

2012-01-01

# A Study of International Wastewater Challenges and Policy in the Tijuana River Watershed

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A STUDY OF INTERNATIONAL WASTEWATER CHALLENGES AND POLICY IN THE TIJUANA RIVER  
WATERSHED

GLORIA ANN VILLAYERDE

ENVIRONMENTAL SCIENCE AND ENGINEERING DOCTORAL PROGRAM

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By

GLORIA A. VILLAVARDE  
2012

## **DEDICATION**

Firstly, I dedicate this work to my parents, Pedro and Josephine Villaverde, who are no longer here but continue to influence me every day. And to my son, Armand, who has spent much of his life with his mother in school. He has given me the best education I will ever have.

A STUDY OF INTERNATIONAL WASTEWATER CHALLENGES AND POLICY IN THE TIJUANA RIVER  
WATERSHED

GLORIA ANN VILLAVERDE

DISSERTATION

Presented to the Faculty of the Graduate School of  
The University of Texas at El Paso  
in Partial Fulfillment  
of the Requirements  
for the Degree of

DOCTOR OF PHILOSOPHY

Environmental Science and Engineering Doctoral Program

THE UNIVERSITY OF TEXAS AT EL PASO  
August 2012

## **ACKNOWLEDGEMENTS**

As long as it's taking me to complete this process, my list of acknowledgements should go on for several pages. First and foremost, I must thank my committee members who have stuck with me while I took the scenic route. My committee chair, Dr. Irasema Coronado, stepped in to the position when all seemed lost. As busy as she is, she has taken the time to read manuscripts, quickly respond to emails and even listen to misere when life was throwing me lemons. She has provided guidance and support whenever possible, especially in the final months of this project. Her dedication to student success is unmatched. Although he is several hundred miles away and has many of his own students to mentor, Dr. Mark Hernandez has provided encouragement throughout the years, and when all seemed lost, he contributed a great deal toward saving this project as well as very helpful editing assistance. He is a true mentor and educator. Dr. Wen-Yee Lee took an early interest in this topic, and from the beginning, she has offered much encouragement and strategic planning for me to pursue this far-from-typical ESE topic and has offered thoughtful analyses of earlier drafts. Dr. Chuck Turner has challenged me to know more and work harder, often with great humor. He has been more than fair and his honesty and forthrightness have been greatly appreciated. I would also like to extend my gratitude to Dr. William Weaver who introduced me to this truly interdisciplinary topic.

I owe great thanks to Cindy Conroy (I think). She, somehow, talked me into doing a doctoral program when I had no intention of going past my master's degree. I have known Cindy for many years. Her support has been invaluable, and I am happy to call her my friend. I would be

remiss if did not mention Drs. Lillian Mayberry and Jack Bristol. What they call mentoring, I call loving harassment. Either way, they have encouraged me not to spend the rest of my life ABD. Dr. Scott Weirich developed the model upon which my analysis is based. He provided much guidance and technical assistance. Dr. Francisco Soto Mas also offered much support and encouragement and is a great role model through his generosity and persistence.

The staff at the UTEP Graduate School and the NSF-funded AGEP program made this process so much easier and less financially painful. UTEP Registrar, Miguel Sifuentes, is a consummate professional, and whether I contacted him as professional staff or a student, I have always been impressed with his speed and willingness to help. Other individuals like Dr. Laura Serpa, Dr. John Walton, and Gilbert Anaya would probably wonder why I'm acknowledging them at all. None of them would question helping someone out because that is who they are.

Fellow ESE classmates like Amit Raysoni, Arturo Woocay, and Stewart Cheung made this endeavor fun. I owe them many thanks for all the laughs we shared. I am greatly indebted to unnamed family and friends, present and past, who have offered support for this and many of my other hair-brained schemes, never saying that I wasn't capable. I'm grateful to Honey Bunny for his support and knowing when to leave town. And finally, I thank my girls, Tobi and Juanda Sue; they kept me moving.

## **ABSTRACT**

Since the 1930s, untreated and undertreated sewage from Tijuana, Baja California, México has been released into the Tijuana River Watershed causing contamination of the water supply, crops, the Tijuana Estuary and California beaches. Passage of the North American Free Trade Agreement (NAFTA) has exacerbated the problem by causing population and industrial growth explosions for which there have been insufficient services to meet the needs of the people. The waters of the Tijuana River flow (from México) north over the International Border, into the Tijuana Estuary, discharge out to the Pacific Ocean and often flow north, up the California Coast; therefore, the river's contents are of great concern to the US.

In the early 1990s, the U.S. and México sections of the International Boundary and Water Commission (IBWC) reached an agreement, in Minute 283, to co-fund a secondary wastewater treatment plant to be placed on the U.S. side of the border, the South Bay International Wastewater Treatment Plant (SBIWTP). The first phase of the facility opened in 1997 with the capacity to treat up to 25 mgd of México's wastewater to an advanced primary process, which is not in compliance with water quality standards established by either federal government.

Through vigorous lobbying, the funding for the secondary treatment phase at SBIWTP was delayed. Instead, a new IBWC minute was adopted and two public laws were passed in favor of a treatment proposal by an upstart U.S. company with no previous wastewater treatment experience. Through a no-bid process, the US IBWC agreed to enter into a public-private partnership agreement with Agua Clara, LLP whose job was to design, construct, operate, and maintain a wastewater treatment plant in México, called Bajagua.



This dissertation reviews the history of water pollution problems in the Tijuana Watershed and the process that resulted in the selection of an anorexic proposal that squandered more than ten years of legitimate action, thus resulting in billions of gallons of undertreated wastewater being discharged into U.S. waters. This study finds that the protracted process seriously jeopardized water quality and public health in the region, placing both in the back seat to politics and patronage.

Mexican authorities have been working to upgrade and expand their treatment systems. México's projects consist of a network of decentralized treatment works as opposed to a large centralized facility. Simulations of decentralized and centralized facilities for the area propound that México's decentralized network is a better strategy to meet the wastewater treatment needs of the basin.

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# CHAPTER I

## INTRODUCTION

### **1.1 *Problem Statement***

Tijuana River Watershed (TRW) straddles the US-México border with over 70% lying within México. The area is rich in floral, faunal, and geologic diversity. In recent years, the Tijuana River Valley area has experienced rapid population growth coupled with inadequate planning and services (Riveles & Gersberg, 1999). In addition, the Mexican Government, at both the local and federal levels, lacks the resources required to enforce environmental laws (Kopinak, 2002). As a result, the western, downstream portions of the watershed, Tijuana River National Estuarine Research Reserve (TRNERR), and near shore Pacific Ocean waters have been contaminated by untreated or inadequately treated domestic and industrial wastewater emanating from the México side of the watershed. Recent industrial growth and associated land-use changes in the region have exacerbated the watershed's pollution problems. Furthermore, sluggish efforts by the US and Mexican governments to address the lack of infrastructure and inadequate environmental regulation have fallen short. Treating the ever-increasing volume of wastewater to desired treatment quality standards has become a serious challenge.

This study examines the wastewater challenges facing the Tijuana Watershed Area and asks the following:

1) Was the protracted political action leading to the selection of the Bajagua alternative and the 10+ year delay of secondary treatment at SBIWTP in the best interest of environmental or public health?

2) Was the implementation of a decentralized network of wastewater treatment facilities a better alternative to a large centralized facility in order to meet the need of the growing Tijuana-Rosarito community?

The questions will be addressed in the following manner: In an effort to familiarize the reader with the setting, Chapter 1 will give a brief history of the wastewater problems plaguing the watershed and characterize the Tijuana River Watershed area: including human populations, physical characteristics, climate, flora and fauna, and inadequate infrastructure. Chapter 2 will review several scientific studies characterizing wet weather flows as well as constituents found in the waters of the TRW; briefly describe wastewater treatment and the IBWC's historical efforts to move from defensive action to offensive action in addressing the problem; and finally, describe the alternatives for treatment as described in the Parsons 2005 Supplemental Environmental Impact Statement. Chapter 3 will describe the selected, controversial alternative, the Bajagua Project including the political process that resulted in the selection of Bajagua and the eventual secondary upgrade of SBIWTP. Chapter 4 answers Question 2 above through the use of Generalized Linear Modeling that contrasts performance and reliability

between Mexico's smaller, decentralized treatment plants and a large, centralized facility, like Bajagua.



**Figure 1.1:** Tijuana River Watershed lies on both sides of the US-México International Border.

## **1.2 History of the Problem**

Tijuana, Baja California, México and San Diego California, US, form an international conurbation, the largest of its kind between the US and México (Alper et al., 2008). Untreated sewage that emanates from México and flows into the US has posed a serious health environmental health risk for over seventy years. Efforts by US governmental entities to control the fugitive flows were mainly defensive until the late 1990s culminating in the opening of the

International Boundary and Water Commission's (IBWC) South Bay International Wastewater Treatment Plant (SBIWTP). Before the operations at SBIWTP were begun, defensive measures included capturing flows and returning them to México for treatment or diverting them to San Diego's public works system for treatment (Parsons, 2005; Jamieson, 2002; IBWC Minute 222, 1967).

In the 1920s, the City of Tijuana established its first public sewer system, which was installed in the Downtown area. By the late 1930s, the raw sewage discharges from México into the Tijuana River prompted the US government to construct an international outfall to discharge Tijuana's sewage off shore. Although less than 30% of the watershed's area lies within California (US), its flows are of great concern north of the border; the Tijuana River water flows north (from México) over the International Border into the US's Tijuana Estuary and discharges out to the Pacific Ocean. Often, the predominant Pacific currents transport diluted wastewater north, up the California (US) coast (Jamieson, 2002).

By 1955, Tijuana's population had increased to over 150,000, and the old, original system was overwhelmed. As a result, 3 million gallons per day (mgd) or 131.4 liters per second (lps) of raw sewage was discharged into the Tijuana River Valley, causing contamination of the water supply, agricultural land, the Tijuana Estuary, and California (US) beaches (Parsons, 2005). By 1961 Tijuana upgraded its collection system and pumped flows to a treatment plant whose construction was delayed, so flows were discharged into the surf 9 kilometers (km) or 5.6 miles (mi) south of the border (Parsons, 2005).

By 1965, Tijuana had grown to over 200,000 residents. Tijuana's pump systems experienced numerous failures resulted in flows into the Tijuana River, so the City of San Diego constructed an emergency connection pipeline to Tijuana to collect and transport up to 13 mgd (569.4 lps) of untreated sewage at San Diego's Point Loma Wastewater Treatment Plant (Pacific Eco-Risk, 1999). By the 1970s, as many as 10 mgd (438 lps) of raw sewage was released into the Tijuana River Valley, resulting in near continuous quarantine of beaches in Imperial Beach, CA, US. By 1990, continuous failures of Tijuana's sewer system resulted in upwards of 20 mgd (876 lps) of raw sewage and other wastewater being released into the Tijuana River, posing continued health threats to populations on both sides of the border (Rodgers & Lee, 2005; Jamieson, 2002).

Since 1997, SBIWTP had begun treating México's wastewater to advanced primary standards only (Gersberg, 2005). Its effluent, therefore, contained large amounts of biological, viral, and chemical loads. In order to comply with water quality standards established by the federal governments of both countries, however, the wastewater must be treated to at least secondary standards to reduce biologically active agents.

Since the 1990s, México has experienced increased urbanization without sufficient planning since the implementation of North American Free Trade Agreement (NAFTA). Critical to the acceleration of wastewater generated in the area was the fast development of the *maquiladoras*. The origin of *maquiladoras* was begun over forty years ago; however, since 1994, NAFTA started a new era in Mexican industry that exploded into opportunities with foreign markets (Kopinak, 2002). Hundreds of *maquiladoras*, assembly plants within a free trade zone

to which foreign materials or parts are shipped and from which the finished product is returned, opened in Tijuana and Tecaté. In fact, the fastest growing aspects of Tijuana's rapidly growing industry have been the *maquiladoras*, while agriculture has experienced a sharp decline over past generations (Riveles & Gersberg, 1999). Industries and domestic urbanization have grown faster than the city governments have been able to provide services to them. The existing infrastructure has not been able to accommodate the needs generated by intensive industrial development that contributes to an incredible amount of industrial waste. Asian investors, such as South Korean, Japanese and Taiwanese –owned businesses, have tripled the amount of hazardous waste with which the cities previously had to contend. Furthermore, these companies have found it more cost effective to pay fines levied, when laws are enforced, rather than properly dispose of hazardous waste (Kopinak, 2002).

NAFTA-stimulated industrial development and economic expansion have caused the region to experience an explosive population growth, ranking it among the fastest growing border regions in the nation (Gersberg et al., 2004). *Maquiladoras* have enticed workers to the Tijuana region from across México (Gersberg, 2005; Kopinak, 2002), creating a higher demand for the region's freshwater sources, which have increased along with the population growth.

Changes in land use patterns, contamination of groundwater sources from sewage and industrial runoff, fertilizers, and pesticides have resulted in the decline of the quality and quantity of surface and groundwater sources, especially during rain events when runoff is washed into the watershed's stream and river systems (Ganster, 2005). Upstream activities have had a tremendous impact on downstream water conditions. Urban, industrial and

agricultural runoff and untreated sewage discharges into the Tijuana River have produced dangerous levels of pollutants and negative effects to human health in the form of gastrointestinal and other diseases (Parsons, 2005). In addition, there have been economic impacts through beach closures and loss in recreation opportunities and tourism.

In order to address the water challenges faced by the region, both IBWC sections entered into a public-private agreement with Agua Clara, LLP, by awarding the partnership a fee-for-services contract to construct and operate a secondary wastewater treatment facility, referred to as Bajagua, in México. The agreement included a 20-year contract lease. Bajagua would work in tandem with SBIWTP and was designed to treat 50 mgd (2190 lps) to 75 mgd (3285 lps) of Tijuana's wastewater. Agua Clara was awarded the contract in a controversial no-bid process.

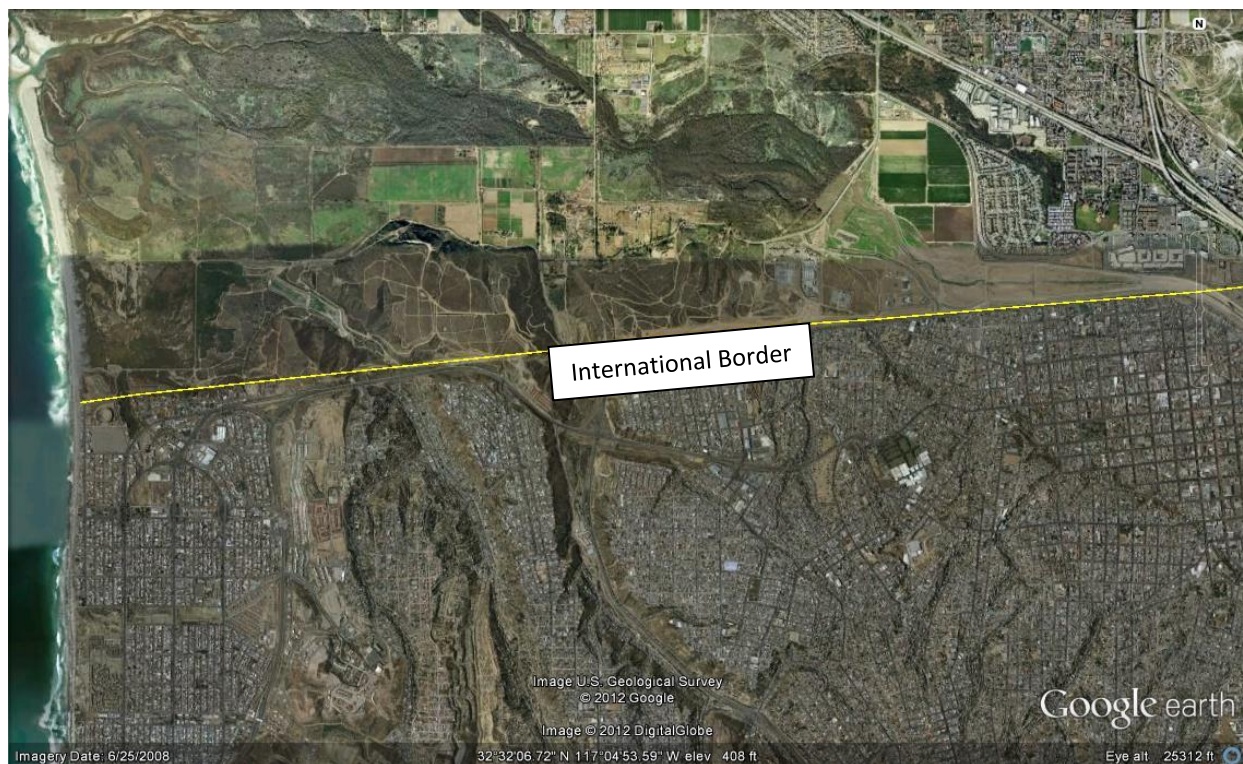
The plan called for primary effluent from SBIWTP to be piped to the Bajagua facility for secondary treatment. Furthermore, wastewater from other sources in México would also be treated at the facility. Secondary effluent discharged by Bajagua could be used for industrial applications where potable water standards were not necessary.

### **1.3 Human Population**

The spatial arrangement of the watershed's population clusters is the primary factor that influences the intensity and location of environmental degradation patterns within the basin. The precise number of inhabitants in the watershed is not known, but estimates for the transborder watershed region suggest the population to be more than 5 million. Indigenous inhabitants of the San Diego – Tijuana region, the Kumeyaay, inhabit either side of the

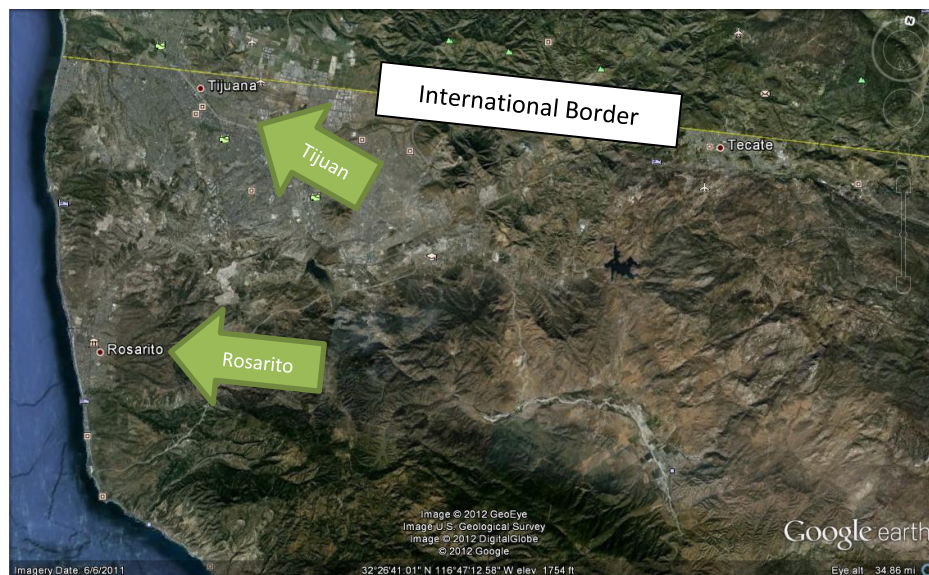


International Border and account for a small but significant portion of the watershed's rural population (Ganster, 2005). A strong contrast between population densities on either side of the border is quite evident (Figure 1.2). There are significant asymmetries with regard to population density, economics, and living standards across the border (Ganster, 2005). On the US side, densities are relatively low, particularly within the vicinity of the International Border (Vela, 2005). The land area of San Diego County is approximately 10,877.95 square kilometers ( $\text{km}^2$ ) or 4,200 square miles ( $\text{mi}^2$ ). Data from the 2010 United States Census for San Diego County include a total population of 3,095,313, a ten year increase of 281,480 people, approximately a 10% growth from the 2000 census (US Census Bureau, 2010), indicating a population density of nearly 737 persons per square mile.



**Figure 1.2:** Satellite image of the contrasts in population densities relative to the International Border

San Diego City Council District 8, which abuts the International Border, is the region closely receiving contamination from the Tijuana River and Imperial Beach, an unincorporated area between District 8 and the Pacific. Important locations in District 8 include the Tijuana River Valley, San Ysidro, and the Otay Mesa. District 8 is predominantly Hispanic, nearly 74%, 11.69% white, and 7.59% Asian. By far, it has the most Hispanics than the other seven districts. Of the nearly one 1M Hispanics in San Diego County, over one third, 376,020, live in District 8 (City of San Diego, 2011). Other municipalities within the southern portion of San Diego County that have been impacted by untreated and undertreated wastewater in the Tijuana Watershed area are National City, Chula Vista, and Imperial Beach.



**Figure 1.3:** Satellite image with arrows indicating communities of Tijuana, Tecaté, and Playas de Rosarito (Rosarito).

Very high population densities south of the International Border, especially on the western portion of the watershed, have resulted in reduced residential open space and deterioration in living standards (Vela, 2005). The municipalities considered in this study are Tijuana and Playas

de Rosarito (Rosarito) (Figure 1.3). Playas de Rosarito is a coastal, tourist community along the coast, approximately 13.5 miles south of the International Border. According to the 2010 census, it has a population of 65,278 (*Instituto Nacional de Estadística y Geografía*, 2010). Tijuana is the largest of the three municipalities whose activities contribute to the Tijuana River Valley. According to Mexico's 2010 census, Tijuana's population was just over 1.3 million (1.78 million in the metro area) in an area of 637 km<sup>2</sup> (246 mi<sup>2</sup>) with an approximate population density of 2,212 km<sup>2</sup> (5,730 persons per mi<sup>2</sup>).

The region's rapidly growing population and burgeoning economy have significantly impacted human health and the environment (Wright, 2005). The rapid growth of Tijuana can be ascribed to in-migration from other parts of México. Tijuana's 2004 annual population growth rate was estimated at 4.9% (Ganster, 2005), and growth projections estimate that by 2025, the watershed's population will double from the 2004 estimates as a result of natural growth and substantial migration to the region (Wright, 2005).

The TRW has highest population densities in Tijuana, Tecaté, and the Mexican communities of San Luis and Terrazas del Valle. US population clusters include the communities of Imperial Beach, San Ysidro, and Otay Mesa. In general, smaller communities, such as Nueva Colonia Hindu, Valle de Las Palmas (México) and Portero, Campo, and Pine Valley (US) exist at their present locations in response to the availability of surface and groundwater that is needed for residential and agricultural uses (Wright, 2005).

Population growth is greatest on the outskirts of the cities of Tijuana and Tecaté. Social anthropologists predict that the cities of Tijuana, Tecaté, and Playas de Rosarito will eventually

meet and form a contiguous metropolitan area. Tijuana is also expanding to the southeast and is likely to conjoin with Valle de Las Palmas within a few years (Wright, 2005). On Tijuana's eastern edge, areas that were moderately populated in 1990 grew to be densely populated by 2000. Topographical features in some parts of the watershed would make the addition of water and sewer infrastructure to these areas exorbitantly expensive (Vela, 2005). In addition to populations of individual communities, approximately 44 million people commute across the International Border at San Ysidro annually for both tourist and business purposes; it is one of the world's busiest border crossings (Emmott, 2007).

Population increases and intensive industrial development have caused a greater demand on the area's resources, in particular, water. The Tijuana Watershed area has been experiencing explosive population growth and is among the fastest growing border regions in the nation (Gersberg et al., 2004). On the Mexican side of the border, insufficient planning and increased urbanization has resulted in an absence of adequate outlets for storm water as well as several large, unserviced squatter developments on the slopes of the hilly region. As the demand for water grows with the population, there will be an increased demand on limited freshwater sources. Furthermore, contamination of groundwater sources from sewage runoff, fertilizers, and pesticides will pose additional environmental challenges and make sources of fresh water scarcer. Sewage problems have worsened in recent years because of Tijuana's significant population growth and the demand for fresh water has grown (Wright, 2005).

#### **1.4 Physical Characterization of the Tijuana Watershed**

The Tijuana River Watershed (TRW) lies within a region of approximately 4,532 km<sup>2</sup> (1,750 mi<sup>2</sup>) on both sides of the International Border, California, US and Baja California, México (Project Clean Water, n.d.). It stretches from the Laguna Mountains in the north (US) to the *Sierra de Juarez* Mountains in the south (México). The watershed features great diversity in landforms and topography. It ranges in elevation from a tidal estuary, where the Tijuana River meets the Pacific Ocean to the mountains of the northeast, at 1944 m (6,378 ft), and southeast, at 1800 m (5900 ft). Its terrain encompasses flood plains, coastal mesas, snow-capped mountains on its eastern edge, over seventy miles of coastline on its western edge, steep narrow valleys, several broad interior valleys, alluvium-filled valleys, and a high plateau, (Parsons, 2005; Gersberg, 2005). The TRW's surface increases in elevation from west to east. At sea level, the mouth of the Tijuana River forms a variable west-east gradient, and many parts of the surface have been well eroded by water forces, particularly in the areas of the major, steeply inclined stream valleys. Some valley slopes are in excess of a 25% grade. Alternatively, the Tijuana River and the Rio Las Palmas are surrounded by gently sloping land with less than 10% grade (Wright, 2005).

The Tijuana River is formed by two drainage networks at approximately 17.7 km (11 mi) from the Pacific Ocean. The terrain south of the International Border is generally higher in altitude than on the north side of the border, resulting in a natural flow from México to the US. The Tijuana River water flows (from México) north over the International Border, into the Tijuana Estuary, out to sea north, and often up the California coast (US). In México, the river flows through a concrete channel; once it crosses the border into the US, however, the conveyance is

natural and unlined as it flows into the Tijuana Estuary and out to the ocean (Parsons, 2005; Wright, 2005).

The TRW drains through the Tijuana River into the Pacific Ocean. Upstream activities have an effect on the quality and quantity of water in the Tijuana Estuary and near shore marine environments (Riveles & Gersberg, 1999). Fluvial transport of large amounts of sediments, agricultural run-off, contaminated wastewater (both municipal and industrial), and increasing demand for potable water from local sources have shown distressing impacts on the Tijuana Estuary, one of the last functioning coastal wetlands in Southern California (Project Clean Water, n.d.). Intense rainfall events combined with steep narrow canyons creates an immense force of water as it makes its way toward the Pacific. Much of the land has been paved, so natural ground infiltration no longer helps reduce massive volume of flow as it rushes downhill; therefore, with fewer obstructions in its path or places to soak-in, little impedes storm water's erosive potential (Vela, 2005). For many years, the IBWC Commissioners have recognized the seriousness of the flood threat to both countries (IBWC Minute 225, 1967).

Changes in topography, land use, and groundcover have increased the potential for flooding. The TRW is subject to El Niño weather events, and at times, overwhelming rainfall can create mudslides and adds tremendous volume to the river flow. Four main factors leave the City of Tijuana highly vulnerable to flooding:

- intense rainfall events that drop a large amount of water in a relatively short period;
- precipitation that falls on mesas, runs into deep, steep-sided, narrow canyons;

- loss of natural ground cover caused by urban growth and the paving-over of permeable ground; and
- poorly designed urban drainage system that cannot adequately contain storm water runoff (Vela, 2005).

The watershed has four major water impoundments: Rodriguez Dam and El Carrizo Dam in México and Barrett Lake and Morena Lake in the US (Gersberg et al., 2004). The Rodriguez and El Carrizo Dams provide the principal water storage for the City of Tijuana (IBWC Minute 240, 1972). The Carrizo Dam is the end point for water imported from the Colorado River, and it serves the City of Tecaté as an emergency water source (Wright, 2005). Water stored in the Bartlet and Morena Dams is conveyed from TRW to the Otay River Watershed to the City of San Diego where it is used as a source for freshwater (Wright, 2005). Stream flows are ephemeral, in the Tijuana River and its tributaries, the result of the region's semi-arid climate and seasonal precipitation. Additionally, the water impoundments and changes in land use in the region modify the flow (Aguado, 2005; Wright, 2005).

#### 1.4.1 Climate

The Tijuana Watershed Area has a great variety of geographical and topological features which contribute to an abundance of microclimates. Overall, the watershed is characterized as a mild, semi-arid and Mediterranean climate; it experiences dry summers and receives most of its precipitation in the form of winter rains. More than 90% of the mean annual precipitation occurs between November and April (Gersberg et al., 2004; Aguado, 2005; National Oceanic and Atmospheric Administration [NOAA] Climate Service, n.d.). Approximate mean annual

precipitation in the watershed varies widely throughout, between 200-1095 mm (8 in. to 43 in.). The amount of precipitation received in any area within the watershed is strongly influenced by elevation, with the northern portion receiving the most precipitation. A precise correlation between elevation and precipitation does not exist; however, slope-aspect relative to prevailing winds strongly influences precipitation. Because of windward influence, the highest mapped precipitation values in the TRW occur just to the west of the two highest elevation areas in the extreme north and south. Infrequent, dissipating tropical storms appear in the late summer off the coast of southern Baja California, but they generally yield small amounts of rainfall on land. On rare occasions, however, those storms have produced significant downpours that result in flash flooding (Aguado, 2005).

The Tijuana River Watershed experiences extratropical seasonal temperature patterns typical for the Northern Hemisphere. The highest temperatures occur in July and August and the lowest in December and January. Temperatures experienced throughout the watershed are influenced by two main factors: elevation and proximity to the ocean. The highest elevations, the extreme northeast and southeast portions of the watershed, experience the lowest temperatures, between 9°C and 11°C (48°F and 52°F). Daytime temperatures in the high elevation areas are to some degree lower than those close to sea level, and the greatest temperature differences occur at night, especially during the winter months. Seasonality is far more pronounced at higher elevations than at the lower elevations. In the lower elevations, mean temperatures generally range between 16°C and 19°C (61°F and 66°F). Proximity to the coast also exerts an effect on temperature. The ocean waters along the coast moderate daytime high temperatures in the western portion, particularly during the summer. This affect



keeps the annual mean coastal temperatures slightly below those of the inland areas (Aguado, 2005).

#### 1.4.2 Geology & Geomorphology

Tectonic plate subduction in the TRW's basin during the Cretaceous Period caused the formation of plutonic rock, the dominant rock type in the upper watershed: metasedimentary, metavolcanic, and batholiths. In the watershed's lower portions, sedimentary rock from the Oligocene, Miocene, Pliocene, and Pleistocene Epochs predominate (Demere, 2005). During the Cretaceous Period, plate subduction action created groups of granite made up of many individual intrusive plutonic bodies along the western edge of the watershed. An ancient river system carried sand and gravel into a Pliocene Epoch bay creating fossil-rich deposits. The modern Tijuana River Valley was carved out nearly 18,000 years ago when the most recent glacial interval reached its maximum (Demere, 2005).

The geomorphology of the California's Baja peninsula is the result of the region's plate tectonic history (Winckell, 2005). At the upper portion of the Baja peninsula, the Tijuana River Valley has four major landscapes: rolling hills, flat, mesas with steep-sided canyons, and terraces. The eastern portions of the watershed exhibit a gentle to moderately rolling terrain that extends to the central portion of the watershed. Included in this landscape is the highest elevation of the watershed at nearly 2000 m (6562 ft). The western edge of this landscape is relatively flat but transforms to a rolling landscape. In contrast, west of this area are regions extending to the northern corner of the watershed that are highly dissected and steeply sloping. There are, however, some areas of gently sloping hills also. Significant mesas with steep-sided canyons

resulting from ancient marine deposits and tectonic uplifting from the coastal zone (Winckell, 2005). Finally, the coastal plain is characterized by a series of wave-cut terraces, which extend ten miles inland, flank the widening Tijuana River system as it heads toward its terminus, the Tijuana Estuary (Parsons, 2005).

Within the TRW, seismically active areas exist. Although the San Diego area is categorized as Seismic Zone 3 (Parsons, 2005), not high seismic activity, but consideration must be paid to the onshore and off shore seismic faults when designing structures, including conveyances.

#### 1.4.3 Soil & Flora

Historically, the Tijuana Watershed has nurtured an extraordinary variety of native floral and faunal communities and ecosystems due to a diverse range of soils, geology, topography, and climate. Vegetation types vary from coastal salt marsh and sage scrub at sea level to a mixed coniferous forest in the high, northern portion of the watershed (O'Leary, 2005).

Soil types in the watershed on both sides of the International Border are comparable; however, a thorough classification of the soils in the entire basin is not available because existing Mexican surveys are scarce and based on different taxonomic criteria that are difficult to correlate with the United States Department of Agriculture (USDA) Soil Taxonomy System used in the US (Greenwood, 2005). The soil development within the Tijuana River Basin is controlled by the region's semiarid (xeric) climate, sparse vegetation, and geomorphic environments. Entisols and Inceptisols dominate the lower basin and foothills on the US side; flooding prevents the soil from forming a mature profile. Inland soils, at somewhat higher elevations and more stable vegetative cover, are primarily Alfisols and Mollisols. Vertisols are scattered

throughout the basin depending on the location of high shrink swell-clays (Montmorillonites) and other smectites found in the parent material (Greenwood, 2005).

The Tijuana Estuary is a wetland-dominated tidal estuary, which has been designated as a National Estuarine Sanctuary for protection of a number of threatened and endangered plant and animal species as well as their habitat (Meyer & Gersberg, 1997). Within San Diego County alone, there are dozens of federally listed endangered and threatened species (City of San Diego, 2003). At the mouth of the Tijuana River, the Tijuana River Estuary is host to a southern coastal marsh, one of the few remaining salt marshes in Southern California.

The watershed hosts a wide variety of floral species: riparian vegetation; oak woodland, pinyon-juniper woodland and Jeffrey pine; coastal sage scrub and chaparral; and Southern coastal marsh. Several examples of riparian vegetation are found in the watershed. It provides an invaluable habitat to a rich diversity of fauna including birds, reptiles, mammals, and freshwater fish. Due to urban sprawl, most of the riparian vegetation in area surrounding Tijuana has been removed or seriously disturbed; however, some riparian vegetation can be found in the undeveloped areas along the Tijuana River's tributaries (O'Leary, 2005). Riparian types include riparian woodland, oak riparian forest, coastal live oak, and riparian scrub. Oak woodland Pinyon-Juniper and Jeffrey Pine Forest make up a small fraction of the watershed's vegetation types, but are a valuable habitat for a variety of wildlife types and contribute to the watershed's vast diversity. The higher elevations of the northeastern and southeastern portions of the watershed are host to Jeffrey pine forests, and at even higher elevation, Pinyon-Juniper forests can be found in the watershed's extreme southeastern portion.

Nearly three quarters of the watershed is covered by two shrub types: coastal sage scrub and chaparral. Coastal sage scrub is found on drier, lower elevation slopes on the western half of the watershed. Coastal sage scrub was once found on most of the land in and around Tijuana and on the Otay Mesa that has since been developed. Sage scrub is mostly deciduous during the summer but provides critical habitat to a large number of rare, threatened, and endangered species most notably, the California gnatcatcher (O’Leary, 2005; Audubon, 2002). Chaparral is found in over half of the watershed and can be located at elevations above coastal sage scrub in the eastern part of the watershed. Chaparral is typically evergreen, deep-rooted, taller and denser than sage scrub (O’Leary, 2005).

Loss of the watershed’s natural flora has led to increased environmental degradation in many parts of the watershed. The process of subdividing a continuous habitat into smaller, disconnected patches, or habitat fragmentation, results in the environment’s inability to support the rich species it once did. Changes in land use, particularly the conversion of natural cover to agricultural and urban uses, are seen throughout the watershed, especially in the rapidly growing Tecaté and Tijuana areas where fragmentation of sensitive habits such as coastal scrub and riparian woodland is most pronounced. To the east, habitat fragmentation has occurred along Highway 2 in México and in the vicinity of El Hongo northward to the International Border (Vela, 2005). Environmental degradation has led to vegetation losses resulting in habitat fragmentation and subsequent biodiversity decreases. Coastal scrub and riparian woodland have seen significant fragmentation due to Tijuana and Tecaté sprawl.

## CHAPTER 2

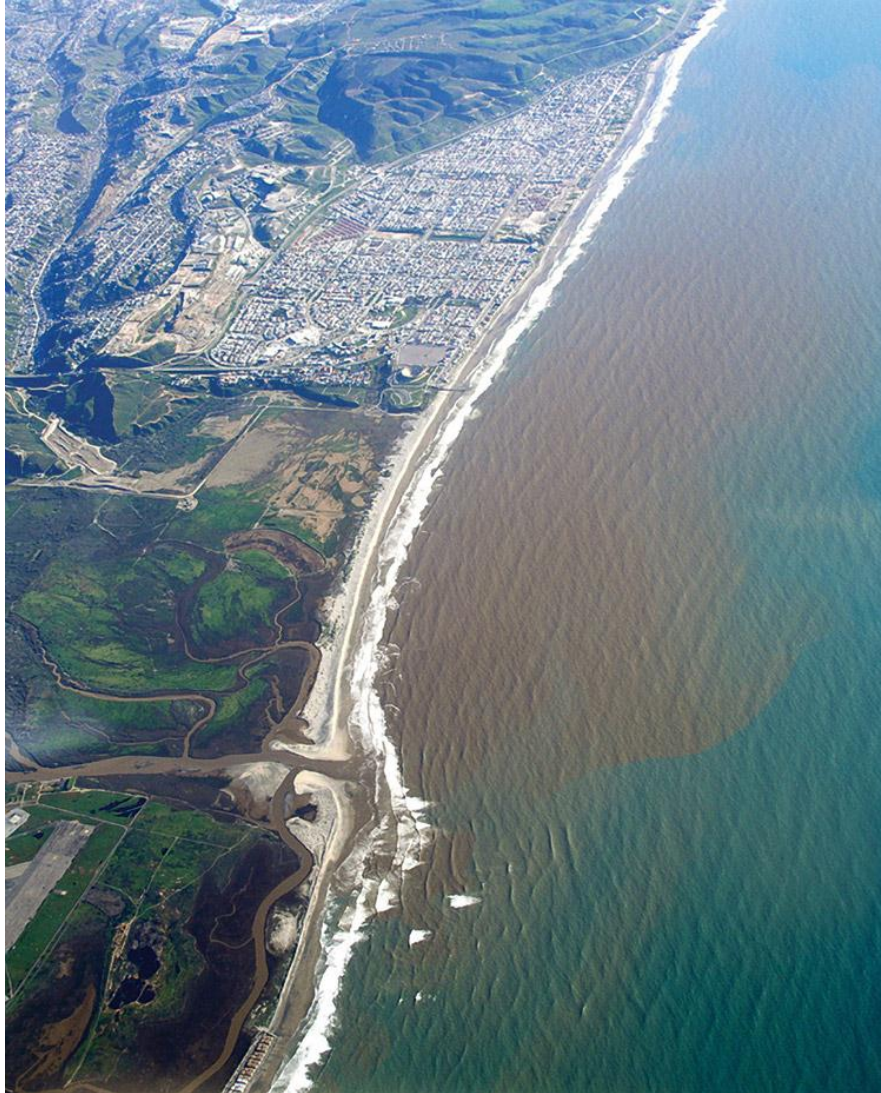
### CHALLENGES, TREATMENT & ALTERNATIVES

#### **2.1 *Characterization of the Wastewater Problem***

The California State Water Resources Control Board (CSWRCB) classified the Tijuana River watershed as Category I (impaired) due to an extensive assortment of water quality problems, largely a result of non-point agricultural sources on the US side of the border and many point and non-point sources on Mexico's side of the border (Project Clean Water, n.d.). Inadequate drainage systems and fragmented landscapes have resulted in surface water quality and habitat degradation and loss, garbage, sedimentation, eutrophication, flooding, erosion, and invasive species. In the surface freshwater, constituents of concern are coliform bacteria, nutrients, trace metals, pesticides, miscellaneous toxics, low dissolved oxygen, and trash. In the groundwater nitrates, petroleum, MTBE, and solvents have been detected. Urban and agricultural runoff, sewage, and industrial discharges, are the suspected source of these constituents (Project Clean Water, n.d.). Polluted runoff from the Tijuana River has been traced to the southern shores of Point Loma causing elevated bacterial concentrations (Svejkovsky, 2005).

