Section 2
Description of the Study Area

As part of the first task outlined in the master plan, and with the purpose of having the most information possible regarding the area of study, the normality and the operations procedures and functionality of the water and wastewater treatment processes under the responsibility of CESPT, a series of documents and reports were compiled by various governmental agencies, including CESPT. The compilation of these reports is included in Appendix A.

2.1 Description of the Study Area

The area of study is located in the urban zones of the municipalities of Tijuana and Playas de Rosarito, in the Northwest portion of the state of Baja California, Mexico. The city of Tijuana is bordered to the north by the metropolitan area of San Diego, located in the state of California in the United States of America, to the east by Tecate and south by Playas de Playas de Rosarito, which in turn is contiguous to Ensenada in the south.

The proximity of the United States, the socio-economic differences between Tijuana and San Diego, and the existence of shared environmental resources, such as the Tijuana River and the Pacific Ocean Coastal Zone provide the region with factors of great importance that must be considered in the production of a master plan.

2.1.1 Geographical and Topographic Characteristics

The municipality of Tijuana, with a total area of 305,382 acres (123,584 hectares), is located in the northwest of the state of Baja California, within the coordinates of 32° 34′ and 32° 22′ latitude north; and 116° 35′ and 117° 07′ longitude west. The municipality is bordered to the north by the United States of America, to the south by the municipality of Playas de Rosarito, to the west by the Pacific Ocean and to the east by the municipality of Tecate. Figure 2-1 illustrates the geographic location and the topography of the area of study.

The orography of Tijuana consists of a series of elevations forming plateaus and hills. Among the most important is Colorado Hill with an elevation of 1,745 feet (532 meters) above mean sea level and San Isidro Hill, with an elevation of 2,690 feet (820 meters) above mean sea level. The slopes and gorges over which the city is built impose problems with settling and consequently elevate the costs of providing basic services. Similarly, these factors create great risks of flooding and slides. Figure 2-2 illustrates a digital model of the elevation of the area of study.

The municipality of Playas de Rosarito has a surface area of 513.3 km^2 and is located to the south of Tijuana. A coastal plane that presents plateaus and staggered hills inland characterizes the orography of Playas de Rosarito. A sandy beach forms the coastal zone with approximately five miles (eight kilometers) in length, which becomes narrower from north to south.

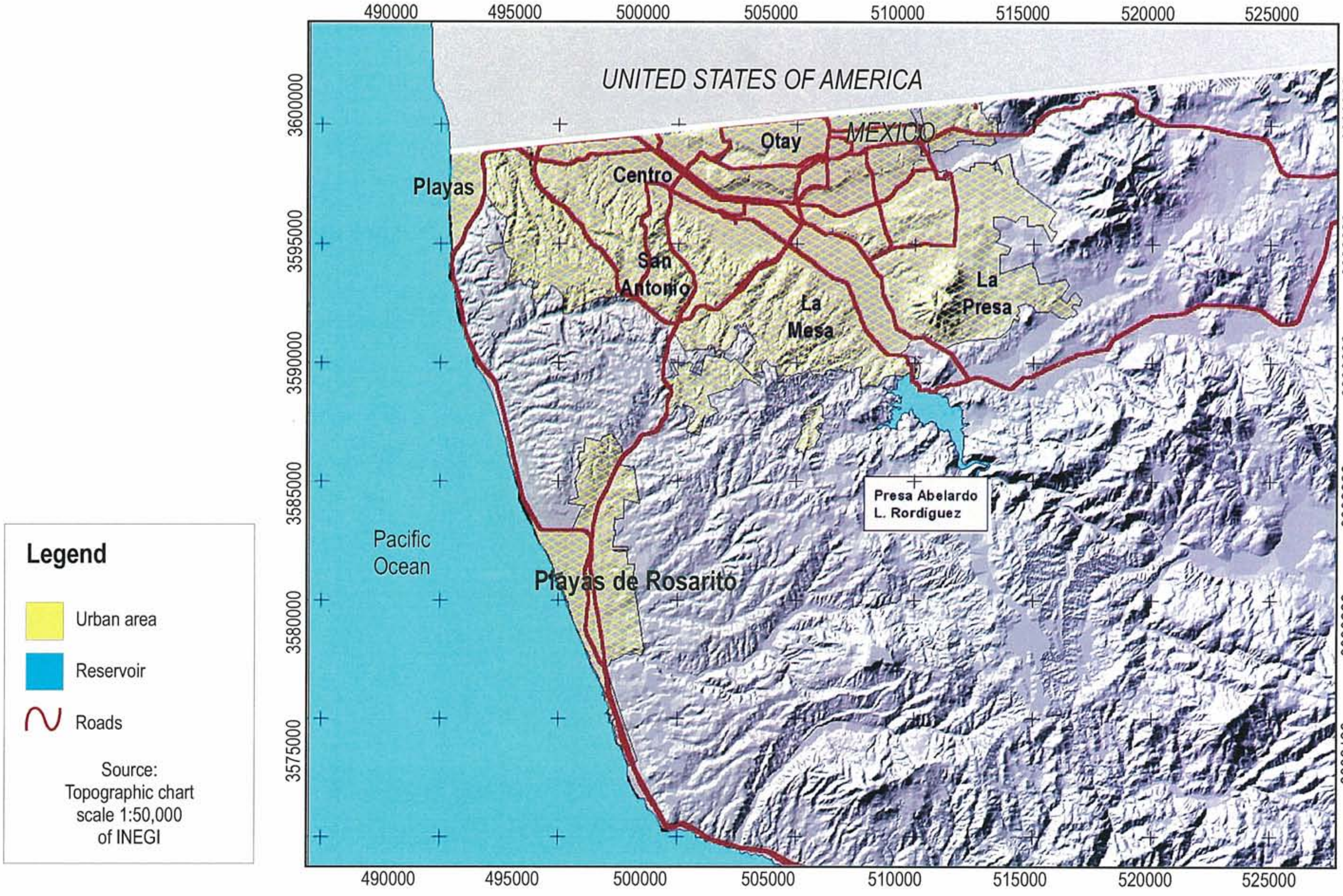
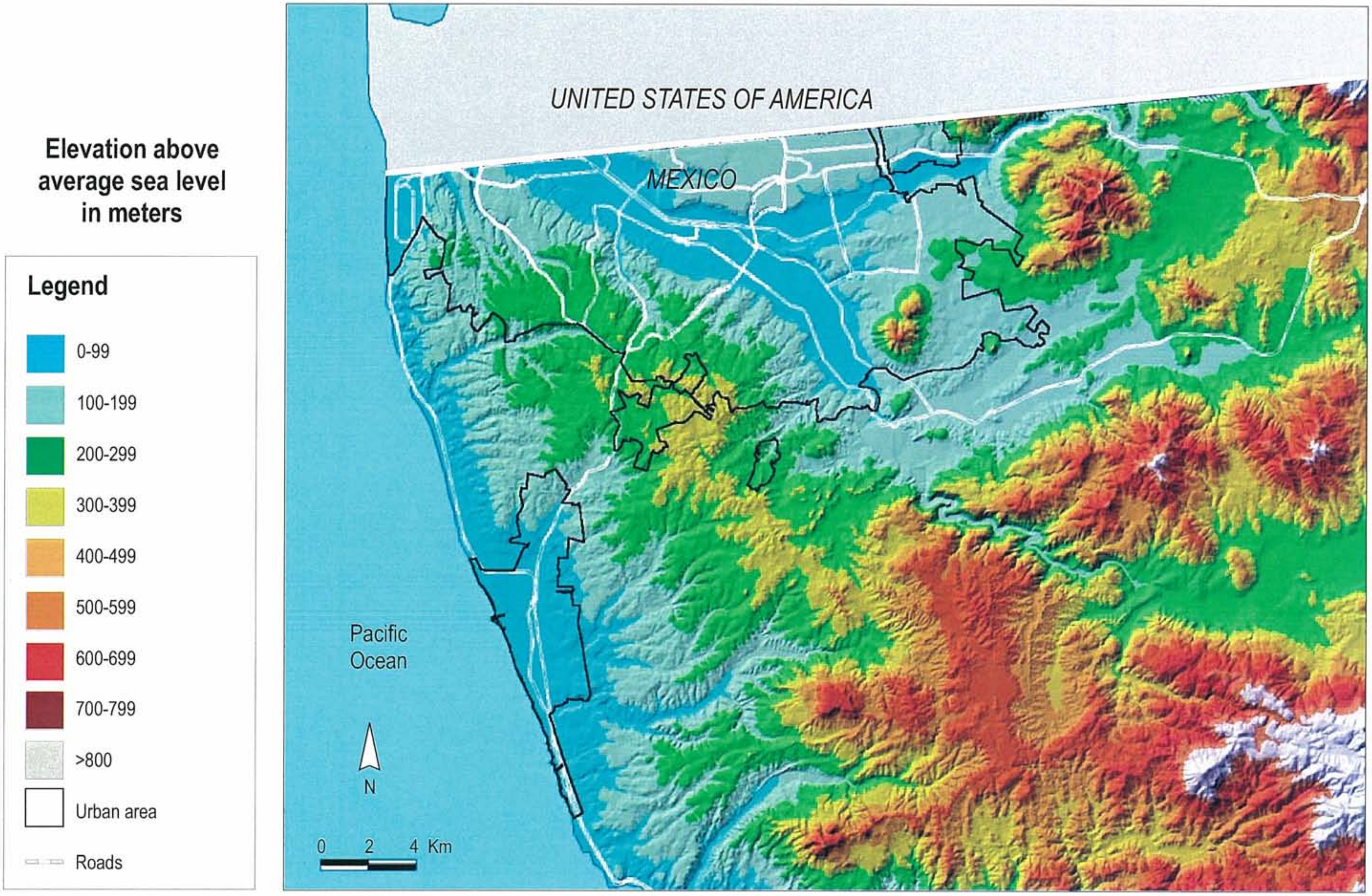


Figure 2-1
Geographic location and topography



CDM

Figure 2-2
Elevation Digital Model

2.1.2 Topography

Topographic conditions of the area of study limit urban development of the cities, due to the uprising of their hills and gorges. The area of study can be classified based on the slopes of the terrain according to the following (Topographic Scale 1:50,000, INEGI, April 1994):

- Slopes between 0 and 10 percent. These are flat zones adequate for urban development. 40 percent of the urban areas of Tijuana and 53 percent of the urban areas in Playas de Rosarito are located in these types of slopes.

- Slopes between 10 to 20 percent. These are zones with a slight slope, which are considered adequate for urban development. However, these areas suffer from a slight susceptibility to erosion. 21 percent of the urban areas of Tijuana and 31 percent of the urban areas in Playas de Rosarito are located in these types of slopes.

- Slopes between 20 and 30 percent. These areas have strong slopes with a high probability of erosion, which presents certain limitations for urban development, due to the ample erosion potential.

- Slopes greater than 30 percent. Extreme slopes with a high potential of risk due to the soil instability. These zones are not apt for urban development, since a high level of erosion and slides characterizes them, especially when they are not protected by vegetation, as is the case in some areas of Tijuana. These types of slopes elevate the infrastructure costs and the facilitation of basic services. 23 percent of the urban areas of Tijuana and 5 percent of the urban areas in Playas de Rosarito lie in these types of slopes (Source: SIGEF, COLEF).

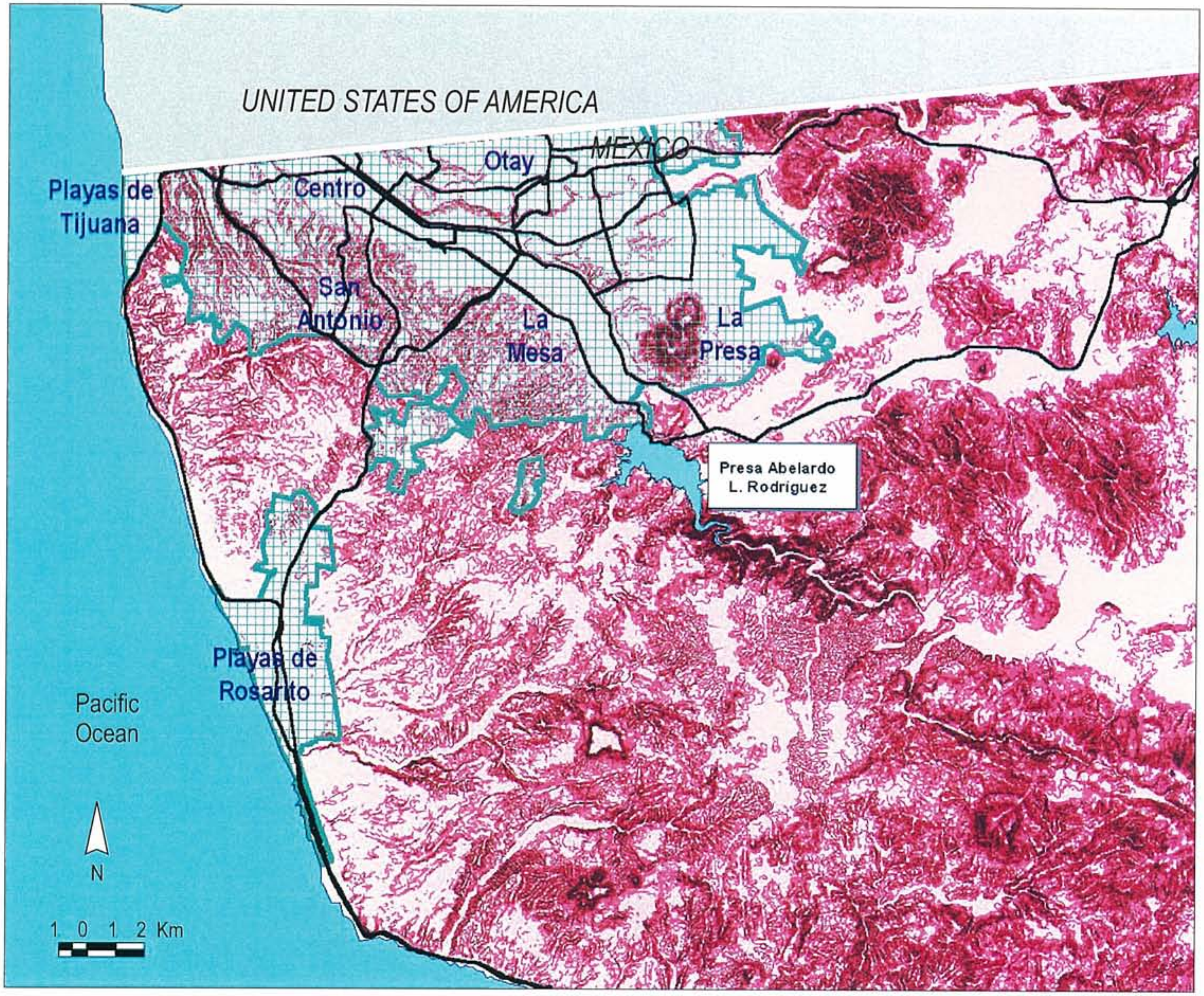
Figure 2-3 illustrates the classification of slopes in the area of study.

2.1.3 Climate

The climate in the area of study, for both municipalities, is of Mediterranean type, temperate and semiarid with temperatures fluctuating between 35 and 97 Fahrenheit (1.5 and 36 degrees centigrade) for Tijuana, and between 45 and 102 Fahrenheit (7 and 39 degrees centigrade) for Playas de Rosarito.

The average annual precipitation for Tijuana is 9 inches (229 mm) and 11 inches (279 mm) for Playas de Rosarito, with prevailing winds from the southwest to northeast, and 1,696 millimeters of evapotranspiration.

It is pertinent to mention that since the bulk of the urban areas interfere with the natural dynamics of the rainwater flow, the risks and vulnerability of flooding and slides for the population settled along riverbeds will be more frequent.



Land slope percentages

Legend

- 0-10%
- 10-20%
- 20-30%
- > 30%
- Urban area
- Reservoir
- Roads

CDM

Figure 2-3
Land slope classifications

2.1.4 Hydrography

According to the classification of the National Commission of Water, the area of study is located within the hydrographic region No. 1 RH1 in Baja California.

Tijuana does not have rivers with permanent flows and the principal intermittent current is the Tijuana River, which originates in Sierra de Juárez and flows southeast-northwest eventually flowing into the Pacific Ocean, in territory belonging to the United States via the estuary of the Tijuana River. The main affluents of the Tijuana River are the Tecate/Alamar River and the streams of Hechicera, Calabazas and Palmas.

In Playas de Rosarito the main surface bodies of water are the Playas de Rosarito and Guaguatay Streams, which flow only during periods of rain and are intermittent.

Figure 2-4 shows 29 micro basins located throughout the city of Tijuana and the 3 colonias (neighborhood) of Playas de Rosarito. In Tijuana, some streams flow directly to the main channel of the Tijuana River and are located in an area with advanced states of urbanization. Other streams, such as Playas Sur, the Sainz, Cueros de Venado and the Matanuco, present a low state of development, even though they are areas in which future urban areas are expected to develop. The rest of the streams flow directly into the Pacific Ocean.

The three basins in the Playas de Rosarito area are: Plan Libertador, Guaguatay, and Playas de Rosarito. Although the level of occupation around these basins is moderate, the future expansions of urban areas are expected to increase in the occupation of the above-mentioned basins.

Table 2-1 shows the basins in the urban areas of Tijuana and Playas de Rosarito.

Table 2-1
Boundaries of the Basins in the Study Area

Code	Name of the stream	Area in square meters	Hectares
15	Agua Caliente	12,617,072	1,262
16	Aguaje de la Tuna	15,489,026	1,549
11	Camino Verde	7,159,156	716
20	Cañón del Sol	4,281,108	428
5	Cerro Colorado	5,837,542	584
30	Cueros de Venado	34,367,827	3,437
2	El Florido	20,418,671	2,042
7	El Gato Bronco	8,732,584	873
21	El Matadero	17,290,795	1,729
3	El Sainz	20,255,203	2,026
18	Emiliano Zapata	17,485,210	1,749
28	Guaguatay	14,105,315	1,411
32	Sin nombre	75,794,161	7,579
6	Guaycura Presidentes	4,883,423	488
8	La Mesa	7,653,144	765
14	La Pechuga	7,100,653	710
31	Los Laureles	12,162,059	1,216
1	Matanuco	168,239,773	16,824
4	México Lindo	5,293,735	529
17	Pastejé o Aviación	22,801,317	2,280

Table 2-1
Boundaries of the Basins in the Study Area

Code	Name of the stream	Area in square meters	Hectares
27	Plan Libertador	32,523,754	3,252
23	Playas Norte	7,453,976	745
24	Playas Sur	9,568,222	957
29	Playas de Rosarito	50,483,092	5,048
25	San Antonio de Los Buenos	41,873,176	4,187
26	San Antonio del Mar	23,089,113	2,309
9	Sánchez Taboada	5,605,933	561
10	Sistema Alamos	3,671,161	367
19	Sistema Centro	15,611,323	1,561
13	Tributario Alamar right	43,968,986	4,397
12	Tributarios Alamar left	39,268,348	3,927

Source: Comisión Nacional del Agua, 1999.

2.1.5 Vegetation

The predominant vegetation in Tijuana consists of scrub and chaparral, located mainly in the hills, streams and plateaus. An important aspect of this type of flora is that it operates in a natural manner against the erosion. There also exists secondary vegetation consisting mainly of shrubbery.

In Playas de Rosarito the predominant vegetation is scrub, chaparral and some induced fields.

2.1.6 Geology and Hydrogeology

The origins of the soil materials in the region are principally sedimentary, alluvial and volcanic. These materials are generally slightly consolidated. The pronounced slopes in the region, present a series of risks of slides. Figure 2-5 illustrates the predominant geological characteristics and Figure 2-6 illustrates the lithologic characteristics of the area of study.

Hydrogeology

The hydrogeological information of the study area is very limited. The most important aquifers are located in the Tijuana and Alamar river basins, as well as the coastal area in the Playas de Rosarito area, extending to the municipal limits of Ensenada. These aquifers are unconfined and they generally present water quality with problematic elements, as described in detail in Section 2.6.1 and 7.

