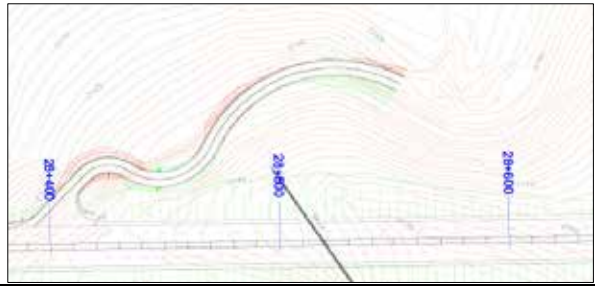
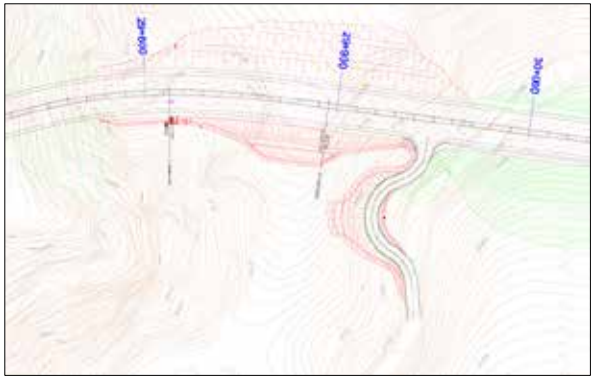
DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the San Juan – Rural road (see section ***3.2.1.2.15 San Juan – Loma de Suras village*** road. in this chapter)	KP18+000	947624	590759		
Crossing of the San Juan – Rural road (see section ***3.2.1.2.15 San Juan – Loma de Suras village*** road. in this chapter)	KP18+200	947725	590836		

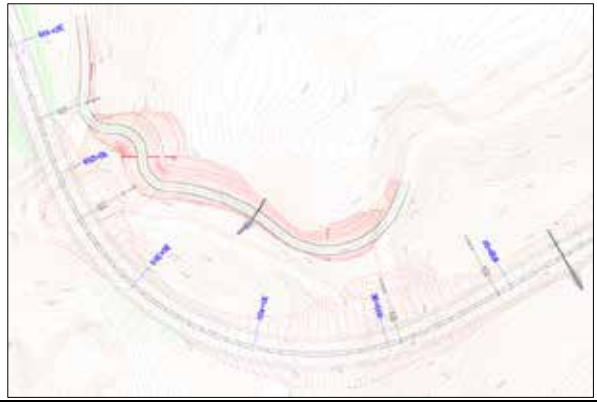
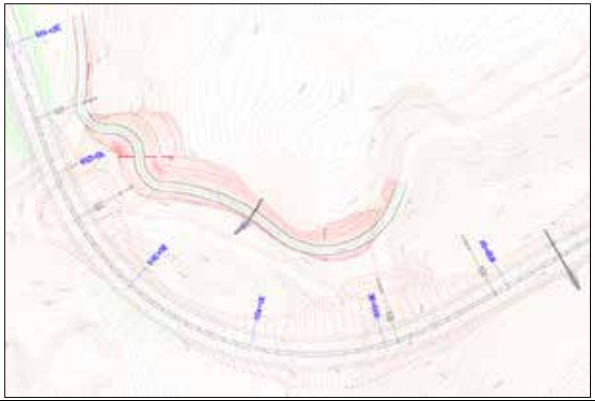
DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the San Juan – Contadero road (see section ***3.2.1.2.3 San Juan – Contadero road.*** in this chapter)	KP18+700	948258	590769		
Crossing of the Contadero – San Francisco road (see section ***3.2.1.2.11 Contadero – San Francisco road.*** in this chapter)	KP19+430	948252	591654		
Crossing of bridle path, access to farm.	KP20+316	948672	591817		

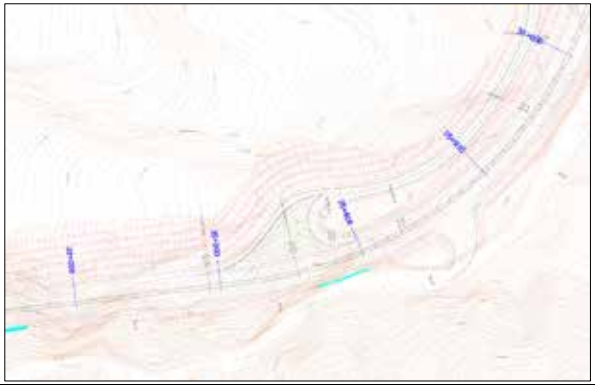
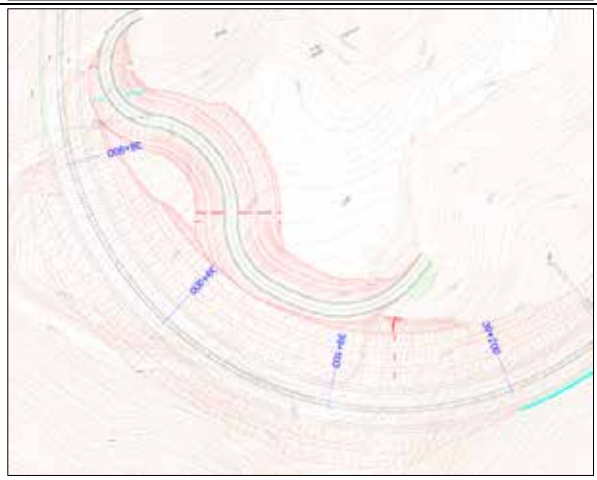
DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of access path to farm, 1.60 m wide.	KP23+500	950391	594030		
Crossing of the Contadero – Iles road (see section ***3.2.1.2.4 Contadero – Aldea*** de María – Iles road. in this chapter)	KP24+100	950507	594542		
Crossing of the Contadero – Iles road (see section ***3.2.1.2.4 Contadero – Aldea*** de María – Iles road. in this chapter)	KP24+100	950608	594576		

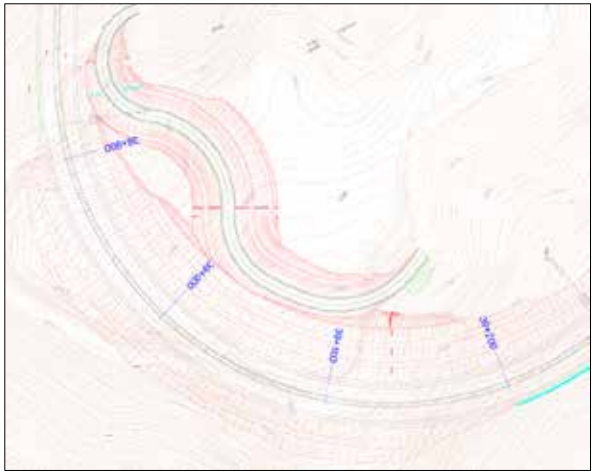
DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the Contadero – Iles road (see section ***3.2.1.2.4 Contadero – Aldea*** de María – Iles road. in this chapter)	KP24+400	950897	594762		
Crossing of the Ospina Pérez access road (see section ***3.2.1.2.13 Ospina Pérez access road.*** in this chapter)	KP26+355	952637	595516		

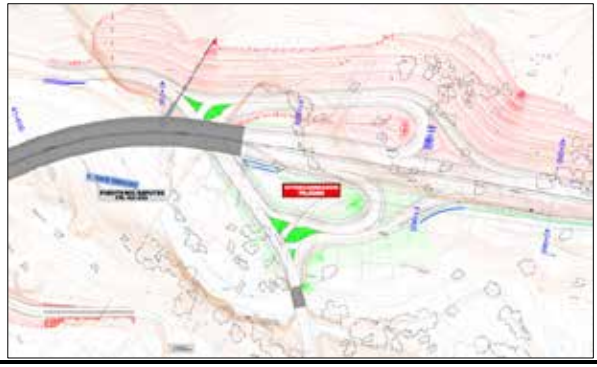
DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the Ospina Pérez access road (see section ***3.2.1.2.13 Ospina Pérez access road.*** in this chapter)	KP26+640	952879	595608		
Crossing of the Ospina Pérez – Iles road (see section ***3.2.1.2.5 Ospina Pérez – Iles road.*** in this chapter)	KP26+677	952920	595659		
Crossing of the Ospina Pérez – Iles road (see section ***3.2.1.2.5 Ospina Pérez – Iles road.*** in this chapter)	KP28+100	953921	596323		

DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the Ospina Pérez – Iles road (see section ***3.2.1.2.5 Ospina Pérez – Iles road.*** in this chapter)	KP28+430	954204	596620		
Crossing of the Ospina Pérez – Iles road (see section ***3.2.1.2.5 Ospina Pérez – Iles road.*** in this chapter)	KP29+965	955398	597503		

DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the Ospina Pérez – Iles road (see section ***3.2.1.2.5 Ospina Pérez – Iles road.*** in this chapter)	KP30+200	955613	597510		
Crossing of the Ospina Pérez – Iles road (see section ***3.2.1.2.5 Ospina Pérez – Iles road.*** in this chapter)	KP30+246	955662	597500		

DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the access road to the municipal center of Iles (see section ***3.2.1.2.2 Access road to the municipal center of Iles.*** in this chapter)	KP35+400	955100	601800		
Crossing of the Pilcuán Viejo – La Rejoya road (see section ***3.2.1.2.10 Pilcuán Viejo – La Rejoya road.*** in this chapter)	KP38+680	954426	604194		

DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the Pilcuán Viejo – La Rejoya road (see section ***3.2.1.2.10 Pilcuán Viejo – La Rejoya road.*** in this chapter)	KP39+100	954509	604341		
Crossing of the Arco Iris Condominium internal road (see section ***3.2.1.2.9 Arco Iris Condominium internal road.*** in this chapter)	KP39+540	953943	604451		

DESCRIPTION	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PHOTOGRAPHIC RECORD	WORK PROPOSAL
		EAST	NORTH		
Crossing of the Arco Iris Condominium internal road (see section ***3.2.1.2.9 Arco Iris Condominium internal road.*** in this chapter)	KP40+100	953942	604799		
Crossing of the Pilcuán Viejo-Arco Iris Condominium road (see section ***3.2.1.2.8 Pilcuán Viejo – Arco Iris Condominium road.*** in this chapter)	KP40+070	954016	604819		
Crossing of the Pilcuán Viejo-Arco Iris Condominium road (see section ***3.2.1.2.8 Pilcuán Viejo – Arco Iris Condominium road.*** in this chapter)	KP41+700	955329	604958		

Source: GEOCOL CONSULTORES S.A., 2017.

· **Viaducts.**

The viaduct information regarding the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment is presented in section ***3.2.3.1.3 Project transportation infrastructure. Bridges*** in this chapter.

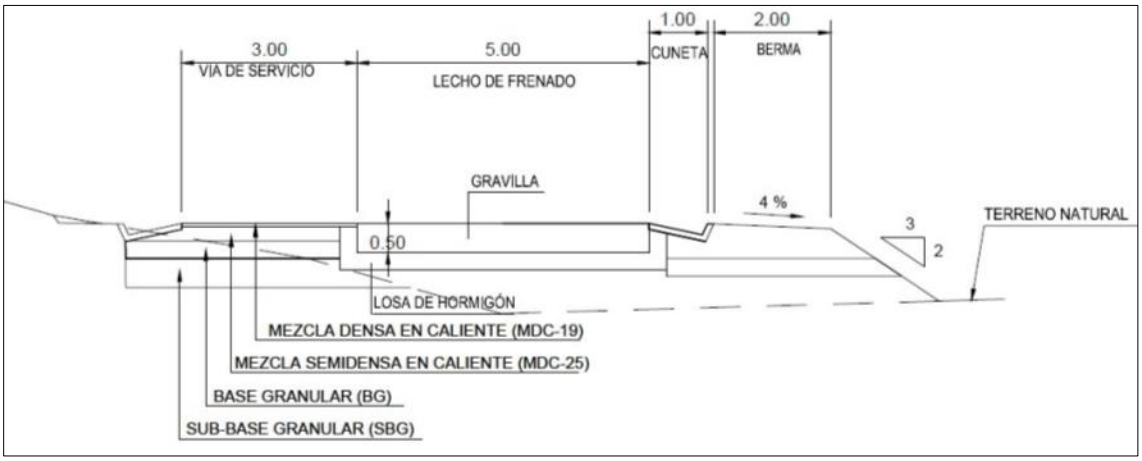
· **Other types of infrastructure included by the project.**

The construction of the following additional infrastructure is planned for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment:

o Escape roads.

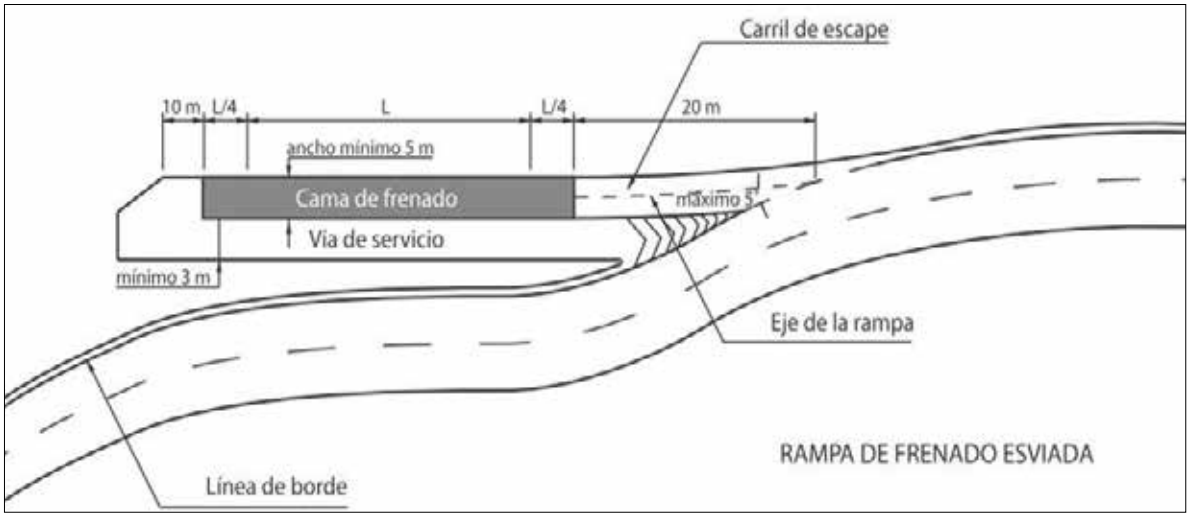
For the San Juan - Pedregal Segment, the plan includes the construction of five (5) escape roads, which will comprise gravel beds, providing a rolling resistance (Rc) of 0.25, and these will be situated on a concrete slab, whose drainage will be ensured through the inclusion of exit pipes. Below, **Figure 3.63** presents a typical cross-section for the escape roads and **Figure 3.64** presents their typical plan section.

Figure 3.63 Typical cross section of escape roads.



Source: Consorcio SH, 2017.

Figure 3.64 Typical plan section of escape roads.

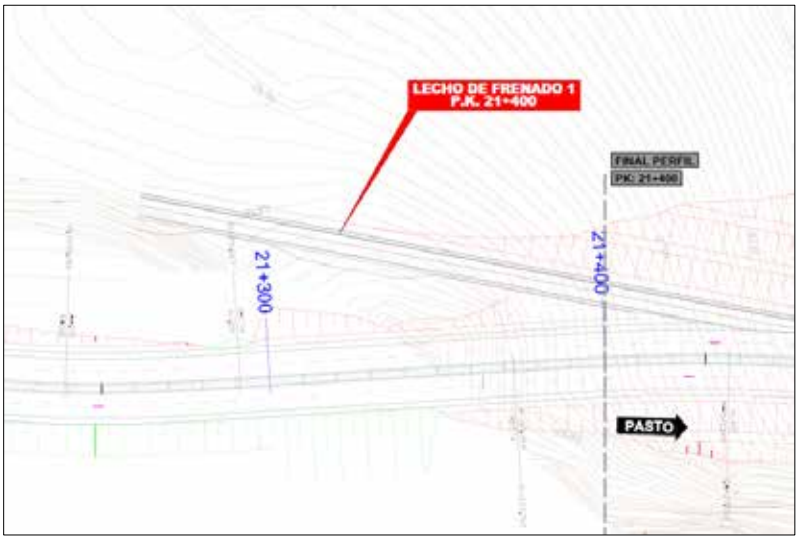


Source: Consorcio SH, 2017.

§ **Escape road KP21+400.**

It will be descending and will have a total length of 292 m (see **Figure 3.65**).

Figure 3.65 Escape road KP21+400.

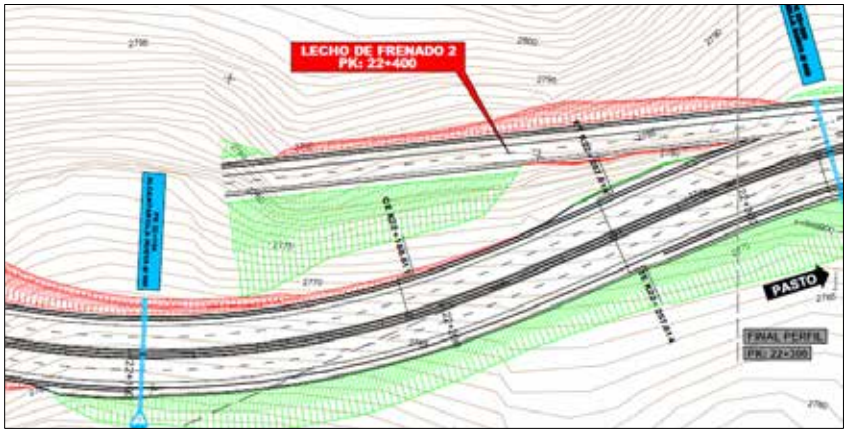


Source: Consorcio SH, 2017.

§ **Escape road KP22+400.**

It will be ascending and will have a total length of 260 m (see **Figure 3.66**).

Figure 3.66 Escape road KP22+400.

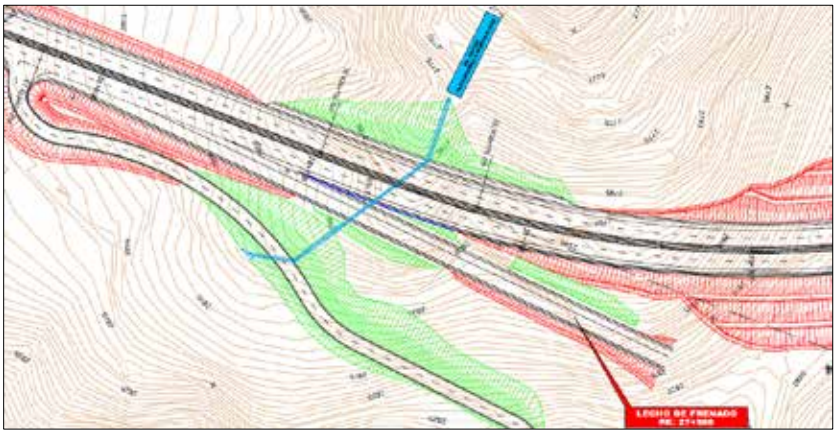


Source: Consorcio SH, 2017.

§ **Escape road K27+980.**

It will be ascending and will have a total length of 300 m (see **Figure 3.67**).

Figure 3.67 Escape road K27+980.

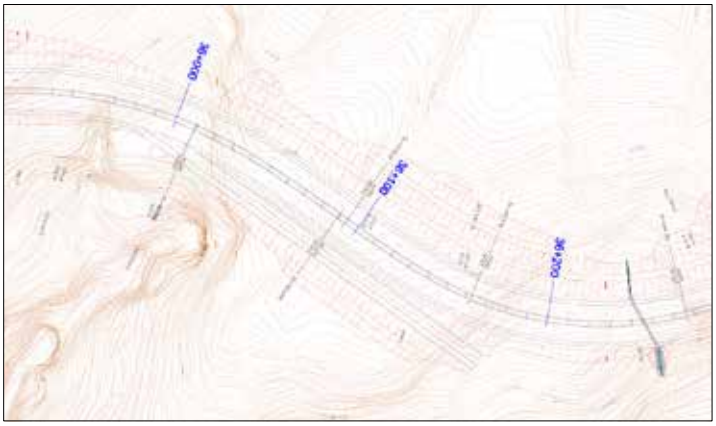


Source: Consorcio SH, 2017.

§ **Escape road KP36+100.**

It will be ascending and will have a total length of 190 m (see **Figure 3.68**), and additionally it will have an impact attenuator device at the end of the structure.

Figure 3.68 Escape road KP36+300.

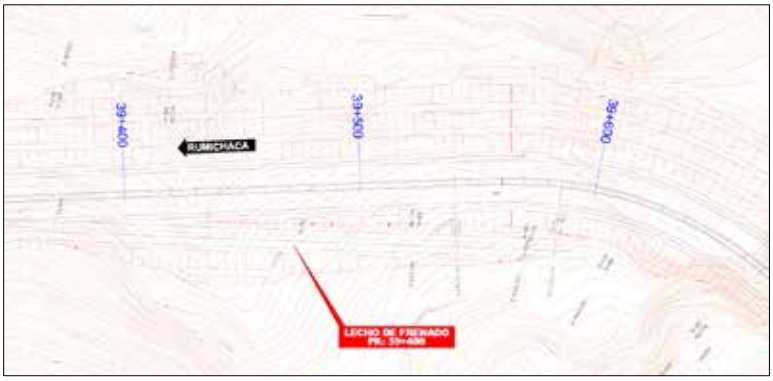


Source: Consorcio SH, 2017.

§ **Escape road KP39+490.**

It will be parallel and descending, will have a total length of 200 m (see **Figure 3.69**), and additionally it will have an impact attenuator device at the end of the structure.

Figure 3.69 Escape road KP39+490.

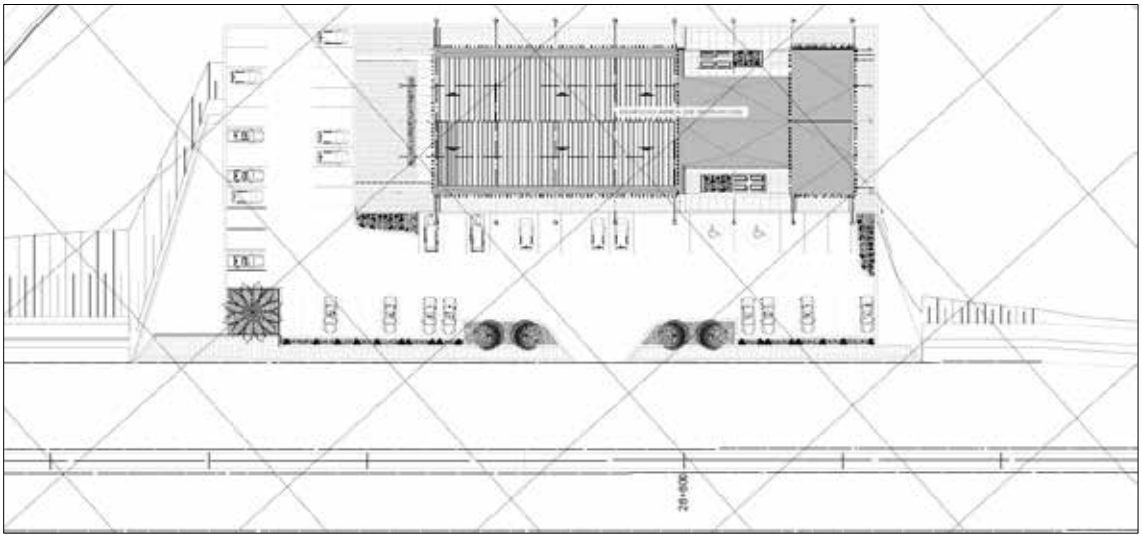


Source: Consorcio SH, 2017.

o Service area.

The San Juan - Pedregal segment will have a service area located at KP40 + 300. This infrastructure will have parking, a food area, first aid post, bathrooms and public telephones, among others (see **Figure 3.70**). It will be a vaulted structure, with large spans to avoid physical interference within the space. It should be noted that the specific designs for this infrastructure are provided in **Annex 2. Civil. X. Urban planning**.

Figure 3.70 Plan Section of Service Area KP28+800.



Source: Consorcio SH, 2017.

Below, **Table 3.26** lists the characteristics to be featured by service area KP28+800.

Table 3.26 Characteristics of Service Area PK28+800KP28+800.

ITEM	DESCRIPTION	QUANTITY	UNIT
1	Food areas	400	m^2
2	Bathroom unit	10	Un
3	Public phones	5	Un
4	Administrative office	40	m^2
5	First aid post (equipped)	40	m^2
6	Covered reception and circulation area	200	m^2
7	Cafeteria	100	m^2
8	Office 2	40	m^2
9	Equipped with utilities relating to electricity and drinking water, which will be destined for use by national or regional tourism entities	1500	m^2
11	Parking area	890.17	m^2

Source: Consorcio SH, 2017.

3.2.3.1.4 Drainage infrastructure.

In order to capture, transport and appropriately redirect surface and subsurface runoff water relating to the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, the following drainage elements will be put in place:

- **Drainage infrastructure.**

In order to manage runoff water and crossings of water bodies intersected by the project, transverse and longitudinal drainage will be constructed on the road's layout.

§ **Transverse.**

Composed of culverts (circular, box culvert) and bridges, along with their respective supplementary works for water disposal, or structures for water energy dissipation (at the entry or exit of drainage works). **Table 3.27** provides a list of transverse works to be built in the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment. It is worth mentioning that the specific designs for this infrastructure are provided in **Annex 2. Civil. VII. Drainage. VIII. Structures**.

Table 3.27 Transverse works to be built in the San Juan Pedregal Segment.

