

## CHAPTER I

### GENERAL INFORMATION REGARDING THE PROJECT, PETITIONER, AND PARTY IN CHARGE OF THE ENVIRONMENTAL IMPACT STUDY

#### I.1. General Project Information

##### I.1.1. Project code to be completed by the department

##### I.1.2. Name of the Project

Construction of the San Juan de los Lagos- Encarnación de Díaz road.  
Stretch from Km. 0+000 to 18+ 636. 443

##### I.1.3. Information regarding the sector and type of project

###### *I.1.3.1. Sector*

The project is undertaken within the General Communication Roads Sector, and it is sponsored by Federal Roads of SCT.

###### *I.1.3.2. Sub-sector*

Road Infrastructure

###### *I.1.3.3. Type of Project*

Construction of a new type A4 road.

##### I.1.4. Type and modality of the study

Environmental Impact Certificate, Regional Modality.

##### I.1.5. Location of the Project

###### *I.1.5.1. Reference geographic features*

The study represents the Environmental Impact Certificate of the construction of a road to be located in the San Juan de los Lagos and Encarnación de Díaz municipalities, in the Altos Norte region of Jalisco. Appendix 5 enlists the plants and UTM coordinates of the inflection points of the stationing. Section 1.1.5.6 of this chapter contains the extreme road coordinates, and the location sketch can be found in Letter 1 of Appendix 3.

###### *I.1.5.2. State*

State of Jalisco

### *1.1.5.3. Municipalities or Districts*

Km 0+ 000 to 11+ 990 will be constructed in the San Juan de los Lagos Municipality.  
Km 11+ 990 to 18+ 636.443 at Encarnación de Díaz.

### *1.1.5.4. Localities*

The localities where the stretch will be constructed are shown on Table I.1

**Table I.1. Localities where the stretch will be built**

<b>Stretch</b>	<b>Municipality</b>	<b>Locality</b>
0+ 000 to 1+ 027	San Juan de los Lagos	El Tajo
1+ 027 to 6+ 593	San Juan de los Lagos	Santa Teresa
6+ 593 to 10+ 990	San Juan de los Lagos	La Laja
10+ 990 to 15+ 999	Encarnación de Díaz	San Matías
15+ 999 to 18+ 637	Encarnación de Díaz	Los Ojos de Agua

### *1.1.5.5. Geographical and/ or UTM coordinates*

The extreme UTM coordinates of the project are: initial 13Q 785804, 2356060 (Km 0 + 000), and final 13Q 791633, 2372425 (Km 18+ 636.443.)

The inflection points of the road are found in the plant plans of Appendix 8.

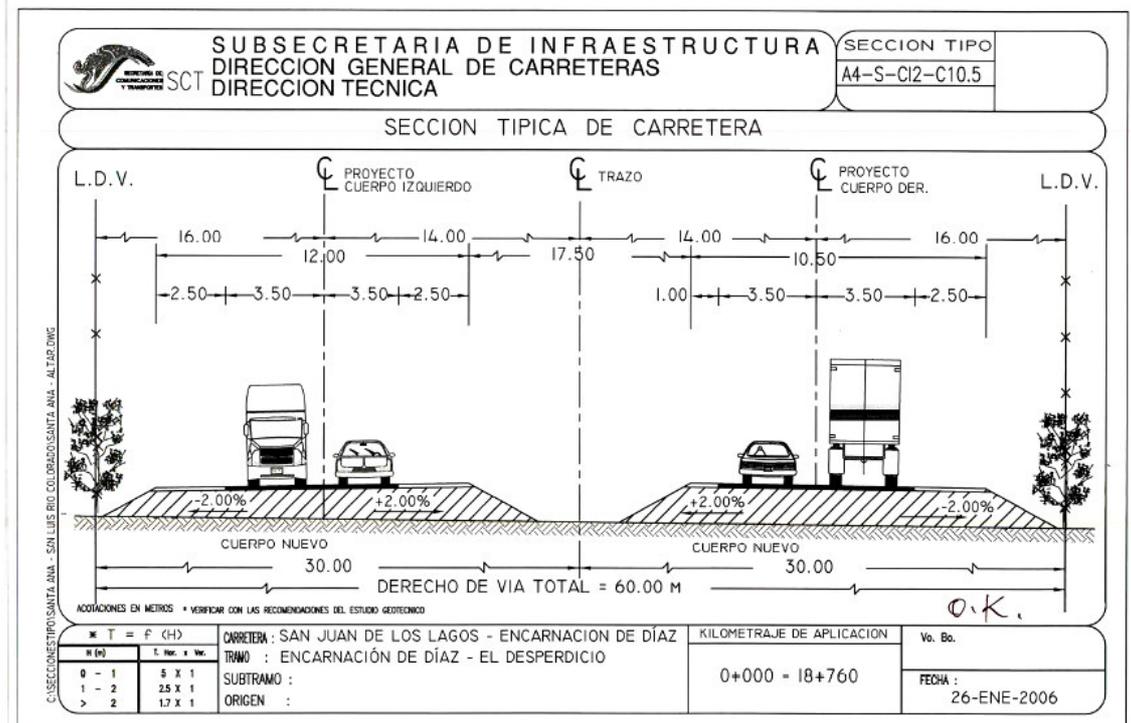
### *1.1.5.6. Project dimensions*

The total length of the project is 18.64 km.

The right of way is 60 m, for a total stretch measurement of 111. 82 Ha.

The road specifications are: Type A4- S- C12- C10.5. The maximum speed is 110 km/h.

The section type is presented in Figure I.1.



**Figure I.1. Section Type of the Project**

## I.2. General Information Regarding the Petitioner

### I.2.1. Name or Trade Name

Dirección General de Carreteras Federales, S.C.T.

### I.2.2. Federal Taxpayer Identification Number

SCT- 850101- 819

### I.2.3. Name of Legal Representative

Cedric Iván Escalante Sauri

### I.2.4. Legal Representative's Position

General Director of Federal Roads

### I.2.5. Legal Representative's Federal Taxpayer Identification Number

ESFC470411- NGS

### I.2.6. Population Registration Code (CURP) of the Legal Representative

ESFC470411HYNSRD06

### **I.2.7. Petitioner's Address for Notifications**

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### **I.3 Information regarding the party in charge of the Environmental Impact Study**

#### **I.3.1. Name or Trade Name**

SGS Qualitest de México, S.A. de C.V.

#### **I.2.2. Federal Taxpayer Identification Number**

SQM950914 AHO

#### **I.2.3. Name of Technical Representative**

M.C. Horacio Martínez Tortolero

Taxpayer No.: MATH670309- Q63

CURP: MATH670309HDFRRR07

Professional license No.: 2045871

#### **I.2.4. Address of technician in charge of the study**

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Tel. (55) 1120- 8682

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## CHAPTER II

### DESCRIPTION OF WORKS OR ACTIVITIES, AND THE PARTIAL DEVELOPMENT PLANS OR PROGRAMS (IF ANY)

#### 1. General Information Regarding the Project, Plan, or Program

The project consists of the construction of a paved road (Type A4- S- C12- C10.5 according to the road classification by the Ministry of Communications and Transport (S.C.T.) The road will have the following features: roadway width of 14 m (7 m on each body), 22.5 m crown width (body A crown width 12 m and body B crown width 10.5 m), 2.5 m mappings, except for the central mapping of body B, which will be 1 m wide.

The maximum speed will be 110 m/h, the road will have a 2% slope and a maximum curvature of 2° 45'.

The stretch with impacts and mitigation measures which will be described in the study includes Km 0+ 000 to Km 18+ 636. 443 of the road starting on Toll Road No. 80 (León- Guadalajara), with an intersection with toll road No. 45 (León- Aguascalientes).

#### 1.2. Justification and Objectives

The San Juan de los Lagos- Encarnación de Díaz road project of Km 0+ 000 to Km 18+ 636. 443 responds to the need for constructing a fast road, which main purpose is to join two highways, No. 80 and No. 45. The relevance of the project is that it constitutes a portion of two trunk axis roads. Highway 80 is a section of the trunk road Manzanillo- Tampico, while highway No. 45 is a section of trunk road México- Nuevo Laredo. On the other hand the Manzanillo- Tampico axis is the one that communicates the cities located on the Gulf of Mexico with the Pacific, whereas the México- Nuevo Laredo axis crosses almost 80% of the country to communicate the center and the north. Therefore, construction of this project is vital to the junction of both trunk axis, as well as to make transportation easier due to time reduction. The union provides benefits at the regional level (with the junction of the trunk roads), which, in turn, fosters the local development between the states of Jalisco and Aguascalientes.

The main objectives of the works are:

- The junction of highways 80 and 45 by means of a fast road to avoid transit through Lagos de Moreno.
- To save 1 h of transit time.
- To enhance the communication and development between the Cities of Guadalajara, Aguascalientes, and the Altos de Jalisco region.

### 1.3 Physical location

The project is located over 2 municipalities of the north Altos region of Jalisco. Km 0+ 000 to 11+ 990 are to be constructed on the San Juan de los Lagos municipality and Km 11+ 990 to 18+ 636.443 on the Encarnación de Díaz municipality.

The UTM coordinates of the 13Q quadrant of inflection points are as follows:

Km	UTM X	UTM Y
0+ 000	785804	2356060
1+ 027	785899	2357056
1+ 200	785993	2358051
3+ 000	786088	2359047
3+ 816	786165	2359859
4+ 000	786186	2360042
4+ 400	786257	2360435
4+ 556	786294	2360587
5+ 000	786406	2361016
6+ 000	786660	2361984
6+ 593	786810	2362558
7+ 000	7866931	2362946
7+ 143	786981	2363080
8+ 000	787296	2363877
8+ 312	787411	2364167
8+ 863	787634	2364672
9+ 000	787694	2364794
10+ 000	788134	2365691
10+ 177	788212	2365850
10+ 577	788404	2366201
10+ 940	788604	2366504
11+ 000	788639	2366553
12+ 000	789222	2367365
12+ 634	789592	2367881
12+ 999	789796	2368184
13+ 137	789867	2368301
13+ 999	790307	2369043
14+ 719	790674	2369662
14+ 824	790723	2369755
14+ 929	790764	2369853
14+ 999	790786	2369918
15+ 981	790810	2370015

15+ 199	790826	2370114
15+ 242	790831	2370157
15+ 999	790890	2370912
16+ 363	790919	2371275
16+ 563	790943	2371473
16+ 763	790985	2371669
16+ 963	791043	2371860
16+ 998	791056	2371893
17+ 875	791059	2371903
17+ 998	791408	2372829
18+ 635	791633	2373425

## 1.4 Investment Required

This project includes the construction of a new 18.35 km work corresponding to a paved road Type A4- S- C12- C10.5. The investment required for the project will be \$18, 930, 000 MX Pesos, equivalent to US \$ 1, 809, 780, which will be divided as shown on Table II.1.

**Table II.1. Investment required for the operation and maintenance of the layout**

Activity	Km	Cost (MX)	Cost (US)
Dirt roads formation	12.68	\$1, 711, 762	\$490, 429
Surfacing	12.68	\$3, 593, 475	\$1, 029, 549
Complementary works	12.68	\$778, 074	\$222, 922
Operation and maintenance	12.68	\$233, 422	\$66, 876

NOTE: Dollar exchange rate of \$10.46, corresponding to March 20<sup>th</sup>, 2006

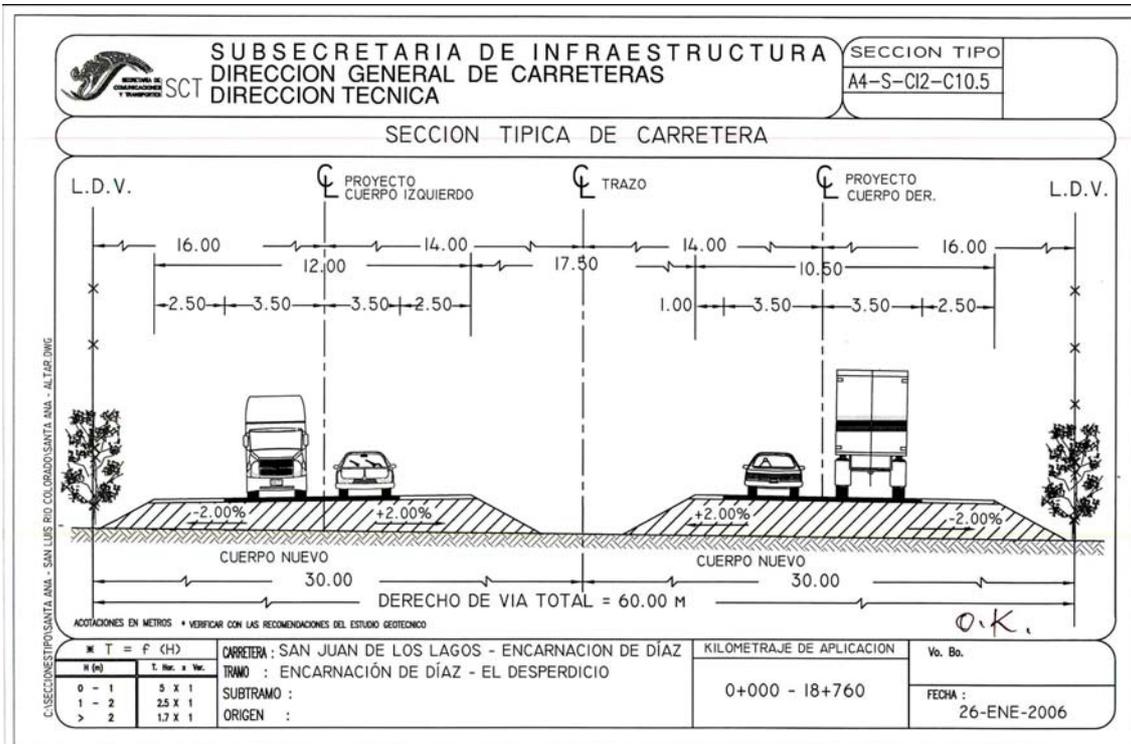
## 2. Particular Project Features

### 2.1. General Works Description

Construction of the new road with 4 transit lanes (2 each direction) of type A4- S- C12- C10.5.

Construction of the road will be undertaken in two construction phases by means of two work sources. The end road will have the following elements and their dimensions

as transversal transit section: two transit bodies with a 7 m roadway each, with 12m and 10.5 m wide crowns, respectively. Cased gutters will be constructed next to the bodies. (Figure II.1.)



**Figure II.1. Section Type of the Project.**

The activities to be performed include:

Preparation of the site, consisting of clearing (trees and bushes), and cleaning.

Construction, consisting of digging and land leveling, underground laying, foundations and asphalt coating, drainage works construction, signaling.

Construction of 2 overpass intersections, 2 minor drainage works with slabs, 5 bridges, 30 lower overpasses to be used by vehicles, cattle, and people willing to reach the opposite side of the road.

Maintenance: Cleaning the asphalt coating, drainage works, central area, and right of way, changing the signals and painting, recoating and patching.

Regarding the dirt road and surfacing structures, they will be undertaken in accordance with Construction Standards of SCT.

### 2.1.1. Surfaces

Table II.2 shows the breakdown of the area that will be affected by the construction of the project.

**Table II.2. Surface taken by the Project Activities**

<b>Activities</b>	<b>Ha</b>	<b>Total Percentage of the Area</b>
Right of way	111.82	100%
Clearing	34.64	31%
Cleaning	64.30	58%
Area between line of zeros	64.30	58%
Leveling	64.30	58%
Overpass intersections	5.1	4.6%
PIV, PSFC and or/ for cattle and pedestrians	0.15	0.13%
Central area between transit bodies	18.64	17%

### **Provisional**

Spoil banks	A 2000 m2 space will be leased to store materials temporarily.
Material banks	No extra areas will be considered for material banks, given that they all constitute private property.

#### *2.1.2. Access roads to the area where works or activities are developed*

In order to access the work area from the San Juan de los Lagos side, the quickest option from the City of Guadalajara is to take Highway No. 80 Guadalajara- León, and to take the overpass intersection to Aguascalientes 3 km ahead of the San Juan de los Lagos exit through the federal San Juan de los Lagos- Encarnación de Díaz road. This road is found at the west of the layout in parallel. At the intersection of highway No. 45 León- Aguascalientes the work site can be approached from the north section (on the Encarnación side.)

In order to access the different front sides of the work site used during the construction of the road, the existing breccias will be used as follows: To reach the last 6 km the cased path starting on the Encarnación- Lagos federal road Km 5 1/2 will be taken towards Santa Bárbara Castro Station. In order to reach Km 12 to 10 the cased Santa Ma. de Enmedio- Santa Bárbara will be taken (towards Km 12), and Santa Ma. de Enmedio- San Matías (towards km 10). For the first 8 km the coated road starting

on the San Juan de los Lagos- León federal road will be taken at Km 27 (El Desperdicio locality) towards El Sauz and La Laja. Intermediate Kms will be reached through the front parts of the site. The aforementioned roads have an average width of 6 m and are available for transit throughout the year, so that both machinery and personnel can use them without the need for adaptations.

### *2.1.3. Description of required services*

#### Electricity

The electrical power necessary for the use of certain equipments, such as welding gear, used for some of the drainage works. Electrical power will be supplied through portable power plants of internal combustion. Power- a 2,500 watts system will be required. The voltage will be 220 volts.

#### Fuels

The fuel will be mainly gasoline and diesel for vehicles, machinery, and equipment.

During the construction stage the fuel supply will be performed in metal or plastic container to avoid loss due to evaporation. Said containers must be safe for transportation to the site of the machinery or device requiring gasoline. Fuel will be taken from the San Juan gas station, located on the San Juan- Encarnación federal road. Due to the short distance from the gas station to the site of works, we do not consider that storing fuel will be necessary, and the fuel will be transported in the case of fixed machinery.

Based on the PEMEX regulations, the Land Transport regulations of SCT and NOM-001- SCT2- 1994, NOM- 020- SCT2- 1994, and LGEEPA, the maximum transportation volume of the Federal Public Service or particular vehicles authorized for the gasoline transportation service is 20,000 liters at points not authorized by PEMEX, Additionally, only 55 gallon drums can be used for storage and the recommendation is to store a maximum of three days of operation or minimize the risk due to conflict, provided that the detonation risk is not foreseen. Other precautions must be taken due to occupational risks involved with fuel management. The volumes required for this stage of the project are 8, 420 barrels of diesel and 5, 892 barrels of gasoline, which will be supplied according to the use demand during the works.

#### Water requirements

Potable water is required for human use, and hard water for construction (irrigation, mixing, etc.). Hard water will be supplied through pipes. An estimate of 40 m<sup>3</sup> of water will be required every day in the construction.

Potable water will be delivered in 20 l plastic carboys to be used by the workers. An estimate of 4 carboys a day will be required during the construction.

#### 2.1.4. Provisional and related works and activities description

No access roads will be constructed. In order to access the different front sides of the work site used during the construction of the road, the existing breccias will be used as follows: To reach the last 6 km the cased path starting on the Encarnación- Lagos federal road Km 5 1/2 will be taken towards Santa Bárbara Castro Station. In order to reach Km 12 to 10 the cased Santa Ma. de Enmedio- Santa Bárbara will be taken (towards Km 12), and Santa Ma. de Enmedio- San Matías (towards km 10). For the first 8 km the coated road starting on the San Juan de los Lagos- León federal road will be taken at Km 27 (El Desperdicio locality) towards El Sauz and La Laja. Intermediate Kms will be reached through the front parts of the site. The aforementioned roads have an average width of 6 m and are available for transit throughout the year, so that both machinery and personnel can use them without the need for adaptations.

No camps, workshops, or warehouses will be constructed. The personnel will be mainly local, from the San Juan de los Lagos and Encarnación de Díaz localities in particular. The specialized staff will be able to travel from the city of Guadalajara (1.30 h) or Aguascalientes (20 min) to the fronts of the site, so no camps will be necessary. Workshops and warehouses will be rented in Encarnación and San Juan. Minor machinery repairs can be performed in any of the two villages, major repairs will be performed in Aguascalientes.

A portable toilet will be placed at each front of the site, on the right of way.

An asphalt plant will be installed to provide service for the whole layout. It will be located in material bank 3 called El Cerillo, located in a village of the same name in the surrounding area of the Santa María de Enmedio locality, coordinates UTM 13Q 789415, 2369995, Km 14+ 500 to 200 m d/d (Chart 44, Appendix 3.) It is a commercial operations bank, where the asphalt plant and grinder will be located on cement. The asphalt mixture will be purchased ready to use.

The total projection is the detonation of 4 material banks. Their location and description are shown in Table II.3

All banks will use the subgrade and underlying layers, and an embankment body will be constructed, with the exception of El Sauz, provided that material originated there is only good for the foundations (Table II.3)

**Table II.3 Material Banks**

No.	Name	Location	Geological class.	Vol. required	Use	State	Chart Appendix 3
1	El Sauz	3+ 389 to 150 m d/ i	Compressed sand with 38% low plasticity clay	36, 297 m <sup>3</sup>	Embankment body	Trade, new opening	42
2	Los Cuartos and	8+000 to 3400 m d/ i	Compressed sand with 23% low plasticity clay	108, 369 m <sup>3</sup>	Embankment body, subgrade and underlying	Trade, exploited and abandoned	43

No.	Name	Location	Geological class.	Vol. required	Use	State	Chart Appendix 3
3	El Cerillo	14+ 500 to 200 m d/ d	Compressed sand with low plasticity	211, 699 m <sup>3</sup>	Embankment body, subgrade and underlying.	Trade, open exploitation fronts	42
4	El Refugio	17+ 300 to 300 m d/ d	Compressed clay of wrong graduation with low plasticity	24, 779 m <sup>3</sup>	Embankment body, subgrade and underlying.	Trade, exploited and operating	43

## 2.2. Graphic General Work Program

The following diagram is a representative scheme of the road construction and operation program of the assumed construction period 2005- 2008.

The works will be developed in stages. The first one will be of project development and right of way acquisition, which may be finished during this year, and the second one corresponds to the construction of the various stretches that are estimated to be accomplished by the year 2008, according to the following diagram.

MMX makes reference to the implementation of mitigation measures proposed on Chapter VI.

Activities	Two- month periods																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<b>Stage 1</b>																								
Clearing																								
Cleaning																								
Leveling																								
Drainage works																								
PIV and cattle																								
Embankment body																								
Signaling Body A																								
<b>Stage 2</b>																								
Clearing																								
Cleaning																								
Leveling																								

Construction of the San Juan de los Lagos- Encarnación de Díaz road.  
Stretch from Km. 0+000 to 18+ 636.443

Activi ties	Two- month periods																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Drainage works																								
PIV and cattle																								
Embankment body																								
Signaling Body B																								

The previous chronogram is not included in the maintenance program, provided that it includes periodical activities related to eventual damage to the works.