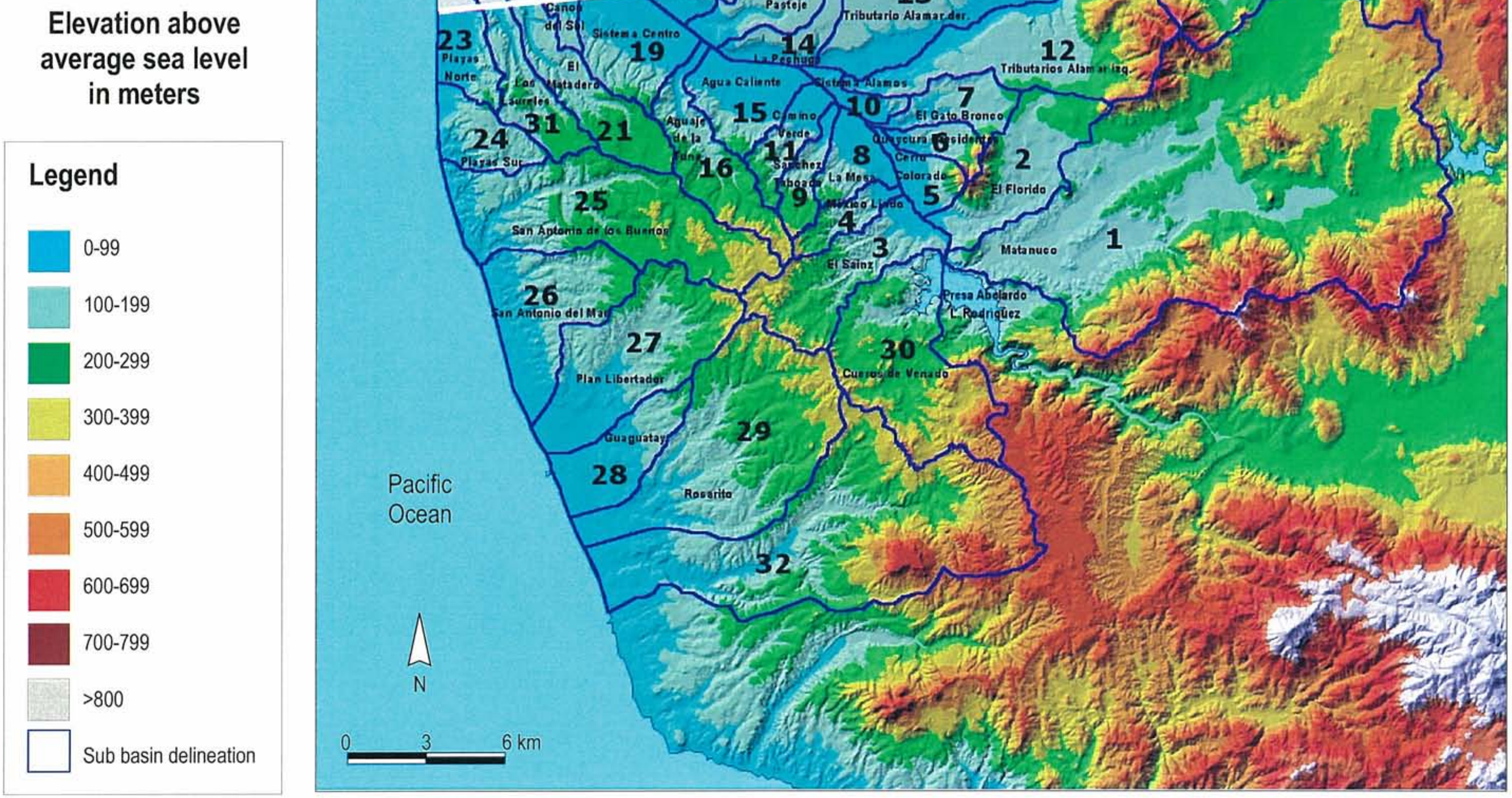
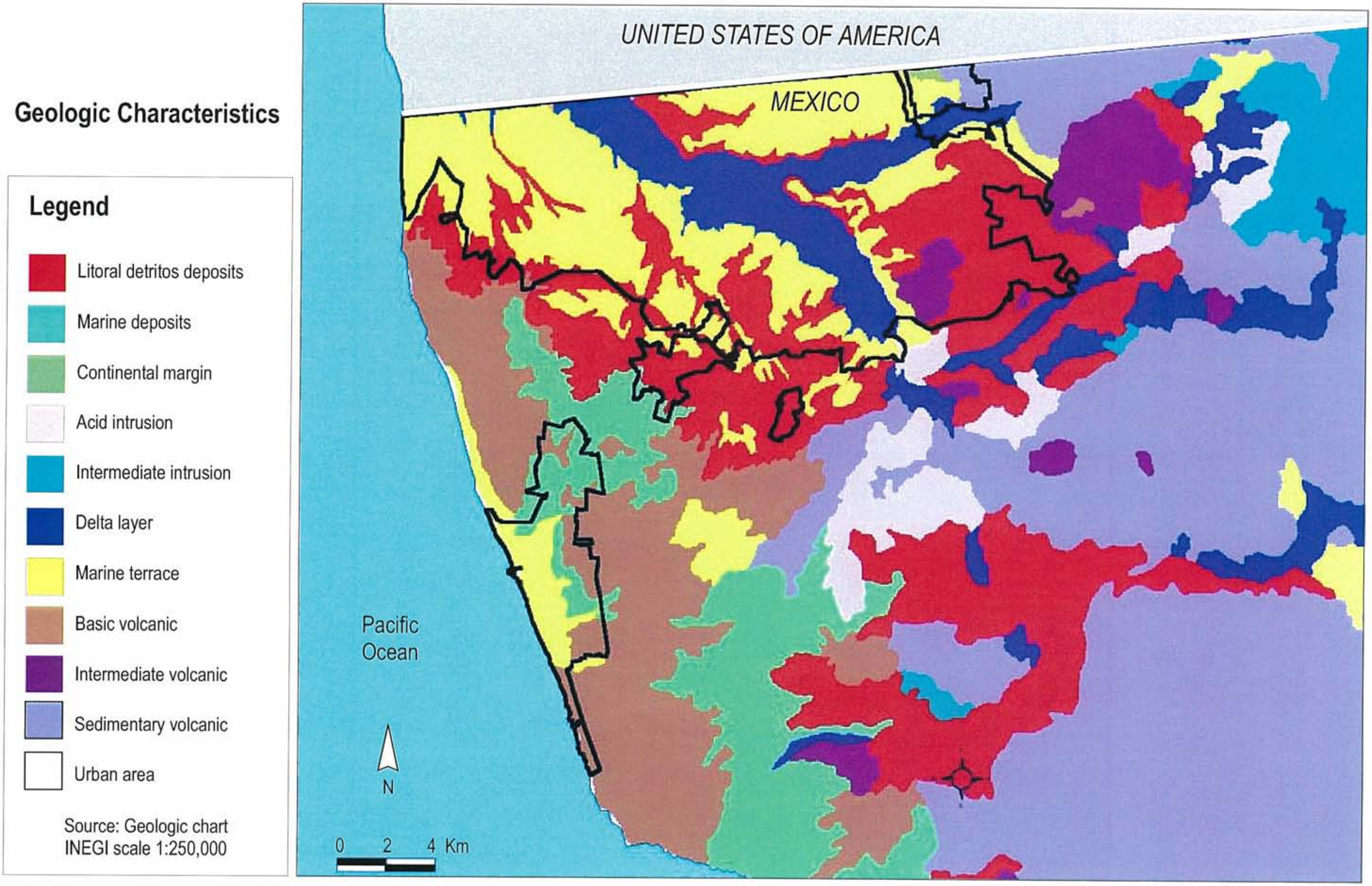


Figure 2-4
Basin delineation



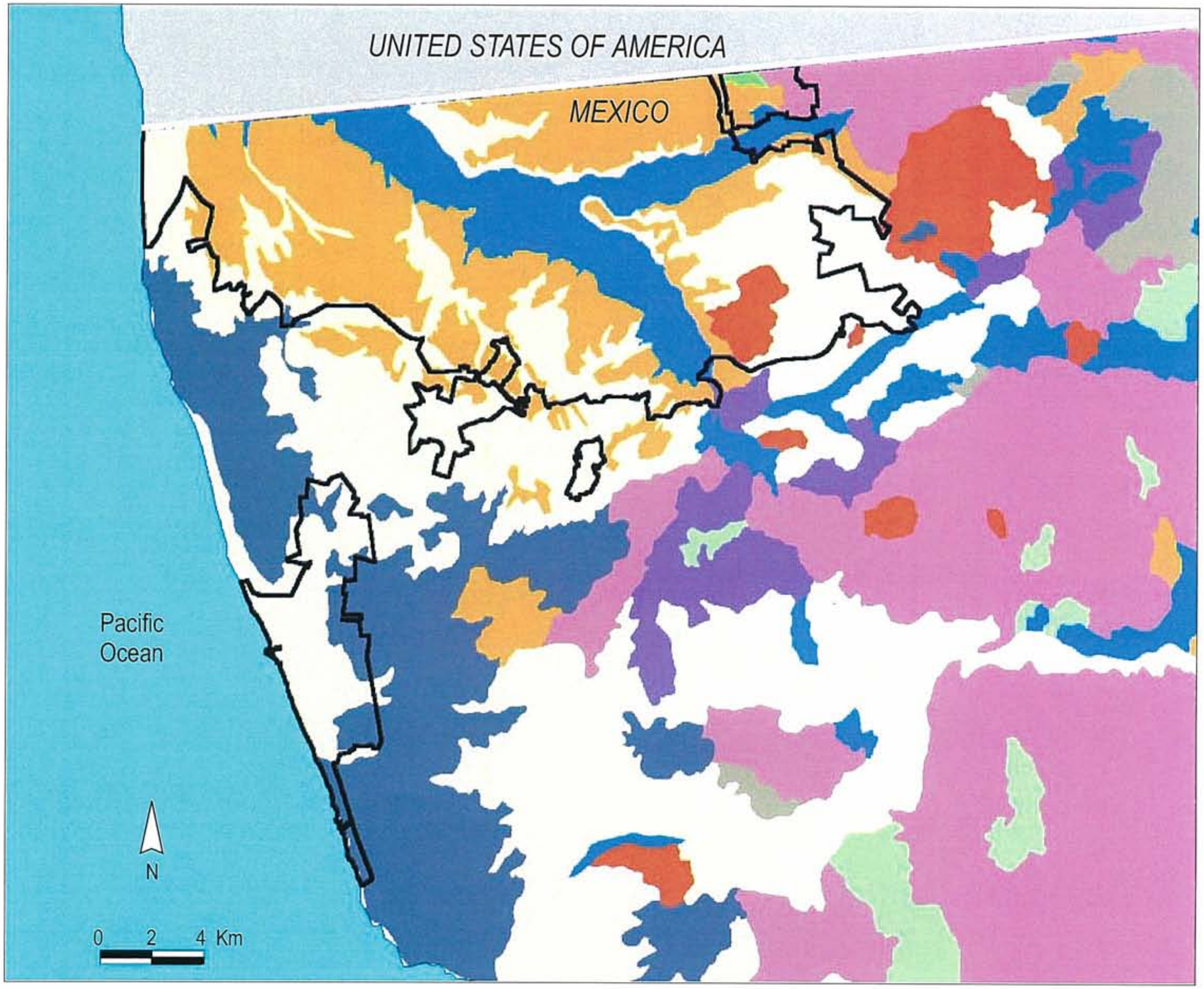
CDM

Figure 2-5
Predominant geological characteristics

Type of predominant rock

Legend

- Alluvial
- Andesine
- Andesita, tuff
- Arenisca
- Basalt
- Conglomerate
- Colluvial Cone
- Granite
- Granodiorita
- Acidic tuff
- Urban area



CDM

Figure 2-6
Predominant lithologic characteristics

According to the cartography of INEGI with a scale of 1: 250,000 (1998), the predominant characteristics in Tijuana are; marine terraces with conglomerate rocks in great extensions, located at both sides of the main stream of the Tijuana River; an alluvial bedrock over Valle del Rio, Tijuana, and detritic deposits with sandy stone, mainly in the south and east of the city. Playas de Rosarito has been established over a marine terrace with sandy stones.

2.1.7 Risks Associated with Natural Phenomena

The zone of study presents risks in the form of potential seismic activity as well as flooding and landslides, particularly in urban developed areas with very pronounced slopes and devoid of vegetation covering. In the following paragraphs these risks are described briefly.

Risks of Seismic activity

In the region there exists a series of tectonic faults, among the most important due to their proximity are La Nación and Vallecitos Faults. Figure 2-7 illustrates the principal faults in the region.

The in-depth study by Colegio de la Frontera Norte (COLEF) in 2000 evaluates the risk of seismic activity and establishes a prioritization of the risks based on the theoretic susceptibility to seismic phenomena of the terrain and the probability that these phenomena would occur. The zoning of the risks is summarized in Figure 2- 8.

Some of the more relevant results of the study are the fact that the Valley of the Tijuana River, which is one of the centers of commercial, financial, and services activities, has the highest risk potential in the city. On the other hand, the regions to the south and occidental are the zones with the least risk, due to the level of development that is projected in these zones over the following years. It is important that compliance with regulations for construction of residences and infrastructure of services be met in order to avoid significant disasters.

Risks during the rainy season

During heavy storms, surface runoff can exceed the capacity of the natural waterways and of the structures designed to capture the flows, resulting in flooding and transportation of materials such as garbage and sediments in areas along the rivers. Housing built in floodplains in some areas of Tijuana is at major risk of flood damage.

Storms also bring the risk of landslides in hilly areas. Lack of vegetation on some hills and mountains and housing built on hillsides, along with the existence of steeply sloping, unpaved streets, exacerbates the problem.

2.1.8 Land Use

The purpose of this section is to analyze the structure of land use and destiny in Tijuana and Playas de Rosarito. The primary sources of input were urban development maps provided by Instituto Municipal de Planeación (IMPLAN) and the

Playas de Rosarito Urban Development and Ecology Office (Desarrollo Urbano de Playas de Rosarito).

Based on the information submitted, the developed area of Tijuana consists of approximately 54,363 acres (22,000 hectares) representing approximately 25 percent of area of the municipality. The territorial distribution for land use can be observed in the maps that show the main land uses projected for Tijuana and Playas de Rosarito for the year 2000.

The developed area of Playas de Rosarito occupies 8,402 acres (3,400 hectares), representing approximately 7 percent of the municipal territory. The residential land use represents almost 54 percent in Playas de Rosarito and 75 percent of the Tijuana urban area.

An important project is currently being developed, called the Corredor Tijuana 2000, has the goal of consolidating the infrastructure and provision of services to encourage the urban development of Tijuana, Playas de Rosarito and Tecate in areas where development is more appropriate based on land use projections. The project will concentrate the intensified economic activity among the municipalities in an area in a well-planned corridor that will extend from the eastern part of Tijuana to the southern end of the current Playas de Rosarito urban area.

Commerce and service sector
There are two important zones in the city that can be clearly defined. The first zone is the Downtown area and the River Zone with an approximate area of 618 acres (250 hectares). This area is important because it brings together the main commercial and financial activities, a historical center, international tourism and government activities. In addition, this zone includes the San Ysidro crossing, which is the main point of entry or departure for those coming into or leaving the country. The second most important zone is distributed from the northwest to the southeast around Agua Caliente, Diaz Ordaz and Federico Benitez Boulevards on a 10-km (6-mile) main highway where commercial and financial activities are conducted to support the local and regional-national markets.

In the last years, new areas of commercial and services activity have developed toward the east and southeast of the city, such as Villa Fontana, El Florido and the third phase of the canalization from the Tijuana River, which seek to decentralize commercial and service activities in the Otay and the La Presa areas through development of small shopping malls that focus on enabling those who live in the east and southeast portions of the city to avoid long distance travel and traffic congestion.

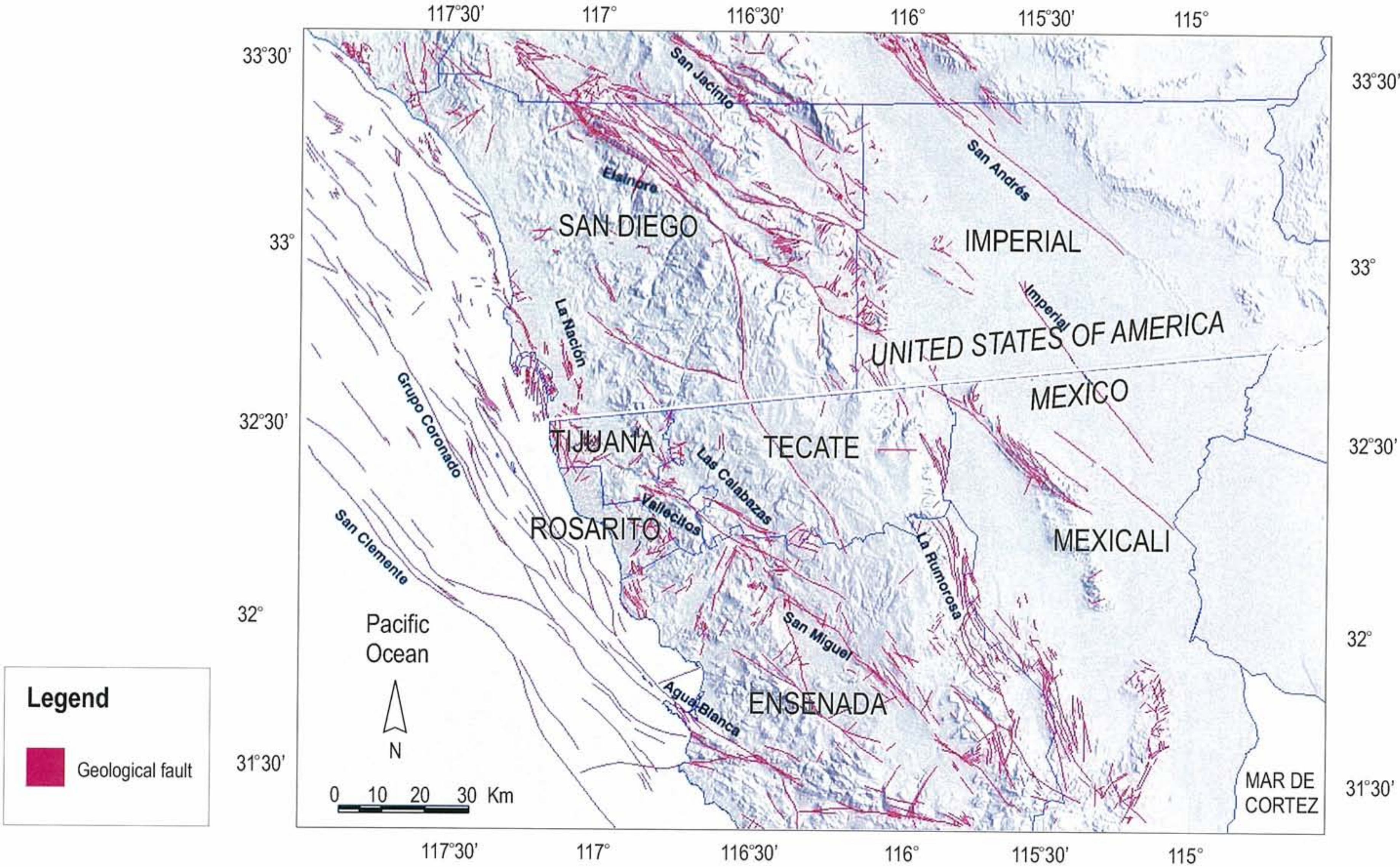
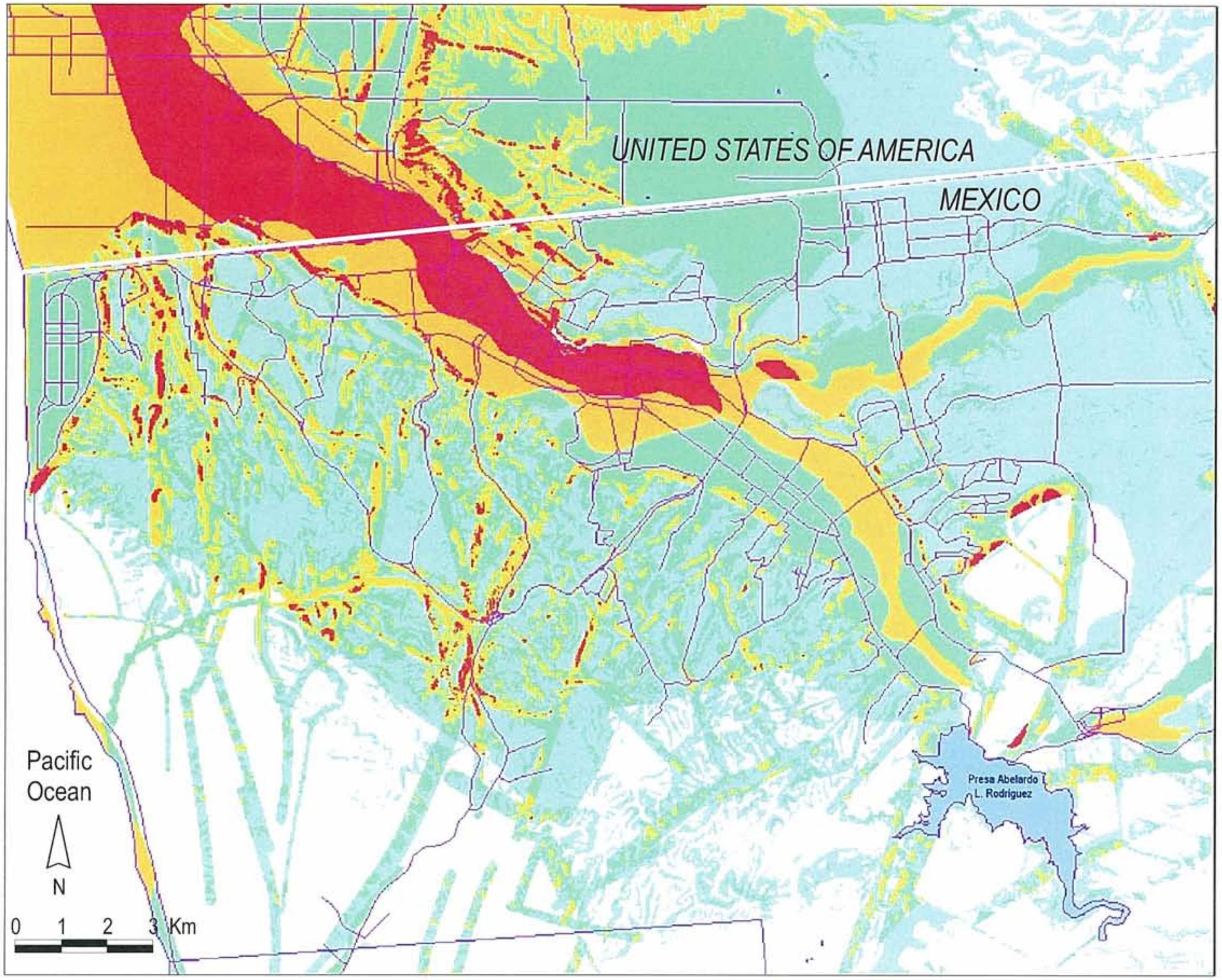