CHAINAGE	DRAINAGE WORK	DIMENSIONS	COMMENTS
KP15+873	Culvert	1200 mm	New structure
KP16+001	Culvert	900 mm	New structure
KP16+120	Box culvert	2 x 2 m	Replacement of existing structure
KP16+329	Culvert	900 mm	New structure
KP16+432	Culvert	900 mm	Replacement of existing structure
KP16+503	Box culvert	3 x 2 m	Replacement of existing structure
KP16+722	Culvert	900 mm	New structure
KP16+840	Culvert	900 mm	Replacement of existing structure
KP16+922	Culvert	1200 mm	Replacement of existing structure
KP17+004	Culvert	900 mm	Replacement of existing structure
KP17+082	Culvert	900 mm	Replacement of existing structure
KP17+303	Culvert	900 mm	New structure
KP17+480	Culvert	900 mm	New structure
KP17+555	Culvert	900 mm	New structure
KP17+761	Box culvert	1.5 x 1.5 m	New structure
KP17+913	Culvert	900 mm	New structure
KP18+089	Box culvert	2 x 2 m	New structure
KP18+169	Culvert	900 mm	New structure
KP18+429	Culvert	900 mm	New structure
KP18+519	Culvert	900 mm	New structure
KP18+590	Culvert	900 mm	New structure
KP19+512	Box culvert	2 x 2 m	New structure
KP19+777	Box culvert	2 x 2 m	New structure
KP20+259	Culvert	900 mm	New structure
KP20+400	Culvert	900 mm	New structure

CHAINAGE	DRAINAGE WORK	DIMENSIONS	COMMENTS
KP20+574	Box culvert	1.5 x 1.5 m	New structure
KP20+831	Box culvert	3 x 3 m	New structure
KP21+060	Culvert	900 mm	New structure
KP21+279	Culvert	900 mm	New structure
KP21+333	Culvert	900 mm	New structure
KP21+585	Culvert	900 mm	New structure
KP21+813	Culvert	900 mm	New structure
KP22+122	Culvert	900 mm	New structure
KP22+192	Culvert	900 mm	New structure
KP22+343	Culvert	900 mm	New structure
KP22+428	Box culvert	3 x 3 m	New structure
KP22+964	Culvert	900 mm	New structure
KP23+157	Box culvert	2 x 2 m	New structure
KP23+370	Box culvert	1.5 x 1.5 m	New structure
KP23+598	Culvert	900 mm	New structure
KP23+710	Culvert	900 mm	New structure
KP23+843	Culvert	900 mm	New structure
KP23+898	Culvert	900 mm	New structure
KP23+950	Culvert	900 mm	New structure
KP24+050	Culvert	1200 mm	New structure
KP24+136	Box culvert	3 x 2 m	New structure
KP24+274	Culvert	900 mm	New structure
KP24+315	Box culvert	2 x 2 m	New structure
KP24+525	Box culvert	2 x 2 m	New structure
KP24+852	Culvert	900 mm	New structure
KP24+947	Culvert	900 mm	New structure
KP25+331	Culvert	1200 mm	New structure
KP25+529	Culvert	900 mm	New structure
KP25+589	Culvert	1200 mm	New structure
KP25+892	Culvert	900 mm	New structure
KP25+952	Culvert	1200 mm	New structure
KP26+121	Culvert	900 mm	New structure
KP0+133	Culvert	900 mm	New structure
KP26+440	Culvert	900 mm	New structure
KP26+800	Culvert	900 mm	New structure
KP27+312	Culvert	1200 mm	New structure

CHAINAGE	DRAINAGE WORK	DIMENSIONS	COMMENTS
KP27+387	Culvert	900 mm	New structure
KP27+565	Culvert	900 mm	New structure
KP27+680	Culvert	900 mm	New structure
KP27+913	Culvert	1200 mm	New structure
KP28+516	Culvert	900 mm	New structure
KP28+677	Culvert	900 mm	New structure
KP28+830	Culvert	900 mm	New structure
KP29+212	Box culvert	3 x 2 m	New structure
KP29+437	Box culvert	3 x 2 m	New structure
KP29+593	Box culvert	3 x 2 m	New structure
KP29+756	Box culvert	3 x 2 m	New structure
KP30+040	Culvert	900 mm	New structure
KP30+318	Culvert	900 mm	New structure
KP30+641	Culvert	900 mm	New structure
KP30+880	Culvert	900 mm	New structure
KP31+080	Culvert	900 mm	New structure
KP31+152	Culvert	900 mm	New structure
KP31+249	Culvert	900 mm	New structure
KP31+306	Culvert	900 mm	New structure
KP31+368	Culvert	900 mm	New structure
KP31+642	Culvert	900 mm	New structure
KP31+746	Culvert	1200 mm	New structure
KP31+958	Box culvert	3 x 3 m	New structure
KP32+103	Culvert	900 mm	New structure
KP32+243	Culvert	900 mm	New structure
KP32+320	Culvert	900 mm	New structure
KP32+489	Culvert	900 mm	New structure
KP32+590	Culvert	900 mm	New structure
KP32+729	Culvert	900 mm	New structure
KP32+984	Culvert	1200 mm	New structure
KP33+176	Culvert	900 mm	New structure
KP33+255	Culvert	900 mm	New structure
KP33+322	Culvert	900 mm	New structure
KP33+406	Culvert	900 mm	New structure
KP33+595	Culvert	900 mm	New structure
KP33+767	Box culvert	1.5 x 1.5 m	New structure

CHAINAGE	DRAINAGE WORK	DIMENSIONS	COMMENTS
KP33+863	Culvert	1200 mm	New structure
KP34+018	Box culvert	1.5 x 1.5 m	New structure
KP34+107	Culvert	1200 mm	New structure
KP34+278	Culvert	900 mm	New structure
KP34+350	Box culvert	1.5 x 1.5 m	New structure
KP34+498	Culvert	900 mm	New structure
KP34+571	Culvert	900 mm	New structure
KP34+662	Culvert	900 mm	New structure
KP34+688	Culvert	900 mm	New structure
KP34+814	Culvert	900 mm	New structure
KP34+942	Culvert	900 mm	New structure
KP35+013	Culvert	900 mm	New structure
KP35+347	Culvert	900 mm	New structure
KP35+483	Culvert	900 mm	New structure
KP35+732	Box culvert	2 x 2 m	New structure
KP35+917	Culvert	900 mm	New structure
KP36+000	Box culvert	5 x 3.5 m	New structure
KP36+060	Culvert	1200 mm	New structure
KP36+180	Culvert	900 mm	New structure
KP36+240	Culvert	900 mm	New structure
KP36+751	Box culvert	2 x 2 m	New structure
KP36+878	Culvert	900 mm	New structure
KP37+471	Culvert	1200 mm	New structure
KP37+959	Box culvert	2 x 2 m	New structure
KP38+144	Culvert	1200 mm	New structure
KP38+514	Culvert	900 mm	New structure
KP38+886	Culvert	900 mm	New structure
KP39+291	Culvert	900 mm	New structure
KP39+518	Culvert	900 mm	New structure
KP39+700	Box culvert	2 x 2 m	New structure
KP39+727	Box culvert	3 x 2 m	New structure
KP40+085	Box culvert	3 x 3 m	New structure
KP40+360	Culvert	1200 mm	New structure
KP40+430	Culvert	900 mm	New structure
KP40+620	Culvert	900 mm	New structure
KP40+923	Culvert	900 mm	New structure

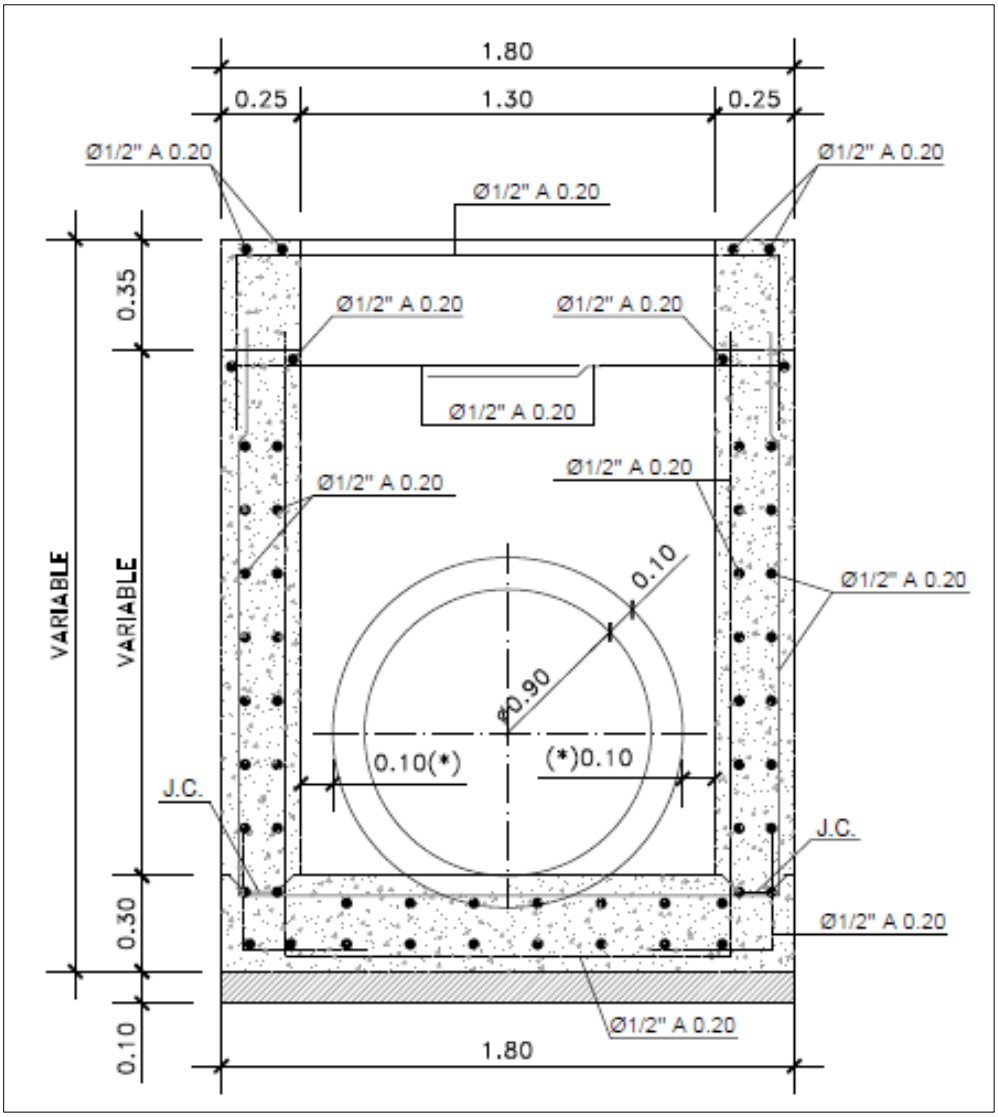
CHAINAGE	DRAINAGE WORK	DIMENSIONS	COMMENTS
KP40+961	Culvert	900 mm	New structure
KP41+749	Box culvert	1 x 1 m	New structure
KP42+108	Box culvert	2 x 2 m	New structure
KP42+274	Culvert	900 mm	New structure
KP42+367	Culvert	900 mm	New structure
KP42+395	Culvert	900 mm	New structure
KP42+604	Culvert	900 mm	New structure
KP42+700	Culvert	900 mm	New structure
KP42+764	Culvert	900 mm	New structure
KP42+881	Culvert	900 mm	New structure
KP43+015	Culvert	900 mm	New structure
KP43+046	Culvert	900 mm	New structure
KP43+082	Culvert	900 mm	New structure
KP43+118	Culvert	900 mm	New structure
KP43+291	Culvert	900 mm	New structure
KP43+489	Box culvert	2 x 2 m	New structure
KP43+543	Culvert	900 mm	New structure
KP43+651	Culvert	1200 mm	New structure
KP43+688	Culvert	900 mm	New structure
KP43+772	Culvert	1200 mm	New structure
KP43+820	Culvert	900 mm	New structure
KP43+846	Culvert	900 mm	New structure
KP43+917	Box culvert	3 x 3 m	New structure
KP43+968	Culvert	900 mm	New structure
KP44+013	Culvert	900 mm	New structure
KP44+071	Culvert	900 mm	New structure
KP44+151	Culvert	900 mm	Expansion of existing structure
KP44+238	Culvert	900 mm	New structure
KP44+317	Culvert	900 mm	New structure
KP44+425	Box culvert	2 x 2 m	New structure
KP44+464	Culvert	900 mm	Expansion of existing structure
KP44+540	Culvert	900 mm	New structure
KP44+580	Culvert	900 mm	New structure
KP44+740	Culvert	900 mm	New structure

Source: Consorcio SH, 2017.

· **Circular culverts.**

In the layout for the San Juan - Pedregal Segment, circular culverts, with concrete pipes 900 mm and 1200 mm in diameter, will be constructed, expanded and/or replaced (as appropriate). **Annex 2. Civil. VII. Drainage. Plans CSH-1-PL-G-G-7106-5_DRAINAGE PLAN, CSH-1-PL-G-G-7107-5_DETAIL, CSH-1-PL-OD-G-7110-5_PIPE CULVERTS** presents the location, plan, elevation and details regarding the circular culverts. By way of an example, **Figure 3.71** presents a cross-section of a circular culvert Ø 900 mm.

Figure 3.71 Cross section, circular culvert Ø 900 mm.

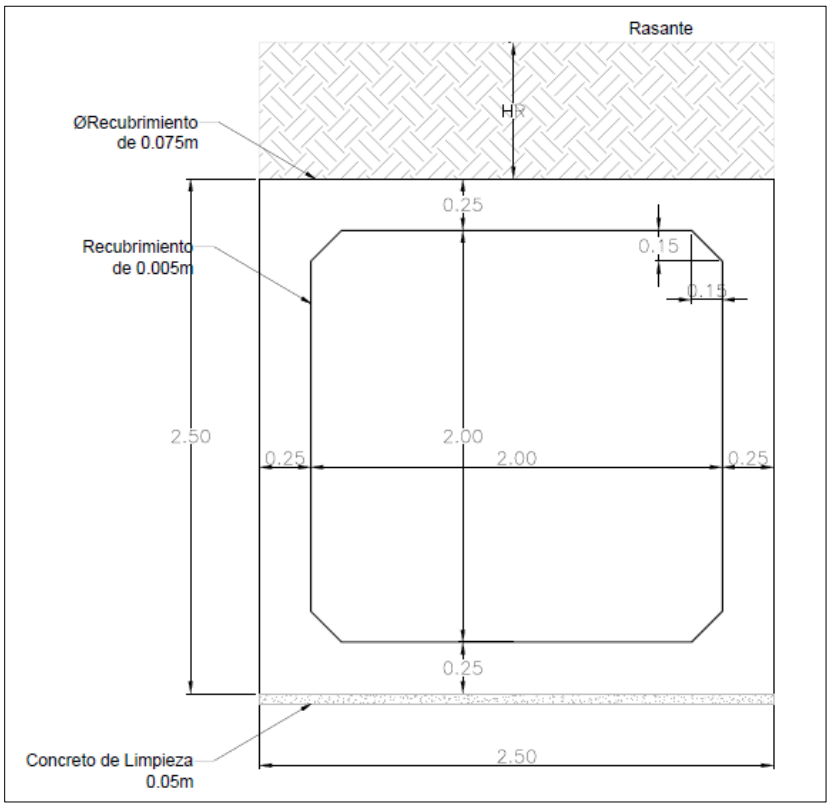


Source: Consorcio SH, 2017.

· **Box culvert.**

In the layout for the San Juan - Pedregal Segment, reinforced concrete box culverts will be constructed and/or replaced (as appropriate), with boxes measuring 1.0 x 1.0 m, 1.5 x 1.5 m, 2.0 x 2.0 m, 3.0 x 2.0 m, 3.0 x 3.0 m and 5.0 x 3.5 m. **Annex 2. Civil. VIII. Structures**, provides the specific designs for these structures. By way of an example, **Figure 3.72** presents the geometry for a box culvert with a 2.0 x 2.0 m box.

Figure 3.72 Geometry of a box culvert with a 2.0 x 2.0 m box.



Source: Consorcio SH, 2017.

· **Bridges.**

The information regarding the bridges that will be built for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment was presented in section **3.2.3.1.3 Project Transport Infrastructure. Bridges**.

· **Supplementary works for water disposal.**

Due to the layout and the land's topography, many of the culverts require energy dissipation works (at the entry and exit to drainage works) and channeling.

· **Water energy dissipaters (at entry)**

At the entry to certain culverts (circular and box), stepped chutes will be built (see **Annex 2. Civil. VII. Drainage. Plan CSH-3-PL-G-G-7107-1_DETAIL**) to direct the flow from the top of the clearing to the inner culvert. **Table 3.28** lists the culverts that will have these stepped chutes (at entry) and the parameters thereof.

Table 3.28

Planned water energy dissipaters (at entry) in the form of stepped chutes.

LOCATION	CULVERT	H (m)	L (m)	RISER (H) (m)	TREAD (m)	WIDTH (m)
15+873	Pipe 1200 mm	12.00	15.00	1.00	0.33	1.00
16+001	Pipe 900 mm	12.00	15.00	1.00	0.33	1.00
16+432	Pipe 900 mm	12.00	15.00	1.00	0.33	1.00
17+303	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
18+089	Box 2x2	15.00	16.77	1.00	0.50	2.00
18+169	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
20+261	Pipe 900 mm	12.00	15.00	1.00	0.75	1.50
20+389	Pipe 900 mm	12.00	15.00	1.00	1.00	1.00
20+566	Pipe 1200 mm	12.00	15.00	1.00	0.75	1.00
21+341	Pipe 1200 mm	12.00	15.00	1.00	0.75	1.00
21+640	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
22+104	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
23+051	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
23+180	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
23+978	Pipe 900 mm	12.00	15.00	1.00	0.75	2.00
24+661	Box 2x2	12.00	15.00	1.00	0.75	1.00
25+570	Pipe 1200 mm	12.00	15.00	1.00	1.00	1.00
26+359	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
26+359	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
27+043	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
27+551	Pipe 1200 mm	12.00	15.00	1.00	0.75	1.00
30+556	Pipe 900 mm	14.00	15.00	1.00	0.75	1.00
30+879	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
31+558	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
32+337	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
32+337	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
32+489	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
32+809	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00

LOCATION	CULVERT	H (m)	L (m)	RISER (H) (m)	TREAD (m)	WIDTH (m)
33+420	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
33+531	Pipe 1200 mm	12.00	15.00	1.00	0.75	1.00
33+531	Pipe 1200 mm	15.00	15.81	1.00	0.33	1.00
33+690	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
33+690	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
34+120	Pipe 1200 mm	12.00	15.00	1.00	0.75	1.00
34+120	Pipe 1200 mm	15.00	15.81	1.00	0.33	1.00
34+175	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
34+175	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
34+249	Box 1.5x1.5	12.00	15.00	1.00	0.75	1.00
34+341	Pipe 1200 mm	12.00	15.00	1.00	0.75	1.00
34+341	Pipe 1200 mm	15.00	15.81	1.00	0.33	1.00
34+510	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
34+730	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
34+802	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
34+802	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
34+889	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
34+931	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
35+048	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
35+048	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
35+172	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
35+245	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
35+245	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
35+591	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
35+740	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
36+489	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
37+126	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
37+696	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
38+660	Pipe 900 mm	12.00	15.00	1.00	0.75	1.00
39+420	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
41+297	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
41+431	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
42+191	Pipe 1200 mm	12.00	15.00	1.00	0.75	1.00
43+110	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
43+107	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
43+181	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00

LOCATION	CULVERT	H (m)	L (m)	RISER (H) (m)	TREAD (m)	WIDTH (m)
43+181	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
43+177	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
43+350	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
44+015	Pipe 900 mm	15.00	15.00	1.00	1.00	1.00
44+207	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
44+207	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
44+254	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
44+254	Pipe 900 mm	15.00	15.81	1.00	0.33	1.00
45+004	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00
45+037	Pipe 900 mm	15.00	16.77	1.00	0.50	1.00

Source: Consorcio SH, 2017.

- **Water energy dissipaters (at exit)**

Due to the terrain that houses the layout for the Rumichaca - Pasto Divided Highway Project, it is necessary to build energy dissipaters at the exit of many of the culverts (circular and square) in order to avoid the uncontrolled flow of water. These structures will be of two types:

Water energy dissipaters (at exit) in the form of stepped chutes

These structures will be constructed to direct the flow of the water collected from the culvert and deliver such water, conforming -to the extent possible- to the slope's gradient (see **Annex 2. Civil. VII. Drainage. Plan CSH-3-PL-G-G-7107-1_DETAIL**). **Table 3.29** lists the culverts for which these water energy dissipaters (at exit) will be built, and the parameters for the stepped chutes.

Table 3.29 Planned water energy dissipaters (at exit) in the form of stepped chutes.

LOCATION	CULVERT	H (m)	L (m)	RISER (H) (m)	TREAD (m)	WIDTH (m)
16+503	Box 3X2	9.00	18.80	1.00	1.50	3.00
20+905	Box 3X3	5.00	10.30	1.00	1.50	3.00
22+554	Box 3X3	22.20	41.80	0.65	1.00	3.00
23+305	Box 2X2	5.00	9.50	0.67	1.00	2.00
24+354	Box 3X2	12.00	26.80	0.56	1.00	3.00
24+661	Box 2X2	7.00	9.20	1.00	1.00	2.00
24+835	Box 3X2	5.00	9.40	0.62	1.00	3.00
25+835	Box 1.5X1.5	27.69	49.69	0.67	1.00	1.50
29+832	Box 3X2	8.66	16.48	0.67	1.00	1.50
29+994	Box 3X2	3.00	5.80	0.67	1.00	1.50
39+828	Box 3X2	28.14	50.75	0.67	1.00	3.00
40+383	Box 3X2	26.00	46.87	0.67	1.00	3.00
43+792	Box 1.5X1.5	2.75	6.54	0.90	1.50	1.50

Source: Consorcio SH, 2017.

Water energy dissipaters (at exit), rapid channel, with cover and swing (CRTC)

These types of structure will be built in order to manage the water flowing through the circular culverts (Ø900 mm and Ø1200 mm). These structures will have a smooth bottom and walls, and will have parallel filters to avoid uplift thrust. For circular culverts measuring Ø900 mm, CRTC energy dissipaters (at exit) shall have a width of 1.0 m, and for circular culverts measuring Ø1200 mm, CRTC energy dissipaters (at exit) shall have a width of 1.0 m (see **Annex 2. Civil. VII. Drainage. Plan CSH-3-PL-G-G-7107-1_DETAIL**).

· **Channeling**

The construction of channeling is planned for certain culverts in the project. The aim is to direct the flow to ground level. They will be built to be trapezoidal in shape and will be covered in rock. **Table 3.30** sets out the culverts that will have this type of structure, as well as the parameters for the channeling.

Table 3.30 Planned channeling.

LOCATION	CULVERT	BASE (m)	HEIGHT (m)	SLOPE	DEPTH (m)
19+780	Box 2x2	3.00	1.50	3H/4V	1.474
20+389	Pipe 900 mm	1.70	1.50	3H/4V	0.222
21+341	Pipe 1200 mm	2.05	1.50	3H/4V	0.429
21+640	Pipe 900 mm	1.70	1.50	3H/4V	0.299
23+051	Pipe 900 mm	2.05	1.50	3H/4V	0.045
23+180	Pipe 900 mm	1.70	1.50	3H/4V	0.061
23+458	Box 2x2	3.00	1.50	3H/4V	0.498
23+978	Pipe 900 mm	1.70	1.50	3H/4V	0.079
25+570	Pipe 1200 mm	2.05	1.50	3H/4V	0.484
26+359	Pipe 900 mm	1.70	1.50	1H/2V	0.160
27+043	Pipe 900 mm	1.70	1.50	1H/2V	0.219
27+551	Pipe 1200 mm	2.05	1.50	1H/2V	0.202
30+879	Pipe 900 mm	1.70	1.50	1H/2V	0.198
32+203	Box 4x2	4.00	1.50	1H/2V	1.251
32+337	Pipe 900 mm	1.70	1.50	1H/2V	0.140
34+120	Pipe 1200 mm	2.05	1.50	1H/2V	0.584
34+175	Pipe 900 mm	1.70	1.50	1H/2V	0.066
34+802	Pipe 900 mm	1.70	1.50	1H/2V	0.196
34+889	Pipe 900 mm	1.70	1.50	1H/2V	0.198
35+048	Pipe 900 mm	1.70	1.50	1H/2V	0.148
35+245	Pipe 900 mm	1.70	1.50	1H/2V	0.117
35+740	Pipe 900 mm	1.70	1.50	1H/2V	0.183
36+489	Pipe 900 mm	1.70	1.50	1H/2V	0.151
37+696	Pipe 900 mm	1.70	1.50	1H/2V	0.402

LOCATION	CULVERT	BASE (m)	HEIGHT (m)	SLOPE	DEPTH (m)
41+297	Pipe 900 mm	1.70	1.50	1H/2V	0.260
41+431	Pipe 900 mm	1.70	1.50	1H/2V	0.196
42+191	Pipe 1200 mm	2.05	1.50	1H/2V	0.709
43+177	Pipe 900 mm	1.70	1.50	1H/2V	0.093
44+207	Pipe 900 mm	1.70	1.50	1H/2V	0.183
44+254	Pipe 900 mm	1.70	1.50	1H/2V	0.164

Source: Consorcio SH, 2017.

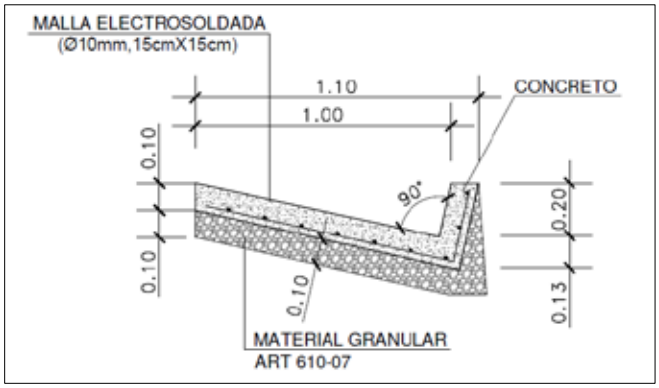
· **Longitudinal.**

Below is a general description of the longitudinal drainage to be built for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment. This drainage will be responsible for collecting and evacuating surface water from the road's slopes and its platform. **Annex 2. Civil. VII. Drainage.** presents the specific designs for these works.

· **Side gutter**

The side gutter defined for the project is consistent with the typical gutter recommended by the INVIAS Road Drainage Manual. It is a triangular-section gutter, with a width of 1.00 m and a depth of 0.20 m, forming an angle of 90° at its slopes. The gutter will be covered with 10 cm of concrete, reinforced with electro-welded mesh and will be supported on a layer of granular material (see **Figure 3.73**).

Figure 3.73 Cross-section of side gutter.

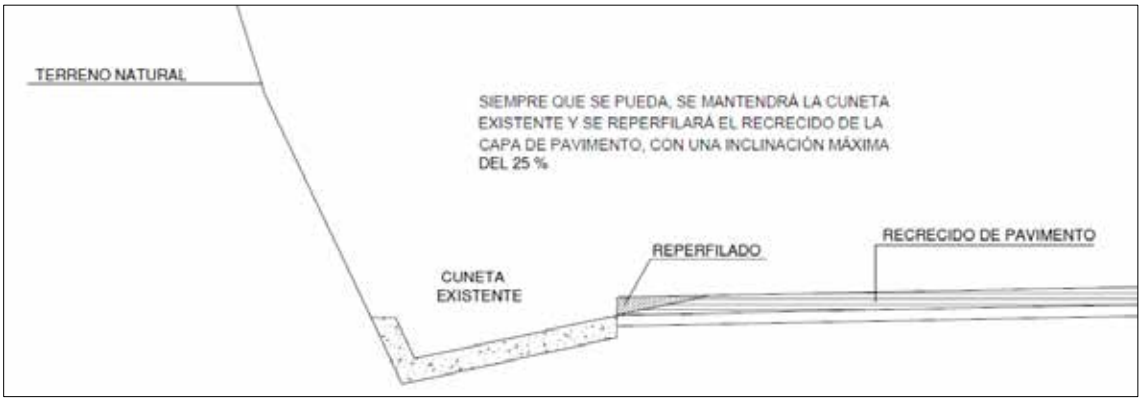


Source: Consorcio SH, 2017.