### 2.3. Preparation of site and construction

Clearing: Clearing will be performed in order to construct the embankment bodies. The affected vegetation will be the induced pasture, agricultural field, and spiny scrubland (Table II. 4), located along the line of zeros. This activity consists of:

- Logging, cutting down trees and bushes.
- Slash and burn, in order to remove weeds, grass, and agricultural waste.
- Cleaning, consisting of the withdrawal of the clearing wastes to the place indicated on chapter VI of the present study (MM5).

The volume of affected wood species can be found in Appendix 6.

Clearing: This activity is performed in order to withdraw the first soil stratum and find the best quality land to build dirt roads. In this particular case clearing will have an average of 0.30 m (Km depth may be found in the plant plans and the Km profile in Appendix 8) and the wastes will be piled up in the spoil banks (MM5, Chapter VI). A total volume of 208, 242 m<sup>3</sup> will be obtained from the clearance material of the embankments and cuts from bodies A and B.

When verifying the field we took samples of the affected vegetation. The following descriptions are classified by stretch (Table II.4.)

**Table II.4. Description of land use for the right of way project by stretch classification**

Stretch	Vegetation
Km 0+ 000 – 0+ 560	Acahual sunflower plant in bearing fields
Km 0+ 560- 0 + 925	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and a few elements of <i>Prosopis laevigata</i> and <i>Forestiera phylloretoides</i> , as well as abundant <i>Mimosa monancistra</i> due to extensive livestock activities.
Km 0+ 925- 1 + 540	Agricultural fields.
Km 1 + 540 – 2 + 400	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and a few elements of <i>Prosopis laevigata</i> and <i>Forestiera phylloretoides</i> , as well as abundant <i>Mimosa monancistra</i> due to extensive livestock activities.
Km 2 + 400 – 2 + 650	Remnants of Spiny Forest with <i>Prosopis laevigata</i> surrounded by agricultural fields.
Km 2 + 650 – 3 + 650	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and a few elements of <i>Prosopis laevigata</i> and <i>Forestiera phylloretoides</i> , as well as abundant <i>Mimosa monancistra</i> due to extensive livestock activities.
Km 3 + 650 – 4 + 370	Agricultural field
Km 4+ 370 – 4+ 385	Gallery Forest of <i>Salix bonplandiana</i> with <i>Senecio salignus</i> , on the El Sauz watercourse
Km 4+ 385 – 4+ 460	Agricultural field
Km 4+ 460 – 4+ 475	Remnant of Spiny Forest surrounded by agricultural fields.
Km 4+ 475 – 4800	Agricultural field up to the junction with the Sauz de Ibarra road.
Km 4+ 800- 5+ 750	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and a few elements of <i>Prosopis laevigata</i> .
Km 5+ 750 – 6+ 900	Agricultural field.
Km 6+ 900 – 7+ 340	Paddock with Pasture remains. Abundant <i>Mimosa monancistra</i> due to livestock activities.
Km 7+ 340 - 7+ 380	Remnant of Spiny forest surrounded by paddock
Km 7+ 380 – 7+ 450	Paddock with Pasture remains. Abundant <i>Mimosa monancistra</i> due to livestock activities.
Km 7+ 450 - 8+ 350	Ecotone of Pasture and Spiny Forest with <i>Opuntia</i> spp. and abundant <i>Mimosa monancistra</i> due to livestock activities.
Km 8 + 350 – 8 + 550	Agricultural field.
Km 8+ 550 – 10+ 370	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp, and a few elements of <i>Prosopis laevigata</i> and <i>Forestiera phylloretoides</i> , as well as abundant <i>Mimosa monancistra</i> due to extensive livestock activities.
Km 10+ 370- 10+ 500	Agricultural field

## Stretch

## Vegetation

Km 10+ 500 - 14+ 650	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp, and a few elements of <i>Prosopis laevigata</i> and <i>Forestiera phyllloireoides</i> , as well as abundant <i>Mimosa monancistra</i> due to extensive livestock activities.
Km 14+ 650 – 14+ 850	Pasture with <i>Acacia schaffneri</i> , with a few elements of <i>Juniperus erythrocarpa</i> .
Km 14+ 850 – 15+ 460	Agricultural fields
Km 15+ 460 – 17+ 100	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp, as well as abundant <i>Mimosa monancistra</i> .
Km 17+ 100—18+ 600	Pasture with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp., as well as abundant <i>Mimosa monancistra</i> on areas of strong water erosion due to impact of livestock practices.
Material Bank 1 El Sauz	Bank to be exploited, located in a site degraded by the livestock activities, with severe water-caused erosion, where most of the vegetable layer has been removed and the soil eroded due to pluvial effects. Vegetation of the area is Pasture with <i>Acacia schaffneri</i> (Chinese Huizache) extremely degraded and includes some elements of <i>Mimosa Monancistra</i> (Garabatillo, Garruño), and <i>Opuntia ictedrica</i> (Nopal negrito).
Material Bank 2 Los Cuartos	Tepetate bank, currently not used, with an approximate depth of 12 m. It is surrounded by remnants of Pasture vegetation, such as <i>Acacia schaffneri</i> (Chinese Huizache) on the east, south, and west limits of the bank, and some elements related to <i>Eysenhardtia polystachia</i> . North of the bank is a remnant of Spiny Forest with <i>Prosopis laevigata</i> (Mezquite.)  Over the slopes and bottom of the bank, some <i>Acacia schaffneri</i> (Chinese Huizache) has grown back due to lack of use.
Material Bank 3 El Cerillo	An exploitation tepetate bank. The surrounding vegetation includes very damaged pasture. South and east are mainly composed of <i>Acacia schaffneri</i> , <i>Forestiera phyllloireoides</i> (Granjeno), <i>Juniperus erythrocarpa</i> (Cedrito, Táscate), <i>Mimosa monancistra</i> , and <i>Cowania mexicana</i> (Romero cedro). The surroundings at the west are mainly of agricultural fields.
Material Bank 4	It is located in an environment that has been deeply degraded by livestock activities, with severe water-caused erosion. Vegetation of this area is Pasture with <i>Acacia schaffneri</i> (Chinese Huizache), and it also includes <i>Opuntia ictedrica</i> (Nopal negrito), <i>Opuntia joconostle</i> (Joconostle), and <i>Mimosa monancistra</i> (Garabatillo, Garruño.)

Letter 7 of Appendix 2 shows the use of land of the influence area for the layout established by INEGI on a 1: 50, 000 scale.

The volume of affected wood species is shown on Appendix 6.

The layout will not affect any preserved type of vegetation. Most of the expansion will be performed on Pasture of induced growth and secondary spiny forest land.

Leveling: It will be performed according to the needs indicated by the project regarding vertical curves (Appendix 8). Soil and rock will be extracted until the required quality is reached. The base of the leveling will be compacted at a 0.10 depth until reaching 90% of its maximum dry volumetric weight on the Proctor test. The product of the excavations will be compensated for the construction of embankments. The remaining material (1,650 m<sup>3</sup>) will be used for compensation works (MM5, Chapter VI.)

Eight excavation areas are being considered, with the highest location point on km 0+ 640 (2.17 m), 5 + 440 (3.3 m), 5 + 510 (4.79 m), 5+ 700 (3.66 m), 5+ 800 (3.35 m), 9+ 498 (2.26 m), 13+ 960 (2.41 m), 14+ 023 (2.53 m), 14+ 440 (2.43 m), and 14+ 578 (8.11 m), Appendix 8. Given that the land has slopes smaller than 15% in the greatest part of the track, the cuts are low (most of them smaller than 4 m in their highest peak) and there are only a few of them.

Out of the overall cuts and excavations 137, 912 m<sup>3</sup> of material will be obtained. 136, 262 m<sup>3</sup> will be used, and 1, 650 m<sup>3</sup> will be used afterwards for mitigation work purposes (M5 and M7, Chapter VI.)

On Table II.5 the volumes of the project reported per Km can be found (Appendix 8.)

**Table II.5 Condensed Project Volumes for Bodies A and B (Appendix 8)**

Concept	m <sup>3</sup>
Clearing on cut	33, 361
Clearing on embankment	174, 881
Used volume- total excavations	136, 262
Material A	27, 582
Material B	110, 330
Compacting of natural land in the area	93, 723
Compacting of bed of cuts 95%	17, 594
Banded A 90%	704, 816

Banded A 95%	154, 027
Banded A 100%	110, 736
Backfill 95%	896
Box 100%	1, 370
Ex.Ac.Te.Co. 95%	0
Clearing, piling up, laying, and compacting	18, 911

Drainage works: Before starting the construction of embankments in the watercourses and run- off channels, drainage works will be constructed, including the slabs mentioned in Table II.6. Bridge structures will also be set up. (Table II.6).

**Table II.6. Listing of major and minor drainage works**

Station	Type of Work	Crossing
1+ 909. 500	L 2.00 x 1.00	Normal in tangent
2+ 440. 900	L 3.00 x 2.00	Esv. 45° 00' right.
2+ 544. 600	L 5.00 x 2.00	Normal in tangent
2+ 860. 000	L 2.00 x 1.00	Normal in tangent
3+ 520. 717	L 2.00 x 1.00	Esv. 30° 00' right
4+ 057. 531	L 2.00 x 1.00	Esv. 10° 00' right
4+ 438. 200	Major work	El Sauz Bridge
5+ 984. 068	L 2.00 x 1.00	Esv. 10° 00' left
6+ 239. 531	Major work	La Alhaja Bridge
6+ 764. 000	Major work	San Fco. Bridge
6+ 846. 600	L 2.00 x 1.00	Normal in tangent
7+ 325.400	L 4.00 x 2.00	Normal in tangent
7+ 605. 096	L 2.00 x 1.00	Esv. 20° 00' left
7+ 953. 668	L 2.00 x 1.00	Esv. 10° 00' left
8+ 885. 851	L 2.00 x 1.00	Esv. 15° 00' left

9+ 016. 595	L 2.00 x 1.00	Esv. 20° 00' left
9+ 263. 531	L 3.50 x 2.00	Esv. 10° 00' right
9+ 368. 00	L 5. 00 x 3.00	Normal in tangent
9+ 780. 00	L 2.00 x 1.00	Normal in tangent
10+ 863. 751	L 2.00 x 1.00	Esv. 15° 00'left
11+ 665. 096	L 2. 00 x 1.00	Esv. 20° 00' left
12+ 303. 200	L 2.00 x 1.00	Normal in tangent
12+ 553. 472	L 2.00 x 1.00	Esv. 25° 00 right
12+ 854. 851	L 2.00 x 1.00	Esv. 15° 00' left
13+ 091. 000	L 2.00 x 1.00	Radial on curve
13+ 540. 731	L 2.00 x 1.00	Esv. 100° 00' right
13+ 755. 40	L 2.00 x 1.00	Normal in tangent
14+ 076. 871	L 2.00 x 1.00	Esv. 25° 00' right.
14+ 220. 551	L 2.00 x 1.00	Esv. 15° 00' left
14+ 324. 200	L 2.00 x 1.00	Esv. 45° 00' right.
15+ 189. 968	Major work	Santa María Bridge
15+ 816. 095	Major work	Santa María Bridge I
16+ 927. 751	L 2.00 x 1.00	Esv. 15° 00' left
17+ 230. 900	L 2.00 x 1.00	Normal in tangent
17+ 906. 900	L 2.00 x 1.00	Normal in tangent
18+ 336. 500	L 2.00 x 0.75	Esv. 24° 00' left
18+ 611. 728	L 2.00 x 1.00	Esv. 25° 00' left

Excavations for the drainage work structures will be executed up to the level of setting indicated on the project or the one deemed adequate with a fatigue capacity of the natural land of 1.80 kg/ cm<sup>3</sup>. For said purpose the excavation must be refined to receive the structural elements of the executive project.

Material resulting from the excavations will be used for protection of the sewers.

Backfills used for protection of the slabs leaning on abutments may be fabricated with materials from the excavations and/ or banks for construction of the dirt roads (Table II.3), compacted in layers of 20 cm. on both sides of the work site until a minimum 90% of the laboratory P.V.S.M.

Masonry for construction of the slab abutments, head walls, and retaining walls will be of 3<sup>rd</sup> class and will be constructed out of stone from the indicated bank with sand-cement mortar in a 1: 5 proportion.

Masonry that will be constructed on the back of the abutments of the slabs supported on abutments or retaining walls will have 30 cm of thickness from which the transversal clay or PVC drain pipes that will be placed on the abutments or walls with a distance of 3.00 m between them.

The stone base will be constructed of 3<sup>rd</sup> class masonry along with the sand- cement mortar 1: 5 of 30 cm of thickness, and will be used for the construction of slab sewers, between the abutments, between the entry and exit eaves of the work sites, in the gutter casings, and anywhere indicated by supervision.

For the construction of bridges excavation underneath the abutments and piles is required, until a homogeneous material layer of a better resistance is reached, usually under the level of the riverbed.

From there the piles and distribution plates supporting the columns are cast. Usually, such activities are performed during seasons when the water recedes, and the works are carried out on dry soil. The columns provide support to a distribution beam where the pre-manufactured beams rest.

The outer side of the beams provides support to a concrete slab and the bearing surface, which will be made out of the same concrete.

The columns provide support to a distribution beam where the pre-manufactured beams and pre-stressed spans lie up to 35 meters, which is the economical length of low height columns. "T" shaped beams usually require seven of them to form a 12.5 and 10.5 m wide section with pedestrian sidewalks, grommets, and parapet walls.

The upper side of the beams provides support to a thin concrete slab and the bearing surface, which can be made out of the same concrete or flexible pavement.

The sidewalk usually has pipes for lighting electrical installation, when applicable, or for electrical power wires, fiber optic, water, etc., taking these elements into consideration for potential future uses.

Vehicle underpasses, railroads, pedestrian, and cattle crosswalks: All the crossings that will be constructed are lower, and in all cases they will be constructed by laying a concrete slab of the dimensions specified along with the location of the works. Given that it relates to slab laying, the construction procedure will be the same that is used for sewers, which will also be constructed with slabs only. The list of vehicle crossings

to be constructed, along with their dimensions, is detailed as follows: PIV of 1 way Km 0 + 140 LC240; PIV of 2 ways Km 0 + 460 LC260; PIV of 2 ways Km 0+ 760 LC280; PIV of 1 way Km 1+ 420 LC100; PIV of 1 way Km 2+ 015 "Montecillo"; PIV of 1 way Km 2+ 260 LC200; PIV of 2 ways Km 2+ 480 LC420; PIV of 1 way Km 5+ 020 LC120; PIV of 2 ways Km 5+ 980 LC260; PIV of 1 way Km 7+ 320 LC80; PIV of 1 way Km 7+ 820 LC140; PIV of 20 ways Km 8+ 430 LC 540; PIV of 2 ways Km 8+ 880 LC 80; PIV of 1 way Km 9+ 270 LC80; PIV of 1 way Km 9+ 860 LC 80; PIV of 1 way Km 10+ 400 LC 120; PIV of 1 way Km 11+ 520 LC 120; PIV of 1 way Km 12+ 300 LC 120; PIV of 1 way Km 12+ 700 LC 100; PIV of 1 way Km 13+ 430 LC 220; PIV of 1 way Km 14+ 160 LC 160; PIV of 2 ways Km 14+ 500 "El Cerillo" crossing LC 500; PIV 2 ways Km 14+ 960 LC 360; PIV 1 way Km 15+ 270 LC 220; PIFC Km 15+ 322.15 México- Ciudad Juárez railroad; PIV 2 ways Km 15+ 910 "Santa María de Enmedio" LC 260; PIV 1 way Km 15+ 910 "Santa María de Enmedio" LC 260; PIV 1 way Km 17+ 240 "El Refugio" crossing LC 140; PIV 2 ways Km 17+ 620 LC 340; PIV 1 way Km 17+ 960 LC 260; and PIV 1 way Km 18+ 230 LC 240.

Embankment body: Embankments will be constructed on stretches of the road where material is missing in order to comply with the section of the geometrical project. Material from approved banks will be used (Table II.3), according to every stretch. The compacting process will be in 30 cm layers, first through the motor grader, then the compactor, until 90% of the maximum dry volumetric weight is reached for the Porter test.

A subgrade layer will be constructed using material from approved banks according to the stretch. Later, rocks will be extracted from the site, and water will be added until compacting its maximum dry volumetric weight up to 95% for Porter tests, in 15 cm layers until reaching a minimum thickness of 30 cm on both cuts and embankment zones. Gutters and top ditches will be constructed where needed.

For pavement structures the following layers will be constructed, following the Construction Standards of SCT 3rd book.

A hydraulic base will be constructed out of bank material indicated on Table II.3, which will be panned to a maximum size of 3.8 cm and will be placed on the stretch in such a way that when mixed with water they become compacted to reach 98% of Porter's maximum dry volumetric weight.

A stabilized base will be constructed out of bank materials (Table II.3) that will be grinded and panned in the bank to obtain the maximum size of 3.8 cm. Material will be transported to the construction stretch to add 5% of Portland cement according to the volumetric weight of the loose material, as well as the necessary water. A layer will be formed, which will be mixed and compacted by 100% of its maximum dry volumetric weight to reach 15 cm.

Irrigation by impregnation will be implemented, so that once the base is ready, swept, moist and free of loose material, it can be irrigated by impregnation to align it. Irrigation will be performed using an asphalt emulsion of quick breakage type RR- 3K or similar with a dose of 0.6 to 1.0 L/m<sup>2</sup>.

Asphalt surface course to be constructed using plant asphalt. Granulometry of the stone material will be 1.9 cm to fine and the asphalt cement will be type AC- 20. It will be compacted by 100% of its maximum volumetric weight determined by the Marshall test in such a way that the resulting thickness is 10 cm. The course must be laid at a minimum 120° C temperature and the compacting process must be started at 110° C.

The irrigation seal is placed to waterproof the course and prevent water filtration and slides. It will be applied with a RR-3K quick breakage asphalt emulsion or similar in a ratio of 1.4 to 1.8 liters per square meter. It is immediately covered with type 2 stone material in variable quantity, from 9 to 11 p/m<sup>2</sup>. Material will be supplied from the material banks presented on Table II.3. Stone and asphalt materials must comply with the quality standards form materials specified on book 4 of SCT technical specifications.

Intersections: 2 overpass intersections are to be constructed in order to join the layout with highways 80 (km 0+ 000) "El Desperdicio Intersection" and 45 (Km 18+ 636. 443) "Santa Barbara Intersection", respectively. For such purpose two branches will be required at the level and one overpass trunk to run above the aforementioned highways. The work will be performed on the right of way of the highways and the right of way for the project.

Since the road is not to service the intermediate villages that it crosses, no other junctions are planned.

Complementary works: With the purpose of providing adequate protection to the dirt roads and pavement, it is necessary to construct complementary works such as: curbs, gutters, channels and culverts that will allow for a quick and easy flow of the pluvial water concentrated on the bearing surface, in accordance with climatologic data from the region where the work site is located.

#### Hydraulic concrete curbs

Hydraulic concrete curbs will be constructed in the locations indicated on the project. Curbs will be  $F'c = 150 \text{ kg/cm}^2$  with a 144 cm<sup>2</sup> section as indicated on the project (Appendix 8), using aggregates that comply with the specified quality standards. Hydraulic concrete cased gutters left or right of the cuts will have a compression resistance of  $F'c = 150 \text{ kg/cm}^2$  and ten (10) of thickness, according to the project specifications, using gravel and sand aggregates from the bank indicated on Table II.3.

Hydraulic concrete culverts and channels: Culverts on the embankment slopes, concrete cased channels, and those required for protection and flow of pluvial water on the bearing surface and drainage works outlet will be constructed using hydraulic concrete with compression fatigue of  $F'c = 150 \text{ kg/cm}^2$  using gravel and sand aggregates from the material banks (Table II.3)

Signals: Finally, horizontal and vertical signals will be installed: preventive, restrictive, and informative signals, as specified on the signal project.

Information regarding the clearing, cleaning, leveling, materials used, and materials disposed volumes is shown in Table II.5.

Transportation for dirt roads and volumes per kilometer specifications can be consulted in the project's plants and profiles, and a summary is included in Table II.5 (Appendix 8).

## 2.4. Operation Program

### 2.4.1. Operation Program

Works referred to in this section are those of operation and preservation of the bodies once they are built: repainting of the lane dividing lines, replacement of signals and warnings, repairing the asphalt course, cleaning the course, right of way and hydraulic works periodically, as well as maintaining the green areas.

Corrective and preventive preservation programs are mentioned herein, as well as the routine preservation program of SCT, which must be observed in order to maintain the roads, to provide an adequate service, and a longer useful life.

Preventive and corrective preservation program by SCT.

1. Initial fortnightly program for prevention and protection, which must be updated annually. The updated fortnightly programs must be delivered to the SCT center.
2. To obtain the current service index or IRI of the bearing surface, to outline the homogeneous stretches. For pavement assessment, proceed as indicated by the Mexican Pavement Protection System, or the system applicable to the road.
3. To assess the state of gutters and culverts, and to repair those showing problem at the time of inspection. Proceed as indicated in appendix PC- 2 corresponding to the Preventive Preservation Program of SCT for undertaking of the corresponding studies.
4. To inspect the sites and signals that show irregularities. For signal assessment, proceed as indicated in appendix PC- 5 corresponding to the Preventive Preservation Program of SCT.
5. To hire the execution of studies concerning the state of the roads. To send the completed study to the corresponding SCT center, indicating the solution alternative deemed adequate.
6. To prepare the alternative works program approved by SCT for reconstruction works if necessary, in accordance with the study outcomes. To settle the execution of the program along with the corresponding General Direction of SCT Center.
7. To supervise the execution of the works in progress permanently until conclusion, performing quality control of the works.

Routine preservation program.

1. To perform daily road inspections in order to identify areas of problem and correcting them, regarding:

- a. Fences and right of way invasion. Reforestation, when necessary.
- b. Landslide, garbage, and bearing surface cleaning.
- c. Lack of signals that pose a hazard to the users or that may cause disorientation.

2. To perform weekly road inspections (or whenever necessary), or to take immediate action when required, in order to detect and correct problems regarding:

- a. Regular signals and barriers
- b. Drainage works
- c. Complementary drainage works
- d. Potholes, patching, cracks, deformation, etc, of the pavement.
- e. Withdrawal or censorship of non- authorized advertisement.
- f. Gutter and right of way cleaning.
- g. Road damage due to accidents.
- h. Top ditches and sub-drainages.
- i. Boxes and/ or input and output channels of drainage works.
- j. Local cut failure.
- k. Poles and warning signs
- l. Weeding and pruning.
- m. General paintworks

#### *2.4.2. Maintenance program*

Replacement of signals will be performed whenever necessary with the purpose of providing an adequate signal layout to prevent accidents.

Slope maintenance involves daily checking of the slopes, in order to report any landslides, with the purpose of cleaning the material and check for possible pavement damage on a daily basis.