Presently, Tijuana sends a portion of its wastewater to South Bay International Wastewater Treatment Plant (SBIWTP), which discharges its effluent through the South Bay Ocean Outfall (SBOO). Once the wastewater crosses the International Border from Mexico to the US, it is subject to the environmental laws and regulations of the US. Until November 2010, the

wastewater was treated to (advanced) primary standards at SBIWTP, meaning the effluent contained large amounts of biological, viral, and chemical constituents, which did not meet US environmental standards for National Pollutant Discharge Elimination System (NPDES) permit discharge.



**Figure 2.1:** Aerial image of runoff from Tijuana Estuary after a rain event.

Prior to the initiation of industrial pretreatment programs in México in the late 90s, there was a continued threat of chemical contamination to the Tijuana Estuary. Meyer and Gersberg (1997) tested this risk by collecting and analyzing core samples of sediment from eight sites throughout the estuary in 1996. Using atomic absorption spectrometry (AAS) the researchers checked for: cadmium, Cd; copper, Cu; nickel, Ni; lead, Pb; and zinc, Zn. The researchers found that concentrations of Cd, Cu, and Ni had increased considerably when compared to a 1989 study that was conducted prior to the passage of NAFTA. Moreover, concentrations for Pb and Zn had increased three fold in sediments, which is of concern because chemical discharges from Tijuana industries could inhibit the secondary biological treatment potential (Meyer & Gersberg, 1997).

Gersberg et al. (2000) conducted a sampling program to assess the quality of runoff associated with a variety of land uses in the Tijuana River watershed. Algorithms were used to model land use types and pollution responses in the following categories: open-space, residential, commercial, industrial, and Tecaté Creek. Runoff samples were collected during the first two to four hours of a storm's inception and once again 24-36 hours later. The researchers tested for Cd, Cr, Cu, Pb, Ni and Zn. Concentrations for metal in all samples collected during the first two hours of runoff were higher than those samples collected 24-36 hours after the rain event. The exception to this general trend was the Tecaté Creek site, where levels of Cd, Cr, Cu and Ni were higher in the later storm sample than in the samples collected during the first one to four hours. The authors attributed this possibly to point source discharge of wastewater effluent from the Tecaté Municipal Wastewater Treatment Plant, just one mile upstream. Tecaté Creek is a major tributary that lies west of the Tijuana River and just below the urban area of Tecaté,

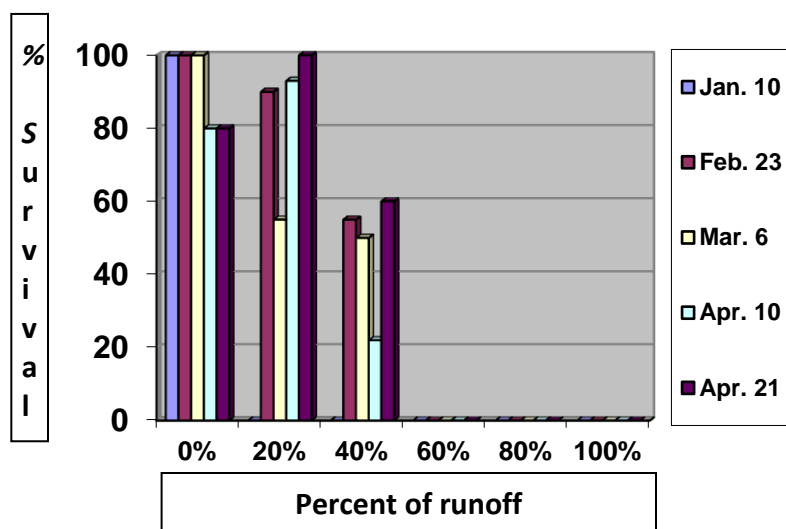
México, a city with a minor sewage treatment and disposal system infrastructure (Gersberg et al., 2000).

Other urban land use sites: industrial, commercial, residential, and open were generally compatible to the 90th percentile values for wet-weather runoff in an urban watershed of Los Angeles County. These researchers concluded that several different types of land uses contributed to non-point source pollution, which will continue to enter the Tijuana Estuary and near-shore ocean during wet weather (Gersberg et al., 2000).

Riveles and Gersberg (1999) conducted chronic toxicity tests. Wet and dry weather samples were collected from the Tijuana River just north of the International Border. To be considered a “dry weather sample” the researchers collected samples from the river at least two weeks after the last rainfall event. The researchers followed the *Ceriodaphnia dubia* Survival and Reproduction Toxicity Test, which measures chronic toxicity of whole effluents and receiving water to *C. dubia*. The chronic exposure lasted for seven days. The samples used were for the wet days of Feb. 28, 1997 and Apr. 2, 1997 and the dry days of Mar. 14, 1997 and Apr. 22, 1997. Toxic units (TU) are referenced to no observable effect concentration (NOEC). NOEC is the highest concentration to which the test subject can be exposed without showing adverse effects. The dry weather samples presented relatively low toxicity with TU values of 1.0 and 1.25. Wet weather TU values, however, 4 for the 28 February sample and 10 for the 2 April sample had an indication of four times the baseline values. These findings strongly suggest that a probable source of pollution in the Tijuana River is from non-point sources emanating from industry in México (Riveles & Gersberg, 1999).



In a related study, Gersberg et al. (2004) collected water samples in the Tijuana River during both wet and dry conditions. Lethal Concentration ( $LC_{50}$ ) toxicity tests were also conducted using *C. dubia*, following US Environmental Protection Agency (EPA) protocols [8,9]. This research, conducted in 2001, indicated that Tijuana River water toxicity was generally low during dry weather conditions. During wet weather, however, toxicity was markedly higher. Tests were performed for runoff samples collected on 10 Jan. 2001, 23 Feb. 2001, 06 Mar. 2001, 10 Apr. 2001 and 21 Apr. 2001. Levels of daily temperature, dissolved oxygen, pH, hardness, and alkalinity readings for the collected river water all fell within the acceptable range for moderately hard water. All tests were conducted using ten, third brood neonates, with the exception of the 10 January sample when five individuals were used. Dry weather samples exhibited very low toxicity to *C. dubia* in 48 hour tests at 97% survival at 100% river water concentration. Conversely, 48 hour survival tests for *C. dubia* using storm water “first flush” runoff ( hours 1 and 2) from the Tijuana River collected during or immediately after a rain event, yielded no survivors under the same conditions. Survival was seen only when the runoff samples were diluted to 40% or below. Solid Phase Extraction (SPE) methods used to pre-treat runoff was the only treatment that showed significant reduction in  $LC_{50}$ , suggesting that the toxicity was probably associated with non-polar organic molecules (Gersberg et al., 2004). Figure 2.2 summarizes the survival rates.



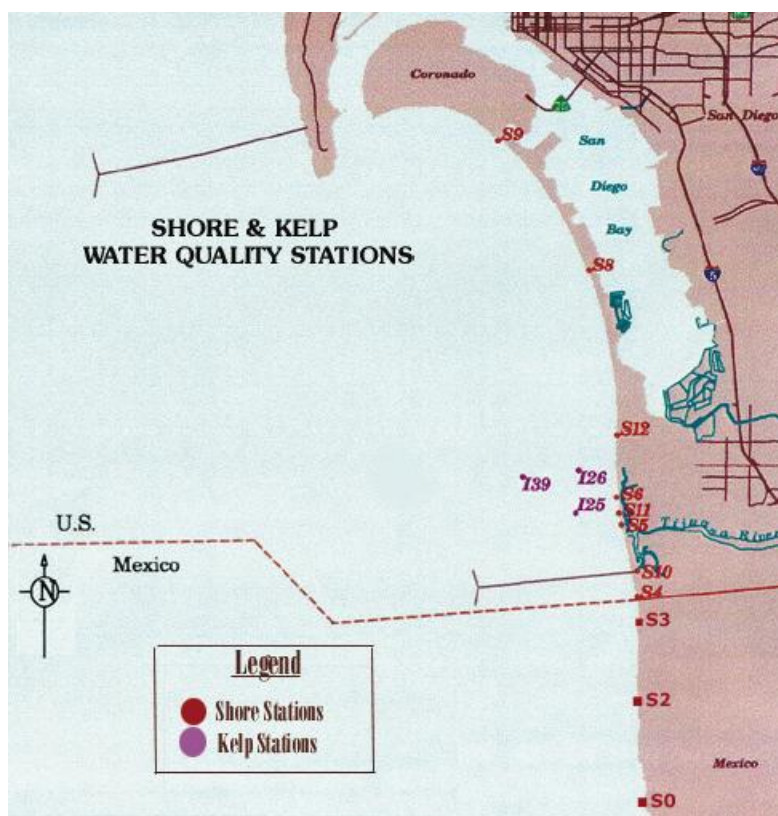
**Figure 2.2:**  $LC_{50}$  survival rates for *C. dubia* for five selected dates during winter/spring 2001. At a concentration of runoff, there is no survival.

Acute toxicity tests conducted by Pacific Ecorisk Labs, Inc. (1999) indicated that the effluent from SBIWTP have failed to meet its National Pollutant Discharge Elimination System (NPDES) permit limits (Pacific Eco-Risk, 1999). While SBIWTP has reduced considerable amounts of water pollution flowing into the Tijuana Estuary during dry weather, it does not have the capacity to treat all the water it receives during wet weather events (Riveles & Gersberg, 1999). Effluent discharged into the Pacific Ocean is commonly thought to be the primary source of contamination at Imperial Beach and San Diego beaches because of prevailing, north flowing ocean currents. Beaches are regularly quarantined, particularly after rain events. Furthermore, tests of wastewater emanating from Tijuana show that there are more organic contaminants than anticipated when SBIWTP was designed (Pacific Eco-Risk, 1999).

NPDES permitting requires that releases to US surface waters must be consistently monitored for priority pollutants. The City of San Diego, monitors oceanic water characteristics because

this municipality also discharges to outfalls in the Pacific. Those include the SBOO and the Point Loma Ocean Outfall (PLOO) 21.67 km (13.5 mi) north of the International Border.

In order to ascertain baseline oceanic water quality conditions that would receive SBIWTP effluent through SBOO, the US IBWC and City of San Diego conducted a monitoring campaign. The program lasted from 1995 until 1998 before discharge from SBOO was begun. The sampling area extended from Punta Bandera, Baja California, MX 9.01 km (5.6 mi) south of the International Border north to the tip of Point Loma 21.67 km (13.5 mi), from the shoreline to sea at a 61 m (200 ft) depth. The Baseline monitoring included standard water quality parameters, benthic communities, epibenthic species, tissue burden (in targeted fish species), and selected toxicity responses. Ambient toxicity was determined through bioassays. Sampling included monthly water column profiles of physical characteristics and discrete samples for coliform, oil and grease, and total suspended solids (TSS). Additionally, sediment samples were collected for chemical characteristic infaunal assessments (Parsons, 2005).



**Figure 2.3:** Map indicates locations for contaminant sampling stations in the San Diego coastal bight.

Water monitoring stations have been placed from south of the International Border to Coronado Island near San Diego (see Figure 2.3). The water is monitored for several constituents commonly used to judge the efficacy of municipal wastewater treatment. Through monitoring, evidence of fecal coliform and enterococcus bacteria have been found near SBOO that carries effluent from SBIWTP. Microbial community structures are strongly influenced by seasonal oceanic conditions, runoff from land and riverine sources, wastewater discharge, and other anthropogenic sources. There was no evidence, however, that discharges from its ocean outfall manifest with contaminant loads in fish. Contaminants found in the muscle tissue (tissue burden) of collected sport fish were found to be within US Food and Drug

Administration human consumption for mercury and DDT (dichlorodiphenyltrichloroethane) (City of San Diego, 2003).

The San Antonio de los Buenos Wastewater Treatment Plant (SABWTP), located 9.01 km (5.6 mi) south of the International Border (see Figure 2.4), has released untreated wastewater in excess of its 25 mgd (1095 lps) capacity directly into the Pacific surf zone at Punta Bandera through Los Buenos Creek. In 2004, the amount that exceeded SABWTP's capacity was 6 mgd (263 lps) (Parsons, 2005). Monitoring results suggest that the SABWTP discharges affected bacterial concentrations from the discharge point in México to just north of the International Border. Remote imaging conducted by Ocean Imaging Corp. (2005) found plumes of effluent discharges on several occasions, see Figure 2.1 (Svejkovsky, 2005).

Baseline monitoring revealed SABWTP discharges and Tijuana River wet weather runoff influence shoreline coliform levels, while Punta Bandera discharges occasionally influenced offshore coliform levels. After discharges from SBOO were begun in 1999, shoreline bacterial concentrations were mostly lower (than before 1999) in the South Bay region during the dry spring and summer months. Furthermore, industrial pretreatment was not begun until 1998. Prior to that, the influent to SBIWTP showed chronic toxicity potential, which correlated with dioxins, exceeding plant permit limits (Kopinak, 2002).

Untreated wastewater introduces bacteria, viruses, and a retinue of potentially toxic constituents into the coastal aquatic environment. Wave action and oceanic currents dilute and mix the discharge within the surf zone, which extends from the shoreline to the breaker line. Offshore monitoring stations generally showed very low coliform densities throughout the year

with the exception of some 30-ft offshore stations. Near the SABWTP discharge site, however, the mean annual coliform density was measured at 2,513 coliform forming units (CFU) per 100 ml during the 12 months of monitoring between July 1995 and June 1996. During the same period, the mean annual coliform density near the International Border was 1,473 CFU per 100 ml. A gradient of coliform densities appeared, indicating that densities were inversely proportional to distance from the discharge site at Punta Bandera, which is consistent with water movement patterns in the vicinity (Parsons, 2005).



**Figure 2.4:** Satellite images indicating the location of the SABWTP.

In 2004, Science Applications International Corporation (SAIC) was contracted by the US EPA to conduct a compliance assessment for discharge quality into coastal receiving waters. SAIC



evaluated bacterial concentrations within the vicinity of SBOO; total coliform, fecal coliform, and enterococcus data were evaluated for single day and multi-day averages, 30 day, 60 day, and 6 month. Shoreline monitoring stations were compared to offshore and near-shore stations. High over-compliance-limit events were measured at the shoreline stations, while “low range” of out-of-compliance events were found in the offshore/near-shore stations. An assessment of percent over-limits before and after the implementation of SBOO for discharge indicated slight mean percentage increases of 0.1 to 2.35 for the offshore and near-shore stations. The compliance assessment found that incidences of over-limit events were low for single samples at all depths and indicator organisms: 0.2% to 4.86% maximum. The majority of the over-limit events were restricted to the bottom and mid-depths with few in the surface layers (Parsons, 2005).

The shoreline assessment of percent over-limits for years before and after discharge through SBOO indicated slight mean percentage increases of 0.9% to 4.23%. In contrast to the offshore and near-shore samples, however, shoreline single sample limits for total fecal coliforms and enterococcus had significantly higher percentage of over-limit events: 1.85% to 18.16%. As would be expected, the northernmost shoreline monitoring stations had the lowest out of compliance among the indicators values, and percentages varied substantially. There was an exception for enterococcus shoreline results from pre- to post- discharge. These showed a predominant increase in mean, lower out-of-compliance values; the highest mean percentages were adjacent to or south of the Tijuana River, and a station in a kelp bed had higher values (Parsons, 2005).



Relatively low concentrations of indicator bacteria were found within the vicinity of SBOO before and after discharge was begun, in addition to greater incidence of over-limit concentrations at the southern shoreline, indicated that the contributions more likely came from river and storm water flow than from offshore discharge (Parsons, 2005).

Using several types of remote sensing technologies, Ocean Imaging Corp. began operational monitoring of the discharge plumes generated by the SBOO, PLOO, the Tijuana River, and the SABWTP in October 2002. During periods of high water clarity, the effluent plume from SBOO is often visible. During the warmer months, late spring through mid-fall, the effluent plume is trapped by cold water near its discharge point, 28.35 m (93 ft) below the surface due to a strong vertical stratification of the water column. When surface temperatures cool, the thermal stratification collapses, and the effluent is able to rise to the upper levels of the water column, and in some cases, to the surface (Svejkovsky, 2005).

In October 1995, prior to SBIWTP operations, water samples were collected at nine shoreline stations and offshore stations around the vicinity of SBOO at a depth of 30 ft. Sampling ranged from an area near Punta Bandera in the southern region north near Coronado Island; offshore sampling included 38 water quality stations and covered an area of 140 Nmi<sup>2</sup> (square nautical miles), or approximately 480.15 km<sup>2</sup> (185.4 mi<sup>2</sup>).

Baseline monitoring undertaken prior to discharge from SBOO revealed that seasonal variations in dissolved oxygen concentrations and pH levels were consistent with the rest of the Southern California Bight. During the months of July and August/September, dissolved oxygen mean values ranged from 7.7 mg/l to 8.8 mg/l respectively at the 90 ft depth contour (Parsons, 2005).

Generally, northern monitoring locations showed lower dissolved and suspended nutrient concentrations than the southern locations. The bottom of the water column has the lowest dissolved oxygen during the spring months. Temporal and spatial trends with respect to temperature, salinity, and dissolved oxygen were also studied. In 2003, average surface temperature ranged from 14.7°C in January to 19.3°C in July (City of San Diego, 2004). During the winter months, however, bottom temperatures were higher when winter storms mixed the water column. Salinity was found to be generally higher at the bottom of the water column than at the surface especially during the spring, and salinity within the vicinity of SBOO ranged from 33.17 g/l in November to 33.57 g/l in June. Sampling of water quality characteristics within the vicinity of SBOO before and after the initiation SBIWTP operations found that conditions were similar, and discharge had little influence on water quality. Large scale oceanographic conditions, on the other hand, strongly influence water quality (Parsons, 2005).

Baseline sampling, conducted prior to the opening of SBIWTP indicated that oil and grease levels were low at all sampling stations, and differences in temperature, transmissivity, suspended solids, salinity, oil and grease could be attributed to seasonal changes rather than to location. Salinity was inversely related to temperature while dissolved oxygen was highest near the surface and closer to shore (Parsons, 2005).

Four surface water transects were used to determine trace element concentrations and distributions along the continental shelf from northern Baja California north to the International Border. Natural and anthropogenic origin of the metals (Cd, Pb, Mn, Fe, and Zn) were studied. Off shore measurements of the metals indicated a gradient with higher

concentrations in coastal waters containing high nutrient and salinity concentrations while a long shore gradient indicated lower concentrations to the south. The area near Punta Bandera showed elevated trace metal concentrations relative to sampling station further south and seemed to correspond with point source wastewater discharges in the area: 1% Cd, 9% Zn, and 29% Pb. Other trace metal enhancements were found to be the result of oceanographic upwelling and advection rather than from anthropogenic sources (Sañudo-Wilhelmy & Flegal, 1991).

In general, the sediment profile in the study area increased in grain size with depth. Sediments throughout the study area were found to be relatively coarse: sand comprised approximately 89 percent of sediments, silt comprised approximately 10 percent, and clays accounted for less than 1 percent. A Tijuana Oceanographic Engineering Study (TOES) conducted in 1992 found the area adjacent to the Tijuana Estuary had higher sediment concentrations of Ni, Zn, Cu, Cr and DDT. The Central Bay sediments had the highest concentrations of Hg, Cd, Ag, and phenol. The northwest area of the bay tested highest for organic carbon, biological and chemical oxygen demand, sulfides, total nitrogen, As, Pb, Ni, Cu, Zn, Cr, CN, and DDT (Engineering-Science, 1992). A study of vertical accretion rates relative to heavy metal accumulations conducted by Weis, et al. (2001) found that despite heightened industrial development in the Tijuana Watershed, the Tijuana Estuary had somewhat low accretion rates relative to other anthropocentrically-impacted estuaries (Weis et al., 2001).

Total organic carbon, total nitrogen, total sulfides, and trace metals were generally low within the vicinity of SBOO compared to other coastal areas in the Southern California Bight. Pesticides

were discovered in the sediment before discharges from SBOO were begun and levels remained unchanged. PAH, PCBs, and pesticides were rarely detected, and there was no correlation found between their occurrence and discharges from SBOO (Parsons, 2005).

Toxicity Identification Evaluations (TIE) were conducted on the treated, final effluent from SBIWTP after acute toxicity to *C. dubia* had been observed. Tests conducted in 1999 indicated that organic compounds, especially surfactants, were the primary causes of the acute toxicity. Furthermore, diazinon and carbofuran were found in the water, and it was concluded that the contaminants appeared to be organic in nature (Pacific EcoRisk, 1999).

## **2.2 Pathogens and Toxic Substances in Wastewater**

Sources of wastewater include stormwater runoff, industrial wastewater, domestic grey water and sewage (blackwater). Untreated, undertreated, or improperly treated wastewater is a threat to human health, the environment, and wildlife. Poor water quality poses a threat to human health worldwide. Each year, estimated 88% of the nearly 2 million deaths caused by diarrheal diseases, 4% of the global disease burden, are the result of unsafe drinking water sources and untreated or poorly treated wastewater (World Health Organization [WHO], 2012). The majority of those affected are children under the age of five years. In areas devoid of safe drinking water or basic sanitation, efforts to prevent diarrheal disease are doomed to failure (World Health Organization [WHO], 2006). Protecting clean freshwater sources and safeguarding public health are the two major reasons for treating wastewater preventing water pollution. Disease-causing pathogens, like bacteria, viruses, and protozoans are present in

wastewater; furthermore, toxic chemicals and heavy metals from runoff and industrial uses can also contaminate waters and beaches and cause serious health risks (United States Geological Survey [USGS], 2012).

Depending on the socioeconomics of the community producing the wastewater, the microbial pathogen types and numbers present vary (Toze, 1997). Many microbial pathogens are enteric. That is, they are eliminated as waste from a host, contaminate the environment and are then introduced (orally) into a new host. Microbial pathogens can be divided into three categories: a) viruses, b) bacteria, and c) pathogenic protozoans and helminthes.

A wide range of viruses can be found in wastewater, and they can be the most difficult to detect and are potentially the most hazardous. They are smaller than other microbial pathogens, are more infectious, and are generally more resistant to treatment processes. The enterovirus is most commonly detected in wastewater (Toze, 1997). Examples of enterovirus are the Poliovirus and coxsackievirus (ex. viral hepatitis). Rotavirus, adenoviruses, reoviruses, astroviruses are non-enteroviruses also found in wastewater. There are also enteric forms of bacteria resulting, most commonly, in gastrointestinal infections like cholera-causing diarrhea, and salmonella. Nonenteric bacteria include *Legionella*, *Staphylococcus aureus* and *E. coli*. Some nonenteric bacteria cause subcutaneous ulcers.

Protozoans are single-celled eukaryotic organisms with the capacity of self-motility. Waterborne protozoans include *Entameoba histolytica*, *Giardia intestinalis*, and *Cryptosporidium parvum* (Toze, 1997). Worms found in wastewater include hook worms, round worms, pin worms and flatworms. *Ascariasis* is a roundworm whose eggs are laid in sewage-

contaminated soil. Once ingested, the roundworm develops in the gut and attacks the lungs, liver and other organs.

Unlike nucleic acid-containing pathogens, prions are infectious agents comprised of a misfolded protein. Prions are responsible for causing a variety of uniformly fatal brain diseases called transmissible spongiform encephalopathies (TSEs) that afflict a variety of mammals like cows (bovine spongiform encephalopathy, BSE), deer, elk and moose (chronic wasting disease, CWD) and humans (Creutzfeldt-Jakob disease, CJD). Several cases of CJD transmission have been documented through such procedures as corneal transplants and receipt of pituitary-derived human growth hormone (hGH) treatments (Belay & Schonberger, 2005). Prions are characterized by a long incubation period and have been known to persist for long periods on terrestrial environments (Bartholomay et al., 2005). Upon entering the host and becoming active, an organism's healthy, normal proteins are induced to misfold into the prion form. The misfolded prion proteins contribute to irreversible, untreatable, neurodegenerative disease processes (Belay & Schonberger, 2005; Centers for Disease Control [CDC], n.d.).

Prions are exceptionally resistant to degradation as well as to many disinfection procedures. It is possible that if prions were to enter a wastewater system, they could survive conventional wastewater treatment, including activated sludge digestion. Prions have been shown to partition strongly into activated sludge solids and remain after treatment (Hinckley et al., 2008).

Excessive quantities of decaying organic matter in water systems can cause anoxic conditions by using up the dissolved oxygen in the water. In extreme examples, the aquatic biota cannot

survive. In addition, excessive nutrients released into water systems can cause eutrophication, ultimately resulting in anoxic conditions (USGS, 2012).

Polychlorinated Biphenyls (PCBs) are anthropogenically produced organochloride compounds that have been found in untreated flows of the Tijuana River and in the Tijuana Estuary. According to the Agency for Toxic Substances and Disease Registry, PCBs are mixtures of up to 209 individual compounds composed of joined benzene rings with attached chlorine atoms and are ranked at number 5 on ATSDR Substance Priority List. They have been used as coolants, lubricants, and insulating fluids. They insulate well and do not easily burn. They have the capacity to bioaccumulate and cause environmental harm. PCBs accumulate in adipose tissue and have been associated with disfiguring dermatitis, endocrine disruption, liver and immunological dysfunction, and neurological damage. They are thought to be a human carcinogen (ATSDR-1, n.d.).

Polycyclic Aromatic Hydrocarbons (PAHs) also found in the waters of the Tijuana River and the Tijuana Estuary. They occur naturally in coal, creosote, crude oil and tar deposits; although, some are manufactured. PAHs belong to a group of over 100 chemical compounds and are formed through incomplete combustion and are ranked at number 9 on the ATSDR Substance Priority List. They have been shown to be carcinogenic, mutagenic, and teratogenic as well as cause skin, liver and immunological disorders (Agency for Toxic Substances and Disease Registry [ATSDR]-2, n.d.).

Dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), and dichlorodiphenyldichloroethane (DDD) are persistent organic pollutants that were banned in

the US in 1972 but DDT and DDD are still in use in some countries. DDT and DDE are ranked 13<sup>th</sup> and 21<sup>st</sup> on the ATSDR Substance Priority List respectively. DDT and DDD have been used widely for pest control but are thought to be human carcinogens and are known to cause endocrine, liver, neurological and reproductive problems (ATSDR-3, n.d.).

Methyl tert-Butyl Ether (MTBE) is a volatile, flammable liquid that replaced lead as a gasoline additive in order to increase the octane rating. It can contaminate surface and ground water in a number of ways, like underground storage tanks (UST), leaking pipes or spills (EPA, 2012a). Small amounts can give water an unpleasant odor and flavor. It is not known to cause cancer, but it has been associated with liver, neurological, and renal problems (ATSDR-4, n.d.).

Benzene Toluene Ethyl-benzene and Xylenes (BTEX) are volatile organic compounds found in petroleum derivatives that can contaminate water and soils. All four compounds are colorless, flammable liquids. Benzene ranks 6<sup>th</sup>, Xylene ranks 62<sup>nd</sup>, and Toluene ranks 74<sup>th</sup> on the ATSDR 2011 Substance Priority list. All four compounds cause problems in the nervous system. Benzene is a known carcinogen and afflicts the immune system. Benzene interferes with proper blood formation while Toluene affects the heart and blood vessels. Ethyl-benzene and Xylenes interfere with normal organ development in developing fetuses. In addition, Xylenes cause liver and renal system disorders (ATSDR-5,6,7,8, n.d.).

Phenol is an organic acid compound that is both naturally occurring as well as a manufactured substance. It has mostly been used in the production of plastics and resins. It also has uses as a slimicide, disinfectant and an antiseptic. Phenol and its vapors can cause damage to the eyes, skin, respiratory tract, kidneys and in inhibit proper blood formation (ATSDR-9, n.d.)



Cyanide ( $\text{CN}^-$ ) is a chemical compound formed with a triple bond between carbon and nitrogen. Most cyanides are highly toxic and are produced by certain bacteria, fungi, and algae and can be found in almonds, and the seeds of mango, peaches, and apples. Cyanide is used in electroplating, metallurgy, some mining processes, and plastics manufacturing. It ranks 35<sup>th</sup> on the ATSDR 2011 Substance Priority List. It causes dermal, neurological and reproductive health issues (ATSDR-10, n.d.).

Heavy metals (like Arsenic, Cadmium, Chromium, Lead, Mercury) can have acute and chronic negative health effects on many species in that they can bind to and cause structural changes in the DNA molecule (Foreman et al., 2011). The following heavy metals have been found in the waters of the Tijuana River and in the Tijuana Estuary.

Arsenic (As) is a naturally occurring metalloid element widely distributed in the earth's crust. It combines organically and inorganically to form many different compounds. Organic arsenic compounds have been used as pesticides. Arsenic is a known human carcinogen, and it ranks 1<sup>st</sup> on the ATSDR 2011 Substance Priority List. Arsenic has also been known to cause dermal, gastrointestinal, neurological, and respiratory illnesses (ATSDR-11, n.d.).

Cadmium (Cd) is an inorganic element, naturally occurring in the earth's crust and is chemically similar to zinc (Zn) and Mercury (Hg). Cadmium is a soft, malleable, ductile metal, and has many common industrial uses, like battery production, metal coatings, pigments and electroplating. Cadmium is a known human carcinogen, and it ranks 7<sup>th</sup> on the ATSDR 2011 Substance Priority List. Cd has also been linked to cardiovascular, neurological, gastrointestinal,

renal, reproductive, and respiratory problems. It has also been linked to defective fetal organ development (ATSDR-12, n.d.).

Chromium (Cr) is an inorganic transition metal, naturally occurring in the earth's crust. Several of the different forms of Cr are used in industry for process like, making steel, chrome plating, making dyes and pigments, tanning leather and preserving wood. Trivalent chromium Cr(III) is an essential nutrient. Hexavalent, Cr(VI) ranks 17<sup>th</sup> on the ATSDR 2011 Substance Priority List and is a human carcinogen. It has been linked to immunological, renal, and respiratory illnesses (ATSDR-13, n.d.).

Copper (Cu) is a naturally occurring metal in the earth's crust. It is soft and malleable with a high thermal and electrical conductivity. It is used for wire and plumbing pipes and sheet metal. Copper can also be combined with other metals to make metal alloys like brass and bronze. It is also used to treat mildew diseases in agriculture. It ranks 125<sup>th</sup> on the ATSDR 2011 Substance Priority List. Copper is a trace element in plants and animals and facilitates iron uptake. Excessive amounts of copper can cause gastrointestinal, blood, and liver disorders (ATSDR-14, n.d.).

Lead (Pb) is a naturally-occurring metal found in the earth's crust. It is classified as toxic and provides no known health benefit to organisms. Most of the Pb in the environment is the result of anthropogenic activities like burning of fossil fuels, mining, and manufacturing. Lead ranks 2<sup>nd</sup> on the ATSDR 2011 Substance Priority List. Although Pb has not been known to cause cancer, it causes a host of illnesses and disorders including cardiovascular, fetal developmental,

gastrointestinal, hematological, musculoskeletal, neurological, ocular, renal and reproductive (ATSDR-15, n.d.).

Mercury (Hg) is a heavy, dense liquid metal that can vaporize at room temperature. It combines with other elements to form many inorganic mercury compounds. Metallic mercury is used in thermometers, dental fillings, batteries and CFLs. It ranks 3<sup>rd</sup> on the ATSDR 2011 Substance Priority List. Exposure to mercury is usually through inhalation of vapors or ingestion. Exposure can cause fetal developmental, gastrointestinal, neurological, ocular, and renal disorders (ATSDR-16, n.d.).

Nickel (Ni) is a highly abundant element in the earth's crust. It combines with other metals to form alloys, and because it has a very slow oxidation rate, it is considered to be corrosion-resistant. Uses include coins, jewelry, stainless steel, valves, heat exchangers, and some batteries. Nickel ranks 57<sup>th</sup> on the ATSDR 2011 Substance Priority List. Exposure to nickel can cause cardiovascular, dermal, immunological, and respiratory disorders. It is also a known carcinogen. (ATSDR-17, n.d.).

Zinc (Zn) is a naturally occurring inorganic element in the earth's crust and is one of the most abundant. It can be found in the air, water, soil, all foods and is an essential mineral. Zinc can be combined with other elements to create compounds or with other metals to create alloys. It is used widely in commercial applications, including rust-preventative coatings, paints, dyes, wood preservatives, ointments, dry-cell batteries. Zinc is not known to cause cancer, and zinc deficiency can lead to immunodeficiency, growth retardation, slowed sexual maturity and

impotence, diarrhea. Excessive uptake of zinc, however, can be harmful. Those include gastrointestinal, hematological and respiratory disorders (ATSDR-18, n.d.).

### **2.3 Wastewater Treatment**

Characterization of wastewater entering and leaving a wastewater treatment plant is achieved through analysis of biological, chemical, and physical characteristics. Some of those include biological oxygen demand (BOD, all references to BOD are assumed to be BOD<sub>5</sub>), which measures the oxygen demand from the degradation of biodegradable constituents; chemical oxygen demand (COD), the oxygen demand for the chemical oxidation organic matter; total suspended solids (TSS), the sum of the organic and inorganic solids suspended in the water: suspended solids, organic solids, inorganic solids, settleable solids, and colloidal suspended solids (EPA [Irish], 1997); potential of Hydrogen (pH); ranges too high or low can interfere with the biological treatment of the wastewater; total organic nitrogen, the amount of nitrogen present in organic compounds, like nitrite, nitrate, and ammonia; organic phosphorus, the amount of phosphorus in organic compounds like proteins; turbidity, color and odor (Metcalf & Eddy, Inc., 2003; Reynolds & Richards, 1996; EPA [Irish], 1997).

Wastewater treatment is typically a multistep process and can involve physical, chemical or biological processes or combinations thereof, depending on the required standards for effluent. The most common municipal wastewater treatment plants in the US include primary and secondary treatment. Flow equalization is important to the overall wastewater treatment process in that it provides a relatively constant flow rate; thus, blunting daily flow variations,

which improves the degree of treatment (Metcalf & Eddy, Inc., 2003; Reynolds & Richards, 1996).

In primary treatment, large objects in influent wastewater are strained out via mechanical means, and the sand and grit settle in channels designed to settle out high density particles. Water is moved to primary sedimentation tanks, or primary clarifiers, where the water's velocity is lowered and quiescent conditions allow the sludge to settle and low density components, like grease, to float, a process known as clarification or settling. The grease and other floating solids (scum) are skimmed off the top layer, and sludge (settled solids) is diverted elsewhere. The efficiency of the primary treatment process is determined by detention time in the settling tanks, and temperature, tank design. Chlorine is often added for disinfection. After sedimentation, the wastewater is typically diverted to the next step in the treatment process. Some forms of advanced treatment require the use of chemical additives to enhance treatment. In advanced primary treatment, a bio-flocculation-adsorption sedimentation and stabilization process (BSS) is used to remove greater amounts of organic wastes than in traditional primary processes; however, studies have shown that removal of organic constituents is lower in the BSS process than in traditional secondary treatment processes (Zhao et al., 2000).

The secondary treatment process includes the removal, or degradation, of the biological constituents in the sewage, namely those that are derived from human and food wastes, soaps, and detergents. Most municipal wastewater treatment plants treat settled sewage using an aerobic biological processes where bacteria and protozoa consume biodegradable soluble

organic contaminants, such as sugars, fats and other carbon molecules, in an oxygen-rich environment. Here too, biological removal is greatly enhanced by flow equalization because of a great reduction in shock loads are minimized (Reynolds & Richards, 1996). The settling of the biological floc (microbes) is the final step in secondary treatment. If processes are functioning correctly, the effluent should contain very low levels of organic material and suspended matter at this point and can usually be discharged to surface waters.

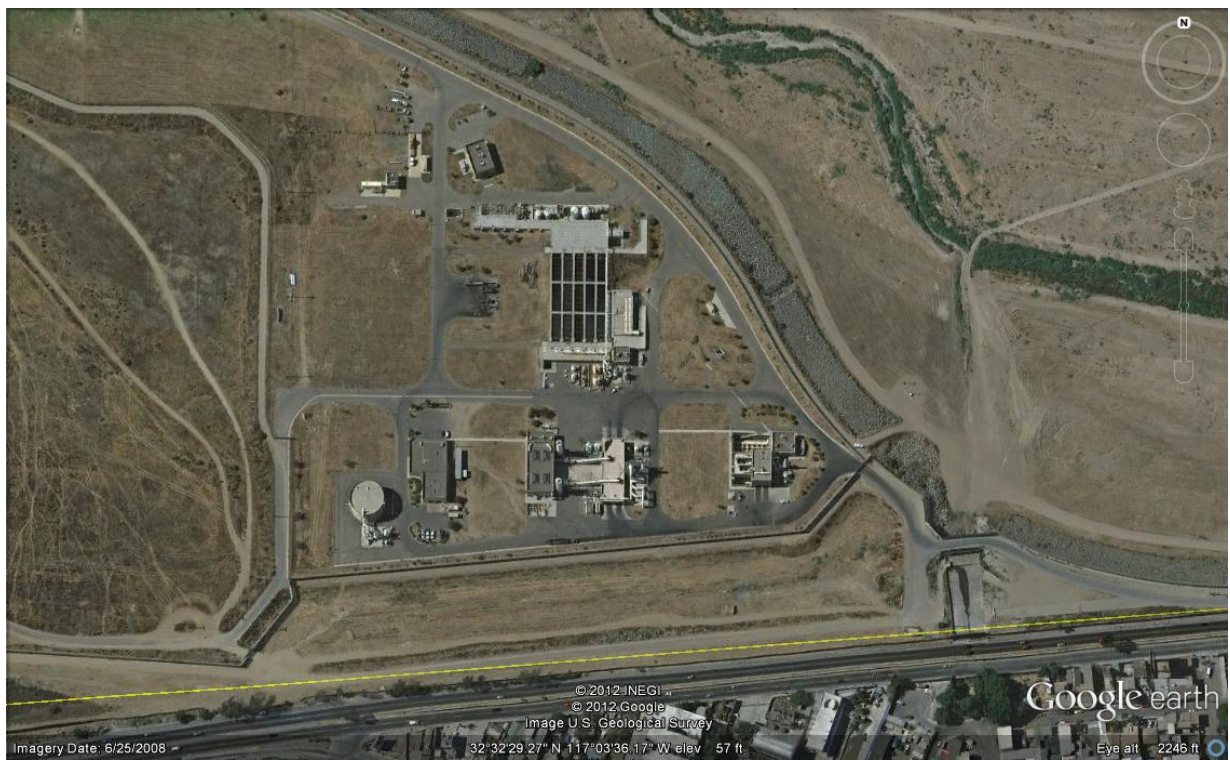
Tertiary treatment usually focuses on the removal of Nitrogen and Phosphorus and, when used, provides a final step that raises the quality of the effluent before being discharged into receiving waters or into the ground, but it is often not necessary. If the effluent is rich in nutrients, like nitrogen and phosphorus, eutrophication can occur in the receiving waters. Table 2.1 summarizes the different steps in the process and the constituents that are removed or remain in the process.