With regard to reinforcement of the gutter, at the discretion of the construction company, it will also be possible to build the gutter in alternate sections measuring 2 or 3 m in length, so that, as there would be no cracking caused by shrinkage, there would be no need for reinforcement.

In segments comprising the use of the existing roadway, the existing gutter shall be maintained wherever possible. These have the same dimensions as the one planned, and therefore the same hydraulic capacity (see **Figure 3.74**).

Figure 3.74 Use of existing gutter.



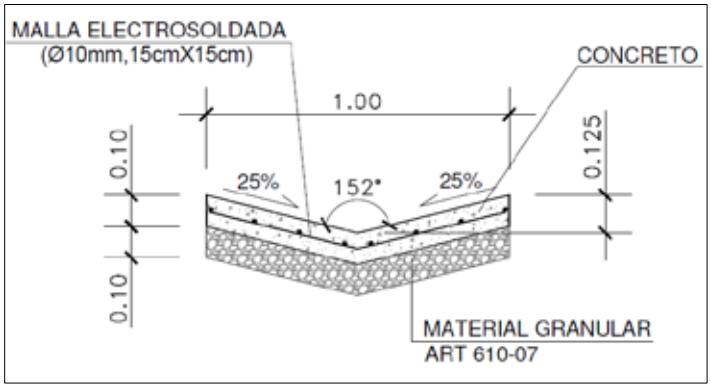
Source: Consorcio SH, 2017.

· **Median gutter – Median strip.**

In divided highway sections with parallel roadways, the project will have median gutters to receive runoff from the top platform in curved sections, to then direct the water to the drainage points.

The gutter planned for the median strip will have a triangular, symmetrical section, be 1.00 m wide and 0.125 m deep, with its slopes forming an angle of 152°. The gutter will be covered with 10 cm of concrete, electro-welded mesh, and it will be supported on a layer of granular material (see **Figure 3.75**).

Figure 3.75 Cross-section of median strip gutter.



Source: Consorcio SH, 2017.

With regard to reinforcement of the gutter, at the discretion of the construction company, it will also be possible to build the gutter in alternate sections measuring 2 or 3 m in length, so that, as there would be no cracking caused by shrinkage, there would be no need for reinforcement.

· **Interceptor ditch.**

These will be located in the foot of the embankment and at the top of the cut, will have a minimum rectangular cross-section of a 0.40 m at the base, and a height of 0.50 m.

Depending on the area that feeds into the interceptor ditches, a series of dimensions has been defined, with sufficient capacity to transport the flow. As a result, interceptor ditches of the following dimensions have been defined:

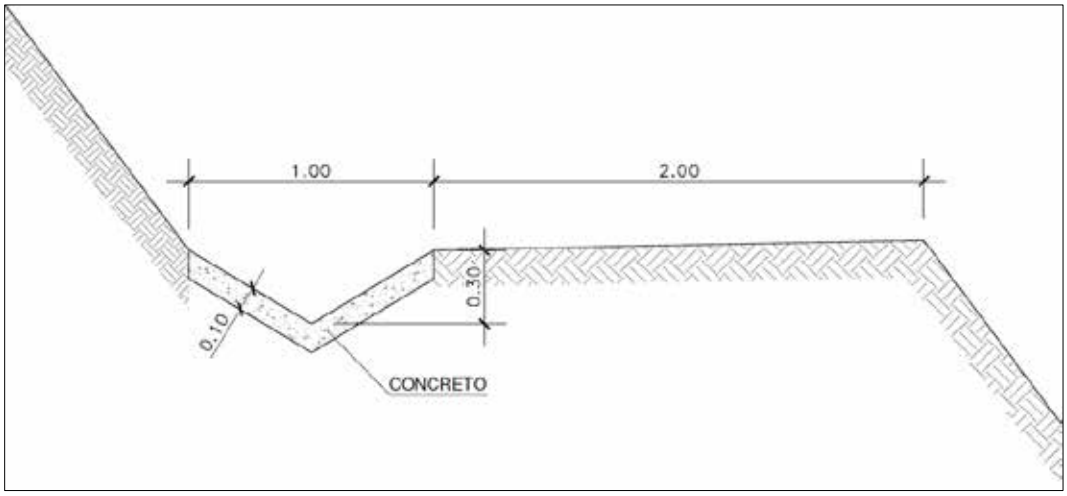
- Interceptor ditch, rectangular cross-section, base 0.40 m and height 0.50 m (minimum dimension of the interceptor ditch).
- Interceptor ditch, rectangular cross-section, base 0.60 m and height 0.50m.
- Interceptor ditch, trapezoidal cross-section, base 0.60 m, height 0.50m and slope 3H/2V.
- Interceptor ditch, trapezoidal cross-section, base 0.40 m, height 0.50m and slope 1H/1V.
- Interceptor ditch, trapezoidal cross-section, base 0.60 m, height 0.50m and slope 1H/1V.
- Interceptor ditch, trapezoidal cross-section, base 1.0 m, height 0.50 m and slope 3H/2V.

All interceptor ditches shall be covered (covered with 10 cm of concrete and electro-welded mesh), founded on a layer of granular material, and with expansion joints every 2 or 3 m (at the discretion of the construction company). There will be at least 2.0 m of separation between the foot of the embankment slope or the top of the cut slope, and the edge of the interceptor ditch (see **Annex 2. Civil. VII. Drainage. Plan CSH-1-PL-G-G-7107-5_DETAIL**).

· **Berm gutters.**

Symmetrical triangular cross-section, 1.0 m wide, 3.0 m deep, coated in concrete (see **Figure 3.76**).

Figure 3.76 Cross section of berm gutter.

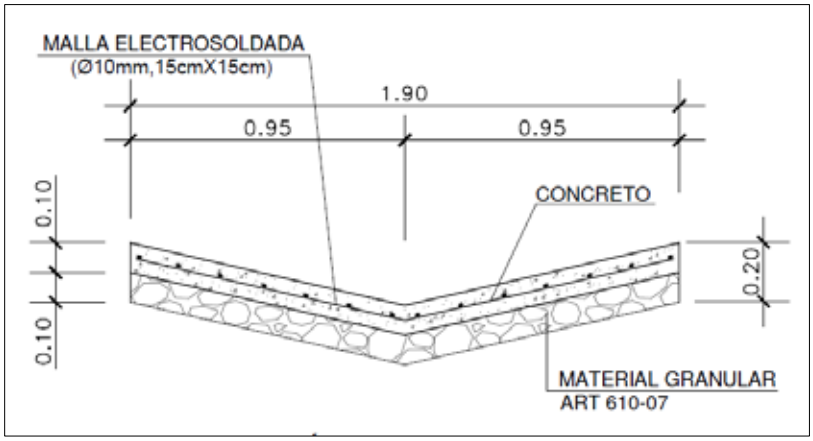


Source: Consorcio SH, 2017.

· **Channel gutter in access.**

Symmetrical triangular cross-section, 1.90 m wide, 0.20 m deep, coated in concrete, reinforced with electro-welded mesh, and founded on a layer of granular material (see **Figure 3.77**).

Figure 3.77 Cross section of channel gutter in access.

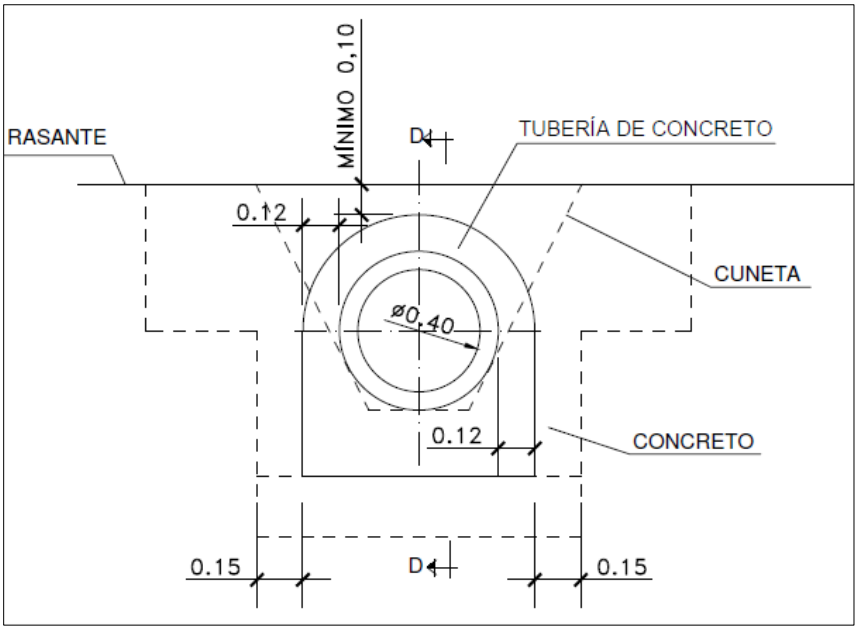


Source: Consorcio SH, 2017.

· **Gutter pipe.**

Reinforced concrete pipe 400 mm in diameter (see **Figure 3.78**).

Figure 3.78 Cross section - gutter pipe.

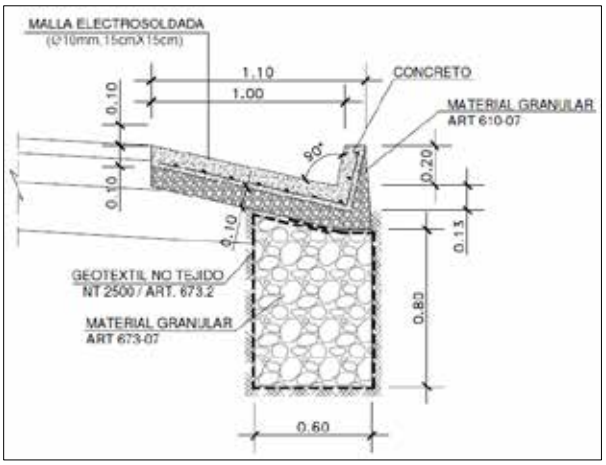


Source: Consorcio SH, 2017.

· **Sub-drainage infrastructure.**

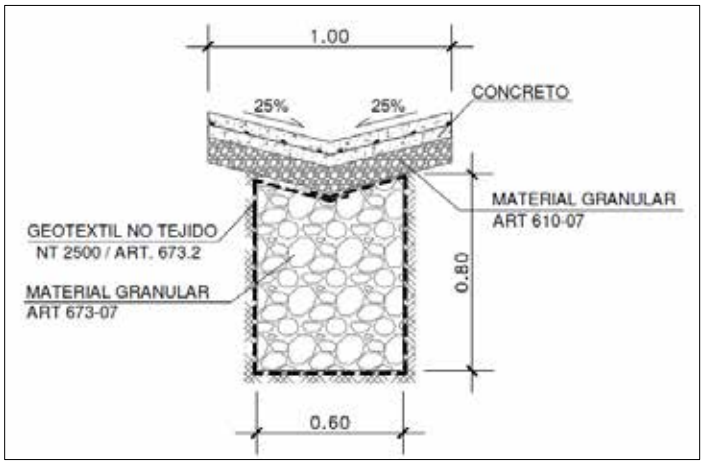
Longitudinal drains will be established on the road, built at the foot of the slope, and these will consist of a rectangular ditch filled with filtering material. The fill will be wrapped in geotextile, which will avoid contamination and obstruction of the filter material. These elements will be placed in sectors where cuts are made to establish the road (mixed or box sections), in order to address flows that would otherwise tend to saturate and weaken the slopes made. These filters will be built under the side gutters in cuts (see **Figure 3.79**) and median strip ditches (see **Figure 3.80**).

Figure 3.79 Cross section of side gutter in cuts, and filter.



Source: Consorcio SH, 2017.

Figure 3.80 Cross-section of median strip gutter, and filter.



Source: Consorcio SH, 2017.

· **Surface water channel crossings.**

Below, **Table 3.31**, sets outs the surface water channel crossing sites for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment.

Table 3.31 Surface water channel crossing sites.

NAME OF WATER BODY	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PROPOSED WORK
		EAST	NORTH	
NN1	KP16+120	946811.93	589397.70	Box culvert 2 x 2 m
NN2	KP16+503	947121.83	589603.72	Box culvert 3 x 2 m
Boquerón River	KP18+700 and KP18+960	948301.45	591158.78	Boquerón Bridge
Yamurayán Stream	KP20+831	949114.02	592065.11	Box culvert 3 x 3 m
NN3	KP22+428	950054.08	593102.63	Box culvert 3 x 3 m
Guayarín Stream	KP23+157	950212.94	593774.90	Box culvert 2 x 2 m
NN4	KP23+370	950321.61	593956.90	Box culvert 1.5 x 1.5 m
NN5	KP24+136	950636.07	594629.81	Box culvert 3 x 2 m
NN5	KP24+136	950617.38	594684.56	Box culvert 3 x 2 m
NN6	KP24+315	950764.62	594725.77	Box culvert 2 x 2 m
NN7	KP24+525	950967.72	594782.47	Box culvert 2 x 2 m
NN8	KP25+529	951686.27	595151.47	Culvert 900 mm
Manzano Stream	KP25+589	951906.14	595274.20	Culvert 1200 mm
Brigada Stream	KP25+952	952253.56	595420.32	Culvert 1200 mm
NN9	KP26+440	952669.62	595499.39	Culvert 900 mm
NN1 Tributary to the La Humeadora Stream	KP28+516	954206.18	596624.50	Culvert 900 mm
NN2 Tributary to the La Humeadora Stream	KP28+516	954290.20	596720.59	Culvert 900 mm
NN10	KP28+677	954363.00	596797.00	Culvert 900 mm
Los Arrayanes Stream	KP29+212	954729.44	597199.25	Box culvert 3 x 2 m
Manzano Stream	KP29+437	954925.68	597342.18	Box culvert 3 x 2 m
NN11	KP29+593	955050.07	597431.63	Box culvert 3 x 2 m
Urbano Stream	KP29+756	955178.38	597501.33	Box culvert 3 x 2 m
NN12	KP30+040	955429.67	597508.01	Culvert 900 mm
NN13	KP30+880	955776.28	598034.29	Culvert 900 mm
NN14	KP31+746	955959.13	598715.59	Culvert 1200 mm
Moledores Stream	KP32+103	955961.93	598913.93	Culvert 900 mm
El Tablón Stream	KP32+729	954964.97	600264.24	Culvert 900 mm
NN15	KP33+863	954928.86	600362.86	Culvert 1200 mm

NAME OF WATER BODY	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST		PROPOSED WORK
		EAST	NORTH	
NN16	KP34+018	954892.74	600499.78	Box culvert 1.5 x 1.5 m
NN17	KP34+107	954867.24	600605.07	Culvert 1200 mm
NN18	KP34+350	954841.74	600838.89	Box culvert 1.5 x 1.5 m
NN19	KP35+732	954860.08	601994.55	Box culvert 2 x 2 m
NN1 Tributary to the San Francisco Stream	KP35+917	954632.16	602074.88	Culvert 900 mm
San Francisco Stream	KP36+000	954609.64	602099.98	Box culvert 5 x 3.5 m
Macal Stream	KP37+100 y KP37+285	953951.30	602936.63	Macal Stream Bridge
NN20	KP36+751	954134.22	602589.08	Box culvert 2 x 2 m
NN21	KP36+878	954020.90	602661.87	Culvert 900 mm
NN22	KP37+959	954012.69	603620.06	Box culvert 2 x 2 m
NN26	KP38+624 y KP38+849	954465.82	604275.77	El Porvenir rural district Bridge
NN23	KP39+700	953918.82	604516.47	Box culvert 2 x 2 m
NN23	KP40+085	953963.00	604813.00	Box culvert 3 x 3 m
Sapuyes River	KP41+056.60 y KP42+256.60	955313.95	604941.52	Sapuyes River Bridge
NN24	KP44+013	956818.81	605952.00	Culvert 900 mm
NN25	KP44+425	956886.56	606301.41	Box culvert 2 x 2 m

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.3.1.5 Geotechnical infrastructure.

In order to meet the geotechnical needs for the layout of the Rumichaca - Pasto Divided Highway Project, San Juan Pedregal Segment, various solutions are presented, as follows:

- Fill support on non-compacted dumps and paleosols.
- Establishment of walls in the mid-slope, to avoid the construction of high fills.
- Establishment of hillside fills.
- Establishment of high fills.

Below is a description of the geotechnical works to be carried out during the course of the project. It should be noted that **Annex 2. Civil. V. Slopes** provides the specific designs for these works.

· **Typical geotechnical and/or stability works.**

o Cut slopes.

The upper slope areas, where the material is more disturbed and is less apt, will be re-excavated in the first meters of the slope at a gradient of 2H/1V.

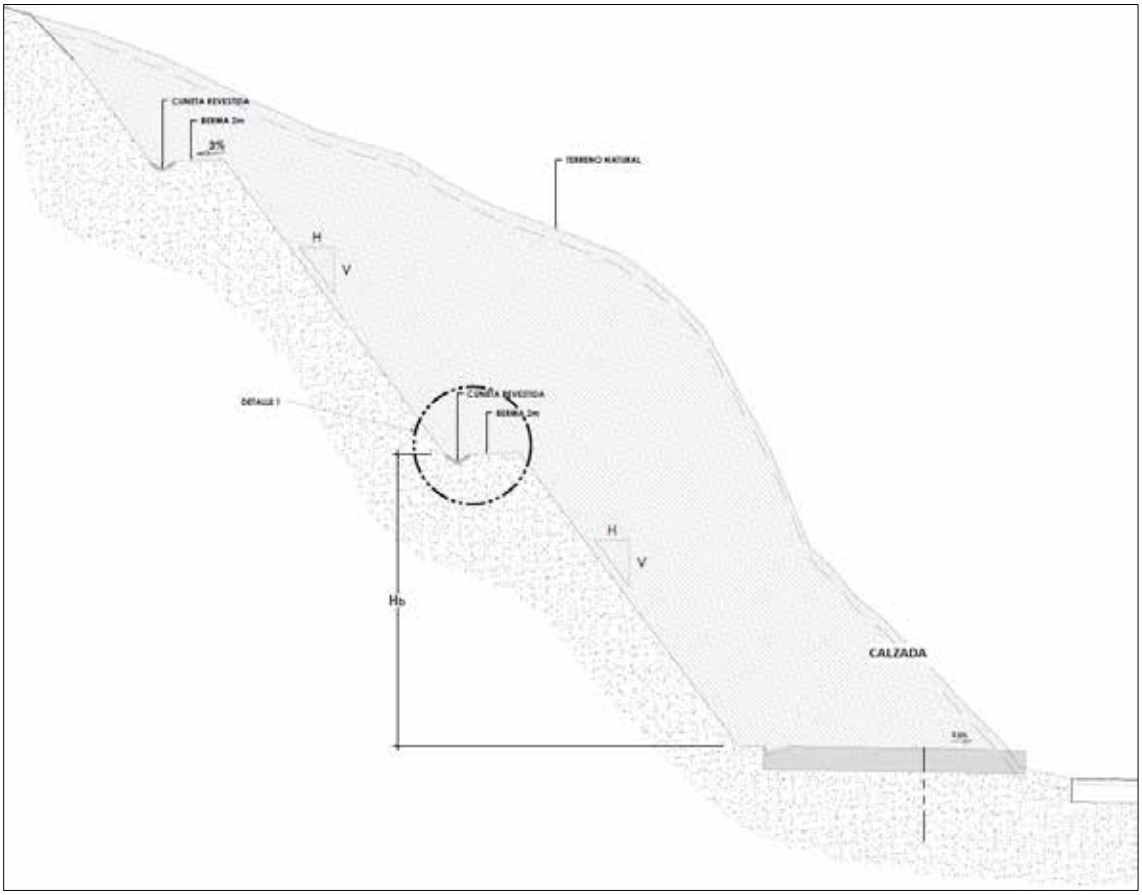
In order to avoid gullies from arising, in addition to the guard gutter at the top, practically the entire slope area will be covered with vegetation.

- Fill slopes.
- Berms.

The use of berms is reserved for slopes of heights greater than 20 m, foreseeing a berm every 15 meters in height, and we will study this arrangement in detail in case it entails substantial increases in the height of the cut. In cases where the materials are less suitable, the distance between berms will be reduced to 12 meters, allowing for berm-less slopes (less than 15 meters high).

The berms will have an inner, coated gutter. To prevent water from infiltrating the cut and runoff from spilling onto the lower slope, the berms should slope towards the inner gutter (3%). The berms should receive periodic maintenance to ensure their correct operation and avoid counter-productive effects regarding the durability and stability of the slope, and therefore the minimum width will be 3 meters (see **Figure 3.81**).

Figure 3.81 Typical cross section of clearing excavation.

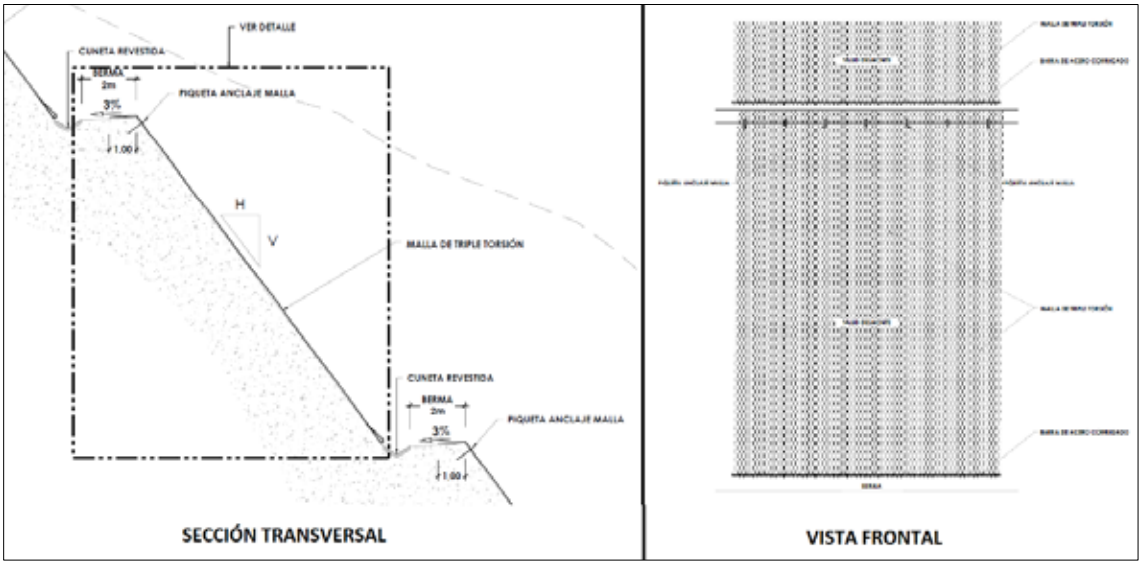


Source: Consorcio SH, 2017.

o Slope mesh.

Consists of a triple torsion mesh attached to the cut, where material that detaches from the slopes is retained, as long as they relate to small volumes, thus avoiding the uncontrolled fall of material to the roadway. In cuts where boulders are present, slope mesh will be put in place to avoid their potential uncontrolled fall on to the road (see **Figure 3.82**).

Figure 3.82 Detail of typical slope mesh.

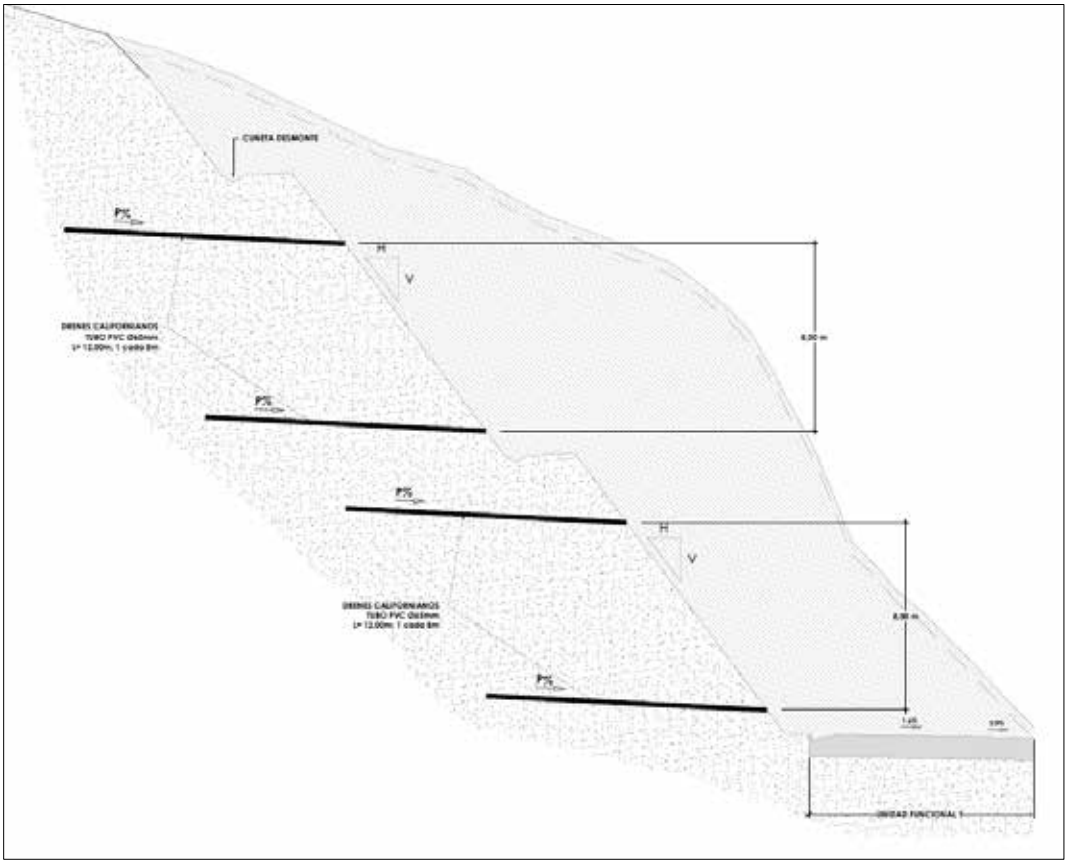


Source: Consorcio SH, 2017.

- Horizontal drains.

On slopes where water emerges, horizontal drains (see **Figure 3.83**) will be made to avoid the occurrence of uplift.

Figure 3.83 Typical cross section, horizontal drains.



Source: Consorcio SH, 2017.

- Protection of traffic on the existing roadway.

For the areas where a second roadway will be built (parallel to the existing roadway), and in order to carry out these excavations and avoid small falls of material affecting vehicles that travel on the road, a Jersey wall will be placed at the foot of the cleared area, prior to the start of excavations, in the entirety of re-excavation cuts.