Overall pavement maintenance can be performed constantly as routine maintenance performing tasks such as patching, seal irrigation, replacement of stone material, warning signs, paint, etc.

Maintenance is performed on a daily basis according to the stretch and deterioration state. Accordingly, periodical maintenance activities must be performed including patching, re-leveling, course relaying, and general maintenance. Periodicity must be included according to the pavement state reports and the general maintenance program throughout the useful life of the road.

### Preventive Maintenance

This stage consist of undertaking preservation works where no special or large size tools are required for procedures such as signal replacement, slope maintenance, lamp checking, painting, and bearing surface material replacement.

### Major Maintenance

This type of maintenance consists of works where a lane or transit body of the road must be closed in order to perform relaying of courses or major maintenance of the bearing surface, and to install warning signs.

### Service Level Verification

This activity consists of test scanning the area with four passenger design vehicles to determine the level of service of the road.

### Review Scanning

Review Scanning is a control and supervision- oriented series of activities for maintenance works and road operation.

The project will not be forsaken, provided that it is a road with high specifications and continuous use.

## 2.5. Personnel and supply requirements

### 2.5.1. Personnel

Personnel required for the different stages of the project will be hired mainly in the surrounding villages, in the case of workers familiar with the activities to be developed, with the purpose of not creating new human settlements in the region. It is worth highlighting that this strategy will promote the fostering of financial resources use in the region. The City of Aguascalientes is located 20 minutes away from the work site, and the city may provide qualified labor required for the preparation, construction, and maintenance of the layout. In case that the Availability (on Table II.5) is marked as "no", this is an indicator that no staff member is available for that particular function in

the surrounding villages, although alternative staff members can travel from Aguascalientes.

**Table II.7. List of personnel required.**

Number	Position	Project stage	Type of labor	Type of worker	Local Avail.	Journals
3	Work supervisor	All	qualified	temporary	no	84
3	Surveyor	Construction	qualified	temporary	no	69
3	Officer	Construction	qualified	temporary	no	69
4	Chain operator	Construction	not qualified	temporary	yes	140
4	Chain operator	Construction	not qualified	temporary	yes	140
12	Major machinery operator	All	qualified	temporary	no	537
7	Minor machinery operator	All	qualified	temporary	no	235
6	Driver	All	not qualified	temporary	no	189
4	Blacksmith crews	Construction	qualified	temporary	no	173
4	Bricklaying crews	Construction	qualified	temporary	no	173
4	Structuring work carpenter	Construction	qualified	temporary	yes	84
4	Painter	Operation and maintenance	qualified	temporary	no	173
16	General helper	All	not qualified	temporary	yes	537

Those marked with no in the availability column will have to travel from Aguascalientes (20 min from the work site) or Guadalajara (an hour and a half away.)

### 2.5.2. Supplies

Dry portable toilets for workers will be installed, so no water supply will be needed.

Drinking water needed for human use (potable water) will be supplied in 20 liter carboys. The minimum consumption will not be considered as part of the work. A 20 m<sup>3</sup> pipe supply will be required, as well as the basic service usage by the personnel, which will be supplied by the construction company.

Fuel volumes will not be significant from the environmental impact standpoint. Load vehicles will get supplies at the local service stations located on the San Juan-Encarnación federal road.

Fuel used for machinery and equipment, if needed, will be transported in airtight metal containers with the purpose of preventing loss due to evaporation. Care must be taken to check for gas generation and overpressure to avoid explosions.

For the construction process significant volumes will be required. An estimate of the water volume required for compacting the embankments, as well as irrigation to prevent dust release, will be of 84 m<sup>3</sup> to be used at different times, according to the work schedule. For the rest of the works, enough potable water will be required for service personnel use and for maintenance crews. The estimated water supply required will be 5 m<sup>3</sup>/d.

Land movements will be performed according to the mass curve diagram (Appendix 8). Construction of the road stretch requires the supply of at least 4 material banks, according to the layout and required amounts for the assigned bank. From that point it is possible to determine the economical transportation distances.

Machinery used on the operation of the road consists of a pick- up truck to transport the personnel and crews required for the road operation. Regarding maintenance, pipes will be required to irrigate the green areas, for vegetation maintenance, and lighting in zones of the road that require so. Furthermore, a truck will be necessary for debris and garbage collection after cleaning works of the course and annex works such as sewers, drains, and gutters, as well as for work quadrille transportation. Eventually, equipment will be required for minor maintenance such as patching, and collocation or replacement of the signals and paint on the bearing surface.

Materials and substances that will be used in the project are those particular ones for use on this type of infrastructure, such as: stone materials, water, cement, steel, etc., as well as supplies necessary in the performance of this project, which are indicated in Table II.8.

**Table II.8 Materials and substances.**

Material	Stage	Supply source	Transportation	Amount Required
Gravel, sand, lime from material banks	Formation of the embankment, works placement	Borrowing banks	Dump trucks	381, 144 m <sup>3</sup>
Type B material	drainage, paving, formation of the embankment	Leveling compensation	Dump trucks	136, 262 m <sup>3</sup>
Type AC- 20 asphalt cement (to be mixed with bank material at a 150 L/m <sup>3</sup> ratio)	Paving	Supply company	Trucks	242, 790 L
Paint	Construction and maintenance	Supply company	Truck	142 L

Vertical signals	Construction and maintenance	Supply company	Trucks	68 pieces
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## 6.2 Wastes

Solid wastes. Wastes from ground and vegetation remains resulting from clearing and stripping. A portion of the cleared material can be donated to the local inhabitants to be used as fire wood and lumber (in the case of trees or woody bushes). Another type of waste will be those produced by the leveling, a portion of these will be used for the construction of the fill; the remainder will be used in the manner explained in the following paragraph.

The material produced by clearing and stripping that is not donated will be used according to Chapter VI, to furnish unused material banks for the growth of the vegetation. The stone material produced by the leveling cuts will be placed in material banks left unused after the work has concluded.

It is estimated that 74 workers, as well as approximately 48 months will be required for the project, although not every activity will be performed simultaneously. It is expected that 80% of the domestic type wastes will be generated in their original locations and only 20% in the work sites. Considering the garbage generation factor of 0.450 kg/person, the domestic wastes generated in the work sites are expected to be approximately 9,590 kg in total for the entire operation.

It is expected that this generation will be produced by waste such as paper bags, card board, glass and plastic packages, among others (12 kg per month maximum); as well as empty cans including some content of paint, solvents, oil or lubricant, used oil and greased burlap, these last ones can not be considered hazardous due to their volume, nevertheless they must be handled separately from the purely domestic wastes. Therefore, two separate litter containers must be used, one for domestic wastes and the other for any material that came in contact with any type of solvent, oil, paint, lubricant or grease. The first container will be delivered to the municipal garbage disposal system, and the second container will be disposed in the nearby gas stations to be handled with their own wastes.

The industrial wastes will be generated at the car and engine workshops commercially operating in the cities of San Juan, Encarnación and Aguascalientes. An inspection of these workshops will be performed to verify that the wastes are handled in accordance to the Guidelines of the Ecological Balance and Environmental Protection General Law in Regard to Hazardous Wastes, as well as NOM-003-SCT2-1994 and NOM-011-SCT2-1994. These workshops must pack these hazardous materials and deliver them to a disposal company authorized by SEMARNAT.

It will be strictly forbidden to perform a mayor overhaul to the machinery in the work site or any site other than the authorized workshops, including for activities such as oil change.

Other types of solid wastes will be produced by the litter generated by the road users. Generally these types of waste consist in paper, tin cans, food remains, plastic bags, etc. Given the rural characteristics of the area, it is likely to encounter rubble and construction waste. These wastes will have to be collected periodically and transferred to disposal sites that comply with the regulations for the final disposal of domestic wastes.

Liquid wastes. The load related to the hygienic and toilet use can be up to 100 l/day/worker (probably less, according to the water used for showers and the shower frequency). Since it is expected that the workers will spend the night in their homes, it is considered that the generation of these wastes will not be a concern of this project.

For this project, and as a mitigation measure for the proper handling of toilet waste, it is established that portable toilets (saniseco or SIDRO) will be installed in the work sites, and the company providing this service will be responsible for the maintenance of this equipment.

The work operation will consider the construction of adequate slopes for the disposal of the water from the bearing surface. Nevertheless, the work site will not be equipped with residual water disposal.

The asphalt plant will be placed above a cement and concrete surface to avoid asphalt leaks.

Emissions to the atmosphere. During construction, there will be a generation of dust during almost every activity, this dust will be dispersed in the air and later deposited in the surrounding areas. Motors will be producing emissions to the atmosphere, but these emissions will be limited in comparison to the emissions that will be generated during the tracing operation.

During the road operation, the only relevant emissions will be generated by vehicular transit. The maximum circulation threshold estimated will be 200 units/hour (peak hour in Easter); considering this vehicular load and because of the rural conditions of the site, an insignificant emission load is estimated.

During the operation phase there will be an absolute control over the gasoline fueled vehicles and a minimum of the emissions will be generated by diesel fueled vehicles. The vehicular transit considered in the project will imply emissions of sulfur dioxide, nitrogen oxide, carbon monoxide, hydrocarbons, and suspended particles. The quantities and concentrations of the emissions will vary depending on the quantity of vehicles, the fuel consumption, and the condition of the engines. The factors mentioned can not be standardized to constant conditions, given that they are characteristics that vary from one vehicle to another. Nevertheless, considering the maximum levels of polluting emissions permitted, published in the Official Journal of the Federation, dated 22<sup>nd</sup> and 25<sup>th</sup> of February, 1996, NOM-041-SEMARNAT-1996 and NOM-045-SEMARNAT-1996, will be applied as standards.

This threshold will be established as a maximum limit, given that any road is subject to a seasonal nature during a day as well as during a year, thus the approximations reflect the moment of maximum environmental impact (vacations, generally Easter and

Year End). The project presents a diminishing effect in pollutant gas emissions because it allows a reduction in the distance and less travel time required. In addition, the zone presents conditions that will aid the quick dispersal of emissions.

## CHAPTER III LINK BETWEEN THE PLANNING INSTRUMENTS AND THE APPLICABLE JUDICIAL ARRANGEMENT

### III.1. LINK FOR THE PLANNING POLICIES AND INSTRUMENTS FOR THE DEVELOPMENT OF THE REGION

#### Link for the National Plan of Development (PND) 2001-2006

Guideline	Compliance proposal
The objective is to support and expand the transportation capabilities of individuals and goods throughout the national territory, updating and maintaining the existing roads, as well as creating new communication routes by offering more modern and safer roads, reducing travel times,	<p>transportation costs, and road accident occurrence.</p> <p>The road from San Juan de los Lagos – Encarnación de Díaz from Km 0+000 to Km 18+636.443 is an excellent example to illustrate this guideline. The construction of this road will link two roads, road No. 45 and road No. 80.</p>

#### Link for the National Plan of the Road and Communications Sector 2001-2006

Guideline	Compliance proposal
Strategic Line 1.3 Establish inclusive programs for road investment with the state governments.	are the population's demands. (Page 83 form Chapter 4).
Strategic Line 1.3.1 National Plan for the Construction of Rural and Feeding Roads.	The approximately 19 km of the project are part of this strategy. Its construction will allow a greater transit capacity as a fast road.
In order to broaden the coverage of the net it is necessary to construct 45,000 km, of which 17,000 km have been identified. These	This project is part of the road program established for the State of Jalisco and executed with the Expenditure Budget of the Federation (PRF).

## Link for the State Plan for the Development of Jalisco 2001-2006

In Chapter 3. Balanced and sustainable development in the matter of Communications and Transportation to the following:

### Link for the National Plan of the Road and Communications Sector 2001-2006

Guideline	Compliance proposal
<p>Line of Action 2. Update the communications sectors and the energy and telephone lines:</p> <p>Road communications. In the first line of the first level communications, with the support if the Federal Government, priority will be given to the termination of the works in process, the termination of the interstate corridors and the termination of the roads in the less accessible zones. (Page 222)</p>	<p>The project is a part of this strategy, given that it would be a part of the Aguascalientes – Bajío interstate corridors.</p>
<p>Line of Action 2. North altos and south altos region.</p> <p>The priorities will be established to consolidate the leadership in the fodder, tequila, food, cured meat, and dairy products industries, as well as the porcine, poultry, and egg production. The objective is to strengthen the manufacturing activities for the textile, clothing, shoe, and leather product industries, as well as to promote the metal-mechanic and motor parts industries. The purpose is to consolidate the production links in the Aguascalientes – Bajío region (page 228)</p>	<p>The project is a basic part for the compliance with this line of action, given that through the construction of the layout the transportation of goods could be significantly improved, facilitating the communications between the states. In addition, by reducing the travel times, several productive sector of the region will be benefited.</p>

## Local and Regional Environmental Guidelines Established

By definition POET is a planning instrument that seeks to establish a balance between the production activities and the environmental protection. This balance is defined in the Environmental Guideline by the social actors through the negotiations and conciliations of interests (SEMARNAT). The state of Jalisco has a Territory Environmental Guideline Model (MOET) established since the 21<sup>st</sup> of June, 2001 (P.O.), and it is currently in effect. MOET is physically a map that contains areas indicated for permitted, prohibited, and conditioned use. Much like the Urban Development Plans, this map can be established at a state level and must be registered in the Property Public Registry with the purpose of establishing its compliance as mandatory by all sectors or individuals that intend to exploit the natural recourses.

The Environmental Management Units (UGA) are used for the proper management of MOET. The UGAs are characteristic areas referring to natural or ecologic resources and common administrations which establishes the following aspects: Environmental and economic behavioral tendencies; Integration level or political or administrative independency; and Development level of the communications, urban, and industrial infrastructure. The UGAs is identified by the Predominant Use, the Frailty, the UGA no., and the Policy (Figure III.1)

UGA Code

Fo<sub>3</sub> 112\_C

Predominant Use      Environmental Frailty      UGA Number      Territorial Policy

**Figure III.1. Example of the UGA identification code. (*Ecological Guideline Model for Jalisco, 2001*)**

According to POET, the project is established for the North Altos region, and includes the municipalities of Encarnación de Díaz (northern section of the project Km 11+990 to 18+636.443), and San Juan de los Lagos (southern section 0+000 to 11+990). The layout is specifically located inside the Environmental Management Unit: Ag<sub>3</sub> 170 A (Table III.1)

**Table III.1. Description of the UGA code through which the layout of the Jalisco MOET project runs through.**

Code	Definition	Description
Predominant use	Agriculture AG	Includes the seasonal, humidity and irrigation agriculture for annual, semi-permanent and permanent crops. The use of technology includes animal or mechanic traction, use of agrochemicals and improved seeds.

Code	Definition	Description
Environmental Frailty	Media 3	The frailty is balanced. A state of equilibrium between the morphogenesis and the pedogenesis can be observed. The production activities must consider the eminent erosion hazards. The primary vegetation is semi-transformed.
UGA Number	170	-
Territorial Policy	Usage A	The UGAs that contain areas indicated for actual or potential production use, as well as areas with adequate characteristics for urban development, will be assigned with a policy for the usage of the natural resources, which entails the sustainable usage of the resources at a large scale.

The policies described in Table III.2 apply to the aforementioned UGA. Upon analysis of this table, no incompatibilities were found in regard to the project, and in the case of the guidelines established by the specific UGA policies no incompatibilities were found (Table III.3)

**Table III.2 UGA "Ag<sub>3</sub> 170\_A" constraints for the infrastructure of the project**

Compatible Use	Conditioned Use	Incompatible Use	Applicable vegetation/wild life use	Human Settlements Criteria Constraints	Infrastructure Criteria Constraints
Livestock	Human Settlements Tourism Industry Aquaculture	None	Ff 1, 3, 4	Ah 13, 14, 19, 24, 26	If 17, 18

**Table III.3. Compliance proposal for the restrictions established by POET for the development of infrastructure**

Code	Moet Description	Compliance proposal
Ff 1	Introduce the present biota to the local communities as a natural patrimony through the basic educations programs	The project is not linked to these policies.
Ff3	Incorporate wild species of high ornamental and/or medicinal value to commercial nurseries	

Code	Moet Description	Compliance proposal
Ff 4	Incorporate the reproduction of reforesting plants, tree species, and/or native bushes	
Ah 13	Establish an integrated system for the management of the municipal solid wastes that includes environmentally adequate actions from their origin, storage, collection, transportation, treatment and final disposition of the garbage, with the purpose of avoiding the contamination of water tables, and superficial waters, soil contamination and health damages.	If necessary, during the construction of the project the waste elements will be deposited in dump sites provided by the municipalities of Encarnación and San Juan, in accordance to MM1 (Chapter VI).
Ah 14	The expansions of new urban and/or tourist settlements must have independent pluvial and/or domestic drainage systems.	The project is not linked to this policy.
Ah 19	The establishment of human settlements is prohibited in high fertility grounds.	Neither camps nor settlements associated with the project will be constructed.
Ah 24	Promote and support the reforestation of native species in green spaces with the purpose of providing a non formal environmental education regarding the biotic richness of the area.	The project is not linked to this policy.
Ah 26	Promote and support the formation of human resources depending on the areas of demand resulting from the guideline proposals, operating as work opportunities for the local inhabitants.	The project intends to hire the personnel from the local communities, and to use the local food and hotel services.
If 17	Perform the cleaning services for the communication roads through methods other than the use of fire.	No fire usage or burning method will be used for the cleaning services performed in the project area. MM1 (Chapter 1) prohibits the use of fire to prepare the worker's food.
If 18	Promote and support the acquisition of efficient irrigation systems for the use of the water resource.	Once the layout is in operation, the green spaces will be irrigated with water transported in tanker trucks.

## III.2. ANALYSIS OF THE APPLICABLE ENVIRONMENTAL NORMATIVE LAWS AND INSTRUMENTS

### Compliance of the regulations regarding environmental protection

#### Ecologic Equilibrium and Environmental Protection General Law (LGEEPA)

Articles 28, 30, and 35, through which it is established that the sponsor of a project must obtain the corresponding authorization from the Ministry in regard to the environmental impact. The type of projects that require the authorization are indicated, as well as the resolution that might be issued by the Ministry.

This document has been prepared as a part of the request presented by the sponsor, and the technical elements that will be evaluated by the SEMARNAT personnel in order to deliver a resolution.

#### LGEEPA Guidelines in regard to environmental impact

Guideline	Compliance proposal
<p>Article 5.- Whoever intends to perform any of the following works or activities are required to have the previous authorization issued by the Ministry in regard to the environmental impact, section b) general routes of communication in which the construction of roads has been indicated.</p>	<p>Article 13.- The environmental impact manifestation in its regional mode must contain the following information:</p>
<p>Article 11.- The environmental impact manifestations will be presented in a regional manner whenever dealing with:</p>	<p>This road is a general communication rout provided that it deals with the construction of a road that will be paid with the federal budget.</p>
<p>IV. Projects that intend to be developed in locations with regional environmental components that entail accumulative, synergic or residual impacts that might result in the destruction, the isolation, or the fragmentation of the ecosystems.</p>	<p>This road is a project with cumulative, synergic, or residual impacts; and like any other road it can produce a barrier effect for the vegetation.</p>
	<p>This study's modality is therefore regional.</p>
	<p>The seven points indicated in article 13 are developed in this study.</p>

Guideline	Compliance proposal
<p>I. General data for the project, sponsor, and individual responsible for the environmental impact study; II. Description of the works and activities, and if applicable, of the partial programs or plans for development; III. Links between the planning instruments and the applicable judicial guidelines; IV. Description of the regional environmental system, and indication of the development trends and of the regional deterioration; V. Identification, description and evaluation of the environmental, cumulative, and residual impacts of the regional environmental system; VI. Strategies for the prevention and mitigation of the environmental, cumulative, and residual impacts of the regional environmental system; VII. Regional environmental forecast, and if applicable, alternative evaluations; and VIII. Identification of the methodological instruments and technical elements that support the</p>	<p>results presented by the environmental impact manifestation.</p>

### General Law for Wild life

Guideline	Compliance proposal
<p>Article 2.- The provisions of The General Law for the Ecologic Equilibrium and Environmental Protection and other related laws in regard to the subjects regulated by this guideline will be applied on any circumstances that are not provided by this Law.</p> <p>Article 18.- The proprietors and rightful owners of the lands where the wild life is distributed will have the right to the sustainable use of these lands and will have the obligation to aid the preservation of the habitat according to the terms established in this Lay. Likewise, they will be entitled to transfer this prerogative to third parties, withholding the right to</p>	<p>participate in the benefits derived from the aforementioned use.</p> <p>The proprietors and rightful owners of the aforementioned land, as well as third parties in use of the land, will be conjointly responsible for the preservation of the wild life and its habitat.</p> <p>The Law does not contemplate the deterioration of the wild life resulting from the construction and operation activities of this project, thus we refer to LGEEPA.</p>

This article allows the use of the land (describing “the use of specimens, parts, or derivatives of the species through their collection or capture”) by the proprietors, which in this case will be SCT once the right of way is released.

Grants the power to transfer the prerogative to third parties, who can be individuals performing MM6 (Chapter VI).

Guideline	Compliance proposal
<p>Article 19. The authorities that intervene in the activities related to the use of the land, water and other natural resources for agricultural, livestock, fish farms, forestry <b>and other</b> purposes will act in accordance to the provisions established this Law, and will adopt the required measures to ensure that the aforementioned activities are performed in a manner that prevents, repairs, compensates, or minimizes any negative effect of these activities on the wild life and its habitat.</p> <p>Articles 29 through 31 in Chapter VI establish that the capture and the handling of wild life must be dignified and respectful causing the least possible amount of stress to the specimen.</p>	<p>This project considers mitigation measures (MM3, MM5, MM6 and MM7; Chapter VI) intended to minimize the negative effects resulting from the construction and operation of the layout on the wild life and its habitat.</p> <p>MM3 (Chapter VI) proposes the rescue of the wild life. First the wildlife is driven away by noise, then the captured specimens are placed in bags to be transported to their new habitat. Supervision will always be present to ensure that the specimens are not damaged.</p> <p>MM1 (Chapter VI) prohibits the workers from capturing specimens or disturbing the wild life.</p>

### Compliance of the guidelines regarding communication routes

#### National Goods Law

Guideline	Compliance proposal
<p>Sections IX and V of Article 29 define the bridges, roads and highways as common use goods.</p> <p>Article 30 defines who has the right to use the common goods, as well as the permitted uses.</p>	<p>Article 22 defines the construction, conservation and exploitation of the roads and bridges as a public right. Therefore, SCT is responsible for the sale and purchase through the interested parties, for the expropriation of lands, for the construction, and for</p>

the material banks required. SCT is authorized to use national land and sea territory, as well as the exiting materials contained within in accordance to the legal provisions.

The road infrastructure contemplated in this project will be for common use.

During the operations stage, SCT will be responsible for the inspection of the use given to the road by its users, and their compliance with the established provisions.