Figure 2-7
Main geological faults in the region

Types of seismic risk

Legend

- RO Very low seismic risk
- R1 Low seismic risk
- R2 Moderate seismic risk
- R3 High seismic risk
- R4 Very high seismic risk



CDM

Figure 2-8
Seismic risk area

This location concentrates its services in the downtown area, the southern portion of the city on Juarez Avenue, and parallel to the coast along a 3-mile (4.8-km) stretch, where tourist and commercial services are predominant. Here one can find hotels, bars, restaurants, dance clubs, arts, crafts stores, and other types of stores that typify locations that make a living from tourist activities.

Industry

The major *maquiladora* (factory) industries have opened primarily in industrial parks or centers because of the size of the industrial plants and the availability of the infrastructure and services that they require. Nevertheless, some smaller *maquiladoras* (factories) have opened in business and residential districts. Twenty-eight industrial parks, most located in the Otay, La Mesa, and La Presa Districts, are the principal centers of *maquiladora* (factory) activity.

Industry in Tijuana is distributed according to different industrial activity development phases. One primarily notices a central axis in the Zona Centro (downtown), along with *Colonia Libertad* (Liberated Neighborhood), as one of the city's first poles of industrial activity. There is also industrial expansion parallel to the Tijuana Riverbed, running south-southeast toward the Abelardo L. Rodríguez Reservoir.

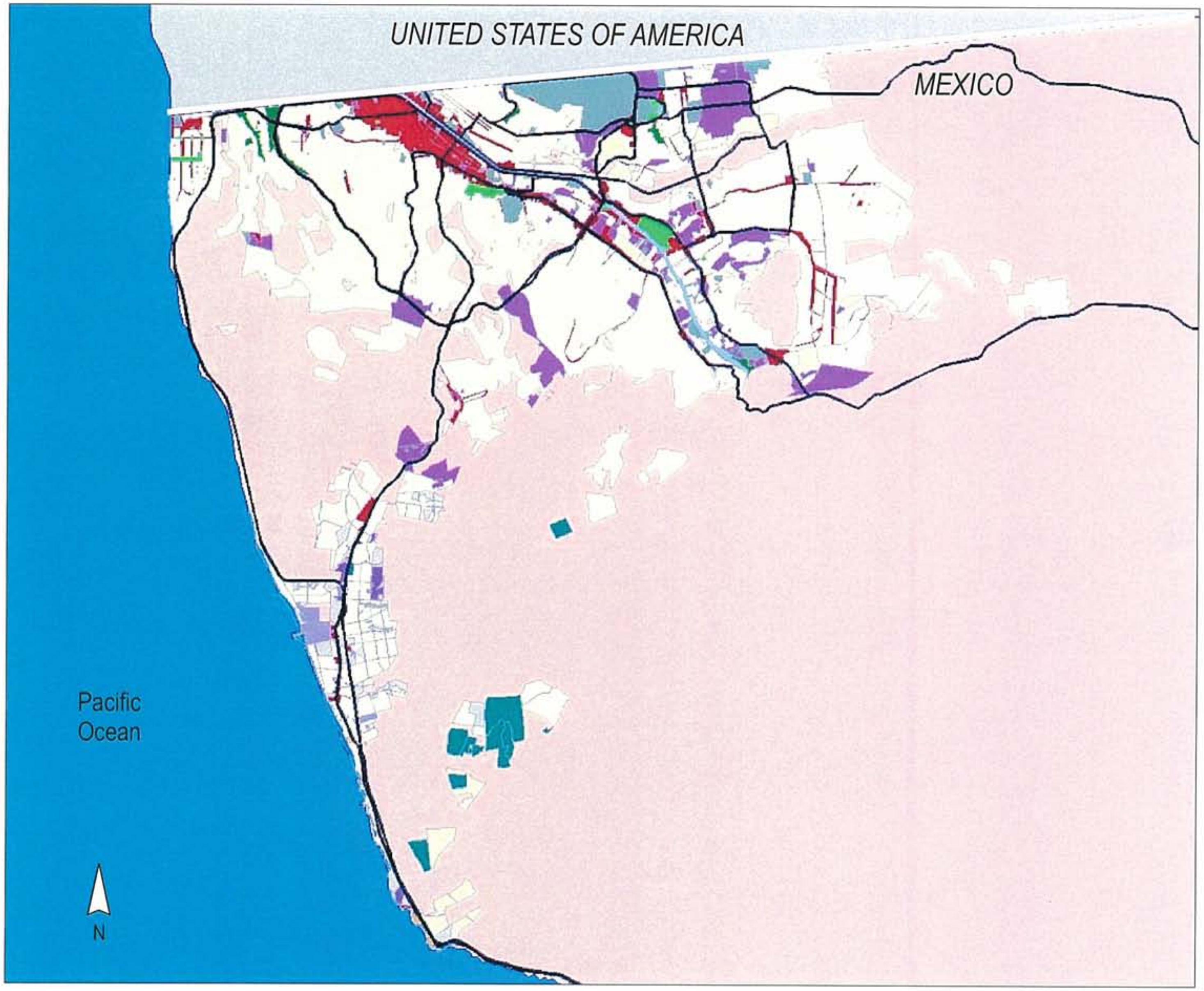
In Mesa de Otay, developed more recently, a series of industrial parks has been set up beginning at the Tijuana Airport and running east toward the toll highway to Tecate. In addition, a series of industrial plants has opened southeast of the city.

The establishment of the Toyota plant in Tijuana will generate new sources of employment and will help create other smaller business activity. As far as basic necessities, the installation of this plant will generate the development of water and sanitation systems, and the delivery of electricity and telephone service.

The Toyota plant will likely change current land use, since many of its future workers will prefer to live near it. This will mean that schools as well as a basic health care clinic will be needed.

Industrial activity in Playas de Rosarito is practically null, being limited to electricity generation by the Federal Electricity Commission, (Comisión Federal de Electricidad), (CFE).

Primary land uses



Legend

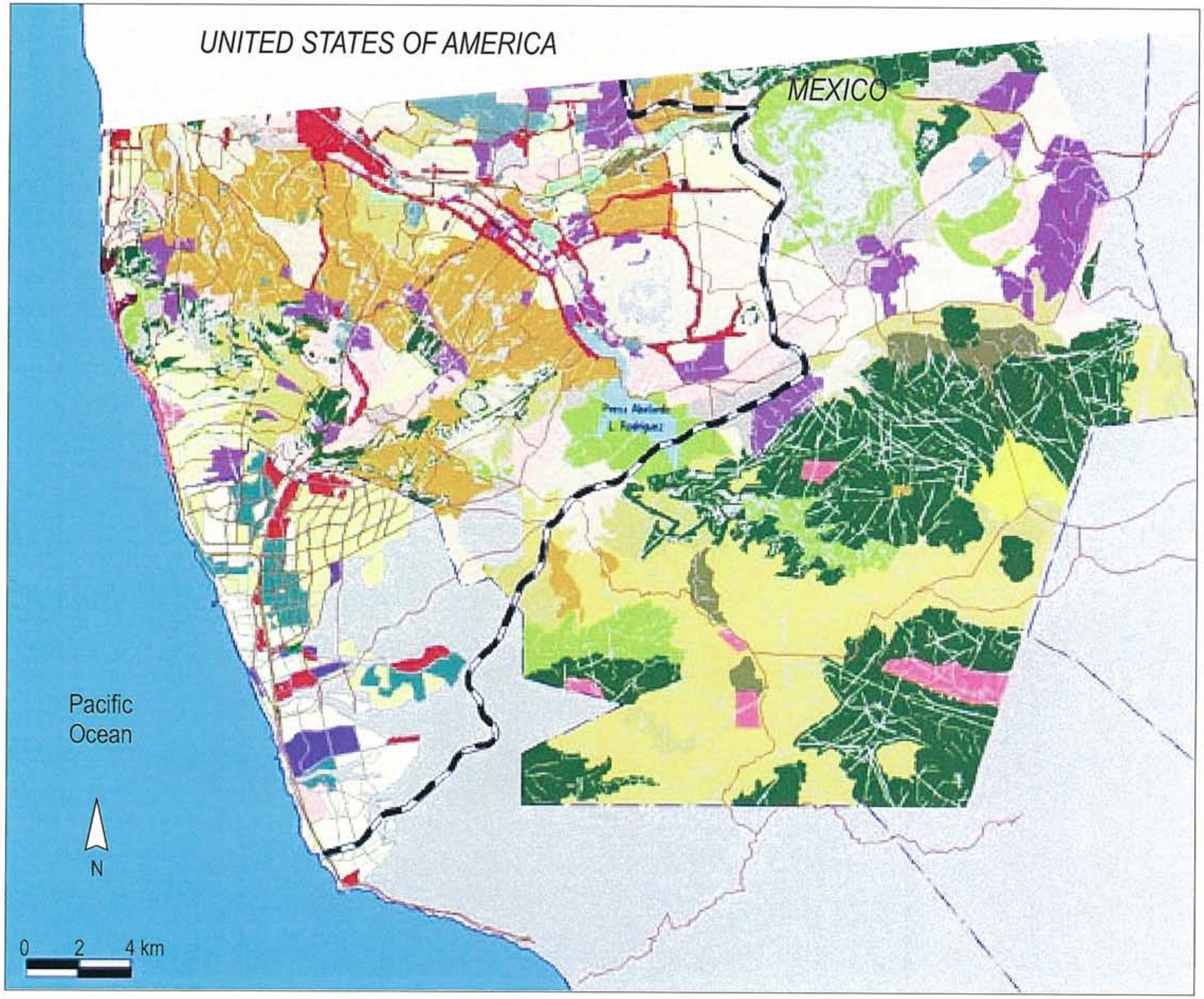
- Green Areas
- Commercial
- Regulated
- Body of Water
- Infrastructure
- Residential
- Industrial
- Preservation
- Special Usel

Source: IMPLAN
and Rosarito Urban
Development Department

CDM

Figure 2-9
Actual urban land use

Primary land use



Legend

- Green Areas
- Commerical
- Regulated
- Body of Water
- Infrastructure
- Residential
- Industrial
- Preservation
- Special Use
- Roads
- Corridor 2000

Source: IMPLAN and Rosarito Urban Development Department

CDM

Figure 2-10
Future urban land use

2.2 Development Plans

Table 2.2 presents a summarized description of the information relevant to the project that was found in official documents related to the water and wastewater issue.

Table 2-2
Summary of the Enforced Development Plans and Programs in Tijuana and Playas de Rosarito

Document	Source	Description
National Development Plan 2001-2006	Federal Government: President's Office, 2001.	This document establishes policy guidelines and general strategies. The potable water and wastewater services are within the frame of the social and urban development policy (section 5.3 strategies b and c referring to the planning horizon and to the urban development policy, respectively).
National Hydraulics Program 2001-2006	Federal Government: National Water Commission, 2001.	This document is the governing document for the national water policy. It establishes general guidelines for the sector and establishes the diagnosis by region, in the matter of water and wastewater service coverage, system quality and levels of efficiency. It establishes national objectives under the terms of sustainable management of the resource, expansion of coverage and improvement of the efficiency.
Situation of Potable Water, Sewage and Wastewater sub Sector 2000	National Water Commission, 2001	This is a statistical compendium that gathers information regarding coverage, rates and the operational and commercial efficiency of potable water and wastewater systems in the country's municipalities.
Hydraulics State Plan 1994-2015	Government of Baja California / Department of Human Settlements and Public Works (SAHOPE) /State Water Commission	The State Plan, the official document of the Government of Baja California, analyzes future water needs in urban areas and establishes the steps the government must take to satisfy those needs. The Plan projects the demand in Tijuana through 2015. This document needs to be updated annually.
State Urban Development Plan	Department of Human Settlements and Public Works (SAHOPE) of the Government of Baja California, October 1998	The Plan establishes the outlines and strategies for urban planning in the state, including an analysis of service coverage and information on the availability of water in the area. It sets strategic priorities for the Tijuana-Playas de Rosarito-Ensenada Coastal Corridor, and for Metropolitan Tecate-Tijuana-Playas de Rosarito, among which are the expansion of drinking water and sewer and sanitation services (subsections 4.1 and 4.6).
Regional Urban Development Program for the Tijuana-Playas de Rosarito Corridor 2000 (Corredor 2000)	Department of Human Settlements and Public Works (SAHOPE) of the Government of Baja California, 2000	Strategic urban planning program for the growth areas of Tijuana and Playas de Rosarito, connected following the construction of the Tijuana 2000 highway. The program establishes areas and spaces in Tijuana and Playas de Rosarito that will be incorporated into the urban system as the population grows; it quantifies these spaces; and it establishes probable densities for each area, with a projection to 2020 of the future population in these spaces.
Program for Urban, Tourist, and Ecological Development of the Tijuana-Playas de	Department of Human Settlements and Public Works (SAHOPE) of the Government of Baja California, October 2001	Regulatory instrument for regional urban and environmental planning in the coastal area between Tijuana and Ensenada. It contains analyses and projections for urban ecology and productive infrastructure in the area, while establishing the bases for inter-institutional and intergovernmental

Table 2-2
Summary of the Enforced Development Plans and Programs in Tijuana and Playas de Rosarito

Document	Source	Description
Rosarito-Ensenada Coastal Corridor (COCOTREN)		(state-municipal) coordination in urban planning for the Tijuana-Playas de Rosarito-Ensenada Corridor. The program's objective is to support the management of urban planning and environmental protection. It establishes trends in housing density, provides relevant information on the Corridor's population, tourist and service infrastructure, land use, and landholding patterns.
Urban Development Program for the City of Tijuana	14th City Government for Tijuana, 1993.	This document sets out guidelines for Tijuana's urban growth in the time period up to the year 2013. It includes relevant information, spatial in character, related to the populated area, available area with feasibility for development, infrastructure conditions etc., for each one of the 16 sectors into which the City is divided. It also mentions growth trends and establishes strategies and actions to guide and induce City growth. It includes population projections and future infrastructure needs to meet future demands.
Urban Development Program for Playas de Rosarito (June 29, 2001)	First City Government for Playas de Rosarito, (Approved by the State Coordination Commission of Urban Development on March 29, 2002)	This document establishes Playas de Rosarito's urban growth strategic guidelines. The forecast for future urban growth scenarios for this municipality establishes that the demographic and urban dynamics for the municipality will be based on Tijuana's growth trends, that in the future the City will be the center of a regional metropolis. Therefore, particularly outstanding are the areas of future growth within the boundaries of Tijuana and around the routes that will connect the two municipalities. The document establishes population projections for the next 20 years in two different scenarios. The policy strategies assume a densification line within the current urban area and another one for expansion in zones adjacent to the routes that will connect Tijuana and Playas de Rosarito.
Urban Development Program for Playas de Rosarito 2000-2020	First City Government for Playas de Rosarito, December 2000	Official document establishing the government's steps and strategies in the area of urban development for 2000-2002. Subsection 3.3.3 establishes trends in demand for water and sanitation and projections for the next 20 years, based on two probable scenarios.
Municipal Government Plan, 17th City Government for Tijuana 2001-2004	City Government of Tijuana	This document establishes the water supply as this administration's highest priority for the municipal government. The goal is to provide 322,171 residences with potable water and to connect 292,392 residences to the sewer system by 2004, thus achieving an 88 percent coverage for water service and 80 percent coverage for sewer service (pp. 18 and 19).
Municipal Development Plan 2002-2004	City Government of Tijuana	The urban development subsection emphasizes the relative aspects concerning urban organization and municipal finances as priorities of the current administration. The topics of water and wastewater are absent, given that they are services managed by the state government.

2.3 Population

This section presents the population growth for border communities, in particular, recent demographic growth in Tijuana and Playas de Rosarito, as well as the age and gender structure for these communities in 2000. The information analyzed in this section is from the 2000 Mexican Population and Housing Census (Censo Mexicano de Población y Vivienda del 2000, CMPV)

Between 1940 and the mid-1970s, the Mexican population grew at a rapid pace, with annual demographic growth rates of 2.5 percent in the 1940s, 3.1 percent in the 1950s, and 3.4 percent in the 1960s. From the mid-1970s on, the Mexican population continued to grow at lower rates: an average annual rate of 3 percent in the 1970s, 2.1 percent in the 1980s, and 2 percent during the 1990s. The explanation for this pattern of demographic growth lies in high fertility levels combined with a continuously declining mortality rate.

The population growth rate has not been the same in all regions of Mexico. The phenomenon of internal migration within the country can explain regional differences in demographic growth. Besides fertility and mortality, the volume and characteristics of migratory flows within Mexico largely explains regional demographic dynamics.

Mexico's northern border has been marked by accelerated demographic growth, greater than for the country as a whole, and comparable only to the growth experienced by Mexico's major metropolitan areas.

Northern states in Mexico that share a border with the United States (Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas) grew from 2.1 million inhabitants in 1930 to 16.6 million in 2000. These border states have grown at a faster rate than the national average in recent years, as shown in Table 2-3.

Table 2-3
Total Population and Rates of Demographic Growth for Border States, 1960-2000

State	Total Population				
	1960	1970	1980	1990	2000
Baja California	226,548	512,683	870,421	1,660,855	2,487,367
Coahuila	719,018	902,884	1,114,956	1,557,265	2,298,070
Chihuahua	844,989	1,218,941	1,612,525	2,005,477	3,052,907
Nuevo Leon	738,811	1,077,780	1,694,689	2,513,044	3,831,414
Sonora	509,727	782,244	1,098,720	1,513,731	2,216,969
Tamulipas	717,334	1,022,858	1,456,858	1,924,484	2,753,222
Border States	3,756,427	5,517,390	7,848,169	10,691,887	16,642,676

State	Rates-of-Growth			
	1960-1970	1970-1980	1980-1990	1990-2000
Baja California	8.5	5.4	3.1	7.8
Coahuila	2.3	2.1	3.4	4.3
Chihuahua	3.7	2.8	2.2	4.3
Nuevo Leon	3.9	4.6	4.0	4.3
Sonora	4.4	3.5	3.3	3.9
Tamaulipas	3.6	3.6	2.8	3.7
Border States	3.9	3.6	3.1	4.5

Source: INEGI, Estimates based on Population Census data, 1950-2000

The general trend shows that in northern Mexican states rates of growth fell during the 1980s, but those rates again increased in the 1990s.