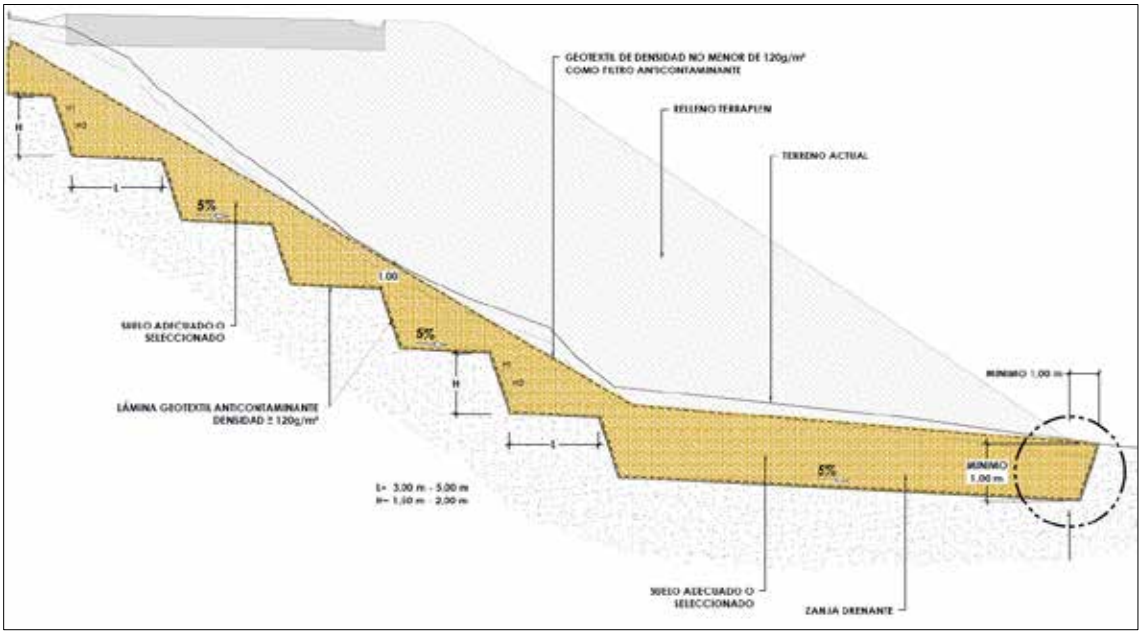
- Treatment of the bottom of the cut

To achieve homogeneous support of the leveled area, 50 cm will be scaled at the bottom of the cut and replaced by soil classified as selected.

- Adzing in hillside fills.

In order to avoid the occurrence of uplift regarding contact of the fill material and the natural terrain, adzing will be carried out in hillside fills using granular material and will be protected by anti-pollution geotextile (see **Figure 3.84**).

Figure 3.84 Typical cross section of adzing in hillside fills.



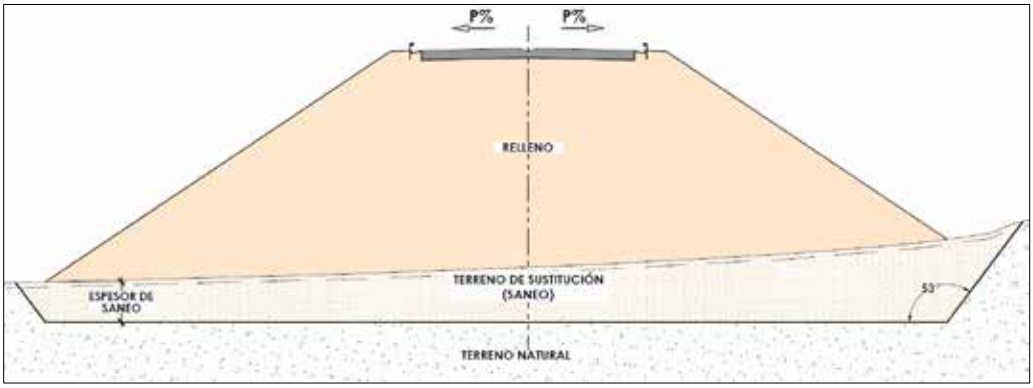
Source: Consorcio SH, 2017.

o Scaling in fill areas.

Support for fills in soils that exhibit low consistency can result in stability problems and the generation of unacceptable settlement. For this reason, they will be scaled and replaced by soil that complies with the technical requirements (see **Figure 3.85**). Thus, the following situations have been considered, and must reflect the materials required in accordance with the characteristics of the support ground and the height of the fill:

- In general, the replacement terrain will have the same characteristics as the body of the fill.
- If the support ground is saturated, the replacement ground will be selected soil or rockfill.
- In cases where all the low-consistency terrain is not replaced due to the fact that the height of the fill to be made is less than 2.0 m, soil catalogued at least as 'selected' will be used as substitute material.

Figure 3.85 Typical cross section of scaling in fills.

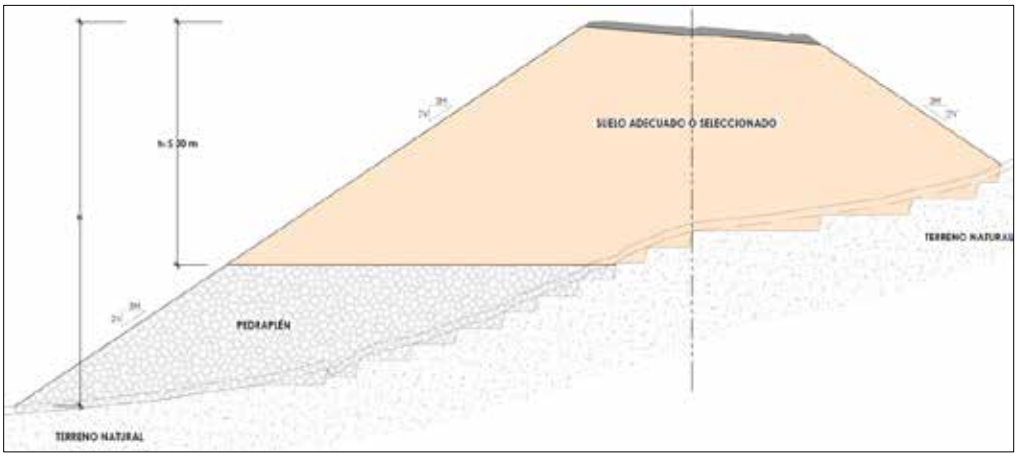


Source: Consorcio SH, 2017.

o Rockfills in fills.

For fills that are more than 20 m in height, the fill body shall be made of material classified as suitable or selected. In addition, fills that are more than 30 m in height will be carried out with suitable or selected soil in terms of the upper 30 m, and the base of the fill will employ rockfill (see **Figure 3.86**).

Figure 3.86 Typical cross section of rockfills in fills.

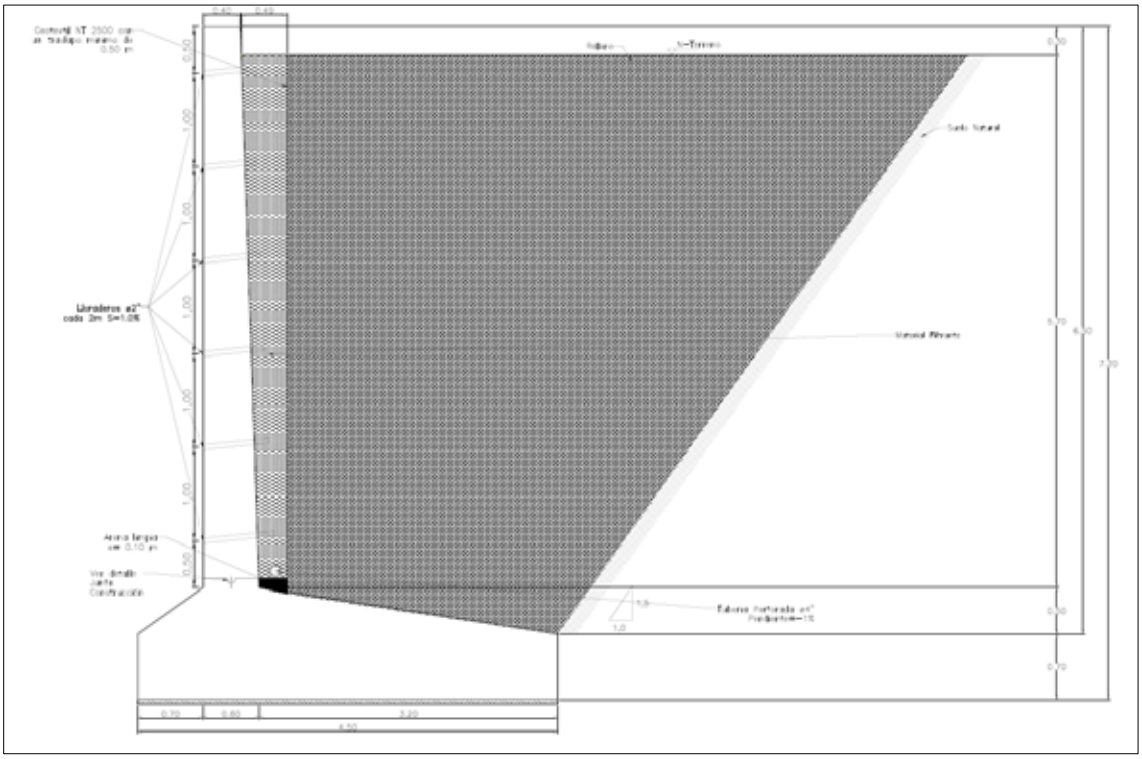


Source: Consorcio SH, 2017.

o Concrete walls.

Concrete walls up to 8.0 m high (rigid structure) will be built in the required sectors, and these will withstand the horizontal thrust of the fill, thanks to their foundations (see **Figure 3.87**). The specific information on the design of concrete walls is set out in **Annex 2. Civil. IV. Foundations. VIII. Structures.**

Figure 3.87 6.0 m high concrete wall.

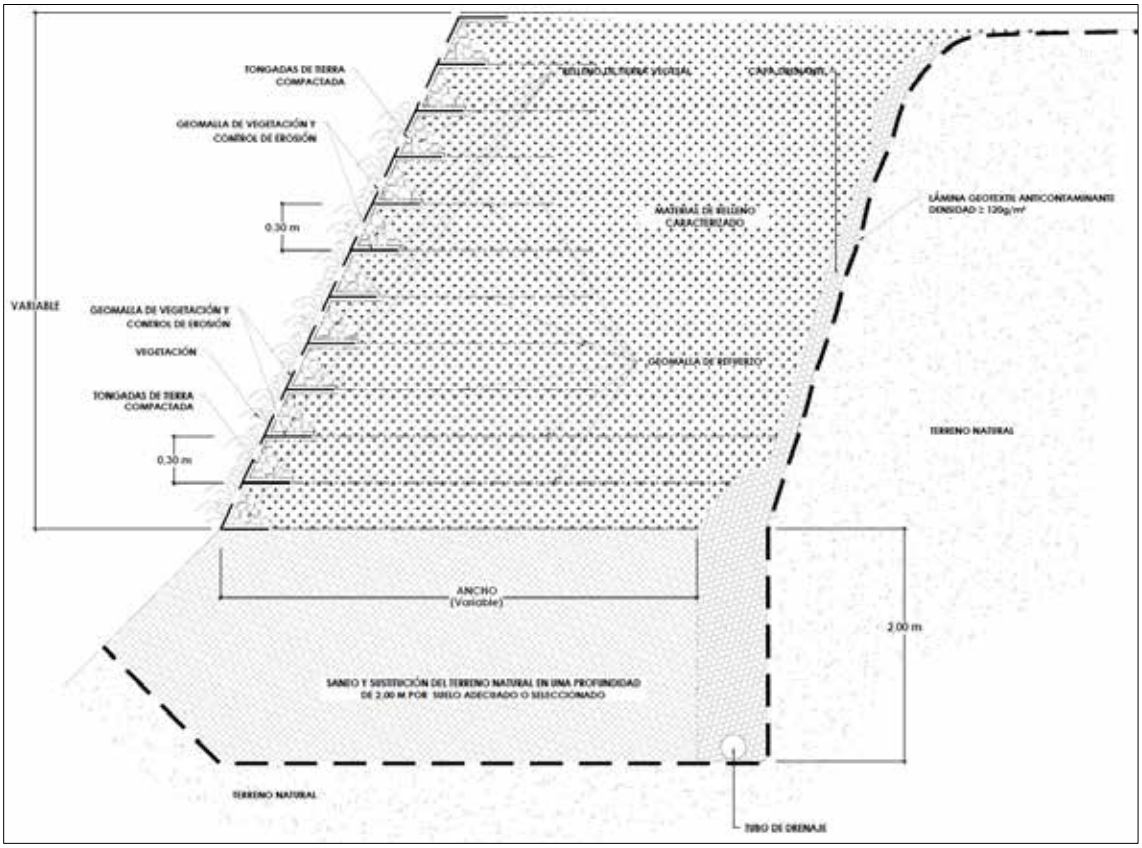


Source: Consorcio SH, 2017.

o Flexible walls.

They will consist of green walls or reinforced earth walls, and will be up to 25 m in height (see **Figure 3.88**). The specific information on the design of flexible walls is set out in **Annex 2. Civil. IV. Foundations. VIII. Structures.**

Figure 3.88 Typical cross section of green or flexible wall.



- **Location of the works.**

Below is the location of the geotechnical stability works, by section and by type (cut or fill).

o Cut location.

In accordance with the characteristics found in the layout for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, the specifications and treatment for cut slopes were defined by section, as set out in **Table 3.32**.

Table 3.32 Sectioning of geotechnical works in cut areas.

SIDE	CHAINAGE		EXCAVATION SLOPE	TREATMENT
	KP START	KP END		
LS	15+750	16+390	1H:3V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m
LS	16+430	16+700	1H:3V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m Slope mesh between KP16+520-KP16+650
LS	17+040	17+720	1H:2V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m Drains between KP17+590- KP17+670
LS	17+800	18+400	1H:2V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m
LS	19+450	20+880	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m
LS	21+000	22+540	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m Drains between KP21+080- KP21+650
LS	22+580	25+180	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m
LS	25+220	25+600	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m Drains between KP25+300- KP25+560
RS	17+000	18+380	1H:2V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 15m starting from a height of 20 m
RS	19+460	25+600	3H:4V 1H/1V: above 2.00 m (Re-excavation)	3m berms every 12m starting from a height of 15 m
-	25+600	29+640	Up to 20.00 m high: 3H:4V Heights greater than 20.00 m: Lower berm 1H:2V Rest at 3H:4V	Berms 3.00 m wide every 12.00 m in height at 3H:4V and every 15.00 m at 1H:2V
-	29+740	29+960	3H:4V	Berms 3.00 m wide every 12.00 m
-	30+010	30+200	3H:4V	Berms 3.00 m wide every 12.00 m Drains in lower berm
-	30+400	31+280	Up to 20.00 m high: 3H:4V Heights greater than 20.00 m: Lower berm 1H:2V Rest at 3H:4V	Berms 3.00 m wide every 12.00 m in height at 3H/4V and every 15.00 m at 1H/2V Drains in lower berm
-	31+340	31+920	Up to 20.00 m high: 3H:4V Heights greater than 20.00 m: Lower berm and following: 1H:2V Rest at 3H:4V	Berms 3.00 m wide every 12.00 m in height at 3H: and every 15.00 m at 1H:2V

SIDE	CHAINAGE		EXCAVATION SLOPE	TREATMENT
	KP START	KP END		
-	32+070	32+700	1H:2V Re-excavation 10.00 m above 3H:4V	Berms 3.00 m wide every 15.00 m in height Drains in lower berm and following
-	32+700	33+050	1H:2V	Berms 3.00 m wide every 15.00 m in height Drains in lower berm and following
-	33+300	33+940	1H:3V Re-excavation 15.00 m above 3H:4V	Berms 1.00 m wide at 15.00 m in height KP 33+360 a 33+410: Area slope mesh 1H:3V. KP 33+610 a 33+720: Area slope mesh 1H:3V.
-	34+030	34+460	1H:3V Re-excavation 20.00 m above 3H:4V	Berms 1.00 m wide every 15.00 m in height at 1H:3V KP 34+070 to 34+100: Area slope mesh 1H:3V. KP 34+130 to 34+200: Area slope mesh 1H:3V. KP 34+280 to 34+390: Area slope mesh 1H:3V. KP 34+390 a 34+490: Triple-twist mesh reinforced with wire grid
-	34+460	34+570	1H:3V	Berms 1.00 m wide every 15.00 m in height at 1H:3V 34+490 a 34+540: Area slope mesh 1H:3V.
-	34+590	35+620	2 Lower berms 1H:3V, Rest 1H:2V	Berms 1.00 m wide every 15.00 m in height at 1H:3V Berms 3.00 m wide every 15.00 m in height en 1H:2V From KP 34+600 a 34+690: Area slope mesh 1H:3V. From KP 34+750 a 34+880: Area slope mesh 1H:3V. From KP 34+940 a 35+150: Area slope mesh 1H:3V. From KP 35+200 a 35+620: Area slope mesh 1H:3V.
-	35+620	35+980	2 Lower berms: 1H:3V Rest 1H:2V	Berms 1.00 m wide every 15.00 m in height at 1H:3V Berms 3.00 m wide every 15.00 m in height en 1H:2V KP 35+620 a 35+710: Area slope mesh 1H:3V KP 35+810 a 35+930: Area slope mesh 1H:3V
-	36+020	36+180	1H:3V	1.00 m berms every 15.00 m in height KP 36+030 a 36+110: Triple-twist mesh reinforced with wire grid. KP 36+110 a 36+130: slope mesh
-	36+300	36+980	1H:2V	Berms 3.00 m wide every 15.00 m in height
-	37+020	37+350	1H:3V	Berms 1.00 m wide every 15.00 m in height KP 37+140 a 37+200: Area slope mesh 1H:3V KP 37+200 a 37+280: Triple-twist mesh reinforced with wire grid. KP 37+280 a 37+330: Area slope mesh 1H:3V
-	37+530	37+600	2 Lower berms: 1H:2V Rest 3H:4V	Berms 3.00 m wide every 15.00 m in height at 1H:2V Berms 3.00 m wide every 12.00 m in height at 3H:4V Drains throughout the slope
-	37+700	37+945	2 Lower berms: 1H:2V Rest 3H:4V	Berms 3.00 m wide every 15.00 m in height at 1H:2V Berms 3.00 m wide every 12.00 m in height at 3H:4V Drains throughout the slope
-	38+320	38+780	1H:2V	Berms 3.00 m wide every 15.00 m in height Drains in lower berm
-	38+980	39+820	1H:2V	Berms 3.00 m wide every 15.00 m in height
-	39+880	40+140	3H:4V	Berms 3.00 m wide every 12.00 m in height Drains throughout the slope
-	40+230	40+320	3H:4V	Berms 3.00 m wide every 12.00 m in height
-	41+200	42+020	RS: Lower berm 1H:3V, rest 3H:4V LD: 3H:4V	RS: Lower berm 1.00 m wide at 15.00 m in height, rest Berms 3.00 m wide every 12.00 m in height LS: Berms 3.00 m wide every 12.00 m in height Drains between KP 41+600 and 42+100

SIDE	CHAINAGE		EXCAVATION SLOPE	TREATMENT
	KP START	KP END		
-	42+250	43+560	From KP 42+250 to 43+000: 3H:4V From KP 43+000 to 43+560: 10.00 m above 1H:2V and rest 1H:3V	KP 42+250 to 43+000: Berms 3.00 m wide every 12.00 m in height KP 43+000 to 43+560: Berm 1.00 m wide every 15.00 m in height. KP 43+210 opt 43+230: Triple-twist mesh reinforced with wire grid. KP 43+230 to 43+270: Slope mesh KP 43+450 to 43+490: Slope mesh on LS KP 43+490 to 43+540: Triple-twist mesh reinforced with wire grid on LS KP 43+450 to 43+490: Triple-twist mesh reinforced with wire grid on RS Drains throughout the slope between KP. 42+280 and 42+580 Specific drainage where water emerges between KP. 43+140 and 43+560
-	43+880	44+360	Lower berm 1H:3V, rest 1H:2V	1.00 m berm at 15.00 m in height at 1H:3V Berms 3.00 m wide every 15.00 m in height at 1H:2V Specific drainage where water emerges
-	44+660	44+840	10.00 m above 1H:2V and rest 1H:3V	1.00 m berm every 15.00 m in height

Source: Consorcio SH, 2017.

o Location of fill works

In accordance with the characteristics found in the layout for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, the specifications and treatment for fill slopes were defined by section, as set out in **Table 3.33**.

Table 3.33 Sectioning of geotechnical works in fill areas.

CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
15+980	15+990	3H:2V	Stepped slope
16+470	16+500	3H:2V	Concrete Wall
16+720	16+830	3H:2V	RS. Flexible wall, 110 m in length and 14.35 m in height
17+060	17+120	3H:2V	RS. Flexible wall, 60 m in length and 12.02 m in height
17+120	17+155	3H:2V	RS. Flexible wall, 35 m in length and 6.42 m in height
17+260	17+335	-	Concrete Wall - Between roadways
17+460	17+570	3H:2V	RS. Flexible wall,110 m in length and 13.63 m in height
17+570	17+580	3H:2V	RS. Flexible wall, 10 m in length and 4.09 m in height
17+650	17+820	3H:2V	Fill carried out with suitable or selected soil Stepped slope
17+650	17+820	3H:2V	Fill carried out with suitable or selected soil Stepped slope
17+820	17+880	-	Concrete Wall - Upper plastering
17+970	17+980	3H:2V	Concrete Wall
18+100	18+180	3H:2V	Scaling 2.5 m
18+380	18+420	3H:2V	Scaling 2.5 m

CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
18+420	18+610	3H:2V	Suitable or selected soil for the top 30 meters and rockfill for the rest Stepped slope
18+610	18+690	3H:2V	Scaling 2.5m
18+960	18+970	-	Concrete Wall - Upper plastering
19+000	19+460	3H:2V	Scaling 4 m Bottom compaction Anti-pollution geotextile at bottom of scaling
20+840	21+050	3H:2V	Scaling of the entire fill 2-3 m
22+100	23+500	3H:2V	Stepped slope
23+550	23+710	3H:2V	Fill carried out with suitable or selected soil Stepped slope
24+020	24+240	3H:2V	Scaling of the entire fill 2-3 m Stepped slope
24+240	24+360	3H:2V	Fill carried out with suitable or selected soil
24+360	24+460	3H:2V	Scaling of the entire fill 2-3 m
24+802	24+812	-	Concrete Wall - Upper plastering
24+812	24+840	3H:2V	Scaling of the entire fill 2-3 m
24+840	25+220	3H:2V	Stepped slope
25+220	25+265	3H:2V	Scaling of the entire fill 2-3 m
25+280	25+285	-	Concrete Wall - Upper plastering
25+820	25+860	3H:2V	Fill carried out with suitable or selected soil Stepped Scaling 2.5 meters Settlement control. Minimum waiting period 3 months
26+000	26+210	3H:2V	Fill carried out with suitable or selected soil Stepped Settlement control. Minimum waiting period 3 months
26+600	26+780	3H:2V	Scaling 2.5 meters Replacement and foundation of the fill with selected soil or rockfill Settlement control. Minimum waiting period 3 months
27+560	27+710	3H:2V	KP 27+640 to 27+700: Stepped
27+740	27+820	3H:2V	KP 27+740 to 27+780: Stepped KP 27+800 to 27+820: Stepped
27+900	27+950	3H:2V	KP 27+940 to 27+950: Stepped
28+070	28+220	3H:2V	Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control
28+580	28+980	3H:2V	KP 28+580 to 28+640: Stepped KP 28+780 to 28+970: Stepped Scaling 2.5 m Replacement and foundation of the fill with selected soil or rockfill Settlement control
29+020	29+180	3H:2V	Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control
29+360	29+540	3H:2V	Fill carried out with suitable or selected soil KP 29+400 to 29+510: Stepped
29+630	29+740	3H:2V	Fill carried out with suitable or selected soil

CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
29+800	29+880	3H:2V	Fill carried out with suitable or selected soil Scaling 3.0 metros Replacement and foundation of the fill with selected soil or rockfill Settlement control. Minimum waiting period 3 months
29+940	30+010	3H:2V	Fill carried out with suitable or selected soil
30+200	30+420	3H:2V	Fill carried out with suitable or selected soil Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control
30+520	30+580	3H:2V	Stepped
31+280	31+600	3H:2V	Fill carried out with suitable or selected soil KP 31+340 to 31+420: Stepped Replacement and foundation of the fill with selected soil or rockfill Settlement control
32+070	33+470	3H:2V	Stepped
33+520	33+940	3H:2V	KP 33+520 to 33+530: Stepped KP 33+690 to 33+700: Stepped KP 33+920 to 33+940: Stepped
34+027	34+620	3H:2V	-
34+690	34+780	3H:2V	KP 34+690 to 34+700: Stepped KP 34+770 to 34+780: Stepped
34+924	37+349	3H:2V	-
37+940	37+945	3H:2V	From KP 37+940 to 37+945 (RS): Reinforced Earth Wall
38+280	38+330	3H:2V	Stepped
38+540	38+780	3H:2V	From KP 38+615 a 38+677: Stepped From KP 38+548 a 38+615 (RS): Reinforced Earth Wall From KP 38+677 a 38+781 (RS): Reinforced Earth Wall
39+010	39+540	3H:2V	From KP 39+006 a 39+040 (RS): Reinforced Earth Wall From KP 39+340 a 39+521 (RS): Reinforced Earth Wall
39+740	39+890	3H:2V	Scaling 3 meters Settlement control From KP 39+740 to 39+820: Stepped Upper part of the fill, up to 30 meters, with improved and selected soil, and the rest with rockfill
40+140	40+280	3H:2V	Fill carried out with suitable or selected soil Stepped
40+300	41+220	3H:2V	Scaling 3 meters. Replacement and foundation of the fill with rockfill Settlement control From KP 40+340 to 40+410 and 41+170 to 41+220: Stepped Upper part of the fill, up to 30 meters, with improved and selected soil, and the rest with rockfill
42+020	42+060	3H:2V	Fill carried out with suitable or selected soil Stepped
42+260	42+430	3H:2V	Scaling 2 meters From KP 42+257 to 42+287: Reinforced Earth Wall
42+450	42+550	3H:2V	From KP 42+447 to 42+540 (RS): Reinforced Earth Wall KP 42+540 to 42+632 (RS): Concrete Wall
42+560	42+610	3H:2V	Stepped
42+880	42+970	3H:2V	From KP 42+870 to 42+966 (RS): Concrete Wall
43+060	43+131	3H:2V	From KP 43+058 to 43+060(RS): Concrete Wall From KP 43+077 to 43+136 (RS): Concrete Wall

CHAINAGE		RECOMMENDED SLOPE	TREATMENT AND COMMENTS
KP START	KP END		
42+930	43+390	3H:2V	From KP 43+340 to 43+370 (RS): Reinforced Earth Wall
43+550	43+910	3H:2V	From KP 43+648 to 43+910: Stepped From KP 43+560 to 43+701 (RS): Reinforced Earth Wall
43+950	44+020	3H:2V	From KP 43+950 to 44+003: Stepped From KP 44+044 to 44+060 (RS): Concrete Wall
44+330	45+130	3H:2V	From KP 44+408 to 44+620 (RS): Reinforced Earth Wall From KP 44+620 to 44+698 (RS): Concrete Wall

Source: Consorcio SH, 2017.