The right of way release procedure will be performed in accordance to the article y and through the agreement with the current proprietors with the purpose of performing the purchase and sale operation or the exploitation of the land.

Guideline	Compliance proposal
Article 27 establishes that STC will be entitled to demand the placement of a fence or division to the proprietors of the neighboring lands for security purposes in regard to the right of way.	The fencing requirement for the neighboring lands is not definitive yet. If necessary, the proprietors of these lands will have to provide the necessary conditions to prevent the trespassing of livestock to the road for security purposes.

**Expropriation Law (1997)**

Guideline	Compliance proposal
Article 10 establishes that the price set as indemnity for the expropriated good will be equivalent to the commercial value set, and in the case of real states, the value must not be lower to the fiscal value assigned in the cadastral or tax collectors offices.	The negotiations for the release of the right of way must be performed with the necessary discretion. No tensions are expected given that the municipal authorities have expressed their intention to have the road built.

**Normative Instruments**

The Mexican Official Standards (NOM) in regard to the environmental impact are a tool that allow the environmental authorities to establish permissible requirements, specifications, conditions, procedures, goals, parameters, and limits that will have to be observed in regions, zones, basins, or ecosystems for the use of the natural resources through the development of economic activities, use of goods, supplies, ad processes. In addition, NOMs perform an essential role in the generation of a confident judicial environment and promote the technological change with the purpose of providing a more efficient protection of the environment.

All the processes involved with the different phases of the project have been evaluated, from the preparation of the site, to the operation of the works, identifying the NOMs provided by SEMARNAT which establish the regulations regarding the aforementioned works and activities (Table III.4).

**Table III.4. Mexican Official Standards issued by SEMARNAT in regard to the Project**

Mexican Official Standard	NOM Specification	Project application
<b>WATER CONTAMINATION</b>		
<p>NOM-001-SEMARNAT-1996. Establishes the maximum permitted limits of the pollutant content in the residual discharges in national waters and goods.</p>	<p>4.1 The concentration of basic pollutants, heavy metals and cyanides in the residual water discharges in national waters and goods must not exceed the maximum permitted limits in Tables 2 and 3 of the Mexican Official Standard. The potential hydrogen (pH) permissible range is 5 to 10 units.</p>	<p>The project will avoid the toilet discharges through the use of portable toilets, as described in the mitigation measure 1.</p>
<p>NOM-002-SEMARNAT.1996. Establishes the maximum permitted limits of pollutant content in the residual water discharges in the urban and municipal sewer system.</p>	<p>4.1 The maximum permitted limits of the pollutants in the residual waters discharged in the urban and municipal sewers must not exceed the figures established in Table 1. IN the case of greases and ails the average is calculated in relation to the flow rate, resulting from the analysis performed to each of the simple samples.</p>	<p>The standard applies for discharges in the sewer systems, it is expected for the workers to contribute to the discharges through the residual water generated by toilet use, showers, dish washing and laundry. Given that a large quantity of the workers will be local, it is reasonable to assume that their daily activities would have produced the same amount of discharges, and therefore the pollutant load increase is insignificant</p>
<b>WATER CONTAMINATION</b>		
<p>NOM-041-SEMARNAT-1999. Establishes the maximum permitted limits for pollutant gas emissions produced form the exhausts of the automotive vehicles in circulation fueled by gasoline.</p>	<p>The standard is mandatory for the individuals responsible for the automotive vehicles fueled with gasoline, <u>with the exception of machinery intended for the construction industry, among others</u> (section 1 of the referred Standard)</p>	<p>The compliance with this standard will be accomplished through the mitigation measure 2, which establishes the inspection of emissions produced by light, medium and heavy trucks employed in the preparation, construction and maintenance of the project.</p>

Mexican Official Standard	NOM Specification	Project application
<p>NOM-045-SEMARNAT-1996. Establishes the maximum permitted levels for the opacity of the smoke produced by the exhausts of automotive vehicles in circulation fueled with diesel o mixtures that include diesel as a fuel.</p>	<p>The standard is mandatory for the individuals responsible for the automotive vehicles fueled with diesel, <u>with the exception of machinery intended for the construction industry, among others</u> (section 1 of the referred Standard)</p>	<p>The compliance with this standard will be accomplished through the mitigation measure 2, which establishes the inspection of emissions produced by trucks employed in the preparation, construction and maintenance of the project according to the terms established in Tables 1 and 2 of the Standard in regard to the vehicular gross weight.</p>
<p>NOM-050-SEMARNAT-1993. Establishes the maximum permitted levels for the gas pollutant emissions produced by the exhausts of automotive vehicles in circulation fueled by blended petroleum gas, natural gas or other alternative fuels.</p>	<p>The standard is mandatory for automotive vehicles in circulation, but does <u>not apply for machinery intended for construction, among others.</u> It is necessary to verify the compliance with Table 2, which indicates the maximum levels permitted for gas emissions produced by the exhausts of the multiple use or utility vehicles in circulation, in consideration of the year-model.</p>	<p>The compliance with this standard will be accomplished through the mitigation measure 2, which establishes the inspection of emissions produced by light, medium and heavy trucks employed in the preparation, construction and maintenance of the project.</p>
<p>NOM-085-SEMARNAT-1994. The atmospheric pollutants – fixed sources – for fixed sources that employ solid, liquid o gas fossil fuels, or any of their combinations, and establishes the maximum permitted levels for the emissions to the atmosphere, total suspended particles, sulfur dioxide, and nitrogen oxide...</p>	<p>5.1 The maximum permitted levels of smoke emissions to the atmosphere, total suspended particles, nitrogen oxides, and sulfur dioxide produced by the combustion equipment of the fixed sources referred to in this Mexican Official Standard are established in Tables 4 and 5.</p> <p>6.1.1.1. A log of the operation and maintenance of the combustion equipment must be kept, also including the measurement and analysis of the emissions, and the quality certificates of the fueled employed.</p>	<p>In this particular case, the equipments employed in the asphalt plant are considered fixed sources, for which the compliance with the terms established in Tables 4 and 5 must be considered, in regard to the pollutant emission to the atmosphere (smoke, total suspended particles, nitrogen oxide, and sulfur dioxide).</p> <p>Its compliance is considered in the mitigation measure 2 (Chapter VI).</p>

<b>Mexican Official Standard</b>	<b>NOM Specification</b>	<b>Project application</b>
<p>NOM-081-SEMARNAT-1994. Establishes the maximum permitted limits for the noise emissions produced by fixed sources and the method for its measurement.</p>	<p>5.3 The following procedure must be applied in order to obtain the noise level produced by a fixed source: An initial recognition; a field measurement; the processing of the measurement data, and; the preparation of the measurement report.</p> <p>5.4 The maximum permitted limits for the noise level produced by fixed sources in calculation "A" are established in Table 1.</p>	<p>The expected noise levels are within the compliance range of NOM-081-SEMARNAT-1994, in regard to activities in the public road: 68 dB(A) between 6:00 and 22:00 hours, and 65 dB(A) in the remainder of the day.</p> <p>In any case, the contractor must comply with mitigation measure 1, and also perform the two moth noise evaluation and inform the results to the municipal and federal authorities. In the case of exceeding the permitted values, the contractor must indicate the adjustments employed to correct the exceeding values.</p>
<b>NATURLA RESOURCES</b>		
<p>NOM-005-SEMARNAT-1997. Establishes the procedure, criteria and specifications required to perform the use, transportation and storing of tree bark, branches and whole plants.</p>	<p>1.1. This standard is must be complied with in all the national territory and has the purpose of establishing the required procedures, criteria and technical and administrative specifications to perform the sustainable use, transportation, and storing of tree bark, branches, and whole plants in natural populations, with the exception of Candelilla (<i>Euphorbia ssp.</i>).</p>	<p>MM4 (chapter IV) explains the proper storing procedures which comply with this standard. Although this is not mandatory for this work, as mentioned earlier.</p>

<b>Mexican Official Standard</b>	<b>NOM Specification</b>	<b>Project application</b>
<p>NOM-007-SEMARNAT-1997. Establishes the procedures, criteria, and specifications required for the use, transportation, and storing of branches, leafs, flowers, fruits, and seeds.</p>	<p>1.1. This standard is must be complied with in all the national territory and has the purpose of establishing the required procedures, criteria and technical and administrative specifications to perform the sustainable use, transportation, and storing of branches, leafs or tendrils, flowers, fruits, and seeds.</p> <p>7.1. This standard is mandatory in the case of individuals performing the use, transportation and storing of branches, leafs or tendrils, flowers, fruits, and seeds in natural populations.</p>	<p>This project <u>will not use nor the commercialize plants in whole or in parts</u>, nevertheless, the rescue and transplantation of the specimens established in Chapter VI is considered as part of the vegetation protection, rescue, and recuperation program (mitigation measure 4). In concern to seed handling during the reforestation activities, the terms established in section 4.1.6 of the Standard, although this the compliance with standard is not mandatory in the case of this project.</p>
<p>NOM_025-semarnat-1995. Establishes the characteristics that must be observed in the marking methods for lumber rolls, as well as the guidelines for their use and control.</p>	<p>1.1. This Standard establishes the characteristics that must be observed in the marking methods for lumber rolls, as well as the guidelines for their use and control, and is applicable for the individuals responsible for the use of forestry lumber products.</p>	<p>This project will not use nor commercialize lumber rolls, although clearing activities will be performed (Appendix 6), and therefore the marking will be preformed according to mitigation measure 5.</p>
<b>PROTECTED SPECIES</b>		
<p>NOM-059-SEMARNAT.2001. Environmental protection – Mexico’s Wild Life and Vegetation Native Species – Endangered category and specifications for their inclusion, exclusion or change – List of endangered species.</p>	<p>The standard establishes the list of species in a protection category and the appropriate procedures for the modification of the list. The endangered species list is presented in the normative Appendix II.</p>	<p>SAR does not distribute any endangered wild life or vegetation species included in the listing of this Standard.</p>



Construction of the San Juan de los Lagos- Encarnación de Díaz road.  
Stretch from Km. 0+000 to 18+ 636. 443



### **Protection of natural areas**

The road layout described in this project does not enter nor is located near to natural areas protected under federal, state, or municipal jurisdiction.

### **Other Regulatory Instruments of the state or municipal order.**

This project is not linked with regulatory instruments of the estate or municipal order, given that its location is within forestry vegetation and agriculture lands.

The regulation for solid wastes, generated by the construction activities, corresponds to the municipalities of Encarnación de Díaz and San Juan de los Lagos. No camp sites will be established, and therefore the residual water discharges will be handled conjointly with the population's drainage.

With the purpose of preventing accidents, the personnel will be adequately trained and will use safety equipment. Regardless, the municipal public security service will patrol inside and outside of the villages in order to provide aid and protection to the inhabitants.

## CHAPTER IV

### DESCRIPTION OF THE REGIONAL ENVIRONMENTAL SYSTEM, AND DEVELOPMENT TREND AND REGIONAL DETERIORATION INDICATIONS

#### IV.1. Regional Environmental System (SAR) Delimitation

The stretch of the San Juan de los Lagos- Encarnación de Díaz road from Km. 0+000 to 18+ 636.443 project is located in the region known as Altos of Jalisco, in the corresponding part of the Neo-volcanic Axis. It comprises the south portion of the Encarnación de Díaz municipality, and the northern portion of the San Juan de los Lagos municipality. The project is located within the río Verde-Grande basin, and crosses two permanent rivers, the San Francisco River, and the Agostadero River, in addition to small intermittent streams. Regarding the sublevel hydrology, the project is located over two geo-hydrological units: 87% in the Encarnación de Díaz aquifer, and 13% in the Lagos de Moreno aquifer. The lithology indicates that the layout of the project is located on sedimentary rocks (conglomerates and sandstones), as well as gravel, sand and silt. 73% of the project's layout is located over an erosive foothill-ramp geomorphologic unit and the remainder over erosive-denudative block mountains.

With the purpose of performing the delimitation to the extension of the regional environmental system (SAR), the cartographic information was examined in regard to the division of municipalities, geomorphologic units, edaphology, vegetation, and use of land (Figure IV.1). The overlapping of maps was performed by means of raster cartographic operations in the Arc View v.3 system. The minimum resolution was 1 Ha per pixel (raster cell). The influence area polygon for the project was established by the pixels containing at least one of the selected characteristics (Table IV.1). IN other words, in order to be considered a polygon element, the cell must contain at least one of the characteristic in each of the four subjects.

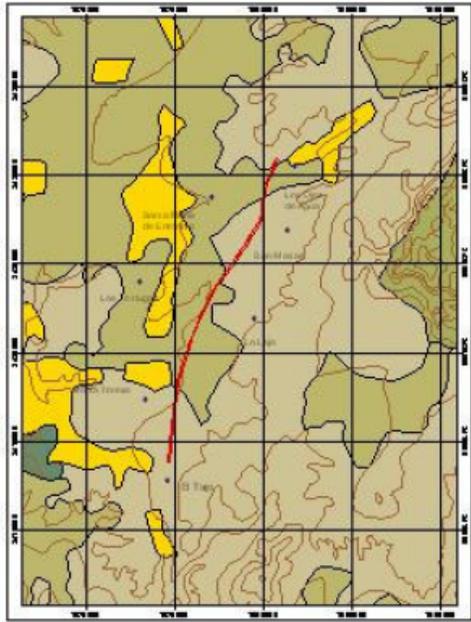
**Table IV.1. Themes employed for the evaluation of the influence area**

Subject	Characteristics
Municipalities	San Juan de los Lagos and Encarnación de Díaz
Use of the land and vegetation	Irrigation agriculture, seasonal agriculture and pasture – huizachal bushes (pasture-huizachal bushed and spiny forest)
Geomorphology	erosive foothill-ramp system and mountains: erosive-denudative block
Edaphology	Haplic phaeozems, autric planisol, pelic vertisol, and haplic xerosol
Weather	BS1hw

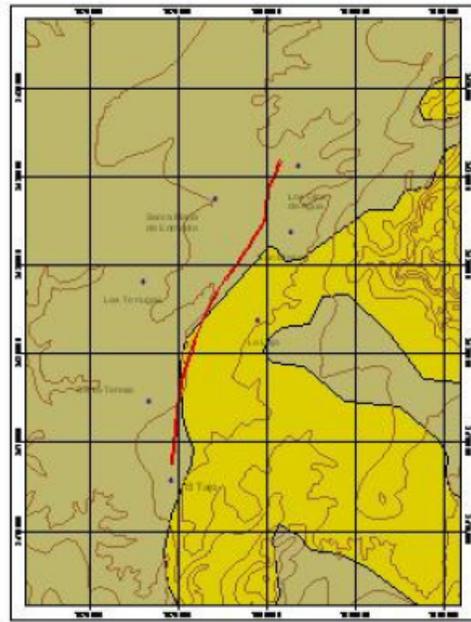
The map resulted in several polygons, and the layout of the project was contained in the main polygon, and the other polygons were isolated elongations. Afterwards, the polygon was cleaned and adjusted by eliminating pixels according to the following criteria:

1. Pixels belonging to the polygons with no connection to the main polygon.
2. Pixels belonging to the hillside facing north, which will not be affected by the project.

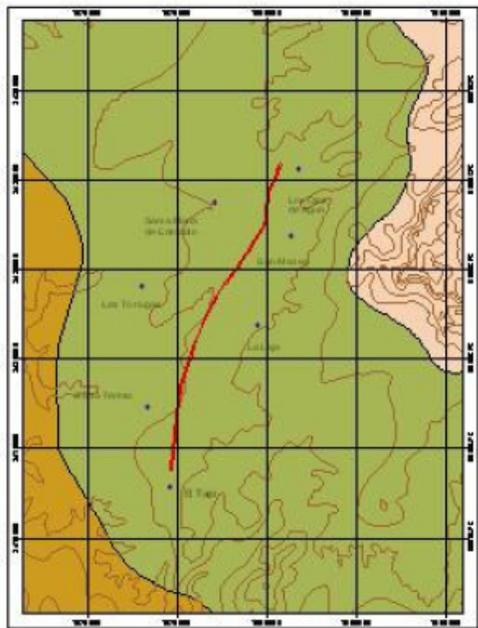
The resulting polygon is presented in Figure IV.2, which has a surface of 35,602.96 Ha. The calculation memory including the overlapping and the criteria application is presented in Appendix 5, in digital format, and in files that can be consulted by Arc View versions 3.x and 8.x.



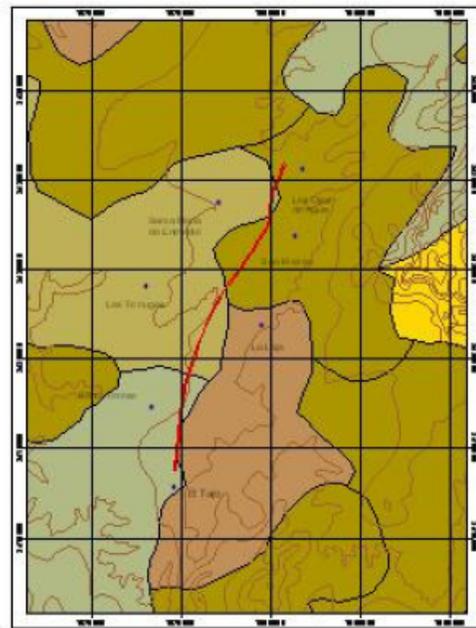
Vegetation and Land Use



Geomorphology

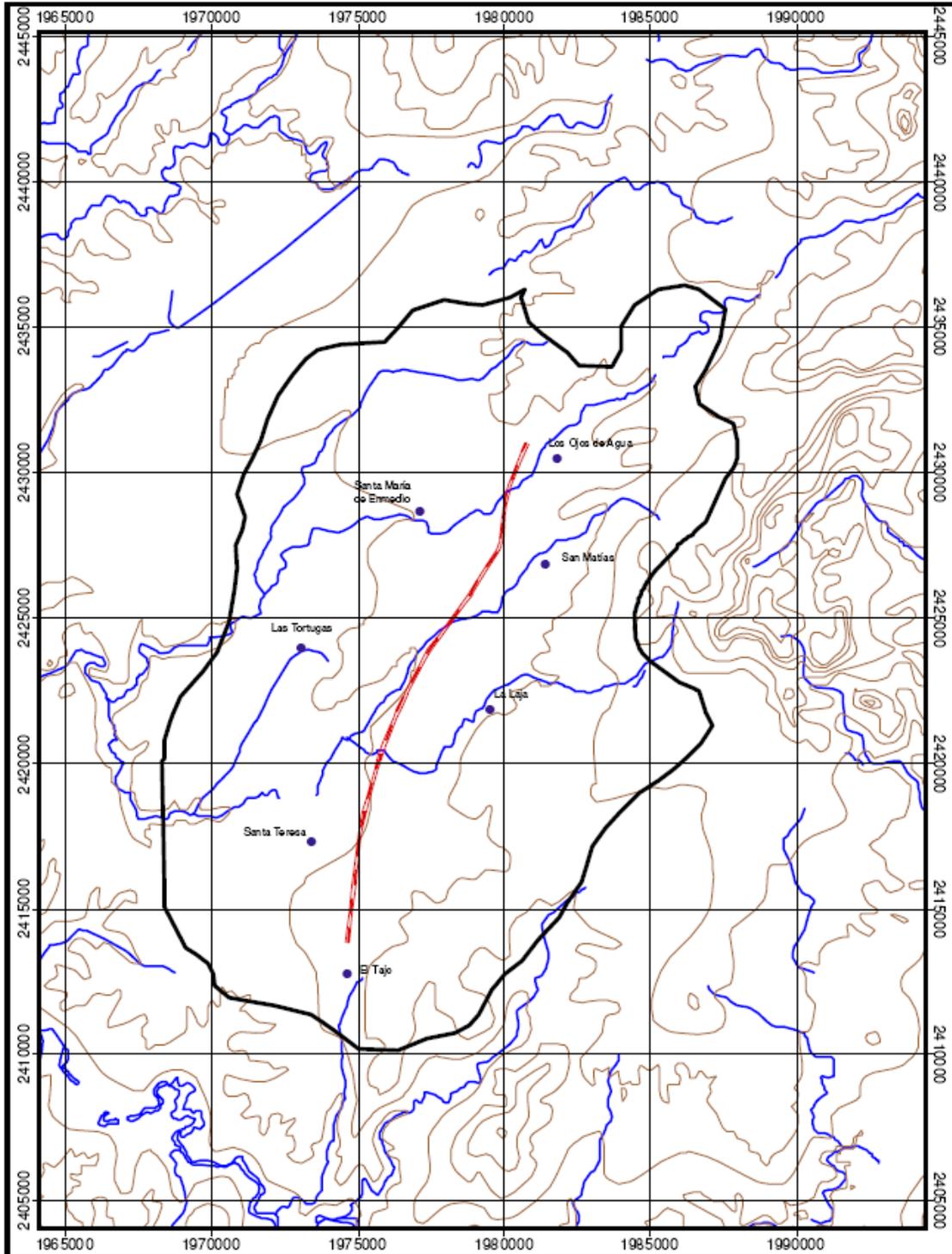


Weather



Edaphology

**Figure IV.1. Themes employed for the Regional Environmental System delimitation**



**Figure IV.2. Regional Environmental System surrounding the project (Black: SAR, Blue: Water Flows, Brown: Contour Lines)**

## IV.2. Characteristics and Analysis of the Regional Environmental System

### IV.2.1. Abiotic Medium

#### WEATHER

The Regional Environmental System presents a semiarid temperate weather type that corresponds to the Northern Altos in Jalisco. According to the Garcia classification (1988), the predominant weather is type BS1hw. This type of weather is characterized for presenting an annual medium temperature of 18° C, the temperature in the coldest month is below 18° C, and the temperature in the hottest month is above 22°C, with summer rains of 5% and 10.2% annually. In order to establish the weather conditions of the Regional Environmental System, the data collected by the Agostadero meteorological station in San Juan de los Lagos was employed. The maximum temperature of the area was reported in May measuring 39°C, while the minimum temperature reported was -2.3° C in November. The precipitation in the area is limited to the four months of summer (June through September), with the maximum precipitation report of 401.2 mm in July. As illustrated in Figure VI.3, the precipitation, occurring only during five months, and the temperature provide favorable conditions for the development of wild life and vegetation that withstand dry and high evaporation conditions.

The Regional Environmental System reports that the predominant winds originate from the northeast from November through February, and from the southeast from March through October, with an average intensity of 8 km/hour in both cases.