Table 2-4
Total Population of Northern Mexican Border Cities, 1970-2000

City	1970	1980	1990	2000	Growth Rate 1990-2000 %
Tijuana-Playas de Rosarito, B.C.	340,583	461,257	747,381	1,274,240	5.5
Cd. Juárez, Chih.	424,135	567,365	798,499	1,217,818	4.3
Mexicali, B.C.	396,324	510,664	601,938	764,902	2.4
Matamoros, Tam.	186,146	238,840	303,293	416,428	3.2
Reynosa, Tam.	150,786	211,412	282,667	419,776	4.0
Ensenada, B.C.	115,423	175,425	259,979	369,573	3.5
Nuevo Laredo, Tam.	151,253	203,286	219,468	310,277	3.5
Nogales, Son.	53,494	68,076	107,936	159,103	3.9
San Luis Río Colorado, Son.	63,604	92,790	110,530	145,276	2.8
Piedras Negras, Coah.	46,698	80,290	98,185	127,898	2.7
Río Bravo, Tam.	71,389	83,522	94,009	103,901	1.0
Acuña, Coah.	32,500	41,948	56,336	110,388	6.8
Caborca, Son.	28,971	50,452	59,160	69,359	1.6
Tecate, B.C.	18,091	30,540	51,557	77,444	4.1
Agua Prieta, Son.	23,272	34,380	39,120	61,821	4.6
Valle Hermoso, Tam.	42,287	48,343	51,306	58,292	1.3
Cananea, Son.	21,315	25,327	26,931	32,074	1.8
Puerto Peñasco, Son.	12,436	26,755	26,625	31,101	1.6
Ojinaga, Chih.	25,560	26,421	23,910	24,313	0.2
Miguel Alemán, Tam.	18,218	19,600	21,322	25,675	1.9
Nava, Coah.	5,682	8,684	16,915	22,986	3.1
Ascensión, Chih.	9,316	11,985	16,361	21,866	2.9

Table 2-4
Total Population of Northern Mexican Border Cities, 1970-2000

City	1970	1980	1990	2000	Growth Rate 1990-2000 %
Anáhuac, N.L.	13,341	16,479	17,316	4,763	-13.0
Gustavo Díaz Ordaz, Tam.	18,261	17,830	17,705	16,223	-0.9
Camargo, Tam.	15,416	16,014	15,043	16,768	1.1
Janos, Chih.	7,028	8,906	10,898	10,225	-0.6
Ocampo, Coah.	9,934	9,000	7,857	12,019	4.3
Guadalupe, Chih.	9,593	8,876	9,054	10,016	1.0
Praxedis G. Guerrero, Chih.	7,950	7,777	8,442	8,924	0.6
Jiménez, Coah.	8,445	8,636	8,253	9,703	1.6
Altar, Son.	3,886	6,029	6,458	7,224	1.1
Mier, Tam.	6,193	6,382	6,244	6,738	0.8
Naco, Son.	4,200	4,441	4,645	5,352	1.4
Guerrero, Tam.	4,249	4,121	4,510	4,370	-0.3
Manuel Benavides, Chih.	5,167	4,164	2,794	1,747	-4.7
Saric, Son.	2,321	2,250	2,112	2,252	0.6
Guerrero, Coah.	2,650	2,316	2,374	2,047	-1.5
Santa Cruz, Son.	1,637	1,587	1,476	1,642	1.1
Hidalgo, Coah.	619	751	1,220	1,442	1.7
Total	**2,358,373**	**3,142,921**	**4,139,829**	**5,967,507**	**3.6**

Source: *INEGI, Censos Generales de Población y Vivienda* (General Census of Population and Housing) 1970, 1980, 1990 and 2000

Mexico's northern city border population is shown in Table 2-4,[1] listed by city name and population size from 1970 to 2000. The population of the cities that lie along the border rose from 279,115 inhabitants in 1930 to 2.35 million in 1970 and to 5.97 million in 2000. Thus, the border cities' populations grew at an accelerated rate, so that the overall population in 2000 was 20 times larger than in 1930. The rate of population growth in border cities is greater than the rate in the northern states or the national average.

The annual average demographic growth of all border cities during the decade of 1990-2000 was 3.6 percent, while nationally the rate was 1.7 percent for this same period. This demographic growth in the border zone is fairly heterogeneous among the cities in this area.

The greatest population growth in recent years in the northern border has occurred in the urban area of Tijuana-Playas de Rosarito. The population in this urban area grew from 65,364 residents in 1950 to 1,274,420 residents in 2000, making it the most

[1] Table 2-4 lists 38 cities, but, in reality, only 35 cities border the United States. The table includes Ensenada, B.C., Manuel Benavides, Chihuahua, and Valle Hermoso, Tamaulipas, because in practice and in terms of federal programs, they are considered "border" cities. Similarly, the table does not contain newly created cities, such as Plutarco Elías Calles, Sonora or the incorporation of Puerto Peñasco. Also, the population of Playas de Rosarito (Baja California), was included in that for the municipality of Tijuana until 1990.

densely populated area on the northern border. Tijuana-Playas de Rosarito grew at a higher rate than other urban border areas.

The 2000 Population and Housing Census reported that 1,274,240 residents live in this border community, of which 5 percent (63,420) resided in Playas de Rosarito with the remainder (1,210,820) residing in the city of Tijuana.

Table 2-5 lists the population distribution in Tijuana and Playas de Rosarito according to age and gender. Note the concentration of children (0-4 years and 5-9 years of age), who account for 24 percent of the overall population. Similarly, young people in their twenties (20-24 and 25-29 years of age) account for 21 percent of the population. The large population concentrations in these two age brackets is primarily due to the arrival of strong flows of immigrants coming from other parts of the country. The concentrated population in the brackets for children is due to the still high fertility rates. The immigrant population that come to Tijuana and Playas de Rosarito are usually still in their reproductive years and have higher fertility rates than the rest of the population.

Table 2-5
Population by Age and Gender, Tijuana-Playas de Rosarito 2000

Age	Men %	Women %	Total %
0-4	12.60	11.90	12.20
5-9	11.80	11.40	11.60
10-14	9.40	9.80	9.60
15-19	9.70	9.60	9.60
20-24	10.20	10.70	10.40
25-29	11.10	10.80	11.00
30-34	9.40	9.20	9.30
35-39	6.70	6.90	6.80
40-44	5.30	5.20	5.20
45-49	3.80	3.80	3.80
50-54	3.10	3.10	3.10
55-59	2.20	2.30	2.20
60-64	1.70	1.90	1.80
65-69	1.10	1.30	1.20
70+	1.80	2.30	2.00
Total	100.00	100.00	100.00
	638,863	628,337	1,267,200
	50.40	49.60	100.00

Source: INEGI, Sample of 10% Population and Housing Census, 2000.

In the Tijuana-Playas de Rosarito population pyramid, it is apparent that the population is relatively young, with approximately one-third (33 percent) falling within the group from 0 to 14 years of age, and another 31 percent falling within 15 to 29 age bracket.

The population in Tijuana and Playas de Rosarito is generally under-educated. Table 2-6 shows the educational levels for the population 5 years of age and older. Of this group, 49 percent has completed no more than primary school, including 5 percent that have no schooling or formal education whatsoever. Only 8 percent of the population has professional training, and only 0.5 percent has pursued graduate studies.

Table 2-6
Population 5 years of Age and Older by Educational Level and Gender, Tijuana-Playas de Rosarito, 2000

Education	Men %	Women %	Total %
None	4.70	5.40	5.00
Preschool or kindergarten	3.80	3.70	3.80
Primary	39.40	40.40	39.90
Secondary	25.60	25.30	25.50
High school	13.90	11.50	12.70
Normal school	0.00	0.20	0.10
Technical or commercial education	2.20	5.10	3.60
Professional	8.90	7.10	8.00
Master's degree or doctorate	0.50	0.40	0.50
Not Specified	0.90	0.90	0.90
Total	100.00	100.00	100.00
	555,139	549,763	1,104,902
	50.20	49.80	100.00

Source: INEGI, Sample of 10 percent Population and Housing Census, 2000

2.4 Existing Potable Water Systems

2.4.1 General Description

The Tijuana and Playas de Rosarito Potable Water System, managed by the State Commission for Public Services for Tijuana (Comisíon Estatal de Servicios Públicos de Tijuana, CESPT), consists of two aqueducts, two reservoirs, two water treatment plants, 8 operational groundwater wells in the Tijuana River / Alamar, La Misión and Rosarito aquifers, and a distribution system divided into conveyance lines, supply distribution pipelines, storage tanks, small pumping stations, and chlorination systems.

The primary sources of water in the study area are: (1) the Colorado River (Irrigation District 014); (2) the Río Tijuana/Alamar aquifer; (3) La Misión Aquifer; (4) the Rosarito Aquifer; (5) surface-water runoff captured in the El Carrizo and Abelardo L. Rodríguez Reservoirs.

In 2001, the Colorado River provided approximately 94.5 percent of the water supplied by CESPT, groundwater sources contributed 4.5 percent of the total, and surface runoff accounted for 1 percent. Playas de Rosarito's Aquifer Wells were out of service during most of 2001 because of seawater intrusion problems.

The Canal Alimentador (Feeder Canal), an open channel from the Morelos Reservoir located in Mexicali, from which it runs through 95 km. of canals in the Irrigation District 014, carries the Colorado River water, with a longitude of approximately 16 miles (26 km), to the control and sedimentation tanks at Pump Station No. 0 (PB-0), 9 miles (15 km) east of Mexicali, Baja California. The tanks have a capacity of 8.6 million gallons (32,750 m^3) (P.DES.INS.1996-2001).

The Colorado River water directly from the PB-0 (zero) is conveyed to Tijuana through a 70 miles (112 km) long aqueduct with a maximum capacity of 87.3 mgd (4

m^3/s), which controls a static load 3,478 feet (1,060 m) in height. After traveling 70 miles (112 km), the aqueduct's waters arrive at El Carrizo Reservoir, which has a storage capacity of 10,502 million gallons (40 million m^3). From El Carrizo Reservoir, the water is sent to El Florido Water Treatment Plant, which also has a designed capacity of 87.3 mgd (4 m^3/s).

Throughout its alignment, the aqueduct has six pump stations, each equipped in the following manner: 1 with 1500 HP, 2 with 8,000 HP and 3 with 3,000 HP, for a flow of 352 gals/s (1,333 l/s) for each unit (3 operate and one is in reserve). The aqueduct accounts for two tunnels of 4.3 and 2.4 miles (6.9 and 3.8 km). The pumps lift the water to 1,060 m.s.n.m., after which gravity carries it to El Carrizo Reservoir, where it is stored to eventually supply the El Florido Water Treatment Plant.

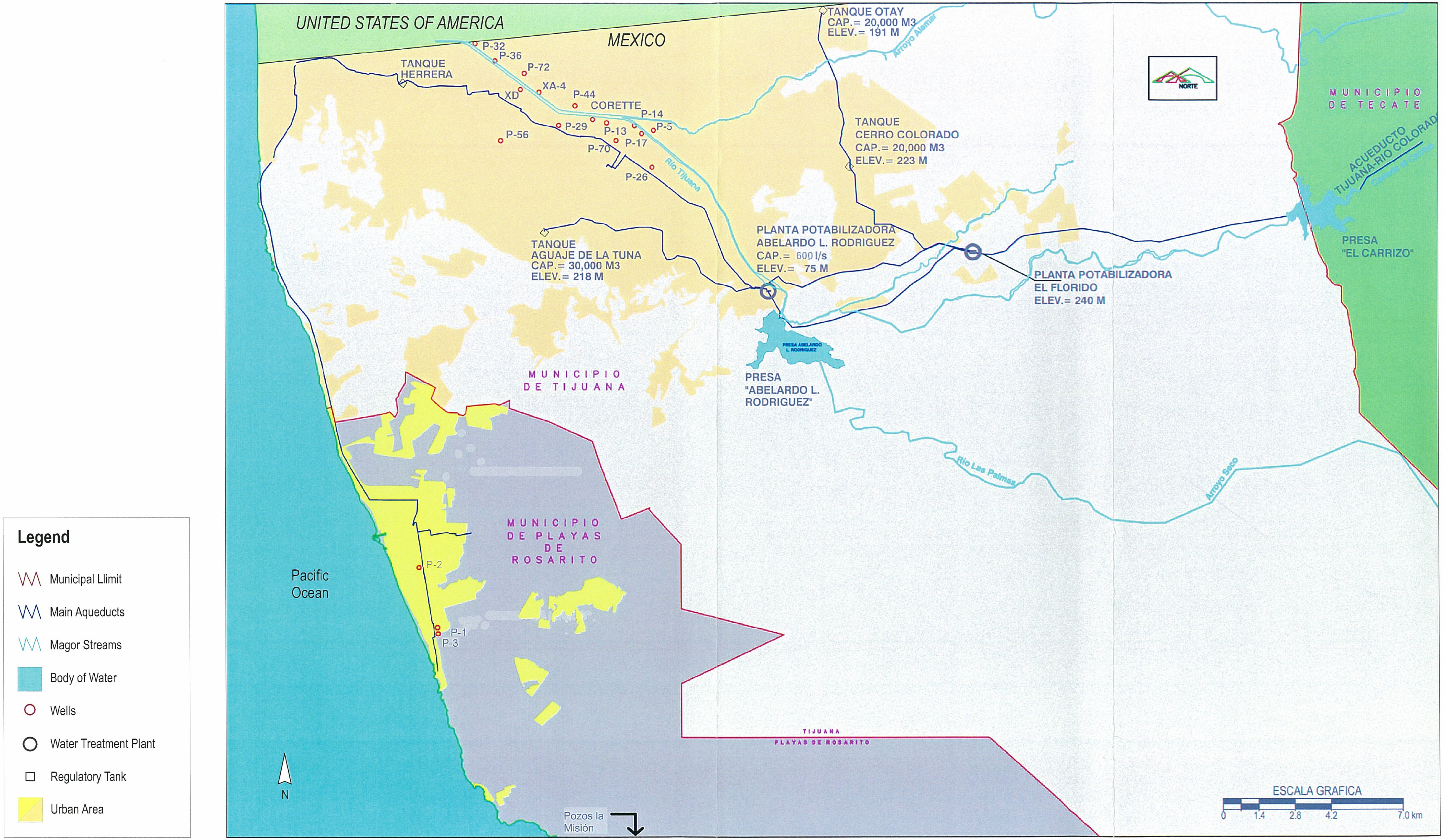
Some Colorado River water is occasionally sent from El Carrizo to Abelardo L. Rodríguez Reservoir for storage and eventual treatment in the Abelardo L. Rodríguez Water Treatment Plant, which has a designed capacity of 159 gal/s (600 l/s). The flow that goes to the Abelardo L. Rodríguez Reservoir varies depending on the demand for water at the El Florido Water Treatment Plant.

Groundwater extraction is achieved by using 15 wells, most located on the Río Tijuana/Alamar Aquifer and the remainder on the Playas de Rosarito and La Misión Aquifers. The water from the Río Tijuana/Alamar wells is previously chlorated to be injected into conveyance lines from the El Florido Water Treatment Plant and sent to control tanks. In the short term, part of the water will be conveyed to Los Olivos plant, where it is considered to be disinfected. The water from the Playas de Rosarito Aquifer is pumped directly to the distribution system. Finally, the water from the La Misión Aquifer is chlorinated and delivered by the La Misión-Playas de Rosarito Aqueduct to a control tank in Playas de Rosarito.

Besides the collection of water from the Colorado River and the region's aquifers, CESPT receives part of its supply from surface runoff captured in the Abelardo L. Rodríguez Reservoir, which has a capacity of 36,152 million gallons (137 million m^3), as well as runoff captured in El Carrizo Reservoir, which has 40 million cubic meters of storage capacity.

Figure 2-11 shows the location of the main sources of supply and principal potable-water aqueducts for Tijuana and Playas de Rosarito.

In 2001, CESPT registered a total of 327,753 water connections, 305,546 for residential use, 18,670 for commercial use, 2,493 for industrial use, and 1,098 for governmental use.



CDM

Figure 2-11
Current potable water sources for Tijuana and Playas de Rosarito

2.4.2 Sources, Quality, and Level of Treatment

Sources

As already mentioned, the principal sources of supply for Tijuana and Playas de Rosarito are the Colorado River, groundwater from the Río Tijuana/Alamar, La Misión, and Playas de Rosarito Aquifers, and, to a lesser degree, surface runoff captured by the Abelardo L. Rodríguez and El Carrizo Reservoirs.

Table 2-7 presents the volume of water supplied by each of these sources during 2001.

Table 2-7
Water Production (2001)

Source	m^3/year	l/s	%
Colorado River	98,809,994	3,133	94.5
Abelardo L. Rodríguez Reservoir [1]	1,184,427	38	1.1
Río Tijuana/Alamar Wells	2,288,145	73	2.2
La Misión Wells	1,601,086	51	1.5
Playas de Rosarito Wells	693,696	22	0.7
Total	**104,577,348**	**3,317**	**100.0**

[1] Includes rainwater volume and volume from the El Carrizo Reservoir.
Source: Maintenance and Operations Division (Dept. of electro mechanics and Office of Hydrometrics, 2001, CESPT).

The annual volume distributed for the study area in 2001 was 27,629 million gallons (104.6 million m³), equivalent to an average flow of 75,709 mgd (3.317 l/s). For a population of 1,330,498 in 2001, this corresponds to approximately 57 gal/inhab/day (215 l/hab/day) per person per day.

The water stored in the Abelardo L. Rodríguez Reservoir comes from the Colorado River Aqueduct or is captured from surface runoff from the Arroyo Seco, a tributary of the Tijuana River. Figure 2-13 shows the collection registered in Rodríguez Reservoir from December 2000 through January 2002, as well as the original source of the water.

Quality

At the Abelardo L. Rodríguez Water Treatment Plant, CESPT has a laboratory for analysis of water quality from the sources of supply. On a daily basis, this laboratory analyzes 35 samples of water taken from the treatment plants, wells, control tanks, and other points in the potable water distribution system.

Table 2-8 gives average values for influent and effluent water quality (annual average, maximum, and minimum values) at the El Florido Water Treatment Plant during 2001.