**Table 2.1:** Summary of three levels of common wastewater processing.

<b>Treatment Level</b>	<b>Removal of:</b>	<b>What Remains:</b>
Primary	Physical removal of organic and inorganic solids, large objects, sand and grit	Biological agents, chemicals
Secondary	Biological agents such as bacteria, fine suspended dispersed and dissolved solids	Nutrients and non-target chemicals
Tertiary	Chemical agents like Nitrogen & Phosphorus	Other non-target chemicals

## **2.4 Treatment at the South Bay International Wastewater Treatment Plant**

Prompted by lawsuits and pressure to comply with the Clean Water Act (CWA), the US Federal Court for the Ninth District ordered the US Environmental Protection Agency (US EPA) to take action. The US International Boundary and Water Commission (US IBWC) was required to provide the secondary treatment of México's wastewater by 30 September 2008 (IBWC, 2005). As previously mentioned, the minimum standard for CWA compliance is secondary treatment, In 1990, US and México IBWC sections reached in agreement to co-fund a treatment plant to be placed on the US side of the border (EPA, 1997a).



**Figure 2.5:** 2008 satellite image of South Bay International Wastewater Treatment Plant.

Construction of the South Bay International Water Treatment Plant (SBIWTP) was begun in San Ysidro, CA, US in 1994 in accordance with IBWC Minute 283. Figure 2.5 is a satellite image of the completed SBIWTP primary treatment facility. The plant, initially an advanced primary facility, was constructed with the capacity to treat 25 mgd (1095 lps) of sewage in order to help relieve the untreated Mexican sewage stream from flowing into the Tijuana River. Construction of the SBIWTP was envisioned as the first step in a plan whose second step was to upgrade the processing to at least a secondary level of treatment. As soon as funding was secured, the secondary treatment portion of the plant would be constructed (Parsons, 2005). In May 1996 while SBIWTP was still under construction, US IBWC applied for a NPDES permit to discharge 25 mgd (1095 lps) of primary effluent from SBIWTP through the ocean outfall (CRWQCB - NPDES, 1996). If the SBIWTP were to begin operation before the outfall was completed, the advanced primary effluent was to be discharged through the emergency connection pipeline to San Diego's sewage system or a Mexican conveyance system. In November of 1996, the California Regional Water Quality Control Board (CRWQCB), San Diego Region sought a preemptive Cease and Desist Order, No. 96-52, prohibiting discharges of sewage to the Tijuana River from the SBIWTP and associated facilities. Discharges from conveyance systems in México were not subject to the order (CRWQCB-C&D, 1996).

In 1997, a supplemental Environmental Assessment (EA) and Record of Decision (ROD) was issued: Secondary Treatment to Safeguard Public Health, the Environment and Public Beaches, Water Quality and Economy of San Diego was issued by the IBWC. The ROD for that decision stipulated that if any level of treatment other than secondary were to be discharged from



SBIWTP, an additional National Environmental Protection Act (NEPA) document would be completed.

The time lag between primary and secondary operations at SBIWTP was yet to be defined. Interim operations indicated, in the 1997 CH2MHill supplemental EIS (SEIS), that operations were to include up to 13 mgd (569.4 lps) to be sent via the emergency connection to the Point Loma Wastewater Treatment facility and México was to construct a parallel pumping and conveyance system that would also transfer effluent on an interim basis (IBWC ROD, 1997).

By early 1997, the advanced primary treatment of Tijuana wastewater at SBIWTP had begun. SBIWTP effluent, however, routinely failed to meet its NPDES permit limits (IBWC, 2005). The 70-year-old discharge problem prompted federal lawsuits by the Surfrider Foundation and San Diego Regional Water Quality Control Board (Rodgers & Lee, 2005). In a settlement agreement, the IBWC pledged to remedy the problem by 30 September 2008.

In 1999, the land and ocean outfall were ready for use, and treated wastewater was transferred overland through the South Bay Land Outfall (SBLO) a 3749 m (12,300 ft) long and 3.66 m (12 ft) diameter conveyance. From the SBLO, the effluent is passed through an anti-intrusion structure before being conveyed through the South Bay Ocean Outfall (SBOO) to the ocean floor at 28.35 m (93 ft) below sea level. The SBOO has an 3.35 m (11 ft) internal diameter and is 5,791 m (19,000 ft) long and releases treated effluent from two sources: SBIWTP and City of San Diego's South Bay Water Reclamation Plant (SBWRP) (City of San Diego, 2003).

Wastewater originating from México in excess of the 25 mgd (1095 lps), SBIWTP's design capacity, as well as wastewater from other Tijuana sources was pumped to the San Antonio de los Buenos Wastewater Treatment Plant (SABWTP) on the coast, approximately 5.6 mi (9.01 km) south of the International Border. The SABWTP plant, a aerated lagoon secondary treatment facility, was built in 1987 with a capacity of 17 mgd (745 lps). It was renovated in 2004, and its capacity was increased from to 25 mgd to (1095 lps). SABWTP, however, had lacked the capacity to treat all of the waste it received, so it previously discharged a mix of treated, partially treated, and untreated wastewater into the surf (R.W. Beck International n.d.; Parsons, 2005). Ocean currents can carry diluted effluent north to Imperial Beach and San Diego.

(Unless indicated otherwise, the SBIWTP descriptions are based on information in the Parsons 2005 Final SEIS.) The South Bay International Wastewater Treatment Plant is located on a 75-acre site just north of the International Border, in south San Diego County. The facility is situated approximately two miles west of the San Ysidro Port of Entry, north of the city of Tijuana, and immediately north of Tijuana's main wastewater pumping station, Pump Station No. 1/1A, the largest raw sewage lift station in Tijuana (Parsons, 2005). There is a 9.44 m (300 ft) wide land buffer between the international boundary line and the treatment plant. Sparsely populated, natural, open space surrounds SBIWTP on the US side of the border. In contrast, Tijuana is a densely populated urban area (refer to Figure 1.2). The South Bay International Wastewater Treatment Plant had provided only advanced primary treatment, from 1997 to 2010, at a rate close to 25 mgd (1095 lps), with the expansion capability of up to 100 mgd

(IBWC-1, n.d.). It was recently expanded to secondary treatment (Net Resources International, 2011).

Most of the wastewater generated in eastern and central Tijuana is collected via the Tijuana wastewater collection system and conveyed to Pump Station 1/1A, across the International Border from SBIWTP. From Pump Station 1/1A, wastewater is directed to SBIWTP, in the United States, through a 96" diameter transborder conveyance. SBIWTP treats peak daily flows from Tijuana, thereby relieving pressure on the overwhelmed Mexican sewage system and reducing contaminating flows in the Tijuana River (IBWC-1, n.d.). Sewage in excess of 25 mgd (1095 lps) had been pumped to the San Antonio de los Buenos Wastewater Treatment Plant (SABWTP) in México via force mains to an open canal and a parallel conveyance system. The wastewater travels south to SABWTP for treatment, or it bypasses the plant and is discharged directly at the shoreline 9.01 km (5.6 mi) south of the International Border (CH2MHill, 1999).

At SBIWTP, the headworks inflow is passed through three mechanical screens with 1.59 cm (5/8 in) openings and three manual bar screens with 3.81 cm (1-1/2 in) openings that trap solids on the faces of the screens. The screenings are scraped and conveyed to grit bins. Five 350 hp vertical turbine solids handling pumps lift the sewage through a 1.52 m (60 in) diameter pipe to the aerated grit chamber.

Spiral flow aeration, provided by two positive displacement blowers, is on one side of the rectangular aerated grit chamber. The spiral flow causes the sewage to make two or three passes allowing the grit to be deposited in steeply sloped hoppers the bottom of the tank. The

grit is moved back to the headworks, with the help of grit pumps, where it is then washed by the hydrogritters and deposited in grit bins, along with the screenings (IBWC-1, n.d.).

The wastewater flows by gravity to the rapid mix chambers after leaving the aerated grit chamber. Ferric chloride,  $\text{FeCl}_3$ , (25-40 mg/l) and an anionic polymer (0.2-1.2 mg/l) are added to assist in coagulation of solids. It is then conveyed to any of five primary sedimentation tanks for settling. The tanks have an average annual flow of 25 mgd (1095 lps) and a peak flow of 75 mgd (3285 lps), with removal efficiencies of 75% total suspended solids (TSS) and 45% biochemical oxygen demand (BOD).

The tanks have chain-mounted scrapers that push the sludge into hoppers. The sludge at SBIWTP has approximate 450 mg/l of suspended solids of which approximately 75% settle out during primary sedimentation. The resultant sludge is then transferred via transfer positive displacement sludge pumps from the hoppers to the unstabilized sludge storage tank. Sludge pumps then transfer the sludge to one of four belt filter presses where the sludge is chemically conditioned with a polymer at 10 lbs/dry ton. The plants four belt presses produce a dewatered sludge cake that is 28 – 32% solids (IBWC-2, n.d.). Quicklime ( $\text{CaO}$ ) is then added to the dewatered sludge for stabilization before it is conveyed to the truck solids loading building where it is deposited into sludge hauling trucks. The minimum pH of the sludge at two hours is pH 12, and at 22 hours, pH 11.5. In accordance with IBWC Minute 296, the sludge, screenings and grit are returned to Mexico for disposal.

When analyzed, sludge produced at SBIWTP is comparable in physical and chemical composition to sludge produced at other municipal wastewater treatment plant in the US.

Some heavy metals have been detected in the sludge produced at SBIWTP; however, all parameters for the sludge have been below the standards set under the US EPA's 503 Regulations for Class B sludge (see Table 2.2).

**Table 2.2:** *Characteristic sludge at SBIWTP compared to EPA biosolids standards.*

Metal	SBIWTP Sludge (mg/kg)	EPA 503 Standards Class B (mg/kg)
Arsenic	4.52	75
Cadmium	undetectable	85
Chromium	61	3,000
Copper	394	4,300
Lead	62	840
Mercury	0.8	57
Nickel	89	420
Zinc	430	500

The South Bay International Wastewater Treatment Plant has odor control facilities for the Headworks, Primary Sedimentation Facilities, USST, and Solids Processing areas. The Headworks and Primary Sedimentation areas have similar *Odor Reduction Stations*, which contain single stage counter current packed columns and exhaust fans that create a slight negative pressure within the containment areas. The scrubber continuously recirculates scrubber solution, sodium hypochlorite (NaClO), sodium hydroxide (NaOH) and water over plastic media that provides a large surface area. The air change time in the covered tanks is 6 per hour and 12 per hour in the building.

The “Odor Reduction Station for Solids Processing” is a two-stage counter current packed column process. Stage one uses sulfuric acid ( $\text{H}_2\text{SO}_4$ ) solution ammonia removal. Stage two uses NaClO and sodium hydroxide NaOH solutions to remove hydrogen sulfide ( $\text{H}_2\text{S}$ ).

In 2004, the State of Baja California constructed a parallel conveyance and treatment system in Tijuana that included pumping facilities, pressure lines, and rehabilitation of the SABWTP. The system interconnected with SBIWTP and follows safeguards against transboundary pollution established by the United States and México (IBWC-1, n.d.)

The connection between the US and México consists of a valved turnout pipe in México, extending northward 300 feet (91.4 m) to the International Boundary. The pipeline continues northward 4,277 feet (1,304 m) into the United States partially under the Tijuana River floodplain to the San Ysidro branch collector line in the United States. The installation includes a metering station in the United States.

Additional wastewater management facilities were needed because when SBIWTP was an advanced primary treatment facility, it could not meet all the requirements of the CWA or its NPDES permit. Public health, environmental health, water quality, and economic factors including tourism were all at risk due to incomplete treatment of the wastewater. Due to lack of funding and questionable political practices, secondary facilities were not completed until 2011. Those upgrades will be discussed in Chapter 3.

## **2.5 2005 Supplemental Environmental Impact Statement Alternatives**

In an effort to comply with US water regulations, the United States Section IBWC (US IBWC) published a Final Supplemental Environmental Impact Statement (SEIS) that detailed Clean Water Act compliance at SBIWTP with regard to impacts of alternative treatment solutions. It evaluated alternatives and options for secondary treatment in accordance with National Environmental Policy Act (NEPA) requirements. A No Action Alternative and six Action Alternatives (several with multiple options) were reviewed, and one was selected. The following information on the alternatives, published on 25 July 2005, is summarized from the final SEIS (Parsons, 2005).

In accordance with the US National Environmental Protection Act (NEPA), a supplemental environmental impact statement (SEIS) was drafted in order to address the cross-border wastewater challenges. NEPA requires the development of reasonable alternative solutions as well as an analysis of those alternatives. Under NEPA (40 CFR 1502. 14), federal agencies are directed **a)** to consider a range of alternatives specific to the particular project that accomplish the agency's objectives and to provide a clear basis from among which the public and decision makers could choose, **b)** to analyze each of the alternatives on an equal basis, **c)** objectively investigate and evaluate a reasonable range of alternatives, and when alternatives are eliminated, the EIS must briefly discuss reasons for their elimination, **d)** include a "No Action" alternative. The "No Action" alternative is an important component of the alternative development process in that it is necessary to examine existing and future conditions if no action is taken.

US IBWC, EPA, and Parsons Corporation (engineering) used February and March, the wet season, 2004 wastewater flows from SBIWTP and the pipeline from Pump Station 1/1A to develop projected flows from Tijuana. Data from 2004 were used for baseline information, and projection estimates were made through the year 2023. Estimates were based on historical trends to account for 2004 dry conditions. In 2004, Tijuana was producing 56 mgd (2453 lps) of wastewater, 25 mgd (1095 lps) of which was being treated at SBIWTP. The projections estimated that by 2009, 65 mgd (2847 lps) of wastewater would be produced in Tijuana, and by 2023, the estimate was 84 mgd (Parsons, 2005).

The seven alternatives under consideration for the 2005 Final SEIS were developed based upon review and assessment of existing and planned facilities on both sides of the border and international agreements between the two countries: IBWC *Minutes* 270, 283, 296, 298, and 311. Domestic legislation and regulation such as the US Clean Water Act, Public Law 106-457 and the Code of Federal Regulations (CFR) guided alternatives' assessments. These will be presented in greater detail in Chapter 4. SBIWTP's environmental documentation, particularly its NPDES discharge permit--issued by the California Regional Water Quality Control Board, San Diego Region, Order No. 96-50, NPDES Permit No. CA0108928, issued on 14 November 1996--were also reviewed during assessment evaluation. Finally, issues identified during the public scoping process were considered during the assessment.



***Alternative 1: No Action (Operation of SBIWTP as Advanced Primary Facility)***  
***Option A: No Future Improvements to México's Conveyance System***  
***Option B: With Future Improvements to México's Conveyance System***

**Alternative 1, Option A** proposed that no new construction is required in the US or México; therefore, the only expenses incurred would be for the operation and maintenance (O&M) of SBIWTP and maintenance of México's conveyance channel. As a result, land use along the Tijuana River, the Tijuana Estuary and Imperial Beach would continue to be impacted by raw and partially treated sewage flows (Parsons, 2005).

Under this alternative, SBIWTP would continue to provide advanced primary treatment for organic loading of 370 mg/l BOD<sub>5</sub>, 350 mg/l TSS for average flows of 25 mgd (1095 lps) and peak flows of 50 mgd (2190 lps); although, advanced primary treatment approximate effluent quality should be in the range of 204 mg/l BOD<sub>5</sub> and 88 mg/l TSS (Parsons, 2005). In this No Action Alternative, México would make no improvements to its existing open air conveyance channel to keep up with population and other growth demands. Pump Station 1/1A would continue to direct daily peak flows to SBIWTP. Flows in excess of SBIWTP's peak capacity would remain in México and be directed to the SABWTP, which can treat up to 25 mgd (1095 lps). Flows in excess of those 25 mgd (1095 lps) would bypass SABWTP and be discharged, untreated, at the Punta Bandera shoreline, 5.6 mi (9.01 km) south of the International Border.

Through 2023, SBIWTP would continue to treat dry flows of 25 mgd (1095 lps), as would SABWTP. The dry weather wastewater flows for 2023 are estimated to be 84 mgd (3679 lps), so up to 50 mgd (2190 lps) of untreated wastewater would be directed to SABWTP whose capacity is 25 mgd (1095 lps). With no enhancement to México's treatment or conveyance systems,

upwards of 25 mgd (1095 lps) of untreated sewage could be released at the Punta Bandera shoreline, and up to 9 mgd would flow into the Tijuana River during dry weather conditions because the described conveyance system would fail to contain the excess wastewater.

**Alternative 1, Option B** would not improve or enhance US facilities as in the previous alternative. SBIWTP would continue advanced primary treatment for average dry weather flows of 25 mgd (1095 lps) and peak flows of 50 mgd (2190 lps), and effluent would continue to be discharged through SBOO. Flows in excess of SBIWTP's capacity would remain in México.

México, however, would construct a pipeline with increased capacity that would replace the existing original (open air) conveyance channel (OCC). The increased channel capacity would facilitate the transport of untreated sewage that the unimproved conveyance would have released into the Tijuana River. Under this alternative, a parallel conveyance line (PCL) would deliver 25 mgd (1095 lps) to SABWTP for treatment, and flows in excess would be sent through the enhanced system and bypass SABWTP for discharge into the shoreline. The 2023 projected shoreline discharge of untreated wastewater is 34 mgd (1489 lps).

Option B is a better option than Option A only given that dry weather flows from Tijuana into the Tijuana River would be avoided, and it would provide a temporary economic benefit to Tijuana through the creation temporary jobs and stimulation of sales. Tourism at the Tijuana Estuary and Imperial Beach would benefit from reduced fouling of the estuary, beaches and near coastal waters. This option was not a viable option because the effluent was in violation of water standards for both countries. Improvements to México's conveyance facilities would not

provide further treatment of the effluent waters. SBIWTP would continue to exceed its NPDES permit limits for either alternative.

***Alternative 2: Operate SBIWTP as an Advanced Primary Facility with All Effluent Treated at the SBIWTP Returned to México***

This action alternative would not improve or enhance US facilities; SBIWTP would continue advanced primary treatment for average dry weather flows of 25 mgd (1095 lps) and peak flows of 50 mgd (2190 lps). As in Alternative 1, SBIWTP would continue to provide advanced primary treatment organic loading of 370 mg/l BOD<sub>5</sub>, 350 mg/l TSS (Parsons, 2005). Instead of being released through the South Bay Ocean Outfall, however, the effluent would be returned to México. In addition, all other flows in excess of SBIWTP's capacity would remain in México.

This alternative requires that México would refurbish its existing conveyance channel as well as increase its present conveyance capacity. The current conveyance in México does not have sufficient capacity to accept effluent from SBIWTP. The present conveyance channel in México needs increased capacity for two reasons: it would convey 25 mgd (1095 lps) of treated primary effluent, which would have been discharged through SBOO, to the shoreline at Punta Bandera, and it would need to carry Tijuana's projected wastewater flows to SABWTP or to be discharged directly.

This alternative is more favorable than Alternative 1, Option A in that it would provide jobs, albeit temporarily, and increase business sales in the Tijuana area during the construction of the enhanced conveyance channel. In order for this option to be feasible, México would need to refurbish Pump Station 1/1A by installing new pumps and motors as well as construct a new

increased capacity force main conveyance pipeline from Pump Station 1/1A to Playas de Tijuana (Parsons, 2005).

As in the previous alternatives, no additional treatment would be provided, so estimated flows of up to 34 mgd (1489 lps) of raw, untreated wastewater would be released at the shoreline at Punta Bandera by the year 2023. The only benefit of this alternative over Alternative 1, Option A is that in the 2023 estimate, 9 mgd (394.2 lps) of untreated wastewater would be conveyed through a pipeline that would release it at the shoreline 5.6 mi (9.01 km) south of the International Border rather than release it in the Tijuana River.

There is no clear advantage of this alternative over Alternative 1, Option B unless the conveyance of effluent to México would relieve SBIWTP of its NPDES permit obligations and the water would be reused in México for non-potable applications. México's *Comisión Estatal de Servicios Públicos de Tijuana* (State Public Services Commission of Tijuana, CESPT), objected to this alternative because it reduces operational flexibility and unnecessarily adds excess water to México's conveyance system (Parsons, 2005).

Technically, this option could work because México's wastewater effluent standards are less stringent than those of the US; however, effluent from SBIWTP, treated to advanced primary standards, could fail México's effluent discharge standards. Once the US is in possession of México's waste, the US is responsible for its proper treatment to US standards prior to disposal.

***Alternative 3: Operate SBIWTP as Advanced Primary Facility and Convey 14 mgd of the SBIWTP Effluent to the City of San Diego Facilities with Remainder of the SBIWTP Effluent Return to México***

SBIWTP's facilities would not be improved or enhanced with Alternative 3, so it would continue to operate as an advanced primary facility for average dry weather flows of 25 mgd (1095 lps) and peak flows of 50 mgd (2190 lps); however, up to 14 mgd would be sent to two of the City of San Diego's treatment facilities, the South Bay Water Reclamation Plant (SBWRP) and the Point Loma Wastewater Treatment Plant (PLWTP). SBIWTP would send the remaining 11 mgd (482 lps) of advanced primary effluent to México, and SBIWTP would discontinue direct discharges through SBOO.

New construction in the US and México are required in order to realize Alternative 3. In the US, a new 30in (0.76 m) diameter pipeline to convey treated or screened effluent from SBIWTP to SBWRP would be necessary. An 8in (0.20 m) secondary waste sludge return would also be added to send the sludge to SBIWTP's solids handling facilities. The screened and sludge pipelines would run parallel to each other. The SBWRP has the capability to treat 15 mgd (657 lps) to a secondary or tertiary level, and its effluent is in compliance with CWA standards. SBWRP's effluent that is not reused is discharged through SBOO. SBWRP would be able to accommodate 5 mgd (219 lps) of primary effluent from SBIWTP. The remaining primary effluent would be sent to PLWTP. It should be noted that PLWTP is also an advanced primary treatment facility with a treatment capacity of up to 180 mgd (7884 lps). Effluent would be sent from SBIWTP to PLWTP for treatment and disposal through the Point Loma Outfall. In México, the OCC would be renovated to transport the 11 mgd (482 lps) back to México. Once in México, the

11 mgd (482 lps) of primary effluent would be mixed with untreated wastewater and discharged into the shoreline at Punta Bandera.

Construction of conveyance systems in both the US and México would provide temporary jobs and business sales in both countries. The annual local and regional economic benefits from this alternative are minor. Furthermore, the 2023 projected flows, consisting of primary effluent and untreated wastewater, discharged into the shoreline at Punta Bandera were estimated to be 45 mgd. This alternative is not increasing the amount of wastewater being treated to secondary standard. By 2023, an estimated 43 mgd (1883 lps) would be discharged into the surf at Punta Bandera.

Alternative 3 was seen as a potential, temporary alternative while secondary treatment facilities were being constructed. This alternative would have required agreements from among the US and México IBWC, the Government of México and the City of San Diego. In 2002, however, San Diego City Council's Rules, Finance and Intergovernmental Relations Committee voted unanimously to deny the IBWC any request to treat SBIWTP's effluent because of the toxicity in Tijuana's wastewater.

***Alternative 4: Public Law 106–457, Secondary Treatment Facility in México  
Treatment Option A: Operation of SBIWTP as Advanced Primary Facility,  
Secondary Treatment in México***

***Treatment Option B: Cease Operation of SBIWTP, Secondary Treatment in México***

***Treatment Option C: Bajagua Project, LLC Proposal – Operation of SBIWTP as  
Advanced Primary Facility, Secondary Treatment in México***

***Discharge Option I: Treated Effluent Discharged in United States via SBOO***

***Discharge Option II: Treated Effluent Discharged in México at Punta Bandera***

Public Law 106-457 became a law in 2000; it will be discussed in more detail in Chapter 4. In summary, the Law authorized the US IBWC to address the Tijuana sewage problem in order to curtail the adverse public health and environmental threats. The IBWC was required, by law, to create a new Treaty Minute or amend Minute 283 to make provisions for secondary treatment in México of not more than 75 mgd (3285 lps): secondary treatment of 25 mgd (1095 lps) of primary effluent from SBIWTP, secondary treatment of an additional 25 mgd (1095 lps) of wastewater emanating from México, and secondary treatment of 25 mgd (1095 lps) of primary treated effluent that would remain in México.

The final design of the facility for Alternative 4 would require the approval of both sections of the IBWC. The facility's design would necessitate wastewater treatment to a quality that would ensure compliance with discharge water quality standards of both the US and México. Flows treated by any of these treatment facilities would need to be in compliance with the Federal Water Pollution Control Act and the NPDES permit for discharge through SBOO.

The implementation of Public Law 106-457 together with Treaty Minute 311 allowed for three treatment options:

- a) SBIWTP would continue to operate as an advanced primary facility and secondary treatment would occur in México;

- b) stop treatment of México's wastewater at SBIWTP, and all of México's treatment would take place in México;
- c) Bajagua LLC Proposal – the chosen option, which is similar to Option A except that it specifically names the company that will be responsible for the construction and management of the facility.

**Alternative 4, Treatment Option A** required that SBIWTP continue to operate as an advanced primary facility for average daily flows of 25 mgd (1095 lps) and peak flows of 50 mgd (2190 lps). The primary effluent would be sent to México for secondary treatment, and any flows in excess of what could be treated at SBIWTP would remain in México. This alternative and treatment option would require the construction of a pump station at the SBIWTP facility to send the primary effluent to the Public Law 106-457 facility in México. Conveyances between the facilities would also be necessary. Also required were a pump station to gather flows from Tijuana's collection system and to send flows to the Public Law facility and a pipeline to return treated effluent from the Public Law facility to SBIWTP for release through SBOO. Under this alternative, 25 mgd (1095 lps) would be sent to SABWTP for treatment, and up to 34 mgd (1489 lps) would be treated at the Public Law facility. Once this facility was online, no flows of untreated wastewater would be released into the surf at Punta Bandera.

The discharge options for this alternative include releases at Punta Bandera or SBOO. The biggest difference being that in Option I, 59 mgd (2584 lps) of secondary effluent would be discharged through SBOO. In Option II, up to 59 mgd (2584 lps) of effluent would be discharged at the shoreline at Punta Bandera. Discharge Option II, Punta Bandera, would require an



additional pump station because topography between the Public Law facility and Punta Bandera do not allow for a gravity flow line. A pump station would be contracted at the Public Law facility that would send treated flows by means of a force main to Pump Station 1/1A. From Pump Station 1/1A, the secondary effluent would be conveyed through the OCC for discharge at the shoreline. The OCC would require improved capacity.

Under Alternative 4, Treatment Option A, operations would continue at SBIWTP, so no jobs would be lost. The construction of the SBIWTP pump station and 800 ft. of pipeline for the return of primary effluent to México and return of secondary effluent through SBOO (discharge Option I) would temporarily stimulate jobs and sales. The new treatment facility in México would create temporary and permanent jobs in México through its construction and operation. For discharge Option II, a new pump station and conveyance facilities would be required to convey the effluent to Punta Bandera, which would require temporary construction employment.

**Alternative 4, Treatment Option B** required that treatment of México's wastewater at SBIWTP would stop. Public Law facility 106-457 would conduct the treatment of 59 mgd (2584 lps) of México's wastewater to secondary standards, and flows in excess of the 59 mgd (2584 lps) would also remain in México for treatment at the SABWTP facility, whose capacity is capped at 25 mgd (1095 lps).

This treatment option differs from option A in that all wastewater flows would remain in México, so no new facilities would be constructed in the US. The capacity of the Tijuana pump station would be increased in order to accommodate 59 mgd (2584 lps) to the Public Law

facility. The new facility would require the addition of preliminary treatment as well as primary sedimentation facilities.

Under Alternative 4, Treatment Option B, discharges are similar to Option II above. Treated effluent would be sent to the shoreline at Punta Bandera. Conveyance facilities would need improvement as would pumping facilities. If all flows were to remain in México, there would be a much greater volume to be pumped and conveyed. It is expected that, once online, no flows of untreated wastewater would be released into the shoreline at Punta Bandera.

Under Alternative 4, Treatment Option B, treatment of México's wastewater at SBIWTP would cease. There would be a loss in permanent employment at that facility. All the resultant temporary and permanent new employment for this option would be in México with the exception of Discharge Option I, through SBOO. If Alternative 4, Treatment Option B, Discharge Option I were selected, new pipelines would be required to deliver the treated secondary effluent to the US for discharge. Regardless of which discharge option is chosen, a secondary treatment plant with the capacity of treating 59 mgd (2584 lps) to secondary standards would be constructed. If discharge Option II were selected, a pump station would be constructed at the Public Law facility. New conveyances as well as refurbishment of the existing conveyances would also create temporary jobs.

**Alternative 4 Treatment Option C**, the selected (Bajagua LLC) Alternative would result in a positive economic impact in Mexico through permanent and temporary jobs as well as through sales. Because SBIWTP would remain in operation, there would be no job losses there. The

proper disposal of all sludge produced by this option would be the responsibility of the facility's owner/operators. This option will be discussed in greater detail in the Chapter 3.

***Alternative 5: Secondary Treatment in the United States at SBIWTP***

***Option 5A: Completely Mixed Aeration (CMA) Ponds at SBIWTP***

***Options 5B-1 and 5B-2: Activated Sludge Secondary Treatment at SBIWTP***

This action alternative would improve US facilities. SBIWTP would continue advanced primary treatment for average dry weather flows of 25 mgd (1095 lps) and peak flows of 50 mgd (2190 lps), and effluent would continue to be discharged through SBOO. Flows in excess of SBIWTP's capacity would remain in México and be sent to SABWTP. Flows in excess of that plant's treatment capacity would be discharged untreated into the shoreline at Punta Bandera.

The lead federal agencies involved with the SBIWTP project considered several long-term treatment alternatives based on a 1994 Final EIS prepared by RECON, and in their 1994 Record of Decision (ROD), they chose to construct a secondary wastewater treatment facility with activated sludge. Later, however, new circumstances necessitated the reevaluation of the long-term treatment options, detailed in a 1999 Final SEIS prepared by CH2MHill. The US EPA and US IBWC selected a CMA system at an area just west of and adjacent to the SBIWTP advanced primary treatment facility. In addition, it included a treatment pond option at SBIWTP, capable of treating 25 mgd (1095 lps) in the US. This alternative included the improvement of México's conveyance systems thereby increasing the volume to SABWTP and curtailing flows into the Tijuana River.

**Alternative 5, Option A: Completely Mixed Aeration (CMA) Ponds at SBIWTP** includes a complete mix aeration (CMA) pond system capable of treating 25 mgd (1095 lps) average daily

flows and 50 mgd (2190 lps) peak. The ponds would be situated just west and adjacent to the SBIWTP. Under this proposed treatment alternative, the primary influent from SBIWTP sent to the CMA pond system was expected to be conventionally treated primary effluent rather than advanced primary effluent that is currently produced at SBIWTP. The primary influent would be treated to a secondary or secondary-equivalent level at the CMA ponds.

The Alternative 5, Option A facility was designed to treat monthly average organic loading of 370 mg/l BOD<sub>5</sub> and 350 mg/l TSS. The secondary effluent quality produced from Alternative 5, Option A plant would be close to 20 mg/l BOD<sub>5</sub> and 20 mg/l TSS with a total system capacity of about 126 million gallons. Treated secondary effluent would be discharged through SBOO.

Alternative, 5 Option A would require new facilities at the site and cover approximately 36 acres. Primary effluent would flow to anaerobic digester pits (ADP) before reaching the CMA ponds and then, finally, the surface aerated ponds. Plans included four replicates and a total pond surface area of 29 acres. In each replicate, the four ADP ponds would have surface aerators and a total volume of 147M gallons (556,456 m<sup>3</sup>). A single completely mixed and aerated CMA cell would receive the effluent from the four ADP ponds. The effluent would flow from the CMA cells to two surface aerated ponds each capable of holding 27M gallons (102,206 m<sup>3</sup>). Each surface aerated pond would be divided into two cells. Sludge would be dewatered and stabilized with lime prior to being sent for disposal in México. Construction of this facility would require additional pump stations, distribution structures, and a new control building as well as improved conveyance systems in México: the PCL and OCC.

While this alternative would improve the quality of the effluent discharged through SBOO, it fails to address the growing amount of wastewater requiring treatment prior to discharge at the Punta Bandera shoreline. Tijuana's total 2023 projected flows are 84 mgd (3679 lps), and Alternative 5, Option A proposed treatment of 25 mgd (1095 lps) at SBIWTP, and SABWTP would treat another 25 mgd (1095 lps), leaving 34 mgd (1489 lps) being released untreated.

This alternative would not result in significant regional economic impacts to the local area. It would provide temporary jobs during the construction process, and the purchase of materials would stimulate sales, but the expansion to secondary treatment would not significantly increase the number of employees at SBIWTP. The dewatered sludge transported from the facility would necessitate its management in accordance with applicable regulatory compliance requirements.

**Alternative 5 Option B: Activated Sludge Secondary Treatment** was the chosen alternative in the final 1994 EIS. Two activated sludge options include: Option B-1, activated sludge with flow equalization basins, and Option B-2, activated sludge with expanded capacity.

For Alternative 5, Option B-1 Activated Sludge with flow equalization basin, the basins would be located within the existing SBIWTP footprint. The facilities were designed to treat a monthly average organic loading of 370 mg/l BOD<sub>5</sub> and 350 mg/l TSS. The primary portion of the treatment facility would receive, as it does presently, daily high/ low dry weather flow variations at 25 mgd (1095 lps) average and 50 mgd (2190 lps) peak. Before entering secondary treatment, however, flows would be equalized in equalization basins capable of storing 26,498 m<sup>3</sup> (7M gallon), which would equalize the flows into the secondary treatment facility to a

steady rate of 25 mgd (1095 lps). The activated sludge portion of the treatment process is designed to produce an effluent quality of 19 mg/l BOD<sub>5</sub> and 19 mg/l TSS.

In addition to the 26,498 m<sup>3</sup> (7M gallon) equalization basin, this alternative and option would also require additional components: a pump station capable of pumping up to 21.5 mgd (942 lps) to the activated sludge process; six single-pass conventional activated sludge tanks with fine bubble diffusers and anoxic zone selectors, including one aeration blower structure with three blowers; eight secondary sedimentation tanks with return-activated sludge pump facilities, a secondary skimming pump station, and an electrical local control center; two 27 ft (8.23 m) diameter dissolved air flotation thickeners with chemical addition facilities; one 34 ft (10.36 m) diameter sludge storage tank; and support facilities extension.

**Alternative 5 Option B-2: Activated Sludge with Expanded Capacity** would require construction within SBIWTP's footprint as well as at the adjacent site. It would treat average daily dry weather flows of 25 mgd (1095 lps) plus in-plant sludge dewatering recycle flows and peak dry weather flows of 50 mgd (2190 lps). Influent wastewater would first enter the advanced primary facility before being sent for secondary treatment. This alternative would need similar facilities as in Alternative 5, Option B-1 with two exceptions: the seven million gallon (26,498 m<sup>3</sup>) equalization basin is unnecessary, and the number of secondary sedimentation tanks would be doubled from 8 to 16. Economic impacts are also similar to the previous option. The effluent quality resulting from this design is expected to be the same as in Alternative 5 Option B-1.

As with all Alternative 5 options, the treatment capacity would not increase beyond the 25 mgd (1095 lps), so untreated flows released at Punta Bandera would go unaddressed. The 2023 projected wastewater flows remaining in México are 59 mgd (2584 lps) with only 25 mgd (1095 lps) being treated at SABWTP. Bacterial concentrations in the shoreline seawater could exceed the California Ocean Plan standards, especially during the summer months when few storms would facilitate mixing. The SBIWTP effluent discharges through SBOO, however, would be of higher quality and presumably within discharge permit limits.

Alternative 5 was not the selected alternative. Both of its options would require the expansion of SBIWTP to a secondary treatment facility. Advantages of this option are that wastewater would be treated to US standards, which are higher than México's standards, a benefit to the receiving waters and public health. The expenses of time and energy pumping primary effluent from SBIWTP to México would be eliminated. Detractors of this option cited the occasional foul odor emanating from the secondary treatment process and sludge disposal.

**Alternative 6: Secondary Treatment in the U. S. and in México** is an amalgam of treatment Alternatives 4 and 5. Secondary treatment for average dry weather flows of 25 mgd (1095 lps) would be provided at SBIWTP using activated sludge or completely mixed aeration ponds, and the secondary effluent from SBIWTP would be discharged through SBOO. México would be responsible for flows beyond SBIWTP's capacity. Flows in excess of what could be treated at SBIWTP would be conveyed to SABWTP via the PCL or OCC and discharged at Punta Bandera. Flows conveyed to the Public Law 106-457 facility would have the additional option of discharging through SBOO.

For this alternative in the Parsons 2005 Final SEIS, the estimated dry weather flows treated to secondary standards at SBIWTP and discharged through SBOO were projected to be 25 mgd (1095 lps) for 2009 and 25 mgd (1095 lps) for 2023. No primary effluent would be sent to México for further treatment or disposal. Via the PCL, SABWTP would receive its capacity dry weather flows of 25 mgd (1095 lps) through 2023. The Public Law 106-457 facility projections included the secondary treatment of 15 mgd in 2009 and 34 mgd (1489 lps) by 2023. The Public Law 106-457 facility would have the option to discharge through SBOO, so the total projected amount of treated wastewater sent through SBOO could possibly be 59 mgd (2584 lps) in 2023. One of the greatest advantages to this option is that no untreated flows are projected to be released into the Tijuana River or at the shoreline at Punta Bandera.

Alternative 6 would economically benefit both the US and México at the local level. Several temporary jobs would be created during the construction of the secondary treatment enhancement at SBIWTP as well as at the construction of the Public Law 106-457 facility and PCL. Additionally, construction of the facilities would stimulate business sales on both sides of the border. The construction of the activated sludge facility would stimulate more than three times the business sales (direct and indirect) than the CMA ponds, and it would require nearly three times the labor (Parsons, 2005). Finally, management and maintenance of the facilities in both countries necessitate additional permanent employment.

This options calls for parallel secondary treatment in the US and México and is a viable option. México would be required to increase the secondary capacity of its San Antonio de los Buenos



Plant or construct another secondary treatment plant. SBIWTP would also require enhancement to secondary treatment.

***Alternative 7: SBIWTP Closure/Shutdown***

Continued noncompliance with the Clean Water Act and chronic exceedance of the NPDES permit would make this alternative compulsory. In order to be a benefit to public health, the environment as well as the economy of San Diego, several projects in México would have to be implemented in order for SBIWTP to discontinue treatment of 25 mgd (1095 lps) of México's wastewater:

- the Tijuana Sewer Rehabilitation Project (MINUTE 298) including 429,034 ft (131 km) of sewer lines, laterals, collectors, subcollectors, and interceptors
- rehabilitation and enhancement of SABWTP
- renovation and rehabilitation of the original conveyance channel (OCC)
- construction of *La Morita* wastewater treatment facility with a capacity of 8.7 mgd (381 lps)
- the construction of *Tecolote-La Gloria* wastewater treatment facility with a capacity of 8.7 mgd (381 lps)
- the construction of the *Monte de los Olivos* (later named Ing. Arturo Herrera) wastewater treatment facility with a capacity of 10.5 mgd (460 lps)
- the construction of the Lomas de Playas de Rosarito wastewater treatment plant with a capacity of 4.8 mgd (210 lps)
- the construction of a regional wastewater treatment plant in the Alamar River area;

- two more existing wastewater treatment plants would require expansion
- additional pumping and conveyance infrastructure to support the improvements would be required.