3.2.3.1.6 Energy supply infrastructure.

· **Power generation systems and sources.**

For the purposes of carrying out activities in process plants (see section ***3.2.3.2.3 Process plants.*** in this chapter), energy supply will be provided by generators or a generator set that will be located away from the process area.

All electric generators or generator sets will be equipped with the best safety and control systems to ensure quality electricity supply, with low fuel consumption.

For camps relating to the construction stage (temporary), there will be electric generators or generator sets for the supply of energy, or a connection to the electricity supply grid relating to the region's energy company Centrales Eléctricas de Nariño S.A. E.S.P. (Cedenar).

3.2.3.2 Infrastructure associated with the project.

3.2.3.2.1 Temporary camps.

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment will have a total of four (4) camps, strategically distributed within the project's layout. Below is a description of each one.

· **San Juan Camp KP18+800.**

The San Juan camp is located at KP18 + 800, has a total land area of 5,374 m2 and its total non-transit area amounts to 2,678.73 m2, comprised by an AMMANN 40m3/h concrete plant, scale, work and ancillary services house, guard booth, additives deposit and a storage area for waste, substances and fuels (see **Table 3.34**). **Annex 2. Civil. XI Project Infrastructure. Camps Plan RP-CM-CSH-GEO-1-AM-000024-1** provides its design, including the approximate quantification of earthworks and drainage networks.

Table 3.34 San Juan Camp facilities KP18+800.

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
1	AMMANN 40m3/h concrete plant	Machinery, silos and hoppers	1	339	2454.33
		Water recycling tank	1	73.2	
		Water tank	1	11.7	

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
		Dirty water tanks	1	11.7	
		Recycled clean water tanks	1	11.7	
		Control house	1	6.9	
		Stockpiles and aggregates	1	1998	
		200 kva generator	1	2125	
2	Scale	Scale	1	87.6	93.80
		Control house	1	6.2	
3	Work and ancillary services house	Office	1	9.84	69.69
		Lounge	1	9.07	
		Bathroom	1	3.7	
		Alcove	20	15.2	
		Meeting room	1	9.6	
		Kitchen	1	3.6	
		Clothing room	1	3.17	
		Walkways	1	3.01	
		Parking area	3	12.5	
4	Guard booth	Stay area	1	2.86	15.71
		Bathroom	1	2.91	
		Room	1	7.61	
		Kitchenette	1	2.33	
5	Additives deposit	Storage area	1	10.2	10.2
6	Storage area for waste, substances and fuels	Oil and filter disposal area		20	35.00
		Area for trash		15	
Total non-transit area					**2678.73**

Source: Consorcio SH, 2017.

· **Iles Camp KP31+000.**

The Iles Camp is located at KP31 + 000, has a total land area of 14,021.34 m2 and a total non-transit area of 1,250.46 m2, comprised by a guard booth, scale, 90 ton/h mobile crushing plant, work and auxiliary services house, and a storage area for waste, substances and fuels (see **Table 3.35**). **Annex 2. Civil. XI Project Infrastructure. Camps Plan RP-CM-CSH-GEO-1-AM-000024-2** provides its design, including the approximate quantification of earthworks and drainage networks.

Table 3.35 Iles Camp facilities KP31+000.

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
1	Guard booth	Stay area	1	2.86	15.71
		Bathroom	1	2.91	

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
		Room	1	7.61	
		Kitchenette	1	2.33	
2	Scale	Scale	1	87.6	93.80
		Control house	1	6.2	
3	90ton/h mobile crushing plant	Machinery			1036.25
		600 kva generator			
4	Work and ancillary services house	Office	1	9.84	69.69
		Lounge	1	9.07	
		Bathroom	1	3.7	
		Alcove	20	15.2	
		Meeting room	1	9.6	
		Kitchen	1	3.6	
		Clothing room	1	3.17	
		Walkways	1	3.01	
		Parking area	3	12.5	
5	Storage area for waste, substances and fuels	Oil and filter disposal area		20	35.00
		Area for trash		15	
Total non-transit area					**1,250.46**

Source: Consorcio SH, 2017.

· **Iles Camp KP35+600.**

The Iles Camp is located at KP35+600, has a total land area of 7,549.68 m2 and a total non-transit area of 1,250.46 m2, comprised by a guard booth, scale, 90 ton/h mobile crushing plant, work and auxiliary services house, and a storage area for waste, substances and fuels (see **Table 3.36**). **Annex 2. Civil. XI Project Infrastructure. Camps Plan RP-CM-CSH-GEO-1-AM-000024-3** provides its design, including the approximate quantification of earthworks and drainage networks.

Table 3.36 Iles Camp facilities KP35+600.

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
1	Guard booth	Stay area	1	2.86	15.71
		Bathroom	1	2.91	
		Room	1	7.61	
		Kitchenette	1	2.33	
2	Scale	Scale	1	87.6	93.80
		Control house	1	6.2	
3	90ton/h mobile crushing plant	Machinery			1036.25
		600 kva generator			

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
4	Work and ancillary services house	Office	1	9.84	69.69
		Lounge	1	9.07	
		Bathroom	1	3.7	
		Alcove	20	15.2	
		Meeting room	1	9.6	
		Kitchen	1	3.6	
		Clothing room	1	3.17	
		Walkways	1	3.01	
		Parking area	3	12.5	
5	Storage area for waste, substances and fuels	Oil and filter disposal area		20	35.00
		Area for trash		15	
Total non-transit area					**1250.46**

Source: Consorcio SH, 2017.

· **Mikel Camp.**

The Mikel camp is located in the municipality of Iles, at KP41 + 300, has a total land area of 77,440.95m2 and a total non-transit area of 32,082.62m2, comprised by a guard booth, caretaker's house, administrative office, cafeteria, auditorium, dormitories for operating personnel, dormitories for administrative personnel, water reserve tank, scale, fuel service station, main warehouse, main workshop, formwork workshop, powder magazine and factory, infirmary, laboratory, AMMANN 60m3 concrete plant, stockpile areas, 150ton/h crushing plant, Intrame_UM 160ton/h asphalt plant, silo deposit, trash deposit, residential parking lot, heavy goods vehicles parking lot, and a storage area for waste, substances and fuels (see **Table 3.37**). **Annex 2. Civil. XI Project Infrastructure. Camps Plan RP-CM-CSH-GEO-1-AM-000024-4** provides its design, including the approximate quantification of earthworks and drainage networks.

Table 3.37 Camp facilities Mikel KP41+300.

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
1	Guard booth	Stay area		2.29	6
		Bathroom		2.04	
		Other		1.70	
2	Caretaker's house	Kitchens + W.C. + Living room		23.18	66.00
		Room	2	17.36	
		Store	2	15.68	
		Washing + clothes		2.00	
3	Administrative office	Administrative office		12.98	172.25
		Auxiliary office	3	38.10	

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
		Meeting room		25.71	
		Workstation office (6p)		23.66	
		Lounge		7.19	
		Security room (safe)		7.90	
		Café		3.38	
		Cleaning room		2.00	
		W.C. (M/F)	2	6.762	
4	Cafeteria, Admin + Operative	Access hall		12.51	419.28
		Pantry		24.38	
		Kitchen (preparation) + service line		56.04	
		Admin. dining room. + W.C.		30.19	
		Worker wining room		230.74	
		Cooks' dormitory		34.04	
		Cleaning room		2.00	
5	Auditorium				166.90
6	Dormitories for operating personnel	Room (5 beds)	4	117.99	287.536
		Room (3 beds)		18.41	
		Stairs		7.26	
		Hall		3.95	
		Bathrooms		32.69	
		Laundry room		67.06	
7	Dormitories for administrative personnel	Room type 1	5	109.63	275.99
		Room type 2	2	47.74	
		Lounge		13.87	
		Stairs		6.27	
		Hall		5.64	
		Laundry room		38.60	
8	Water reserve tank				
9	Scale	Scale	1	87.6	93.80
		Control house	1	6.2	
10	Fuel service station	Control house		6.0	218.70
		Fuel pump		212.7	
11	Main warehouse	Warehouse man's office + W.C.		14.80	253.40
		Warehouse 1		10.60	
		Warehouse 2		46.20	
		Warehouse 3		46.20	

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
		Bathroom area + cleaning		35.00	
		Pumps		12.00	
		Depository		67.40	
12	Main store	Office		10.20	848.30
		Warehouse 1		8.70	
		Warehouse 2		20.80	
		Infirmary		11.40	
		Bathrooms		10.00	
		Workshop area		230.00	
		Welding area		55.20	
		Oil warehouse		36.10	
		Vulcanizer		19.40	
		Maneuvering area		446.50	
13	Main workshop	Office		10.20	848.30
		Warehouse 1		8.70	
		Warehouse 2		20.80	
		Infirmary		11.40	
		Bathrooms		10.00	
		Workshop area		230.00	
		Welding area		55.20	
		Oil warehouse		36.10	
		Vulcanizer		19.40	
		Maneuvering area		446.50	
14	Formwork workshop	Office		10.20	848.30
		Warehouse 1		8.70	
		Warehouse 2		20.80	
		Infirmary		11.40	
		Bathrooms		10.00	
		Workshop area		230.00	
		Welding area		55.20	
		Oil warehouse		36.10	
		Vulcanizer		19.40	
		Maneuvering area		446.50	
15	Ferrata workshop	Office		10.20	848.30
		Warehouse 1		8.70	
		Warehouse 2		20.80	

ID	MAIN AREAS	FACILITIES	QUANTITY	AREA/FACILITY (m^2)	AREA/MAIN (m^2)
		Infirmary		11.40	
		Bathrooms		10.00	
		Workshop area		230.00	
		Welding area		55.20	
		Oil warehouse		36.10	
		Vulcanizer		19.40	
		Maneuvering area		446.50	
16	Powder magazine + factor				1000.00
17	Infirmary	Reception		2.50	39.62
		Waiting room		6.54	
		Warehouse + store		5.00	
		Cleaning room		1.50	
		Archive		2.00	
		Consulting room	2	22.08	
18	Laboratory				59.20
19	AMMANN 60m3/h concrete plant	Machinery, silos and hoppers		339.00	456.325
		Cleaning tank		73.20	
		Water tank		11.7	
		Dirty water tanks		11.7	
		Recycled clean water tanks		11.7	
		Control house		6.9	
		200 kva generator		2.12	
20	Stockpile area				11013.40
21	150ton/h crushing plant	Machinery		10807.5	10816.46
		1000 kva generator		8.96	
22	Intrame-UM 160ton/h asphalt plant	Machinery		1290	10816.45
		800 kva generator		8.06	
23	Silo deposit		3	609.00	609.00
24	Trash deposit				
25	Residential parking lot		48	12500	12.50
26	Heavy goods vehicles parking lot		40	1375	1375.00
27	Storage area for waste, substances and fuels	Room for scrap		15	50.00
		Oil and filter disposal area		20	
		Area for trash		15	
Total non-transit area					**1,250.46**

Source: Consorcio SH, 2017.

3.2.3.2.2 Material sources.

The material sources nearby the area of influence of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, are listed in section ***3.2.1.8 Mining rights.*** in this chapter.

However, it is clarified that the company shall be able to work with other material extraction and marketing companies other than those set out above, provided that they hold valid mining-environmental permits. This information must be attached to the environmental compliance reports.

3.2.3.2.3 Process plants.

The process plants will be located in each of the camps in accordance with that set out in section ***3.2.3.2.1 Temporary camps.*** in this chapter. **Table 3.38** provides their geo-referenced location.

Table 3.38 Location of process plants.

CAMP	PLANTS	PROJECT CHAINAGE	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST	
			EAST	NORTH
San Juan	AMMANN 40m3/h concrete plant	KP18+800	948159	590955
Iles 31+000	90ton/h mobile crushing plant	KP31+000	955531	598238
Iles 35+600	90ton/h mobile crushing plant	KP35+600	954891	601759
Mikel Mine	AMMANN 60m3/h concrete plant	KP41+300	954927	604465
	150ton/h crushing plant		955000	604467
	Intrame-UM 160ton/h asphalt plant		954936	604379

Source: Consorcio SH, 2017.

3.2.3.3 Infrastructure and services affected by the project.

Below are the utilities networks identified throughout the right of way of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal segment. **Annex 2. Civil Networks Inventory - CSH-1-VD-G-G-W100-3** provides a detailed description of the networks, and also presents maps setting out the location of the utilities infrastructure and networks subject to transfer, relocation and/or protection.

3.2.3.3.1 Utilities.

· **Water supply and sewage networks.**

The water supply and sewage networks present in the project and that may be affected, relate to the infrastructure belonging to the community action board for the district of Pilcuán, municipality of Imués.

o District of Pilcuán – municipality of Imués.

The networks identified belong to the water supply system parallel to the road, consisting of 4 and 6" diameters, and they supply the urban area of the district of Pilcuán Viejo and Pilcuán la Recta. Below, **Table 3.39** presents the location of the water supply networks and **Table 3.40** provides the location of sewage networks.

Table 3.39 List of water supply networks.

TYPE	LOCATION	LENGTH (m)	DIAMETER	START COORDINATES		END COORDINATES	
				EAST	NORTH	EAST	NORTH
Water supply	Underground	235	2”	956823.98	606012.04	956840.05	606069.50
Water supply	Underground	155	3”	956932.40	606382.13	956995.54	606442.01
Water supply	Underground	3	3”	957002.02	606593.00	957004.77	606592.92
Water supply	Underground	128	4”	955179.06	604824.33	955158.43	604830.57
Water supply	Underground	194	4”	956757.68	605772.31	956801.60	605957.94
Water supply	Underground	400	6”	955722.57	604940.16	955772.66	604957.98

Source: Consorcio SH, 2017.

Table 3.40 List of sewage networks.

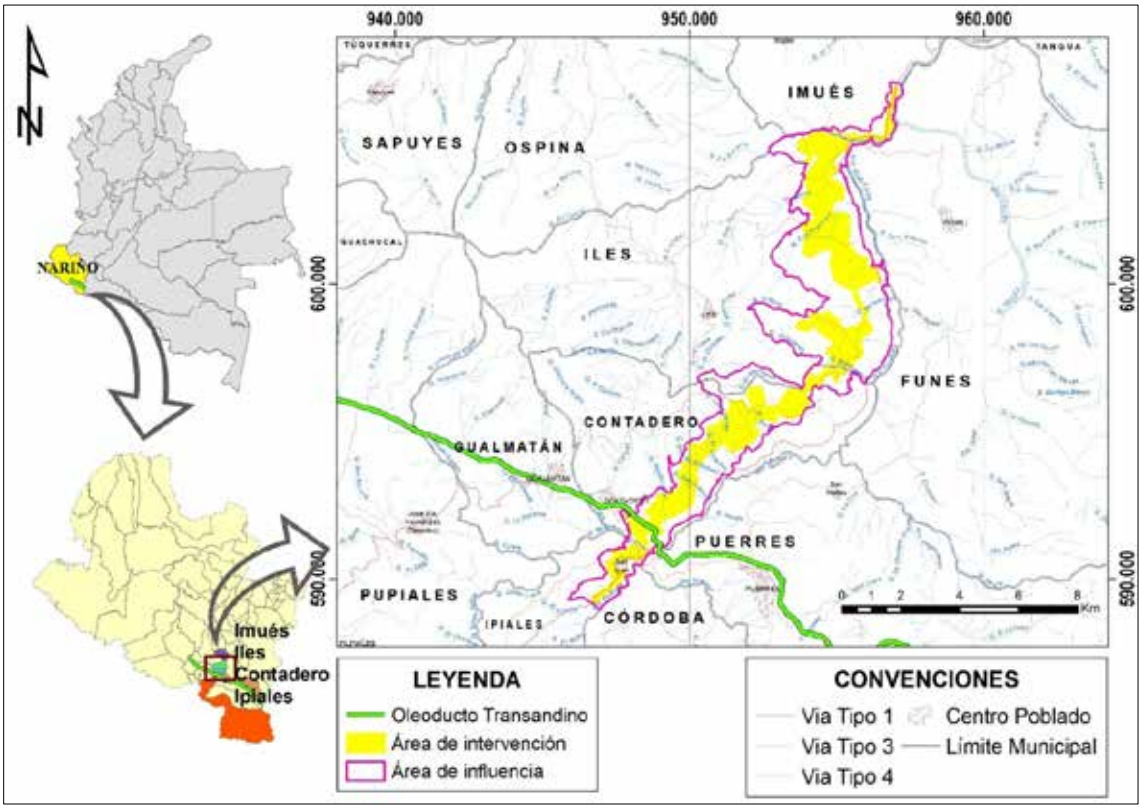
TYPE	LOCATION	LENGTH (m)	DIAMETER	START COORDINATES		END COORDINATES	
				EAST	NORTH	EAST	NORTH
Sewage	Underground	2020	8”	956823.98	606012.04	956840.05	606069.50

Source: Consorcio SH, 2017.

- **Oil pipeline and gas networks.**

Within the corridor of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, a pipeline is crossed. It belongs to the national oil pipeline network (Oleoducto Trasandino - OTA) and it transports oil from Ecuador to the port of Tumaco. This pipeline is located at chainage KP19 + 300, at Coordinates E 948,293.98 N 591,987.23 and E 948,279.63 N 591,995.76, crossing the road transversally, at a depth of approximately 1.0 m of the current terrain. **Figure 3-88** provides the geographic location of the pipeline relative to the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment.

Figure 3.89 Geographical location of the OTA - Orito - Tumaco oil pipeline relative to the Rumichaca – Pasto Divided Highway Project, San Juan Pedregal Segment.



Source: GEOCOL CONSULTORES S.A., 2017.

· **Electricity networks.**

The electricity networks present in the project and that may be affected relate to infrastructure belonging to operating company Centrales Eléctricas de Nariño S.A. E.S.P. (Cedenar).

o Centrales Eléctricas de Nariño S.A. E.S.P. (Cedenar).

The project crosses low, medium and high voltage electricity networks belonging to Cedenar. The crossing points are set out below.

§ **Low voltage electricity networks.**

Relates to networks with voltages below 1 kV and that are reduced even more so that they can be used for industry, street lighting and in the home. The most used voltages in industry are 220 and 440 V (AC) and in homes it's between 110 and 120 V. Below, **Table 3.41** provides the location of the low voltage networks that will be affected by the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment.

Table 3.41 List of low voltage electricity networks.

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
25	946968.80	589513.50	946986.10	589495.00
31	947447.40	590634.70	947469.80	590615.40
77	947577.40	590744.20	947653.60	590758.40
103	948089.50	591029.70	948179.10	590979.80
38	948156.20	591926.70	948183.80	591900.20
29	948179.10	590979.80	948190.30	590952.70
95	948290.00	591638.60	948308.60	591545.80
31	948369.90	591359.00	948398.90	591348.80
23	949304.50	592319.00	949326.90	592314.30
60	949408.40	592431.70	949386.00	592376.40
95	950078.30	593564.10	950132.40	593642.70
53	950362.20	594282.60	950352.30	594335.00
54	950412.90	594350.80	950358.80	594345.90
1	950894.70	594908.30	950893.30	594908.70
100	952664.40	595472.30	952762.60	595488.90
13	952912.90	595587.00	952910.70	595599.40
48	952934.20	595699.30	952963.30	595661.50
33	953921.40	596353.40	953933.40	596383.70
67	953933.40	596383.70	953946.50	596449.00
17	954379.40	596726.10	954384.30	596742.30
175	954384.30	596742.30	954440.50	596906.30
32	954772.70	604755.40	954804.00	604759.60
70	955046.00	604803.30	955113.80	604785.90
37	955421.60	604933.60	955458.30	604932.80
44	955316.90	597519.10	955340.80	597556.10
47	955458.30	604932.80	955495.60	604961.20
28	955759.90	604975.60	955772.40	604950.40
37	956048.90	598347.20	956081.90	598329.50
210	956558.90	605294.50	956407.20	605319.20
58	956667.70	605328.60	956647.80	605374.60
3	956690.60	605205.60	956693.10	605206.00
210	956890.70	606294.40	957002.90	606470.30
11	943554.50	585648.10	943559.40	585657.50
11	943554.50	585648.10	943559.40	585657.50

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
19	949519.40	592514.90	949538.00	592509.20
155	949538.00	592509.20	949682.50	592453.40
41	935782.20	582269.70	935770.50	582307.50
3	935782.20	582267.00	935782.20	582269.70
41	936175.60	582598.40	936200.60	582568.20
1	936200.60	582568.20	936201.40	582567.50
37	936334.00	582594.50	936364.60	582614.40
5	936328.70	582589.70	936332.10	582593.30
1	936328.60	582589.50	936328.70	582589.70
118	936211.80	582572.80	936328.60	582589.50
29	936310.80	582612.90	936328.60	582589.50
5	936328.60	582589.50	936329.80	582584.80
12	936739.50	582641.60	936734.40	582652.80
30	936751.20	582614.50	936739.50	582641.60
25	937165.10	582630.30	937148.50	582611.60
1	937148.50	582611.60	937147.80	582610.70
21	937147.80	582610.70	937129.50	582600.00
15	937271.50	582515.20	937280.40	582527.50
6	937268.20	582510.80	937271.50	582515.20
19	937571.90	582371.50	937590.50	582370.90
14	937590.50	582370.90	937604.80	582370.40
9	937597.60	582397.70	937595.70	582406.50
29	937604.80	582370.40	937597.60	582397.70
37	938654.90	582407.30	938643.60	582442.50
26	938694.40	582334.50	938670.90	582344.80
14	939384.40	582617.20	939395.70	582608.80
9	939376.00	582614.90	939384.40	582617.20
2	939362.10	582611.10	939363.70	582611.60
233	939211.40	582439.80	939361.50	582611.00
8	939194.70	582418.60	939199.40	582424.60
4	939182.70	582403.50	939185.50	582407.00
52	939422.80	582642.80	939468.40	582639.20
23	939384.40	582617.20	939403.50	582629.50
1	939678.90	582810.40	939678.90	582810.80
49	939668.30	582762.70	939678.90	582810.40
5	940107.40	582972.00	940102.50	582970.10

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
19	940074.50	582959.00	940057.30	582952.10
51	940189.10	583093.50	940160.40	583050.80
44	940132.00	583008.60	940107.40	582972.00
15	940899.80	583388.30	940914.50	583389.70
28	940930.00	583389.10	940953.90	583386.00
2	941050.70	583364.30	941052.50	583365.40
41	940965.20	583314.20	941001.10	583333.40
29	941380.30	583631.80	941403.20	583649.10
1	941379.50	583631.20	941380.30	583631.80
153	941257.40	583539.10	941379.50	583631.20
3	941380.30	583631.80	941378.80	583634.50
4	941381.10	583627.50	941380.30	583631.80
9	941381.70	583619.20	941381.10	583627.50
89	941583.40	583783.30	941654.60	583836.30
1	941576.80	583778.10	941576.90	583778.20
49	942823.40	584447.60	942775.00	584454.70
27	942850.20	584444.60	942823.40	584447.60
60	943136.70	584908.60	943165.30	584961.30
3	943135.50	584906.30	943136.70	584908.60
232	943021.20	584704.50	943135.50	584906.30
13	943365.90	585323.30	943378.30	585328.30
1	943365.30	585323.10	943365.90	585323.30
15	943358.50	585309.60	943365.30	585323.10
19	943350.00	585292.90	943358.50	585309.60
4	943488.20	585511.10	943491.70	585510.60
17	943463.30	585503.00	943479.60	585507.40
27	943559.40	585657.50	943572.20	585681.50
104	943509.20	585556.20	943554.50	585648.10
14	943491.90	585510.40	943496.60	585523.70
16	943487.30	585495.00	943491.90	585510.40
1	943491.90	585510.40	943491.70	585510.60
17	943491.60	585494.30	943491.90	585510.40
1	943967.70	587241.40	943967.80	587241.80
46	943963.60	587195.90	943967.70	587241.40
6	943977.00	587331.50	943976.40	587325.90
76	943975.50	587317.40	943967.80	587241.90

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
4	944228.70	587639.20	944229.50	587643.00
14	944225.90	587625.00	944228.70	587639.20
103	944796.80	588100.10	944864.50	588174.70
1	944796.50	588099.70	944796.80	588100.10
49	944771.10	588057.70	944796.50	588099.70
2	944770.10	588056.10	944771.10	588057.70
37	944750.70	588024.10	944770.10	588056.10
12	944760.70	588065.60	944748.70	588065.60
9	944748.70	588065.60	944740.00	588065.60
1	945101.50	588375.40	945102.00	588375.40
53	945062.60	588341.60	945101.50	588375.40
8	945173.30	588430.40	945179.40	588435.40
90	945102.10	588375.30	945173.30	588430.40
10	945100.00	588376.40	945091.20	588380.80
2	945102.00	588375.40	945100.00	588376.40
1	945102.10	588375.30	945102.00	588375.40
19	945118.30	588364.70	945102.10	588375.30
14	945410.50	588563.40	945419.60	588574.00
15	945400.60	588551.80	945410.50	588563.40
27	945649.30	588822.20	945652.50	588795.50
2	945652.50	588795.50	945652.70	588793.60
7	946949.90	589471.60	946955.80	589475.60
6	946918.80	589450.40	946923.60	589453.70
32	955242.40	604980.80	955273.50	604973.10
98	955326.20	604955.90	955421.60	604933.60
410	955772.40	604950.40	956173.30	604999.00
50	955723.30	604941.60	955772.40	604950.40
11	955711.60	604939.00	955722.40	604941.40
134	955458.30	604932.80	955589.30	604931.10
4	955772.40	604950.40	955776.10	604948.90
14	955781.80	604946.60	955787.30	604935.40
3	956770.20	605690.30	956770.40	605693.10
309	956693.50	605332.90	956745.60	605628.40
90	956691.80	605242.60	956693.50	605332.90
37	956690.60	605205.60	956691.80	605242.60
244	956635.90	604975.60	956690.60	605205.60

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
418	956777.50	605832.60	956879.70	606235.40
136	956770.40	605693.10	956776.90	605829.00
3	956691.80	605242.60	956694.60	605243.00
1	956691.80	605242.60	956691.80	605242.60
26	956693.50	605332.90	956667.70	605328.60
114	956667.70	605328.60	956558.90	605294.50

Source: Consorcio SH, 2017.

§ **Medium voltage electricity networks.**

Relates to networks with voltages greater than 1 kV and less than 34.5 kV. They are used to transport medium voltages from substations to low voltage substations or transformer banks, from which the electric current is supplied to cities. Medium voltage cables can be hung on metal towers, supported by wooden or cement posts, or be buried, as is the case in most major cities. Below, **Table 3.42** provides the location of the medium voltage networks that will be affected by the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment.