Table 2-8
2001 Monthly Average Water Quality Results – Influent and Effluent at El Florido Water Treatment Plant

Parameters	Units	2001 Influent Average	2001 Influent Minimum	2001 Influent Maximum	2000 Revised NOM 127 SSA1 1994	2001 Effluent Average	2001 Effluent Minimum	2001 Effluent Maximum
Odor		Odorless			Odorless	Odorless		
Taste					Tolerable	Tolerable		
Visible Color	ClPt	9	5	25	20 REAL	5	5	10
Turbidity	NTU	1.8	0.7	4.0	5	0.8	0.4	1.3
Aluminum	mg/l Al	<0.04			0.20	<0.04		
Arsenic	mg/l As				0.05	<0.04		
Total Cyanide	mg/l CN	<0.015			0.07	<0.015		
Residual Chlorine	mg/l Cl_2				0.2 - 1.5	2.61	2.50	3.00
Chlorides	mg/l Cl	148	131	169	250	151	140	170
Copper	mg/l Cu	<0.015			2.00	<0.015		
Total Chromium	mg/l Cr	<0.015			0.05	<0.015		
Detergents	mg/l SAAM	0.04	0.01	0.08	0.50	0.04	0.02	0.07
Overall Hardness	mg/l $CaCO_3$	337	320	370	500	340	318	364
Fluoride	mg/l F	0.64	0.55	0.68	1.50	0.57	0.07	0.69
Total Iron	mg/l Fe	<0.06			0.30	<0.06		
Manganese	mg/l Mn	0.10	<0.03	0.60	0.15	<0.033		
Mercury	mg/l Hg.				0.001	<0.00005		
Nitrates	mg/l N	1.07	0.80	2.00	10.00	0.96	0.50	1.60
Nitrites	mg/l N	0.02	<0.005	0.12	1.00	<0.005		
Ammoniac Nitrogen	mg/l N	0.30	<0.1	0.71	0.50	0.24	0.07	0.53
PH	pH	7.78	7.50	8.20	6.5 - 8.5	7.73	7.20	8.00
Lead	mg/l Pb.	<0.007			0.010	<0.007		
Sodium	mg/l Na	156	140	180	200	155	140	180
Total Dissolved Solids	mg/l	837	800	905	1000	837	800	920
Sulfates	mg/l SO_4	327	316	354	400	324	308	358
Zinc	mg/l Zn.	<0.04			5.00	<0.015		
Total Coliform Organisms	NPS/100 ML	91	0	>240	absent	<2		
Analyzed Parameters Not Covered by Mexican Regulations								
Total Alkalinity	mg/l $CaCO_3$	123	106	144		123	108	146
Boron	mg/l B	0.20	<0.07	0.70		0.23	<0.07	0.70
Calcium	mg/l Ca	78	70	85		78	70	92
Conductivity	uSiemens/cm	1,340	1,290	1,450		1,344	1,280	1,460
Chemical Oxygen Demand	mg/l O2					7.3	2.0	15.0
Calcium Hardness	mg/l $CaCO_3$	195	176	212		195	176	230
Magnesium Hardness	mg/l $CaCO_3$	142	120	160		140	128	162
Total Phosphate	mg/l PO4					0.04	0.04	0.04

Table 2-8
2001 Monthly Average Water Quality Results – Influent and Effluent at El Florido Water Treatment Plant

		2001 Influent			2000 Revised NOM 127 SSA1 1994	2001 Effluent		
Parameters	**Units**	**Average**	**Minimum**	**Maximum**		**Average**	**Minimum**	**Maximum**
Silver	mg/l Ag	<0.07				<0.07		
Magnesium	mg/l Mg	35	29	39		34	31	39
Silicon	mg/l SiO_2	12.09	10.80	12.90		12	11	14
Anion-Cation Difference	percent	0.3	0.5	0.8		0.2	-0.4	0.7

Source: Abelardo L. Rodríguez Reservoir Water Treatment Plant Laboratory, Dept. of Potable Water, Operations & Maintenance Division, CESPT, 2002.

According to the water quality results in Table 2-8, the monthly water quality averages meet the 2000 Revised NOM-127-SSA1-1994 regulations for the routinely measured parameters, with the exception of residual chlorine. The monthly average for residual chlorine for the water that leaves the plant ranges from 2.5 to 3.6 mg/l. The regulations only require meeting a maximum of no more than 1.5 mg/l of residual chlorine. Nevertheless, as discussed in the report evaluating the existing conditions (Section 3 of the master plan), the El Florido Water Treatment Plant has rapid filters, which do not allow sufficient time to achieve disinfection. Higher residual chlorine concentrations in the water from the plant guarantee a minimum concentration of 0.2 mg/l residual chlorine, established by the regulations, might be maintained throughout the distribution system. One of the disadvantages of having such a high concentration of residual chlorine is a possible increase in the formation of carcinogenic compounds. Nevertheless, no information is available that analyzes organic materials present in the water, including total trihalomethanes (which according to Mexican regulations must be less than 0.2 mg/l). As already explained, it is impossible to provide a specific evaluation of the impacts of residual chlorine.

Although the monthly water quality results in Table 2-8 meet the 2000 Revised NOM-127-SSA1-1994 regulations for the regularly analyzed parameters, it would be useful to carry out an optimization study for plant operation. Such a study could identify operational improvements and minor capital investments with the potential for significantly improving operation and reliability. These improvements might also potentially create opportunities to increase plant capacity through minor investments. This will be discussed in greater detail in Section 3 of the master plan, in the plant valuation.

Table 2-9 shows the results of the physical and chemical analyses performed in 2001 on wells operating in the Río Tijuana/Alamar, La Misión, and Playas de Rosarito Aquifers. This summary contains only the wells for which there were at least 4 months of data (Wells 3, 36, 56, 17, and 14 for Río Tijuana/Alamar, Wells 4 and 5 for La Misión, and Wells 1 and 3 for Playas de Rosarito). In general, the water extracted from the Río Tijuana/Alamar Aquifer has more coloration and turbidity than that of the other aquifers. This implies that the aquifer is infiltrated by surface water at certain points. However, the reported levels of fecal coliform are less than 2 NMP/100 ml. This water extracted from Rio Tijuana/Alamar and the Playas de Rosarito aquifer is chlorinated, and the samples are taken before chlorination (INF.PER.TEC. 2001). All the waters sources contain concentrations higher than the limits established by the Mexican regulations for chloride and sodium. The highest levels of iron and manganese are in the Río Tijuana Aquifer Wells, and the highest levels of fluorine were in the La Misión Wells. In both cases, these concentrations were greater than the limits set by the Mexican official regulations (Norma Oficial Mexicana, NOM). It seems the Playas de Rosarito Wells have problems with high concentrations of manganese. As anticipated, the Playas de Rosarito wells have the highest levels of total dissolved solids, sodium, chloride, and overall hardness, which can be attributed to the wells' proximity to the ocean and seawater intrusion. The samples taken for the analysis were primarily from the first six months of 2001.

Table 2-9
Year 2001 Monthly Average Water Quality Results – Well Water

Parameters	Units	2000 Revised NOM 127 SSA1 1994	Río Tijuana/Alamar Aquifer			La Misión Aquifer			Playas de Rosarito Aquifer		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
Odor		Odorless	Odorless			Odorless			Odorless		
Taste		Tolerable	Tolerable			Tolerable			Tolerable		
Visible Color	ClPt	20 REAL	11.1	5.0	30.0	5.0	5.0	5.0	5.6	5.0	10.0
Turbidity	NTU	5	2.0	0.2	11.6	0.7	0.1	1.1	0.8	0.4	2.5
Aluminum	mg/l Al	0.20	<0.04			<0.04			<0.04		
Arsenic	mg/l As	0.05	<0.04								
Total Cyanide	mg/l CN^-	0.07	0.020		0.066	<0.015			<0.015		
Residual Chlorine	mg/l Cl2	0.2 - 1.5	1.1	0.2	3.2				0.9	0.2	3.0
Chlorides	mg/l Cl	250	580	320	880	374	350	412	1,511	354	3,620
Copper	mg/l Cu	2.00	<0.015		0.021	<0.015			<0.015		0.022
Total Chromium	mg/l Cr	0.05	<0.015			<0.015			<0.015		
Detergents	mg/l SAAM	0.50	0.14	<0.015	0.28	0.03	0.01	0.07	0.04	<0.015	0.10
Overall Hardness	mg/l CaCO3	500	749	144	1,360	149	100	234	1,322	700	3,500
Fluorides	mg/l F	1.50	0.79	0.36	1.25	5.06	3.47	6.70	0.50	0.33	0.64
Total Iron	mg/l Fe	0.30	0.32	<0.06	4.40	<0.06		0.11	<0.06		
Manganese	mg/l Mn	0.15	0.48	<0.033	0.87	<0.033		0.04	0.16	<0.033	1.50
Mercury	mg/l Hg.	0.001	<0.00005								
Nitrates	mg/l N	10.00	1.74	0.60	5.80	0.85	0.60	1.80	2.57	1.60	4.00
Nitrites	mg/l N	1.00	0.063	<0.005	0.53	0.021	<0.005	0.078	0.008	<0.005	0.134
Amoniac Nitrogen	mg/l N	0.50	0.84	0.00	2.43	0.19	0.03	0.52	1.62	0.23	6.10
PH	pH	6.5 - 8.5	7.0	6.8	7.1	7.3	6.9	8.4	7.0	6.8	7.1
Lead	mg/l Pb.	0.010	<0.007			<0.007			<0.007		
Sodium	mg/l Na	200	357	290	425	298	250	390	478	160	1,100
Total Dissolved Solids	mg/l	1000	1,800	1,000	2,400	993	895	1,080	3,218	1,340	6,700
Sulfates	mg/l SO4	400	310	138	480	166	88	210	336	160	516
Zinc	mg/l Zn.	5.00	<0.015		0.168	0.063	<0.04	0.161	0.522	0.056	1.970
Total Coliform Organisms	NPS/100 ML	absent	<2			<2			<2		
Analyzed Parameters Not Covered by Mexican Regulations											
Total Alkalinity	mg/l CaCO3		393	210	538	56	36	70	255	126	350
Boron	mg/l B		0.58	<0.07	2.20	3.13	1.40	4.40	0.79	<0.07	1.90
Calcium	mg/l Ca		184	40	324	44	35	62	382	160	857
Conductivity	uSiemens/cm		2,993	1,700	4,000	1,597	1,420	1,690	5,524	2,200	11,610
Chemical Oxygen Demand	mg/l O2		226	1	560	114	110	118	503	400	680
Calcium Hardness	mg/l CaCO3		406	42	810	75	34	154	887	300	2,140

Table 2-9
Year 2001 Monthly Average Water Quality Results – Well Water

Parameters	Units	2000 Revised NOM 127 SSA1 1994	Río Tijuana/Alamar Aquifer			La Misión Aquifer			Playas de Rosarito Aquifer		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
Magnesium Hardness	mg/l CaCO3		228	10	550	23	8	80	603	72	1,620
Total Phosphate	mg/l PO4		0.08								
Silver	mg/l Ag		<0.07			<0.07			<0.07		
Magnesium	mg/l Mg		80	47	107	9	2	19	271	135	393
Silicon	mg/l SiO2		25	18	122	54	8	116	58	11	117
Anion – Cation Difference	%		-0.19	-1.90	1.20	0.35	-0.10	1.30	-0.13	-1.20	1.20

Source: Abelardo L. Rodríguez Reservoir Water Treatment Plant Laboratory, Dept. of Potable Water, Operations and Maintenance Division, CESPT, 2002.

Table 2-10 summarizes the results of the monitoring done on the Reforma, Aguaje de la Tuna, Francisco Villa 4 and Herrera Control Tanks (CESPT, 2000 and 2001).

Table 2-10
Parameter Averages Found in Tanks Monitored by CESPT

Characteristic	Reforma Tank	Aguaje de la Tuna Tank	Francisco Villa Tank 4 1/2	Herrera Tank	NOM-127-SSA1-1996
Turbidity (NTU)	2.0	1.0	0.9	1.1	5
Residual Chlorine (mg/l)	1.6	1.5	1.4	1.6	0.2 - 1.5
Chlorides (mg/l)	125	152	153	153	250.0
Manganese (mg/l)	0.02	0.01	0.01	0.02	0.15
PH	7.8	7.8	7.7	7.7	6.5 - 8.5
Total Dissolved Solids (mg/l)	829	837	844	846	1,000

Source: Abelardo L. Rodríguez Reservoir Water Treatment Plant Laboratory, Dept. of Potable Water, Operations and Maintenance Division, CESPT, 2002.

In Table 2-10, note that the turbidity in the Herrera Control Tank is high when compared to the El Florido Water Treatment Plant effluent. Some of the water stored in the Herrera Control Tank comes from wells, and the well water might have a higher level of turbidity. High turbidity in the wells is an unusual condition and is generally due to the groundwater coming in direct contact with surface water, which means that disinfection should be considered a priority for the water in these wells.

Finally, to monitor concentrations of residual chlorine, CESPT has 36 sampling points in the distribution system for Tijuana and 11 in the system for Playas de Rosarito. Table 2-11 shows the results of the samples taken at these sites.

Table 2-11
Average Levels of Residual Chlorine
Found at Monitoring Points in the Potable Water System

Sampling Site	Average Residual Chlorine (mg/l)
Rodríguez Reservoir Water Treatment Plant Fraccionamiento Tona	1.50
Calle Cerro Colorado and Monte Horeb Col. Lomas de la Presa	0.70
Ave. García and Calle Rey Leonardo Frac. Los Reyes Azteca	0.80
Ave. Mayapán and Calle Monte Alban Frac. Azteca	1.50
Ave Cerro Colorado and Calle Tecate Frac. C. Colorado 2da. Sección.	1.30
Ave. Miguel Alemán and Vicente Guerrero Infonavit Presidentes	1.20
Ave Paredones Calle Japa Fraccionamiento Guaycura Ampliación 1er Sección	1.70
Paseo del Cucapah and Ave. La Bufadora, Fraccionamiento Guaycura Ampl. 2da Sección	1.50
Blvd. De las Joyas and Ave. Brillante Fraccionamiento Los Álamos	0.30
Ave. Venustiano Carranza and Heriberto Jara, Fraccionamiento Otay Sección Constituyentes	0.80
Ave. Bellas Artes and Lic. José L. Portillo Poniente Fraccionamiento Los Módulos	1.00
Calzada del Tecn. And Ave. de Los Químicos, Fraccionamiento Otay Sección UABC	0.80

Table 2-11
Average Levels of Residual Chlorine
Found at Monitoring Points in the Potable Water System

Sampling Site	Average Residual Chlorine (mg/l)
Ave. Defensores de la Baja California and C. Kepter Colonia López Leyva	0.80
Ave. Constelación and Alectra, Fraccionamiento Alfonso Garzón	0.60
Calle Ignacio Ramos and Ave. Azueta Col. Libertad	0.50
Paseo Reforma and Calle Panameños, Fraccionamiento Latino	0.80
Ave. De las Huertas and Calle Higo. Fraccionamiento Las Huertas 2da Sección	0.60
Ave. Baja California and Mayorca, Fraccionamiento Chapultepec California	0.80
Ave. Ermita ky Coral Fraccionamiento Carlos	0.60
Blvd. De las Américas and Calle Brasilia Fraccionamiento El Paraíso	1.00
Colonia Chinacos and Tehuacan, Fraccionamiento Colinas de Agua Caliente	1.80
Ave. De Los Olivos and Calle Ébano Col. Cubilla Sur	1.00
Ave. Cuauhtemoc and Ave. Paseo de Los Héroes, Zona Urbana Río Tijuana	1.20
Calle 3ra Carrillo Puerto and Avenida Const. Zona Norte	1.4
Ave. 18 de Marzo and Calle Francisco Márquez Col. Hidalgo	1.00
Calle Club 20 30 and Guanajuato Cañón México	0.80
Ave. Donato Guerra and Profesor Francisco Hernández. 1de mayo	0.80
Ave. Abelardo L. Rodríguez and Calle. A Bustamante Fraccionamiento. Jardines del Rubí	0.70
Ave. Del Encino and Calle Cedro, Col. Manuel Paredes 1er Sección.	0.60
Ave. Esthela Pavón and Rodolfo Landa, Fraccionamiento Miramar	1.00
Bahía del Rosario and la Bufadora, Fraccionamiento El Mirador	1.30
Ave. Parque México and Paseo Playas de Tijuana Fraccionamiento. Playas Sección Costa	0.70
Ave. Lisboa and Calle Reforma, Fraccionamiento Playas Sección Cantineros	1.00
Ave. Braulio Maldonado and Calle Culiacán, Fraccionamiento Soler	0.5
Ave. Venustiano Calle. and Ave. Josefa Ortiz de Domínguez Col. Castillo	0.5
Ave. Boulevard and Calle Jazmín, Fraccionamiento El florido	1.00
Playas de Rosarito	
Lagunas Aireadas	---
Pina Norte	0.80
Calle Naranja	0.70
Calzada de la Playa	1.00
Vía de las Olas	0.80
Calle Federico Siordia	0.60
Delegación Playas de Rosarito	0.80
Calle Mar del Norte	0.70
Calle Ciprés	1.00
Calle Federico Froebel	0.80
Cobach	0.60

Source: Abelardo L. Rodríguez Reservoir Water Treatment Plant Laboratory, Dept. of Potable Water, Operations and Maintenance Division, CESPT, 2002.

Of the 36 sampling points in the city of Tijuana, only one in 2001 exceeded the maximum permissible limit for annual average residual chlorine. In addition, the annual averages for all 11 sites in Playas de Rosarito were within the range permitted by NOM regulations.

The results of the monitoring of residual chlorine concentrations in the water distribution system are periodically delivered to the Environmental Health Department (Secretaría de Salubridad y Asistencia, SSA).

Treatment Levels

Surface Water Treatment
Surface water from the Colorado River and runoff captured by the El Carrizo and Abelardo L. Rodríguez Reservoirs is treated respectively at the El Florido and Abelardo L. Rodríguez Water Treatment Plants. A detailed description of current water treatment conditions in the study area is presented in Section 3 of the master plan.

The El Florido Water Treatment Plant is located in the southeastern part of the city at an elevation of 801 feet (244 m) above sea level, and it was a designed with a capacity for treating 87.3 mgd (4 m^3/s) in two treatment modules of 52.4 mgd (2 m^3/s) each. Because of its high elevation, it topographically dominates most of the distribution system.

This plant's first module has flocculation, a pulsator type of clarificator (super-pulsator), rapid filtration, and chlorination. The second module, however, consists of a direct filtration process.

The Abelardo L. Rodríguez Water Treatment Plant has a designed capacity of 159 gal/s (600 l/s), although it is currently limited by its internal pumping capacity, so that it has a real capacity of 145 gal/s (550 l/s) (CESPT, 1985-1993).

The Abelardo L. Rodríguez Water Treatment Plant utilizes a conventional treatment process, which consists of pre-chlorination, coagulation, sedimentation, filtration, and post-chlorination.

Finally, the plant at La Misión, to the south of Playas de Rosarito, is a conventional type. It was built to treat water coming from the La Misión Wells. It was designed to have a capacity of 87 gal/s (330 l/s), although currently it is out of operation and is used solely to chlorinate the well water prior to sending it through the distribution network.

Groundwater Treatment
Groundwater extracted from the Río Tijuana/Alamar Wells is fed into the distribution network with chlorination treatment. In the system, this water mixes with water coming from the El Florido plant, and it arrives at the Lázaro Cárdenas, Morelos, and Herrera Re-Pumping Stations, where it is analyzed to verify its residual chlorine content. The well water from La Misión is chlorinated before being sent to Playas de Rosarito.

The Playas de Rosarito Aquifer Wells were out of operation for most of 2001, due to seawater intrusion.

2.4.3 Aggregate Water Usage

The CESPT customer registry classifies users based on four types of connections: residential, commercial, industrial, and governmental. Residential users are not subdivided according to socioeconomic status, as is done in other parts of Mexico.

Table 2-12 shows the number of accounts and the annual average billing volume for 1997-2001.

Table 2-12
Volume Invoiced by Year and Number of CESPT Registered Customer Accounts

	Year				
Service	**1997**	**1998**	**1999**	**2000**	**2001**
			Number of Users		
Residential	224,025	248,353	269,898	285,805	305,546
Commercial	13,499	14,602	15,863	17,303	18,670
Governmental	703	784	864	959	1,098
Industrial	1,653	1,815	2,021	2,257	2,439
Total	239,880	265,554	288,646	306,324	327,753
			Volume Invoiced		
	(thousands of m³)	**(thousands of m³)**	**(thousands of m³)**	**(thousands of m³)**	**(thousands of m³)**
Residential	49,517	51,858	55,785	59,917	60,240
Commercial	6,951	7,108	7,396	8,011	8,107
Governmental	2,904	3,142	2,940	3,630	3,423
Industrial	6,432	5,935	6,792	8,380	8,233
Total	**65,804**	**68,043**	**72,913**	**79,938**	**80,003**

Source: Department of Micro-measures, Commercial Division, CESPT, 2002.

The volume invoiced in 2001 was equivalent to 76.5 percent of the water produced, which is shown in Table 2-7.

Table 2-13 shows an estimate of consumption and supply of potable water for 2001.

Table 2-13
Estimated Consumption and Supply of Potable Water, 2001

Population	
Population in the study area (thousands):	1,330.5
Population with Potable Water (%):	94.6 %
Population with Potable Water Connections (thousands):	1,258.80
Land Use	
Residential Area (ha):	18,001
Total Urban Area (ha):	25,292
Unit Water Demand	
Residential Water Consumption (l/person/day):	131
Industrial Consumption of water (Industrial Parks)(%):	6.51
Specific Industrial Water Consumption (m³/day):	11,280
Commercial Consumption of water (Commercial areas)(%):	10.64
Specific Commercial Water Consumption (m³/day):	4,443
Governmental Consumption Distributed in Residential Areas (%):	5.68
Water Supplied by Trucks or Hydrants to Unplanned Residential Areas (m³/day):	4,900
Overall Consumption to Fight Fires, Clean Collectors (%):	2.28
Water Loss	
Physical Water Loss, Colorado River Aqueduct-El Florido Water Treatment Plant (%):	10.00
Physical Loss during Water Treatment (%):	0.02
Water Unaccounted for in Water Distribution (%):	23.50
Loss in Residential Land (%)	0.00
Loss in the Sewer System (%):	14.41
Loss in Wastewater Treatment or Recycled Water (%):	2.50

Source: Elaborated for the study.