Projections for wastewater produced in Tijuana for the years 2009 and 2023 were 65 mgd (2847 lps) and 84 mgd (3679 lps) respectively. Under this alternative, no flows would be sent from México to SBIWTP or be discharged through SBOO, and if improvements were made only to México's conveyance to SABWTP, no flows were projected to be released into the Tijuana River during dry weather conditions. If the previously mentioned improvements were not made in México prior to the closure of SBIWTP, a projected 84 mgd (3679 lps) of wastewater would be sent to SABWTP in 2023, resulting in a projected discharge of 59 mgd (2584 lps) of untreated, raw sewage into the Punta Bandera shoreline.

Alternative 7 assumes that México would make significant improvements to its wastewater collection, transfer, conveyance, and treatment systems. The economic impacts of this alternative would mostly be temporary construction jobs with the exception of several permanent jobs at the new treatment facilities. Considering the scope of the projects, many people would be employed during the construction phase. Business sales would also benefit. In contrast, the closure of SBIWTP would result in US job losses.

This alternative provides no solution to the wastewater problem. SBIWTP was conceived and constructed to help alleviate wastewater problems in México because of the lack of adequate sanitary services.

## CHAPTER 3

### THE CHOSEN ALTERNATIVE: DESCRIPTION, CONTROVERSY & DELAYS

#### **3.1 *Bajagua's Request to be Listed as an Alternative***

International Boundary and Water Commission treaty, *Minute 283*, recommended that wastewater emanating from Tijuana, México, must be treated to secondary standards in the United States (*IBWC Minute 283*, 1990). The result of *Minute 283* was the construction and operation of SBIWTP, which became operational in April 1997. Concentrations and mass emission rates for TSS, carbonaceous BOD, and whole effluent toxicity, however, have routinely exceeded NPDES permit limits because SBIWTP had treated wastewater to advanced primary standards only until recently. In order to comply with water quality standards established by the federal governments of both countries, wastewater emanating from Tijuana, but treated in the US, must be treated to at least secondary standards to remove the biological agents, the minimal level of treatment as directed by the US Clean Water Act (Bell, 2002).

On 7 July 1997, a letter from Agua Clara, LLC was sent to Felicia Marcus, Regional Administrator, Region IX, US EPA and to John M. Bernal, Commissioner US IBWC, requesting that the Bajagua project be included as an alternative in the Supplemental Environmental Impact Statement currently being prepared by CH2M Hill (Agua Clara LLC, 1997). The SEIS reviewed options for the long-term treatment at SBIWTP. The letter stated that Agua Clara LLC, a private, US development company and the State of Baja California, México were developing a joint project to treat and recover the primary effluent from the International Wastewater Treatment Plant.

The ten page letter called the anticipated partnership a “true public private partnership between the State of Baja California and Agua Clara,” and the Bechtel Corporation would be involved to provide the design, construction and operation of the privatized “Bajagua” facility.

The letter assured its readers that by adopting Agua Clara’s proposed option, they could “avoid health and environmental problems” in the Tijuana Watershed Region and ensure long-term water availability. Without providing specific details, Agua Clara outlined their plan, which included providing a low-head pump station and 10.94 km (6.8 mile) conveyance main to facilitate the movement uphill of the effluent to a site along the Rio Alamar, a “simple and inexpensive” plan to implement.

Agua Clara would provide secondary, tertiary and advanced water treatment facilities for the SBIWTP’s effluent with “at a minimum Mexican and US secondary” standards being met using the same technology as described in the 1994 EIS’s preferred alternative: secondary treatment with activated sludge at the SBIWTP site. Its worst case, “fallback alternative” stated that the primary effluent would be treated to secondary standards, sent back to SBIWTP, and released through the SBOO.

Agua Clara had no history or experience in the wastewater treatment industry, so it was completely dependent on its partnership with Bechtel to provide expertise in that arena. It gave assurances that the international company operating the facility would implement the project effectively and meet all environmental standards and would “provide performance guarantees to the Mexican authorities, to the IBWC, and other concerned parties” (Agua Clara LLC, 1997).

In addition, Agua Clara took full responsibility for providing or arranging financing, which would probably be “a blend of private and international public or quasi-public financing elements.” More specifically, of the public equity and debt, the debt portion was “anticipated” to be provided by NADBank after the Border Environmental Cooperation Commission (BECC) certified the project. Public and private funds would finance the remaining balance. The letter also stated that locating a secondary treatment plant in México (identical to the chosen alternative) would be less costly because of lower land and labor costs (Agua Clara LLC, 1997).

In March 1999, CH2MHill released the final SEIS for the IBWC South Bay International Wastewater Treatment Plant Long-Term Treatment Options, Volume I. Section 3.1.5 addressed Agua Clara’s proposal. The final SEIS stated that in the draft SEIS, which was released in January 1998, the interested agencies considered the Bajagua project alternative, but it was eliminated from further consideration because “it was not a reasonable and feasible method for substantially accomplishing the objective of providing long-term treatment at the SBIWTP.” The Bajagua plan offered no formal details of the project to the lead agencies; it was in the conceptual stage only. Furthermore, it was not endorsed by the Mexican Federal Government and *Minute 283* and the *Water Quality Act of 1987*, Section 510 called for secondary treatment in the US. Although Agua Clara provided additional information to the EPA and US IBWC, the plan was still considered not to be a feasible alternative.

In January 1999, however, the US EPA and US IBWC sent a letter to Agua Clara informing them that their alternative could be re-evaluated if they completed the following five actions:

1. The US Congress would have to legislatively provide authority for the implementation of the Bajagua project. Money would have to be appropriated to the US IBWC that could be used to fund project costs over the 50-year service agreement period.
2. The Mexican government needed to demonstrate its support for the project through a request from the MXIBWC to the US IBWC for a renegotiation of *Treaty Minute 283*, so that the secondary treatment facility could be placed in México.
3. Agua Clara was required to establish enforceable legal mechanisms to ensure that the quality of the secondary effluent returned to the US would be within NPDES compliance.
4. Agua Clara was required to provide an environmental information document (EID) by 30 April 1999 to fulfill NEPA requirements.
5. Written land options for the project site, pipeline right-of-way, preliminary design, and a detailed estimate of funding for the project design needed to be submitted.

### **3.2 Political Wrangling**

In November 2000, Public Law 106-457 (PL 106-457), Title VIII, *the Tijuana River Valley Estuary and Beach Sewage Cleanup Act of 2000*, was unanimously passed by the 106<sup>th</sup> Congress and signed into law by President Bill Clinton. Its purpose was to authorize US entities to comprehensively treat sewage emanating from the Tijuana River area. The US IBWC was given the authority to take the necessary measures to provide secondary wastewater treatment of up to 75 mgd (3285 lps) in México. Furthermore, PL 106-457 stipulated that 25 mgd (1095 lps) of the advanced primary effluent from SBIWTP could be treated in México if treatment was not provided in the US, and an additional 25 mgd (1095 lps) of México's untreated wastewater

flows could be also be processed to secondary standards at this facility. This authority was subject to the renegotiation of *Minute 283*, which was realized with *Minute 311 Recommendations for Secondary Treatment in México of the Sewage Emanating from the Tijuana River Area in Baja California, México* (IBWC Minute 311, 2004).

In 2004, IBWC *Minute 311* established the framework for the design, construction, and operation of a secondary treatment works in México if secondary treatment was not provided in the US at SBIWTP. *Minute 311* allowed for a third party (private party) to provide secondary treatment services in México through a public-private partnership contract.

The IBWC Commissioners observed that it was acceptable to develop a partnership with a private US company. The private company would submit a proposal to engineer, construct, operate, and maintain treatment works in México, in compliance with applicable Mexican legislation (IBWC, 2006a). The operating lease would be a 20-year fee-for-services contract (rather than the original, proposed 50-year contract) between the US and México IBWC Sections (IBWC *Minute 311*, 2004; R.W. Beck, 2004). Payments for treatment services made to the service provider would be offset by compensations or credits that the provider would supply treated wastewater to México for non-potable applications. Compensation or credits would be mutually agreed upon by both the US and Mexican governments through the IBWC, and under no circumstances would the service provider be authorized to decide on the fate or use of the treated Tijuana wastewater (IBWC *Minute 311*, 2004). Upon termination of the 20 year contract, the facility would be transferred to the responsible Mexican authorities in good condition.

The contract for treatment was awarded to Agua Clara LLC for the Bajagua Project by the IBWC through a no-bid process. Soon after the contract was awarded, the IBWC gave its approval for Agua Clara to issue a request for quotations (RFQ) for the construction bidding process to ensue (IBWC, 2006b).

### **3.3 Bajagua: the Preferred Alternative**

In the 2005 final SEIS prepared by Parsons, the Bajagua project was selected as the preferred alternative:

***Alternative 4: Public Law 106–457, Secondary Treatment Facility in México***

***Treatment Option C: Bajagua Project, LLC Proposal – Operation of SBIWTP as Advanced Primary Facility, Secondary Treatment in México***

***Discharge Option I: Treated Effluent Discharged in United States via SBOO***

***Discharge Option II: Treated Effluent Discharged in México at Punta Bandera***

*Chosen Alternative: Alternative 4, Option C, the chosen alternative:*

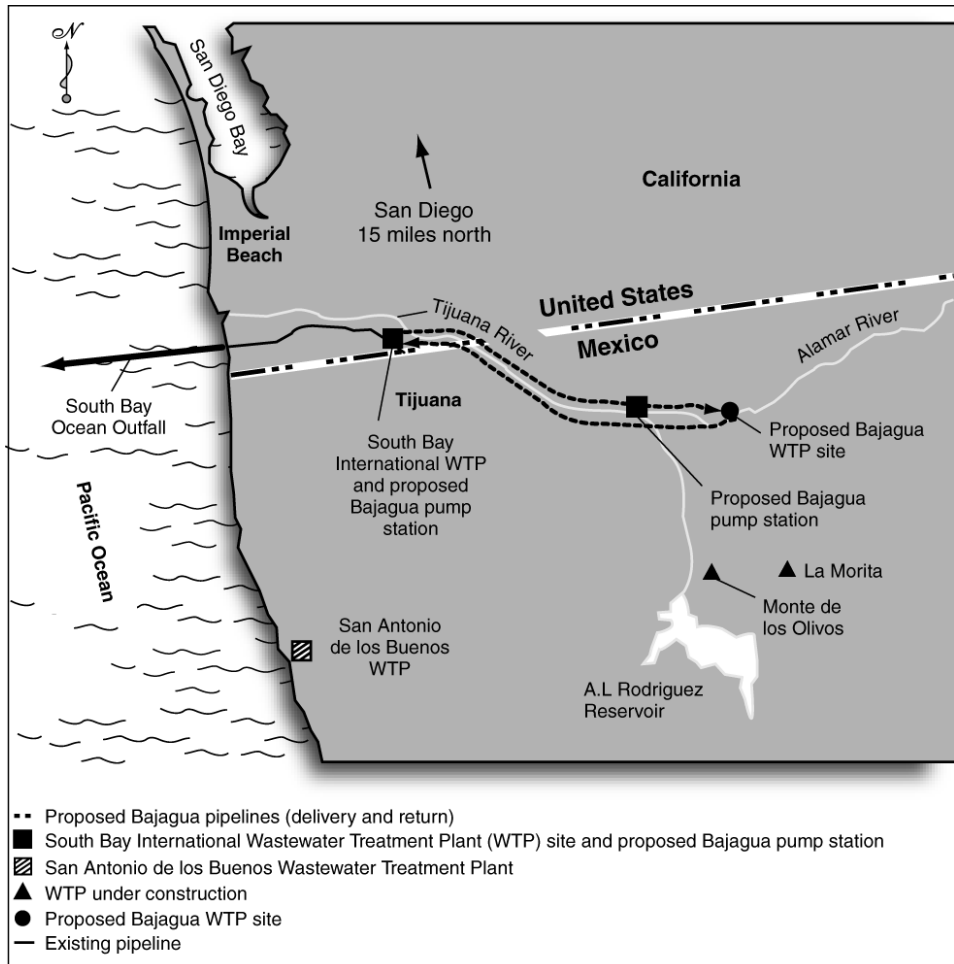
The Bajagua plant was proposed to work in tandem with SBIWTP, which would continue to treat 25 mgd (1095 lps) of raw wastewater to advanced primary standards, and the Bajagua facility would progress the treatment to a secondary standard. Any flows in excess of 25 mgd (1095 lps) emanating from México would remain in México. The Bajagua plant proposed to treat an additional 34 mgd of Tijuana’s raw wastewater and to remove more than 90% biological oxygen demand (BOD, all references to BOD are assumed to be BOD<sub>5</sub>) and 75% TSS. In 2005, the influent BOD at SBIWTP was 306 mg/l and TSS is 125 mg/l. The Bajagua plant proposed to treat the water to 30 mg/l BOD and 30 mg/l TSS to meet water quality standards of



both the US and México, in accordance with NPDES permit limits (R.W. Beck International, 2004; Parsons, 2005).

The Bajagua alternative is an unusual process in that the wastewater would possibly cross the International Border several times before finally being discharged or reused in México: 25 mgd (1095 lps) of Tijuana's raw sewage would be pumped to the US for treatment at SBIWTP; primary effluent leaving SBIWTP would be pumped back over the International Border into México to the proposed Bajagua site, approximately 19.3 km (12 miles) up the Tijuana and Alamar rivers from SBIWTP; the Bajagua WTP would treat the water to secondary standards and (possibly) deliver it back over the International Border where it could be released through the SBOO or sent to a pump station where it would be delivered back to México for reuse in non-potable applications. Figure 3.1 indicates the water path and general siting of the Bajagua facility.

Alternative 4, Option C required new infrastructure in both the United States and México. At SBIWTP, a new "Bajagua Pump Station" with a connection to SBIWTP's discharge pipes would be constructed as would approximately 244 m (800 ft) of 1.22 m (48in) diameter force main pipeline. The pump station would also include a 5,678 m<sup>3</sup> (1.5M gallon), short-term storage wet well, constructed of reinforced concrete, for peak flows (Parsons, 2005). Five 900 hp pumps would be required to deliver primary effluent 10.94 km (6.8 miles) to the Bajagua site for secondary treatment (R.W. Beck International, 2004).



Source: GAO analysis of data provided by U.S. Section, IBWC, and Bajagua, LLC.

**Figure 3.1:** Map indicating the flow of wastewater with the Bajagua project working in tandem with SBIWTP.

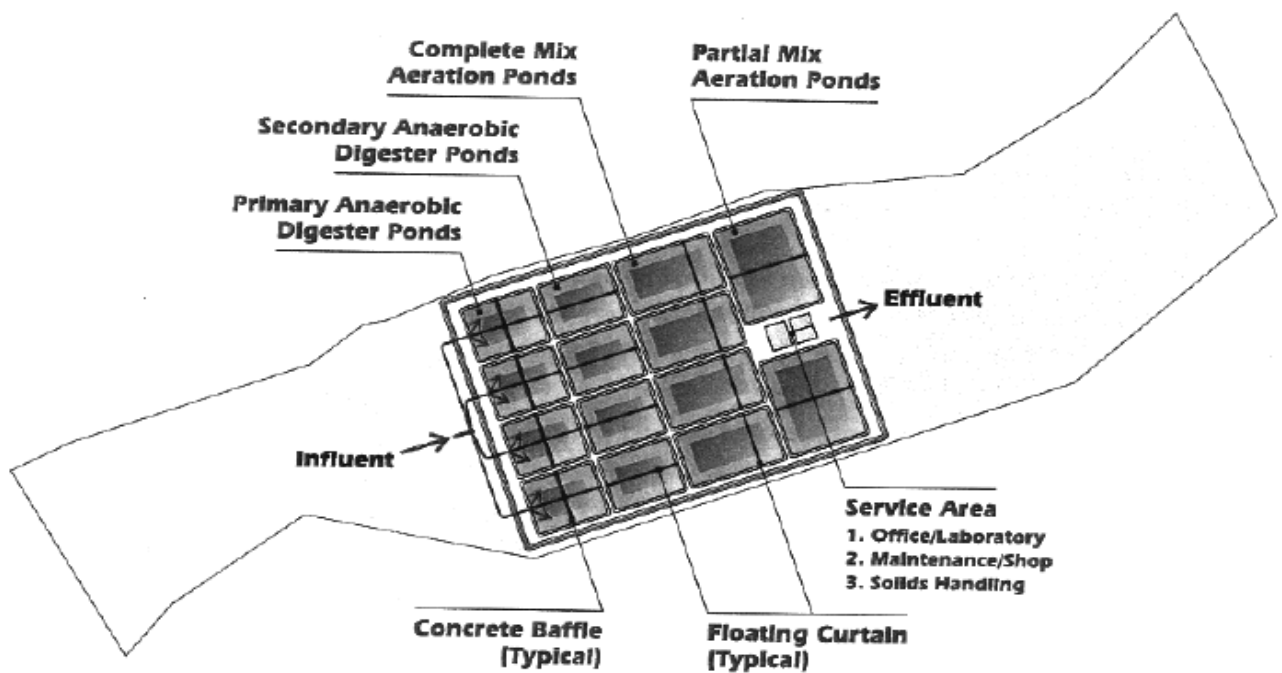
The new facilities required in México would have also included a Tijuana pump station approximately half way between SBIWTP and the Bajagua site along the force main for conveying the primary effluent the final 10.94 km (6.8 miles) for treatment. The force main would have a capacity of 50 mgd (2190 lps) and would also be connected to the Tijuana sewer system in order to collect raw wastewater flows for primary and secondary treatment at Bajagua. The 1.22 m (48 in) diameter force main would have a 150 psi maximum operating

pressure and steel construction with a cement mortar lining, gasketed rubber joints, and manholes placed every 609.6 m (2,000 ft). To return secondary treated flows, gravity-return pipeline for carrying the treated secondary effluent would run roughly parallel to the force main. The reinforced concrete return flow pipe would have rubber O-ring joints, a capacity of conveying 25 mgd (1095 lps), and manholes every 304.8 m (1,000 ft) (R.W. Beck International, 2004; Bajagua Proposal Bajagua, n.d.; Parsons, 2005).

The 233 acre site for the proposed Bajagua Project was along the Rio Alamar with more or less flat terrain and alluvial soils. The land is gently sloped downward from east to west and from south to north. The groundwater table beneath the proposed site ranged between 4.57 m and 6.10 m (15 ft and 20 ft) and is mostly used for agriculture (Parsons, 2005). All water deliveries to the proposed Bajagua facility would enter at the site's eastern boundary in order for gravity to facilitate water movement through the treatment process. The plant plan had the ability to separate the incoming SBIWTP primary effluent from the raw Tijuana wastewater for treatment, or it could blend the primary and raw and treat them together.

The proposed Bajagua Plant design was also unusual in that it lacked facilities for primary sedimentation or sludge disinfection. Figure 3.2 is a schematic of the initial design proposal by Bajagua representatives. Instead, it proposed clarifiers and an extended complete mix aeration (CMA) pond system with parallel trains of ponds working in sequence. The ponds would operate through settling, completely mixed activated sludge, and diffusers with a fine bubble aeration system. Gravity would facilitate the movement of water from the south to the north side of the ponds. Continuous aeration would optimize air transfer and oxidation. The plant also

proposed a second set of digester ponds (R.W. Beck International, 2004). Settled sludge from the clarifiers would be removed and dewatered using a belt filter press. As stated in IBWC *Minute 311*, treated secondary effluent from the proposed plant could be reused in Tijuana for industrial applications for irrigation. Effluent that is not reused would be returned to SBIWTP for disposal through SBOO.



**Figure 3.2:** Schematic from Bajagua proposal, plant design including flow path.

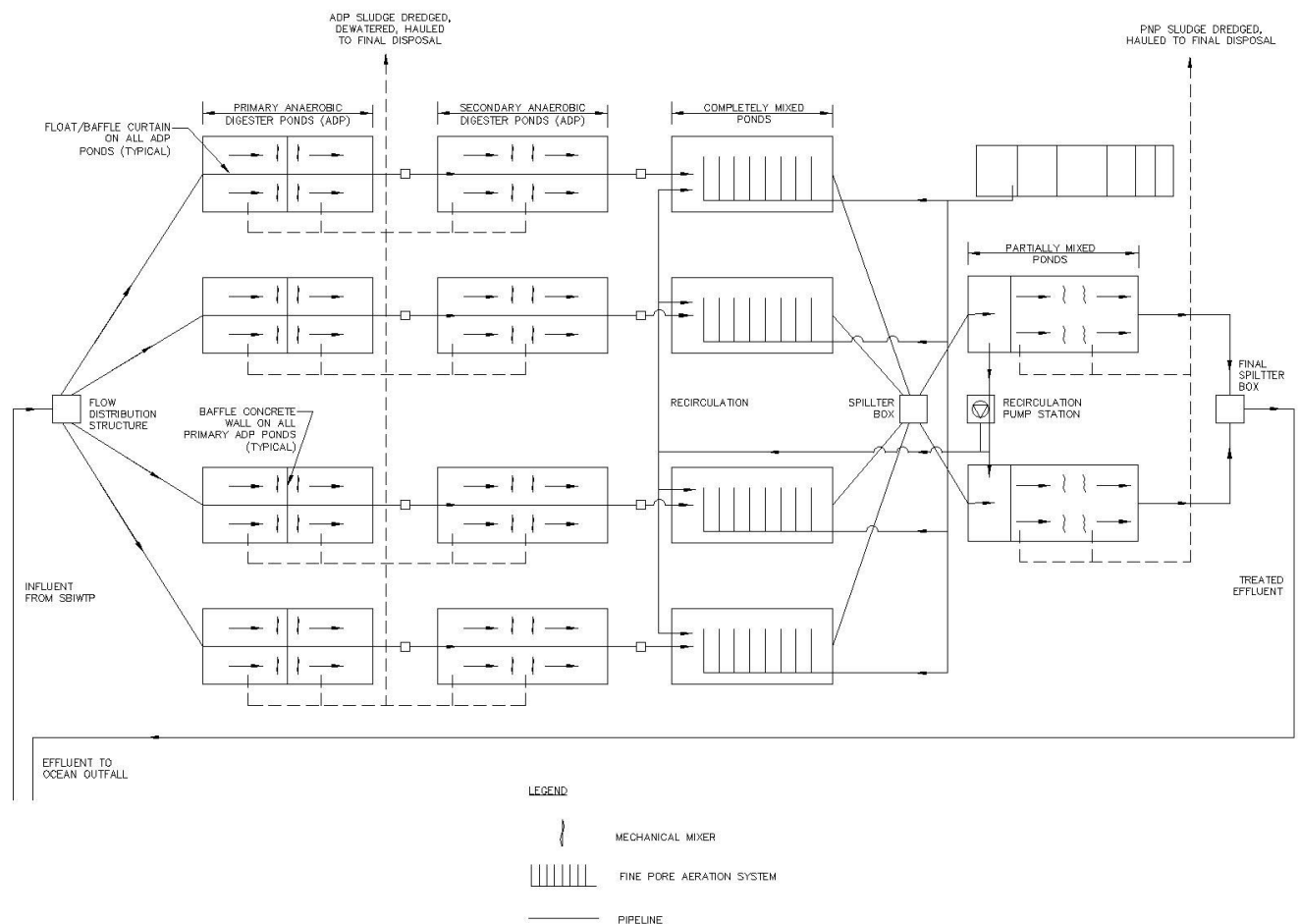
### 3.3.1 Specific Bajagua Plant Design as Described in the 2005 SEIS

The original design of the Bajagua Wastewater Treatment Plant was submitted to the IBWC in 1999. The design proposed treatment of 25 mgd (1095 lps) average flow organic loadings and 40 mgd average peak flows with BOD of 139 mg/l and TSS of 150 mg/l. In 2004, the proposal was modified in order to treat more wastewater. The new design proposed treating 59 mgd (2584 lps) average flows with 75 mgd (3285 lps) peak flows, BOD of 325 mg/l and TSS of 300 mg/l. The Draft SEIS (Parsons, 2004) identified the average daily flows to be 50 mgd (2190 lps).

The Final SEIS (Parsons, 2005), however, increased that amount to 59 mgd (2584 lps). The unit treatment process in the proposed plant included the use of three duty, one standby, and one bypass 50 mgd (2190 lps) mechanically cleaned bar screens. The total screens area would be approximately 2,000 m<sup>2</sup>. There would be eight aerated grit removal tanks, 25 m<sup>2</sup> each. The facility design included two dual stage scrubbers that would target mercaptans (thiols), amines, ammonia, aldehydes, ketones, and VOCs using acid, caustic, and hypochlorite. The twelve aeration basins with fixed mechanical aerators were proposed and would have been lined with a HDPE polyethylene system, which would have helped to prevent leaks into groundwater and, each basin was designed with a volume of 10 Mg. BOD loading in the basins was designed for 0.08 lb per pound mixed liquor volatile suspended solids (mlvss).

The plant's design called for 12 clarifiers, each with the volume of 1.0 Mg and an average detention time of 3.8 hours. The clarifier design included a 500 gpd/ft<sup>2</sup> hydraulic loading with a 20,000 m<sup>2</sup> total area. The design for the sludge handling facility included four (three duty and one standby) dissolved air flotation tanks, each with a 17 m (55.8 ft) diameter, total area of

20,000 m<sup>2</sup>, a flow rate of 2,500 gpm, and a hydraulic loading of 500 gpd/ft<sup>2</sup> for sludge thickening. The sludge watering area design included seven (six duty and one standby) belt presses, each with the 150 gpm. The planned disinfection area proposed Sodium Hypochlorite (NaClO) at a dose of 5 mg/l or 3,100 lbs per day at peak. The chemical would be distributed with the use of three (two duty and one standby) chemical pumps. Figure 3.3 is a schematic of the proposed design in the 2005 SEIS.



**Figure 3.3:** Schematic of the design for the Bajagua plan in submitted in the Parsons Final 2005 SEIS.

### **3.4 Controversy**

Typically in scientific writing, editorials and newspaper articles are not used as references, for articles are often biased, include hearsay, and fact checking is less stringent. In short, these types of writing/reporting are not held to the scrutiny of peer-reviewed, scholarly articles. Nonetheless, public opinion is often shaped by media reports irrespective of their veracity, and often, public opinion is the genesis of political action. The Bajagua project was not only political in nature but also highly controversial. Information that influences the politics and public sentiment regarding this project should be included while reviewing this topic.

At the very onset, the implementation of the Bajagua proposal was controversial, and opponents challenged it for a suite of reasons. It garnered some appreciation due to its promise of alleviating the water contamination problem. However, it was condemned for a myriad of reasons as explained in the following pages. There was no opposition to the cleaning-up of the polluted waters near and around the Tijuana River, estuary, and near ocean and shore. In the early 1990s, San Diego spent as much as \$500,000 per month collecting and treating average flows of 13 mgd (570 lps). In 2006, all, most, or parts of the beaches along Imperial Beach and the Tijuana Estuary were closed. Among many studies, researchers at the Graduate School of Public Health at San Diego State University documented high levels of Hepatitis A, and enterovirus, and human intestinal viruses at two sampling sites in ocean waters after rain events. The two sampling sites were 1) at the Tijuana River and ) 1.4 km (0.87 mi) north at the Imperial Beach Pier (Brooks et al., 2005). By some estimates, less than 60% of Tijuana's sewage was being treated, some to minimal standards, leaving 40% to flow into the Tijuana River or to be released at Punta Bandera (Paltrow, 2007).

Bajagua LLC was established in order to build a wastewater treatment plant in México under a US Government contract. Its founders, former San Marcos city council representative, Jim Simmons, and Rancho Santa Fe architect, Enrique Landa, were poised to earn millions of dollars in a fee-for-services contract and for selling the treated effluent for industrial and agricultural purposes.

The Bajagua project was well in-line with the regions environmental and economic needs, but its opaque negotiation process had raised the ire of some watchdogs. The contract for the Bajagua project was awarded, without any competitive bidding, to a start-up company with no experience with wastewater treatment (POGO, 2005). Bajagua was given sole authority to operate a wastewater treatment plant in México through a public-private partnership, specifically authorized by the US Congress, circumventing normal federal rules barring sole source contracts (Weaver, 2006). In fact, several laws were passed in support of the project. US IBWC Commissioner, Arturo Duran, 2004-2005, commented that US government operations do not typically involve sole-sourcing contracts worth hundreds of millions of dollars (Paltrow, 2007).

On grounds that the project proposal was inadequate and impractical and would violate existing laws and treaties between the US and México, the US State Department, EPA, Justice Department and Clinton White House's Office of Management and Budget all rejected the Bajagua plan, according to governmental records (Paltrow, 2007). The US and México had already agreed to build a treatment plant in the US in *Minute 283*, and the Bajagua plan was contrary to that agreement. In fact, the Clinton White House's Office of Budget and



Management stated, "Its approach raises serious foreign policy and legal concerns and will hinder our ongoing efforts to address the regions wastewater treatment needs"(Paltrow, 2007).

Undeterred, Bajagua representatives hired former policymakers and government officials to lobby legislation in favor of the project, among them were Matthew Simmons, a former legislative director for Rep. Duncan Hunter and James R. Jones, former US Ambassador to México. Bajagua promoters spent millions of dollars lobbying for the project (Weaver, 2006; Lee and Rodgers, 2006). US Representatives Bob Filner and Brian Bilbray sponsored a bill promoting Bajagua. The original draft of the bill actually named Bajagua as the selected company that would treat the wastewater, but the specific use of the name met opposition with other lawmakers. Consequently, it was removed, but the bill was worded specifically enough to exclude others but Bajagua. According to Rep. Fillner, "We basically wanted one company," so we had to find a way to do it within the law" (Paltrow, 2007). Eventually, Representative Bilbray was hired by Bajagua after leaving Congress (POGO, 2006). From 1996 through 2005, Representative Filner received more than \$56,000 in campaign contributions from Bajagua officials and their immediate relatives. Public records indicate that \$585,000 was spent between 2001 and 2006 for lobbying (Paltrow, 2007). By 2005, after ten years of working on the project, about \$20M had been spent on lobbying and engineering, etc. (Lee & Rodgers, 2005).

In October 2002, Simmons and Landa had a meeting with Vice President Dick Cheney at a Republican fund-raiser at the home of energy executive George Yates (Paltrow, 2007), which eventually culminated in the disappearance of federal opposition to the project (POGO, 2006).

Mr. Simmons followed-up the meeting with a letter (on Bajagua stationery) thanking the vice president for facilitating the introduction of the Bajagua proposal to the new administration. Simmons also gave Mr. Cheney's top adviser a "Bajagua Project Briefing" packet. By 2003 the White House pressured interested government agencies to embrace the Bajagua project. When a Justice Department staff attorney supported the IBWC's opposition on legal grounds, the attorney was replaced by a political appointee who reported to an Assistant US Attorney General who, in turn, reported to Dick Cheney (POGO, 2006). The opposing voices from some IBWC staff members were subsequently silenced (Weaver, 2006). Personal efforts by US Representative Duncan Hunter made the meeting with the vice president happen. He also pushed the legislation that favored Bajagua. In exchange, he received thousands of dollars in campaign contributions from Simmons, Landa, and their relatives (Paltrow, 2007).

One of the more innovative aspects of the Bajagua proposal was that Bajagua would initially fund the project, and the US government would repay the "loan" in annual installments over the 20-year contract term (*Public Law 106-457*, 2000), while earning the investors about a 20% return. There was also an undisclosed operations fee that Bajagua would receive. After the contract expired, the plant would become the property of the Mexican government (Rodgers & Lee, 2005). In March 2006, a deadline to negotiate an agreement to set financial terms for the 20-year contract deal was missed. By January 2007, Bajagua representatives had missed important deadlines such as financing commitments, proper permits, and land. It had claimed to have achieved its goals but failed to produce documentation. They failed to submit specific plans for the facility, construction permits, evidence of land acquisition, and it was unclear whether they could legally sell reclaimed water in México (Paltrow, 2007). The final cost for the

project was unknown. The final 2005 Parsons SEIS estimated that the Bajagua project would cost approximately \$336M (Parsons, 2005), but Congressional Budget Office (CBO) estimated the US's portion as ranging between \$580M to \$780M over the two decades of the contract (Paltrow, 2007). The vast difference in cost estimates between the final SEIS and the CBO is presumably for the interest Agua Clara would have to pay to the project's financier. Public Law 106-457 states that the US IBWC would pay the "owner of the Mexican facility" for costs associated, among other things, financing, which overrides the government's own Federal Acquisition Regulation (FAR) that categorizes interest as an unallowable cost (POGO, 2006).

In the end, the US government would have reimbursed Bajagua \$4.5M to \$6M on its investment at a "20% equity position in the capital structure", plus fees for managing the facility (*Public Law 106-457*, 2000). On top of that, they would have earned many millions of dollars selling reclaimed water. A senior IBWC engineer who evaluated the plan concluded that the proposed plan was unnecessarily exorbitant because of the routes the water took: sometimes crossing the border three times before being discharged through SBOO (Paltrow, 2007).

In a 2000 press release, Bajagua representative, Jim Simmons, stated that the project received "strong and unanimous, bi-partisan support in Congress" putting Agua Clara in the position to complete the Bajagua Project in 18 months (Benedetto, 2000).

In a letter, dated 28 July 2005, labeled as "sensitive but unclassified," MxIBWC Principal Engineer Luis Antonio Rascon Mendoza wrote to US IBWC Principal Engineer Bernardino Olague regarding an announcement released on the previous day by the US IBWC. The Mexican Section

felt that the US Section was unilaterally making decisions with regard to the Bajagua project. The US IBWC press release titled, “US IBWC Commissioner Reaches Milestones in Border Sanitation Project” announced that the US Commissioner, Arturo Duran, had passed two significant hurdles, and the IBWC was making “quick and substantive progress” with regard to the San Diego border sanitation project:

- The final 2005 SEIS had been released
- And negotiations for the Bajagua project had begun

Duran further stated that the Bajagua proposal was the Preferred Alternative in the final SEIS, the Bajagua plant would eventually be able to treat up to 59 mgd (2584 lps), and the plan complied with *Public Law 108-425 (an amendment to PL 106-457)* and *Minute 311*. Also, Bajagua would provide up-front financing for the project and would be in compliance with applicable Mexican laws.

In Mr. Rascon Mendoza’s response to the US IBWC press release, he pointed out that the Final 2005 SEIS indicated that the site to be chosen for the location of the facility was the responsibility of Bajagua. México, on the other hand, had stated numerous times in correspondence and during meetings that there needed to be flexibility in the siting of the facility; the needs of the City of Tijuana needed to be considered in making this decision. Presumably, the Mexican section was concerned that a public announcement was made for something that may not be possible.

The US IBWC press release also announced that the project goals would be achieved in two phases:

- 1) there would be contract negotiations for treatment facility ownership (with Agua Clara)
- 2) the facility owner (Agua Clara) would acquire the necessary land and easements and would procure engineering, construction, operation and maintenance.

Mr. Rascon Mendoza responded to that announcement saying the plans for contracting, engineering were not even discussed formally between both sections, yet they had already been announced publically. The Mexican section wanted an opportunity to comment on the plan.

Other items mentioned in the press release but not addressed by Mr. Rascon Mendoza were that the US Army Corps of Engineers would advise on the contracting, and most importantly, the Mexican facility needed to be online, treating to the water quality standards for both countries on or before 30 September 2008. The US Federal Government's agreement with Bajagua could be cancelled if they failed to meet this deadline, which it was. Bajagua was unable to obtain approvals from the Mexican Government (US IBWC ROD, 2008).

On 24 April 2008, the US Government Accountability Office (GAO) released a 66 page report stating that, among other things, there were still many uncertainties associated with the Bajagua project, and in the end, it would cost US tax payers far more money to proceed with the Bajagua project than the upgrade to the SBIWTP. US IBWC and Bajagua were slow in providing the GAC complete project timelines and cost estimates, which were finally received

only a month earlier, so because of time constraints, the information could not be verified. At that time, the latter half of March 2008 (GAO, 2008), the Bajagua project should have been near completion in order to comply with the September 2008 court-ordered deadline. According to the GAO report, the US IBWC estimates for upgrading the SBIWTP were just over \$100M in construction costs and \$16.7M for O&M during the first year of operations. Bajagua, on the other hand, would cost the US Federal Government \$331M and 20 years of operational costs (in 2008 dollars). Bajagua estimates for their project were \$195.6M, which Bajagua would finance. Wastewater treatment (including primary at SBIWTP), recovery of construction costs, equity and debt service, management fees, and profit would cost the US Government \$33.8M during the first year of operation, and over the 20-year term of the contract, the cost would be nearly \$540M in 2008 dollars.

On 15 May 2008, the Bajagua project was killed (Davis, 2008). A Revised Record of Decision was approved by US Commissioner Carlos Marin. Referring to the 2005 ROD, Section II was replaced by the following:

*After revaluation, which is discussed below, the US IBWC has decided to upgrade the SBIWTP to secondary treatment in the United States (Secondary Treatment, Alternative 5, Option B-2, Activated Sludge with Expansion Capacity, with discharge Option 1) to achieve compliance with CWA and the NPDES permit (US IBWC ROD, 2008).*

In a press release, the US IBWC announced publically that they would be upgrading the facilities at the SBIWTP to a secondary treatment level. In November of that year, the *Notice to Proceed* was signed, and the construction contract for the upgrade was awarded to S&B Infrastructure, LTD, and PCL Construction, INC. The initial award amount was about \$87.6M (IBWC Report,

Nov. 2010). On 5 January 2009, the onsite works for the upgrade began. By mid-November 2010, the final preparations for secondary treatment were underway (see image in Figure 3.4). Activated sludge from another WTP was brought into seed the basins, and by 24 November 2010 the plant was online (IBWC Report, 2010; Water-Technology, 2011). The construction project lasted 830 days, and the final cost was approximately \$92.7M after 57 modifications (IBWC Report, 2010). Figure 3.4 is an image of the aeration basins at SBIWTP during the testing phase prior to seeding in early November 2010.



**Figure 3.4:** Aeration basins during testing phase at SBIWTP, Nov. 2010.

### **3.5 Delays & Criticisms**

From the time the South Bay International Wastewater Treatment Plant was online with primary treatment, April 1997, to the time the US Section of the International Boundary and Water Commission discarded the Bajagua project, 15 May 2008, over ten years had passed. By

the time SBIWTP's secondary treatment phase came online and thus, was in compliance with its NPDES permit, November 2010, an additional two-and-a-half years had passed.

Given the asymmetrical economic and political relations between the US and México, implementing the "polluter pays principle" (PPP) would not be a viable option for solving the problem (Fischhendler I, 2008), especially when many US interests were in México fouling that countries waters. Furthermore, asymmetries in technology, water quality and enforcement standards and political structure create a difficult environment for equivalent cooperative resolution.

As stated previously, no one was opposed to the treatment of Tijuana's wastewater, it was the way in which the Bajagua proposal was promoted and adopted that raised the ire of so many.

The greatest opposition was due to the following points:

1. Agua Clara, Bajagua, representatives had no prior experience with wastewater treatment, plant design, construction, or operation and maintenance.
2. The decision to expand the SBIWTP to secondary had been twice made, and a costly SEIS and more laws were passed, tailor-made for the Bajagua project.
3. It was promoted as *the* alternative, yet Bajagua representatives had not released firm plans until March of 2008, a scant two months before the IBWC killed the Bajagua project.
4. The plan's adoption was politically motivated, and campaign donations were freely flowing.
5. The project was awarded though a no-bid contract.
6. The project would have been run and repaid at US tax payer expense, yet the facility owners would make millions of dollars selling the secondary effluent.



7. Some questioned whether the plant's sketchy design would accomplish what it claimed it would.

The US IBWC had initially rejected Bajagua, but it had suddenly begun to espouse it. A public private partnership was not a novel, unproven arrangement. Several contracts for other projects had been awarded to positive results. In fact, the 1944 Water Treaty allowed for either the US or Mexican Section's government to contract with competent public or private agencies. Being that Bajagua had no prior experience in design, construction, operation or maintenance, one can argue that Bajagua did not fit the definition as competent. They were merely acting as a middleman.