Table 3.42 List of medium voltage electricity networks.

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
83	947621.40	590778.80	947703.60	590793.60
46	947924.70	590911.90	947950.60	590950.10
53	950068.80	593482.20	950114.80	593456.80
104	952911.30	595706.80	952927.00	595603.70
20	954377.10	596725.60	954382.80	596744.30
167	954382.80	596744.30	954436.50	596901.90
76	954930.40	601949.40	954994.00	601990.10
39	955420.20	604936.40	955458.30	604932.80
17	955449.00	604877.00	955446.20	604859.90
57	955458.30	604932.80	955449.00	604877.00
157	956462.60	605345.90	956558.90	605294.50
146	956558.90	605294.50	956693.50	605332.90
12	956682.50	605243.10	956693.20	605246.70
10	937599.40	582396.40	937597.20	582406.60
23	937604.80	582370.40	937600.10	582392.80
31	938667.70	582416.80	938653.30	582444.50
15	938686.40	582380.80	938679.50	582394.10

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
113	939419.80	582683.60	939338.00	582746.80
83	939367.00	582624.10	939419.80	582683.60
120	939293.60	582536.90	939367.00	582624.10
42	939367.00	582624.10	939331.00	582645.10
14	939375.10	582614.90	939367.00	582624.10
3	939386.40	582612.60	939383.90	582613.60
2	939392.70	582608.80	939390.60	582610.10
58	939419.90	582683.80	939458.00	582727.50
1	939419.80	582683.60	939419.90	582683.80
7	940666.10	583280.20	940666.20	583287.10
23	940647.40	583266.30	940666.10	583280.20
213	940436.60	583243.40	940647.40	583266.30
49	940666.10	583280.20	940714.80	583281.90
10	940655.90	583279.60	940666.10	583280.20
93	940563.40	583273.70	940655.90	583279.60
3	940522.70	583271.10	940526.00	583271.30
16	940504.80	583270.00	940520.60	583271.00
4	940480.20	583268.40	940484.30	583268.70
24	941639.30	583807.60	941658.80	583821.60
68	941584.30	583768.00	941639.30	583807.60
1	941584.20	583768.00	941584.30	583768.00
251	941381.70	583619.20	941584.20	583768.00
263	941168.00	583466.20	941381.70	583619.20
25	941146.10	583457.20	941168.00	583466.20
5	941141.70	583455.30	941146.10	583457.20
36	941112.40	583436.00	941141.70	583455.30
70	941023.80	583397.30	941082.20	583420.30
13	940965.80	583386.60	940978.90	583388.30
5	940960.60	583386.00	940965.80	583386.60
37	942168.20	584194.80	942199.00	584215.80
13	942137.70	584177.70	942149.40	584182.00
597	941658.80	583821.60	942137.70	584177.70
21	941661.60	583818.10	941678.00	583804.60
14	941678.00	583804.60	941689.10	583795.60
28	942130.50	584261.10	942153.00	584275.60
3	942129.80	584257.80	942130.50	584261.10

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
33	942130.50	584261.10	942109.80	584286.90
9	942130.60	584254.70	942130.50	584261.10
40	942137.70	584177.70	942125.20	584214.50
147	943105.50	584823.00	943175.50	584952.30
71	943065.10	584752.40	943100.30	584813.70
35	943039.70	584707.60	943056.80	584738.00
12	943032.20	584694.10	943038.20	584704.90
340	942815.90	584460.40	943031.20	584692.30
4	942811.90	584459.80	942815.90	584460.40
1	942809.20	584459.40	942809.70	584459.50
13	942775.10	584455.50	942787.80	584457.80
228	945325.00	588536.60	945497.20	588657.80
15	945310.80	588531.90	945325.00	588536.60
61	945255.40	588507.20	945310.80	588531.90
117	945166.60	588438.90	945255.40	588507.20
95	945095.50	588379.20	945166.60	588438.90
181	944961.50	588267.60	945095.50	588379.20
70	944914.00	588216.70	944966.90	588262.90
35	944872.30	588184.80	944899.50	588205.20
89	944820.60	588117.80	944869.80	588182.80
4	945325.00	588536.60	945327.50	588540.40
61	945272.30	588507.00	945325.00	588536.60
17	945257.90	588498.20	945272.30	588507.00
5	945254.20	588495.40	945257.90	588498.20
196	945101.70	588375.20	945254.20	588495.40
176	944966.90	588262.90	945101.70	588375.20
11	945255.40	588507.20	945248.50	588514.40
10	945257.90	588498.20	945255.40	588507.20
4	945524.00	588672.90	945527.10	588674.70
10	945497.20	588657.80	945505.60	588662.50
25	955242.30	604977.70	955265.90	604971.00
102	955322.30	604955.10	955420.20	604936.40
18	955242.20	604975.70	955259.20	604969.30
41	955307.30	604951.50	955346.00	604937.10
10	955448.50	604855.30	955457.90	604858.70
8	955555.10	604924.60	955557.50	604931.80

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
70	955490.90	604870.70	955548.10	604903.30
5	955485.90	604868.80	955490.90	604870.70
15	955457.90	604858.70	955471.80	604863.70
130	955964.30	604986.70	956090.20	605003.20
14	956107.20	605002.30	956121.50	605001.60
178	956157.10	604999.80	956332.10	604968.50
285	955687.80	604937.00	955964.30	604986.70
3	955679.00	604935.40	955681.50	604935.90
29	955646.00	604932.70	955674.70	604935.00
55	955557.50	604931.80	955611.70	604931.60
99	955458.40	604932.90	955557.50	604931.80
3	955637.60	604931.90	955640.40	604932.20
46	956332.10	604968.50	956376.60	604956.40
5	956376.60	604956.40	956380.20	604953.30
9	956167.50	604990.20	956176.00	604988.90
27	955964.30	604986.70	955991.50	604988.50
11	956689.40	605153.10	956687.60	605163.80
13	956691.60	605140.50	956689.40	605153.10
26	956665.80	605031.80	956684.70	605050.10
280	956411.50	604948.90	956665.80	605031.80
11	956400.70	604948.00	956411.50	604948.90
44	956756.80	605652.80	956765.10	605696.20
117	956702.50	605516.70	956742.20	605620.00
222	956695.00	605278.00	956701.00	605496.30
18	956693.80	605246.90	956694.70	605264.70
93	956689.40	605153.10	956693.70	605244.30
127	956665.80	605031.80	956689.40	605153.10
300	956411.50	604948.90	956665.80	605031.80
36	956376.60	604956.40	956411.50	604948.90
149	956950.60	606367.00	957004.70	606505.50
472	956765.10	605696.20	956878.50	606141.60

Source: Consorcio SH, 2017.

§ **High voltage electricity networks.**

In the San Juan - Pedregal segment, one high voltage power line was identified and the road will cross it perpendicularly. This line is set out in **Table 3.43**.

Table 3.43 List of high voltage electricity networks.

LENGTH (m)	START COORDINATES		END COORDINATES	
	EAST	NORTH	EAST	NORTH
49	939981.30	582904.60	939953.90	582945.20

Source: Consorcio SH, 2017.

o Unión Temporal de Alumbrado Público de Ipiales (Utapi)

Utapi is the company responsible for the operation and maintenance of public lighting, and this consists of lighting for public streets, public parks and other free circulation areas that are not under the responsibility of any natural persons or legal entities. The lamps that make up the public lighting system are installed in the municipalities' utility poles. Below, **Table 3.44** presents the location of the public lighting networks present in this project's layout.

Table 3.44 List of public street lighting electricity network.

TYPE	LENGTH (m)	START COORDINATES		END COORDINATES	
		EAST	NORTH	EAST	NORTH
Underground	53	956753.20	605645.20	956764.10	605696.80
Underground	632	956683.00	605064.30	956749.20	605636.80
Underground	430	956777.70	605832.90	956879.80	606235.90
Underground	142	956764.10	605696.80	956776.80	605829.80
Underground	342	955709.90	604939.00	956026.80	604998.80
Underground	29	955682.00	604936.60	955709.30	604938.90
Underground	3	955678.90	604935.40	955681.50	604936.50
Underground	119	955557.50	604931.80	955674.70	604935.00

Source: Consorcio SH, 2017.

· **Information and communication technology networks.**

The information and communication technology networks present in the project and that may be affected for the implementation of the project, relate to the networks belonging to operating companies Colombia Telecomunicaciones S.A. E.S.P – Telefónica – Movistar Colombia, Claro Comunicaciones S.A. E.S.P and Azteca Comunicaciones Colombia. These companies offer services relating to voice calls, data transmission and access to wireless broadband and fiber optics. Below, **Table 3.45** sets out the points identified along the San Juan - Pedregal road segment.

Table 3.45 List of information and communication technology networks.

COMPANY	LENGTH (m)	START COORDINATES		END COORDINATES	
		EAST	NORTH	EAST	NORTH
Azteca	312	956069.70	605006.40	955470.50	604868.30
Azteca	159	956165.10	604995.40	956335.80	604963.40

COMPANY	LENGTH (m)	START COORDINATES		END COORDINATES	
		EAST	NORTH	EAST	NORTH
Azteca	3	956335.80	604963.40	956376.60	604956.40
Azteca	54	956636.80	604972.80	956541.00	604927.70
Azteca	263	956707.10	605551.30	956675.70	605028.60
Azteca	387	956834.30	605982.70	956774.20	605772.60
Azteca	64	957014.50	606635.10	957012.20	606630.70
Azteca	196	956960.60	606378.60	956884.20	606139.70
Movistar	399	947525.90	589984.50	947309.80	589762.80
Movistar	524	947286.30	589638.00	947593.50	590043.60
Movistar	524	947286.30	589638.00	947593.50	590043.60
Movistar	77	955993.90	604992.90	955993.80	604992.90
Movistar	77	955993.90	604992.90	955993.80	604992.90
Movistar	35	956296.50	604971.40	956331.70	604969.10
Movistar	35	956296.50	604971.40	956331.70	604969.10
Movistar	917	956707.10	605551.30	956438.40	604951.30
Movistar	917	956707.10	605551.30	956438.40	604951.30
Movistar	399	956986.00	606415.40	956834.30	605982.70
Movistar	399	956986.00	606415.40	956834.30	605982.70
Telemática	18	947433.10	590598.10	947451.10	590596.00
Telemática	19	947451.10	590596.00	947469.50	590593.60
Telemática	19	947413.80	590598.90	947433.10	590598.10
Telemática	19	947413.80	590598.90	947433.10	590598.10
Claro	99	956892.70	606278.50	956778.50	605811.60
Claro	6	956168.30	604988.70	956174.20	604987.50
Claro	285	956659.20	605009.50	956438.40	604951.30
Claro	4	956696.60	605238.10	956696.50	605242.40

Source: Consorcio SH, 2017.

3.2.3.3.2 Other

· **Irrigation districts**

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment intersects with one (1) irrigation district in the San Francisco rural district, municipality of Contadero, at the coordinates set out in **Table 3.46.**

Table 3.46 Project intersection with irrigation district.

COMPANY	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST	
	EAST	NORTH
San Francisco irrigation district	948117.72	591919.40

Source: Consorcio SH, 2017.

· **Roads**

The roads relating to the national, secondary and tertiary network that are intersected by the Divided Highway Project for the San Juan - Pedregal segment are described in the bullet point named "other linear works crossed" in section **3.2.3.1.3 Project transportation infrastructure**. in this chapter (see **Table 3.25**).

3.2.4 Project supplies.

Below is the list and estimation of the volume of supplies that will be used to carry out the Rumichaca - Pasto Divided Highway Project, San Juan Pedregal Segment.

3.2.4.1 Construction materials.

The stone material that will be used to carry out the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment are listed in **Table 3.47**. These materials will form part of the aggregates for the manufacture of concrete, pavement and rockfill, among others.

Table 3.47 Stone supplies

DESCRIPTION	QUANTITY	UNIT
Embankment Material	6,403,862.66	m3
Rockfill Material	97,067.44	m3
Selected Material for Fills	139,297.64	m3
Filtering Material	1,466.06	m3
Improvement Material	225,500	m3
Sub-base	321,430.48	m3
Base	203,594.07	m3

Source: Consorcio SH, 2017.

3.2.4.2 Other.

3.2.4.2.1 Fuels, oils, greases and solvents.

Below, **Table 3.48** lists the estimated quantities relating to supplies derived from fuels, oils, greases and solvents:

Table 3.48 Supplies derived from fuels, oils, greases and solvents.

DESCRIPTION	QUANTITY	UNIT
Acrylic paint	5,237.22	gal
Epoxide	2,191	kg

Source: Consorcio SH, 2017.

3.2.4.2.2 Processed supplies.

Below, **Table 3.49** lists the estimated quantities relating to processed supplies for the project, such as hydraulic concrete, prefabricated asphaltic concrete and crushed material, among others.

Table 3.49 Processed supplies for the project.

DESCRIPTION	QUANTITY	UNIT
Class E Concrete (17.5 MPa)	1,079.43	m3
21 MPa concrete	1,112.76	m3
28 Mpa concrete	45,351.73	m3
Grout a/c 0.40: 0.60	643.44	m3
35 MPa concrete	13,220.15	m3
Self-leveling mortar	626.55	l
MDC-2 hot dense mix	1,152.83	m3
MDC-3 hot dense mix	48,728.76	m3
30 MPa concrete	1,254	m3
45 MPa concrete	13,631.99	m3
CRR-1 asphalt emulsion	438,557.96	l
MSC-1 hot dense mix	51,230.22	m3
Asphalt emulsion	2,214,435.17	l
Priming irrigation	984,193.73	m2
14 MPa concrete	26,185.02	m3

Source: Consorcio SH, 2017.

3.2.4.2.3 Explosives.

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment will require the use of explosives. Below, **Table 3.50** sets out the estimated quantities of these materials to be used in demolition and/or blasting.

Table 3.50 Explosives supplies for blasting.

DESCRIPTION	SUPPLY	QUANTITY	UNIT
Bench excavation blasting	Kg of explosive (ANFO)	1925	Kg
	450g booster (Pentolite Multipliers)	45	Kg
	Non-electric detonators	102	U.
	Non-electric connectors	102	U.
	Specific load	0.47	Kg/m3
	Lead wire	400	m
Pre-splitting	80g cord	12	m
	12g cord	3	m
	Bottom explosive (Riogel) Kg	1.2	Kg
	Non-electric detonators	3	U.
	Lead wire	400	m

Source: Consorcio SH, 2017.

· **Drilling and blasting specifications.**

Taking into account the amount of material to be removed and/or cut, 436 bench excavation blasts and 60 pre-splitting blasts will be carried out (see **Table 3.51**). Similarly, **Table 3.52** provides a description of the blasting (type, class of explosive, and final quantities of explosives to be used) and **Table 3.53** sets out the specifications.

Table 3.51 Number of blasts by quantity of material.

DESCRIPTION	QUANTITY	NUMBER OF BLASTS
Bench excavation blasting	1.797.625 m3	436
Pre-splitting blasting	72056 lm	60

Source: Consorcio SH, 2017.

Table 3.52 Total supplies.

DESCRIPTION	SUPPLY	TOTAL QUANTITY	UNIT
Bench excavation	Kg of explosive (ANFO)	838.892	Kg

DESCRIPTION	SUPPLY	TOTAL QUANTITY	UNIT
blasting	450g booster (Pentolite Multipliers)	19.610	Kg
	Non-electric detonators	44.450	U.
	Non-electric connectors	44.450	U.
	Lead wire	174.315	m
Pre-splitting	80g cord	72.056	m
	12g cord	18.014	m
	Bottom explosive (Riogel) Kg	7.206	Kg
	Non-electric detonators	18.014	U.
	Lead wire	24.019	m

Source: Consorcio SH, 2017.

Table 3.53 Blasting specifications.

DESCRIPTION		QUANTITY	UNIT
Bench excavation blasting	Stone	2.5	m
	Spacing	3	m
	Bank height	6	m
	Overdrilling	0.5	m
	Tamping	2	m
	Drill diameter	3.5"	
	Number of holes	100	U.
	Volume	4125	m3
	LM of drilling	650	m
Pre-splitting	0.80 x 12		m
	Number of bores	100	U.
	Drill diameter	3"	
	Drilling	12	m
	Overdrilling	1	m

Source: Consorcio SH, 2017.

- Fragmentation projections.

Fragmentation projections were produced using the Kuz-Ram fragmentation model, using the following equation:

$$X50=A \times (Vo/Qe)^{0.8} \times (Qe)^{1/6} \times (115/S\ Anfo)^{0.633}$$

Where:

X50: Average size (cm)

Vo: Rock blasted per blast (m3)

Qe: Kg of explosive

S: Relative energy in weight of explosive.

A: Blastability index.

A=0.06 x (RMD + JF + RDI + HF)

A= 0.06*(50+(20+30)+(25*2.6-50)+14)=7.74

X50=7.74*(4125/1925)^0,8*(42.5)^1/6*(115/100)^0.633=29.06 cm

X50 = 29.06 cm

o Type of storage and transport.

The storage and transportation of explosives shall be carried out in accordance with the management measures set out in **Chapter 11 Plans and Programs, Sheet 4 Management and use of explosives**, in this assessment.

o Estimated vibrations.

The vibrations transmitted by blasting depend on the maximum speed reached by ground particles when vibrating as a result of the action of the seismic wave. In accordance with the above and taking into account the law of particle velocity propagation, **Table 3.54** estimates the peak velocity according to the explosive load in each delay interval and the distance.

Table 3.54 Estimated vibrations.

LOAD (KG)	25	50	75
Distance (m)	PPV (mm/s)		
50	24.58	34.76	42.58
100	11.33	16.02	19.62
200	5.28	7.47	9.15
300	3.39	4.8	5.88
500	1.95	2.76	3.38
1000	0.92	1.31	1.6
2000	0.44	0.62	0.76

Source: Consorcio SH, 2017.

3.2.4.2.4 Other supplies.

In addition to the above supplies, the materials listed in **Table 3.55** will be required for implementation of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment. It should be noted that the quantities are estimated.

Table 3.55 Estimated amounts for other supplies.

DESCRIPTION	AMOUNT	UNIT
Geotextile NT 1600	231,013.34	m2
Reinforcing steel fy = 420 MPa	14,269,443.15	Kg
Concrete Pipe D = 1.2m	1,551.39	lm
Concrete Pipe D = 0.9m	5,419.36	lm
PVC Perforated Pipe 2-1 / 2 "	27,132	lm
Structural Steel ASTM A500	26,423.7	Kg
Metal formwork	95,513.67	m2
PVC pipe 4 "	749.6	lm
PVC pipe 2 "	446.91	lm
Biomantle	517,020.72	m2
Bolt D = 25mm	2,400	lm
Transflex Joint TR2400	89.02	lm
Pre-stressed steel	650,447.13	Kg
Topsoil - Clearing	987,418.8	m2
Climbing Formwork	25,083.83	m2
Bailey Bridge	97.8	lm
Microspheres	5,105.53	Kg
Marking lines	225,726.9	lm
Reflective studs	11,134	U.
Type I Signs (90x90)	969	U.
Type V Sign	217	U.
Prefabricated Post for Mileage	180	U.
Type II Vertical Sign	146	U.
Type III Vertical Sign	1,010	U.
Metal Guardrail	36,652.7	lm
Final Section	888	U.
Light reflectors	11,384	U.
Transflex Joint TR3200	45.6	lm
Hawthorn wire fencing	91,200	lm
Surplus material	14,763.9	m3
100mm Bolt	942	lm
Bar Plate and Nut D = 100mm	174.26	lm
Transflex Joint TR2000	1	lm
Neoprene D-60, 40x50x10 cm	2	U.
Neoprene D-60, 45x60x10 cm	2	U.

DESCRIPTION	AMOUNT	UNIT
Vulcanized neoprene for support	1,801,513.28	cm3
Anchoring plate support HDNx128 includes bolts	224	U.
Vulcanized steel plate D = 400mm	224	U.
Treated wood board; 22 mm thick	35.52	m2
Drain pipe, diameter 100 mm	118	lm
Metallic stringcourse	488.5	lm
6" drain pipe	268.6	lm
Transflex joint TR1600	43.6	lm
Transverse Guide 2000T	2	U.
Transverse Guide 2800T	1	U.
Neoprene D-60, 40x60x10	2	U.
Neoprene D-60, 30x50x10	2	U.
Provisional Neoprene D-60, 65x65x15 cm	1	U.
Geotextile NT3000	187.7	m2
Multi-directional POT support device 1200T	2	U.
Multi-directional POT support device 1500T	2	U.
Multi-directional POT support device 1500T anchored for 400T earthquake traction	2	U.
Multi-directional POT support device 5300T	2	U.
Drain pipe, diameter 50 mm	7.2	lm
Geogrid UX11	358,662.69	m2
Geogrid UX15	405,830.83	m2
Geogrid UX16	62,842.41	m2
Road geo-drain	3,454.46	lm
Planar geo-drain	15,529.01	m2
Mantle, TRM 500	46,292.68	m2
Triple-twist mesh	92,550.95	m2
Topographical set-point	394	U.
Piezometer	70	U.
Geotextile 120 g/m2	886,980.67	m2
Inclinometer	5	U.

Source: Consorcio SH, 2017.

3.2.4.3 Leftover material.

The mass balance for this project was calculated as follows: the first section between chainage KP15 + 750 and chainage KP37 + 600, and the second section between chainage KP37 + 600 and chainage KP44 + 844.

For the first section, the total volume of material resulting from cuts is 6,227,510 m^3, and compensation including clearings and embankments using cut material is **60.5%**, equivalent to 3,957,987.39 (including the expansion factor of 1.05). Given the above, the resulting volume of non-usable leftover cut material is 2,826,697.93m3 (including the expansion factor of 1.05), while the volume of suitable material results in a surplus of about 2,988,490.43 m3, giving a total volume of 5,815,188.36 m3 of leftover material.

For the second section, the total volume of material resulting from cuts is 3,944,142.80 m^3, and compensation including clearings and embankments using cut material is **88.0%**, equivalent to 3,644,387.95 (including the expansion factor of 1.05). Given the above, the resulting volume of non-usable leftover cut material is 473,297.14 m3 (including the expansion factor of 1.05), while the volume of suitable material results in a surplus of about 2,526,835.14 m3, giving a total volume of 1,000,132.28 m3 of leftover material. **Table 3.56** shows the general volume of earthworks and Annex 2. Civil V. Slopes, report CSH-1-VD-G-G-5100-5, ANNEX Nº 8 EARTHWORK STUDY sets out the earthworks study for each section.

Table 3.56 Volume of earthworks.

DESCRIPTION	UNIT OF MEASURE	QUANTITY KP15+750 - KP37+600	QUANTITY KP37+600 -KP44+844.	TOTAL QUANTITY
Clearing	m^3	764,459	298,618	1,063,077
Soil excavation	m^3	4,889,469	3,123,311	8,012,780
Rock excavation	m^3	1,398,530	594,886	1,993,416
Embankment	m^3	1,769,144	1,469,781	3,238,925

Source: Consorcio SH, 2017.

3.2.5 Management and disposal of leftover excavation, construction and demolition material.

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, comprises the construction and/or establishment of 39 Zones for the Management of Excavation Material (ZODME), and two (2) non - structural fills (ZODME attached to the structure of the road). The following is a description of the designs for each ZODME, which are presented in **Annex 2. Civil. III. ZODME DESIGN.**

3.2.5.1 List of estimated volumes for disposal.

Following the stability analyses, and the design of the Zodme and non-structural fills, we came to the estimated volumes to be disposed of, as set out in **Table 3.57** and **Table 3.58**, respectively. The material to be disposed of in each Zodme and/or non-structural fill comes from the cut and excavation activities that will be carried out during implementation of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, and such material will be transported via the roads described in section **3.2.1.2 Road infrastructure.** in this chapter.

Table 3.57 Usable volume for the ZODME.

NAME OF STRUCTURE	PROJECT CHAINAGE	SIDE OF THE ROAD	AREA (m^2)	CAPACITY (m^3)
Z1-11	15+800	Right	13,124	57,488
Z1-11B	16+400	Right	9,116	27,365

NAME OF STRUCTURE	PROJECT CHAINAGE	SIDE OF THE ROAD	AREA (m^2)	CAPACITY (m^3)
Z1-12	17+200	Right	19,658	133,600
Z1-13	17+600	Left	8,847	38,847
Z1-14	18+000	Left	22,533	207,400
Z1-14B	18+500	Right	28,581	324,587
Z1-14C	18+800	Right	13,437	100,600
Z1-15	19+600	Left	34,241	238,245
Z1-15B	20+800	Left	27,382	203,804
Z1-15C	21+200	Left	26,643	307,869
Z1-16	22+350	Left	8,149	42,982
Z1-16A	22+500	Right	47,727	323,059
Z1-16B	22+700	Left	15,050	156,251
Z1-18	25+600	Left	80,920	1,097
Z1-17	24+100	Right	4,362	18,718
Z1-17B	24+400	Left	14,121	126,933
Z1-17C	24+600	Left	12,935	87,025
Z2-1B	26+500	Left	196,939	1,868,746
Z2-2	27+600	Right	113,502	2,440,663
Z2-3 A	30+700	Left	203,089	1,906,098
Z2-3B	30+700	Left	41,146	280,321
Z2-3C	30+700	Left	82,154	989,765
Z2-3D	31+700	Left	18,342	164,276
Z2-4	30+700	Left	57,982	318,587
Z2-5	30+700	Left	69,149	646,039
Z2-7	33+300	Right	8,225	49,831
Z2-8	33+800	Right	31,825	352,389
Z2-9	34+000	Right	62,742,00	656,890
Z2-10	35+600	Left	8,166	36557,43
Z2-10 A	34+700	Left	19,908	138,412
Z2-11	35+600	Left	9,517	81,832
Z2-13	35+000	Left	27,663	184,618
Z2-14	36+400	Left	17,524	167,553
Z3-1B	38+100	R - L	69,014	373,710
Z3-2B	38+700	Right	11,503	59,507
Z3-2	38+900	Right	29,856	454,052
Z3-3	39+300	Right	22,368	177,485
Z3-4	41+500	Right	64,449	205,387

NAME OF STRUCTURE	PROJECT CHAINAGE	SIDE OF THE ROAD	AREA (m^2)	CAPACITY (m^3)
Z3-6	43+500	Right	16,148	180,562
			TOTAL CAPACITY	**14,092,593**

Source: Consorcio SH, 2017.

Table 3.58 Usable volume for non-structural fills.

NAME OF STRUCTURE	PROJECT CHAINAGE	SIDE OF THE ROAD	AREA (m^2)	CAPACITY (m^3)
R1-9	18+940	Right	34,019	122,531
R2-1	30+200	Right	51,353	844,672
			TOTAL CAPACITY	**967,203**

Source: Consorcio SH, 2017.