CESPT provides water for irrigation of green areas (parks, gardens, and median strips). There are other green areas, such as golf courses, open spaces, sports fields, and industrial parks, which are watered with the discharge from private wastewater treatment plants. In the study area, no water is used for agricultural irrigation; therefore no data is included here relating to that topic.

2.4.4 Level of Service

As presented in Table 2-13, in 2001 CESPT had 305,546 residential water connections. According to the 2000 Census, the household density index in the study area is 4.12 people per household. Multiplying the number of connections by the index, one can obtain the serviced population, which is 1,258,850, which in turn corresponds to 94.6 percent of the population.

For the remaining commercial, governmental, and industrial CESPT customers, service coverage is 100 percent for both cities.

However, the INEGI has obtained results on the level of service coverage based the 2000 Census. Note that the levels of coverage INEGI presents are lower than the calculations based on the number of connections registered with CESPT. The discrepancy may result from the fact that INEGI uses data from 2000, and CESPT data is from 2001. In addition, the CESPT registry includes repeated and out-of-service accounts. Table 2-14 summarizes the results of the 2000 Census in regard to service coverage.

Table 2-14
Service Coverage Reported by INEGI for 2000

Parameters	Tijuana		Playas de Rosarito	
	Number	% of the total	Number	% of the total
Residences	265,683	100	13,134	100
Occupants	1,096,731	100	53,957	100
Occupancy Index	4.13		4.11	
Residences with potable-water connections	188,563	71	6,909	53
Residences with sewer connections	200,067	75	3,485	27
Residences with septic tanks	21,763	8	6,945	53
Residences without sewage services	43,853	17	2,704	20

Source: 2000 Census, INEGI

2.5 Description of the Current Wastewater Disposal System

2.5.1 General Description

The wastewater disposal system for the cities of Tijuana and Playas de Rosarito consists, in general terms, of a collection system made up of water conduits, main and secondary sewers, interceptors, emitters, small pump stations, wastewater treatment plants, and conveyance lines that transport the collected water to treatment plants.

Most of the sewer collection system's service area is located within the Tijuana River basin, which crosses the city and extends into the United States, ultimately flowing into the Pacific Ocean (Figure 2-12). The topography of Tijuana causes the city's drainage to run naturally toward the Tijuana River and beyond to the United States. Nevertheless, various infrastructure works intercept the water flow within Mexican territory for its eventual delivery to the San Antonio de Los Buenos Wastewater Treatment Plant, located in southern Tijuana.

The remaining wastewater collected within the Tijuana River basin, at approximately 291 gal/s (1,100 l/s), flows toward the United States for its eventual treatment in the South Bay International Wastewater Treatment Plant (SBIWTP), located in San Diego. The treated water is discharged into the Pacific Ocean through an underwater ocean outfall pipe.

The wastewater generated in areas of the city outside the Tijuana River basin flows naturally within Mexican territory toward the Pacific Ocean. Some of this water is treated before being discharged into the ocean. Playas de Rosarito has its own treatment plant based on aerated ponds, with a designed capacity of 24 gal/s (90 l/s) (P.DES.INS. 1996-2001). Similarly, the San Antonio del Mar and Puerto Nuevo Treatment Plants have capacities of 0.7 and 0.4 gal/s (25 and 1.5 l/s), respectively.

2.5.2 Service Levels

In 2001, CESPT recorded 276,039 discharge connections to the sewer collection system. Of these, 254,763 were residential, 17,914 commercial, 2,335 industrial, and 1,027 governmental.

The number of residential accounts in 2001 (264,078) represents 79 percent of all residential buildings in Tijuana and Playas de Rosarito in that year.

Of the total population, 21 percent does not have access to the sewer collection system and depend instead on latrines, septic tanks, and open-air discharges to satisfy their wastewater disposal needs. Some private companies provide septic tank cleaning with tankers or cistern trucks. The material produced in the cleaning is transported to treatment plants operated by CESPT for treatment and disposal.

2.5.3 Treatment and Disposal Levels

In the study area, there are five wastewater treatment plants, which vary in capacity from 0.4 to 291 gal/s (1.5 to 1,100 l/s). Two plants treat wastewater from Tijuana, one treats wastewater from Playas de Rosarito, and the remaining two serve San Antonio del Mar and Puerto Nuevo. The last two plants are of less relevance to the development of this plan, due to their location and low treatment capacity. Figure 2-13 shows the location of the five treatment plants.

The wastewater generated in Tijuana is treated in the San Antonio de Los Buenos Wastewater Treatment Plant, located 11 miles (18 km) south of Tijuana, next to the

Pacific Ocean, and in the SBIWTP, located in San Diego. The SBIWTP, despite its U.S. location, treats exclusively the flows generated by Tijuana.

The area's topography provides a natural canalization of the wastewater, leading it to the Río Tijuana and ultimately to the United States. Pumping plant PB-1 is located near the border and intercepts part of the wastewater flow for its eventual transmission to San Antonio de Los Buenos. Gravity carries the rest of the flow to SBIWTP.

Both plants discharge their wastewater into the ocean. San Antonio de Los Buenos Wastewater Treatment Plant uses an open channel that leads directly to the coast, while SBIWTP uses an underwater outfall that discharges 2.9 miles (4.8 km) out to sea.

SBIWTP provides advanced primary treatment, and it has an average capacity of 291 gal/s (1,100 l/s). In the future a secondary treatment module will be built, although the type of secondary treatment has yet to be determined.

The San Antonio de Los Buenos Plant is based on an aerated pond system and is designed for an average flow of 198 gal/s (750 l/s). It is currently undergoing renovation that will increase its treatment capacity to an average of 291 gal/s (1,100 l/s). The renovation consists primarily of the addition of more superficial aerators to the aerating ponds and in the division of the sedimentation tank. The renovation began in December 2001 and will be completed in 2003.

On average 334 gal/s (1,265 l/s) of wastewater arrived at the plant during 2001. Approximately 97 gal/s (366 l/s), or 29 percent of the flow, eludes the treatment process. This wastewater is chlorinated and mixed with the discharge from the treatment system before being released into the ocean. The plan is with the in-progress expansion project, the untreated water will also be treated in the near future.

Three Official Mexican Regulations, (Normas Oficiales Mexicanas, NOMs), establish the maximum allowable limits for wastewater discharges, depending on the recipient body of water or the use to which the wastewater will be put. NOM-001-ECOL-1996 sets the maximum allowable municipal discharges to the nation's bodies of water. NOM-002-ECOL-1996 sets maximum concentrations for discharges to sewer systems, particularly industrial discharges. NOM-003-ECOL-1997 sets the quality standards for recycled wastewater.

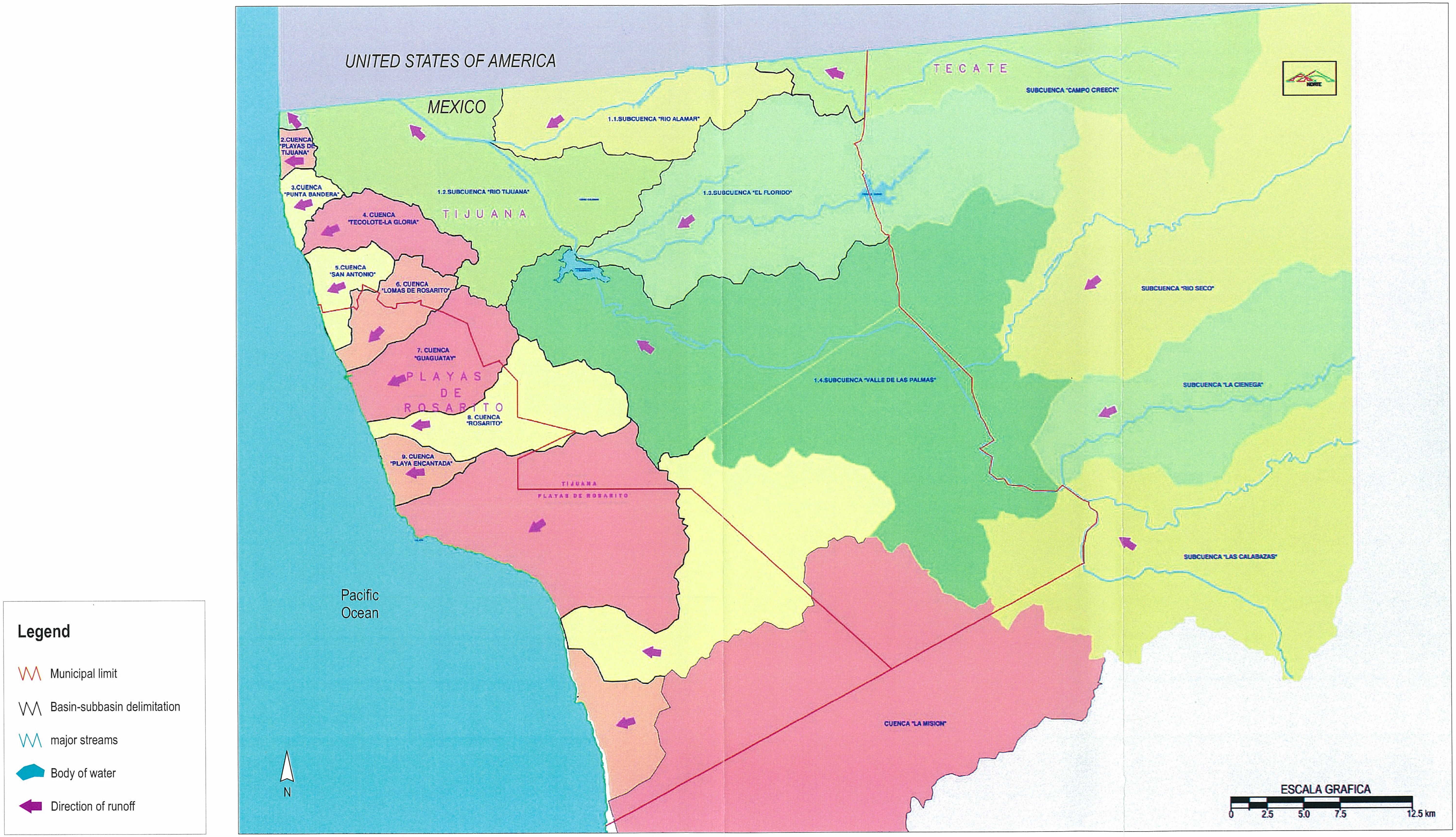


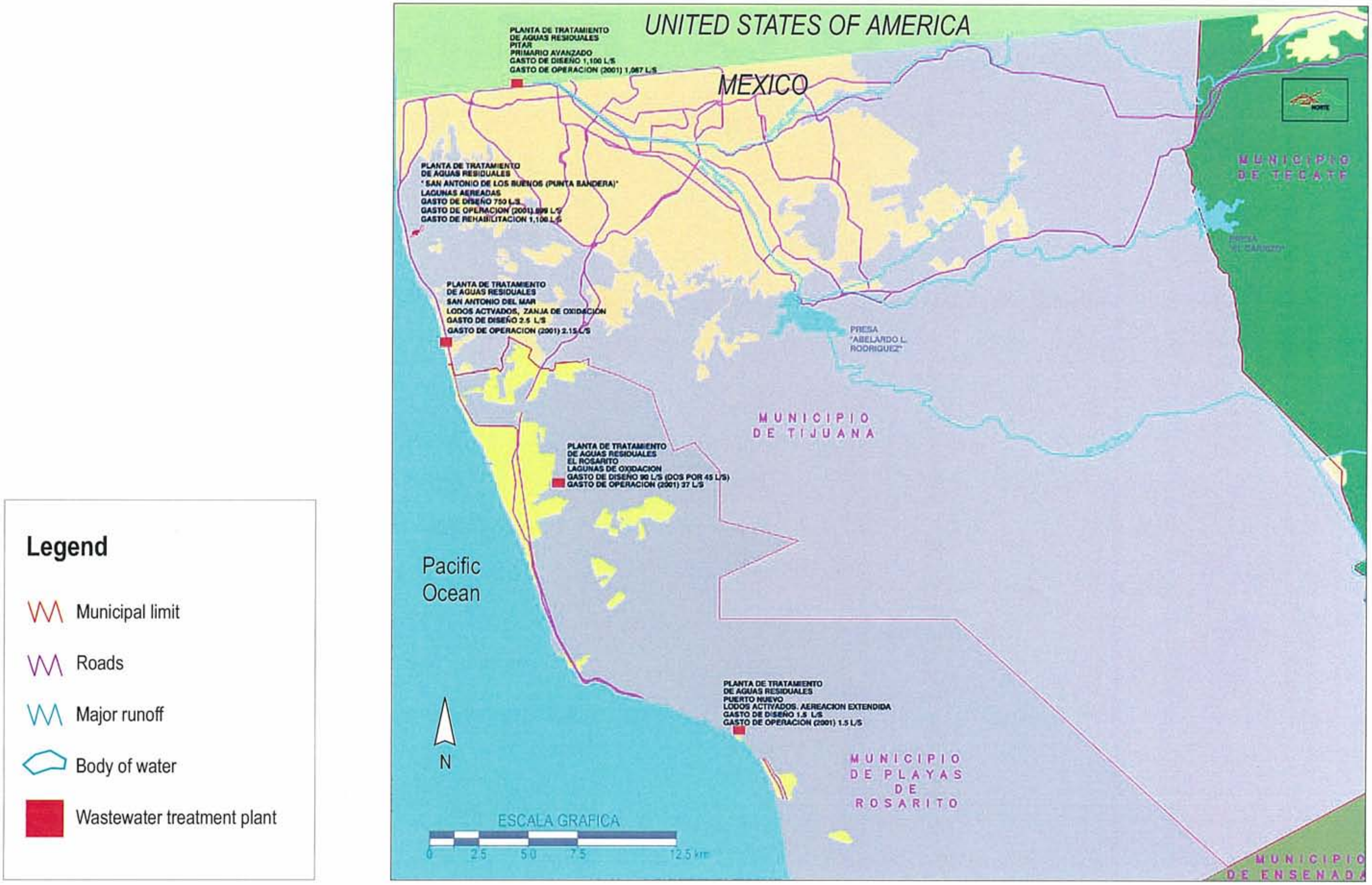
Figure 2-12
Hydrological basins of Tijuana and Playas de Rosarito

Tables 2-15, 2-16 and 2-17 show the parameters that each NOM has set and the maximum allowable limits.

Table 2-15
Maximum Allowable Limits for Discharges to Recreational-Use Coastal Waters
NOM-001-ECOL-1996

Parameters (mg/l, except where otherwise specified)	Monthly Average	Daily Average
Temperature (°C)	40	40
Grease and Oil	15	25
Floating Matter	Absent	Absent
Sedimented Solids (ml/l)	1	2
Total Suspended Solids	75	125
Biochemical Oxygen Demand ($BCOD_5$)	75	150
Total Nitrogen	N.A.	N.A.
Total Phosphorous	N.A.	N.A.
Total Arsenic	0.2	0.4
Total Cadmium	0.2	0.4
Total Cyanide	2.0	3.0
Total Copper	4.0	6.0
Total Chromium	1	1.5
Total Mercury	0.01	0.02
Total Nickel	2	4
Total Lead	0.5	1
Total Zinc	10	20
Fecal Coliform (MPN)/100 ml)	1000	2000

Source: Federal Environmental Protection Agency. Published in the Diario Oficial de la Federación on January 6, 1997.
Secretary of the Environment, Natural Resources, and Fishing (SEMARNAP).



CDM

Figure 2-13
Existing wastewater treatment plants in the area of study

Table 2-16 Maximum Allowable Limits for Contaminants in Wastewater Discharges to Urban or Municipal Sewer Collection Systems NOM-002-ECOL-1996			
Parameters (mg/l)	Monthly Average	Daily Average	Instantaneous
Grease and Oil	50	75	100
Sedimented Solids	5	7.5	10
Total Arsenic	0.5	0.75	1
Total Cadmium	0.5	0.75	1
Total Cyanide	1	1.5	2
Total Copper	10	15	20
Hexavalent Chromium	0.5	0.75	1
Total Mercury	0.01	0.015	0.02
Total Nickel	4	6	8
Total Lead	1	1.5	2
Total Zinc	6	9	12

Source: Federal Environmental Protection Agency. Published in the Diario Oficial de la Federación on June 3, 1998.
Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP).

Table 2-17 Maximum Allowable Limits for Contaminants in Treated Wastewater for Public Re-Use NOM-ECOL-003-1997					
	Monthly Average				
Type of Re-Use	Fecal Coliform MPN/100 ml	Helminth Eggs (eggs/l)	Grease and Oil (mg/l)	$BCOD_5$ (mg/l)	Total Suspended Solids (mg/l)
Direct Contact Services	240	≤ 1	15	20	20
Indirect or Occasional Contact Services	1,000	≤ 5	15	30	30

Source: Procuraduría Federal de Protección al Ambiente. (Federal Environmental Protection Agency). Published in the Diario Oficial de la Federación on September 21, 1998.
Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP).

The 2001 data provided by CESPT show that the collection of wastewater in Tijuana averaged 1,589 million gallons/month (6,017,130 m³/month) and 25.5 million gallons/month (96,384 m³/month) in Playas de Rosarito. The first set of data was obtained by measurements made by CEPST personnel in the wastewater pump stations. Of this volume, 1,355 million gallons/month (5,130,210 m³/month) was treated in Tijuana and San Diego, and 25.5 million gallons/month (96,384 m³/month) was treated in Playas de Rosarito, which represents 85 percent of the wastewater captured in Tijuana and 100 percent of that captured in Playas de Rosarito.

Note that the volume of wastewater captured and measured is not necessarily equal to the volume generated, presumably residual flows exist that do not reach the sewer collection system or which exit as leaks and overflows prior to reaching the pump station or treatment plants.

The percentages of treated water mentioned earlier correspond to water measured at the various CESPT control points, including Arroyo Alamar and Río Tijuana. The flow in these riverbeds includes storm runoff and upstream wastewater discharges. In the areas of Tijuana that are without access to the sewer system and in Tecate the average rate of flow is 140 l/s. The Río Tijuana waters are intercepted in the CILA pump station, from which they are sent to the San Antonio de Los Buenos Wastewater Treatment Plant.

According to agreements between Mexico and the United States, the CILA station pumps less than 132 gal/s (500 l/s), while flows greater than 132 gal/s (500 l/1) which correspond to the flow of the river during storms, are allowed to flow toward the United States and discharge into the ocean.

The sludge volume generated at the SBIWTP is 0.02 mgd (90 m³/day), less than what was calculated in the executive project of 110 m³/day. The sludge from this plant is sent to Mexico for its disposal within the territory of the plant. In addition, the sludge produced in the San Antonio de Los Buenos Plant is accumulated in ponds, from which it is rarely removed.

Table 2-18 shows the plants that CESPT operates, and their designed and actual rates of flow.

Table 2-18
Wastewater Treatment Plants Operated by CESPT

No.	Wastewater Treatment Plant	Designed Rate of Flow (l/s)	Actual Rate of Flow (2001) (l/s)
1	SBIWTP	1,100	1,100
2	San Antonio de Los Buenos	750	899
3	Playas de Rosarito	90	37
4	San Antonio del Mar	2.5	2.2
5	Puerto Nuevo*	1.5	1.5
	Total	**1,944**	**2,040**

* The data for this plant are for 2002; (plant received by CESPT in December of 2001)
Source: Sewage Division, CESPT.

2.5.4 Wastewater Discharge Regulations

As mentioned above, NOM-001-ECOL-1996 sets the maximum allowable limits for wastewater discharges to the nation's bodies of water. Nevertheless, National Water Commission (CAN), can establish Particular Conditions of Discharge (PCDs) for specific treatment plants. Where PCDs exist, they take precedence over the NOM regulations.

CESPT has a document specifying PCDs issued by the CNA for the San Antonio de Los Buenos and Playas de Rosarito Wastewater Treatment Plants, summarized in Tables 2-19 and 2-20.