### **3.6    *Why Did the IBWC Select This Alternative?***

For many years, the IBWC had enjoyed a reputation as a professional, competent, technically-focused agency of the US State Department, staffed with qualified personnel, the type of agency that would revel in much autonomy in its operation (Mumme & Little, 2010). Article 2 of the 1944 Water Treaty clearly states that the head of each section would be an Engineer Commissioner. In addition, there would be two principal engineers, a legal adviser, and a secretary who all would enjoy diplomatic immunity in order to facilitate work on either side of the International Border. The IBWC was not set-up as an entity that was political in nature. It was set up to manage certain technical needs of the border region. Commissioners were chosen for their technical expertise, not partisan politics.

The longest serving US Commissioner, Lawrence Lawson 1927-1954, held his position from the Coolidge through the Truman administrations. Leland Hewitt, 1954-1962, and Joseph Friedkin, 1962–1986, also served under both Democrat and Republican presidents. It was not until the Reagan administration and the appointment of Narendra Gunaji in 1986 that a US IBWC Commissioner was also politically active. Gunaji, a hydrologist and Professor of Civil Engineering at New México State University was also a Republican Party activist, which indicated a shift in the US Section's orientation (Mumme & Little, 2010). John Bernal, 1994-2000, was appointed by President Clinton. By most accounts, Bernal politically skilled and savvy, with strong leadership skills and he proved to be adept at his job. After Bernal, who had endorsed Al Gore during the 2000 Presidential Election, former El Paso Mayor, Carlos Ramirez, who had endorsed George W. Bush, was appointed to the position. He, however, stepped down the following year after contracting a degenerative brain disease. The Commission was left without a leader for two years until President Bush appointed Arturo Duran in January 2004, a Republican with strong political ambition (Mumme & Little, 2010). Duran's short tenure as the US Section's Commissioner was brief and wrought with problems. In a March 2005 report from the State Department's Inspector General, Duran was characterized as politically minded, petty, paranoid, and by several accounts, incompetent (Mumme & Little, 2010). He was asked to resign after fewer than 20 months as Commissioner.

The IBWC had rejected the initial Bajagua proposal on the grounds that it provided little technical substance. Furthermore, the Clinton White House was opposed to Public Law 106-457, but the bill was signed into law because of overwhelming congressional support (Paltrow, 2007). The project was championed by local San Diego Area politicians. During the Bush 43

administration, voices, with or without technical expertise, in the US IBWC and EPA opposing the project were silenced (Paltrow, 2007). The Commissioner's role at the US IBWC had been transformed from a professional, engineer focused on technical aspects of the job done to a politician with a background in engineering, the face of the IBWC had been transformed (Mumme & Little, 2010).

In response to the 2005 SEIS on 7 July 2005, Chief Engineer of MX IBWC, Luis Antonio Rascon Mendoza, sent a letter, labeled as "sensitive but unclassified," to his counterpart in the US Section in an attempt to clarify a few issues with regard to the Final July 2005 SEIS:

1. The additional SEIS was due to US legislative requirements, and the US would select an alternative to be constructed in México, but México would also give input on the selection.
2. The alternative selected by the US Section would include consideration for México's needs corresponding to the long-term wastewater plans for Tijuana as well as aspects delineated in Minute 311.
3. At a 12 April meeting of the Commission, the US section was in the process of evaluating the requirements for the bidding procedures for both the US and México, and the US Section was considering a two-step contracting process. In the first phase, the US Section would contract with a service provider, and the second phase would include a contract for design, construction, and operation and maintenance. Details on their implementation, however, were scant.
4. Any contract to be implemented in México needed the full endorsement of the Mexican government, and México needed to be consulted throughout the project. The Mexican Section was unclear as to how the US intended to contract and administer the project. Mr. Rascon Mendoza asked that the US not formalize any contract for work in México without the express consent of the Mexican Section.

5. The appropriate Mexican authorities should be given some decision-making authority in the project's phases like site selection, treatment, design, effluent resale, construction and operation and maintenance.

The Mexican Section did not have a clear understanding how Minute 311 would be implemented; although, both sections signed off on it. Mr. Rascon Mendoza gently reiterated that México should be included in the decision-making process and supported the formation of a binational technical group. México felt left out of a project that would constructed, operated, and maintained entirely within its borders. Arturo Duran, reportedly, had little respect for his own staff much less the Mexican Section with whom he was exceedingly disrespectful (Weaver, 2005). The Mexican Section was left out of much of the process, and they were aware of it.

In an undated essay in support of public-private partnerships and the Bajagua project, Gary L. Sirota, Esq., a partner at Coast Law Group in San Diego, CA., argued that private participation in projects should be included in projects especially when the government is unwilling or unable to undertake project implementation, regardless if the private sector is in it for profit. He further asserted that the private sector is often more efficient, innovative, and flexible and works at a greater speed and at a lower cost (Sirota, n.d.). With regard to the Bajagua project, there was little if any opposition to it being a public-private partnership, but according to the GAO report, which ultimately terminated the Bajagua project, it would have been more costly than upgrading SBIWTP to secondary treatment. In his essay, Mr. Sirota also stressed that the public-private partnership "model provides for full disclosure, transparency, public comment, oversight, and regulatory control." While the attributes of public-private partnership can be

ascribed to the model and other projects, the adoption of the Bajagua project was rife with secrecy. Since it was never implemented, it is impossible to say how much transparency and disclosure would have been utilized.

One of the main reasons cited for giving the Bajagua alternative a strong consideration was the lack of funding available for the SBIWTP's completion, secondary treatment. In his essay, Mr. Sirota asserted that in 1993, Congress was aware that the IBWC historically ran over budget on time and finances on its projects, the SBIWTP was no different. The IBWC exhausted its budget with the first phase of construction. However, at the time the first phase was completed, the Bajagua project was already being promoted.

## CHAPTER 4

### WATER LAW AND POLICY

#### ***4.1 Review of Water Laws and International Policy***

A thorough characterization of the wastewater problem and possible solutions in the Tijuana Watershed Area would be incomplete without reviewing the laws and policies that have influenced decisions prior to this point. Summaries of Treaties, IBWC Minutes, and other legislative actions are presented in chronological order and were gleaned from the actual documents unless otherwise indicated.

##### ***4.1.1 México Treaty of Peace, Treaty between the United States of America and the Mexican Republic. Peace, Friendship, Limits and Settlement.***

Otherwise known as the Treaty of Guadalupe Hidalgo, 1848, this treaty officially ended the Mexican-American War (1846-1848) and assured “good friendship” and neighborliness between the two countries. Article I of the Treaty affirmed that there should be “firm and universal peace” between the US and México, its towns, and people.

In addition to discussing troop withdrawal, duties and tariffs, the Treaty established the Rio Grande as the boundary line between Texas and México. In Article III, the western border between the two countries was determined such that the “limit shall consist of a straight line, drawn from the middle of the Rio Gila, where it unites with the Colorado to a point on the coast of the Pacific Ocean, distant one marine league due south of the southernmost point of the

Port of San Diego.” The boundary lines established were to be “religiously respected” by both Republics.

Mexicans who were established in the newly-acquired US territories were allowed to retain their property and were extended US citizenship. They were allowed one year to decide whether to remain Mexican citizens or become citizens of the US. If no decision was made, they were assumed to be US citizens. “Savage tribes” of Native Americans within the territory of the US were designated to be under the control of the US.

Under Article XII, the US Government agreed to pay the Mexican government \$15M. Three million dollars (US) was to be paid immediately upon ratification of the Treaty, and annual installments of \$3M plus interest were due until the remaining \$12M balance was paid. All claims by US citizens against the Mexican Government were discharged.

#### ***4.1.2 México Resurvey of Boundary Line, Convention between the United States of American and the United States of México***

This Treaty, ratified in 1882 during the Chester Arthur administration, provided for an International Boundary survey to relocate the existing frontier line between the two countries west of the Rio Grande. Each government was to appoint a surveying party consisting of a Chief Engineer and two associates, one of which would be an astronomer. The two parties would meet in El Paso, TX or another convenient place and shall form the International Boundary Commission (IBC), a temporary joint commission. The Commission would have the authority to set boundary lines from the Pacific to the Rio Grande and place boundary markers, or Monuments indicating the boundary. The expenses incurred by each individual section would

be the responsibility of their corresponding governments; however expenses for boundary markers would be shared equally by the US and Mexico. If a person were to move or deface a boundary s/he would be charged with a misdemeanor.

#### ***4.1.3 Treaty of 1889 Convention between the United States and Mexico: Water Boundary***

This Treaty was framed because the Colorado and Rio Grande (Rio Bravo) rivers formed the boundaries between the two countries; however, rushing bodies of water have the tendency of to meander, so using nonstatic object as a boundary was presenting some political challenges. The International Boundary Commission (IBC) was established on 1 March 1889 and given jurisdiction over decisions in boundary disputes. The IBC, a temporary agency, would have both a US and Mexican Commissioners and consulting engineers. No business transaction would take place unless both commissioners were present. If either river were to change course, it is the responsibility of the both sections of the Commission to fix it. Local authorities are prohibited from making changes to the boundary. They were obligated to notify the Commission which was given the power to request any information regarding the boundaries, and it was the duty of local authorities in either country to provide it.

#### ***4.1.4 Rivers and Harbors Appropriations Act of 1890***

Discarded objects/refuse in the waterways created problems for water navigation and often interfered with commerce resulting in the enactment of the 1890 Rivers and Harbors Act. In 1899, the Act was amended by the Rivers and Harbors Appropriation Act, which is also known as the Refuse Act. The Act made it illegal to construct or begin construction of “any bridge, causeway, dam, or dike over or in any port, roadstead, haven, canal, navigable river or other



navigable water of the United States...” without congressional approval. The Act also regulated the construction of wharves, piers, jetties, bulkheads, and similar structures in ports, rivers, canals, or other areas used for navigation (Pollution Issues, 2012)

The Refuse Act required permits in order to construct allowable structures that did not interfere with navigation and commerce in waterways. If the Act was violated, civil and criminal penalties would be imposed (Pollution Issues, 2012). States had little weight in the Act’s application unless structures were built on waterways wholly within a state. In those cases, permission was still necessary. The Act, however, did not apply to municipal discharges including sewage because they did not interfere with commerce (USFWS, n.d.).

**4.1.5 *Treaty Between the United States and Mexico* (Signed in Washington, DC on 3 February 1944) and *Protocol* (Signed in Washington, DC on 14 November 1944)**

The 1944 Treaty between the US and Mexico went into effect on 8 November 1945. This 1944 Treaty recognized that the 1848 Treaty of Guadalupe Hidalgo regulated the waters of the Colorado and Rio Grande (Rio Bravo) rivers for navigation purposes only, and the waters could be used for other purposes that were in the interest of both countries.

Under Section I Preliminary Provisions, Article 1 defined the terms being used in the Treaty. Article 2 established the International Boundary and Water Commission out of the International Boundary Commission. The IBWC would function as an international body for as long as the treaty was in force. The head of each section should be an Engineer Commissioner. The Commissioners, their two principal engineers, legal advisers and secretaries were given diplomatic immunity within the jurisdiction of the other country in order for their personnel to freely carry out their duties. The Commission was given jurisdiction over extending to the

border of the adjacent country where the rivers formed the boundary, the Rio Grande (Rio Bravo) and the Colorado Rivers, as well as the land boundary between the two countries. Each Section of the Commission would retain jurisdiction over any project conducted within its borders unless consent to the other country was given. Each section would be responsible for the expense of maintaining its Section. In the case of joint expense, the costs would be equally shared by the two governments.

Article 3 provided a hierarchical guide for condition in which the Commission could make policy with regard to international waters. Provisions were subject to sanitary measures or works agreed upon by both countries. Priority was to be given to all border sanitation problems.

1. *Domestic and municipal uses*
2. *Agricultural and stock raising*
3. *Eclectic power*
4. *Other industrial uses navigation*
5. *Fishing and hunting*
6. *Any other beneficial uses that may be determined by the Commission*

In Section II, Article 4 specifically addressed the division of the waters of the Rio Grande (Rio Bravo) between Ft. Quitman, TX and the Gulf of Mexico. Article 5 delineated the works to be conducted be jointly. Article 6 addressed flood control works, and Article 7 directed the Commission to investigate the feasibility of constructing hydroelectric plants at the international reservoirs that were to be constructed. In Article 8, each section of the Commission was to agree upon regulations for storage, capacity, conveyance and delivery, through their respective governments, waters held in the international reservoirs. Article 9 allowed for the use of the Rio Grande (Rio Bravo) to convey the water belonging to either

country, and either country could divert any water belong it. The Commission could authorize the diversion of the waters belonging to one country to the other so long as the diversion would not harm the owner of the water and the water could be replaced somewhere along the river. Temporary diversions were also possible if the owner of the water didn't need it. In the case of one country experiencing an extreme drought and the other having an abundant water supply, the Commission could consent to withdraw water from an international reservoir for the country in drought. Water could be diverted for production of electricity in each country so long as it didn't interfere with the international power generation. The Commission had the responsibility of keeping records of the waters belonging to each country, and each country was required to provide information on diversions, consumptive uses, and unmeasured tributaries to the Commission.

Specifics addressing the Colorado River begin in Section III, Article 10. Mexico would be allotted a guaranteed annual quantity of 1.5M acre feet or approximately  $1.85B \text{ m}^3$ . The US section would determine any additional surplus not needed in the US could also be diverted to Mexico for use. In instances of extreme drought or accident, the guaranteed allotment to Mexico could be reduced. In Article 11, Mexico's allotment, as long as it arrives in the bed of the Colorado River, regardless of its source, is considered to be Colorado River water. Article 12 provided for the Mexico's diversion structure, levees, interior drainage facilities, and other works at Mexico's expense. The US would construct, at its own expense the Davis storage dam and reservoir and any works necessary to convey Mexico's allotment to its diversion points. Both Sections were responsible for studying and preparing flood control plans on the Lower Colorado

River, and each section would be responsible for construction and expense of those works and both would be responsible for joint projects according to Article 13.

Under Article 14, if Mexico were to use the American Canal for deliveries of its allotment, the US would have to be compensated. Article 15 stipulated the schedules of two annual water deliveries. Under Schedule I, Mexico would receive 1M acre feet (1.23B m<sup>3</sup>) through the Colorado River channel. The remaining portion would be delivered through the All-American Canal, per Schedule II.

Specifics addressing the Tijuana River fell under Section IV, beginning with Article 16. Those included the equitable distribution of the river's waters, storage plans, and costs for works and maintenance. Work and expenses undertaken of the proposed improvements were the responsibility of the Commission, which would be equally shared.

Section V covered General Provisions. Under Article 17, flood or excess waters could be discharged through the channels or international rivers, and neither country could lay claim against the other. Under Article 18, common surface water lakes formed by international dams would be available for public use by individuals in either country, subject to the laws or regulations of the respective countries. Neither country's military could use the waters unless agrees upon by both countries. Under Articles 19 & 20, the governments of both countries would make special agreement with regard to hydroelectric power generation. Each government was responsible for their respective construction works and could contract with competent public or private agency to do so. Work conducted in either country would be free from duties on supplies or immigrations restrictions of employees. Articles 22 and 23 address

boundary issues. International dams or lakes formed by the works of the IBWC would not change the International Boundary, and buoys would mark the delineation in lakes. The 1933 Convention would govern boundary delimitation, jurisdiction and sovereignty, and relations with private land owners. In cases of private land ownership, the two countries can employ eminent domain to acquire property for public good. Through the Commission's determination, conveyance works for water or energy will be located where necessary, and either country's laws would have jurisdiction within its boundaries.

The IBWC was given additional powers under Article 24. Those duties include: a) the obligation to initiate, investigate, and plan construction works; b) conduct or supervise construction of works; c) to carry out duties and discharge specific powers entrusted to the Commission; d) settle difference between the US and Mexico with regard to interpretation and application of the (1944) treaty; e) to furnish information jointly or individually with regard to individual jurisdictions; f) each section will construct, within the boundaries of their country, stream gaging stations in order to glean hydrographic data; g) the Commission should submit an annual joint report regarding its activities or more frequently if necessary.

Article 25 stipulated that 1889 Treaty Articles III & VII would govern the proceedings of the Commission recorded in the force of Minutes, duplicated in English and Spanish. Each Commissioner was obligated to execute, within his/her jurisdiction, the decisions of the Commission. If either section disapproves a decision, the respective governments are required to forge a mutual agreement and communicate it to the Commission.

Section VI, titled Transitorily Provisions, contained articles 26 and 27. Article 26 stipulated that within eight years of the treaty's force or until the onset of operations of the lowest international reservoir in the lower Rio Grande (Rio Bravo), and Mexico would cooperate with the US to help irrigate in times of drought with waters from the El Azucar reservoir. Under Article 27 Articles 10, 11 and 15 were given a five year period prior to their application or until the Davis data and Mexican diversion of the Colorado River was in place. In the meantime, Mexico would place a temporary diversion structure within the US in order to divert its allotment to the Alamo Canal. The US retained the right of approval on the structure. The US would cooperate with Mexico in order to satisfy Mexico's irrigation requirements. Under Section VII, Final Provisions, the only article, 27, stipulated that the treaty would be ratified in Washington, DC. And enter into force that day. Hereafter, this treaty will be referred to as the *1944 Water Treaty* or the *Water Treaty of 1944*.

***4.1.6 IBWC Minute 222 Emergency Connection of Sewage System of the City of Tijuana, Baja California to the Metropolitan Sewage System of the City of San Diego, California.***

The US and México engaged in a joint project to address the sewage problems in the border cities of Tijuana, México, and San Ysidro, US. In 1938, the international project, which included a septic tank and collector for the conveyance and discharge of wastewater to the, Pacific was completed. By the 1950s and 1960s, however, population growth overloaded the system as Tijuana's population reached over 150,000 by 1955.

In 1962, Tijuana began transport of wastewater with its own domestic conveyance and discharge system. The system consisted of collector lines, two pumping plants, two pressure

discharge lines, and an outfall channel parallel to the Mexican Pacific Coast. At the time they were constructed, the pumping plants and pressure discharge lines had double the needed capacity. US authorities, however, thought it prudent to include additional safety measures to prevent flows to the US in case of an accident. The IBWC Principal Engineers, W.E. Walker and Norberto Sanchez G., recommended building a sewage conveyance line between the Tijuana collector system and the San Diego Metropolitan Sewage System with the idea to drain the collector in instances of an emergency. During times of Tijuana pumping plants' or facilities' breakdown, this connection provided the safe disposal of Tijuana sewage into the San Diego system. This alternative disposal would avoid serious unsanitary conditions that might be caused by an overflow of wastewater into the US and/or the streets of Tijuana. A trunk line of San Diego's system ran within 0.8 mi of the international border opposite the main Tijuana collector.

The IBWC Principal Engineers produced the, *"Joint Report of the Principal Engineers Concerning the Advisability of Connecting the Sewage System of the City of Tijuana, Baja California to the Metropolitan Sewage System of San Diego, California as an Additional Measure of Safety."* The report made each country responsible for the expenses incurred within its own border. The report made five recommendations:

- construct a sewage line to connect the sewage system of Tijuana with San Diego's Metropolitan Sewage System
- each country was responsible for the design and construction and operation of the interconnection facilities under the supervision of the Commission

- each calendar year, México was required to pay the US \$743/day for the first five days of service and \$520/day thereafter for each day Tijuana's sewage was sent to San Diego's system for processing;
- construction was to begin as soon as possible
- the connection would remain available as long as San Diego's system had excess capacity to receive it

The commission agreed that the report was in accord with the 1944 Water Treaty, and they approved the recommendations outlined in the report for the construction, operation and maintenance of an emergency connection.

#### **4.1.7 IBWC Minute 225 Channelization of the Tijuana River**

In June 1967, the Commission met in El Paso, TX to address the flood problem caused by the Tijuana River. After review of Article 16 of the 1944 Water Treaty, they considered the, *"Joint report of the Principal Engineers on the International Works needed in the in the United States and México for the Tijuana River Flood Control in Both Countries"* submitted by IBWC Principal Engineers William Walker and Norberto Sanchez G. The Commissioners agreed that the threat of flood in the Tijuana River was serious for both countries because the river flows between both countries. They agreed that the solution should be a coordinated effort between both governments, and it should be carried out as soon as possible. Subject to the approval of both governments, the following resolutions were adopted:



- 1) The flood control project described in the report should be adopted, and the Governments of the US and México should approve the construction operation and maintenance of the project for the Tijuana River with the reservation of item 4.
- 2) The Joint Report of the Principal Engineers should be approved.
- 3) Each Government should, as soon as possible, jointly design and complete the detailed plans for works in its own country.
- 4) Work would not begin until each government arranged for financing for projects undertaken within its borders.
- 5) Minute 225 required the approval of the US and Mexican Governments.

#### **4.1.8 IBWC Minute 236 Construction of Works for the Channelization of the Tijuana River**

In July 1970, the Commission met to consider a requirement for executing the construction of the joint project for channelizing the Tijuana River. They reviewed Minute 225 and the preliminary designs for the project. As a consequence of the amount of work to be undertaken within the borders of their respective countries, the Commissioners agreed that construction of the project could begin independently within each country, but once the work was within 400 meters, north and south, of the international boundary, a coordinated effort would ensue.

The commission adopted the following resolutions, subject to approval of both Governments:

- 1) Minute 225, Resolution 4 would be applied only to the reach of the Tijuana River channelization within approximately 400 m (1312 ft) north and south of the International Boundary.

2) The remainder of the channelization works may be executed by each government within its own territory.

3) In order to avoid damage, commission required approval of project construction in both countries.

#### **4.1.9 IBWC Minute 240 Emergency Deliveries of Colorado River Waters for Use in Tijuana**

The Commission met in June 1972 to discuss emergency water deliveries of the Colorado River, allotted to México by the 1944 Water Treaty Article 10(a), to the City of Tijuana. Due to drought conditions in the Tijuana River Watershed, Tijuana's immediate water sources were insufficient, so the Government of México requested deliveries from the Colorado River. The deliveries of water from the Colorado, however, would require a 323 mile (520 km) long conveyance. The commission noted that an effect of the emergency deliveries would be salinity levels of 10ppm rather than 5ppm as specified in the 1944 Water Treaty. The Commissioners also recognized that increased water deliveries could lead to an increase wastewater discharge. Briefly, the following resolutions were adopted:

- Several California US agencies that had already established conveyances from the Colorado River to San Diego County would allow México's deliveries to flow through their conveyances for five years.
- Deliveries would begin as soon as possible and were limited to the capacity of the conveyances.

- Deliveries would be to the International Boundary near Tijuana and would be increased by 12% to cover loss.
- The delivery schedule would be formulated by the Mexican Section.
- México would be responsible for the construction of any new conveyances.
- México would be financially responsible for emergency deliveries including the use of existing conveyances, the actual cost of construction, and energy for the new connecting works.
- The new connecting works would be removed at the end of the specified delivery period of Minute 240.
- The use of the US conveyances would be for emergency purposes for a period not to exceed five years, which cannot be extended, and fulfillment of the Minute would not be the basis for financial responsibility.
- The purpose of Minute 240 was for emergency deliveries only.
- Because the Mexican Government was requesting *emergency* deliveries, there would be an increase in the salinity of delivered waters.
- Because of the increase in the water supply to Tijuana, the Commission expected an increase in sewage produced, and it was México's responsibility to take additional measures to prevent further contamination of the beaches resulting from the increased discharges.

#### **4.1.10 Federal Water Pollution Control Act 1972 (*Clean Water Act*)**

The Federal Water Pollution Control Act laid the foundation of surface water protection in US rivers, lakes, estuaries, coastal waters, and wetlands. Its sole objective has been to “restore and maintain the chemical, physical, and biological integrity of the nation’s waters” (EPA, 2011). It has established a framework for protection of water quality and set the basic structure for the regulation of pollutant discharge. The Federal Water Pollution Control Act of 1948 was the first major US law to address the many types of water pollution, not just those that interfered with commerce and navigable waters. In 1972 the law was amended to large degree, which was when it received its common name, *The Clean Water Act* (CWA). The 1972 amendments instituted a new requirement for technology-based standards for point source discharges. In fact, the Act has been termed a “technology-forcing statute” because technological advancements force the regulated to achieve increasingly higher standards of pollution abatement. The water quality standards have been developed without regard to the conditions of the receiving waters. In earlier versions of the law, emphasis on discharge control was placed point source discharges and conventional pollutants like suspended solids or bacteriological factors. Later, toxic discharges and nonpoint sources became the primary focus of amendments (Copeland, 2012).

Some water improvement programs were somewhat ambiguous in the 1972 version, so the following amendments were added in 1977:

- The basic structure for regulating pollutants discharges into US waters.
- The EPA was given authority to set standards and implement pollution control programs.

- It maintained existing requirements to set water quality standards for all contaminants released into surface waters.
- Anyone who released a pollutant from a point source into navigable waters was required to seek a permit to do so under penalty of law.
- Sewage treatment plants were funded under grant programs
- Acknowledged the need to address problems posed by nonpoint source contamination.

In 1981, the process for municipal works grants was refined through the Municipal Wastewater Treatment Construction Grants Amendments, Public Law 97-117. In 1987 through Public Law 100-4, the federal construction grants program was replaced with the State Water Pollution Control Revolving Fund, which addressed water quality needs by building on EPA-state cooperation. Congress passed Section 319, which instituted a national program to control non-point source water pollution, and water quality criteria for the Great Lakes was established for maximum levels of 29 toxic pollutants, which the EPA was required to implement on a specified schedule (EPA, 2012b; Copeland, 2002).

The Clean Water Act has two major components: 1) provisions that authorize federal assistance for municipal wastewater treatment plant construction, research, and related programs, under Titles I & II; and 2) regulatory requirements for industrial and municipal discharges, Titles III & IV. Under a federal-state partnership, states have certain responsibilities under the act. Discharges to water could be regulated at the federal, state or local level because the federal program provides only a minimum regulatory framework, and the state and local regulators can impose stricter but not lower standards if the national standard is not sufficiently protecting a particular location (Bell, 2002; Copeland, 2002).

The basis for the Clean Water Act lies in its water quality standards and designated uses. Water quality standards are defined in the Code of Federal Regulations as "provisions of State or Federal law which consist of designated use or uses for the Waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act." (USGPO, 2011). In 1994, the EPA established minimum water quality standards for states, and defined the criteria under which they would be judged:

- **Designated Uses** - Designated use should include existing and desired uses for a particular body of water. Those can include public consumptive water supply, protection of fish and wildlife, agricultural uses, navigation, recreation.
- **Water Quality Criteria** - Developed to protect each designated use and have numeric and narrative descriptions of the biological, chemical and physical conditions that are necessary to support each of the designated uses for that body of water.
- **Antidegradation Requirements** - No activity that would compromise any of the three tiers of antidegradation is allowable.

Industry as well as municipal works had been mandated to employ *best practicable control technology* (BPT), defined by the EPA, to clean-up their discharges prior to 1 July 1977; emphasis was placed on biodegradable pollutants. By the late 1980s, the Act required more stringent clean-up standards and demanded *best available technology economically achievable* (BAT) of industry, and more attention was paid to toxic substances (EPA, 2012b; Copeland, 2002). Discharges containing conventional pollutants, such as bacteria and oxygen-consuming materials were initially of great concern for regulation limitations with regard to BPT. BAT, however, has emphasized the control of toxic pollutants, like heavy metals, pesticides, and

other organic chemicals. Furthermore, the EPA has issued list of chemical pollutants it regulates, including 129 named classes or categories of toxic chemicals, or “priority pollutants.” The list facilitates testing and regulation and enforcement because it specifies individual chemicals by name. Another list, the list of toxic pollutants, is more difficult to test and regulate because it contains hundreds of compounds in open-ended groups of pollutants.

The Act uses both water quality standards and technology-based, numerical, limitations on discharges. Each state is required to establish its water quality standards for all the bodies of water within its borders to work in communion with the federally established technology-based standards (Copeland, 2002).

#### 4.1.10.1 NPDES Permitting

Under Title IV, *Permits and Licenses*, effluent discharges from industry and publically owned treatment works (POTW) are regulated in the CWA through the National Pollutant Discharge Elimination System (NPDES) permit program, which controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The Clean Water Act absolutely prohibits the discharge of pollutants to “surface waters of the Unites States” unless the polluter has secured a NPDES permit (Viessman and Hammer, 2005). The term “pollutant” is broadly defined by NPDES regulations and litigation, so any type of waste discharge into water is considered a pollutant. Sources can be direct or indirect. Direct sources are those that discharge directly into US waters. Indirect sources are those that are released to an intermediate, and the intermediate discharges into receiving waters. Only direct, point source

are dischargers are eligible for NPDES permitting. The National Pretreatment Program was designed for industrial and commercial indirect dischargers EPA, 2012b).

The NPDES program imposes limits on pollutants that can be discharged into receiving waters and requires that a discharger attain technology-based effluent limits BPT or BAT for those discharges. Limits are based on the stricter of minimum performance standards or the quality of the receiving waters. Technology-based effluent limitations, for certain pollutants from specific sources, are definite numerical limitations established by the EPA. Permits specify the control technology applicable to each pollutant, the effluent limitations a discharger must meet, and the deadline for compliance. Dischargers are required to maintain records and to carry out regular effluent monitoring activities. Permits are renewable and are issued for a period of 5-year periods. There are two basic types of permits issued, individual and general. Individual permits are issued to an individual facility and it is based on the type of activity and, therefore, nature of discharge and receiving water quality. A general permit could be issued to multiple facilities within a specific category and discharge similar wastes or require the same or similar monitoring, like a POTW.

All NPDES permits have five major components: 1) the cover page indicates the name and location of the permittee, specific information as to where the discharge is authorized, and a statement authorizing the discharge; 2) effluent limits for the discharge into the receiving waters; 3) monitoring and reporting requirements of the permittee in order to assure permit compliance, evaluate treatment efficiency, and characterize waste streams; 3) Special



conditions supplement effluent limit guidelines; and 5) standard conditions delineate the legal, administrative, and procedural requirements of all NPDES permits (EPA, 2012b).

Since its introduction in 1972, the NPDES permit program is responsible for significant improvements to our Nation's water quality (EPA, 2012b). It applies to All municipal and industrial “point source discharges” of pollution in waters of the United States--interstate and intrastate lakes, rivers, tributaries, wetlands, impoundments, intermittent streams. A point source discharge emanates from “any discernible, confined, and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged.” If, however, the discharge falls into a mixing zone, where the pollutants are sufficiently diluted that the water quality will not be degraded, water quality standards are waived in some waters.

#### ***4.1.11 IBWC Minute 243 An Amendment to Minute 240 Emergency Deliveries of Colorado River Waters for Use in Tijuana***

Minute 243 assured that the minimum rate of delivery from the Colorado River would not be reduced. This amendment to *Minute 240* added an additional resolution: Point 12—México’s deliveries from the Colorado River will not be less than 900 ft<sup>3</sup>/second (25.5 m<sup>3</sup>/second).

#### **4.1.12 IBWC Minute 258 Modification of the United States Portion of the Plan for the Channelization of the Tijuana River**

The Commission met in May 1977 to consider modifying the US portion of the plan to channelize the Tijuana River as agreed upon in Minute 225. IBWC Principal Engineers, Delbert McNealy and Norberto Sanchez G. submitted a new joint report, *“Joint Report of the Principal Engineers on the Modification of the United States Portion of the Plan for the Channelization of the Tijuana River.”* The commission confirmed the 1977 findings of the engineers and agreed that the modified plan would afford México the same protection against overflows as the previous 1967 plan did.

The new plan included the construction of an ungated structure on the south levee of the US channel, located opposite *Calle N* in the City of Tijuana, for discharge of waters from a tributary arroyo to the Tijuana River. The new plan included a drainage channel in the US with a reach from the International Boundary to the south levee’s ungated structure and indications to remove an old dike and silt deposits on the Boundary’s north side. Once a year, the US and México were responsible for the removal or spreading of the silt that would accumulate in the channel. The Commission agreed that all work should be undertaken as soon as possible and that each country was responsible for expenses it incurred within its borders. In the final point approved by the Commission, any fencing or other works constructed in the channel of the Tijuana River and its tributaries that formed part of the project were subject to the prior approval of the Commission. This point was added to ensure that such structures would not obstruct water flow in the channel.

#### **4.1.13 IBWC Minute 261 Recommendations for the Solution to the Border Sanitation Problems**

The Commissioners met in El Paso, TX in September 1979 under the direction of US President Jimmy Carter and Mexican President Jose Lopez Portillo in order to address the growing sanitation problems that plagued the border area. Provisions from the 1944 Water Treaty were examined, and Commissioners observed that Article 3 of the Treaty obligated the governments to find a solution to all border sanitation problems. Articles 2 and 24 gave the Commission the authority to meet the obligation.

The “border sanitation problem” was defined as cases when the wastewater crossed the international boundary either on land or water. These included coastal waters and flows in the limitrophe of the Rio Grande and Colorado Rivers. Commissioners noted that each country had taken the responsibility to address water quality issues within their respective borders; however, some problems persisted. The Commission also noted that each country had its own water quality standards. The present sanitary conditions were a health hazard and beneficial uses of the waters were impaired. They observed that in addition to solving existing problems they should take timely steps to prevent any future problems. The Commissioners made the following Recommendations:

- 1) The two governments needed to recognize that the term “border sanitation problem,” as stated in the 1944 Water Treaty, referred to waters that crossed the International Boundary and included coastal waters as well as the limitrophe that flowed in the Rio Grande and Colorado Rivers. Furthermore, that those waters were of

an unhealthy, unsanitary quality and in their present condition, they threatened the well-being of Americans and Mexicans and impaired the beneficial uses of the waters.

2) Under Article 3 of the Water Treaty of 1944, the Commissioners were obligated to focus their attention on border sanitation problems and give present challenges their immediate attention.

3) Current sanitation problems should be resolved in a timely manner to prevent foreseeable problems. Agencies from each Government were to provide technical advice to the Commission for their respective challenges.

4) The Commission was responsible for preparing Minutes to address each of the border sanitation problems, which required the approval of both Governments. Problems needing identification included, a definition of the condition needing remediation, specific quality standards that would be applied, the course of action in order to reach a solution, and a implementation time schedule.

5) In cases where the course of action lies within the boundaries of only one of the countries, that government was urged to develop the plan and design for the Commission's approval. That government would then be urged to carry out its plans including construction, operation and maintenance in a timely manner.

6) In cases where joint US and Mexican efforts were required, the Commission would be responsible for developing plans and designs. The division of work and costs would be shared between the two countries, so approval was required of both Governments. Upon approval, the construction, operation and maintenance would occur in as timeless a manner as possible through its section of the Commission.

7) In accordance with Article 24 (b) of the 1944 Water Treaty, the two Governments were to give their respective sections of the Commission the authority to exercise jurisdiction over sanitation works undertaken in their respective countries.

8) Each country's Commission is responsible for keeping the other informed of the other's progress.

9) Minute 261 required approval from both governments.

***4.1.14 IBWC Minute 264 Recommendations for the Solution of the New Border Sanitation Problem at Calexico, California—Mexicali, Baja California Norte***

The Commission met in Cd. Juarez, Chih. in August 1980 to discuss the flows in the New River from Mexicali, MX, into the US at Calexico, CA. They referred to Minute 261, Recommendation 4, that required both Governments to a) identify the problem, b) define the problems that require resolution, c) specify quality standards to be applied, d) identify a course of action, and e) create a specific time schedule for the project's implementation.

The Commission agreed that interim measures, which included qualitative and quantitative standards, should be taken until a permanent solution was found. For qualitative measures, the waters were to be free of untreated discharges, free of toxic substances including pesticides in harmful concentrations, free of trash, oil, scum, and free of sludge deposits from municipal and industrial wastes.

**4.1.15 IBWC Minute 270 Recommendations for the First Stage Treatment and Disposal Facilities for the Solution of the Border Sanitation Problem at San Diego, California-Tijuana, Baja California**

The Commissioners met to consider the San Diego—Tijuana border sanitation problem in April 1985. The commission referred to the 1944 Water Treaty, Article 3; it was noted that the two governments would “agree to give preferential attention to the solution of all border sanitation problems.” The Commission reviewed border sanitation problems and agreed that the San Diego—Tijuana sanitation problem, untreated sewage flowing in the Tijuana River flowing northward across the International Boundary, and in coastal waters flowing northward in littoral currents was the one in most urgent need of resolution.

In 1962, the existing facilities for Tijuana wastewater disposal were constructed for discharge at a point 5.6 mi (9.01 km) south of the International Border. The facility experienced long and frequent nonoperational periods, and in the last 20 years, Tijuana had grown from 200,000 to 800,000 inhabitants, which greatly increased wastewater flows causing pollution of the coastal waters and beaches and, thus, impairing the beneficial uses of the waters.

The Commission reviewed México’s Integrated Project for Potable Water and Sewage for the improvement of its potable water supply and distribution system and the expansion of the sanitary wastewater collection system. The project would triple Tijuana’s current water supply by constructing an aqua duct with an 80 mgd (3504 lps) capacity from the Colorado River. The current average wastewater production was 18 mgd (788 lps) and was expected to increase to 38 mgd (1664 lps) by 1989 and to 73 mgd (3197 lps) by 2000. They noted that the integration project should be carried out in two stages.

The first stage was to be undertaken by SEDUE, a Mexican company, which provided a description including location plan copies, a general plan, a flow diagram, a construction schedule, and an estimated projected flow increase. The plans included a pump station near the International Border with a maximum capacity of 50 mgd (2190 lps) and a reinforced concrete pipeline with a maximum capacity of 62 mgd (2716 lps) that would convey the flow 2.7 miles (4.3km). From there, the wastewater would be conveyed by gravity in a closed conduit and then in an open canal to the first stage treatment facility approximately 4 miles (6.4 km) south of the International Border. The plans also included collecting wastewater from a western Tijuana subdivision.

The first stage treatment facilities were designed to average flows of 34 to 50 mgd (1500 to 2190 lps) and included two modules each containing facultative aerated and polishing lagoons. The peak inflow to the plant of 62 mgd (2700 lps) was limited by the maximum capacity of the conveyance facilities. Some of the effluent from the first stage treatment plan would be used for irrigation, and the remainder would be chlorinated and conveyed 1.6 miles (2.6 km) south to Punta Bandera where it would be released into the shoreline.

The first module of the treatment facility was expected to be completed by December 1986, and the second module would be completed by the time the raw wastewater flows exceeded 25 mgd (1095 lps). The Commissioners noted that by 1989 the second stage facilities would be complete when the projected discharge of the first stage facilities reached maximum capacity. Others at the meeting included engineers and technical advisors from both sections of the IBWC, US EPA, and the México's Secretary of Urban Development and Ecology. The group

expressed satisfaction with the conceptual plans and agreed that the first stage plans would meet the treatment and disposal needs of Tijuana until 1989 if the facility were designed, constructed, operated, and maintained in a way to prevent discharge of untreated sanitary and industrial waters across the International Boundary. Furthermore, they expressed a desire that the design would assure that the quality of effluent discharged meet the 1985 quality criteria for primary contact recreation use of the receiving Pacific waters in the US and México. They agreed that the facilities should be constructed in as timely a manner as possible.