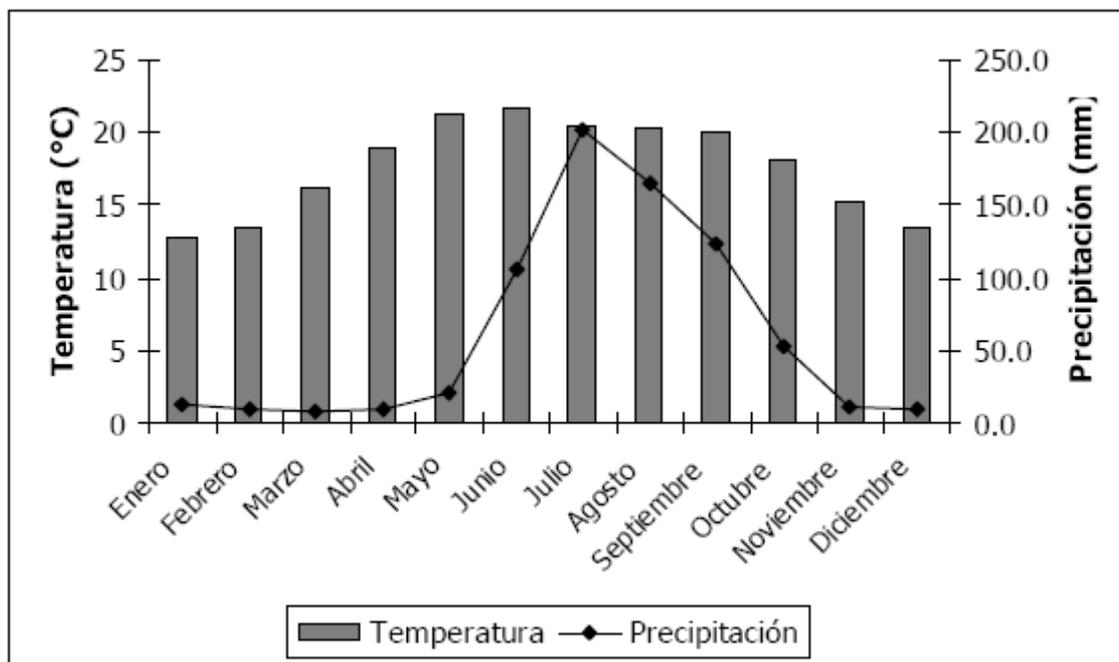


Figure IV.3. Average temperature and standard normal precipitation.

### *Natural Hazards*

The effect of the meteorological phenomena that can represent natural hazards for the constructions activities of the project, are considered of extremely low influence. These would include electric storms, eolic erosion, hail storms, and frost. The most hazardous events would be the heat waves and drought.

The Regional Environmental System establishes that the environmental temperature does not allow the necessary conditions for frost of snow. Hail storms occur at a rate of 0 to 1 days per year. There is no previous record of hail storm occurrences directly in the delimited area, and therefore only the aforementioned rate is considered. In regard to the Regional Environmental System, the weather hazards are minimal and no risk factors for the civil works exist in general.

## **GEOLOGY AND GEOMORPHOLOGY**

### *Geology*

From a geological point of view, the Regional Environmental System is located in the physiographic province of the Neo-volcanic Axis, in the sub province of the Altos in Jalisco, in the northwestern zone, considered within the boundaries of the Mesa Central of the río Verde sedimentary basin, and of the elevated blocks of the "riolitic plateau" that composes the Arandas and San Julian plateau. Three different points of interest appear in the landscape of this sector of the state, these are evident due to the contour lines and the agricultural zones more so than for any other natural characteristic.

IN the northeastern point of the Regional Environmental System, neighboring the states of San Luis Potosi, Zacatecas, and Guanajuato, a landscape composed of plains, plateaus, and pastures can be observed. These pastures are used for livestock and complementary agriculture dependent on livestock activities, but have scarce water resources. The geological construction of the Regional Environmental System corresponds to Tertiary and Cenozic (superior and inferior) sandstones and conglomerates, and Pleistocene and Recent maritime benches, gravel, sand, and silt with alluvial and lacustrine deposits,

On one hand, the *conglomerates* are sedimentary stones formed by the consolidation of rounded stones, pebbles and gravel, with fragmentations larger than 4 mm, surrounded by a sand or clay matrix and with a fine grain cement holding them together (calcareous or siliceous). Three main factors are responsible for the composition of the conglomerates: the lithology of the zone that feeds the sedimentary basin, the weather, and the contour of the zone subject to erosion. The weather and the lithology determine the materials that will be a part of the conglomerate, whether this is a result of chemical alteration or physic disintegration of the preexisting rocks. The contour determines the speed of the erosion, transportation, and sedimentation process, given that the contour of the terrain will provide more or less time for the chemical alteration of the minerals.

Similar to conglomerates, the *sandstones* are sedimentary rocks containing grains with a maximum diameter of 2 mm. These are composed of cemented sand in a siliceous matrix, although its nature might vary. The permeability of these rocks depends on the quantity and size of the intercommunicating pores. The other elements contained in the Regional Environmental System are gravel, sand, and silt. These are primary structures (sediments) produced by the commonly water erosion. The sedimentary rocks are formed by the petrographic processes throughout time.

In general terms, the geology of the Regional Environmental System is closely related to the geological forms of the area. This means that in the Regional Environmental System the slopes are low (merely 27%) and in association to the block mountain formations (refer to the *Geomorphology* section) the conglomerates of the zone are formed. Thus, the soil is receptive like *Planosol* and *Vertisol* (refer to the *Edaphology* section). A continuous formation of parental material (gravel, sand and silt) exists due to the erosive ramp of the mountain unit, generating a loss of soil, similar to *Xerosol*.

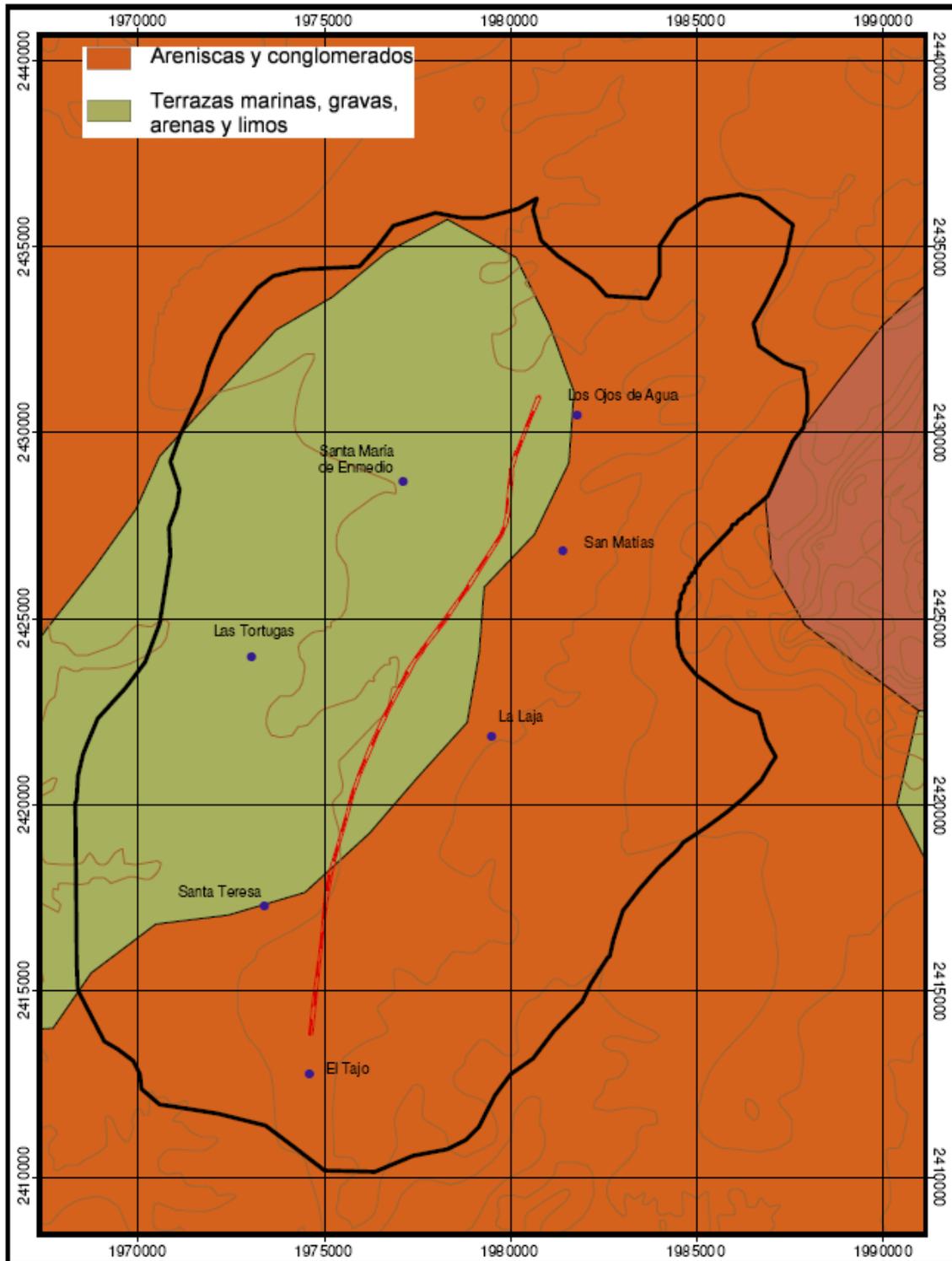
**Table IV.2. Predominant geologic composition**

<b>Superficial lithology</b>	<b>Implications for the Regional Environmental System</b>
Sandstones and conglomerates	Present in 56% of the area, which represents the occupancy of the entire northeastern region of the Regional Environmental System. This zone possesses a great influence over the water flows located within the Regional Environmental System, and in association to the geomorphology of the area (mountain in low block) they produce leaking zones and low or no filtration. The sandstones and the conglomerates are the result of the aforementioned association. This lithology is composed of sand, gravel and silt, and these elements are responsible for the origin of the different soils in the area.
Gravel, sand and silt	Its distribution is limited to the south, southeast portion of the Regional Environmental System, and is located in 44% of the area. This lithology is the result of the foothill geological unit erosive ramp with continuous erosion (commonly water based erosion). This produces a low to moderate rate filtration in this area. In addition, the soil formed in this area is the product of the deposits and weathering, such as the <i>phaeozem</i> . Finally, this parental material from this unit generates the <i>xerosols</i> .



Construction of the San Juan de los Lagos- Encarnación de Díaz road.  
Stretch from Km. 0+000 to 18+ 636. 443





**Figure IV.4. Superficial lithology of the Regional Environmental System**

### *Geomorphology*

The Regional Environmental System is located in the physiographic province known as the "Mesa Central". The region where our polygon was inserted is composed by a large extension of mountains, hills, valleys, and plains. In concern to the Regional Environmental System, there are two geomorphologic units within it, the *erosive ramp foothill*, and the *erosive denudative block mountains* (Table IV.3, Figure IV.5). The foothill in the Mesa Central is a part of the boundaries neighboring the state of Aguascalientes and San Luis Potosí. This system is composed of sloped plains attached to the foothill and surrounding the mountain elevations, formed by the accumulation of transported debris from the higher portions of the mountain and deposited by alluvial fans, where the coalescing and the superposition characteristics allow the vertical and spatial growth (sedimentary accretion). The *erosive ramp* is expressed with a residual contour resulting from the lineal erosion of the elevations and hills molded by the cut of the fluvial dissection of the regressive erosion. The dissection process, evident in the ramp through the incision of canyons and the erosion of thresholds, is distinguished by the lack of sedimentary erosion, and therefore there is no edification of the ramp by the substitution of an erosive contour expressed in the arranging of hills dissected by the canyon network.

The *erosive-denudative block mountains* present an organized contour from disjunctive structures resulting in a tectonic style of raised blocks in different levels, between which are located deep streams with steep slopes linked to tectonic faults or pits. Generally, this exhibits an arrangement of aligned block mountains in different levels. Sometimes in the low elevation blocks, depending on the orthogonal system, a contour of a mosaic of domes is formed with multi-convex geometry and soft slopes. This lithology contains sandstones, siltstones, shales, and limestones, which are the most representative in the area. The term *erosive-denudative* indicates de coexistence of the erosion process and the dissolution process of the erosive-corrosive forms in circulation in the hydrodynamic or sub-superficial zone, including fluvial dissection, and dolonization processes in large scale.

The block *mountain system* indicates that the mountain does not have a slope or cone, but has similar formations. It is formed by a differentiation of a block and the earth's crust: The crust is fractures, one block is elevated and another block sinks, the resulting fault presents creeks and steeper slopes, and the block presents softer slopes. The Regional Environmental System only contains the block sinking. The separation existing between the foothill and sinking block is very soft, and barely perceptible. This is clearly observed in the level curves in the eastern section of the Regional Environmental System (Figure IV.2.). That is where the difference between the blocks is evident, a zone of sharp slopes (outside the Regional Environmental System and corresponding to the fault zone) can be observed next to an elevated block with soft slopes.

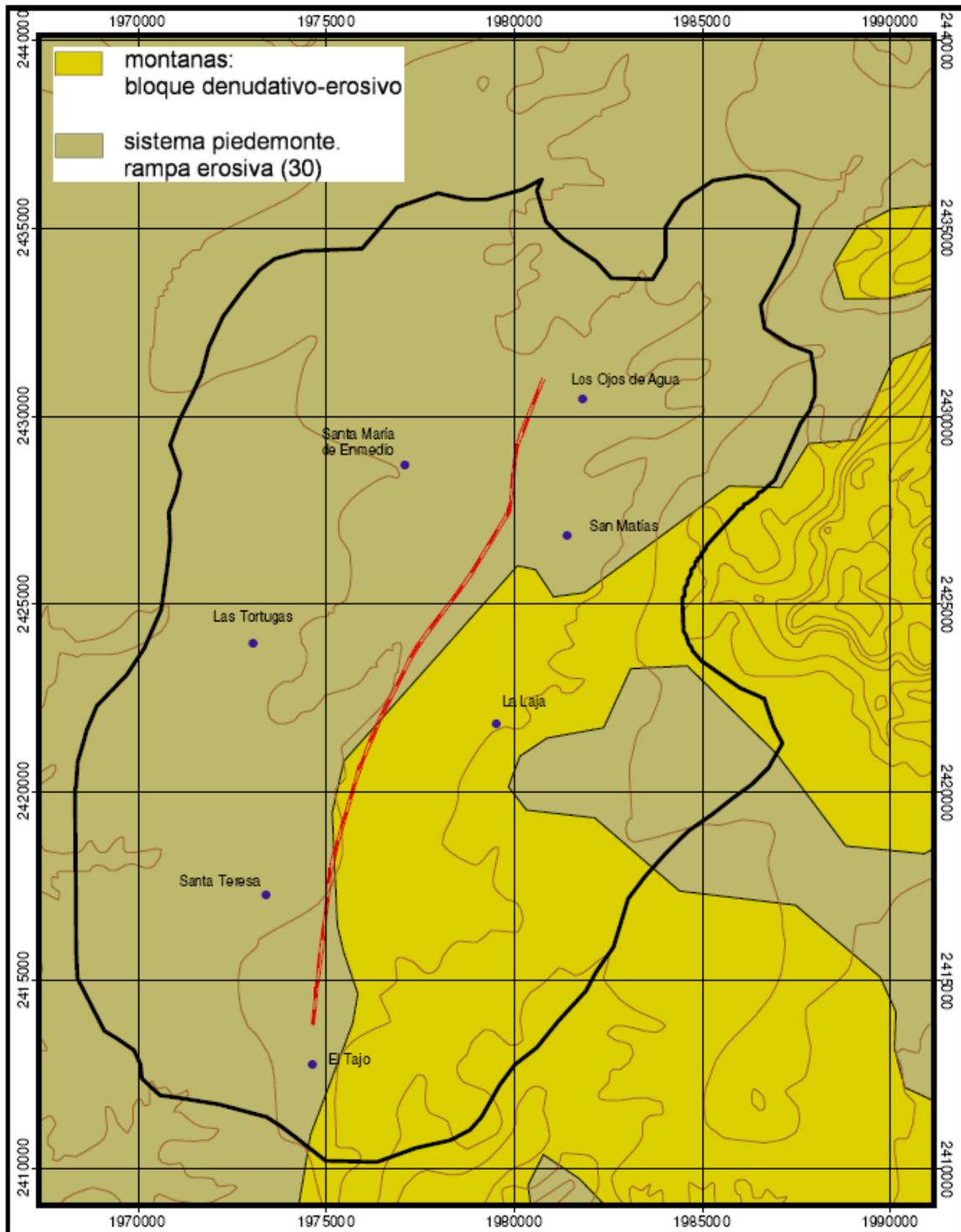
**Table IV.3. Predominant geomorphologic composition of the area with direct influence over the project.**

Geomorphologic unit	Implications for the Regional Environmental System
Erosive ramp foothill system	<p>This unit occupies 72% of the area of the Regional Environmental System. It is distributed throughout the Regional Environmental System, with the exception of the southern portion. In the hydrologic sense, this is a low to moderate filtration area, which makes it an area eroded by water related processes. The erosive ramp foothill represents a material receptor geological form. Intemperization exist on top of the erosive ramp, and the material is accumulated in the lower parts where the formation of <i>phaeozem</i> and planosol soil is common. Finally, given that this soil is exclusive to this unit, <i>xerosols</i> are also present and generated by the parental material from the erosive ramp.</p>
Erosive-denudative block mountains	<p>26.76% of the total area of the Regional Environmental System corresponds to this unit. It is located in the southern region of the study. This unit has a high leaking and low filtration rate.</p> <p>The Regional Environmental System only contains the sinking block of the mountain system. Thus, it is considered a subunit receptive of the material generated by the block with higher elevation. This favors the formation of soils receptive to materials with fine textures, such as planosol and vertisol.</p>



Construction of the San Juan de los Lagos- Encarnación de Díaz road.  
Stretch from Km. 0+000 to 18+ 636. 443





**Figure IV.5. Geomorphology of the study area.**

### *Seismicity*

85 to 90% of seism or earthquakes in Mexico occur in the subduction zone of the tectonic plates located on the Pacific Cost, from Puerto Vallarta in Jalisco, to Tapachula in Chiapas. According to seismic regionalization, SAR is located in region B. This is an intermediate zone, where seism activities are not recorded often or it is a zone affected by high accelerations that do not go over 70% of ground acceleration. Seismic danger is low, and it has an index of 0.14. Because of the location where SAR is established, it is not considered to be within simulation of return periods. In conclusion, SAR is not considered to be a danger zone in terms of seism activities that require special specifications for the present project.

### *Landslides and Earth Slips (Movement of Masses)*

In SAR slopes are soft and do not present important mass removal; therefore, they do not affect neither economic activity on the zone nor human settlements.

## EDAPHOLOGY

According to soil classification made by FAO-UNESCO (1990), within the area specified for the project, four types of soil are identified. From these, the largest within SAR is haplic Planosol (Table IV.4), followed by haplic Xerosol, pelic Vertisol, and haplic Feozem. According to the definite project of the sketch (Appendix 8) this shall only be settled in three types of edaphics. 82.4% in haplic Feozem, 9.4% in haplic Xerosol, and finally 8.2% in haplic Planosol, that even though is predominant in the SAR, in the right of way of the sketch (Figure IV.6). In general, a medium fertility is found for all four types of soil, erodability is divided into two groups, low erodability (haplic Planosol, and haplic Xerosol), and moderate erodability (haplic Vertisol, and haplic Feozem), fragility is according to erosion capacity of the soil.

**Table IV.4. Type of Soil According to FAO-UNESCO Classification found in SAR.**

Code	Type of Soil	SAR (% of area)	Soil Characteristics				
			Texture	Physic F.	Fertility	Fragility	Erodability
We	Haplic Planosol	43	Medium and fine	Duric	Moderate	Moderate	High
Xh	Haplic Xerosol	25	Medium	Duric	Moderate	Moderate	High
Vp	Pelic Vertisol	20	Fine	Stony	Low	Moderate	Moderate
Hh	Haplic Feozem	12	Medium	Lytic	High	Moderate	Moderate

Characteristics of the types of soils of each association within SAR are described below:

### *Feozem*

Among the main characteristics of this type of soil we have its good development. Even though they are deep, in some places they are limited by stony and gravelly in the surface, or by lytic phases, and deep lytic in the subsoil. They present dark colors due to the high organic matter contents. They present high levels of nutrients. They have medium textures coming close to argillaceous loams. They can also present fine and thick texture. Its productivity is good, but if not well handled; its susceptibility to water erosion goes from moderate to high. The aptitude of these soils is basically cattle raising and farming; of course, with suitable handling so that the soil does not lose its fertility.

### *Planosol*

This type of soil is characterized by a degraded alluvial horizon overlaying abruptly on dense subsoil. The original material is constituted by argillaceous alluvial or colluvial deposits. They are associated to flat terrains, seasonal or periodically flooded, of subtropical, temperate, semi-arid, and sub-humid regions with clear rainforest vegetation or meadow. They have an AEBC profile. Destruction, or translocation, of clay produces a whitened horizon with a thick texture that overlies abruptly on finer one. The hampering of water flow generates stagnic properties in the whitened horizon. Planosol are poor soils. In the regions with warm summers, they are used for flooded rice growth. In dry zones, they are used for fodder plants or for extensive pastureland. Much of them are not used for agricultural purposes.

### *Vertisol*

Usually, Vertisols on the area are deep and very well developed. They present a reddish and dark grayish color. With fine textures due to high concentrations of clay. Even some of the soils to which Vertisol is associated with present fine textures; this gives them a series of limitations for its use and handling. Because of its vertic properties, when dry, they contract generating cracks, and they are hardened in such a way that they make agricultural works hard. When humid they behave as expansive soils and drainage is deficient. Besides they are susceptible to flooding. Some Vertisol associations have medium texture that depends on the soils with which they share a cartographic unity. Among the processes that cause its deterioration it is important to point out the physical ones such as water erosion, its erodability is estimated to go from moderate to high. They present different physical phases that increase intrinsic limitations of these soils such as the stony, lytic, and deep lytic ones.