Table 2-19
Particular Conditions of Discharge from the San Antonio de Los Buenos Wastewater Treatment Plant

Parameters	Unit	Average Concentration	Maximum Instantaneous Concentration	Discharge (kg/day)
$BCOD_5$	mg/l	30	45	3,888
$BCOD_{sol}$	mg/l	20	25	
DQO	mg/l	100	140	12,960
TSS	mg/l	30	40	3,888
pH	Units		not less than 6.5 nor greater than 8.5	
Temperature	°C		30	
Sedimented Solids	mg/l	1.0	1.2	
Grease and Oil	mg/l	10	15	1,269
Floating Matter	mg/l		absent	
Ammoniac Nitrogen	mg/l	10	15	
Total Kjeldahl Nitrogen	mg/l	20	25	2,592
Total Phosphates	mg/l	8	10	
Inorganic Phosphorous	mg/l	6	8	
SAAM	mg/l	5	8	
Fluoride	mg/l	1.15	1.25	
Sulfates	mg/l	131	138	
RAS	Units		5	
Conductivity	µohms/cm	1,270	1,455	
Total Hardness	mg/l	300	314	
Total Alkalinity	mg/l	255	273	
Arsenic	mg/l	0.5	0.75	
Cadmium	mg/l	0.05	0.075	
Hexavalent Chromium	mg/l	0.5	1.0	
Phenol	mg/l		0.1	
Nickel	mg/l	1.0	1.5	
Lead	mg/l	1.0	2.0	
Fecal Coliform	mg/l		1,000	
Total Coliform	**mg/l**		**10,000**	

Source: National Water Commission. Concession Title No. 01BCA10030/07HMSG94, dated October 13,1994.

Table 2-20
Specific Discharge Conditions: Playas de Rosarito Wastewater Treatment Plant

Parameter	Unit	Average Concentration	Maximum Instantaneous Concentration	Amount (kg/day)
Arsenic	mg/l	0.1	0.2	
Cadmium	mg/l	0.1	0.2	
Cyanide	mg/l	1.0	2.0	
Copper	mg/l	4.0	6.0	
Fecal Coliform	mg/l	1000	2000	
Chrome	mg/l	0.5	1.0	
COD_5	mg/l	75	150	220.35
Total Phosphorous	mg/l	20	30	
Grease and Oil	mg/l	15	25	36.72
Floating Matter	mg/l	Absent	Absent	
Mercury	mg/l	0.005	0.01	
Total Kjeldahl Nitrogen	mg/l	40	60	
Nickel	mg/l	2.0	4.0	
Lead	mg/l	0.2	0.4	
TSS	mg/l	75	125	183.62
Sedimented Solids	mg/l	1	2	
Temperature	°C	40	40	
Zinc	mg/l	10	20	
pH	Units	5-10	5-10	

Note: The maximum daily BCOD discharge (220.35 kg/day) and TSS discharge (183.62 kg) refer to the maximum instantaneous concentrations or cover a rate of flow of 34 l/s of average concentration.
Source: National Water Commission. Concession Title No. 01BCA101978/01HRGR97, dated April 11,1997.

To date, the San Antonio del Mar and Puerto Nuevo Treatment Plants do not have Specific Discharge Conditions (SDC) even though CESPT is currently processing these with the CNA. Consequently, the NOM regulation should be followed.

The current regulation does not include an official norm (NOM) on the quality of residual sludge. Nevertheless, a proposed regulation, PROY-NOM-004ECOL/2001 sets maximum allowable limits for contaminants in biosolids, summarized in Tables 2-21 and 2-22.

Table 2-21
Allowable Limits for Heavy Metals in Biosolids
PROY-NOM-004-ECOL-2001

Contaminant (determined from totals)	Excellent mg/kg in dry base	Good mg/kg in dry base
Arsenic	41	75
Cadmium	39	85
Chromium	1200	3000
Copper	1500	4300
Lead	300	845
Mercury	17	57
Nickel	420	420
Zinc	2800	7500

Source: Secretaria de Medio Ambiente y Recursos Naturales; Oficial Mexican Standards Project published in the Diario Oficial de la Federación on February 18, 2002.

Table 2-22
Allowable Limits for Pathogens and Parasites in Biosolids
NOM-004-ECOL-2001

	Pathogens		Parasites
Type	Fecal Coliform MPN/g in dry base	Salmonella MPN/g in dry base	Helminth Eggs/g in dry base
A	Less than 1000	Less than 3	Less than 10
B	Less than 2000000	Less than 300	Less than 35

Source: Secretaria de Medio Ambiente y Recursos Naturales; Oficial Mexican Standards Project published in the Diario Oficial de la Federación on February 18, 2002.

2.5.5 Wastewater Quality and Effects

Quality

Table 2-23 gives information on the average water quality for water entering and leaving the five wastewater plants in the study area during 2001. Section 3.5 presents this information in greater detail.

Table 2-23
Water Quality Limits Established by the Regulation

No.	Wastewater Treatment Facility	Year	Parameters						
			BCOD (mg/l)			TSS (mg/l)			
			Influent	Effluent	Efficiency (%)	Influent	Effluent	Efficiency (%)	Notes
1	SBIWTP	2001	275	102	63	330	70	79	*
2	San Antonio de Los Buenos	2001	411	145	65	308	76	75	NC
3	Playas de Rosarito	2001	276	65	76	191	71	63	NC
4	San Antonio del Mar	2001	100	6	94	70	15	78	IC
5	Puerto Nuevo	2002	1162	519	55	486	219	55	NC

Source: Division of Sewage, CESPT, 2002.
NC= Not in compliance with regulatory requirements. (NOM-001-ECOL-96)
IC=. In compliance with regulatory requirements.
* The treated water is carried 4.8 km into the ocean through an 18-km-long underwater outfall pipe.

Generally speaking, we can conclude that of the five plants in the study area, only San Antonio del Mar meets the established maximum allowable limits.

2.6 Environmental Impacts

The objective of this section is to describe the environmental context and the public health issues in the study area. Additionally, the section will discuss some important topics to consider during the planning process, including the development of alternatives.

2.6.1 Environmental Context

Tijuana River

The Tijuana River is one of the most important environmental resources in the study area, due to both its location in central areas of the city of Tijuana and its binational character. The river gets its water from the Tecate River and some other small tributaries, such as the Arroyo Seco. Because the Tijuana River receives the city of Tecate's wastewater (most of it already treated), the Tecate River has the potential to significantly influence the quality and quantity of the water in the Tijuana River.

Surface wastewater runoff from the city of Tijuana can also affect the quality and quantity of water in the Tijuana River, whether this is from colonias (neighborhoods) that lack sewer service or from spills resulting from blockages or collapsed pipes. Currently, the Tijuana River does not receive treated wastewater (effluent) although it might if treatment plants were built within its watershed.

The Tijuana River is important internationally because it enters the United States to eventually discharging in to the Pacific Ocean through the Tijuana River Estuary. The estuary is an important environmental resource, the United States is very interested in the quality and quantity of Tijuana River water. The estuary's environmental quality can be affected not only by contaminants typical of municipal wastewater but also by the quantity of fresh water that reaches it. Large amounts of fresh water entering the estuary, without considering the level of cleanliness, can alter the delicate balance of salinity required to protect the aquatic life that inhabits the estuary.

As mentioned earlier, both countries have signed treaties in which Mexico has agreed to intercept the flow of the Tijuana River during the dry season for its eventual transport to either one of two wastewater treatment plants. During the rainy season, however, the Tijuana River flow is allowed to continue into the United States and to discharge into the estuary.

The alternative plans that this study evaluates should take into account the role that the river plays as a potential receiving body and an environmental resource shared by two countries. Given the estuary's vulnerability to flows of fresh water and to the contaminants in them, the feasibility of utilizing the river as a receiving body for treated wastewater will probably prove to be limited.

The Pacific Ocean

The Pacific Ocean is another important environmental resource shared by both countries. Currently, various wastewater treatment plants in the region discharge into the ocean, which can affect environmental quality. The San Antonio de Los Buenos Wastewater Treatment Plant, located approximately 9 miles (15 km) south of the border, discharges a combined effluent treated wastewater and chlorinated raw wastewater directly in the ocean. Some argue that the coastal currents in the region sometimes move from south to north, creating the possibility that discharges from the San Antonio de Los Buenos Wastewater Treatment Plant could affect the quality of the water in the San Diego Bay in the United States.

The SBIWTP is located in San Diego and treats wastewater from Tijuana at an "advanced primary" level. The SBIWTP discharges into the bay through an underwater ocean outfall pipe, which helps to dilute effluent entering the ocean and to reduce environmental impacts. However, this plant does not meet U.S. quality standards on several parameters, among them toxicity. There are plans to provide secondary level treatment, although to date the type of technology to be used and the location of the secondary treatment module is still undecided.

Finally, the Point Loma Wastewater Treatment Plant, located at the far north end of the bay, discharges advanced primary effluent that meets with the requirements established by the California Ocean Plan.

In addition to its ecological and intrinsic value, tourist and recreational use makes the ocean a very important economic resource for the region. Communities such as Playas de Rosarito and Puerto Nuevo rely heavily on the ocean to attract recreational users. For that reason they ultimately depend on the quality of the ocean and its coast.

The scarcity of fresh and potable water in the study area makes the ocean a potentially inexhaustible source of potable water; provided that economic, financial, technological, and institutional conditions are implemented so that desalinization programs can be developed.

In the future the ocean will continue to receive treated wastewater from both countries. The development of alternatives should consider discharging into the ocean since it is a resource worthy of protection, both for its ecological value and the role that it plays as a tourist attraction. Similarly, seawater should be considered a potential future source of drinking water, provided that successful large-scale desalinization programs are implemented.

The Colorado River

As mentioned earlier, the Colorado River, located approximately 78 miles (125 km) east of Tijuana, provides almost 94.5 percent of the potable water supplied to Tijuana and Playas de Rosarito. Given the scarcity of water locally in the study zone, the Colorado River is a major environmental resource in the region. An aqueduct with a 87.3 mgd (4 m^3/s) capacity carries Colorado River water to Tijuana.

The evaluation of alternatives for supplying water will probably include the Colorado River as one of the most important sources for the future. Because the river's flow is allocated internationally (between Mexico and the United States) and nationally (agricultural and urban uses in Mexicali, any increase in the supply taken from this source will have to include transfers in the designated use of the water. Similarly, the transfer of additional volume to Tijuana would have environmental implications, including the impact on the river and its delta, the additional energy required to pump the water, and its disposal following its use.

Local Aquifers

As mentioned in Section 2.4, the aquifers in Tijuana, La Misión, Playas de Rosarito and the Abelardo L. Rodríguez reservoir provide approximately 5.5 percent of the potable water supply for Tijuana and Playas de Rosarito. The aquifers represent a secondary source of water, and their potential to produce greater quantities in the future is questionable.

The quality of the groundwater is not acceptable in every case. Some wells of the Río Tijuana aquifer produce water that does not meet the quality standards established by Mexican regulations, in particular those that refer to concentrations of iron and manganese. Moreover, the Playas de Rosarito aquifer produces water with high concentrations of dissolved solids (salts). It is believed that the quality of this source has deteriorated because of saltwater intrusion into the aquifer, which will cause deterioration to increase as the rates of extraction rise.

In this context, the aquifers probably will not play an important role in the overall supply for the study area, although they could be important in managing droughts and emergencies and in attempting to optimize the system's pumping requirements. Similarly, it should be studied and considered for the possibility of using aquifers to store surface water (for example, from the Colorado River) or treated wastewater.

Water and Sewer Infrastructure

As described in Section 2.3, Tijuana and Playas de Rosarito have grown at an accelerated rate in recent decades.

Rapid demographic growth, combined with the lack of economic, political, and financial conditions that are favorable and appropriate for adequate development of water and sewer infrastructure in Tijuana and Playas de Rosarito, has resulted in deficient levels of service coverage, as noted in Sections 2-4 and 2-5. Similarly, the potable water and wastewater treatment plants fail to meet Mexican regulations for water quality.

Historically, these shortfalls in the level of service have posed environmental and human-health risks, which will continue in the future if we do not address these deficiencies. The quality of water supplied sometimes fails to meet the allowable limits required to protect human health. Similarly, in some areas of the city, the lack of pipeline water distribution impedes the creation of conditions conducive to good health.

The evaluation of alternatives in the master plan will include expanding the coverage of the water and sewer systems, the capacity of the potable water, and wastewater treatment systems. These works will benefit public health and the quality of life, but they may have adverse environmental impacts during the construction phase and during their operation (greater consumption of water and greater generation of wastewater).

2.6.2 The Issue of Public Health

Within the environmental context already described, one can identify certain public health issues in Tijuana and Playas de Rosarito. First, areas of the city lack access to the water distribution system. In these colonias (neighborhoods), residents rely on alternative sources of water, mainly water trucks, which are of questionable quality. CESPT provides this service for free, but private companies also provide it for a fee. In the homes, it is a common practice to store water in containers not designed for this purpose, which can allow the entrance of pathogens.

Additionally, neighborhoods with access to the water distribution system on occasion receive water that does not comply with the water quality standards established by the Department of Health and Assistance, SSA (Secretaría de Salubridad y Asistencia), as described in Subsections 3.2 and 3.3.

The shortcomings in the sewer and sanitation system also pose public health risks. Residents in colonias (neighborhoods) that lack access to the sewer system rely on septic tanks, latrines, and open-air discharges to dispose of their wastewater and excrement. Additionally, the conditions in the sewer system cause the collected wastewater to overflow into streets and arroyos (natural channels), presenting a health risk. Finally, the quality of discharges from the wastewater treatment plants do not meet regulations, and it negatively affects the quality of water in the receiving bodies.

2.6.3 Environmental Issues

The current main environmental issues, largely caused by rapid demographic growth and deficiencies in infrastructure, are closely related to the problems of human health just described. The lack of sewer system coverage, the poor condition of the system, and the level of treatment the wastewater plants provide have historically affected the quality of the environment, in particular, the quality of the receiving bodies of water.

Additionally, demographic growth and increasing demand for water has meant an important obligation to achieve the sustainability of hydraulic resources. For example, the presence of saltwater intrusion observed in the Playas de Rosarito aquifer may be the result of excessive rates of extraction. Similarly, the growing demand for Colorado River water could affect the availability of water for other uses, such as agriculture and environmental protection. Also, a significant amount of energy is needed to carry the water to Tijuana.

2.6.4 Major Considerations in the Planning Process

The development of alternatives within this master plan must take into account the region's environmental situation. First, any proposed alternative should meet the Mexican regulations currently enforced regarding potable water quality and wastewater discharges. Similarly, some of the proposed work could attempt to reach the goal of meeting U.S. regulations in order to qualify for grant funding from the EPA's Border Environment Infrastructure Fund BEIF (Fondo de Infraestructura Ambiental Fronteriza).

The alternatives also must attempt to eliminate, or at least reduce, the service-coverage deficiencies mentioned above.

Finally, the concept of sustainable development will be incorporated during the development and evaluation of alternatives. It is important that the alternatives proposed be the most sustainable possible in regard to energy requirements and the potential for reclamation of water and other waste products (for example biosolids).

One objective is to avoid increasing flows discharged into the Tijuana River from wastewater treatment plants located within the river's watershed. As indicated, international treaties exist to eliminate flows entering the estuary to the greatest degree possible.

The binational character of the region presents opportunities for binational coordination of information exchange, knowledge transfer, and even financing. The US EPA BEIF, administered by NADBank, which offers financial resources in the form of grants for Mexican projects that would resolve the human health and environmental problems in Mexico, while providing a direct benefit to the United States.

Additionally, CESPT can make use of the experience that the United States already has to facilitate the implementation of programs in the area of industrial discharge control and treated wastewater reclamation. To date, CESPT, the City of San Diego, and the State of California Environmental Protection Agency have worked together to transfer monitoring equipment that might be utilized to control industrial discharges.

2.7 Economic Factors and Activity

2.7.1 Economic Factors

This section analyzes, in a very general manner, the prevailing economic conditions in Tijuana and Playas de RosaritoPlayas de Rosarito and the economic factors that affect these cities as a result of the project.

The objective of this section is to understand the level of well being of the population when compared with the state and with the national average, and the probable effects of the project. The first subsection discusses the quality of life and income of the population in these two cities. This section analyzes two central issues: 1) regional poverty rates, using a calculation of poverty, which measures and reflects three dimensions (absolute, relative, and inferred), and 2) income distribution in the two cities and the state.

The second subsection analyzes the quality of life with estimates of the provision of public services -- health care, education, electricity, potable water, sewer, and sanitation. At the end of this section, a summary statistic is presented to evaluate the well being of the population. A Human Development Index calculation for the two cities and the state makes it possible to classify them according to level of social development.

Quality of Life and Income Levels

The well being of the population is associated with the satisfaction of basic needs that are defined socially. There are various methodologies to measure well being, and the choice of which to use depends on the objectives. In evaluating the well being of the population on Mexico's northern border, several measures of well being are used that evaluate different dimensions of the quality of life of the region's residents.

Poverty Conditions

One way of evaluating the population's quality of life is to determine the poverty rate using the methodology of poverty lines. The monetary value of a basket of consumer goods that would meet the minimal needs of a typical family is determined, and the proportion of the population that cannot cover the cost of those items is measured. That is the population that is considered poor. The utilization of this criterion in the measurement of poverty implies two challenges: 1) the determination of the poverty line itself; that is, of the value of the basket meeting the minimal needs of a family, and 2) a lack of information that would allow us to identify the true income of families.

These two challenges are present in measuring poverty in the cities and the state. In Mexico, no sources of data are available that would provide a detailed understanding of income of families at the municipal or state level.[2] Thus, the analysis we present here should be seen as an estimate of the measurement of the region's poverty. We use information from XI General Census of the Population and Residences for 1990 (XI Censo General de Población y Vivienda de 1990), the Tally of the XII General Census of the Population for 1995 (Conteo del XII Censo General de Población de 1995), and from the XII General Census of the Population and Residences for 1990 (XII Censo General de Población y Vivienda de 2000), where income is categorized in multiples of the minimum salary. The analysis is based on an estimate of the data from two poverty lines, which are the equivalent in value to one and two minimum salaries.

In 2000, 8.3 percent of the households nationally had a level of income below the minimum salary, and 28.5 percent lived on incomes of less than two minimum salaries. In general, the rates for the state of Baja California in the moderate and extreme poverty categories were less than the national average. Moreover, as Table 2-24 shows, the poverty rates for Tijuana and Playas de Rosarito in the extreme and moderate categories are similar to state rates and much less than the country rates.

Table 2-24
Poverty Rates

Federal Entity City	Poverty Indicator (1 Min. Salary)	Poverty Indicator (2 Min. Salary)	Poverty Rates				
			Poverty Line = 1 Min. Salary		Poverty Line = 2 Min. Salary		
Federal Entity			Percentage of Poor People	Poverty Gap	Percentage of Poor People	Poverty Gap	Gini Coefficient
Mexico	11.9	19.9	26.9	15.6	64.0	30.6	0.4631
Baja California	4.1	8.3	9.6	5.7	40.6	15.6	0.3951
Tijuana	3.6	7.1	7.7	4.9	34.9	13.2	0.3852
Tecate	4.1	8.4	9.4	5.6	43.6	16.2	0.3828
Mexicali	4.4	9.3	11.1	6.3	44.5	17.3	0.4032

Source: Economic Studies Dept., El Colegio de la Frontera Norte. Calculations based on information from INEGI, Conteo de Población y Vivienda (Population and Housing Tally) 1995.

Results show that while the poverty rate in Baja California and Tijuana and Playas de Rosarito is lower than the national level, the proportion of people who earn salaries below the minimum salary is very high. When we put the poverty line at two minimum salaries, the rate in the state and the two cities nears the poverty rate at the national level. These results indicate a relatively delicate situation in Baja California. A decline in the level of economic activity could thrust a large proportion of the population into conditions of moderate poverty.

Table 2-25 illustrates the percentage distribution of the population by minimum salary ranges.

[2] The National Household Surveys, which INEGI publishes, are representative solely at the national level and for those areas that INEGI defines as being high and low density.