The Commissioners adopted the following resolutions:

- 1) México should proceed with the construction, operation, and maintenance of the SEDUE designed facility as the first stage of the Integrated Project for Potable Water and Sewage.
- 2) The facility's design, construction, operation, and maintenance of the wastewater should prevent discharge of untreated sanitary and industrial wastewater from crossing the International Boundary.
- 3) The facility's design and construction should include standby equipment.
- 4) The first stage treatment facility should treat the water to such a quality that coastal receiving waters and waters at the International Boundary comply with water quality criteria established for primary contact recreation: coliform of less than 1,000/100 ml provided that not more than 20% of the total monthly samples (at least five) exceed that limit and any single sample during the 48 hour verification period cannot exceed 10,000/100 ml.



- 5) Prior to the beginning of construction, SEDUE's construction plans and designs for the first stage would be jointly reviewed by the Commission, including monitoring and supervision.
- 6) México should progress in the treatment and disposal facilities' construction in a timely manner, so its installed capacity is not exceeded by the rate of discharge of collected sanitary wastewaters.
- 7) México should take measures to assure availability of funds for the construction of the first stage facility in accordance with plans and specifications.
- 8) México should also assure funds would be available for the operation and maintenance of the treatment and disposal facilities in an effort to prevent against breakdowns or interruptions.
- 9) México should be prepared to take immediate action in the event of a breakdown or interruption of the first stage facilities, and if necessary, the US would provide assistance, through the Commission, if México should request. Any untreated, uncontrolled Tijuana wastewater that crosses the International Boundary will be collected by the US and returned to México's conveyance system.
- 10) Representatives of the Commission will jointly supervise construction, operation, and maintenance of the facilities in accordance with Article 2 of the 1944 Water Treaty.
- 11) The IBWC should attempt to arrange for continued use of the emergency connection to San Diego's wastewater treatment system until the first stage treatment facility is completed.

12) México should immediately commence studies and design alternatives for the second stage treatment facility, so the rate of wastewater would not exceed the treatment capacity of the facility. Once a plan is adopted for the second stage facilities, México should present it to the Commission for approval.

13) Minute 270 required the approval of both Governments.

***4.1.16 IBWC Minute 283 Conceptual Plan for the International Solution to the Border Sanitation Problem in San Diego, California/Tijuana, Baja California.***

Commissioners met on 2 July 1990 in El Paso, TX, and referring to the 1944 Water Treaty, they concurred that border sanitation problems should be given priority. The Commissioners noted the steady progress that México was making toward implementing measures stipulated in Minute 270. They also discussed how sewage was handled in San Diego and Tijuana:

- wastewater generated in the southern portion of San Diego County is pumped via pressure or gravity lines to the Point Loma advanced primary treatment facility, and effluent is discharged into the Pacific through an 11,500 ft (3.4 km) deep ocean outfall 13.5 mi (21.67 km) north of the International Border
- sewage generated in the City of Tijuana is conveyed via pressure or gravity lines to the San Antonio de los Buenos Wastewater (secondary) Treatment Plant southwest of the city. The plant has a 25 mgd (1095 lps) capacity, and its effluent is discharged to the Pacific Coast, 5.6 miles (9.01 km) south of the International Border
- uncontrolled flows from México into the US are intercepted and returned to the City of Tijuana's disposal system. On occasion, in times of emergency when Tijuana's Pumping

Plant No. 1 (PP No 1) is not functional, discharges are conveyed in San Diego's sewage collection and treatment system. However, all uncontrolled flows from México to the US have not been eliminated: a) Tijuana River—10 mgd (438 lps) and B) Goat's Canyon—0.11 mgd (5 lps)

US Commissioner, Narendra Gunjari, informed the Commission that the City of San Diego was planning to upgrade its potable water and sewage collection system, and it was possible that one of the treatment facilities could be located in the Tijuana River Valley on the US side of the border. Additionally, the City of San Diego, the State of California, and the US Government would be responsible for costs associated with the treatment of San Diego's wastewater. Mexican Commissioner, J. Arturo Herrera Solis, informed the Commission that the Mexican Government had financed the construction, operation, and maintenance of the first step as outlined in Minute 270. However, in deviation from Minute 270, his government planned to construct a secondary treatment facility in east Tijuana instead of the second module of the first stage treatment facility. The new plan was to discharge secondary effluent into the Rio Alamar, a tributary of the Tijuana River. The US Commissioner responded with a proposal for a binational secondary treatment plant in the US, and México's financial burden for construction, operation, and maintenance would be equal to that of the proposed Rio Alamar treatment plant. The Commissioners agreed that México's participation in the construction, operation, and maintenance of the binational treatment plant in the US would be an acceptable alternative to satisfy the commitment for the secondary module in Minute 270. They also agreed that the Commission should jointly determine the costs of the construction, operation, and maintenance of the proposed secondary treatment plant on the Rio Alamar. The US

Commissioner noted that although the binational treatment plant would provide secondary treatment and disinfection, US water quality standards would require deep ocean discharge of the effluent through an ocean outfall. Because US water discharge standards are stricter than those of México, the US Commissioner informed the Mexican Commissioner that only the US would be financially responsible for the construction and maintenance of the ocean outfall.

The Commission reviewed the infrastructure required for the construction of sanitation facilities in the US and México:

- the construction plans for the gravity sewer trunkline from Tijuana's PP No 1 to the International Boundary needed to be completed
- sewage collection works to convey flows in México and to the proposed international secondary plant rather than the proposed Rio Alamar plant needed to be constructed
- the Commission needed to construct a 25 mgd (1095 lps) capacity international secondary treatment plant with disinfection in southern San Diego County; furthermore, the international facility would treat flows in excess of the capacity of conveyance and treatment facilities of the Minute 270 first stage works situated in México
- the new plan would require the construction of a land outfall with at least a 25 mgd (1095 lps) capacity from the international treatment plant for conveyance of effluent to the coast
- construction of a deep ocean outfall with at least a 25 mgd (1095 lps) capacity would be required for discharge of the effluent into the Pacific Ocean

The Commissioners agreed that the aforementioned works would permanently and definitively resolve the existing border sanitation problems (at that time) and agreed that a cooperative alternative would be the best solution. They also agreed that effluent reuse by either country was a desirable future possibility, and either country using the effluent could arrange for construction of the necessary conveyances. The following recommendations were adopted for approval by the US and Mexican Governments:

- 1) Rather than construct the second stage module described in Minute 270, a binational treatment plant would be built in the US, and México would participate in the construction, operation, and maintenance of the facility.
- 2) México would be financially responsible for the completion of the Tijuana sewage collection system.
- 3) The US and México would be financially responsible for collection works and conveyance systems leading to the international sewage treatment plant in their respective countries, and the cost of such works would not exceed \$4M in the US. The Mexican Government, at its expense, would assure completion of the collection works and would be responsible for construction, operation, and maintenance.
- 4) The international secondary treatment plant was envisioned to have an approximate capacity of 25 mgd (1095 lps), disinfection facilities, sludge digesters, and sludge transport vehicles, and its final design and joint construction would be in the US outside of an environmental protection area.

5) The US would be responsible, financially and otherwise, for the construction, operation, and maintenance of a pipeline (land outfall) with the capacity to deliver at least 25 mgd (1095 lps) from the international secondary treatment facility to coastal waters.

6) At the expense of the US, a deep ocean outfall, with a capacity of at least 25 mgd (1095 lps), would be constructed, operated, and maintained to deliver effluent from the land outfall to the deep Pacific Ocean.

7) The US and Mexican Governments would be responsible for the cost of construction, operation, and maintenance of the international secondary treatment plant. México's financial burden would be equivalent to the expense it would have incurred in constructing, operating, and maintaining the proposed Rio Alamar facility. México's financial obligation would be paid in ten annual payments, each equal to 1/10<sup>th</sup> of the total construction cost, to be determined by both Governments. The US government would be responsible for the remainder of the construction, operation, and maintenance costs.

8) Through subsequent Minutes, the Commission would determine the specific division of construction, operation, maintenance responsibilities, and expenditure schedules subject to the approval of both Governments. Design of the facility would be subject to the standards, criteria, and restrictions of the City of San Diego and the State of California.

9) If the Mexican Government were to supply electricity for the international treatment plant's operation, México could defray or completely cover its financial responsibility for the operation and maintenance of the facility.

10) México would be responsible for the disposal of the sludge produced from Tijuana's wastewater treatment at the international treatment plant, and it would be México's responsibility to collect and transport the sludge from the plant to México at México's expense.

11) The US and Mexican Governments would reserve the right to dispose of part or all untreated sewage in their own territory so long as the disposal did not add to the border sanitation problems. In addition, if either the US or México wanted to reuse the treated effluent, the cost of construction for those works would be the responsibility of the government benefitting from the reuse.

12) The Mexican government would require wastewater pre-treatment from all industries discharging into the Tijuana sewage collection system in accordance with México's laws.

13) In order to avoid negative impacts, any wastewater treatment facilities constructed in the Tijuana River Valley, including the international treatment facility, must be in compliance with the laws and regulations of each country.

14) The construction, operation, and maintenance of the international treatment plant and the design and construction of the Tijuana collection and conveyance facilities to

the plant would be under both Sections' supervision, and neither country would confer jurisdiction to the other if a project is jointly financed but solely within the territory of the other.

15) Upon approval of Minute 283, the principal engineers of both Sections were responsible for developing and designing a sampling and analysis program for water quality inflows to the Tijuana River that would be captured by collection works in México for conveyance to the international treatment plant.

16) The Mexican Government would no longer discharge treated or untreated municipal or industrial wastewater into the Tijuana River if the discharge were to cross the International Boundary, and in the event of a breakdown resulting in flows to the Tijuana River, the Mexican Government would take immediate measures to stop discharges and make repairs. If México were to request assistance through the IBWC, the US Section would make an attempt to assist in containing discharges and make temporary repairs.

17) Minute 283 required the approval of the US and Mexican Governments and would enter into force upon approval with the understanding that a) funding to cover costs in the US was subject to availability, b) the (tbd) funds for the advance payment by the US Government to be reimbursed by the Mexican Government were subject to availability, c) the Mexican Commissioner would notify the US Commissioner when the Mexican Secretary of Planning and Budget had approved financing of México's responsibility in the joint project.



**4.1.17 IBWC Minute 296 Distribution of Construction, Operation and Maintenance Costs for the International Wastewater Treatment Plant Constructed under the Agreements in Commission Minute 283 for the Solution of Border Sanitation Problem in San Diego, California/Tijuana, Baja California.**

The Commission met Dated in April 1997 to discuss the specific distribution of costs for the construction, operation, and maintenance of the international wastewater treatment plant (IWTP). The Commissioners observed that Minute 283, Resolution 8 required both Governments' approval regarding each country's specific costs corresponding to the plant's construction, operation, and maintenance.

A. In discussion of general issues, each country's contributions in furtherance of Minute 283 were mentioned:

1) México was completing the sewage collection works to convey the City of Tijuana's wastewater to the IWTP.

2) The US was completing the construction of the IWTP for advanced primary treatment, had developed its operations and maintenance manual for the advanced primary module, and had begun design and an environmental review of the secondary module to determine the best secondary treatment alternative. The US had also begun construction of the land and ocean outfalls for conveyance of the effluent to the Pacific.

3) The Commissioners coordinated efforts for the daily transfer of sludge generated at the IWTP to México, and México was completing arrangements for disposal.

4) The US was considering alternatives for the interim discharge of the advanced primary effluent from the IWTP including a) the continued use of the emergency connection to San

Diego's conveyances and treatment systems for up to 13 mgd (570 lps), and México would be responsible for flows beyond that amount; b) discharge to the Tijuana River; and c) the return of effluent to México. The Commissioners noted that if this alternative were selected, the IBWC would be responsible for the construction of necessary conveyances to Tijuana's PP No 1.

5) The wastewater characterization program was progressing. The data collected on pollutants sent to IWTP would protect the efficiency of the plant and help México implement its industrial pretreatment programs; discharges of industrial wastewater could not exceed limits for non-conventional pollutants. Commissioners agreed that water quality experts from each country should determine pollutant concentration limits to ensure the plant's efficiency. They agreed to monitor IWTP's effluent for non-conventional pollutants biannually or more often if excessive amounts were discovered, and results would be given to the appropriate Mexican officials in an effort to locate the source and apply the appropriate laws. The effluent discharge from the IWTP must meet water quality standards set forth in the US.

6) Mexican Commissioner J. Arturo Herrera Solis announced that México was seeking alternatives for the treatment of future flows in excess of 25 mgd (1095 lps). The IBWC, at such time, would determine whether it was practical to expand the IWTP to handle flows in excess of 25 mgd (1095 lps), and if so, the IBWC would make recommendations on terms for México's financial participation.

B. Commission also discussed the distribution of construction, operation, and maintenance costs:

México's National Water Commission (CAN) developed a cost estimate for the construction of the wastewater plant that had been planned for the Rio Alamar. The IBWC Principal Engineers presented the commission with the information and agreed that \$16.8 M (US) was appropriate for México's share for the construction of the IWTP. Under Minute 283, Resolution 7, México could make 10 annual installments of \$1.68M with the first due in December 1997. The Principal Engineers also presented the Commission with an estimated cost of operation and maintenance of a 25 mgd (1095 lps) plant in México at \$0.034/m<sup>3</sup> (\$0.034/264.2 gal), but that cost could be adjusted as necessary, based on the Mexican economy. Once treatment at IWTP was begun, México, through *Commission Estatal de Servicios Públicos de Tijuana* (CESPT), would make quarterly payments to cover its part of the costs of operation and maintenance.

The Commissioners requested that CESPT and the agency responsible for the operation of IWTP should exchange information in order to carry out an accurate accounting of flows delivered for treatment to IWTP as well as effluent flows from the plant. The Principal Engineers were encouraged to develop a similar program for the effluent data generated from the treatment plant and the ocean discharge systems. Finally, Commissioners observed that if water from canyons or other collectors were conveyed to IWTP for treatment, México would be responsible for the treatment cost at the previously mentioned rate. The Mexican Section was obligated to inform the US Section of discharges and their volume.

Prior to adjournment of the meeting, the following resolutions were adopted for the approval of both Governments:

- 1) México would be responsible for \$16.8M (US) of the construction costs of the IWTP to be paid in 10 annual fixed installments of \$1.68M upon the start of treatment at IWTP.
- 2) The operation and maintenance rate charged to México for up to 25 mgd (1095 lps) would be \$0.034/m<sup>3</sup> (\$0.034/264.2 gal). Cost adjustment factors for subsequent years would be based on the prior year's performance, and an accounting would be conducted at the end of each year.
- 3) For construction, operation, and maintenance payments, the Mexican Section would collect amounts corresponding with CESPT and, where appropriate, CNA to complete payments to the US.
- 4) When treatment at the IWTP was to begin, México would pay its proportionate operation and maintenance costs according to Resolution 2.
- 5) The Mexican Section would receive from the US Section a copy of the developed IWTP operation and maintenance manual to assist the responsible Mexican authorities in understanding the plant's operations.
- 6) Wastewater released by México into the canyons or to other collectors and conveyed to the IWTP for treatment would be assessed the operation and maintenance costs at the rate of \$0.034/m<sup>3</sup> (\$0.034/264.2 gal) in quarterly payments. The Mexican Section would give advance notice to the US Section of such releases and their estimated volumes excluding drinking water and storm runoff. In the event of discharges in excess

of 25 mgd (1095 lps), computed quarterly, the Commission would determine the rate at which México will be assessed for excess discharges.

7) On a monthly basis, data between CESPT and the agency responsible for the IWTP would exchange information for the plant's operation and hydrometric data generated through the IWTP system measuring devices, including but not limited to influent from México for accurate accounting of flows. The Commissioners considered it appropriate that the Principal Engineers should develop a similar data accounting program for the effluent from the IWTP to be discharged through the yet to be built land and ocean outfalls.

8) In the context of 1979 Minute 261, *Recommendations for the solution to the border sanitation problems*, the IBWC would review treatment alternatives for future flows in excess of 25 mgd (1095 lps) being considered by México. The IBWC would make recommendations and develop terms for México's financial participation if the IWTP were expanded.

9) The IBWC would continue to analyze US environmental studies in order to determine the best means of achieving secondary treatment.

10) Flows would continue to be characterized by the Commission, and authorities would abide by water quality expert recommendations for pollutant concentration limits to ensure the efficient operation of the IWTP. The Commission would monitor flows at the

International Boundary and provide information on potential pollutant exceedance levels to the Mexican officials who would be expected to apply the appropriate laws.

11) If primary effluent were discharged to México on an interim basis, IBWC would make the arrangements for conveyance and disposal infrastructure in México.

12) If primary effluent were to be discharged using the emergency connection to San Diego's collection system, México would have to cooperate in keeping control of flows in excess of the connection's capacity.

13) The IBWC would recommend the necessary infrastructure to collect sewage flows currently discharged to the Tijuana River, thus preventing wastewater or industrial waters from flowing across the International Boundary.

14) Any activities carried out pursuant to Minute 296 were subject to availability of funds, resources, personnel, and applicable laws and regulations of each country.

15) Minute 296 would enter into force when each of the two countries had notified their corresponding IBWC Sections of their approval in writing.

***4.1.18 IBWC Minute 298 Recommendations for Construction of Works Parallel to the City of Tijuana, B.C. Wastewater Pumping and Disposal System and Rehabilitation of the San Antonio de los Buenos Treatment Plant***

Commissioners met in December 1997 to consider the construction of works parallel to Tijuana's wastewater pumping, disposal system, and rehabilitation of the San Antonio de los Buenos Wastewater Treatment Plant, which had been certified by the Border Environment Cooperation Commission (BECC). The Commissioners agreed that the parallel works would be

complimentary to the works described in Minute 270. The parallel pumping and conveyance system would provide the main objective of a reliable back-up for the overloaded system presently in use in Tijuana. Furthermore, the parallel works would allow a possible means of returning effluent from the IWTP back to México for disposal before the US ocean outfall was completed.

I        The works certified by BECC contained the following components:

1. Pumping plant—would be located in the sump and present old pump plant building adjacent to Pumping Plant No 1 (PP No 1). Sumps and grit screening chamber improvements would be made to both plants to enhance settlement, head, and, sand movement. A new regulating tank would be added to the new pump station only. The new pump station would have five motor pumps: four use and one reserve, two 600 hp centrifugal horizontal sewage pumps connected in series and have a daily discharge of 12.5 mgd (550 lps) with a 2:1 peak factor. The new facility would pump against a head of 427 ft (130 M) similar to the Stage I facility.
2. Boundary to IWTP Connection—would include the continuation of a 48" (1.22 m) diameter reinforced concrete pipe extend approximately 1,000 ft (305 m) from a 72" (183 cm) x 48" (1.22 m) tee at the IWTP discharge. To facilitate maintenance, a magnetic flow meter and motor operated vault-housed control valve would be included in the connection.
3. The conveyance system—would include a pressure line section and a gravity section. The total pipeline length from PP No 1 to the ocean discharge site is 11.4 miles (18.3 km). The conveyance lines from the International Boundary to PP No 1 would include 48" (1.22 m) conveyance polyethylene pipeline extending 1066 ft (325 m). The first pipeline section from PP No 1 would extend 2.9 mi (4.66 km) and consist of gravity-facilitated 54" (1.37 m) metal

pressure pipe. The remaining 8.5 mile (1.36 km) distance would be gravity flow conveyances composed of conduits and siphons. The 54" (1.37 m) diameter conduits would be constructed of high density polyethylene or similar, and the siphons would be composed of 54" (1.37 m) metal pipe.

The 2.9 miles (4.6 km) pressure line section would be composed of 48" (1.22 m) ductile iron or similar pipe and would run parallel to the existing reinforced concrete 42" (1.07 m) pipeline. Along its distance, it would feed into a surge tower as well as three additional control structure inlets to receive connections from sewage lift stations that catch transboundary surface flows and an interconnection from the Playas de Tijuana pumping plant system. The 5.8 miles (9.3 km) Gravity section pipeline would be located at the end of the pressure line section and would consist of high density polyethylene pipe extending to the SABWTP site. It would have five siphons and transition gravity flow reaches and would follow an excavated route along the existing open conveyance channel. From the SABWTP, a structure would distribute flows either into SABWTP for treatment or in a conveyance pipeline 2.6 miles (4.2 km) to the ocean for discharge approximately 5.6 miles (9.0 km) south in the International Border.

4. Rehabilitation of the San Antonio de los Buenos Wastewater Treatment Plant—included the pretreatment train rehabilitation, grit chamber improvements, existing diffusers' replacement, lagoon plastic baffles' installation for enhanced hydraulic movement, biomass recirculation equipment to recirculate from the third lagoon to the first and second lagoon. Planned improvements were expected to increase the plant's capacity to 25 mgd (1095 lps) with an



effluent that would meet México's treatment standards. The Mexican standard requires that treated effluent have a maximum BOD of 75 mg/l monthly average of 150 mg/l daily average.

## II Cost Distribution:

1. The estimated construction cost for the parallel pumping and disposal works was \$16M (US), but that figure did not include design costs, value added tax (VAT), or the connection to the IWTP.
2. The estimated construction cost for the enhancement of the SABWTP was \$2.2M (US), excluding design and VAT.
3. Work to be performed in the US was estimated at \$1.5M (US).
4. Funds up to \$1.5 M that had been earmarked for Minute 283, Recommendation No. 3 would cover the cost of this project including the design and other associated costs. Payment of these costs would fulfill all outstanding obligations with regard to Minute 283, Resolution No 3.
5. The US agreed to cover construction costs up to \$16M (US) from funds managed by NADBank. The Baja California State Government would be responsible for any expenses beyond \$16M (US).
6. The State of Baja California requested a loan from NADBank in order to cover its financial obligations on the project.

## III IBWC's Participation

The Commissioners reviewed former treaties and Minutes regarding the responsibilities of border sanitation problems and observed that the joint practices could be used in support of

NADBank's construction supervision of the projects described in Minute 298 as well as future project regarding border sanitation problems.

#### IV Project Execution

Commissioners for both sections noted that the project to improve México's infrastructure should be in accordance with the recommendations set forth in Minutes 261 and 270:

1. All the work undertaken in México should be the responsibility of the Mexican Government, acting through the State of Baja California.
2. The US Section would design, construct, and generally supervise the conveyance line from the IWTP to the International Boundary once the State of Baja California had secured funding for the project.
3. Each country's government would be responsible for obtaining rights of way for works conducted within their own country.
4. Each country would be responsible for all services—water, telephone, electricity—for the project that is undertaken within their borders.

#### V Operation and Maintenance

Due to the obligation indicated in Minutes 270, 283, 296, both countries' Commissioners concluded that certain guidelines should steer the operation and maintenance of the proposed works:

1. The existing pumping plant, PP No 1 should have a connection to the proposed new pumping plant where wastewater could be diverted at PP No 1 in case of an emergency, so the connection could aid conveyance to SABWTP or the new conveyance system.
2. The new conveyance system shall be designed in a manner that untreated wastewater would be delivered to SABWTP or bypass the treatment plant for direct discharge into the ocean.
3. Once completed and the IWTP effluent is diverted to the parallel system, México would be tasked with developing and executing a PP No 1 inspection and the present conveyance system, and CESPT would make necessary repairs to the current system to ensure a parallel system to convey wastewater from PP No 1 to the Mexican treatment facilities.
4. Once the projects in both countries had been completed, México's system would be maintained and operated by México at a cost to CESPT, and upon completion of the US's ocean outfall, the new system would form part of Tijuana's sanitation system. The conveyance line from the IWTP to the International Boundary would be operated and maintained by the US. If, however, prior to the completion of the ocean outfall, the US should need to dispose of secondary treated effluent through the Mexican system, the cost of operation and maintenance of the pumping and conveyance lines components would be at the US Government's cost.
5. Once the ocean outfall's operation was begun, and should México elect to reuse the effluent, México would be responsible for the pumping/conveyance line operation and maintenance costs necessary to deliver effluent to México.

6. In accordance with Minute 283, wastewaters conveyed to IWTP would be limited to 25 mgd (1095 lps), and once the US ocean outfall was complete, the parallel pumping and disposal system would aid in reducing flows conveyed to SABWTP to design capacity.
7. The Mexican Government, through CESPT, would be responsible for the operation and maintenance costs of the SABWTP.
8. The IBWC would receive operation and maintenance plans as well as monitoring, startup, safety, and pollution prevention contingencies. The IBWC would be expected to make joint observations and maintain records for the works' operations and maintenance phases. The observations would include recommendations for corrective measures and compliance with Minute No 270's transboundary prevention provisions.

## VI Monitoring Program

The Commissioners agreed that continued transboundary impacts monitoring of the works in either country was appropriate and in accordance with Minute 270. They specifically noted Minute 270, Recommendation 4: the quality of receiving coastal waters at the International Boundary should meet the quality criteria for primary contact recreation, "the most probable number of coliform bacteria will be less than 1,000 organisms per 100 milliliters (ml), provided that no more than 20% of the total of the monthly samples (at least 5) exceed 1,000 per 100 ml; and that no single sample taken during a verification period of 48 hours should exceed 10,000 per 100 ml..."

The Commissioners concurred that joint monitoring should include coastal waters along the International Boundary and a minimum of two monitoring stations should be located south of

the International Boundary and a minimum of two north. US entities would be responsible for northern station sampling and analysis, and Mexican entities would be responsible for southern sampling and analyses. Both IBWC sections would be responsible for the sampling and analysis at a station near the International Boundary. Furthermore, both Sections would coordinate all data obtained through sampling and analysis for the purposes of verification and use by the US and México as a basis for corrective measures. The IBWC would maintain records regarding compliance with international agreements and corrective measures.

## VII Handling of Future Wastewater Flows

1. The operation of the parallel system works should not exceed its design capacity of 25 mgd (1095 lps).
2. Sixty days after approval of Minute 298, the IBWC would begin consultations regarding future flows in Tijuana. The feasibility of a second 25 mgd (1095 lps) module at the international plant site and México's role in the project would be considered.
3. Support for the development of an integrated plan for City of Tijuana with a planning horizon of 2010 and 2020 would be sought.

Recommendations were made for the approval by both Governments:

1. Both governments should proceed with the construction of the works certified by the BECC, namely the pumping facility's and parallel conveyance system's construction and SABWTP refurbishment.

2. Funds for the project in excess of the \$16M (US) would be loaned to the State of Baja California by NADBank to ensure completion of the project. Under the terms of the Border Environmental Infrastructure Fund (BEIF), the US would cover the first \$16M (US) of the project from funds managed by NADBank.
3. The US Government would be responsible for costs, estimated at \$1.5M (US), for designing and contracting of the project in the US from the IWTP to the International Boundary. Those costs would be covered from funds available to the US that were originally earmarked in accordance with Minute 283, Recommendation 3. The payment of those costs for the present project would satisfy the US IBWC's obligations under Minute 283.
4. NADBank's construction supervision practice of this and future projects could be used to help solve the border sanitation problems.
5. Each country, through their responsible government entities, would be responsible for the design and construction of works in their respective countries. The structure built in the US would complete the line from the IWTP to PP No 1 and would fulfill its function.
6. Once complete, CESPT (or its successor) would operate and maintain the pumping and conveyance structures described in this Minute at its own cost. Prior to the operation of the ocean outfall, if the US were to use the Mexican facilities to pump and convey IWTP effluent through México's system, the US would be charged for its use. After completion of the outfall, if México were to request effluent for reuse, the infrastructure for its deliveries would be at México's cost.

7. A joint coastal waters monitoring program would be conducted by both Sections. A minimum of four monitoring station would be located: to south of the International Boundary and two to its north. Each country would be responsible for collection analyses from stations on their respective coasts. Both US and Mexican Sections would ensure sampling and analyses of a station near the International Boundary. The IBWC would also establish a program of coordination, verification, and documentation regarding compliance with the international agreements as well as execution of corrective actions.

8. Sixty days after approval of Minute 298, the IBWC would begin consultations regarding future flows including a second 25 mgd (1095 lps) facility at the IWTP and México's participation in such.

9. If desired by the City of Tijuana, technical assistance would be given by the IBWC for planning horizons of 2010 and 2020.

10. Any activities carried out under Minute 298 would be subject to availability of funds, resources, personnel, and applicable laws and regulations of each country.

11. Upon written notification of its approval to the IBWC from each country's Government, Minute 298 would enter into force.

***4.1.19 IBWC Minute 299 International Boundary and Water Commission Support to the Border Environment Cooperation Commission in Development of Projects for the Solution of Border Sanitation Problems***

The Commission met in December 1998 to consider supporting the Border Environment Cooperation Commission (BECC) infrastructure development projects to solve the border

sanitation problems according to Chapter I, Article III, Section 6 of the Agreement between the US and México concerning the BECC and the North American Development Bank (NADBank), 1993. Section 6 of the Agreement holds that the BECC and IBWC may enter into agreements for use of their facilities, personnel, and services for reimbursement costs by one organization on behalf of the other. Additionally, under Article 3 of the 1944 Water Treaty, the Governments of the US and México were to give preferential attention to the resolution of all border sanitation problems. Wastewater project development undertaken by the IBWC has been directed to include planning that would safeguard against hazardous conditions in international waters as well as make the IBWC border sanitation problems eligible for BECC certification and NADBank financing. Commissioners Bernal and Herrera Solis agreed that it would be appropriate for the IBWC to enter into a Coordination Memorandum of Understanding (Coordination MOU). The Coordination MOU provided several points for interested parties:

- 1) Either Section of the IBWC may provide to the BECC the planning, development, and execution of wastewater infrastructure projects for international sanitation problems that threaten the well-being of inhabitants and the beneficial use of waters. Depending on the arrangements, IBWC's support could be reimbursable.
- 2) Those arrangements between the IBWC and BECC should include description, cost estimates, due dates, and personnel specialization, based on salary/hour, and should provide for timely reimbursement.
- 3) If only one Section of the IBWC entered into an arrangement with the BECC, that section should keep the other informed of the arrangement.



4) If an activity involves both sections of the IBWC, they must determine the level of support that each section will provide in the joint effort.

5) 30 days written notice by either party, the IBWC or BECC, is required in order to terminate the Coordination MOU. Efforts will be made not to disrupt the projects in cases of Coordination MOU termination, but any specific arrangements concluded under the Coordination MOU would be effected.

6) There must be a provision of reimbursable support by the BECC to the IBWC.

7) Neither the IBWC nor the BECC would be held liable for acts, omissions, or obligations of the other arising from the performance of the Coordination MOU.

Upon agreement of the provisions in the Coordination MOU, the Commissioners made the following Recommendations:

1. The International Boundary and Water Commission may enter into a Coordinated MOU with the Border Environmental Cooperation Commission provided that under the following terms:

a) either Section of the IBWC may enter into specific arrangements with the BECC for reimbursable support in planning, development and execution of wastewater infrastructure for projects involving waters that cross the border, possibly causing health hazards, or impairing the beneficial uses of such waters;

- b) the arrangements need to at least include descriptions of the requested support, cost estimates, due dates, personnel specification based on an hourly rate, benefits ordinarily covered by the Section and the timely reimbursement by BECC;
- c) if services of only one section are utilized, that acting Section will keep the other Section apprised of its arrangements;
- d) joint efforts between both Sections would require determining what action each section will provide toward that action;
- e) the Coordination MOU may be terminated with 30 days' advance written notice by either party, but every effort will be made to ensure that project activities will continue uninterrupted;
- f) there will be a provision of reciprocal report by the BECC to the IBWC;
- g) there be a provision that neither the IBWC nor the BECC would be held liable for acts or omissions of obligations arising from the Coordination MOU.

2. All activities undertaken in furtherance of Minute 299 would be subject to the availability of funds, resources, and corresponding personnel in addition to applicable laws in each country.

3. Minute 299 would enter into force upon notification of approval by the Governments of the US and México through their IBWC Sections.

***4.1.20 Public Law 106-457 A Bill to Encourage the Restoration of Estuary Habitat Through More Efficient Project Financing And Enhanced Coordination of Federal and Non-Federal Restoration Programs, and for Other Purposes.***

This law, signed in 2000, outlined the framework for a public-private project between the US EPA, IBEC and a facility owner operator. Four years later and after Minute 311, Public Law 108-425, an amendment to PL 106-457, was passed. Those changes will be presented in italics immediately following the portion they amend.

Title VIII under this law commonly known as the Tijuana River Valley Estuary and Beach Sewage Cleanup Act of 2000, the US was authorized to take action to comprehensively address the treatment of sewage that is generated in Tijuana and flows north over the International Border. The untreated and partially treated flows for decades have been known to cause significant undesirable public health and environmental impacts along the Southern California Coast. Subject to funding availability, the Commission was authorized to enter into a fee-for-services contract with and make payments to the owner of the Mexican Facility in order to carry out the secondary treatment.

Under Sec. 804—Actions to be taken by the Commission and US EPA--the IBWC was authorized and directed to provide a secondary level of treatment in México if treatment were not provided in the US. The IBWC provided treatment was limited to 50 mgd (2190 lps), 25 mgd (1095 lps) of which was primary effluent from SBIWTP if treatment were not provided in the US. The remaining 25 mgd was for the treatment additional wastewater emanating from the Tijuana River area. This action was subject to the negotiation of a new Treaty Minute or a Minute 283 amendment.

The IBWC was limited to providing treatment for only 25 mgd (1095 lps) to a secondary level in México. That amount could be increased, however, subject to the outcome of a comprehensive plan that was to be developed by the US EPA not later than 24 months after Public Law 106-457 was signed. Under the comprehensive plan, the EPA was charged with assessing the long-term secondary treatment needs of the area and the need for upgrades to Tijuana's collection and conveyance systems as well as identifying options including preferred option recommendations for additional sewage treatment capacity for future flows from Tijuana.

Any contract between the service provider/facility owner should minimally include the following terms:

- a) The contract will provide for conveyances for the primary effluent from SBIWTP to the Mexican facility
- b) SBIWTP's advanced primary effluent must be treated to standards compliant in the US, California, US, and México
- c) Return conveyance from the Mexican facility if the secondary effluent cannot be reused in the US or México. That unreused effluent would be discharged through SBOO and must comply with US and California, US water quality laws
- d) The outcome of the comprehensive plan will determine the additional advanced primary and secondary treatment capacity needed for further flows in the region
- e) The contract term between the IBWC and the service provider/facility owner would be for 20 years
- f) Arrangements for monitoring, verification, and water quality standards enforcement must be included

- g) The disposition of the sludge from SBIWTP and the Mexican facility to locations in México
- h) The owner would enjoy a 20% equity position in the capital of the structure through its maintenance throughout the term of the contract.
- i) The IBWC will pay the Mexican facility owner for sewage treatment services. The total payment would include the annual amount reflecting all agreed upon costs associated with the development, financing, construction, operation, and maintenance of the facility as well as the owners 20% equity position throughout the contract term
- j) If the IBWC fails to meet its contractual obligations, the contract should have a provision that transfers ownership of the Mexican facility to the US in addition to a cancellation fee paid to the Mexican facility owner by the US. The cancellation fee should be configured in declining amounts over the contract term and be sufficient to repay remaining unamortized debts due to the owner as a result of early contract termination
- k) If the owner of the Mexican Facility fails to perform his obligations under the contract, there would be a provision for the transfer of the facility to the US without a cancellation fee
- l) The owner of the Mexican facility must use competitive practices in the procurement of property or services for the engineering, construction, operation, and maintenance of the facility
- m) The Commission would be allowed to review and approve the selection of engineering, construction, operation and maintenance contractors for the Mexican facility.

- n) The Mexican facility owner would be required to maintain all records necessary to demonstrate compliance with the terms of the Public Law 106-457 and the contract.
- o) The Inspector General of the US State Department or a designee would be allowed access to audit and examine all records to facilitate monitoring and evaluation.
- p) The Commission would receive an agreed upon percentage of payments offsets or credits against the payments to be made for O & M, which the owner of the Mexican facility would receive through the sale of water treated by the facility.

The US State Department's Inspector General would oversee contract implementation and evaluate the extent to which the Mexican facility owner has met the obligations included under the terms of the contract. The Inspector General would submit a report to Congress regarding the evaluation of Mexican facility's owner compliance to obligations no later than two years after contract execution, three years after the first report, and periodically thereafter.

Congress requested that the Secretary give the San Diego-Tijuana sanitation problem the highest priority and negotiate a new Treaty Minute or modify Minute 283 to be consistent with provisions in Public Law 106-457, so the river and ocean pollution problems can be addressed as soon as possible. Congress requested that the Secretary initiate negotiations with México for a new Treaty Minute or to modify Minute 283 within 60 days after the passage of Public Law 106-457. Implementation of the new Treaty Minute or modified Minute 283 would be subject to the provisions of the National Environmental Policy Act of 1969. Minimally, the new Treaty Minute or modified Minute 283 should address the following points:

- a) Where the facilities in the US and México would be cited

- b) Provisions for secondary treatment of SBIWTP's effluent in México if the advanced primary effluent is not treated in the US
- c) Provisions for the advanced primary and secondary treatment of Tijuana's wastewater in addition to the 25 mgd (1095 lps) treated at SBIWTP
- d) Provisions for any and all approvals from Mexican authorities necessary to facilitate water quality verification and enforcement at the Mexican facility
- e) If surplus reclaimed water is available and México has no use for it, provisions for possible use in the US so long as its use is consistent with applicable with US and California, US law
- f) Any other terms and conditions the Secretary believes necessary in order to implement the provisions of Public Law 106-457.

Congress appropriated \$156M for fiscal years 2001 through 2005, which would remain available until expended under this title.

***4.1.21 IBWC Minute 311 Recommendation for Secondary Treatment in México of the Sewage Emanating from the Tijuana River Area in Baja California, México.***

The Commission met in February 2004 in order to discuss the construction of a wastewater treatment plant and related facilities that would treat raw flows emanating from the Tijuana River area and partially treated flows from the South Bay International Wastewater Treatment Plant. The Commissioners referred to the 1944 Water Treaty as they discussed the obligation of both governments in addressing the transboundary wastewater problem. They also referred to Minute 283, which resulted in the construction and operation of the SBIWTP. Treatment,

however, was supposed to be at the secondary level not advanced primary, which it was currently.

US Commissioner, Arturo Duran, noted that the level of treatment, advanced primary, conducted at the SBIWTP had continually failed to meet treatment standard levels set forth by the State of California, US, for concentration and mass emission rates for TSS and Carbonaceous BOD and whole effluent toxicity and had routinely exceeded permit levels since initiation of advanced primary treatment since the plant began operation in 1997. Furthermore, he noted that failure to comply with NPDES Permit discharge standards had resulted in court litigation in the US, which could result in cessation of discharges from the SBIWTP resulting in 25 mgd (1095 lps) of México's wastewater no longer being treated in the US.

The Commissioners also discussed the Passage of Public Law 106-457 "The Tijuana River Valley Estuary and Beach Cleanup" in 2000 by the US Congress. The Public Law authorized the appropriation of up to \$156 M to comprehensively address the treatment of untreated or partly treated transboundary sewage emanating from México, flowing into the US, and resulting in significant adverse public health and environmental impacts. The Commissioners considered constructing a secondary treatment facility in México consistent with the secondary treatment that was originally to be provided at SBIWTP in conformance with Minute 283. Commissioners also discussed City of Tijuana water and sanitation plans through 2023 that CESPT and US EPA had developed, which were published on 7 March 2003. The Mexican IBWC Commissioner, J. Arturo Solis, noted that the proposal for a secondary facility in México would complement the provision in the City of Tijuana Master Plan that suggested wastewater treatment of 33.5 mgd



(1470 lps) as well as secondary treatment of 25 mgd (1095 lps) of SBIWTP's primary effluent if secondary treatment were not provided in the US at that or another plant. The total capacity needed through the year 2023 was estimated at 59 mgd (2570 lps).