### *Xerosol*

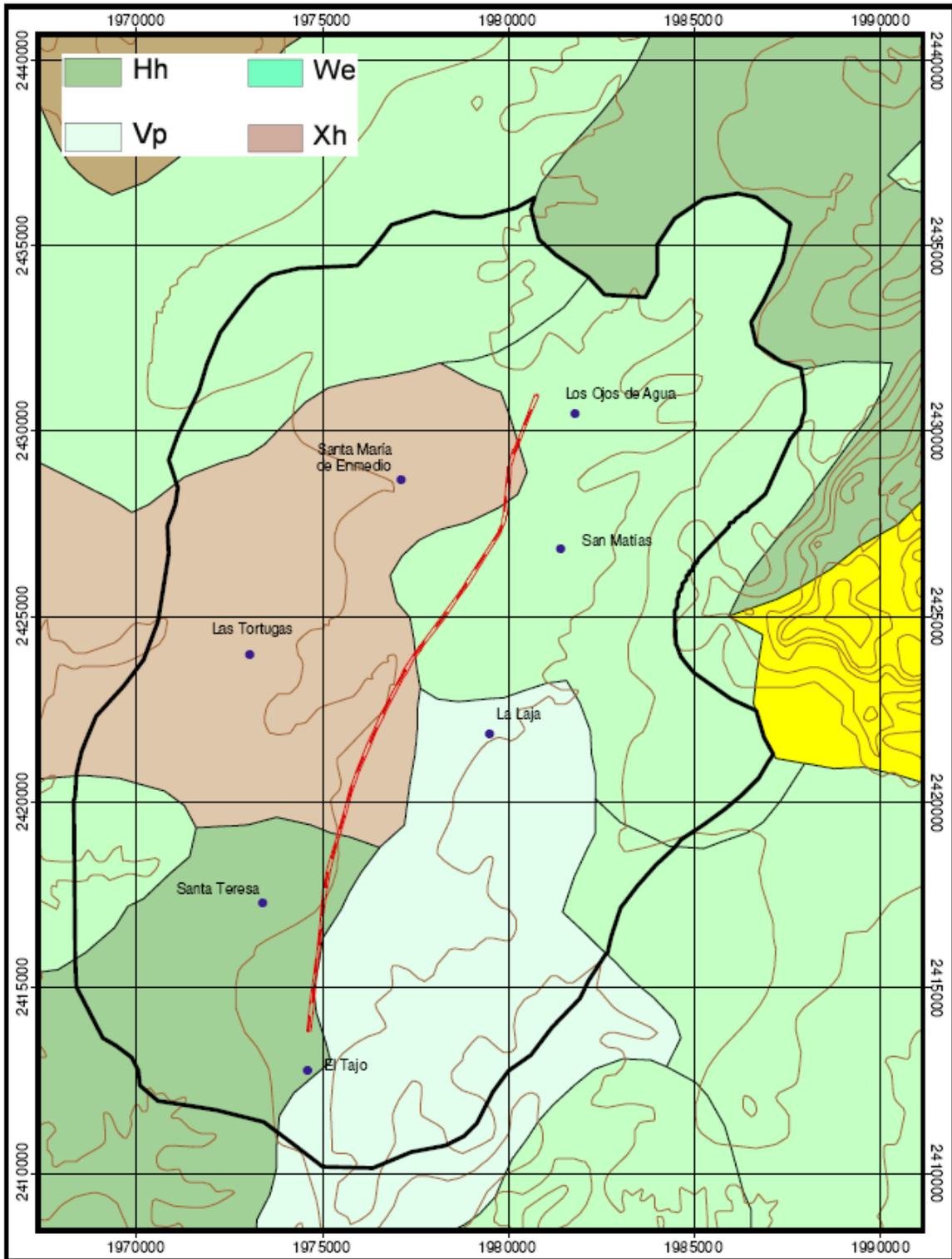
They are characterized by a light superficial layer very poor in humus, underneath which there can be subsoil rich in clay. Most of the times they present stains, dust, or lime

agglomeration at a certain depth, as well as plaster crystals or caliche. Occasionally, they present salinity. Scrubland exploitation is carried out in this type of soils in species such as candelilla. Xerosols present low susceptibility to erosion; safe when they are in slopes or on caliche.

In Table IV.5 below, the implications for type of soil in SAR are described.

**Table IV.5. Edafic Implications for the Area Concerning the Project**

Type of Soil	Implications for SAR
Haplic Feozem	This type of soil is considered to be one of the most fertile. In SAR it is located in growth fields, mesquite woods, and pastureland-huizachal. This type of soil is successful for cattle raising, as well as for growing zones, due to its moderate erodibility, and its high fertility. Therefore, within SAR, where there is extensive cattle raising the pastureland-huizachal is basic for the success of said activity. Fact that founds its foundation in Feozem soils.
Haplic Planosol	Unlike the previous edafic soil, planosols rate from moderate to low fertility, depending on the handling given to them. In the case of SAR, due to the erosion that they have suffered, they are frequently found in the covering used for fodder, as in pastureland-huizachal. Even though, they are also found in little thorn forest sprawl (mesquite). In respect of SAR, this type of soil is fine-textured, and also it has high erodibility that generates a poor soil.
Pellic Vertisol	Vertisol soils themselves in SAR are destined for plant covering for mesquite wood or thorn forest. They are not suitable for agriculture, due to their fine texture, and easy cracking. Within the area covered by vertisol it is the least disturbed in SAR.
Haplic Xerosol	Even though this soil is not suitable for agricultural use, within SAR it is found in growing fields (low production), as well as in the pastureland-huizachal. Most of water erosion is given in this type of edafic soil. This generates a impoverishment and soil degradation, because of a constant loss of material in the superficial horizon.



**Figure IV.6. Soil distribution within SAR  
(codes are specified in Table IV.4)**

## HYDROLOGY

### a) Superficial

SAR is located within Administrative Region VIII Lerma-Santiago, in sub-region Alto Santiago, (Table IV.6), in which Hydrological region No. 12 is included, corresponding to Rio Verde-Grande basin (9,589 km<sup>2</sup> total surface). Of this, SAR is distributed in sub-basin H; Rio Grande. In general, basins located within sub-region Altos Santiago they are classified as in balance, most of them with abundance classification and availability. There is not accurate data containing characteristics of the sub-basin covered by SAR.

**Table IV.6. General Characteristics of Balance and Availability in Sub-Region Alto Santiago (CAN 2002) (Res/Waters AB volumes reserved for down basins)**

Water Condition (hm <sup>3</sup> /year)	Alto Santiago
Surface (km <sup>2</sup> )	34,665
Offer	8,268
Extractions	1,467
Res/Waters AB	1,734
Availability	2.58
Condition	Balance

In the SAR region four tributary rivers drain off, La Alhaja River, (km 6+239), San Francisco River (km 6+764), Santa María River (km 15+189), and El Sauz River (km 15+816). However, in drought season they can reduce significantly their banks. The use of rivers is domestic, agricultural, and as a watering place.

Draining pattern is dendritic, where these rivers are usually fed by some sporadic streams. Freshets are torrential, and draining off is turbulent. Nevertheless, there is no accurate data of expenses and of draining of volume.

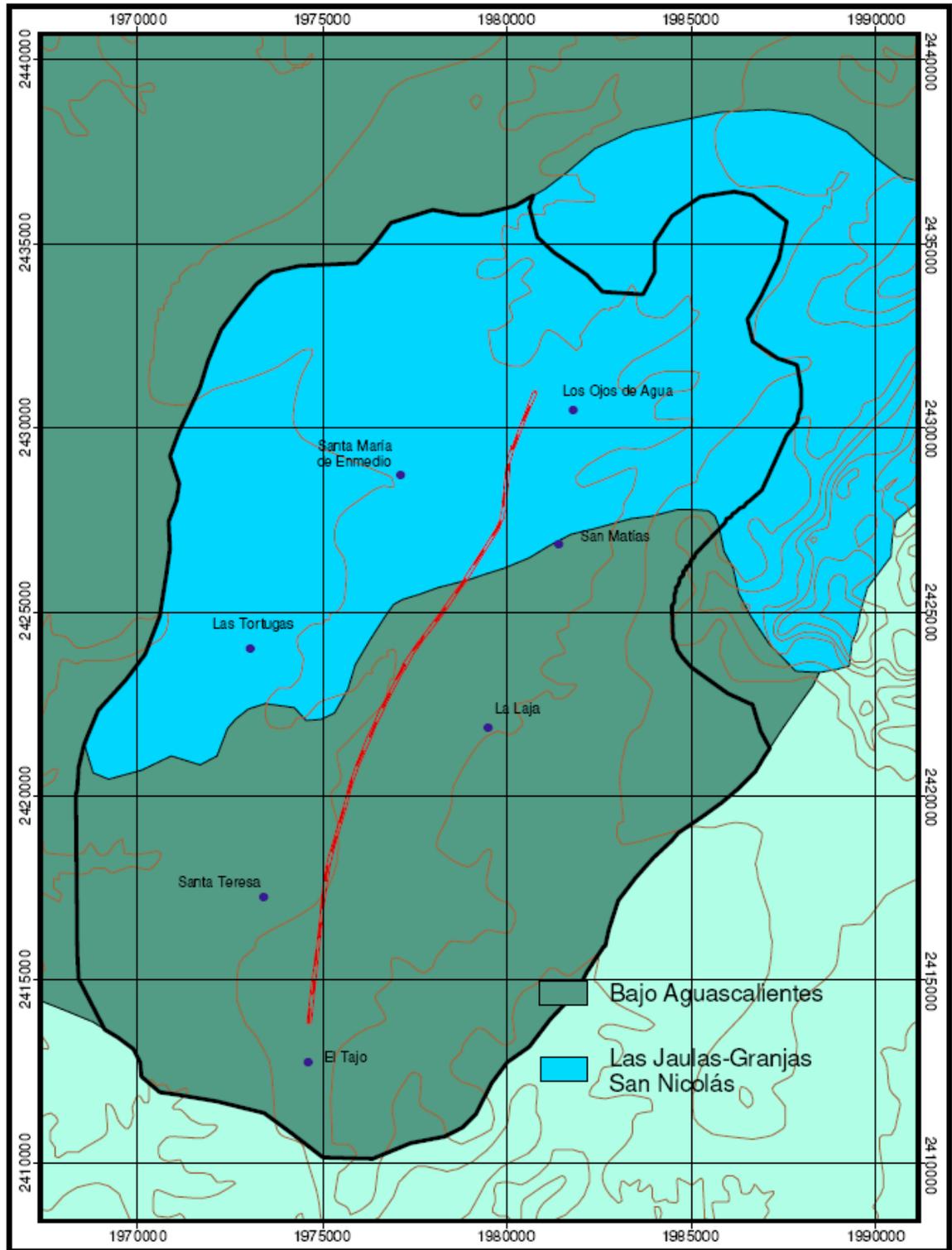


Figure IV.7. Sub-basins where SAR is settled (draining off can be consulted on Figure IV.2)

**Table IV.7. Aquifers within Influence Area of the Project.**

<b>Aquifers</b>	<b>Surface within SAR</b>
Lagos de Moreno	4,696
Encarnación	30,906

A detailed description of superficial and underground hydrology is given below:

b) Underground Hydrology

The limited area is settled in two geo-hydrologic units: Zone 9 Lagos de Moreno (Lagos de Moreno aquifers), and zone 10 Altos de Jalisco (Encarnación aquifers), as part of the Neovolcanic Belt (Figure IV.8, Table IV.8). Lagos de Moreno aquifers is formed by gravel fillings, sand, and tufa, constituting a semi-confined and free aquifers in certain zones and it overlays another aquifers in extrusive rocks (basalt and andesite), and they present secondary permeability due to fracturing. Encarnación aquifers ranges from free to semi-confined type, the latter due to a predomination of clay packages over gravel and sand, educing permeability on the upper layer. For both aquifers there is any kind of closed season. Likewise, because of structural and geologic conditions, they manage to create a defense against infiltration of pollution agents into the subsoil; therefore, to the water stored within. Specifically for the Encarnación Aquifers, depth is a relevant protection factor. This due to the fact that the levels located in the zone are the deepest of the entity, because with the Aquifers located in an elevated plateau of about 100 m over their surrounding valleys, it turns out that the deep pool are located with levels of 100 and 130 m depth.

**Table IV.8. Hydrologic Characteristics of Aquifers Directly Involved with the Project.**

<b>Aquifers</b>	<b>Surface in SAR (ha)</b>	<b>Annual Medium Recharge (Mm<sup>3</sup>)</b>	<b>Extraction Volume</b>	<b>Geo-Hydrologic Condition</b>
Lagos de Moreno	4,696	196	93	Sub-exploited
Encarnación	30,906	105	112	Balanced

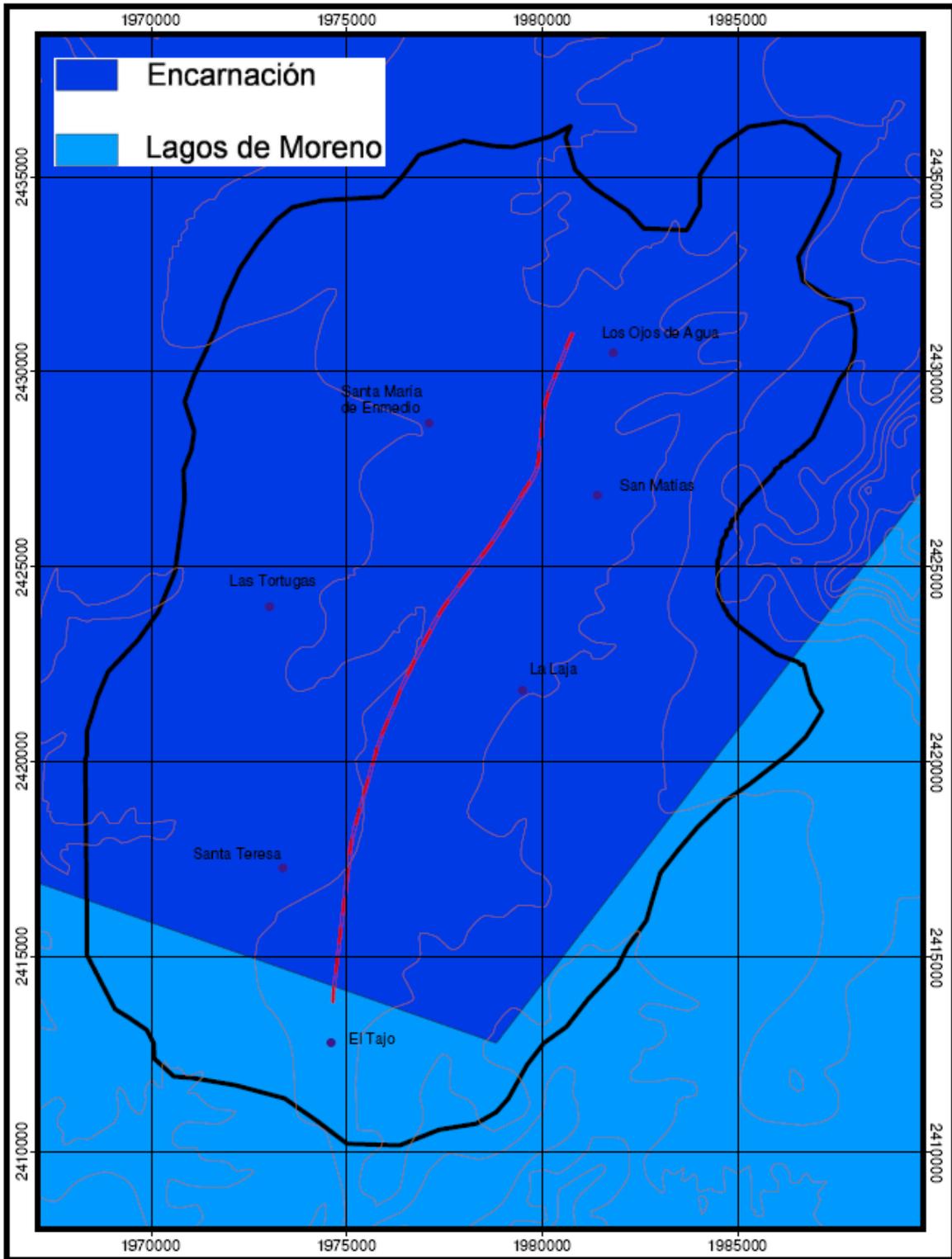


Figure IV.8. Aquifers that the Project Covers

## IV.2.2 Biotic Factors

### VEGETATION

SAR presents 3 types of vegetation, according to Rzedowski's nomenclature (1978). Throughout the sketch native vegetation is alternated with agricultural fields both temporal as well as for irrigation (illustration 1, 3, 5, and 6; 12 a 21, and 26; Appendix 3). These last three, specially of alfalfa (*medicago sativa*).

The types of vegetation found in SAR are:

1. Pastureland (Pastureland-Huizachal) (illustration 3 a; 4; 5, 7 a and b, 13 a and c; 25 b; Appendix 3) in abandoned or resting agricultural fields.
2. Thorn Forest (illustration 15 a; 16 and 18; Appendix 3).
3. Gallery Forest (illustration 17; Appendix 3).

Because of the complexity in the agro-ecologic system that forms an intricate mosaic of native vegetation mixed with agricultural and pasture fields. Cartographically thorn forests and gallery forest shall be included conventionally within Pastureland-Huizachal, since it is the largest plant formation, separated from areas used for temporal agriculture and irrigation agriculture. They shall be taken as well, as a way to estimate areas in terms of vegetation, in comparison with the extension and distribution of agricultural fields.

Pastureland

Rzedowski (1978) describes this type of vegetation conventionally as plant communities where the main role corresponds to grass, also known as Zacatal.

Among these variants we have both those communities where grass, along with other herbaceous species is the only participant. Without participation of woody species, or those formations where woody elements play an important role within pastureland, without losing the latter its identity as ecologically differentiated community from scrublands or other types of vegetation.

According to a field investigation performed, the pastureland variant found on SAR is pastureland with *Acaica schaffneri* (Pastureland-huizachal). This community is the most characteristic of the Altos de Jalisco region formed by an herbaceous carpet where the preponderant role is played by grass; however, in SAR because of extensive cattle raising, Chinese huizaches population is increasing due to seed distribution when cattle eats pods. Another type of species also found their habitat frequently in pastureland accompanying *Acacia schaffneri* (Chinese huizache), is different prickly pear species (*Opuntia* family) (illustrations 8-9; Appendix 3); among which it is important to highlight: *Opuntia icterica* (black cactus), *Opuntia joconostle* (joconostle, xoconostle) and *Opuntia streptacantha* (cardon cactus). In a more sporadic way it was observed in *Opuntia robusta* (plug cactus).

Individual emerging mezquite are also mixed with pastureland. *Proropis laevigata*, illustration 14; Appendix 3) but they do it in an ecotonic way, for in certain areas with deep soils groves of mezquite are established, forming thorn forests, already relictual, as we will see later on.

Another specie that we found is a combination of big bushes or little trees, depending on their age, that are also found sporadically or forming restricted set, sometimes apparently covering the most disrupted areas. Among these species we have the "farmer" *Forestiera phyllireoides* and the sweet stick or sweet pole, *Eysenhardtia polystachya*. *Cowania Mexicana* also participates and we can also find sporadically huizache individuals (*Acacia farnesiana*), specially associated to roads (Illustrations 10-11; Appendix 3).

An interesting case is the presence of small populations or lonely little trees of táscate or little cedar, *Juniperus erythrocarpa* (illustrations 11 a and 20; Appendix 3), a conifer that usually, as most species of the same family, share biotopes with the flora located in arid zones as well as semi-arid zones.

A shrub-like stratum to all lights secondary is formed by a dense community of individuals of garruño, garabatlillo or cat's nail, *Mimosa aculeaticarpa* is confised among the communities of the first. In particular, the first one forms dense scrublands that hinder transit and modify pastureland appearance in such a way that they make it look like a secondary scrubland.

In the Herbaceous stratum there is a great variety of grass species. The dominants in such communities are *Bouteloua filiformis*, (Navajita), *Hilaria cenchroides*, *Lycurus phleoides*, *Buchloe dactyloides*, *Tripogon spicatus*, *Muhlenbergia rigida* (Popote) and, in less proportion a *Bouteloua gracillís*, *B hirsute* (Navajitas).

Several species favored by the disturbance are non-grass herbaceous species. Within these we can find: wormseed, *Chenopodium graveolens*, *Astragalus mollissimus*, *Ipomoea stans* (Tumbavaquero), *Stevia serrata* (curd cheese), *Baccaris pteronioides* (Barrendero), *Polygala glochidiata*, *Zornia diphylla* (Snake's herb), and *Zinna peruviana* (maize) and *Zanvitalia procumbens* (Chicken eye).

A usually and sometimes inevitably associated, it seems, to Chinese huizaches is the climber known as *Clematis dioica*, also known as goat's beard, that always grows laid on *Acacia schaffneri* branches, covered from the base of huizache branches.

It is common, on the other hand, to find the epiphyte known as hey or gallito, *Tillandsia recurvata* (Illustration 10a; Appendix 3) on the branches of the huizaches or the mezquites and sometimes in the trunk of the cactus.

The impact of human activities especially in this type of pastureland is very noticeable. There are large areas dedicated to growing and cattle raising is carried out in terrains covered by natural vegetation, which, according to our observations, is suitable for growing of abundant thorny bushes (*Mimosa spp.*) and other secondary herbs that substitute original grass and that hamper the transit in the pastureland (illustrations 7 and 19; Appendix 3) from both people as well as the cattle itself. This kind of impact was predictable due to extensive cattle raising practiced in the area since the Colonization, because since then, the vocation of pasturelands of the area established for cattle raising turned the region of Los Altos into one of the most important milk regions of Mexico (Illustration 40 a; Appendix 3).

For this type of vegetation an analysis of the horizontal structure was performed by means of a quadrant sampling. Such analysis is located at the end of the flora section in this same chapter and also the method as well as its reach is explained in Appendix 6. The two remaining types of vegetation are only represented by relicts, which makes it non feasible to apply a representative sampling to them.

#### *Spiny forest*

This type of forest located within SAR is formed by *Prosopis laevigata*, colloquially known as Mezquite. Therefore, it can also be known as mesquite wood (Illustrations 15,16, and 18; Appendix 3).

Throughout the sketched projected and same as it is in the rest of the country, this type of vegetation, characteristic of alluvial terrains (edafic climax) with deep soils very useful for agriculture has been nearly eliminated and there is only few little enclaves with continuous vegetation; however, in most cases we find isolated trees or skirting roads and growth small farms. So, certainly they used to form much wider populations that were dismantled for agricultural works, and also they were taken advantage of as a source of wood, firewood, and coal.

The undergrowth of this type of vegetation when disturbed (as in the case of SAR) is also formed by bushes characteristic of pastureland and given the fact that there is no tangible difference between the preferences of Chinese Huizache for low depth soils or for slightly deep soils. This comes to form a medium stratus in spiny forest communities opened because of the disturbance. Likewise the *Opuntia* species mentioned before also participate in such stratus.

It is important to remember that the spiny forest is a type of vegetation by edafic climax and; therefore, the difference between biotopes that occupies, as well as those occupied by pastureland only rests on soil depth. This makes that spiny forest is particularly used in soft slopes towards stream banks and in hollows where alluvial fans serve as deposits for deeper soils. Out of these areas mezquite is ecotonically mixed with pastureland, which in many occasions has been misunderstood taken as a typical part of pastureland.

### *Gallery Forest*

This is the term used to name arborous communities that exist throughout meadows and riverbanks as well as permanent or semi-permanent streams, and that in this sense they can be of specific heterogeneous structure depending on region, climate, and topography. In semi-arid areas such as the one subjected to the present study, it is common that gallery forests stand out from surrounding vegetation. In this sense, Sabinos or Ahuehetes forests (*Taxodium mucronatum*) are common. In other cases, species from *Populus* gender (Poplar) form some variations of the Gallery Forest.