Table 2-25
Percentage Distribution of the Population by Minimum Salary Ranges

Period	Total	Less than 1 Min. Salary	From 1 to 2 Min. Salaries	More than 2 up to 5 Min. Salaries	More than 5 Min Salaries	No Income	Not Specified
National							
1998	100	11.8	33.3	33.2	11.9	4.9	4.9
1999	100	10.6	32.1	36.7	11.5	4.4	4.8
2000	100	8.3	28.5	40.8	15.0	3.9	3.6
Mexicali							
1998	100	4.4	20.6	48.2	24.2	2.0	0.6
1999	100	3.2	15.7	55.0	24.1	1.6	0.5
2000	100	2.0	11.7	57.3	27.7	1.2	0.2
Tijuana							
1998	100	1.6	13.4	58.7	24.1	2.2	0.0
1999	100	1.6	11.2	61.3	23.2	2.7	0.1
2000	100	1.5	10.7	54.9	30.6	2.0	0.3

Source : Banco de información económica (Economic Information Databank), INEGI, 2001

The Poverty Gap

In measuring poverty, we are interested not only in the percentage of households whose income is below the poverty line, but also the distance that exists between the household income and the poverty line. This method of quantifying poverty is known in literature as *poverty gap*, because it indeed captures the breadth of the problem. Table 2-26 presents the results of the calculation that we have made for the *poverty gap*[3] for one and two minimum salaries in the columns labeled FGT 1. This data also shows the size of the income transfers that would have to occur to eradicate poverty. It shows the proportion (in regard to the poverty gap) that each household would have to contribute to eradicate poverty, supposing that we know exactly where and how poor the poor households are.

Table 2-26
Contribution of Cities to National Poverty Rates

Federal Entity City	Poverty Rates						Municipal Contribution to National Poverty Rates					
	Poverty Line = 1 Min. Salary			Poverty Line = 2 Min. Salary			Poverty Line = 1 Min. Salary			Poverty Line = 2 Min. Salary		
	FGT 0	FGT 1	FGT 2	FGT 0	FGT 1	FGT 2	FGT 0	FGT 1	FGT 2	FGT 0	FGT 1	FGT 2
Mexico	26.86	15.57	11.90	64.01	30.61	19.88						
Baja California	9.56	5.67	4.12	40.61	15.56	8.34	0.7277	0.7439	0.7072	1.2967	1.0395	0.8572
Tijuana	7.70	4.85	3.62	34.94	13.23	7.07	0.2637	0.2868	0.2801	0.5021	0.3976	0.3271
Tecate	9.36	5.57	4.11	43.57	16.20	8.43	0.0221	0.0227	0.0219	0.0432	0.0336	0.0269
Mexicali	11.07	6.29	4.44	44.51	17.30	9.30	0.3054	0.2994	0.2765	0.5152	0.4186	0.3468

If we accept that a minimum salary is enough to cover the population's most basic necessities, then a redistribution equivalent to 15.6 percent of a minimum salary from all households would be sufficient to eradicate poverty in Mexico. To the extent that the poverty rate in the northern region of the country is lower, the cost to eradicate its

[3] Strictly speaking, the calculations presented in these columns correspond to the proportional poverty gap. Mathematically, the estimate is made by taking the sum of the gaps, weighted by the total population.

poverty is also lower. In the best of all cases, in Baja California, it would suffice for each household to contribute 5.7 percent of a minimum salary in order to raise income in poor households to at least the equivalent of a minimum salary household.

If we take two minimum salaries to be the poverty line, at the national level, it would require a redistribution of 30.6 percent of two minimum salaries. In the state, it would require a variable volume of income from between 15.6 percent of the value of two minimum salaries

Income Distribution
If we use the Gini Coefficient to measure inequality in income distribution among families, we find that Baja California, compared to the nation overall, has more equitable patterns of income distribution[4]. For example, in Baja California, the border state with the most equitable pattern of income distribution, the value of the Gini Coefficient is 15 percent lower than at the national level. In the two cities in question, we generally find much more equitable forms of income distribution, even compared to the rest of the state. Probably the more equitable distribution of income in the two cities is associated with a combination of factors related to the specific characteristics of the economy and "border" life. Certainly, the access that border residents have to U.S. labor markets plays an important role. Quite possibly, the basis for this may also be the structure and type of employment this region has generated, with its proliferation of activities involving intensive use of manual labor (maquiladoras, services, informal sector, and so forth).

Rates of Shortage in Basic Services
A third essential aspect of well being for the population is the access that families have to basic services. In this section, we present estimates of the provision of five services that we consider essential: health care, education, electricity, potable water, and sanitation. As in the previous section, we calculate the rate of service shortfalls for each border state and city. The rate of shortfall at the national level serves as a reference point to evaluate the coverage of services in the northern border region[5].

Unlike the poverty rates and income distribution in the region, the provision of basic services along the northern border faces huge backlogs when compared to the provision of these services nationally. We take as a starting point the simple average of the rates for shortages in the services that we list in the last column of Table 2-27. It is evident that, compared to the rest of the country, in Baja California the coverage in health care, education, electricity, potable water, sewer and sanitation services is more limited. For the two cities in the study, limitations are even more marked.

Table 2-27 shows rates for shortages in health care and education. The health care rate is calculated as the complement of the average percentage of the population that can be seen by physicians and nurses and that has access to a hospital bed. In each category, international norms were used that set the ratios at one doctor for every 1,117 residents,

---

[4] The value of the Gini Coefficient increases when the income-distribution inequality increases.
[5] The methodology utilized to calculate these rates can be found in Appendix B of this section.

one nurse for every 559, and one hospital bed for every 532. To determine the number of people who has access to medical services, these norms are multiplied by the number of physicians, nurses, and beds, and then, for each category, the proportion that it represents, with respect to the total population under study, is then calculated.

The rates for shortfalls in education are represented by the percentage of the population between 5 and 14 years of age that does not attend school. The quotient is the number for the population between 5 and 14 that does not attend school divided by the overall number of people in that age bracket who indicated that they attend school. From the Census of the Population and Residence for 1990 (*XI Censo General de Población y Vivienda de 1990)*, Table No. 14 Population of 5 years of age and older, by city, school attendance, age according to level of instruction, and primary grades passed.)

Table 2-27
Rates of Shortfalls in Basic Services, 1995

Federal Entity City	Shortfall					Rate of Shortfall in Provision of All Basic Services Combined
	Health Care	Education	Electricity	Potable Water	Sewer and Sanitation	
Mexico	11.71	15.86	12.99	20.97	37.38	19.78
Baja California	13.83	12.90	10.49	39.36	33.64	22.04
Tijuana	10.43	14.79	14.32	43.57	35.92	23.81
Tecate	29.58	12.68	21.81	44.83	36.44	29.07
Mexicali	17.22	10.42	3.15	34.08	30.06	18.99

Source: Economic Studies Dept., El Colegio de la Frontera Norte. Calculations based on information from INEGI, *Conteo de Población y Vivienda* (Population and Housing Tally) 1995.

Health

The shortfall in health care service coverage was calculated by city using information from the Annual State Statistics Reports (Anuarios Estadísticos Estatales). At the state level, the shortfall in the provision of health care services fluctuates around the level for the national rate. Nevertheless, when we analyze the provision of these services for each of the Baja California cities, we find major disparities.

Education

The level of coverage in educational services in the Baja California cities is broader than the national average. Table 2-28 reveals the statewide level of educational coverage is higher than the national average.

Electricity

The rate of shortfall in electricity service is simply the percentage of the population that lacks that service. As Table 2-28 shows, the electricity coverage in the state is very close to the national average.

At the municipal level, the rate of shortfall is high in Tijuana and Playas de Rosarito. The provision of electricity service is not necessarily related to the size of the population. It is certainly also influenced by factors such as the dynamics in population growth or the spread of unplanned human settlements.

Potable Water

To calculate the shortfall in potable water, we considered only those households that lack service inside the home. Table 2-28 clearly states that the unavailability of potable water in the home is one of the state's biggest problems. The proportion of households that lack this service is much higher than the national average.

In Baja California, this shortage is even greater in the major cities, such as Tijuana, and indicates a generalized shortfall in supplying potable water to homes.

Sewer and Sanitation

On average, the breadth of sewer and sanitation services in the state is very close to the national average.

The state's cities vary widely, despite, which, it is possible to identify in the two groups of cities we have worked with.

Summary

It is important to note that the city of Tijuana has experienced very high levels of population growth, in excess of 3 percent annually. It is evident that these high growth rates imply that there are tremendous pressures on the delivery of public services. In Tijuana, it is apparent that there are major backlogs in the provision of services. It seems that the rapid population growth has not been accompanied by a systematic effort to broaden public service coverage, which lowers the city's average for provision of services compared to state averages.

Human Development Index

In the previous sections, we have analyzed the well being of the population in Baja California and its cities by evaluating specific dimensions of well-being: income levels, distribution, and the provision of five basic services. In this section, we present one single statistic of well being, which combines the components. The Human Development Index (HDI) integrates statistics on income levels, educational levels that are measured by illiteracy rates, and average years of schooling, while incorporating statistics of health care coverage.[6]

The HDI is a relative statistic that ranks border cities according to their levels of well being. Table 2-28 lists the state, cities, and their rankings. The levels of well being in the state, as shown in Table 2-28, especially in Tijuana and Playas de Rosarito, are substantially above the national levels.

[6] The methodology to determine the Human Development Index is found in Appendix B of this subsection.

Table 2-28
Human Development Index 2000
(Adjusted for Income Distribution)

Ranking	Federal Entity City	Average Daily Income[1]	Average Annual Income[1]	Gini Coefficient	Income Utility	Adjusted Income Utility Gini Coefficient	Adjusted Human Development Index
7	Tijuana	131.00	47,815.00	0.385	10,833.40	6,660.42	0.826
11	Baja California	117.83	43,008.80	0.395	10,832.72	6,552.75	0.792
15	Mexicali	110.00	40,148.41	0.403	10,832.57	6,465.04	0.771
22	Tecate	104.50	38,142.58	0.383	10,832.48	6,686.03	0.717
37	Mexico	63.26	23,091.48	0.463	9,741.72	5,229.91	0.496

Source: Economic Studies Dept., El Colegio de la Frontera Norte. Calculations based on information from INEGI, Censo General de Población y Vivienda 2000 (Population and Housing Tally) 2000; Department of Health and United Nations Children's Fund (UNICEF), Health Information Data Base, Municipal Statistics, 1994.
[1] All income figures presented are in pesos per capita.

2.8 Transboundary Considerations

This section is a review of all the existing information in relation with the valid outstanding agreements between Mexico and United States, as well as other projects or institutional arrangements of transboundary characteristics, whose existence has implications in the development of the activities of CESPT.

Binational Agreements

International Treaty for the distributions of the waters form February 3rd, 1944

This treaty represents the most important agreement between Mexico and the United States about the distribution of common water resources, specially focused superficial streams. In this treaty the rules on how the water coming from mainly the Colorado and Bravo Rivers will be allocated. In the case of the Colorado River, the treaty specifies a deliverable that the United States should provide Mexico with 0.5 million gallons (1,850 m^3); this water is stored by Mexico en the Morelos Reservoir located in the Mexicali Valley. This water volume represents approximately 85 percent of the water resources available in Baja California; the cities of Tijuana and Tecate receive this water through the Colorado River Aqueduct - Tijuana.

International Minutes

The International Boundary and Water Commission (Comisión Internacióńal de Límites y Agua, CILA), in Mexico and its counterpart in the U.S.A. International Boundary and Water Commission, (IBWC), were created following a treaty between the countries in 1944 and these agencies are in charge of dealing with everything that refers to the water resources shared with the United States. For the case of Mexico and the United States, the minutes are considered very important and presented in chronological order, which are linked to water resources shared between Mexico and the United States. In respect to Tijuana and Playas de Rosarito, in Table 2-29 are presented the most relevant minutes historically agreed on.

Table 2-29
International Boundary and Water Commission Relevant Agreements

Minutes	Date	Description
270	April 30, 1985	In this minute, the governments of Mexico and the United States, in accordance with their current national laws, agree to cooperate in anticipating and considering the environmental effects and consequences of planned projects to address the border sanitation problem in the Tijuana-San Diego area. This problem results from untreated sewage discharges from Tijuana, which cross the international border and contaminate the coastline. Both governments agreed to actions that include the development of bilateral consultations on the development, operation, and maintenance of projects as well as specific actions related to ongoing sewer spillages in the area.
283	July 2, 1990	This minute establishes and describes the obligation, contracted by the United States, to provide secondary treatment in an installation built on U.S. territory for 1100 l/s of wastewater from Tijuana, the cost of which both governments shall share. The agreement includes the construction of an ocean outfall, located approximately 3.5 miles offshore in the Pacific Ocean.
296	April 16, 1997	This minute establishes the distribution of construction, operation, and maintenance costs for the international wastewater treatment plant, constructed under the agreements in Minute 283 for the international solution of the San Diego-Tijuana border sanitation problem. It also establishes monitoring activities related to wastewater projects in Tijuana; the construction by the United States of a binational plant and ocean outfall; and additionally, steps aimed at solving operational and environmental contingencies.
298	December 2, 1997	This minute establishes recommendations for the construction of works parallel to the city of Tijuana wastewater pumping and disposal system as well as the rehabilitation of the San Antonio de Los Buenos Wastewater Treatment Plant. This renovation would increase the level of treatment to the secondary stage and the total treatment capacity to a volume of 1100 l/s. The treated water final discharge would occur at a point approximately 9 km south of the international border.
301	October 14, 1999	This minute establishes the terms for coordinating a joint planning study by federal and state authorities in Baja California and state authorities in California to consider options for conveyance of Colorado River water to the Tijuana-San Diego region. The final objective of the study is the generation of basic information to support future decision making by the competent authorities in each country concerning the region's water supply.

Source: International Boundary and Water Commission, http://www.ibwc.state.gov
Note: Act 261, dated September 24, 1976, titled "Recommendations for the solution to the Wastewater Border Problems", is a general antecendent for all the border.

In addition to the minutes, a plan for emergency delivery of water exists today, to which the two countries agreed in an unnumbered Commission (appendix to Minute 240). This plan is governed by the terms of Minute 240, dated June 13, 1972, and also by the modifications that preceded it, as guaranteed in Minutes 243, 245, 252, 256, 259, 260, 263, 266, and 287. It is expected that this delivery plan will begin to function in 2003 and that it will last for five years. In accordance with the 1944 treaty, Mexico's quota of Colorado River water will be charged in correspondence with the volume of water delivered. The preliminary terms of the arrangement establishes the utilization of a network of aqueducts belonging to and operated by the Metropolitan Water District of Southern California (MWDSC), the San Diego County Water Authority (SDCWA), and the Otay Water District (OWD) for the deliveries up to a maximum of 150 gal/s (600 l/s). The point of delivery on Mexican territory is the existing emergency connection at the international border, located near the international border crossing at Otay Mesa. The access to these emergency deliveries of water meets the objectives facilitating CESPT's ability to meet a peak demand of 28,477 million gallons (4 m^3/s) (IBWC, 2001), which presents itself in summer.

Another appendix is related to the system to collect wastewater flowing toward the Tijuana River (PBCILA:1991-92), which exists to resolve the problem of runoff from the city of Tijuana. The arrangement includes runoffs from the city of Tecate even though this is not established in an official minute.

Border Environment Cooperation Commission (BECC) and North American Development Bank (NADBank)

These institutions were created as a result of the agreement between Mexico and the United States. The purpose of the agreement is to certify and finance environmental infrastructure projects along the border. To date, BECC has certified a number of projects relating to the master plan, among them the South Bay Water Reclamation Plant in San Diego, the Tijuana Parallel Wastewater Works, the Tijuana sewer system rehabilitation project, and the Project to Enlarge the COLEF-ECOPARQUE Wastewater Treatment Plant. Some other relevant transborder considerations address regulations and projects in San Diego County, and, in particular, the cities of San Diego and Imperial Beach. Others address industrial pretreatment currently under evaluation.

In addition to the international agreements of relevance for the master plan, there is a US Public Law. On November 6th, 2000, the United States Congress enacted Public Law 106-457 Act, Estuaries and Clean Waters Act of 2000, which President Clinton signed into law. Title VIII, entitled Tijuana River Valley Estuary and Beach Cleanup, states that subject to the negotiation of a new treaty minute, the United States International Boundary and Water Commission (USIBWC) is authorized to take the necessary measures to provide secondary treatment in Mexico of up to 50 million gallons per day (mgd) (2,190 l/s) of: 1) 25 mgd (1,090 l/s) of advanced primary effluent of the South Bay International Wastewater Treatment Plant (SBIWTP) and 2) of additional wastewater generated in Mexico. Additionally, the Public Law plant could provide 25 additional mgd (1,090 l/s) of secondary treatment in Mexico subject to the results of the comprehensive plan.

The Public Law also directs the USEPA to develop the comprehensive plan with stakeholder involvement to address transborder sanitation problems in the San Diego-Tijuana border region.

Other relevant project and studies

There are dos studies that have been recently concluded have important implications in the master plan. The first of them is the final environmental assessment done according to the international treaty between the Mexico and the United States for the supply of emergency water for the city of Tijuana, as part of the water allocation assigned to Mexico according with the Water Treaty of 1944. This assessment it was in charge of the U.S. section of the IBWC and it was finished in August of 2001. The conclusions of the report indicate that the mentioned agreement "doesn't present a federal action that could have an adverse significant effect on the quality of the human environment" (IBWC, 2001).

The second study does a the feasibility analysis for the conveyance of Rio Colorado water to the Tijuana region and San Diego, it was written following the guidelines established in the Minute 301 of the CILA. The objective of study was to obtain basic information about the option that considered bringing water to Mexican or American land from a binational perspective, including different alternatives to increase the capacity of distribution and storage systems, taking into account the future demands of the region (Tijuana and the County of San Diego.) The mentioned study provided more information to the a previous evaluation done by the San Diego County Water Authority about alternatives related with the distribution and storage of water in the United States, analyzing the alternatives in Mexican territory.

This study was finished on February 2000, and its results and recommendations are currently being reviewed by the Binational Technical Committee (BTC). The Binational Technical Committee was in charge of the following up and evaluation, and the following agencies have a representative that is a member of the committee: CILA, CNA, COSAE, CESPT. The U.S. delegation of CILA, the San Diego County Water Authority and the California Department of Water Resources as part of the BTC representing the U.S.A.

2.9 Other Services Provided by CESPT and by Private Infrastructure

CESPT also sells potable water to companies that own water trucks. These companies deliver the water to areas without potable water service. Water tanks are supplied with water from 30 standpipes that CESPT has in Tijuana and Playas de Rosarito. Figure 2-30 lists CESPT standpipes that are strategically located in the study area. Table 3-20 shows the standpipes actually in service under CESPT jurisdiction.

Table 2-30
Standpipes operated by CESPT used to provide water to water trucks

Maintenance district	Number of standpipes
Ing. Juan Ojeda	2
Paraíso	4
Independencia	4
Matamoros	7
Reforma	8
Playas de Rosarito	5
Total	**30**

Source: CESPT, Sub-direction of Operations and Maintenance.

In the private infrastructure there are 53 different wells distributed in different parts of the Tijuana. 49 of them are located in the urban area of Tijuana (all of them out of the service area) and 4 of them are located outside the urban area (on the bank of the

Alamar River). The last 4 wells belong to private initiative, 3 of them are operated to refill water trucks for water distribution to the *colonias* (neighborhoods) without potable water service, the fourth one belongs to Yessenia Valencia Manzo and María de Los Angeles Herrera. The use of the last well is unknown.

CESPT also provides the service of cleaning latrines and septic tanks through Vacom or Hidro-Cleaner Equipment, in the colonies that do not have wastewater collection.

CESPT has no direct jurisdiction on the control of discharges to the municipal wastewater system. The agency in charge is the Director General of the State of Ecology (Dirección General de Ecología del Estado), they are in charge of the regulation of industrial discharges made by the industries that have wastewater treatment plants before they discharge to the municipal wastewater system. CESPT has registered the operation of 22 private wastewater treatment plants. Table 2-31 shows the main characteristics of these plants.

Table 2-31
Wastewater treatment plants not operated by CESPT

Installation	Capacity (l/s)
Parque Industrial El Florido	16.0
Samsung	9.0
Parque Industrial Pacífico	22.8
El Jibarito	1.2
Pórticos de San Antonio	7.2
Real de la Gloria	0.1
Real del Mar	24.0
Parque Industrial La Joya	0.5
Valle Sur I	3.5
Valle Sur II	0.2
Ecoparque	1.0
Cumbres Juárez	0.5
Hacienda de las Fuentes I y II	8.0
Campestre	4.6
Lomas del Mar	1.4
Punta del Mar	0.1
COLEF	0.4
Playa Blanca	0.5
Baja Malibu	N/A
Oasis Resort	0.8
Santa Mónica	N/A
Vista al Mar	Out of service
Total	**101.7**

Source: CESPT, Sub-direction of Operations and Maintenance, Wastewater Department.