#### I      The Proposed Project

The Commissioners agreed that it was possible to site the referenced secondary facility in México under a public-private agreement. The US Government would agree to partly fund up to \$156 M depending on availability and if secondary treatment were not provided at the SBIWTP. The contract for the 59 mgd (2570 lps) facility would be for 20 years' operation and maintenance. As predetermined in Minutes 283 and 296, The Mexican Government would be responsible for the costs of treatment of the first 25 mgd (1095 lps).

At minimum, the proposed public-private arrangement would consider the following items:

- the proposed Mexican facility would be directly associated facilities in the US and México
- secondary treatment of SBIWTP's effluent would take place in México if secondary treatment were not provided in the US
- the facility would treat up to 59 mgd (2570 lps) to a secondary quality level in México including 25 mgd (1095 lps) of SBIWTP's effluent if secondary treatment were not provided in the US
- responsible parties (Bajagua representatives) were required to obtain all permits necessary required by Mexican entities in order to facilitate compliance with laws related to treatment facilities constructed in México

- any effluent water produced in the Mexican facility but not used in México and discharged through the SBOO had to be in compliance with US and California water quality laws
- pumping and conveyance systems and secondary treatment of 59 mgd (2570 lps) of Tijuana's wastewater must be provided as indicated in the City of Tijuana's Master Plan.
- supervision and approval of each phase of the project is required
- treated and untreated wastewater emanating from Tijuana would remain under the jurisdiction of the Mexican Government who would maintain control over its disposal in accordance with applicable Mexican laws

## II Contract Services

Both the US and Mexican Commissioners observed that it was within their ability to develop the US's proposal to engineer, construct, operate, and maintain treatment works in México. The facility would conform to applicable Mexican laws and operate under a lease contract between the Commission and Mexican facility's service provider to whom the US Section would make payments depending on availability of annual appropriations. Payments would be administered by the Mexican Section, and the sale of water treated at the facility could offset compensations or credits received by México. The percentage of payments for the compensations/credits would be mutually agreed upon by the Commission as representatives for their respective governments. The Mexican Government alone would decide the fate or use of Tijuana's wastewater, not the service provider. The contracted service provider could propose mechanisms and specific actions only.

Subject to availability of annual appropriations, the US Government would provide up to \$156M for the project's implementation. Additional Minutes would be required if that amount were to be exceeded.

Minimally, the contract would include the following points:

- conveyance for SBIWTP's primary effluent to the Mexican facility must be built if secondary treatment were not provided in the US
- secondary treatment in México must be in conformance with applicable US and Mexican water quality laws
- a return conveyance from the Mexican facility for discharge through SBOO must be constructed if the effluent were not reused in México. The effluent quality must meet the treatment standards of the State of California, US
- the facility must have a total secondary treatment capacity of 59 mgd (2570 lps) in addition to the capacity of SBIWTP
- the contract term would be for 20 years, and upon termination of the contract, the well-functioning facility would be handed over to responsible Mexican authorities
- permitting must allow the Commission to monitor, verify, and assure compliance with California US and Mexican water quality standards
- the Commission would assure arrangements for the proper disposal of the sludge produced at SBIWTP and the Mexican facility
- the US Section would be responsible making payments to the Mexican secondary treatment facility's service contractor. Funds would be subject to annual appropriations

availability and would cover agreed-upon annual costs associated with the development, finance, construction, operation, and maintenance of the Mexican facility

- in instances of contract non-compliance, provisions would be made to address those issues
- applicable competitive procedures in México would be used in the procurement of all property and/or services for the engineering, construction, and operation and maintenance of the Mexican facility
- appropriate US and Mexican technical advisors would comprise a Binational Technical Committee, which would be presided over by the IBWC. The Committee would provide support in supervising different phases of proposed actions from Minute 311 and subsequent Minutes. The Technical Committee may include among its members representatives from the State of California, US EPA, *Comisión Nacional del Agua* (CAN) and the Government of Baja California
- the Commission supported by the Binational Technical Committee will have the ability to review and approve the selection of all contractors who would perform the engineering, construction, operation and maintenance for the Mexican facility
- proper maintenance records for the Mexican facility pertaining to its operation by the service provider would be ensured in order to demonstrate compliance with the contract and Minute 311 and to allow access by the Commission for audit and examination of all records. This provision would facilitate the Mexican facility's monitoring and evaluation

The Commissioners suggested quarterly monitoring of any contract executed under provisions of Minute 311 with the support of the Binational Technical Committee, including progress, status, and evaluation to the extent that the terms of the contract have been met. They also recommended the presentation of findings, through their respective sections to domestic agencies, beginning no later than two years after execution of such a contract and each year afterward until contract close-out.

### III Previous Consultations

The Commissioners noted that commutations between both sections and at the diplomatic level had been ongoing since January 2001. The Mexican Government had shown interest in the US proposal and expressed its willingness to further discuss this matter for several reasons: a) the concept was compatible with the option recommended in the City of Tijuana Master plan, b) it presented opportunities for additional investment in México, c) it included an arrangement for the disposal of effluent by means of the SBOO, d) it allowed opportunity to realize the existing potential for effluent reuse, e) it decreased the pressure on supply sources by placing the effluent closer to the potential sites for potable and non-potable reuse, and f) it involved cooperation between both countries for treatment and disposal of a volume of Tijuana wastewater greater than the present 25 mgd (1095 lps).

The following understandings were noted from the various meetings and exchange of letters:

1. A public-private service provider could participate in the wastewater treatment in accordance with applicable Mexican regulations.

2. In accordance with Mexican law and terms of subsequent Minutes, the Commission could enter into an operating lease contract with the public-private company for the engineering, construction, operation, and maintenance of the Mexican facility. The operating lease contract for the Mexican facility would be in accordance with the 1944 Water Treaty, applicable Mexican law, and terms and conditions established in subsequent Minutes.
3. The project would address infrastructure capacities, land use land acquisition, treatment type, and effluent disposal, and it would be consistent with the solution identified in the Tijuana Master Plan. The project would satisfy CAN and the State Government of Baja, California; dedicate special attention to odor control; address service provider selection in accordance with applicable Mexican law; and define the facility's fate at the end of the contract period.

#### IV Implementation Plan

Commissioners from both sections noted that Public Law 106-457, the Tijuana Master Plan's conclusions, and the Commission's own discussions had given a sufficient basis to proceed with the secondary treatment plans for SBIWTP's effluent and future flows from Tijuana. The following actions were to be implemented:

- the Commission would develop an operating lease arrangement contract as defined under Minute 311, Section II "Contract Services" for the financing and development of the engineering, construction, operation, and maintenance of the Mexican facility.

Approval from both governments, expressed in subsequent Minutes, would be required for this arrangement as well as the availability of funds

- the facility would be constructed in México. Subsequent Minutes would indicate the terms for implementation, design, operation, and maintenance as well as payment for those services. If consensus on lease agreement and design is not reached, Minutes 283 and 296 would apply
- at the end of the contract period, the facilities in México would be transferred to appropriate Mexican authorities. Terms for operation thereafter will be established in subsequent minutes as well as terms for effluent discharge if necessary

The following recommendations were submitted to their respective governments for approval:

1. The US Section would cover up to \$156 M for the engineering, construction, and 20 years' operation and maintenance of a secondary treatment 59 mgd (2570 lps) facility to be constructed in México. Effluent water quality would be in compliance with water quality laws of the US, State of California, and México. The Mexican Government would be responsible for costs for the first 25 mgd (1095 lps) as stipulated in Minutes 283 and 296.
2. The IBWC should adopt the implementation plan from Minute 311, Section IV .
3. Technical advisors for each Section were to review and approve the terms of reference for the selection of a service provider.
4. The Tijuana Master Plan's identified solution would guide the project. The Commission would administer the plan in a manner that would satisfy the requirements of the responsible Mexican authorities to address infrastructure capacities, land use, land

acquisition, treatment type, odor control, sludge management, and effluent disposal if not reused in México. Effluent discharged through SBOO must be in compliance with water quality laws of the US and State of California.

5. Any project conducted under Minute 311 would be supervised by the Commission, which would require quarterly monitoring of progress and performance status on any contract executed under that Minute. The results of the reports would be submitted to each country's agency requiring such reports. Submission would begin no later than two years after contract execution and annually thereafter in accordance with Minute 311, Section II.
6. All activities that were to take place under Minute 311 were subject to applicable laws and regulations of each country as well as the availability of appropriated funds, resources, and personnel.
7. Minute 311 would enter into force upon notification of approval to each Section by their respective governments, and Minute 311 would terminate when the lease contract referenced in Section IV, Paragraph 1 concludes.

***4.1.22 Public Law 108-425 of 2004 to Amend the Tijuana River Valley Estuary and Beach Sewage Cleanup Act of 2000 to Extend the Authorization of Appropriations, and for Other Purposes.***

Public Law 108-425 (PL 108-425) was written after the passage of Minute 311, to amend Public Law 106-457 (PL 106-457), and was signed into law on 30 November 2004. Table 4.1 indicates the modifications made to PL 106-457: the original wording is on the left hand column and the rewording and/or restructuring is presented on the right hand column.



**Table 4.1:** Summary of changes made to PL 106-457 as a result of the passage of PL 108-425. Items underlined (on the left) were eliminated. Items bolded either replaced the eliminated portion or were simply added. Other changes are indicated in italics.

Public Law 106-457	Public Law 108-425
<p>SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR</p> <p>(A) SECONDARY TREATMENT--</p> <p>(1) IN GENERAL.—<u>Subject to the negotiation and conclusion of a new Treaty Minute or the amendment of Treaty Minute 283 under section 1005 of this Act, and notwithstanding section 510(b)(2) of the Water Quality Act of 1987 (101 Stat. 81), the Commission is authorized and directed to provide for the secondary treatment of a total of not more than 50 mgd in Mexico—</u></p>	<p>SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR</p> <p>(A) SECONDARY TREATMENT--</p> <p>(1) IN GENERAL. — Pursuant to Treaty Minute 311 to the Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, dated February 3, 1944, and notwithstanding section 510(b)(2) of the Water Quality Act of 1987 (101 Stat. 81), the Commission is authorized and directed to provide for the secondary treatment of a total of not more than 50 mgd in Mexico—</p>
<p>SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR</p> <p>(C) CONTRACT--</p> <p>(1) IN GENERAL --<u>Subject to the availability of appropriations to carry out this subsection and notwithstanding any provision of Federal procurement law, upon conclusion of a new Treaty Minute or the amendment of Treaty Minute 283 under section 5, the Commission may enter into a fee-for services contract with the owner of a Mexican facility in order to carry out the secondary treatment requirements of subsection (a) and make payments under such contract.</u></p>	<p>SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR</p> <p>(C) CONTRACT--</p> <p>(1) IN GENERAL -- Notwithstanding any provision of Federal procurement law, the Commission may enter into a multiyear fee-for-services contract with the owner of a Mexican facility in order to carry out the secondary treatment requirements of subsection (a) and make payments under such contract, subject to the availability of appropriations and subject to the terms of paragraph (2)</p>
<p>SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR</p> <p>(c) CONTRACT --</p> <p>(2) TERMS –</p> <p>(J) Provision for the transfer of ownership of the Mexican facility to the United States, and provision for a cancellation fee by the United States to the owner of the Mexican facility, if the Commission fails to perform its obligations under the contract. The cancellation fee shall be in amounts declining over the term of the contract anticipated to be sufficient to repay construction debt and other amounts due to the owner that remain unamortized due to early termination of the contract.</p> <p>(K) Provision for the transfer of ownership of the Mexican facility to the United States, without a cancellation fee, if the owner of the Mexican facility fails to perform the obligations of the owner under the contract.</p> <p>(L) The use of competitive procedures, consistent with title III of the Federal Property and Administrative</p>	<p>SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR</p> <p>(c) CONTRACT --</p> <p>(2) TERMS –</p> <p><i>(J inserted)</i> Neither the Commission nor the United States Government shall be liable for payment of any cancellation fees if the Commission cancels the contract.</p> <p><i>(K inserted)</i> The owner of the Mexican facility may purchase insurance or other financial instrument to cover the risk of cancellation of the contract by the Commission. Any such insurance or other financial instrument shall not be provided or guaranteed by the United States Government, and the Government may reserve the right to validate independently the reasonableness of the premium when negotiating the annual service fee with the owner.</p> <p><i>(L formerly J)</i> Provision for the transfer of ownership of the Mexican facility to the United States, and provision for a cancellation fee by the United States to the</p>

Services Act of 1949 (41 USC. 251 et seq.), by the owner of the Mexican facility in the procurement of property or services for the engineering, construction, and operation and maintenance of the Mexican facility.

(M) An opportunity for the Commission to review and approve the selection of contractors providing engineering, construction, and operation and maintenance for the Mexican facility.

(N) The maintenance by the owner of the Mexican facility of all records (including books, documents, papers, reports, and other materials) necessary to demonstrate compliance with the terms of this section and the contract.

(O) Access by the Inspector General of the Department of State or the designee of the Inspector General for audit and examination of all records maintained pursuant to subparagraph (N) to facilitate the monitoring and evaluation required under subsection (d).

(P) Offsets or credits against the payments to be made the Commission under this section to reflect an agreed upon percentage of payments that the owner of the Mexican facility receives through the sale of water treated by the facility.

owner of the Mexican facility, if the Commission fails to perform its obligations under the contract. The cancellation fee shall be in amounts declining over the term of the contract anticipated to be sufficient to repay construction debt and other amounts due to the owner that remain unamortized due to early termination of the contract.

(M *formerly K*) Provision for the transfer of ownership of the Mexican facility to the United States, without a cancellation fee, if the owner of the Mexican facility fails to perform the obligations of the owner under the contract.

(N *formerly L*) The use of competitive procedures, consistent with title III of the Federal Property and Administrative Services Act of 1949 (41 USC. 251 et seq.), by the owner of the Mexican facility in the procurement of property or services for the engineering, construction, and operation and maintenance of the Mexican facility.

(O *formerly M*) An opportunity for the Commission to review and approve the selection of contractors providing engineering, construction, and operation and maintenance for the Mexican facility.

(P *formerly N*) The maintenance by the owner of the Mexican facility of all records (including books, documents, papers, reports, and other materials) necessary to demonstrate compliance with the terms of this section and the contract.

(Q *formerly O*) Access by the Inspector General of the Department of State or the designee of the Inspector General for audit and examination of all records maintained pursuant to subparagraph (N) to facilitate the monitoring and evaluation required under subsection (d).

(R *formerly P*) Offsets or credits against the payments to be made the Commission under this section to reflect an agreed upon percentage of payments that the owner of the Mexican facility receives through the sale of water treated by the facility.

SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR

(c) CONTRACT --

(2) TERMS --

(L *formerly J*) Provision for the transfer of ownership of the Mexican facility to the United States, and provision for a cancellation fee by the United States to the

SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR

(c) CONTRACT --

(2) TERMS --

(L) Transfer of ownership of the Mexican facility to an appropriate governmental entity, other than the United States, if the Commission cancels the contract.

owner of the Mexican facility, if the Commission fails to perform its obligations under the contract. The cancellation fee shall be in amounts declining over the term of the contract anticipated to be sufficient to repay construction debt and other amounts due to the owner that remain unamortized due to early termination of the contract.

(M formerly K) Provision for the transfer of ownership of the Mexican facility to the United States, without a cancellation fee, if the owner of the Mexican facility fails to perform the obligations of the owner under the contract.

SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR

(c) CONTRACT --

(2) TERMS --

(L) The use of competitive procedures, consistent with title III of the Federal Property and Administrative Services Act of 1949 (41 USC. 251 et seq.), by the owner of the Mexican facility in the procurement of property

SEC. 805. NEGOTIATION OF NEW TREATY MINUTE.

*Previously, there had not been a subsection (c)*

SEC. 806. AUTHORIZATION OF APPROPRIATIONS.

There is authorized to be appropriated a total of \$156,000,000 for fiscal years 2001 through 2005 to carry out this title. Such sums shall remain available until expended.

(M) Transfer of ownership of the Mexican facility to an appropriate governmental entity, other than the United States, if the owner of the Mexican facility fails to perform under the contract.

SEC. 804 ACTIONS TO BE TAKEN BY THE COMMISSION AND THE ADMINISTRATOR

(c) CONTRACT --

(2) TERMS --

*(L changed to N -- see above)* The use of competitive procedures, under applicable law consistent with title III of the Federal Property and Administrative Services Act of 1949 (41 USC. 251 et seq.), by the owner of the Mexican facility in the procurement of property

SEC. 805. NEW TREATY MINUTE.

(c) IMPLEMENTATION- In light of the continuing threat to the environment and to public health and safety within the United States as a result of the river and ocean pollution in the San Diego-Tijuana border region, the Commission is requested to give the highest priority to the implementation of Treaty Minute 311 to the Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, dated February 3, 1944, which establishes a framework for the siting of a treatment facility in Mexico to provide for the secondary treatment of effluent from the IWTP at the Mexican facility, to provide for additional capacity for advanced primary and secondary treatment of additional sewage emanating from the Tijuana River area, Mexico, and to meet the water quality standards of Mexico, the United States, and the State of California consistent with the provisions of this title, in order that the other provisions of this title to address such pollution may be implemented as soon as possible.

SEC. 806. AUTHORIZATION OF APPROPRIATIONS.

There is authorized to be appropriate such sums as may be necessary to carry out this title. Such sums shall remain available until expended.

## CHAPTER 5

### ANALYSIS AND CONCLUSIONS

#### **5.1    *A Better Alternative***

It would be difficult to determine if the Bajagua proposal would have been a reliable treatment alternative without a critical review of detailed design plans. Presumably, the design and construction company whom they had chosen to contract would have been experienced and competent.

At the time the first phase the South Bay Wastewater treatment Plant was complete, the Tijuana-Rosarito area had three wastewater treatment plants online or soon to be online: San Antonio de los Buenos (17.1 mgd or 774.6 lps); San Antonio del Mar (.057 mgd or 2.5 lps); and Rosarito I (1.37 mgd or 60 lps), in total treating approximately 18.6 mgd (837 lps) of raw sewage collected from over a million people. During the time that the Bajagua project was under consideration, nine more wastewater treatment facilities were opened or were under construction. Additionally, the ailing San Antonio de los Buenos Wastewater Treatment Plant (SABWTP) was rehabilitated and enlarged to treat 25 mgd (1095 lps). By 2011, two additional facilities were operating. Figure 5.1 indicates the wastewater treatment plants in the Tijuana-Rosarito area, their approximate locations, their design capacities, and the year treatment was begun. All plants use an activated sludge process for a secondary treatment level with the exception of SABWTP, which uses aerated lagoons for secondary treatment.



**Figure 5.1:** Satellite image of the Tijuana-Rosarito area. Indicated are the approximate locations of the wastewater treatment facilities, their design capacity and year treatment was begun.

In 2009, the state commission of public services of Tijuana, *Comisión Estatal de Servicios Públicos de Tijuana* (CESPT) began its *Cero Descargas* and *Proyecto Morado* programs, among other things, to further address the wastewater treatment needs of Tijuana's growing population and reduce or eliminate sewage discharge into the Tijuana River and into the surf at Punta Bandera. According to CESPT, 90% of area's water supply was delivered from the Colorado River, a limited freshwater source. Through cooperative financing from among the IBWC, BECC, US EPA, and NADBank, and an extension of credit from the Japan Bank for

International Cooperation the Mexican government would undertake a multifaceted project that allowed for the upgrade of existing wastewater treatment plants, the construction of additional wastewater treatment plants, the improvement of drainage in 16 neighborhoods, and the installation of a water delivery system that, by 2013, would reuse effluent for parks and industry.

Central to the plan was the *Cero Descargas* (Zero Discharge) program whose principle objective was to eliminate sewage discharge into the Tijuana River and Tijuana and Rosarito Beaches. Public works infrastructure projects, like two new secondary wastewater treatment plants in eastern Tijuana: the *Arturo Herrera* WTP, at a cost of \$10M and capable of treating 10.5 mgd (460 lps); and the *La Morita* WTP, at a cost of \$8M and capable of treating 5.8 mgd (254 lps), used up 66% of the budget. Also included in the plan was a reliability assurance system of preventative maintenance, the purchase of emergency generators, and monitoring, inspection and testing of arroyo discharges (Duran-Cabrera, 2009). An additional \$4.8M loan from NADBank allowed for the completion of the *Tecolote-La Gloria* WTP in the southern part of Tijuana, which would have capacity to treat 8.68 mgd (380 lps) and eliminate the discharge of raw sewage in to the Pacific (Dibble, 2011).

In an effort to preserve clean water for human consumption and reduce discharges to the Pacific Ocean, CESPT introduced *Proyecto Morado* (Purple Project) in Tijuana in June 2009. One of the goals for the *Proyecto Morado* was to reach a secondary effluent reuse level of 20% by the year 2013 (Duran-Cabrera, 2009). Purple pipes, purple-colored conveyances for treated effluent for to be delivered for reuse, were installed in Tijuana where secondary effluent was

available for irrigation. The reuse would lower the demand on the fresh water supply as well as lower the pressure on the San Antonio de los Buenos Wastewater Treatment Plant because less effluent would be conveyed to it for discharge. The first phase of *Proyecto Morado* was to connect the purple pipes from the *Arturo Herrera* WTP where 0.47 mgd (2.06 lps) of secondary effluent could be used to irrigate sprawling Moreleos Park, three miles away. The next WTP in line was *La Morita*, whose secondary effluent would also be used for park irrigation (Dibble, 2009). The second phase of *Proyecto Morado* would expand the purple pipes to industrial parks (Duran-Cabrera, 2009).

The addition of the decentralized wastewater treatment facilities and the development of the *Cero Descargas* and *Proyecto Morado* projects in the Tijuana-Rosarito Basin would provide a superior treatment alternative to a centralized treatment facility for several reasons:

- 1) Wastewater is being treated close to its source. If the wastewater is treated in the neighborhoods where it is being produced, it travels a shorter distance for processing, fewer conveyances could reduce the chance for conveyance failure, a problem that has plagued systems in the past;
- 2) Less energy is consumed when pumping shorter distances;
- 3) smaller facilities pose a smaller potential risk in the case of a system failure. Several decentralized facilities would have to fail simultaneously to equal possible releases from the failure of a central facility;
- 4) in the case of a failure, the contaminated flows would be localized to a particular area;

- 5) the treated effluent would have less distance to travel for reuse, so potentially less energy is required for its delivery;
- 6) the reuse of effluent for park irrigation as well as industrial purposes would put less strain on the area's potable water budget, 90% of which comes from Colorado River deliveries.

Decentralized (or cluster scale) wastewater treatment systems are a type of collection and treatment system that does not serve an entire community but instead treats and disposes of relatively small volumes of wastewater for groups of dwellings and businesses, which are located relatively close together. Further considerations include the collection, treatment, and possible reuse within close proximity to the site of generation (Crites & Tchobanoglous, 1998). In a report to the US Congress, the US EPA held that decentralized systems were a long-term cost effective option for meeting wastewater treatment goals (EPA, 1997b). Decentralization allows sanitary services to be added as needed as clusters of communities develop, increasing responsiveness to localized demand (Parkinson & Tayler, 2003). Conversely, to be effective, centralized wastewater treatment systems must accurately anticipate future growth well in advance, so their planning is financially a much riskier endeavor. They require disproportionately larger investment in advance of growth and are often unaffordable in poorer communities (Parkinson & Tayler, 2003).

Conveyances for wastewater treatment that extend over long distances are relatively costly, which is exacerbated by a geologically driven excavation processes that must conform to urban



landscapes. Expenses for both can account for a large portion wastewater utility expense and, in some cases, can exceed that expense of treatment several times over (US EPA, 1997b; Water Environment Foundation [WEF], 2008). Treatment closer to the source of generation reduces the large capital investment of trunk sewers (Parkinson & Tayler, 2003). Furthermore, conveyance systems age, corrode, and fail, a problem that has long-plagued the Tijuana area because of relatively high sulfate load is this region's wastewater. Replacement of longer pipe reaches is done at considerably more cost than shorter distances. In addition, long distance conveyances often increase the need for lift stations, which increase capital and operating expenditure (WEF, 2008; Parkinson & Tayler, 2003).

Gravity flow is the desired mode for conveying wastewater. Treatment facilities, therefore, are typically located at a lower elevation than the areas they serve. In the case of effluent reuse, the recycled water would have to be pumped back uphill, so a reduced service area would have lesser pumping requirements, consuming less energy. Because the Bajagua facility was to be situated several miles uphill from the sites of wastewater generation, pumping expense and energy consumption would have factored into the operating expense regardless of reuse. A savings on pumping costs would have been realized only in the delivery of Bajagua's effluent because it would have been delivered through gravity flow; however, the extended distance for the reuse delivery system would have impacted associated savings.

## **5.2 Comparative Performance Modeling**

A model developed by Scott R. Weirich (2012), which predicts long-term treatment performance, was used to determine whether a decentralized wastewater treatment network, a system presently in use in the Tijuana-Rosarito area, is a better treatment alternative to the proposed Bajagua, centralized system. More specifically, the model was used to quantify the influence of facility size and capacity utilization on effluent biological oxygen demand (BOD, all references to BOD are assumed to be BOD<sub>5</sub>) and total suspended solids (TSS). The model addresses the effect of system scale coupled with design capacity used and predicts the cumulative influence on effluent water quality and reliability, resilience, and stability of treatment.

The statistical model was developed through analysis of a national database of operating US wastewater treatment facilities using a Generalized Linear Model (GLM) that allows for the simultaneous consideration of more than one independent variable but does not assume a linear relationship between the independent and dependent variable. Independent variables considered were 1) average monthly flow rate and 2) capacity utilization. Relative concentration was used as the dependent variable for regression. Relative concentration is described as the average monthly discharge concentration for a given constituent divided by the discharge permit standard (Weirich, 2012). In addition, other factors can influence facility performance, and thus, effluent quality within a single facility. Those factors include facility age, process type, equipment, maintenance levels, and labor quality (Niku & Schroeder, 1981).

In order to determine the relationship between a facility's size and capacity utilization on effluent quality, Weirich culled data from the Environmental Protection Agency's Integrated Compliance information System (ICIS), which lists enforcement and compliance information for over 10,000 NPDES permitted US wastewater facilities. Through systematic randomized sampling, the data set of wastewater treatment plants was reduced to 5%. Facilities with incomplete data were eliminated, further reducing the pool. The resultant number of facilities used for determining treatment performance as judged by violations for BOD and TSS was 209 and 211 respectively. Other constituents were considered but are not the focus of this study.

Weirich found that large facilities operating at a high capacity have a lower expected effluent BOD than small facilities operating close to or over their permitted capacity. Under Weirich's scenario, to be considered a large facility, a treatment plant would process over 100 mgd (4380 lps), and small facilities would process  $1.06 \times 10^{-2}$  mgd (0.46 lps). The statistical analysis predicted effluent BOD from large facilities was consistently discharging at approximately 33% of permit limits while small facilities were predicted to discharge BOD that averaged 40% or more of permit limits. Increasing capacity utilization had little to no effect on effluent BOD for plants with a design capacity of 10.6 mgd (464.3 lps) or greater; however, for smaller facilities, increasing capacity utilization is associated with increasing relative BOD. A similar relationship was found with TSS: small plants operating at higher capacity will have a higher rate of TSS permit violation and magnitude.

#### 5.2.1 Applying Performance Models to Treatment Scenarios in the Tijuana Basin

The following procedure was applied in producing the Tijuana-Rosarito Basin data for application to the model:

- 1) Mexican secondary treatment facilities were assumed to perform like US facilities of the same size.
- 2) Information on the 17 wastewater treatment facilities was obtained from a) the US EPA US-Mexico Border Office in San Diego and b) through a request submitted to the US IBWC field office in San Diego County that worked with the MxIBWC counterpart.
- 3) Some of the information received from México for the area's 17 wastewater treatment plants was either missing or inconsistent, so estimates on those facilities were made with regard to design capacity and capacity utilization. Table 5.1 includes the design and operational data used to populate this contextual model.

**Table 5.1:** Summary of data used for simulations of 17 Tijuana-Rosarito wastewater treatment plants. Plants are arranged from largest to smallest. The never built Bajagua facility is included last.

Treatment Plant	Design Capacity (mgd)	Capacity Utilization (mgd)	Monthly Permit Limit BOD/TSS (mg/l)	Reported 2011 BOD <sub>5</sub> /TSS Average (mg/l)	Receiving Waters (discharge)
1. SBIWTP	25	23	30/30	25/25	Pacific Ocean
2. SABWTP	25	24.13	75/75	104/135	Pacific Ocean
3. Ing Arturo Herrera	10.5	3.72	30/30	15/4	Tijuana River
4. La Morita	5.8	1.8	30/30	9/4	Tijuana River
5. Rosarito Norte	4.8	1.05	30/30	13/13	Pacific Ocean
6. Valle de San Pedro	1.53	NA	75/75	13/2	Tijuana River
7. Rosarito I	1.37	1.46	30/30	17/9	Pacific Ocean
8. Uribe Villa del Prado	1.28	0.48	30/30	24/37	Pacific Ocean
9. Santa Fe	0.43	0.14	30/30	8/10	Pacific Ocean
10. Los Valles	0.34	0.11	75/75	NA	Pacific Ocean
11. Porticos de San Antonio	0.17	0.17	75/75	45/130	Pacific Ocean
12. Vista Marina	0.137	0.05	75/75	29/27	Pacific Ocean
13. Planta CAR	0.11	0.11	75/75	NA	Tijuana River
14. La Cuspide	0.068	0.05	75/75	NA	Pacific Ocean
15. San Antonio del Mar	0.057	0.06	75/75	17/10	Pacific Ocean
16. Hacienda Las Flores	0.046	0.02	75/75	NA	Pacific Ocean
17. Puerto Nuevo	0.046	0.05	75/75	NA	Pacific Ocean
Bajagua	75	NA	30/30	NA	Pacific Ocean

4) Specific permit limits for the plants above listed were not provided by Mexican authorities, so NORMA OFICIAL NOM-001-ECOL-1996, which establishes México's permissible pollutant limits on wastewater discharges was used to assign limits for modeling purposes. Under the category of "Maximum Permissible Limits for Basic Contaminants," receiving waters are divided into three categories: 1) rivers, 2) artificial and natural reservoirs, and 3) coastal waters. Effluent from the 17 wastewater plants was first categorized according to discharge: a) the Tijuana River with the determination of "*rivers, public urban uses*" or b) the Pacific Ocean with the determination "*coastal waters, recreation*." For "*rivers, public urban uses*," under Mexican law, the monthly average BOD<sub>5</sub> limit is 75 mg/l and 150 mg/l daily average. The monthly average discharge for TSS is limited to 75 mg/l and 125 mg/l daily. Permit limits for ocean discharge, "*coastal waters, recreation*," are BOD<sub>5</sub>, 75 mg/l monthly and 150 mg/l daily. For TSS ocean discharge limits are 75 mg/l monthly and 125 mg/l daily.

Wastewater treatment plants that reuse water are governed by stricter effluent standards in Mexican Official Standard NOM-003-ECOL-1997, which establishes the maximum permissible contaminant levels for the treated wastewater that is reused in services to the public. Contaminant limits for reuse are determined depending upon the water's use. There are two categories: a) *Indirect or Occasional Contact* and b) *Direct Contact*. Indirect contact limits are 30 mg/l for both TSS and BOD<sub>5</sub>. For *direct contact*, limits are 20 mg/l for both TSS and BOD<sub>5</sub>. For the purpose of this study, the designated use was determined to be "*indirect or occasional contact*," 30 mg/l for both TSS and BOD<sub>5</sub>. Six of the Tijuana—Rosarito wastewater treatment plants reuse wastewater.

Those are: Ing. Arturo Herrera, La Morita, Rosarito Norte, Rosarito I, Uribe Villa del Prado, and Santa Fe.

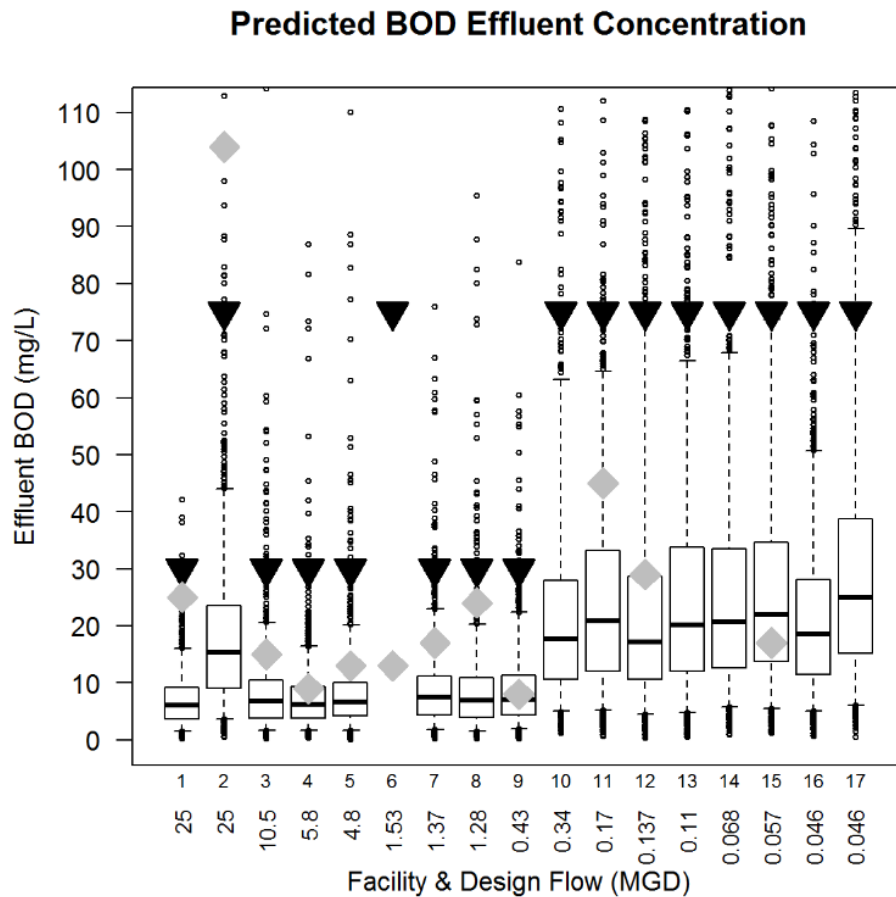
5) The open source statistical computing and graphics software, *R*, version 2.15.1 (2012-06-22) – “Roasted Marshmallows,” (32-bit) was used to run the simulations. Relevant data, like design capacity, capacity utilization, and permit limits were populated onto a Microsoft Excel (2010) spreadsheet for the 17 existing facilities and Bajagua. The information was then imported into the *R* program. The *R* script and nationwide data set were supplied by Dr. Scott Weirich, under conditions described in his doctoral dissertation (Weirich, 2012).

Of the 17 Tijuana-Rosarito area wastewater treatment facilities studied, one is sited in the US, the South Bay International Wastewater Treatment Plant (SBIWTP), and managed by Veolia, US IBWC contract operator for the facility. Because the SBIWTP is sited in the US, it is subject to US discharge limits, BOD and TSS at 30 mg/l. The remaining 16 facilities are situated throughout the Tijuana-Rosarito area and are managed by CESPT, and their permit limits are either 30 mg/l or 75 mg/l. See Table 5.1 for the permit limits of each facility.

### 5.2.2 Simulations

Simulations for each of the wastewater treatment facilities were run for a period of 1200 months, or 100 years, using reported flow rates (where available) and established permit limits. Figure 5.2 shows boxplots of the 17 wastewater facilities in order from largest (SBIWTP, 25 mgd) to smallest (Puerto Nuevo, 0.046 mgd), the same order as in Table 5.1. In figures 5.2

through 5.5, each box represents a single treatment plant's effluent and the range of simulated effluent BOD<sub>5</sub>/TSS concentrations. The boundaries of each box indicate the 25<sup>th</sup> percentile on the lower end and the 75<sup>th</sup> percentile on the upper end. The whiskers designate the 5<sup>th</sup> and 95<sup>th</sup> percentiles, and the remaining points are considered outliers. The thick line within each box represents its median. Black triangles represent the present permit limit, and grey diamonds represent the actual effluent concentration (if reported).



**Figure 5.2:** Distribution of predicted BOD<sub>5</sub> effluent concentrations for each of the 17 facilities at present permit limits. Facilities are arranged from largest to smallest. For larger images of individual facilities, see Appendix A (Legend: Box boundaries represent upper and lower quartile; – represents the median, the upper line represent the 95<sup>th</sup> percentile; the lower line represents the 5<sup>th</sup> percentile; the black triangle represents the permit limit; and the grey diamonds indicate the actual reported effluent concentrations).

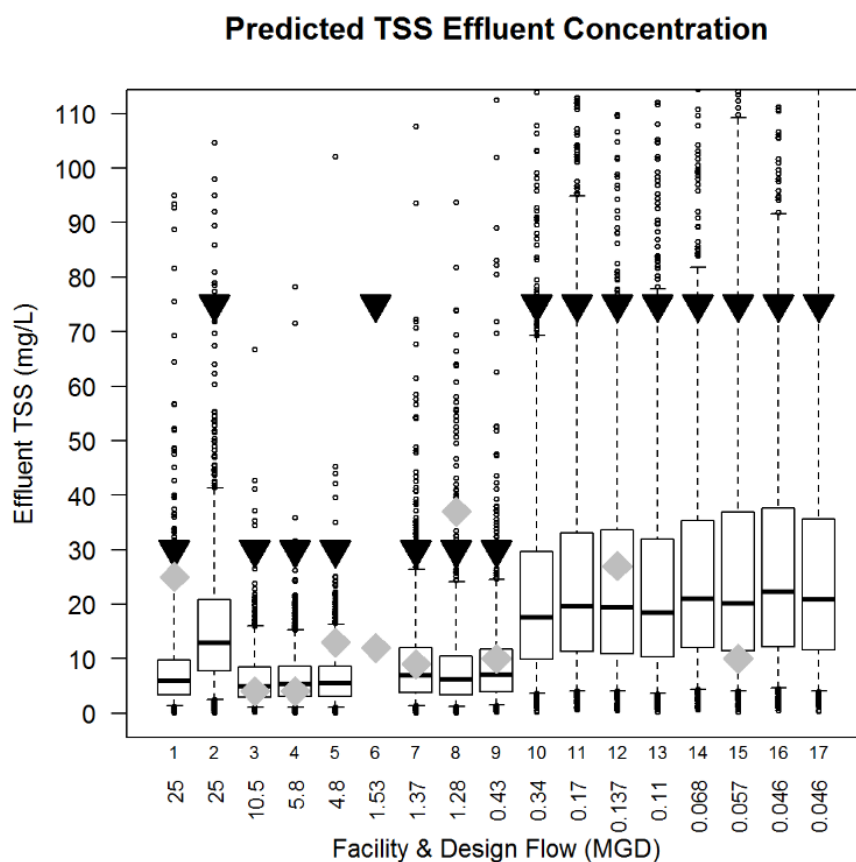
No capacity utilization was provided for the Valle de San Pedro facility, so boxes for that facility were not generated; although, the permit and actual effluent concentration are indicated on the figure because that information was provided. If a grey diamond is absent for any of the 17 boxes, no flow concentration information was reported with two exceptions: SABWTP and Porticos de San Antonio. Their actual TSS readings fell beyond the scale of the figure.