In SAR, the Gallery Forest found in here is formed by *Salix bonplandiana* (Illustration 17; Appendix3), and it was the one with the least representation. Species such as *Baccharis salicifolia* (Cistus) and *Senecio salignus* (Cistus) can be commonly found in the undergrowth.

This vegetation is mainly sustained by El Sauz stream, and also by Santa María stream.

### **Structural Analysis of Vegetation.**

This part refers only to pastureland and its ecotones with spiny forest for its is the vegetal association with more abundant wild elements and with a more continuous covering in SAR. An structural analysis was performed related to horizontal spatial parameters in the superior stratus. For this purpose, quadrants were performed throughout the sketch in the following six sites:

- Site 1: Coordinates UTM 13Q 785404, 2357222
- Site 2: Coordinates UTM 13Q 785689, 2360186
- Site 3: Coordinates UTM 13Q 786024, 2361662
- Site 4: Coordinates UTM 13Q 787040, 2365913
- Site 5: Coordinates UTM 13Q 789503, 2369951
- Site 6: Coordinates UTM 13Q 789915, 2372684

In each site 5 quadrants were performed randomly for a total of 30, using a vegetation sampling method known as Quadrants Centered on one Point Method (Table IV.9).

**Table IV.9. Results of Natural Vegetation Sampling of Pastureland with *Acacia schaffneri* and Ecotonic Elements of *Prosopis laevigata* Regarding Spiny Forest**

Species	Number of Sampled Individuals: 120		Medium Distance Between Individuals: 6.68m			Total Absolute Density: 224.11 Individuals / Ha			Value of Importance	
	No. of Trees / Species	No. of Points with Species	Medium Height (m)	Medium A.B. (D.A.P.)* in cm	Do-A*	F-A*	F-r*	De-r*		Do-r*
<i>Acacia schaffneri</i>	93	30	2.91	23.1	2139.0	100.0	54.55	77.5	74.69	206.74
<i>Forestiera phyllireoides</i>	3	3	2.25	27.3	81.9	10.0	5.45	2.5	2.86	10.81
<i>Juniperus erythrocarpa</i>	1	1	4.0	31.0	31.0	3.33	1.81	0.83	1.08	3.72
<i>Opuntia joconostle</i>	2	2	2.2	25.5	51.0	6.66	3.63	1.66	1.78	7.07
<i>Opuntia icterica</i>	7	5	3.85	25.85	180.95	16.66	9.08	5.83	6.31	21.22
<i>Opuntia streptacantha</i>	2	2	2.6	22.5	45.0	6.66	3.63	1.66	1.57	6.86
<i>Opuntia robusta</i>	1	1	1.40	30	30	3.33	1.81	0.83	1.04	3.68
<i>Prosopis laevigata</i>	11	11	5.46	27.72	304.92	36.66	20.0	9.16	10.64	39.8
	120						100.0	100.0	100.0	

\*Do-A = Absolute Dominance, F-A = Absolute Frequency, F-r = Relative Frequency, De-r = Relative density  
Do-r = Relative Dominance, A.B. = Basal Area, D.A.P. = Chest Height Diameter  
Sampling included only superior stratus.

A total of 8 species were recorded within superior stratus of pastureland (Table IV.9), with a medium distance between individuals of 6.68 m. This gives a total of 224.11 individuals per Ha. The Species with the biggest relative density, as expected, was *Acacia schaffneri* with 77.5, followed by *Prosopis laevigata*, with a relative density of 9.16 ind/Ha and *Opuntia icterica* with 5.83 ind/Ha. On the contrary, species with the least representation were *Juniperus erythrocarpa* and *Opuntia robusta*, both with relative density of barely 0.83 ind/Ha.

Out of the sampling results it is also estimated that species with most value of importance are the species with more density, this result is not only because of abundance, but also as a sum of their relative frequency, relative density, as well as relative dominance, reaching the highest value we have *Acacia schaffneri* with 206.74 points, then *Prosopis laevigata* with 39.8 points and in third place *Opuntia icterica* with 21.22 points. Said value of importance means a greater number of individuals (high density), which shows a good adaptive strategy, and also a higher frequency denotes an evenly distributed reproduction, while dominance, derived from heftiness or biomass of the specie means a good use of alimentary resources both spatial, along with an ecophysiological efficiency, becoming evident in a dominance over species of lower importance, which is to say, species with greater value of importance work as controlling species in the ecosystem, to which, other vegetal species are coming before. In a wider sense, they are the most direct responsible of the vegetal formation definition (type of vegetation) and of the landscape.

The fact that huizache (*Acacia schaffneri*) has a value of importance up to 7 times greater to the one following it (Table IV.9), indicates a strong disturbance in SAR, where cattle is the main responsible, due to the fact that cattle eats huizache seeds and distributes them across SAR at the expense of original associations where the specie with the highest value of importance should be the Mezquitee (*Prosopis laevigata*).

### State of Preservation of the Vegetation

Evident fragmentation of habitat is one of the clearest indicators of the state of preservation of the area subjected to study. In SAR, dominant association is Pastureland – Huizachal with a 61% of the area. This association is interrupted by agricultural fields (39%) (Table IV.10). It has to be estimated that basically all areas with native vegetation are dedicated to pasturage or that they are used for woody resource extraction. Therefore, there is a whole series of variants that impact pastureland – huizachal.

**TableIV.10. Distribution of the Vegetation within SAR.**

Vegetation	Surface	Percentage in SAR
Set corresponding to Pastureland-Huizachal	21,962.31 Ha	61%
Temporal Agriculture	10,001.69 Ha	26.5%
Irrigational Agriculture	4,281.30 Ha	12.5%

The erosion existing over the unit of erosive ramp at mountain foot (over the xerosol) it is due, among other factors to clearance (Illustration 40 b; Appendix 3) and to wood chopping, but above all, to the practice of extensive and intensive cattle raising; because over-pasturage takes the vegetal covering off the soil (Illustrations 24, 25 a and 40 c; Appendix 3). This lack of vegetal covering is what allows soil washing because of raining and this cause an immediate and unrecoverable loss, having a loss in the capacity to maintain a vegetal covering in detriment, the ecological processes, and its own resilience capacity of the ecosystem as a consequence. This means a dreadful state of the ecosystem. In contrast, because of cattle raising itself, there are areas of natural vegetation used as pasture fields, densely populated by *Mimosa monancistra* (Garruño or Garabatillo) scrublands in such a way that it makes difficult to access these areas (Illustrations 7 and 19; Appendix 3). These dense populations, induced by cattle raising along with other weeds also induced by antropic causes, modify the original vegetal covering of the pastureland, replacing original grass, in such a way that herbivorous animal populations such as Lagomorfos are affected by the reduction of their feeding areas. This causes that said animals search for alternative sources of alimentation, which is substituted by local crops (among others there is Lucerne, (*Medicago sativa*), specially all of those maintained by irrigation. Perhaps that is the reason why rabbit and hare populations, but specially the latter, show an acceptable size.

#### Use

*Prosopis laevigata* is used as timber-yielding specie.

*Acacia schafneri* and *Prosopis laevigata* are used for wood and coal.

*Opuntia streptacanta* is used as edible (vegetable).

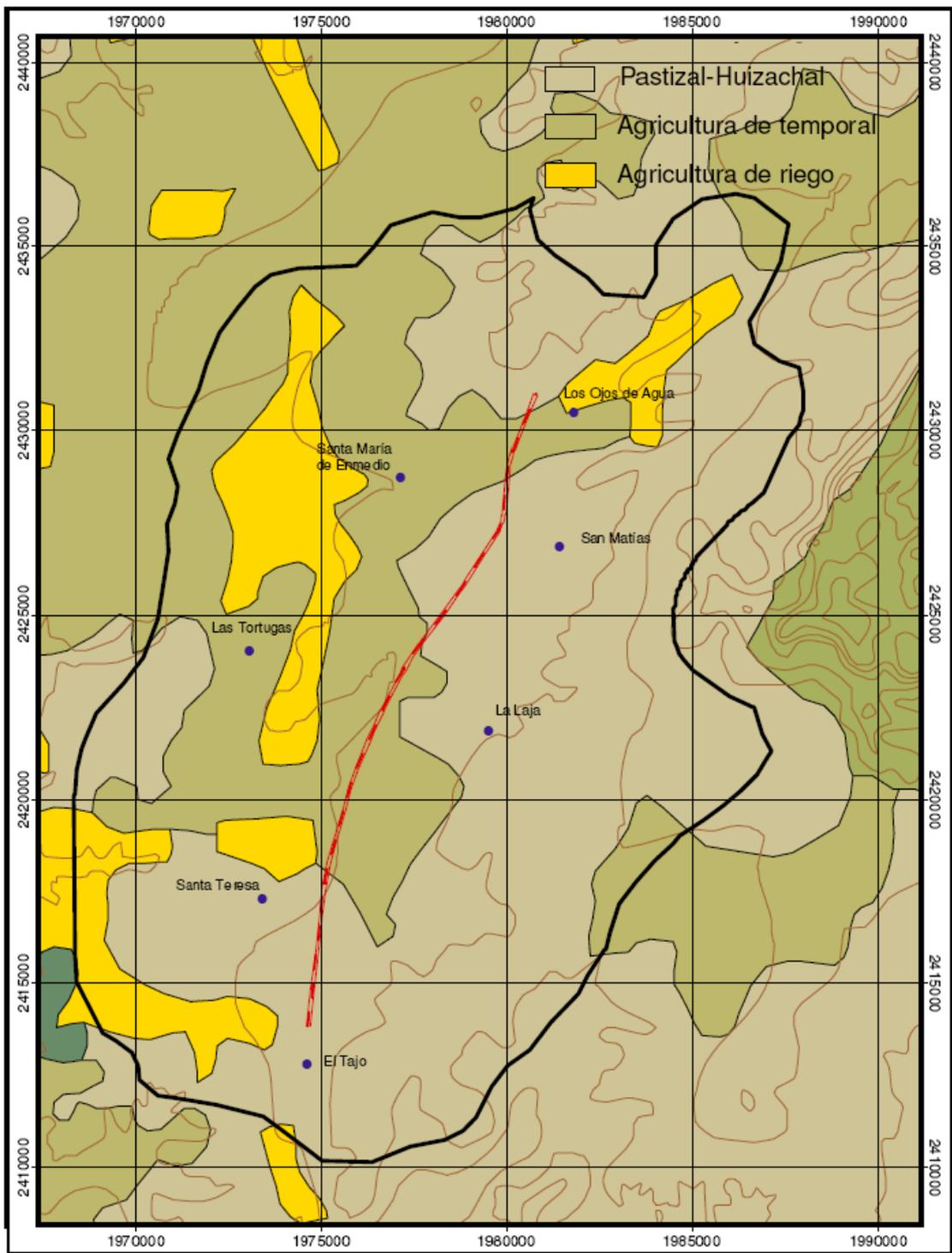
*Opuntia joconostle* is used as medicine and as edible (condiments).

There were no vegetal species included in NOM-059-SEMARNAT-2001:



Construction of the San Juan de los Lagos- Encarnación de Díaz road.  
Stretch from Km. 0+000 to 18+ 636. 443





**Figure IV.9. Vegetation located in SAR**

### Vegetation by Stretch in the Sketch of the Project

Finally, a description of the vegetation growing over the right of way was performed. The distribution is indicated in the design of vegetation patches and its alternation with agricultural fields. (Table IV.11)

**Table IV.11. Description of the Vegetation in the Right of Way by Stretch**

Stretch	Vegetation
Km 0 + 000 – 0 +560	Achual in resting agricultural field.
Km 0 + 560 – 0 +925	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and scarce elements of <i>Prosopis laevigata</i> and <i>Forestiera phylloreoides</i> . Abundant <i>Mimosa monancistra</i> due to extensive cattle-breeding.
Km 0 + 925 – 1 +540	Agricultural fields
Km 1 + 540 – 2 +400	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and scarce elements of <i>Forestiera phylloreoides</i> . Abundant <i>Mimosa monancistra</i> due to extensive cattle raising.
Km 2 + 400 – 2 +650	Relicts of Spiny forest with <i>Prosopis laevigata</i> surrounded by agricultural fields.
Km 2 + 650 – 3 +650	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and scarce elements of <i>Forestiera phylloreoides</i> . Abundant <i>Mimosa monancistra</i> due to extensive cattle raising.
Km 3 + 650 – 4 +370	Agricultural field.
Km 4 + 370 – 4 +385	Gallery Forest of <i>Salix bonplandiana</i> with <i>Senecio salignus</i> , in El Sauz stream.
Km 4 + 385 – 4 +460	Agricultural field.
Km 4 + 460 – 4 +475	Relict of Spiny forest flanked by agricultural fields.
Km 4 + 475 – 4800	Agricultural field until crossing road to Sauz de Ibarra.
Km 4 + 800 – 5 +750	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp. and scarce elements of <i>Prosopis laevigata</i> .
Km 5 + 750 – 6 +900	Agricultural Field
Km 6 + 900 – 7 +340	Pasture field with pastureland remains. Abundant <i>Mimosa monancistra</i> by cattle raising.
Km 7 + 340 – 7 +380	Relict of spiny forest surrounded by pasture fields.
Km 7 + 380 – 7 +450	Pasture field with pastureland remains. Abundant <i>Mimosa monancistra</i> by cattle raising.
Km 7 + 450 – 8 +350	Ecotone of pastureland with spiny forest with <i>Opuntia</i> spp. and abundant <i>Mimosa monancistra</i> because of extensive cattle raising.
Km 8 + 350 – 8 +550	Agricultural field
Km 8 + 550 – 10 +370	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia icterica</i> , and

	scarce elements of <i>Forestiera phylloreoides</i> . Abundant <i>Mimosa monancistra</i> due to extensive cattle rasping.
Km 10 + 370 – 10 +500	Agricultural field.
Km 10 + 500 – 14 +650	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp. and scarce elements of <i>Prosopis laevigata</i> and <i>Forestiera phylloreoides</i> . Abundant <i>Mimosa monancistra</i> because of Extensive cattle raising.
Km 14 + 650 – 14 +850	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp. with scarce elements of <i>Juniperus erythrocarpa</i> .
Km 14 + 850 – 15 +460	Agricultural fields
Km 15 + 460 – 17 +100	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp. and abundant <i>Mimosa monancistra</i> .
Km 17 + 100 – 18 +600	Pastureland with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp. and abundant <i>Mimosa monancistra</i> in degraded areas with strong water erosion by impact of cattle practices.
Bank of Material 1 El Sauz.	It is a bank to be explored and it is located in an highly degraded environment because of cattle activities, with severe water erosion because most part of the vegetal covering has been removed and the soil has been erode by pluvial effects. Vegetation located in this area is Pastureland with <i>Acacia schaffneri</i> (Chinese huizache) highly degraded and it includes some individuals of <i>Mimosa monancistra</i> (Gabarabatillo, Garruño) and <i>Opuntia icterica</i> (Black cactus).
Bank of Material 2 Los Cuartos	It is a tepetate bank used more frequently, with an approximate depth of 12 meters. It is surrounded in its limits east, south and west by relictual vegetation of Pastureland with <i>Acacia schaffneri</i> (Chinese Huizache) with some associated individuals of <i>Eysenhardtia polystachia</i> . In the northern part of bank a Spiny forest relict is available with <i>Prosopis laevigata</i> (Mezquite).  Above the slopes and the bank's bottom it has been installed with the discontinuation of some Chinese Huizaches ( <i>Acacia schaffneri</i> ).
Bank of Material 3 El Cerillo	It is a tepetate bank in exploitation. Surrounding vegetation to the bank includes a highly disturbed pastureland, in the south and east mainly with <i>Acacia schaffneri</i> , <i>Forestia phyllireoides</i> (Farmer), <i>Juniperus erythrocarpa</i> (Táscate, little cedric), <i>Mimosa monancistra</i> and <i>Cowania Mexicana</i> (Romero Cedric). To the west is bordered agricultural fields.
Bank of Material 4 El Refugio	It is located in a highly degraded environment by cattle raising, with severe water erosion. Vegetation located in this area is Pastureland with <i>Acacia schaffneri</i> (Chinese Huizache), and also includes <i>Opuntia icterica</i> (Black Cactus), <i>Opuntia joconostle</i> (Joconostle) and <i>Mimosa monancistra</i> (Garaballito, Garuño).

## FAUNA

### Fauna Recorded in Field

There was a total of 37 vertebrate species for SAR in regard to this study: 3 amphibious species, 4 reptiles, 23 birds, and 7 mammals. This is of course a partial study according to the project's frame, for a thorough record of species requires at least a timeframe of one year that includes seasonal fluctuations, local migration, continental migrations, and the time required for a sufficient spatial sampling, plus the correspondent literature reading. In this last regard it is important to say that no information sources for the zone were found; therefore, no more species to the ones recorded in the field study were added. Species were recorded by direct observation or by track evidence (excretas).

### Amphibious

This class includes frogs and toads recorded on streams with permanent waters in SAR. Out of these, an *Eleutherodactylus nitidus* specie frog as well as two toads, one of *Bufo compactilis* and the other, the cutwater toad, *Scaphiopus multiplicatus* were recorded (Illustration 29; Appendix 3)<sup>2</sup>.

### Reptiles

Reptiles were also scarce, only two lizards and two serpents were recorded. The collar lizard (from the group of thorny lizards) *Sceloporus torquatus melanogaster* (Illustration 29; Appendix 3) is a type of lizard classic to be found climbing stone and adobe walls even in urban areas. The other species of lizard, striped gecko, *Cnemidophorus communis* (illustration 29; Appendix 3); is typical of flat areas where it is located near ant holes. It can be found even in the outskirts of urban zones, where scrublands of huizaches as well as other types of bushes and within populations in the clear zones of the margins of river banks. Serpents recorded were amba snakes, one known as Chirriónera, *Masticophis flagellum* and the other, *Pituophis deppei*, the Alicate (Illustration 29; Appendix 3).

It is considered that scarcity of reptiles is because of the strong disturbance in SAR, due to the fact that reptiles have been indirectly affected by human activities; in the case of lizards, for instance, an impact in the vegetation affects insect population and, as a consequence lizard populations, main insect eaters.

<sup>2</sup> The scope of the present study (since it is not a purely faunistic work from a particular group) cannot establish whether the amphibious species and populations in SAR are found in good or bad shape of preservation, but given the fact that most amphibious in Mexico is found in a risk category, it is to be expected that for this region, this situation is not the exception. Only deep studies by groups pertaining ton the area would allow to clear out these details.

## Birds

Birds were the most abundant class in the record (Illustrations 30-35).

As to the habits of recorded animals, we shall mention that bird pigeons, *Zenaida macroura*, the Huihota, *Zenaida asiática*, White Winged Dove and *Leptotila verreauxi*, common partridge dove stand out. These grain eating birds are distributed in all the studied area and they perch over Mezquites). Their nests are built on both cacti as well as in Huizaches and Mezquites.

Another grain eater bird recorded was Cotulí quail, *Colinus virginianus*, scarce due to the pressure of cattle pasturage, for this specie is very sensitive to disruptions in the herbaceous stratum, where it fed. Quail prefers to be safe in herbs and bushes and it rather walk or run, than flying. It nests in the ground, between herbs.

Another evident group of birds is carrion-eating birds as the turkey vulture *Coragyps atratus* and *Aura Cathartes aura*, even though these do not nest in SAR. To this group the Cara Cara or Bone breaker can also be added, *Polyborus plancus*, that besides of feeding of small vertebrates and insects; it likes to feed of small ran over animals; therefore it is common to spot it near roads.

The raven, *Corvus Corax*, was also recorded; it is omnivorous specie that behaves as pray bird, for it hunts small vertebrate.

Other recorded birds include Cuitlacoche, as *Toxostoma curvirostre* and *Toxostoma bendirei*, as well as the Matraca, *Campylorhynchus gularis*, that nest on trees and cactus, among other open areas birds.

In SAR a series of ponds are scattered out (characteristic of the Los Altos region) where rain water is accumulated and in some cases little dams built *ex profeso*, that work as watering place for cattle. Some of these damming are dried during summertime but others remain with water, this favors that during winter season some populations of migratory ducks from various species are seen in them. The ones recorded in this study fell in the following species: *Anas clypeata* (Cucharon Duck), *Anas Americana* (Chalcuan Duck), and *Anas cyanoptera* (brown, blue-winged Cerceta). They can also be found in streams, as the Sauz, where they form little dams in the stream banks.

Two species associated to human beings observed are the conguita, *Columbiana inca*, and the agrarista, *Passer domesticus*, only associated to villages and farmhouses.

Besides:

- *Cathartes aura* and *Coragyps atratus*, aura turkey vulture, and common turkey vulture respectively, inhabit both well preserved environments as well as those already disrupted (conventional urbanist and rara urbanist, respectively according to López, and Gerrero, 2004). Both species were carrion-eaters).
- *Columbina inca*, conguita, was observed only in places within SAR where there is strong antropic activity (it is normal that this bird is never found in well preserved places); therefore it falls into the holourbanist category (López and Guerrero, 2004).
- *Polyborus plancus*, cara-cara, is a bird seen in the vicinity of roads, where there usually are ran over animal corpses, from which, cara-cara is fed.
- *Zenaida asiática* and *Z. macroura*. This two pigeons are spotted flying not too far off the ground, in groups of several individuals, in well preserved places.

Within this group of recorded, 6 species are found in both well preserved environments, as well as disturbed ones; 10 of them inhabit only well preserved environments and 4 of them only inhabit places with a strong antropic activity.

#### Bird Species indicating Preservation State of the Studied Area.

In those located only in well preserved environments and; therefore, indicators of well-preserved areas within SAR due to persistence of superior stratus, they are:

1. *Campylorhynchus gularis*
2. *Chondestes grammacus*
3. *Colinus virginianus*
4. *Corvus corax*
5. *Leptotila verreauxi*
6. *Melanerpes uropygialis*
7. *Passerculus sandwichensis*
8. *Picoides scalaris*
9. *Zenaida asiática*
10. *Zenaida macroura*

The ones living only in places with a strong antropic activity, and; therefore, indicators of disturbed area of study, are:

1. *Columbina inca*
2. *Passer domesticus*

3. *Pipilo fuscus*
4. *Quiscalus mexicanus*

Species found in both well-preserved environments as well as disturbed ones (generalist species); therefore, indicators that the area of study has well-preserved zones as well as disturbed ones:

1. *Cathartes aura*
2. *Coragyps atratus*
3. *Falco sparverius*
4. *Polyborus plancus*
5. *Toxostoma bendirei*
6. *Toxotoma curvirostre*

#### Mammals

Out of recorded mammals, the Lagomorfos stood out, which is to say, rabbits and hares, the first one represented by *Sylvilagus audubonni*, Audubon rabbit and the latter represented by *Lepus callotis*, dappled hare. Both herbivorous, the rabbit nests in warrens, but hares only has its nests between herbs, where it spends hours of warm resting to the shade of bushes. Both species are evident during early hours in the morning.