3.2.5.2 Location of potential sites for ZODME placement.

The location of potential sites for the placement of Zodme and the non-structural fills relates to the coordinates set out in **Table 3.59** and **Table 3.60** (see **Figure 3.90**). In addition, the geo-referenced location and the topographic maps containing the planimetry and altimetry of designs at the feasibility level can be found in **Annex 2. Civil. III. Geology**.

Table 3.59 Location of the ZODME.

NAME OF STRUCTURE	PROJECT CHAINAGE	SIDE OF THE ROAD	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST	
			EAST	NORTH
Z1-11	15+800	Right	946843	589280
Z1-11B	16+400	Right	947098	589500
Z1-12	17+200	Right	947725	590122
Z1-13	17+600	Left	947274	590469
Z1-14	18+000	Left	947551	590856
Z1-14B	18+600	Right	948178	590769
Z1-14C	18+800	Right	948420	590906
Z1-15	19+600	Left	948094	591726
Z1-15B	20+800	Left	948856	592284
Z1-15C	21+200	Left	949178	592483
Z1-16	22+400	Left	949938	593046
Z1-16A	22+500	Right	950136	593107
Z1-16B	22+700	Left	949849	593330

NAME OF STRUCTURE	PROJECT CHAINAGE	SIDE OF THE ROAD	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST	
			EAST	NORTH
Z1-17	24+100	Right	950915	594516
Z1-17B	24+400	Left	950698	594998
Z1-17C	24+600	Left	950916	595145
Z1-18	25+600	Left	951292	595530
Z2-1B	26+500	Left	952268	596191
Z2-2	27+600	Right	953729	595878
Z2-3A	30+700	Left	954695	598394
Z2-3B	30+700	Left	954817	598552
Z2-3C	30+700	Left	955528	598524
Z2-3D	31+700	Left	955861	598500
Z2-4	30+700	Left	954787	598824
Z2-5	30+700	Left	953875	598590
Z2-7	33+300	Right	955670	599909
Z2-8	33+800	Right	955408	600370
Z2-9	34+000	Right	955694	600613
Z2-10	35+600	Left	954992	601715
Z2-10A	34+700	Left	954748	601380
Z2-11	35+600	Left	954397	601721
Z2-13	35+000	Left	954099	601178
Z2-14	36+400	Left	954312	601979
Z3-1B	38+100	R - L	954205	603578
Z3-2B	38+700	Right	954331	604024
Z3-2	38+900	Right	954685	604146
Z3-3	39+300	Right	954208	604696
Z3-4	41+500	Right	954933	604548
Z3-6	43+500	Right	956878	605387

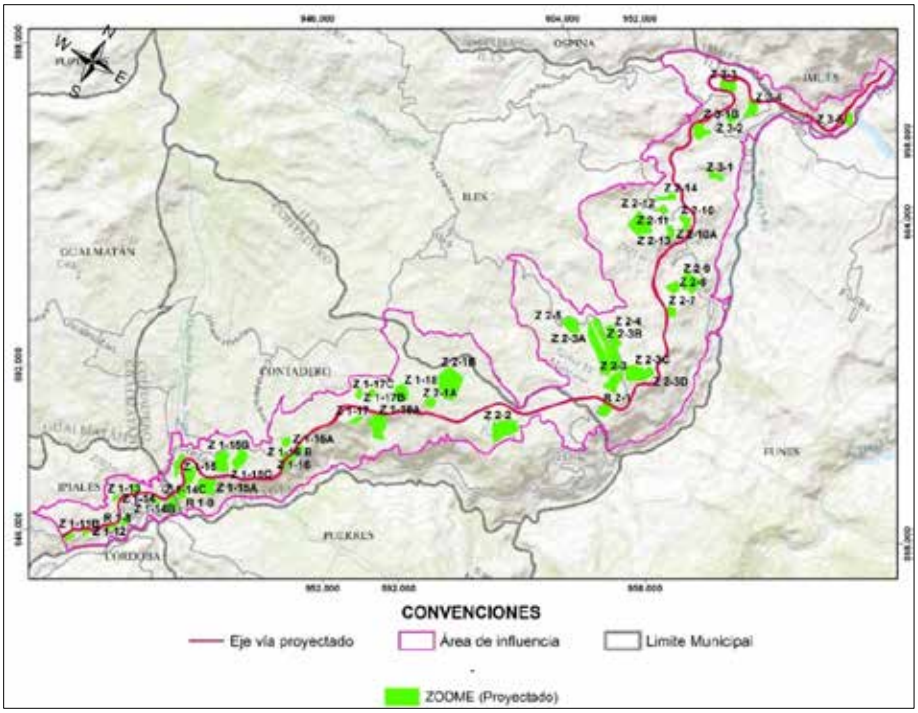
Source: GEOCOL CONSULTORES S.A., 2017.

Table 3.60 Location of non-structural fills.

NAME OF STRUCTURE	PROJECT CHAINAGE	SIDE OF THE ROAD	DATUM COORDINATES MAGNA SIRGAS ORIGIN 3 WEST	
			EAST	NORTH
R1-9	18+940	Right	948404	591721
R2-1	30+200	Right	955450	597384

Source: GEOCOL CONSULTORES S.A., 2017.

Figure 3.90 Location of the ZODME and/or Non-Structural fills.



Source: GEOCOL CONSULTORES S.A., 2017.

3.2.5.3 ZODME design.

3.2.5.3.1 Analysis of safety factors and displacement risk.

Based on the results from the field tests and laboratory tests, the geological units were defined for each potential site for the establishment of the Zodme and/or non-structural fills (see **Table 3.61**).

Table 3.61 Geotechnical units in the assessment area.

GEOTECHNICAL UNIT	GEOTECHNICAL CHARACTERIZATION	FRICTION ANGLE Φ (°)	COHESION, C (KN/M2)	UNIT WEIGHT, G (KN/M3)
GU I	Anthropic fills	30	0	16
GU II	Soils with OM And paleosols	28	20	15
GU III	Quaternary volcanic ash	30	30	17
GU IVa	Loose lithified ash (NSPT <10)	28	25	16

GEOTECHNICAL UNIT	GEOTECHNICAL CHARACTERIZATION	FRICTION ANGLE Φ (°)	COHESION, C (KN/M2)	UNIT WEIGHT, G (KN/M3)
GU IVb	Medium lithified ash (10 <NSPT <30)	33	50	16
GU IVc	Dense-very dense lithified ash (NSPT> 30)	37	70	16
GU V	Volcanic agglomerate. Soft rock (IV-V)	26	120	22
GU VI	Volcanic agglomerate. Medium Rock (II-III)	37	160	26
Zodme fill material		28	20	17

Source: Consorcio SH, 2017.

Taking into account soil parameters and earthquake parameters, a stability analysis was performed for the establishment of ZODME and non-structural fills using the SPENCER methodology, in which the stability of the structures to be established was demonstrated, as set out in **Annex 2. Civil. III. ZODME DESIGN**.

3.2.5.3.2 Identification of dwellings and water bodies.

The dwellings identified in the Zodme and non-structural fills are presented in **Chapter 5. Socioeconomic Characterization. Section. 5.3.9. Information on the population to be resettled** in this assessment. In the event that dwellings are affected as a result of the establishment of Zodme and non-structural fills, consideration will be given to that set out in **Sheet 23. Support for the social management of property** from **Chapter 11. Plans and programs** in this assessment.

Moreover, for purposes of deciding on the location of Zodme and non-structural fills, consideration was given to respecting the protection corridors for lotic water bodies (streams and rivers), keeping a distance of 30 m. Similarly, for springs and areas where water emerges, a corridor of 100 m was taken into account.

3.2.5.3.3 Design parameters.

The design parameters for the Zodme and non-structural fills are set out in:

Table 3.62 Design parameters for the ZODME.

NAME OF STRUCTURE	GRADIENT OF FILL SLOPE	FILL HEIGHT (m)	INTERMEDIATE BERM WIDTH (m)
Z1-11	2.0H;1.0 V	20	3.0
Z1-11B	2.0H;1.0 V	10	2.83
Z1-12	2.0H;1.0 V	23	3.0
Z1-13	2.0H;1.0 V	12.9	12.0
Z1-14	2.0H;1.0 V	36	3.0
Z1-14B	2.0H;1.0 V	33	10.0
Z1-14C	2.0H;1.0 V	31	3.0
Z1-15	2.0H;1.0 V	21	3.0
Z1-15B	2.0H;1.0 V	26	3.0
Z1-15C	2.0H;1.0 V	54	3.0

NAME OF STRUCTURE	GRADIENT OF FILL SLOPE	FILL HEIGHT (m)	INTERMEDIATE BERM WIDTH (m)
Z1-16	2.0H;1.0 V	23	3.0
Z1-16A	2.0H;1.0 V	49.15	5.0
Z1-16B	2.0H;1.0 V	34	6.0
Z1-17	2.0H;1.0 V	29	6.0
Z1-17B	2.0H;1.0 V	53	6.0
Z1-17C	2.0H;1.0 V	43	8.5
Z1-18	2.0H;1.0 V	50	3.02
Z2-1B	2.0H;1.0 V	138.0	3.0, 6.0 , 20
Z2-2	2.0H;1.0 V	64.6	3.0
Z2-3A	2.0H;1.0 V	30.0	6.0
Z2-3B	2.0H;1.0 V	38.5 21.3	3.0 3.0
Z2-3C	2.0H;1.0 V	93.3	6.0, 10.0
Z2-3D	2.0H;1.0 V	29.5	3.0
Z2-4	2.0H;1.0 V	56.9	3.0 , 6.0
Z2-5	2.0H;1.0 V	51	14.0
Z2-7	2.0H;1.0 V	35.0	3.0 , 6.0
Z2-8	2.0H;1.0 V	63.2	2.0
Z2-9	2.0H;1.0 V	46.0 76.0	3.0 6.0
Z2-10	2.0H;1.0 V	9.2 11.0	12 9
Z2-10A	2.0H;1.0 V	28.6	3.0
Z2-11	2.0H;1.0 V	20.0	3.0
Z2-13	2.0H;1.0 V	61.0	3.0 , 6.0
Z2-14	2.0H;1.0 V	45.5	3.0 , 6.0
Z3-1B	2.0H;1.0 V	70.6	3.0, 6.0
Z3-2B	2.0H;1.0 V	54	6.0
Z3-2	2.0H;1.0 V	35.0	3.0 , 6.0
Z3-3	2.0H;1.0 V	38.0	3.0, 6.0
Z3-4	2.0H;1.0 V	8.3	795
Z3-6	2.0H;1.0 V	27.3	3.0

Source: Consorcio SH, 2017.

Table 3.63 Design parameters for non-structural fills.

NAME OF STRUCTURE	GRADIENT OF FILL SLOPE	FILL HEIGHT (M)	INTERMEDIATE BERMS (M)
R1-9	2.0H;1.0 V	45.0 and 32.0	9
R2-1	2.0H;1.0 V	57.9	6.0

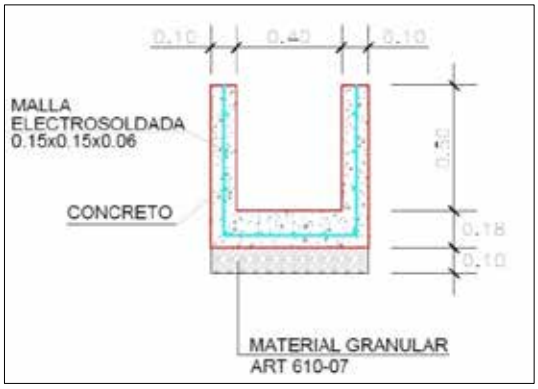
Sucre: Consorcio SH, 2017.

- **Required drainage and sub-drainage infrastructure works for confinement and containment structures, and slopes.**

The drainage and sub-drainage works to be implemented in the Zodme and non-structural fills are presented in **Annex 2. Civil. Zodme Design**. Below is a general description of these works:

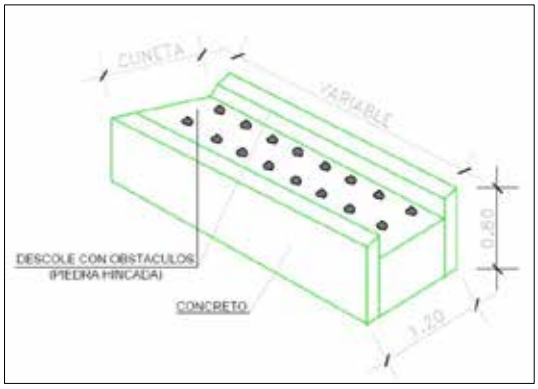
Gutters will be built in the perimeter of the work area and in the inner part of the berms relating to the earthworks (disposal and shaping of the material) in order to capture and channel surface runoff water (see **Figure 3.91**). These will lead to stepped chutes (energy dissipaters), for suitable delivery without causing erosion to the ground (see **Figure 3.92**).

Figure 3.91 Cross section of the perimeter gutter



Source: Consorcio SH, 2017.

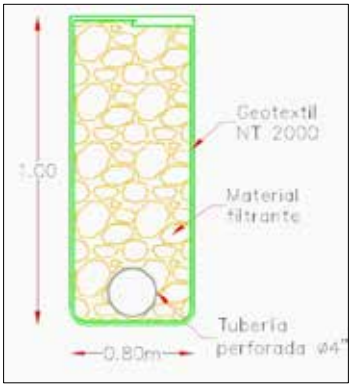
Figure 3.92 Perimeter gutter water energy dissipater



Source: Consorcio SH, 2017.

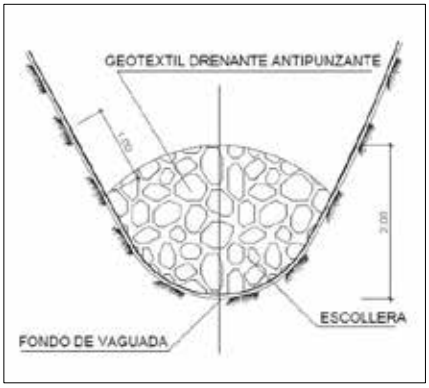
Where necessary and/or when planned in the design for the Zodme, fishbone collection channels will be put in place (comprised by filters), to reduce water infiltration, and direct the water collected outside the vulnerable areas of the slope, delivering them to the gutters' energy dissipaters (at exit) (**Figure 3.93**). Similarly, and where required, riprap cordons should be constructed (**Figure 3.94**) to reduce erosion problems and ultimately prevent surface movement of the ground.

Figure 3.93 Detail of the fishbone filter



Source: Consorcio SH, 2017.

Figure 3.94 Riprap cordon



Source: Consorcio SH, 2017.

3.2.5.3.4 Plan view and cross-sections for final structure.

The plan and profile views of the Zodme and non-structural fills are set out in **Annex 2. Civil. Zodme Design.**

3.2.5.3.5 Identification of end uses.

Upon completion of the materials' disposal in the deposit area, a layer of native vegetation species will be established, using plant material removed and recovered from slope cuts and clearing work, or through controlled hydroseeding, in accordance with Article 810 of INVIAS - 12. In terms of the end use, this will be agreed with the owner of each property, as established in **Sheet 23. Support for the social management of property** in **Chapter 11. Plans and programs** in this assessment.

3.2.6 Demolition material.

The project's construction will generate material resulting from the demolition of existing infrastructure such as dwellings, culverts, pavement, etc. The debris produced will be transported to the waste dump located at the Antanas Landfill, located 13 kilometers from the city of Pasto, on the Daza Buesaco bypass, in the rural district of Josefina, district of Morasurco. Annex 2. Civil. WASTE DUMP PERMIT.

3.2.7 Hazardous and non-hazardous waste.

Decree 838 of 2005 defines solid waste as any solid object, material, substance or element resulting from the consumption or use of goods in domestic, industrial, commercial, institutional or service activities, which the generator subsequently abandons, rejects or delivers, and can be used or transformed into new goods that have financial value, or is sent to final disposal. Such solid waste is divided into usable and non-usable waste.

3.2.7.1 Classification of solid waste.

During the project's various domestic and industrial activities, three types of waste will be generated: non-hazardous, hazardous and special. In turn, non-hazardous waste can be sub-classified into: usable, non-usable and biodegradable organic. Below, **Table 3.65** provides a description of the types of waste.

Table 3.64 Classification and description of types of solid waste.

TYPE OF WASTE	DESCRIPTION
Usable	This waste is of no use to whoever generates it, but can be reintegrated into a production process, and therefore it has commercial value. Example: file paper, cardboard, glass, plastic (containers, bags, cups, etc.) and metal, among others.
Non-usable	Relates to all material that, due to its characteristics, does not offer any possibility for use, whether through reuse or through reincorporation into a production process. They do not have any commercial value, and therefore require final disposal. Example: dirty paper (toilet paper, towels, etc.), sweeping material, cigarette butts, expanded polystyrene, and metal foil, among others.
Biodegradable organic waste	Relates to waste that, due to its organic properties, is degradable by means of biological processes, transforming into another type of organic matter. Example: fruit peels, food waste and/or plant material.
Hazardous	This waste possesses corrosive, explosive, reactive, toxic, infectious, flammable and/or radioactive characteristics, and may represent a risk to human health and the environment. Similarly, containers, packages and packaging that have been in contact with such waste (Decree 4741 of 2005) are considered to be hazardous waste. Example: batteries, chemicals, drugs, waste oils, and biological waste, among others.
Special	Relates to any solid waste that, due to its nature, composition, size, volume and/or weight, transportation needs, storage conditions and compaction, cannot be collected, handled, treated or disposed of normally by the waste collection provider, and therefore may be potentially dangerous and thus require special handling. Example: tires, mattresses, furniture, bulky waste, sludge, etc.

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.7.1.1 Domestic waste.

During the course of domestic activities, a variety of solid waste will be generated, including: food waste, waste from sweeping and bathroom cleaning, plastic, paper, cardboard, contaminated and uncontaminated wood, glass, aluminum and other metals, expanded polystyrene, and cardboard impregnated with other waste, food bags, napkins, paper towels and sanitary waste. Such waste is subjected to a classification process by type of waste, according to its nature (usable, non-usable, biodegradable and hazardous, mainly).

3.2.7.1.2 Industrial waste.

The industrial solid waste that will be generated during the course of the project, as well as its type, treatment, handling and disposal are presented below in **Table 3.66**.

Table 3.65 Management of industrial solid waste.

INDUSTRIAL WASTE		TREATMENT, HANDLING AND DISPOSAL
Usable	Cans, paper, cardboard, glass, plastic and scrap, as well as packages or packaging that is free of polluting substances.	Chemical-free waste that can be treated as recyclable and grouped with waste of domestic origin. This waste will be separated at the source and will be collected regularly by recycling

INDUSTRIAL WASTE		TREATMENT, HANDLING AND DISPOSAL
		companies or cooperatives that hold the respective environmental permits for the final disposal of such waste.
Hazardous	Paper and cardboard from bags and sacks used as packaging for chemicals, cements.	Waste and packaging from chemicals and cement, among others, used in the civil works stage. This waste will be removed and disposed of by contractors and/or supply companies.
	Tows, gloves, overalls, rags and other textiles, which cannot be recycled because they are contaminated.	They will be stored in properly marked containers for transportation and disposal by a company that holds valid environmental permits for the transportation, treatment and final disposal of such waste.
	Containers used for oil changes, antifreeze, concrete curing chemicals, engine lubricants, aerosols, blowing agents, bitumen containing tar, silicone and other sealing products, diesel use, and packaging for chemicals.	They will be temporarily stored at the camps' collection points, and will be properly marked, roofed and preferably waterproofed. They will then be delivered to suppliers and/or delivered to companies that hold valid environmental permits for transportation and final disposal.
	Batteries, lead, acid, tires, storage batteries, bulbs, computers and/or peripherals, drugs, paints, equipment, electronic and electrical parts.	They will be classified at the source, temporarily stored in clearly marked containers, and delivered to the suppliers, which will finally dispose of the waste in accordance with the purchase agreements established prior to the start of the project and the current environmental regulations (Resolution 371 of February 23 from the Ministry of Environment, Housing and Territorial Development).
	Medical sharps	These will be stored in a red container in the infirmary area, and will be delivered to agents that have been authorized by the regional autonomous corporation to manage these items.
Special	Bricks, tiles, hardened concrete, hardened mortar, steel reinforcements, metal structure debris, frames, and formwork panels.	All these items will be sent to the authorized dump via the departmental transport companies that are authorized to do this. This will occur if, due a certain characteristic, the material cannot be used.

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.7.1.3 Overburden.

During the course of excavations and/or grading, large amounts of overburden will be produced, which can be reused on the same work fronts (either to establish fills or base layers). The volumes that cannot be reused due to their physical characteristics will be stored and transported for final disposal in the project's Zodme (see section ***3.2.5 Management and disposal of leftover excavation, construction and demolition material.*** in this chapter).

3.2.7.2 Projected volumes of solid waste.

Below is a projection of the solid waste that could be generated during the project's various stages, as a result of domestic and industrial activities.

3.2.7.2.1 Domestic solid waste

Taking into account that the workforce for the camps will total approximately 250 people (**Table 3.67**), the ordinary waste generated by this personnel will be in the range of 0.4 and 0.6 kg/inhabitant-day, which

relates to a critical-scenario waste production of approximately 150 kg/day, with a margin of 10 kg/day in the event that there are additional personnel present at the project's facilities.

Table 3.66 Personnel who will work on different stages of the project.

AREA	No. OF PERSONNEL	WASTE GENERATION (kg/day)	WASTE GENERATION (kg/month)
Camp	250	100-150	3000-4500

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.7.2.2 Industrial solid waste

Regarding industrial solid waste, the main waste anticipated relates to concrete waste, reinforcing steels, formwork woods and earthworks generated during the course of excavations and/or leveling, and that cannot be reused. Typical amounts are used as a reference, and these are presented in **Table 3.68**.

Table 3.67 Industrial solid waste.

TYPE OF WASTE	WASTE GENERATION (month)	UNIT
Excavation	713	m^3
Concrete	125.6	m^3
Reinforcing steel	1179.2	kg
Wood	140	m^2
Demolition	4	m^3
Other	100	kg

Source: Moncada Rojas, Ramírez Naranjo, & Chávez Porras, 2009.

3.2.7.3 Foreseeable environmental impacts.

The most significant environmental impacts associated with the disposal of solid waste are set out in **Table 3.69**. Chapter 8 of this assessment shows the impacts caused by this activity.

Table 3.68 Impacts identified relating to solid waste.

ACTIVITY	ENVIRONMENTAL ASPECTS	ENVIRONMENTAL IMPACT
Generation and disposal of solid waste	Soil characteristics	Alteration of the physicochemical and/or microbiological characteristics of the soil
		Change in current land use
	Surface water characteristics	Alteration of the physicochemical and bacteriological characteristics of surface water
	Resource availability	Change in the availability of surface water resources
	Groundwater characteristics	Alteration of the physicochemical and bacteriological properties of groundwater
	Resource availability	Change in the availability of groundwater resources

	Air quality	Change in gas concentration

Source: GEOCOL CONSULTORES S.A., 2017.

The impacts generated by solid waste can basically arise due to the degradation of organic matter, as this leads to the generation of leachates that can affect the soil as a result of infiltration. Moreover, gases can also be produced -also arising from the decomposition process-, such as methane and carbon dioxide, which are considered to be greenhouse gases. The following is an overview of the waste's treatment, management and disposal.

3.2.7.4 Management and disposal.

The following should be carried out prior to commencing activities:

- Identification of the waste that will be generated during the activities to be carried out.
- Identification of generation points.
- Procedure for classification and separation at the source.
- Procedure for the collection of waste in work fronts and temporary sites.
- Procedure for separation, quantification and storage at temporary storage sites.
- Establishment of collection periods and final waste disposal, in accordance with the type of waste generated.

As a strategy for the management and final disposal of solid waste, the plan is to deliver such waste to an authorized agent, which will be responsible for its collection, transportation, treatment and final disposal and/or delivery to legally established municipal utilities that have a landfill possessing a valid environmental license.

3.2.7.4.1 Identification and classification of waste.

We will encourage the minimization of waste at generation points, with priority being given to minimization at the source (reduce, recycle and reuse, harnessing the materials and/or energy contained in the waste). To this end, the following activities should be considered for the minimization of potential impacts from waste generation:

- Classification at the source: the waste must be separated in the work front, in accordance with its origin and nature.
- Reuse: where possible, waste such as paper, cardboard, containers, packaging, structures, cables and insulators etc. should be reused.
- Recycling: solid waste that can be reused as a raw material for the production of new items should be separated.
- Final disposal: after being classified and packed, the waste must be delivered to an authorized agent and disposed of in sites authorized for this purpose.

As part of the process of classifying waste at the source, ecological points will be set up in the project's work fronts, camps and work areas for the separation of waste, taking into account the type of waste. **Table 3.70** provides a color chart regarding the containers for the potential waste that will be generated, as well as how it will be managed and the typical final disposal suggested for each waste group.

In order to control the waste generated and delivered, it will be weighed before delivery to authorized third parties, and they must guarantee the final management of such waste by means of disposal records. Based on the 2015 environmental agenda for the municipality of Ipiales, it was identified that refuse collection companies collect organic waste separately, and therefore a unique category is included for biodegradable waste.

Table 3.69 Classification of ordinary solid waste.

TYPE OF WASTE	MANAGEMENT LOCATION / DISPOSAL	CONTAINER
ORGANIC	The waste will be collected in black bags, in containers properly marked as being for this type of waste. The bags must be transported and disposed of in a landfill that has an environmental license, after a period that guarantees the absence of vectors in the vicinity of the storage container. The storage containers will be strategically located, in accordance with the distribution of the facilities and the volume of personnel.	BLACK (food waste and plant waste)
NON-USABLE	This waste will be separated at the source in green bags, and then temporarily stored in the solid waste management hut. Finally, if it cannot be used, it will be delivered to a company responsible for treating such waste and performing final disposal in a landfill. This company must have valid environmental documentation for transportation and final disposal. Example: dirty paper (toilet paper, towels, etc.), sweeping material, cigarette butts, expanded polystyrene, and metal foil, among others.	GREEN (ordinary and inert)
USABLE	These materials will be separated at the source through the use of properly marked colored bins. The waste that can be used will be delivered to companies that treat and recover the materials, whether through reuse and/or recycling. Example: Plastic bottles, disposable cups, water bags, milk bags, containers, plastic, spheres, plastic cutlery, paper, cardboard, newspaper, notebooks, magazines, calendars, and clean glass bottles, etc.	BLUE (recyclable plastic) GREY (paper, cardboard, clean newspaper)
HAZARDOUS WASTE	This waste will be temporarily stored in 55-gallon metal containers or red bags depending on the state of the waste and its source of generation. The way it is handled must be consistent with the nature of the waste. The waste will be labeled for delivery, with basic information that will enable the authorities or the transport / final disposal company to fully identify the waste and the amount generated. The waste will be delivered to companies that possess the necessary environmental permits for the operation, and they must issue a certificate regarding disposal of the waste collected. Example: batteries, chemicals, drugs, waste oils and biological waste, among others.	RED (material contaminated with hazardous waste or substances posing biological risk)

Source: GEOCOL CONSULTORES S.A., 2017.

3.2.7.4.2 Temporary storage of waste.

During the generation of solid waste, a collection center will be required for the temporary storage of such waste, until it is delivered to a third party for treatment, use and/or final disposal. The following should be considered for implementation of the collection center:

- The collection center must be protected from the weather and potential vectors, and it should only be accessed by personnel authorized for waste storage or disposal.
- It must have an impermeable surface made of cement or geomembrane.
- For safety, hazardous waste should be kept isolated from non-hazardous waste by means of a compartment. This is in order to avoid contamination.
- The collection center should have good ventilation as a safety measure, and as a means of controlling potential odors.
- The collection center should be located far away from canteens or camps, and should take into account the direction of the wind.
- A fire-fighting system should be implemented as a precautionary measure, in addition to wash units in the event of contact with hazardous waste, and personal protective equipment.
- Proper signage must be put in place, and in the case of hazardous waste, the respective identification regarding the waste's nature must be provided.

The collection center must comply with all other provisions established by Decree 2981 of 2013.

Special waste of a high volume must be disposed of in areas suitable for this purpose. In case of material such as scrap, the area must be conditioned to avoid exposure to the weather and avoid the corrosion-related leaching of secondary waste.

The waste storage period must be such that it ensures that the collection center's capacity does not exceed 90% of its total capacity, and this also depends on the conditions relating to the waste stored. For example, it should be ensured that biodegradable waste is delivered at certain intervals in order to avoid the occurrence of odors, vectors and leaching.

3.2.7.4.3 Collection and transport.

The collection routes will be implemented and adjusted in accordance with the volumes and characteristics of the waste, with a view to carrying out ongoing collection that prioritizes waste that, due to its characteristics, needs to be transported and disposed of within a shorter period of time.

Waste that requires special handling, such as hazardous waste and certain special waste, must be delivered to third parties that hold the respective permits for treatment and final disposal.

The following minimum precautions must be taken during the collection and transportation process:

- The load in the vehicle must be properly accommodated, stowed, stacked, secured and covered, in such a way as not to pose danger to persons or the environment.
- The transporter must have basic emergency response items, such as: a fire extinguisher, protective clothing, flashlight, first aid kit, collection and cleaning equipment.

- The waste transporter must have a contingency plan, since in the event of a spill or leak of hazardous waste during transportation, they must adopt the necessary contingency measures to protect human health and the environment.
- Those providing the collection, utilization, treatment and final disposal service must certify the weight of the waste delivered by the company, while the company will also keep a regular record of the weight generated, by type of waste.
- The collection and transportation of waste must comply with the requirements established in Decrees 2981 of 2013, 1609 of 2002, and 4741 of 2005.

3.2.7.4.4 Final disposal

The final disposal of waste will be in accordance with its nature as non-usable, usable or hazardous.

With regard to ordinary non-usable waste, it will be disposed of in a landfill that possesses an environmental license and/or it will be delivered to companies authorized for its transportation and final disposal.

Usable solid waste will be delivered to recycling companies for reuse or re-inclusion in the life cycle.

Hazardous waste will be delivered to companies responsible for its treatment and disposal, and that have the respective environmental permits to carry out this type of activity.

Special industrial solid waste must be delivered to companies authorized for its collection, treatment and final disposal.

3.2.8 Project costs.

The implementation of the activities relating to the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, will have an estimated average cost of seven hundred seventy eight billion two hundred and twenty three million seven hundred and thirteen thousand one hundred six ($778,223,713,106) Colombian pesos.

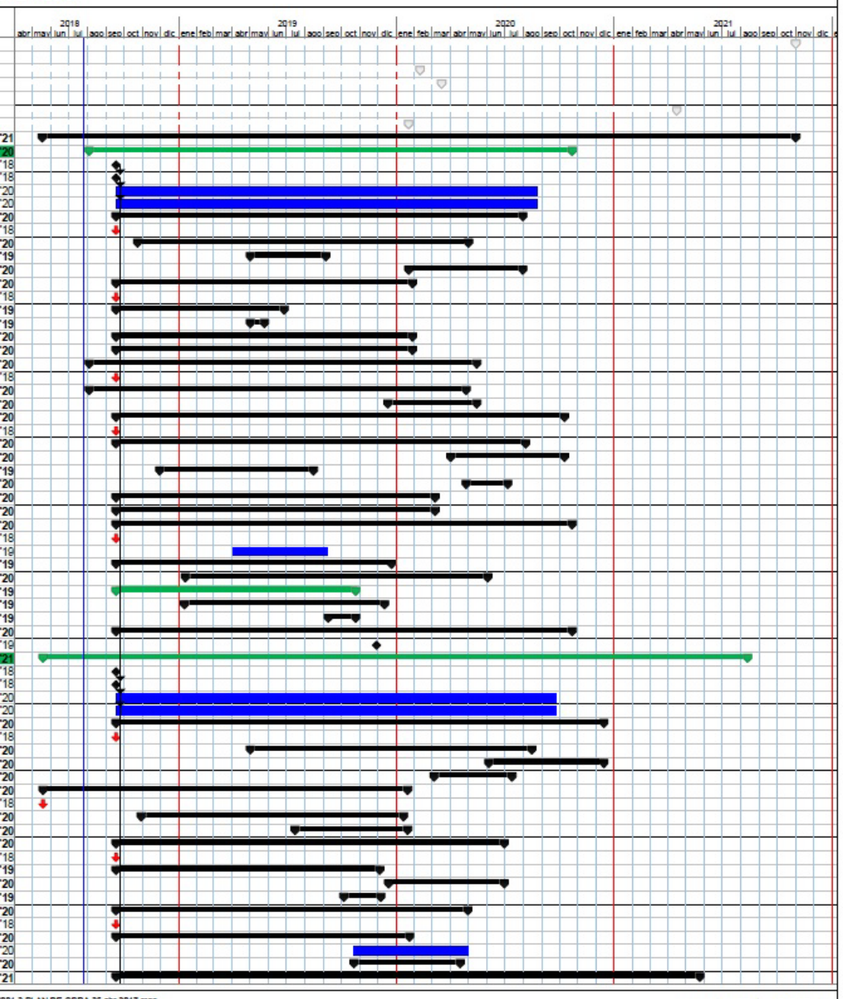
3.2.9 Project schedule.

The Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment, will last for 1,264 days according to the scheduling for the implementation of works, as set out in **Annex 2. Civil. XII. Schedule and Organizational Chart** (See **Figure 3.95**).

Figure 3.95 Work plan for the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment.

PLAN DE OBRA RUMICHACA PASTO
UF1 - UF2 - UF3

Id	EDT	Predecesor	Sucesor	Nombre	Comienzo	Fin
1						
2						
3						
787						
3784						
3853						
4843						
4847	1.8			UF1 (15+750 al 25+600) UF2 Y UF3	17 may '18	1 nov '21
4848	1.8.1			UF 3	4 ago '18	22 oct '20
4849	1.8.1.1	389,753F	4850	Instalaciones auxiliares campamentos y movilizacion	18 sep '18	18 sep '18
4850	1.8.1.2	4849,389,	5045,5(	INICIO UF3	18 sep '18	18 sep '18
4851	1.8.1.3	4850		Reubicacion redes secas	18 sep '18	24 ago '20
4852	1.8.1.4	4850		Reubicacion redes humedas	18 sep '18	24 ago '20
4853	1.8.1.5			T1 44+909 - 42+150	18 sep '18	31 jul '20
4854	1.8.1.5.1	389,753F		DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF2-T1	18 sep '18	18 sep '18
4855	1.8.1.5.2			MOVIMIENTO DE TIERRAS	24 oct '18	1 may '20
4894	1.8.1.5.3			DRENAJE	1 may '19	5 sep '19
4900	1.8.1.5.4	4880CC+		MUROS SUELO REFORZADO T1	22 ene '20	31 jul '20
4902	1.8.1.6			T2 42+150 - 41+700	18 sep '18	28 ene '20
4903	1.8.1.6.1	389,753F	4906,4(	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF3-T2	18 sep '18	18 sep '18
4904	1.8.1.6.2			MOVIMIENTO DE TIERRAS	18 sep '18	27 jun '19
4917	1.8.1.6.3			DRENAJE	1 may '19	25 may '19
4930	1.8.1.6.4			ESTRUCTURAS	18 sep '18	28 ene '20
4931	1.8.1.6.4.1			PUENTE SAPUYES PK 41+857	18 sep '18	28 ene '20
4967	1.8.1.7			T3 41+700 - 39+700	4 ago '18	15 may '20
4968	1.8.1.7.1	389,753F		DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF3-T3	18 sep '18	18 sep '18
4969	1.8.1.7.2			MOVIMIENTO DE TIERRAS	4 ago '18	27 abr '20
4982	1.8.1.7.3			DRENAJE	18 dic '19	15 may '20
4996	1.8.1.8			T4 39+700 - 37+300	18 sep '18	9 oct '20
4997	1.8.1.8.1	389,753F	5000,5(	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF3-T4	18 sep '18	18 sep '18
4998	1.8.1.8.2			MOVIMIENTO DE TIERRAS	18 sep '18	5 ago '20
5024	1.8.1.8.3			MUROS SUELO REFORZADO T4	1 abr '20	9 oct '20
5026	1.8.1.8.4			MUROS CONCRETO REFORZADO	30 nov '18	15 ago '19
5028	1.8.1.8.5			DRENAJE	27 abr '20	6 jul '20
5042	1.8.1.8.6			ESTRUCTURAS	18 sep '18	6 mar '20
5043	1.8.1.8.6.1			PUENTE EL PORVENIR PK 38+781	18 sep '18	6 mar '20
5079	1.8.1.9			GENERALES	18 sep '18	22 oct '20
5080	1.8.1.9.1	389,753F	5083,5(	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF3-GENERALES	18 sep '18	18 sep '18
5081	1.8.1.9.2			INSTALACIONES DE CONCESION	2 abr '19	7 sep '19
5082	1.8.1.9.3			ZODMES	18 sep '18	24 dic '19
5086	1.8.1.9.4			TRATAMIENTO DE TALUDES	12 ene '19	2 jun '20
5088	1.8.1.9.5			PAVIMENTOS	18 sep '18	25 oct '19
5097	1.8.1.9.6			DRENAJE LONGITUDINAL	11 ene '19	12 dic '19
5099	1.8.1.9.7			SEÑALIZACIÓN Y DEFENSAS DEFINITIVAS	9 sep '19	25 oct '19
5113	1.8.1.9.8			CERRAMIENTO	18 sep '18	22 oct '20
5115	1.8.1.10			FIN UF 3	29 nov '19	29 nov '19
5116	1.8.2			UF 2	18 may '18	12 ago '21
5117	1.8.2.1	389,498,5	5118	Instalaciones auxiliares campamentos y movilizacion	18 sep '18	18 sep '18
5118	1.8.2.2	5117,389	5382,C(	INICIO UF2	18 sep '18	18 sep '18
5119	1.8.2.3	5118		Reubicacion redes secas	18 sep '18	24 sep '20
5120	1.8.2.4	5118		Reubicacion redes humedas	18 sep '18	24 sep '20
5121	1.8.2.5			T1 25+600-28+000	18 sep '18	14 dic '20
5122	1.8.2.5.1	389,753F	5130	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF2-T1	18 sep '18	18 sep '18
5123	1.8.2.5.2			MOVIMIENTO DE TIERRAS	1 may '19	15 ago '20
5139	1.8.2.5.3	5135CC+		MUROS SUELO REFORZADO T1	4 jun '20	14 dic '20
5141	1.8.2.5.4			DRENAJE	4 mar '20	13 jul '20
5155	1.8.2.6			T2 28+000-30+000	18 may '18	20 ene '20
5156	1.8.2.6.1	389,753F	5159	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF2-T2	18 may '18	18 may '18
5157	1.8.2.6.2			MOVIMIENTO DE TIERRAS	30 oct '18	13 ene '20
5177	1.8.2.6.3			DRENAJE	15 jul '19	20 ene '20
5192	1.8.2.7			T3 30+000-31+970	18 sep '18	30 jun '20
5193	1.8.2.7.1	389,753F	5196,5(	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF2-T3	18 sep '18	18 sep '18
5194	1.8.2.7.2			MOVIMIENTO DE TIERRAS	18 sep '18	4 dic '19
5205	1.8.2.7.3	5200CC+		MUROS SUELO REFORZADO T3	19 dic '19	30 jun '20
5207	1.8.2.7.4			DRENAJE	5 oct '19	6 dic '19
5220	1.8.2.8			T4 31+970-36+000	18 sep '18	30 abr '20
5221	1.8.2.8.1	389,753F	5224,5(	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF2-T4	18 sep '18	18 sep '18
5222	1.8.2.8.2			MOVIMIENTO DE TIERRAS	18 sep '18	23 ene '20
5242	1.8.2.8.3	5244		MUROS SUELO REFORZADO T4	22 oct '19	30 abr '20
5253	1.8.2.8.4			DRENAJE	22 oct '19	17 abr '20
5265	1.8.2.9			T5 36+000 - 37+300	18 sep '18	24 may '21



Página 1 -CSH-G-PR-PF-PO-G-G-0001-2 PLAN DE OBRA 25 abr 2017.mpp
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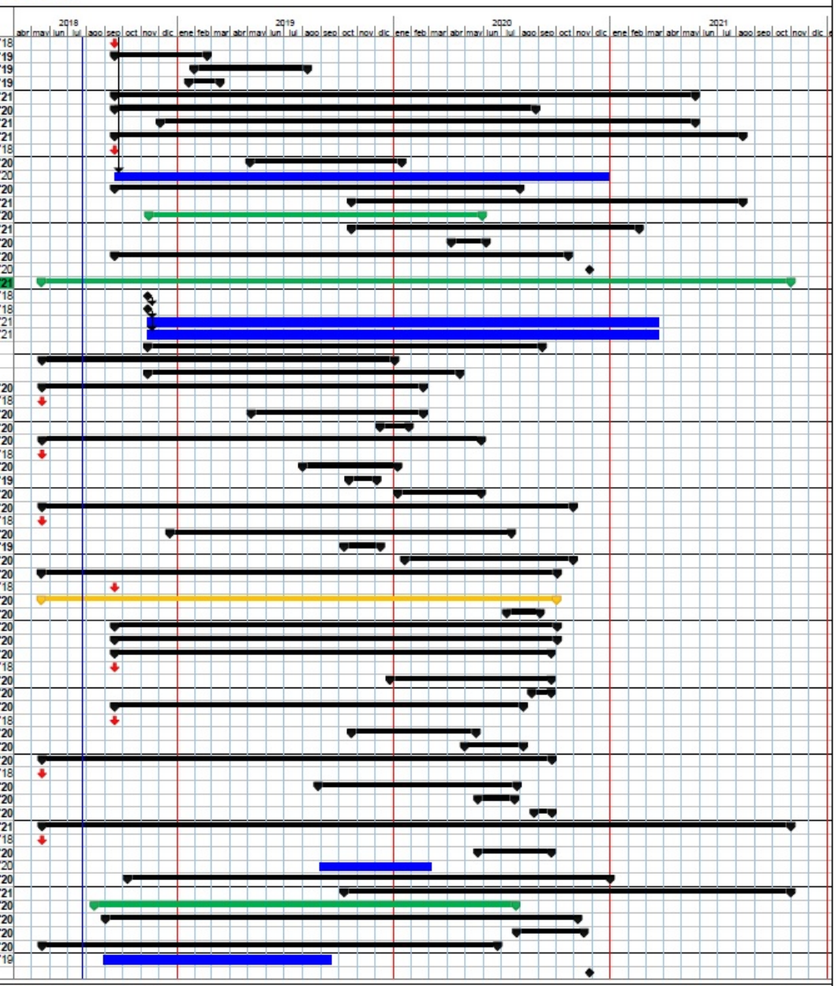
PLAN DE OBRA RUMICHACA PASTO
UF1 - UF2 - UF3

Id	EDT	Predecesor	Sucesora	Nombre	Comienzo	Fin
5266	1.8.2.9.1	389,753F	5269,5	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF2-T5	18 sep '18	18 sep '18
5267	1.8.2.9.2			MOVIMIENTO DE TIERRAS	18 sep '18	21 feb '19
5281	1.8.2.9.3	5277CC		MUROS SUELO REFORZADO T5	30 ene '19	9 ago '19
5283	1.8.2.9.4			DRENAJE	21 ene '19	14 mar '19
5294	1.8.2.9.5			ESTRUCTURAS	18 sep '18	24 may '21
5295	1.8.2.9.5.1			TABLON ALTO PK 36+604	18 sep '18	28 ago '20
5336	1.8.2.9.5.2			EL MACAL PK 37+349	4 dic '18	24 may '21
5376	1.8.2.10			GENERALES	18 sep '18	12 ago '21
5377	1.8.2.10.1	389,753F	5382,5	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF2-GENERALES	18 sep '18	18 sep '18
5378	1.8.2.10.2	5277CC+		MUROS CONCRETO REFORZADO	4 may '19	15 ene '20
5380	1.8.2.10.3	4850		INSTALACIONES DE CONCESION	18 sep '18	28 dic '20
5381	1.8.2.10.4			ZODMES	18 sep '18	1 ago '20
5385	1.8.2.10.5			TRATAMIENTO DE TALUDES	22 oct '19	12 ago '21
5387	1.8.2.10.6			PAVIMENTOS	15 nov '18	29 may '20
5395	1.8.2.10.7			DRENAJE LONGITUDINAL	22 oct '19	18 feb '21
5397	1.8.2.10.8			SEÑALIZACIÓN Y DEFENSAS DEFINITIVAS	7 abr '20	5 jun '20
5410	1.8.2.10.9			CERRAMIENTO	18 sep '18	22 oct '20
5412	1.8.2.11			Fin UF2	27 nov '20	27 nov '20
5413	1.8.3			UF 1	17 may '18	1 nov '21
5414	1.8.3.1	482,487,5	5415	Instalaciones auxiliares campamentos y movilizacion	12 nov '18	12 nov '18
5415	1.8.3.2	5414,231,5	918C0	INICIO UF1	12 nov '18	12 nov '18
5416	1.8.3.3	5415		Reubicacion redes secas	13 nov '18	22 mar '21
5417	1.8.3.4	5415		Reubicacion redes humedas	13 nov '18	22 mar '21
5418						
5566						
5605						
5644	1.8.3.8			T4 14+000 - 16+000	18 may '18	20 feb '20
5645	1.8.3.8.1	231,753F	5648	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-T4	18 may '18	18 may '18
5646	1.8.3.8.2			MOVIMIENTO DE TIERRAS	6 may '19	20 feb '20
5667	1.8.3.8.3			DRENAJE	9 dic '19	27 ene '20
5681	1.8.3.9			T5 16+000 -17+000	18 may '18	28 may '20
5682	1.8.3.9.1	389,753F	5685	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-T5	18 may '18	18 may '18
5683	1.8.3.9.2			MOVIMIENTO DE TIERRAS	1 ago '19	8 ene '20
5692	1.8.3.9.3			DRENAJE	18 oct '19	4 dic '19
5704	1.8.3.9.4			MUROS SUELO REFORZADO	8 ene '20	28 may '20
5706	1.8.3.10			T6 17+000 - 18+800	18 may '18	30 oct '20
5707	1.8.3.10.1	389,753F	5710	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-T6	18 may '18	18 may '18
5708	1.8.3.10.2			MOVIMIENTO DE TIERRAS	20 dic '18	18 jul '20
5723	1.8.3.10.3			DRENAJE	10 oct '19	10 dic '19
5737	1.8.3.10.4			MUROS SUELO REFORZADO	20 ene '20	30 oct '20
5740	1.8.3.11			T7 18+800 - 22+000	17 may '18	3 oct '20
5741	1.8.3.11.1	389,753F	5779	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-T7	18 sep '18	18 sep '18
5742	1.8.3.11.2			MOVIMIENTO DE TIERRAS	17 may '18	2 oct '20
5761	1.8.3.11.3			DRENAJE	10 jul '20	4 sep '20
5776	1.8.3.11.4			ESTRUCTURAS	18 sep '18	3 oct '20
5777	1.8.3.11.4.1			PUENTE BOQUERON	18 sep '18	3 oct '20
5828	1.8.3.12			T8 22+000 - 23+000	18 sep '18	23 sep '20
5829	1.8.3.12.1	389,753F		DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-T8	18 sep '18	18 sep '18
5830	1.8.3.12.2			MOVIMIENTO DE TIERRAS	26 dic '19	23 sep '20
5841	1.8.3.12.3			DRENAJE	21 ago '20	23 sep '20
5855	1.8.3.13			T9 23+000 - 24+000	18 sep '18	7 ago '20
5856	1.8.3.13.1	389,753F		DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-T9	18 sep '18	18 sep '18
5857	1.8.3.13.2			MOVIMIENTO DE TIERRAS	22 oct '19	19 may '20
5868	1.8.3.13.3			DRENAJE	30 abr '20	7 ago '20
5881	1.8.3.14			T10 24+000 - 25+600	18 may '18	24 sep '20
5882	1.8.3.14.1	389,753F	5911C0	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-T10	18 may '18	18 may '18
5883	1.8.3.14.2			MOVIMIENTO DE TIERRAS	27 ago '19	27 jul '20
5894	1.8.3.14.3			DRENAJE	22 may '20	23 jul '20
5910	1.8.3.14.4			MUROS SUELO REFORZADO	25 ago '20	24 sep '20
5912	1.8.3.15			GENERALES	18 may '18	1 nov '21
5913	1.8.3.15.1	389,231,7	5918,5	DISPONIBILIDAD ARQUEOLOGICA, PREDIAL O AMBIENTAL UF1-GENERALES	18 may '18	18 may '18
5914	1.8.3.15.2	5887		MUROS CONCRETO REFORZADO	22 may '20	23 sep '20
5916	1.8.3.15.3			INSTALACIONES DE CONCESION	29 ago '19	4 mar '20
5917	1.8.3.15.4			ZODMES	10 oct '18	31 dic '20
5921	1.8.3.15.5			TRATAMIENTO DE TALUDES	10 oct '19	1 nov '21
5923	1.8.3.15.6			PAVIMENTOS	15 ago '18	25 jul '20
5932	1.8.3.15.7			DRENAJE LONGITUDINAL	3 sep '18	6 nov '20
5934	1.8.3.15.8			SEÑALIZACIÓN Y DEFENSAS DEFINITIVAS	27 jul '20	17 nov '20
5948	1.8.3.15.9			CERRAMIENTO	19 may '18	24 jun '20
5950	1.8.3.15.10			PEAJE - EDIFICIOS	31 ago '18	17 sep '19
5951						



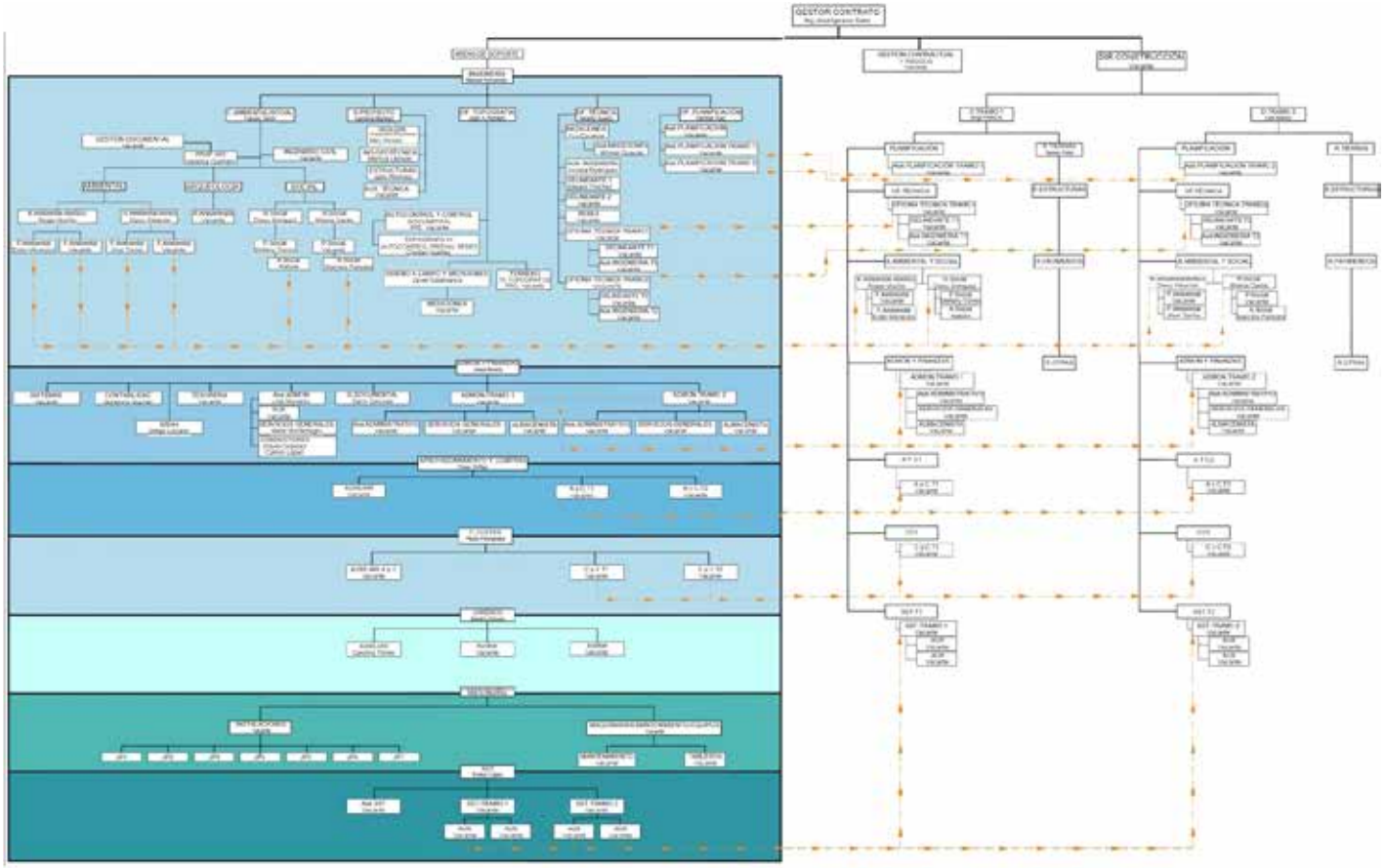
Página 2 -CSH-G-PR-PF-PO-G-G-0001-2 PLAN DE OBRA 25 abr 2017.mpp — Impresión: 27 abr '17 5:37 p.m.

Source: Consorcio SH 2017.

3.2.10 Project organization.

The organizational chart presented in **Annex 2. Civil. XII. Schedule and Organizational Chart** (see **Figure 3.96**) will be in place for implementation of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment.

Figure 3.96 Organization of the Rumichaca - Pasto Divided Highway Project, San Juan - Pedregal Segment



Source: Consorcio SH, 2017