Grey Fox, *Urocyon cinereoargenteus*, was also recorded, even crossing the outskirts of villages. A habit the Gray Fox has is the fact is that it tends to climb trees (Leopold, 1959); therefore, pastureland huizaches are an excellent resource for them. Guerrero and Zalapa (2004), mention that the Fox is one of the animals that have adapted itself to anthropic influence in such a way that allows them to live in zones where the change of the use of soil has been important, such as in the growing zone. Another canine recorded was Coyote, *Canis latrans*. Both this specie as well as the Fox has been benefit from their habits, because of the presence of urban and growing nucleus.

Other mammals recorded as the listed Skunk, *Mephitis macroura*, and the Tlacuache, *Didelphis virginiana*, are species commonly seen in environments where human activity is more frequent. They are usually spotted crossing roads, or, in the surrounding areas of farmhouses the characteristic skunk smell can be sensed. An additional data about this last animal as well as the Tlacuache is that they are frequently ran over in roads in the field as verified in the roads located in the SAR area.

*Lepus callotis* and *Liomys pictus* dappled hare and thorny mouse respectively are less common in the environments where human activity is stronger.

Of this recorded group of mammals, three species can be found in both well preserved environments as well as in disturbed ones, and the remaining three can be recorded only in half preserved environments.

Mammal species found only in half preserved environments, and so indicating that the area of study is only half preserved are:

1. *Lepus callotis*
2. *Sylvilagus auduboni*
3. *Liomys pictus*

Those found in both well-preserved environments as well as disturbed ones, and so indicating that the studied area has both well-preserved zones and disturbed ones are:

1. *Mephitis macroura*
2. *Didelphis virginiana*
3. *Urocyon cinereoargenteus*

#### Uses

These species are hunted, (according to Leopold, 1959):

- *Lepus callotis*, for human alimentation.
- *Didelphis virginiana*, for human alimentation.
- *Sylvilagus auduboni*, for human alimentation.
- *Urocyon cinereoargenteus*, when populations are abundant, they are hunted because they are predators of farm birds.

#### State of Preservation of Fauna.

In general terms an according to the fauna recorded in the present study. Its composition indicates a mixture of habitat conditions that go from what is regularly preserved to what is decisively deteriorated by anthropic activities. It is a fact that some species like the Coyote, the Tlacuache, and the Gray Fox seem to benefit from modifying activities of the human being over ecosystems, especially when they are transformed into agro-ecological systems. Pigeon abundance is considered as an indicator of an acceptable state of the herbaceous covering, supplier of grains. However, it must be considered that fragmentation of habitat is a factor of strong pressure on the most sensitive species like rabbits, hares, and birds such as quails.

Animal species were not spotted in SAR, included in NOM-059-SEMARNAT-2001.

#### Interactions between Flora and Fauna in SAR

In general within SAR, interaction between flora and fauna are kept. We find an ecosystem in which there is still interaction between flora and fauna establishing relationships that can be enunciated in general terms in the following way:

1. Trofic chains Flora-Fauna-Flora
2. Distribution of seeds by vertebrates.
3. Habitat for fauna
4. Predation-Control of populations (Fauna-Fauna-Flora)
5. Vegetal architecture supporting the Fauna (perch for birds).

### IV.2.3. Landscape

Landscape analysis, for a long time has been subjective, mainly because landscape studies were founded in European studies. Unfortunately, these cannot be applied to landscapes in all the different types of American landscapes where physical, biologic, and social conditions are completely different (Forman and Godron, 1986). It is for this reason that in the last 20 years there has been an attempt of establishing methods that allow evaluating landscapes objectively in different landscape conditions. For the present project the methods established by Forman and Godron were used (1986) for American Landscapes. The following landscape description of SAR is divided into two parts: quality of scenery and fragmentation (deterioration).

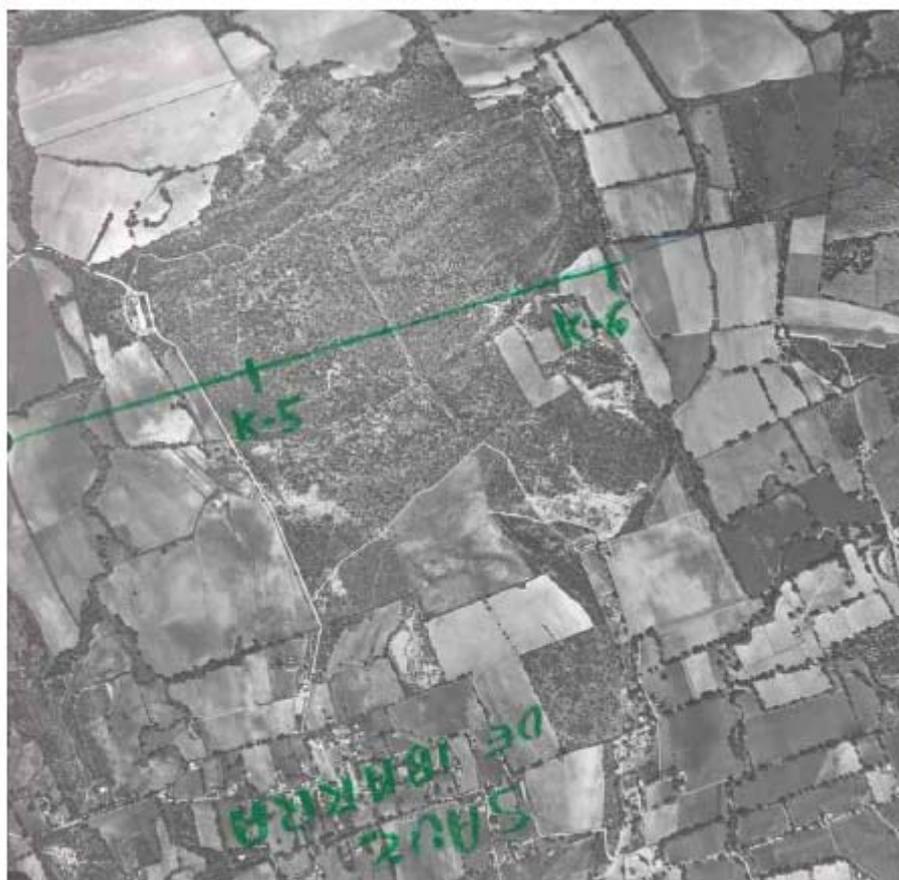
In first place, quality evaluation of scenery within SAR involved the state of preservation. For this, a field work was performed where vegetal covering was analyzed. Of this it was determined that the quality of scenery within SAR rates from medium to low, because it is an area with highly disturbed zones with crops and pasture fields. The only remaining of natural vegetation are isolated and located much as the Gallery Forest, that can be found in humid areas associated to streams.

In second place, we have fragmentation analysis in which two scales were evaluated, regional (SAR), and local (project sketch). For it, photographs were used of the actual SAR region, and also a field tour. By extension, the matrix of the area was of the studied area was classified as growing areas, pasture fields, and induced pasturelands, while patches were considered to semi-natural covering of the area (gallery forest, huizachal, and mesquite woods). The results of the analysis were the following:

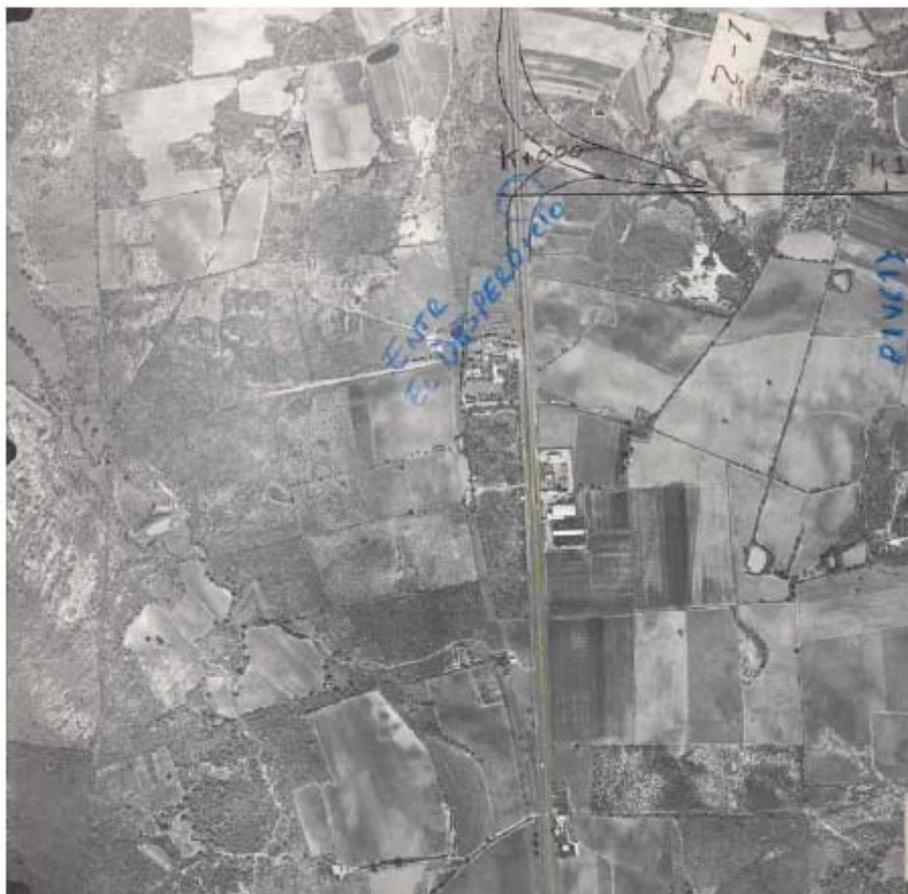
At a landscape level (SAR) there is only one zone where a situation of high preservation of mezquite equivalent to approximately 2 Ha (that it is not affected by the sketch) is seen. Gallery Forest cannot be appreciated in a regional scale. There are only vegetation relicts of induced pastureland, frequently combined with shrub-like species for cattle raising (this is 20,961 Ha) in the remaining area. Last, with a total of 14,639 Ha, there are areas for temporary and permanent growing (Figure IV.10).

In brief, fragmentation analysis indicates that SAR is a semi-altered landscape, with considerable anthropogenic intervention, where patches are only remainders of low-connectivity vegetation. In terms of preservation, SAR could be considered as a highly fragile landscape for natural communities, mainly for relict or specific zones such as the

Gallery Forest. Instead, in anthropogenic terms, this landscape presents disturbance factors that can increase fragmentation, and to degrade the landscaping value of the region even more.



**Figure IV.10 Aerial Photograph of a SAR fraction where the Vegetation Patch of the Projectlocation is shown.**



**Figure IV.11. Aerial Photograph of Growing Areas within SAR.**

#### IV. 2.4. Social Environment

Construction of the road stretch of this project is located in two municipalities of los Altos de Jalisco. The majority of SAR (58%, 14, 792 Ha) is located within the Encarnación de Díaz municipality jurisdiction, and only 42% (20, 811 Ha) in the San Juan de los Lagos jurisdiction. The social environment analysis was performed at municipal scale, due to lack of information at the locality level. Nonetheless, certain exceptions were made in cases like demography. In all cases, bibliographic information analysis was put in context with the field observations

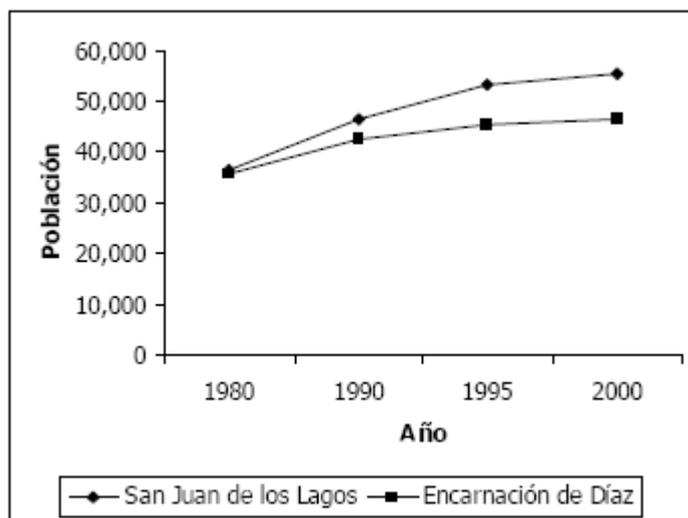
#### DEMOGRAPHY

SAR registers a total of 75 localities, out of which 73 are located in the Encarnación de Díaz municipality, and 52 in the San Juan de los Lagos municipality. Out of the localities contemplated by SAR, Santa María Transpontina, Santa María de Enmedio, and Santa Bárbara stand out, due to their size. Totally, the SAR population is of 7,172 inhabitants, out of which 43.95% live in the afore mentioned localities. Considering the two main localities with 1,000 inhabitants, the population they concentrate sums up to 33.78%. The 16 localities that range between 1,000 and 100 inhabitants represent 47.31% of the SAR population, while 18.91% of the population is represented by the remaining 57 localities. (See Table IV. 12).

**Table IV. 12. Population Distribution within SAR**

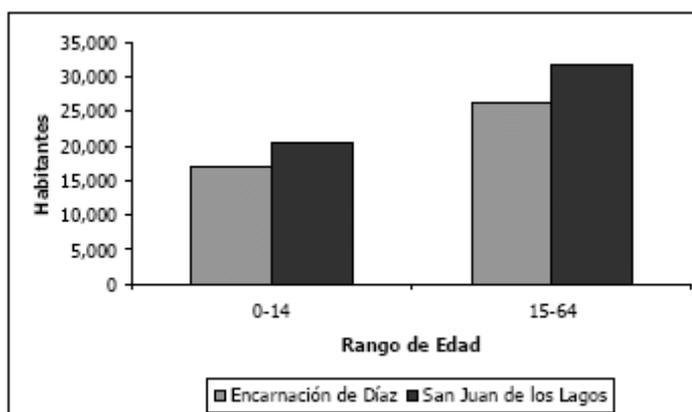
Municipality	Locality	Population
Encarnación de Díaz	Santa María Transpontina	1, 296
Encarnación de Díaz	Santa María de Enmedio	1, 127
	16 villages ranging from 100- 1,000 inhabitants	3, 339
	57 villages under 100 inhabitants	1. 356
<b>Total</b>		<b>7, 172</b>

In the last 30 years, the Encarnación de Díaz municipality population has remained stable. In fact, in the 1995- 2000 period the annual growth rate decreased from 1.4% to 0.9% (Figure IV. 12). The San Juan de los Lagos municipality had a growth rate decrease from 2.8% (during the 1990- 1995 period) to 1.8% for the 1995- 2000 period). Furthermore, it is classified in the expulsion migratory category. On the other hand, Encarnación de Díaz, despite showing a similar behavior, has not shown a dramatic population reduction, and so its migratory category is Balanced.



XII 2000 General Population Census, INEGI  
**Figure IV. 12. Demographic evolution of the Encarnación de Díaz and San Juan de los Lagos municipalities**

According to the age distribution of the population, SAR and the state have shown that the average population in the range of 15 to 64 years of age exceeds by 20% the 1 to 14 population. In a comparison of both municipalities, the age range of 15- 64 years of age is slightly higher for San Juan de los Lagos. For Encarnación de Díaz, the age range 0- 14 is very low in comparison to the other municipality, and the state. (Figure IV. 13.)



XII. 2000 General Population Census, INEGI

**Figure IV. 13. Demographic evolution of the Encarnación de Díaz and San Juan de los Lagos municipalities**

In terms of the population density, Encarnación de Díaz has registered 35. 79 inhabitants/ km<sup>2</sup> in 2000, which means that in a 30 year period an increase of 8. 36 inhabitants/ km<sup>2</sup> has occurred, generating an unpopulated area. On the other hand, San Juan de los Lagos had a reported population density of 63. 24 inhabitants/ km<sup>2</sup> in 200, with a population increase of 21. 42 inhabitants/ km<sup>2</sup> in the last 30 years. However, it must be considered that part of the population migrates to other cities, like Guadalajara.

The municipal seat and major cities of the municipalities concentrate the population and services. The population weight of the municipal seats is significantly higher in San Juan de los Lagos with 76. 68%. On the other hand, Encarnación de Díaz has 44. 74%. As refers to SAR, the population weight of the municipal seats has no impact. Nonetheless, the Encarnación de Díaz municipality presents the greatest number of localities (358), while the San Juan de los Lagos municipality has 241.

### INDIGENOUS POPULATION AND MARGINALIZATION

According to the National Population and Housing Board, the Encarnación de Díaz and San Juan de los Lagos municipalities are of low marginalization, and are located on the 1, 790 and 2, 030 places respectively in the State of Jalisco (Table IV. 13.) Note must be taken that the public services tend to be concentrated in the municipal seats, as well as education and the third sector jobs (mainly related to the development of worker capabilities), so that for several small localities the marginalization level is higher than that corresponding to the municipality.

The indigenous population of the municipalities is scarce, with values under 1% for both of them (Table IV. 13). The Encarnación de Díaz municipality has Mixteco as the main indigenous language, while Purepecha is the predominant one in San Juan de los Lagos. Due to the nature of the project no direct relation is forecasted between the activities of the project and the conditions of the indigenous inhabitants.

**Table IV. 13. Marginalization and indigenous population per municipality in SAR**

Variable	Municipality	
	Encarnación de Díaz	San Juan de los Lagos
Marginalization	Low	Low
Place, entity	1, 790	2, 030

<b>Municipality</b>		
<b>Variable</b>	<b>Encarnación de Díaz</b>	<b>San Juan de los Lagos</b>
Index	-0. 713	- 1. 09
Indigenous population <sup>3</sup>	0. 19%	0. 25%
Languages	Mixteco	Purépecha

Municipal Information System 200

### SOCIAL DEVELOPMENT

#### *Housing*

The number of houses in both municipalities is proportional to the number of inhabitants. For both municipalities the average is of 4 inhabitants/ house (table IV. 14). Regarding household services, the potable water coverage percentage is higher in San Juan de los Lagos (10. 65%) than in Encarnación de Díaz (5. 51%). Similarly, regarding piped water supply, San Juan de los Lagos has an average of 3.88%, while Encarnación de Díaz has 2.06%. In the case of drainage, both municipalities have similar coverage values for said service. Finally, the electrical power values are also very similar. Generally speaking, both municipalities have services of excellent quality, and both are self-sufficient.

**Table IV. 14. Household characteristics for SAR municipalities.**

<b>Municipality</b>		
<b>Variable</b>	<b>Encarnación de Díaz</b>	<b>San Juan de los Lagos</b>
Piped water	199	435
Houses with potable water	731	1, 194
Houses with drainage	7, 819	9, 676
Houses with electrical power	8, 966	10, 794

#### *Education*

The San Juan de los Lagos municipality has 144 schools, while Encarnación de Díaz has 131. Generally speaking, this covers the educational infrastructure required by the population. Regarding literacy, the San Juan de los Lagos population has a greater number of literates.

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<sup>3</sup> – 5 years and older indigenous language speakers.

Nonetheless, the number of illiterates in both municipalities is similar. It is necessary to consider that having a greater population, San Juan de los Lagos has relatively fewer illiterate inhabitants than Encarnación de Díaz, which has a smaller population (Table IV. 15).

**Table IV. 15. Illiterate population**

Variable	Municipality	
	Encarnación de Díaz	San Juan de los Lagos
Literates	25, 442	30, 817
Illiterates	3, 505	3, 544
Elementary education facilities	69	79
Secondary education facilities	16	15

#### *Health*

Regarding health services, both municipalities have ISSSTE, IMSS, and SSJ services. Only San Juan de los Lagos has DIF services (Table IV. 16.) Both municipalities have several private clinics. Nonetheless, no specialty services are offered, due to which emergency patients are transported to Guadalajara.

**Table IV. 16. Medical units of the public health sector institutions.**

Type of service	Medical unit	No. of Medical Units per Municipality	
		Encarnación de Díaz	San Juan de los Lagos
		Social Security	IMSS
	ISSSTE	1	1
Social Assistance	SSJ	7	3
	DIF	-	2
Total		9	7

#### *Accessibility*

SAR municipalities are distributed on the space existing between federal road No. 45 and 80. Both municipalities have trunk federal roads, and Encarnación also has a rural path- type road. Said municipality has a greater road infrastructure than San Juan de los Lagos (Table IV. 17). Lack of communication may cause significant delays in terms of production, economy, life quality, and wellbeing.

**Table IV.17. Length in kilometers of the road network by type of road**

Type of road	Specific characteristic	Municipality	
		Encarnación de Díaz	San Juan de los Lagos
Federal Trunk		36	16.70
Rural roads	Coated	2.60	--
Total		48.60	16.70

Statistics Year Book – Jalisco 2004. INEGI

### ECONOMIC DEVELOPMENT

The employed population data by sectors indicate that at Encarnación de Díaz the population is balanced in three sectors, slightly inclined to the secondary sector which is equivalent to 33.33% in total of the EAP. On the contrary, at San Juan de los Lagos, the dominant sector is the tertiary, with more than 58% of the active EAP (Table IV.18). Regarding the number of inhabitants in the active EAP, in the two municipalities the primary sector is similar. However, regarding the total number of active EAP for each municipality differences are large, since for Encarnación de Díaz it is equivalent to 32.09%, and at San Juan de los Lagos it only represents 18%. Both municipalities have employment offer, due to the cattle raising and textile industries, since the former has been flourishing there. In general, the economy of the SAR is good, there are people coming from other states (such as Aguascalientes) to work in the area.

**Table IV. 18. Distribution of Economically Active Population by sectors at the SAR**

EAP Percentage	Encarnación de Díaz	San Juan de los Lagos
Primary sector	4,981	3,690
Secondary sector	5,173	4,230
Tertiary sector	4,946	11,658

Table IV.19 clearly shows that the EAP employed in primary activities is targeted at agriculture, mainly cattle raising, with 32.30% for the municipality of Encarnación de Díaz, compared to San Juan de los Lagos where the largest percentage is in trade. As it can be seen, differences are every time more clear between the municipalities, mainly in economic development. Even though, the municipalities are considered as self-sufficient and with good economic level.

**Table IV.19. EAP by activity area. (XII 2000 General Population Census, INEGI)**

Activity	Encarnación de Díaz	San Juan de los Lagos
Agriculture, cattle raising, forest exploitation, fishing and hunting	4,981	3,690
Manufacturing industries	3,678	2,390
Trade	2,071	5,713
Construction	1,467	1,788
Hotels and Restaurants	492	1,769
Transport, mail and storage	295	639
Government activities	221	320

Healthcare and social care services	165	271
Professional services	118	185
Recreational and cultural services	80	154
Financial and insurance services	29	84
Mass media	20	49
Power and water	18	25
Real Estate Services	14	20
Mining	10	27

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