Performance predictions in this modeling scenario are strongly influenced by permit limits and capacity utilization. The simulations show marked variability in effluent BOD for the smaller facilities with less strict permit standards. SBIWTP through Santa Fe (excluding SABWTP and Valle de San Pedro) are facilities with treatment standards of 30 mg/l for BOD and TSS. These plants show a lesser variability range than do the facilities with less strict permit standards of 75 mg/l for BOD and TSS. Both of the examples contrasting the two largest facilities to each other and the two smallest facilities to each other indicate how permit limits and capacity utilization can influence effluent variation.

The boxes elongate indicating greater variability (Figure 5.2). The largest facilities have a similar design capacity, and while both SBIWTP and SABWTP are designed to treat 25 mgd (1095 lps), SABWTP shows greater variability in effluent quality; although, both are functioning at similar utilization capacities. SBIWTP has a permit limit of 30 mg/l BOD and 30 mg/l TSS. It uses an activated sludge process, is functioning at 92% capacity and has a reported effluent quality of 25 mg/l for both BOD and TSS. SABWTP's permit limits are 75 mg/l for both BOD and TSS, but SABWTP uses an aerated lagoon process, functions at 96.5% capacity, and has a reported BOD effluent of 104 mg/l and a TSS of 135 mg/l, well beyond its permit limits. The median predicted



discharge for SBIWTP is approximately 7 mg/l and for SABWTP it's approximately twice, at 15 mg/l. This difference in the plotted variation is mainly due to the difference in permit limits because the model did not take type of process into consideration; although, process type can influence actual effluent quality.



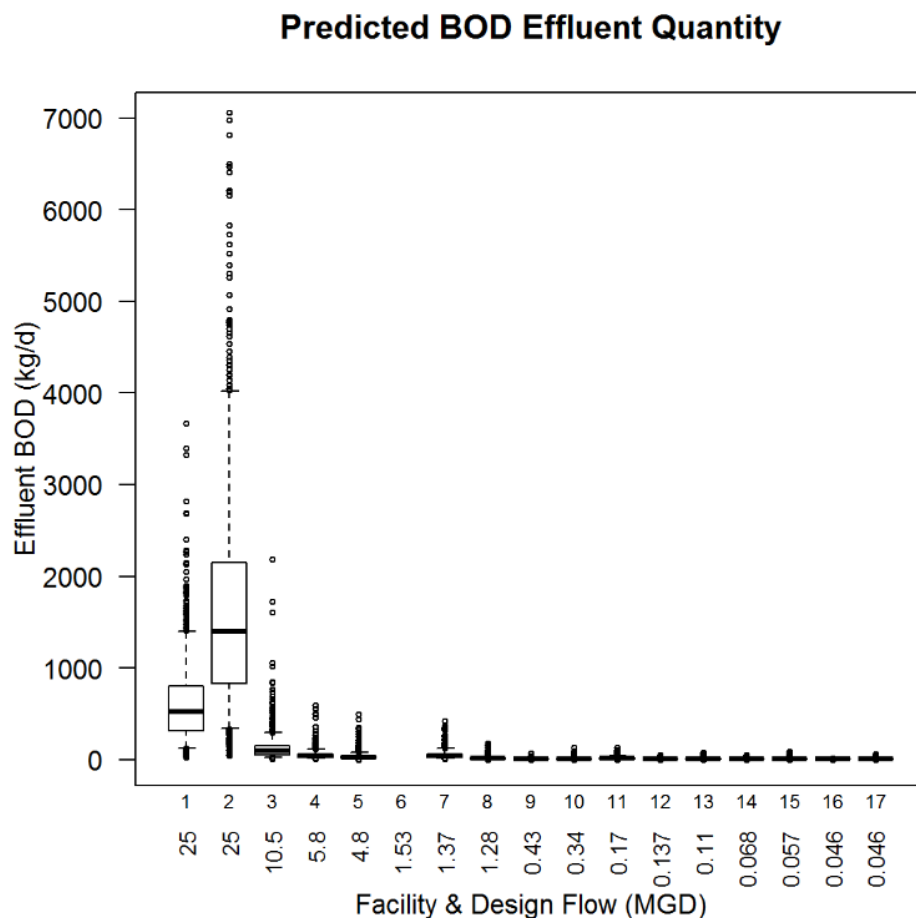
**Figure 5.3:** Distribution of predicted TSS effluent concentrations in for each of 17 facilities at present permit limits, arranged from largest to smallest. Facilities are arranged from largest to smallest. Grey diamonds (actual discharge readings for TSS) are absent for SABWTP and Porticos de San Antonio because their actual TSS discharge is beyond the scale of the figure. For larger images of individual facilities, see Appendix A. (Legend: Box boundaries represent upper and lower quartile; – represents the median, the upper line represent the 95<sup>th</sup> percentile; the lower line represents the 5<sup>th</sup> percentile; the black triangle represents the permit limit; and the grey diamonds indicate the actual reported effluent concentrations).

These results also suggest significant differences between the two smallest facilities, Hacienda las Flores and Puerto Nuevo. Each has a design capacity of 0.046 mgd (2.02 lps) and BOD and TSS permit limits at 75 mg/l. The Hacienda las Flores facility reports capacity utilization near 44% while the Puerto Nuevo facility operates over capacity. The higher capacity utilization results in a greater range of variability in BOD effluent concentration as well as a higher median discharge concentration.

Simulations for total suspended solids (TSS) followed a pattern similar to BOD, Figure 5.3. There is a significant difference in the predicted variation range for the two largest facilities that have the same design capacity and similar utilization capacities. SABWTP shows a greater variability range; although, it has the same design capacity and is functioning at a similar utilization to SBIWTP. The greatest difference between the two facilities that appears to influence this result is SABWTP's less stringent permit limit. The smaller treatment facilities, which also have less strict permit standards (BOD and TSS each at 75 mg/l), show a greater range of variation for TSS than do the six treatment plants with more stringent permit standards, 30 mg/l for TSS. The smallest treatment plant with a stricter permit standard, Santa Fe whose design capacity is 0.43 mgd (20 lps), shows a much less variability than the facility with the closest capacity, Los Valles whose design capacity is 0.34 mgd (15 lps) but whose permit limit is 2.5 times lower.

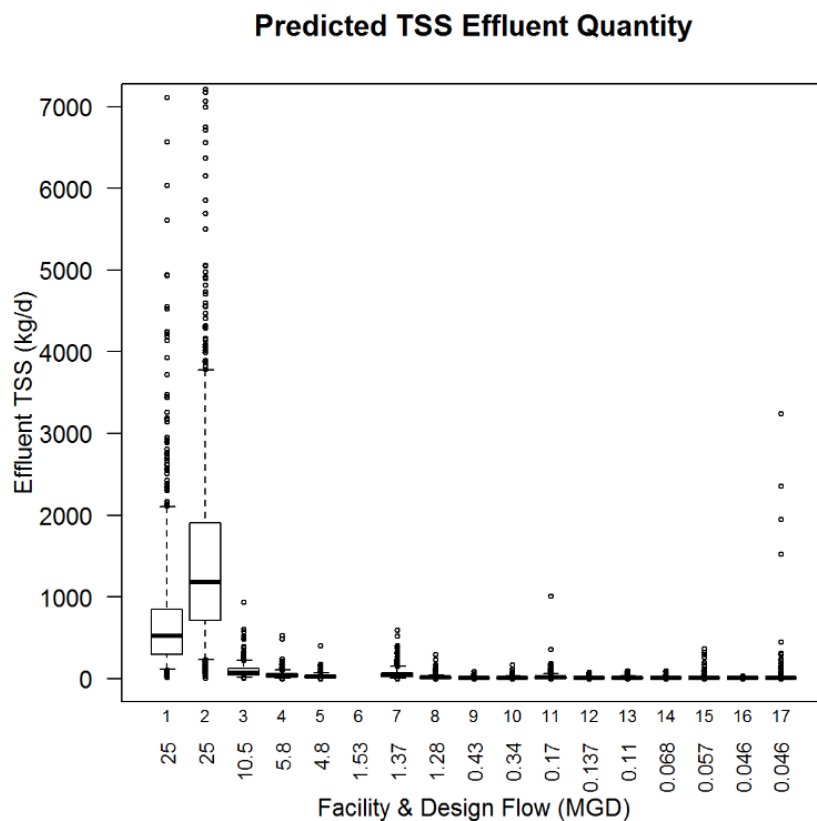
In order to examine BOD and TSS among the 17 facilities on a comparable level, scale effects were removed. Effluent quantity, or mass flow rate, was calculated: concentration (mg/l) \* actual flow in (l/s), yielding units in kg per day (kg/d) after conversions. Figure 5.4 shows the mass flow rate for BOD for all the facilities, which are organized as in Table 1 from largest to

smallest. Due to relative volume produced, the smaller facilities beginning with Ing. Arturo Herrera, whose design capacity is 10.5 mgd (460 lps), show a much smaller when compared to the two largest facilities. Relative to its size, however, SABWTP continues to show the greatest range in variability, well beyond that of any of the other facilities.



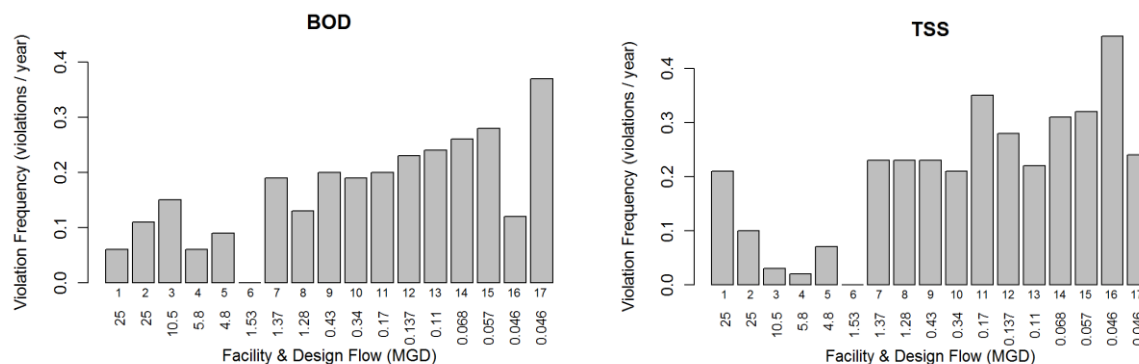
**Figure 5.4:** Indicates the daily mass flow rate for all 17 facilities for BOD<sub>5</sub>. Facilities are organized from largest to smallest. For larger images of individual facilities, see Appendix A. (Legend: Box boundaries represent upper and lower quartile; – represents the median, the upper line represent the 95<sup>th</sup> percentile; and the lower line represents the 5<sup>th</sup> percentile.

Figure 5.5 shows the mass flow rate for TSS for all the facilities. Once again, the TSS boxplots show a trend very similar to the BOD plots. SABWTP, whose reported TSS at 135 mg/l is far beyond its permit limits, shows an elongated box indicating greater range in effluent variability. All facilities smaller than SBIWTP and SABWTP (both 25 mgd or 1095 lps) show a markedly smaller distribution of BOD release. For some of the facilities, simulations predicted lower effluent concentrations than what they were actually producing, which indicates that those facilities perform worse than typical US facilities for their size and capacity utilization.



**Figure 5.5:** Indicates the daily mass flow rate for all 17 facilities for TSS. Facilities are organized left to right from largest to smallest. For larger images of individual facilities, see Appendix A. (Legend: Box boundaries represent upper and lower quartile; – represents the median, the upper line represent the 95<sup>th</sup> percentile; and the lower line represents the 5<sup>th</sup> percentile .

Frequency potential for BOD and TSS permit violations are presented Figure 5.6. The increasing violation trend for the smaller facilities is particularly evident for BOD. For the most part, as design capacity decreases, the greater the predicted violation frequency.



**Figure 5.6:** Bar graphs indicate frequency of permit violation for each facility. Facilities are organized left to right from largest to smallest as in Table 5.1.

Of the 17 wastewater facilities, eight are operating at less than 40% capacity while seven are operating at a capacity of 90% or greater. According to information received from CESPT with regard to average effluent quality for 2011, three of the facilities regularly violated their discharge permits. SABWTP routinely violated limits for both BOD and TSS at 104 mg/l and 135 mg/l respectively, well beyond the monthly average limits of 75 mg/l for both. In Figure 5.3, the gray diamond (actual effluent reading) for SABWTP's TSS is not seen because it is beyond the scale of the figure. Both Uribe del Prado and Porticos de San Antonio were often over their permit limits for TSS in 2011. Uribe del Prado has a reported TSS of 37 mg/l and Porticos de San Antonio has a reported TSS of 130 mg/l. Relative to the other TSS violators, Uribe del Prado

Uribe facility's effluent TSS is low, but it's effluent is reused, so it must adhere to the stricter, 30 mg/l reuse standard.

### 5.2.3 Bajagua Simulations

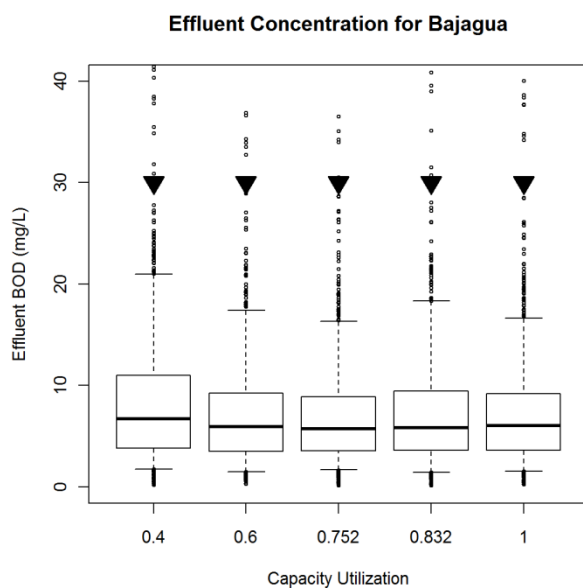
Plans for the Bajagua facility indicated a 75 mgd (3285 lps) design capacity. Its permitted limits would have been 30 mg/l for each BOD and TSS. The simulations for the Bajagua facility were run using several different scenarios for capacity utilization: 40%, 60%, 75.2%, 83.2% and 100%. Table 5.2 indicates the different utilization capacities for effluent BOD and influences on various types of permit violation, including violation percent (portion of months violating the permit), duration of violation, and annual frequency, none of which show any particular trend as the capacity increases. Overall, the larger, centralized facility was not predicted to have many violations, and if so, those violations would be of a short duration and infrequent.

**Table 5.2:** *Bajagua facility simulation for BOD permit limits at 30 mg/l at five different capacities utilization.*

<b>Capacity Utilization</b>	<b>0.4</b>	<b>0.6</b>	<b>0.752</b>	<b>0.832</b>	<b>1.0</b>
Flow Rate (MGD)	30	45	56.4	62.4	75
Violation Percentage (%)	1.9	1.3	1.2	1.4	1.2
Average Violation Duration (months)	1.8	1.7	1.3	1.9	1.4
Violation Frequency (violations / year)	0.13	0.09	0.11	0.09	0.1

Figure 5.7 shows the stability of BOD processing even at high capacity. The greatest predicted variation in treatment performance was observed the lowest utilization capacity. Simulated effluent concentration discharge for BOD is well below permit limits for all utilization capacity scenarios, indicating that facilities with large design capacities show a great amount of stability

regardless of the utilization capacity. This assumes that the Bajagua facility would have been operated as designed to US standards.



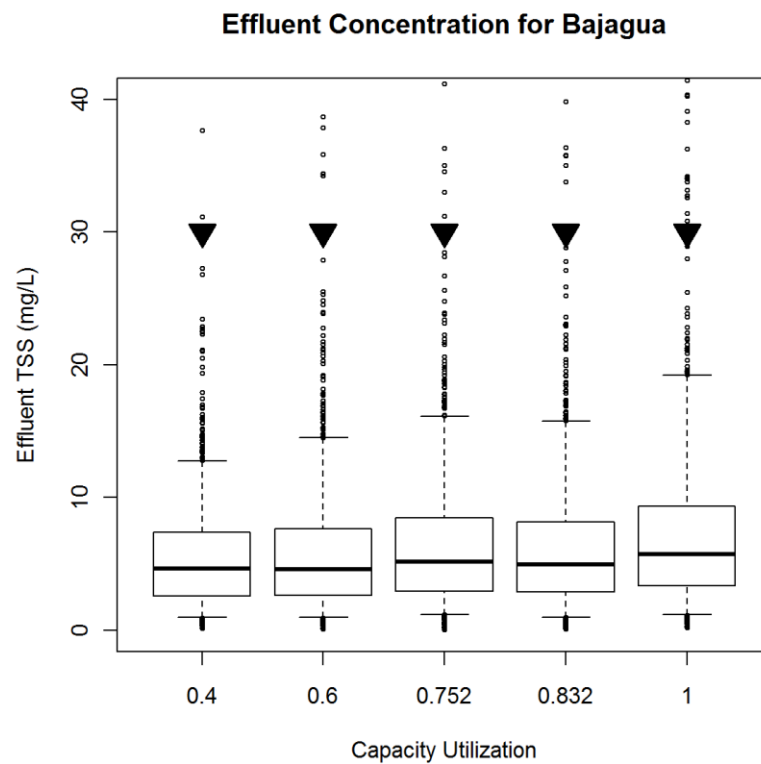
**Figure 5.7:** Bajagua facility simulation for  $BOD_5$  permit limits at 30 mg/l at five different capacities utilization.

Table 5.3 indicates the different utilization capacities for effluent TSS and influences on different types of permit violation, including violation percent, duration of violation and annual frequency. In most instances, as the utilization capacity increases, the violation occurrences, monthly duration, and annual frequency do also, albeit slightly. As with BOD simulations, the larger facility is predicted to have few violations of short duration with respect to suspended solids.

**Table 5.3:** Bajagua facility simulation for TSS permit limits at 30 mg/l at five different utilization capacities.

Capacity Utilization	0.4	0.6	0.752	0.832	1.0
Flow Rate (MGD)	30	45	56.4	62.4	75
Violation Percentage (%)	0.5	0.8	1.0	1.2	2.7
Average Violation Duration (months)	1.5	1.8	1.5	2.0	2.5
Violation Frequency (violations / year)	0.04	0.05	0.08	0.07	0.13

As with BOD simulations in Figure 5.7, simulated effluent concentration discharge for TSS fall below permit limits for all capacity utilization scenarios. The simulations for TSS, Figure 5.8, show the stability of the large facility. The greatest variability, although within permit limits, is seen when processing at 100% capacity utilization.



**Figure 5.8:** Bajagua facility simulation for TSS permit limits at 30 mg/l at five different capacities utilization.

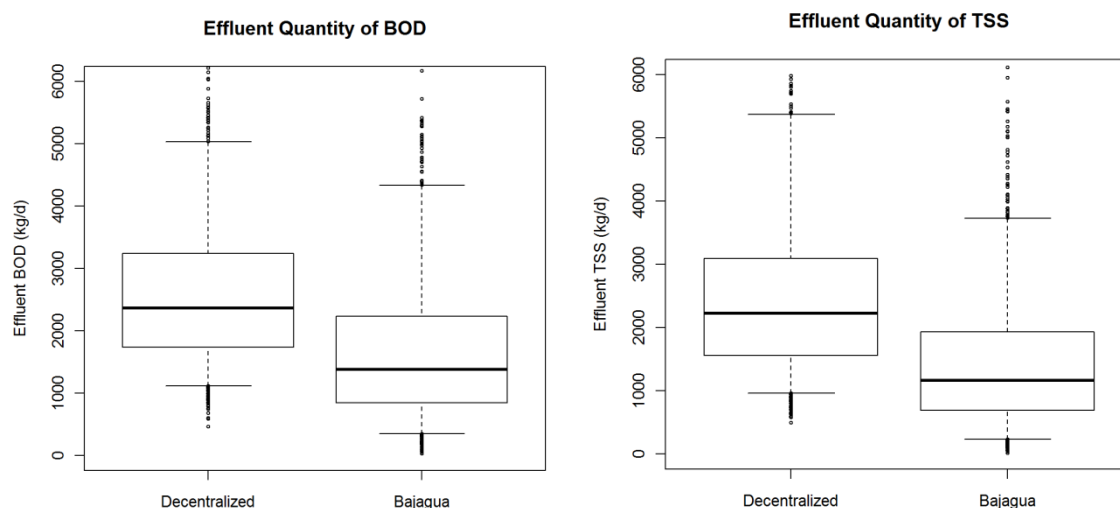


Due to the Bajagua facility's size, considerable stability is predicted with regard to the effluent quality with respect to its decentralized counterparts. At no level of capacity utilization was it predicted to fail consistently. Neither violation duration nor frequency would be greatly affected. Only a portion of months violating the TSS permit would be affected.

Effluent simulations for all 17 decentralized facilities were contrasted to a hypothetical centralized Bajagua system with a 56.4 mgd (2470 lps) flow, representing the sum total of the 17 decentralized facilities. The permit limits for the Bajagua system were set at 30 mg/l for BOD and TSS for the simulation, which was the level indicated in the Bajagua proposal. The effluent limits for the 17 decentralized facilities were dependent on their present permit limits, either 30 mg/l or 75 mg/l for BOD and 30 mg/l or 75 mg/l for TSS, see Table 5.1. Ten of the decentralized facilities have permit limits of 75 mg/l for both BOD and TSS, and higher effluent concentrations from those facilities should increase the overall total of the network sum. Those treatment plants, however, are small, so their influence would carry proportionally less impact. Moreover, most of the treatment facilities whose permit limits are 75 mg/l for BOD and TSS are reporting effluent concentration below lower 30 mg/l.

Figure 5.9 below indicates that the one, relatively large, centralized facility would perform better than a network of smaller facilities with regard to reliability of BOD and TSS removal. The simulated BOD effluent quantity for the decentralized facilities indicates a median value of 2360 kg/d. The decentralized facilities' performance in the 5<sup>th</sup> and 95<sup>th</sup> percentile ranges between just over 1000 kg/d and 5000 kg/d. Conversely, the Bajagua facility's simulated median value for the BOD effluent quantity is 1470 kg/d with the 5<sup>th</sup> and 95<sup>th</sup> percentiles

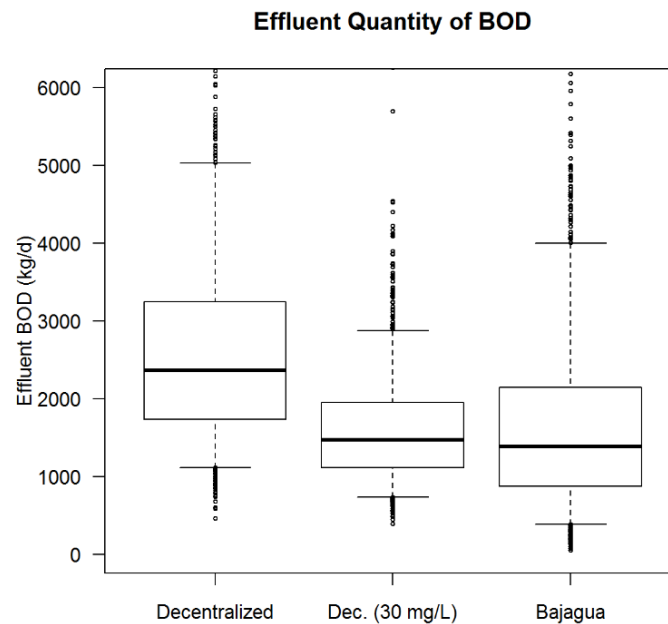
ranging between 400 kg/l and 4330 kg/l. This outcome is based on the assumption all of the facilities, the 17 decentralized and Bajagua, perform like typical US facilities of the same size.



**Figure 5.9:** Comparison of a cohort of decentralized wastewater treatment facilities to the hypothetical Bajagua treatment facility for BOD and TSS effluent quantity, flow rate. The center lines show the median, the boxes show the 25<sup>th</sup> and 75<sup>th</sup> percentile, and the lines respectively show the 5<sup>th</sup> and 95<sup>th</sup> percentile.

These simulations indicate that the proposed centralized treatment facility, Bajagua, would have provided better treatment performance and reliability when contrasted to the decentralized network as it currently exists. The higher level of effluent quality is largely due to the stricter permit standards of 30 mg/l for BOD and TSS, which would have been imposed on the Bajagua facility. Of the 17 decentralized facilities, seven already have permit standards of 30 mg/l for BOD and TSS. The remaining ten have permit standards of 75 mg/l for BOD and TSS. Of those ten, only two presently release effluent above 30 mg/l for both BOD and TSS, SABWTP and Porticos de San Antonio. One facility, Uribe Villa del Prado, releases only TSS above the 30 mg/l limit it's BOD limit is below 30 mg/l. Increasing the permit standards on the ten less

stringent-standard facilities from 75 mg/l to 30 mg/l for both BOD and TSS and implementing the process improvements necessary to meet those standards would result in treatment performance comparable to the proposed Bajagua treatment facility.

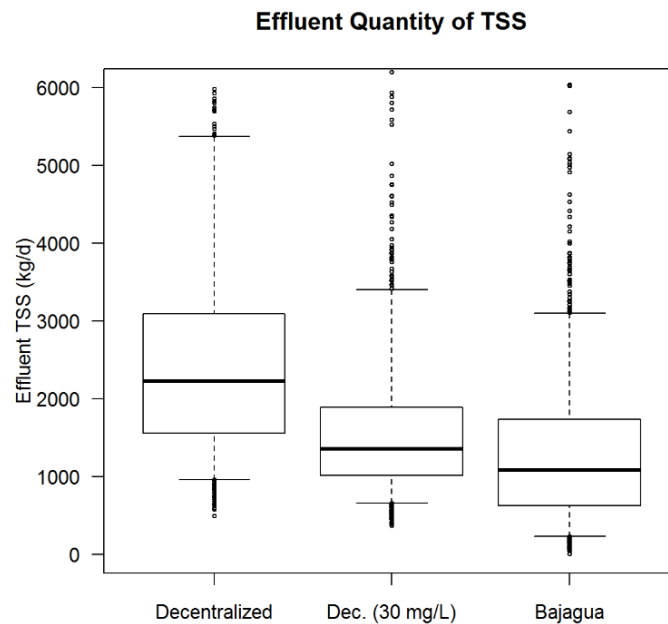


**Figure 5.10:** Comparison of predicted  $BOD_5$  effluent quantity performance for the cohort of 17 decentralized facilities with current permit standards (left), the same facilities with more stringent 30 mg/l permit standards (center), and the hypothetical Bajagua facility (right).

The median  $BOD_5$  discharge of the 17 facilities (2360 kg/d) at current permit standards is higher than either the Bajagua facility (1380 kg/d) or the decentralized facilities (1470 kg/d) with permit limits matching the Bajagua facility at 30 mg/l (Figure 5.10). Currently, the 95<sup>th</sup> percentile of effluent quantity discharge for the network of decentralized facilities is only marginally worse than the simulated discharge for the Bajagua facility; although, the network's median discharge is 70% higher. These differences are less pronounced for the 95<sup>th</sup> percentile

discharge; the decentralized network's 95<sup>th</sup> percentile discharge is 5030 kg/d at present permit limits, only 16% higher than the simulated 95<sup>th</sup> percentile discharge for the Bajagua facility (4330 kg/d). Both the proposed Bajagua facility and the network as it presently operates are, however, considerably higher than the 95<sup>th</sup> percentile effluent discharge simulations (2880 kg/d) for the decentralized network with stricter 30 mg/l permit limits.

Simulations for TSS show a similar trend to BOD<sub>5</sub>. Figure 5.11 indicates that the performance of the network as it currently exists (left), with a combination of permit standards of both 30 mg/l and 75 mg/l, has wider range of variability. The median TSS discharge of the 17 facilities at present permit standards, 2260 kg/d, is beyond the 75<sup>th</sup> percentile range the network with more stringent permit standards (center) or the Bajagua facility (right). The median predicted performance for TSS for the network, when matched to Bajagua's permit standards, is only slightly higher (1230 mg/l) than the predicted performance of Bajagua (1110 mg/l). As with BOD, the network at stricter permit limits as a whole is predicted to perform with greater reliability and narrower range variability than Bajagua.



**Figure 5.11:** Comparison of predicted TSS effluent quantity performance for the cohort of 17 decentralized facilities with current permit standards (left), the same facilities with more stringent 30 mg/l permit standards (center), and the hypothetical Bajagua facility (right).

When the entire network of 17 decentralized facilities is held to the stricter, 30 mg/l, TSS discharge standard and is contrasted to performance projections of the Bajagua facility, the performance medians become nearly equal; however, the network as a whole is predicted to perform with greater reliability and less variability.

The previous simulations included all the treatment facilities in the Tijuana-Rosarito area. The following simulations assume that no additional treatment facilities would have been constructed in the Tijuana-Rosarito area after the year 2000 because, instead, Bajagua would have been built to meet the basin’s wastewater treatment needs. Table 5.2 lists the facilities that are assumed not to have been constructed, their design capacities, their current capacities,

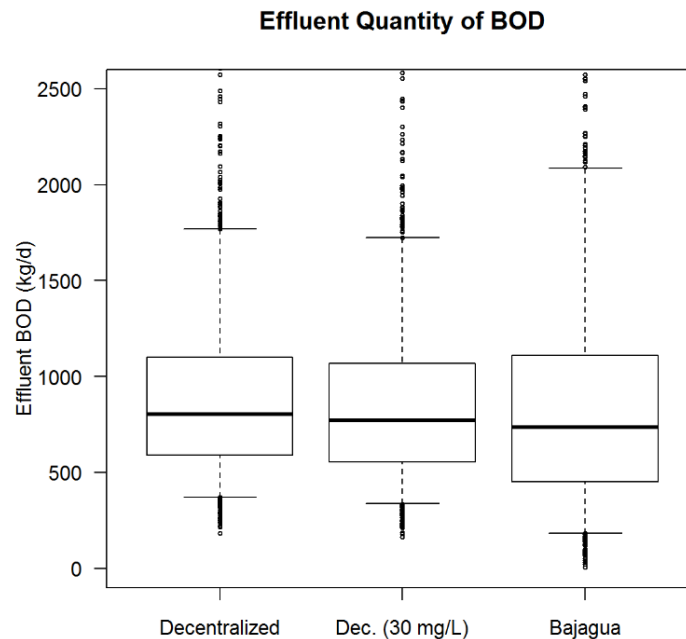
and their present permit limits. Although SBIWTP was constructed in 1997, it is included in the list because its primary effluent would have been conveyed to Bajagua for secondary treatment. The sum utilization flows of the below listed 14 facilities, 30.75 mgd, were used in the simulations to predict Bajagua's performance for BOD and TSS. Simulations for network performance were conducted at currently existing permit standards and a scenario with all facilities with 30 mg/l standards for both BOD and TSS.

**Table 5.4:** Summary of data used for simulations of facilities constructed after 2000.

Treatment Plant	Design Capacity (mgd)	Capacity Utilization (mgd)	Monthly Average Permit Limit BOD/TSS (mg/l)
SBIWTP	25	23	30/30
Ing Arturo Herrera	10.5	3.72	30/30
La Morita	5.8	1.8	30/30
Rosarito Norte	4.8	1.05	30/30
Valle de San Pedro	1.53	NA	75/75
Uribe Villa del Prado	1.28	0.48	30/30
Santa Fe	0.43	0.14	30/30
Los Valles	0.34	0.11	75/75
Porticos de San Antonio	0.17	0.17	75/75
Vista Marina	0.137	0.05	75/75
Planta CAR	0.11	0.11	75/75
La Cuspide	0.068	0.05	75/75
Hacienda Las Flores	0.046	0.02	75/75
Puerto Nuevo	0.046	0.05	75/75

Figure 5.12 indicates the network of 14 facilities at either permit limit scenario and the Bajagua facility would perform at nearly identical levels with regard to median discharge for BOD. There is little predicted difference between the two network scenarios for BOD; differences between 25<sup>th</sup> and 75<sup>th</sup> percentile ranges, medians, and simulated 95<sup>th</sup> percentile discharges are negligible. The network of facilities either with existing permit limits or all permitted to 30 mg/l

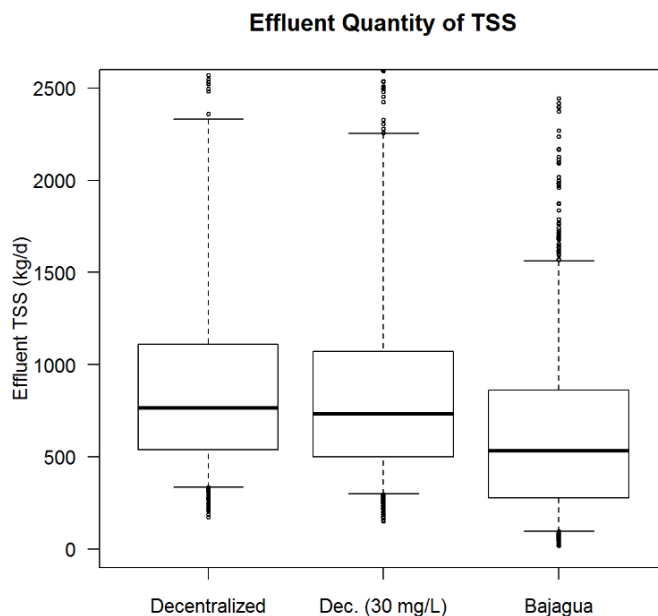
BOD is actually predicted to perform with greater reliability and less variability than the Bajagua facility.



**Figure 5.12:** Comparison of predicted  $BOD_5$  effluent quantity performance for 14 decentralized facilities constructed after the year 2000, with current permit standards (left), the same facilities with more stringent 30 mg/l permit standards (center), and the hypothetical Bajagua facility (right).

The simulation for TSS indicated a slightly better treatment performance for the Bajagua facility. Figure 5.13 indicates the two networks each with 14 facilities and present permit limits or all facilities permitted to 30 mg/l TSS discharge would perform nearly identically to each other. The scenario for the cohort at present permit standards shows a slightly higher variability range at the 95<sup>th</sup> percentile. The Bajagua facility, on the other hand, shows a lower median and 95<sup>th</sup> percentile discharge but a similar range overall. Over all, there is very little difference

between the two network scenarios for either BOD or TSS because these simulations do not include SABWTP whose over-permit effluent discharges influenced predicted performance of the network.



**Figure 5.22:** Comparison of predicted TSS effluent quantity performance for 14 decentralized facilities constructed after the year 2000, with current permit standards (left), the same facilities with more stringent 30 mg/l permit standards (center), and the hypothetical Bajagua facility (right).

#### 5.2.4 Summary

As judged by stochastic observations, facility size affects treatment performance. Simulations indicate that Bajagua's design capacity would have produced a higher quality effluent for BOD and TSS and greater reliability than would individual, smaller scale facilities. When operated at full capacity, occurrence, duration, and frequency of violation would be relatively low for both BOD and TSS from Bajagua. These simulations also indicate that smaller facilities running at high capacity experience more frequent and longer permit violations. However, violation risk or



failure dispersed across many facilities will result in less overall environmental risk to the Tijuana Watershed than a centralized facility of similar capacity. Moreover, a single violation or failure in a large, centralized facility could release more contaminants than one or several smaller, decentralized facilities. The possibility of several facilities experiencing a simultaneous failure further lowers that risk. If either the entire network of 17 decentralized facilities or the 14 post 2000 facilities were operating at a 30 mg/l standard for BOD and TSS, the network sum would perform similarly to or better than the centralized Bajagua facility.

### **5.3 Conclusion**

US authorities were cognizant of billions of gallons of undertreated wastewater releases containing, among other things, biological agents into the Pacific Ocean, violating their own NPDES permit. It took over twelve years implement reliable secondary treatment at the SBIWTP alone. Swifter action to help the Tijuana-Rosarito solve its wastewater treatment deficiencies could have helped reduce vast amounts of otherwise preventable water pollution that threatened public and environmental health. Political forces endorsed a centralized treatment scenario, Bajagua, which was never compared to a network of decentralized treatment facilities operating within the same watershed area. Strong objections to the proposed Bajagua facility included the way in which it was selected, and this thesis exposes the paucity of a technical alternative comparison.

Decentralized systems can be less costly because less excavation and fewer conveyances are required to move waste shorter distances where networks serve a smaller area. Influent to

Bajagua would have traveled uphill for 12 miles, which is very costly due to pumping (energy) requirements. Influent to most treatment facilities arrives via gravity flow. Often, only when water reuse is involved, is pumping necessary, but again, the recycled water would be conveyed over a shorter distance in a decentralized network. Bajagua, conversely, would have required front-end pumping over a long distance to the facility regardless of reuse; its effluent, however, would have traveled a long distance via gravity flow. While this analysis focused only on comparative performance projections, a parallel energy audit would likely expose the Bajagua design to consume markedly more energy for the same level of wastewater treatment in the Tijuana Basin.

In order to compare BOD and TSS effluent quality for the existing 17-facility and 14-facility decentralized networks to the proposed Bajagua facility, four scenarios of 10-year simulations were conducted: (1) the entire existing 17 wastewater treatment facility network and the 17 wastewater treatment facility network with current discharge permit limits; (2) those same networks with a 30 mg/l BOD and TSS permit limit for all the facilities; and (3) the Bajagua facility treating the sum of the present flows of the network. The 30 mg/l standard was chosen to match the proposed limits of the Bajagua facility so as to allow for a normalized comparison. This limit would also allow the conglomerate of facilities to meet reuse standards.

Implementing the higher effluent standards would promote effluent reuse basin-wide, a water conservation strategy that will have to be adopted more readily in the Tijuana-Rosarito area, given the recent demographic trends. Reliance on Colorado River flows for 90% of the area's freshwater needs must be revisited in order to meet future demand in this watershed.

Previous studies (Weirich et al., 2012) have shown that decentralized treatment networks can overcome the decreased reliability and treatment performance of small facilities through risk distribution. As a contextual example, on 4 April 2012, the SBIWTP experienced a computer software programming error, and as a result, the facility released approximately 1.4M gallons of untreated wastewater into the Tijuana River. Several hours passed before operators noticed and corrected the error. Had this event occurred in a network of smaller facilities, a similar error would have released less wastewater, thus, lowering environmental impact to the basin.

The Bajagua facility proposed treating up to 75 mgd (design capacity). The raw, influent wastewater would have to have been conveyed uphill through a series of lift stations to the facility. The energy requirement for this design would likely have been enormous, and system failure would likely have been accordingly disastrous. Even a partial failure of Bajagua's treatment and conveyances systems could release far more contamination than any one of the decentralized facilities. Smaller facilities are more prone to failure; however, environmental consequences are accordingly restricted to a localized area, resulting in less risk. In the final analysis, the Bajagua facility would not have provided sufficient improvement in treatment performance over a decentralized system to justify the operations costs for lift stations and extended conveyances that would have been required to collect and transfer the wastewater to a central, elevated location. Those funds would be (and can be) better spent on other infrastructure improvements within the region including optimization of decentralized treatment with local reuse.

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## GLOSSARY OF TERMS & ACRONYMS

Alfisols	soil in semi-arid to humid environments typically under hardwood forest cover with a clay-enriched subsoil.
Alluvium	unconsolidated soil or sediments
Aldehydes	organic compound with a formyl group
Amine	organic derivative of ammonia
BAT	best available technology
BPT	best practicable control technology
Batholith	igneous rock formed from cooled magma
BECC	Border Environment Cooperation Commission
Benthic	zone at lowest level of a body of water
biological floc	gelatinous biological solids formed in the activated sludge process
BOD	biochemical oxygen demand
BOD <sub>5</sub>	5-day biochemical oxygen demand
BSS	bio-flocculation-adsorption sedimentation and stabilization process
BTEX	benzene, toluene, ethylbenzene and xylene
°C	Degrees Centigrade
Carbofuran	one of the most toxic broad-spectrum carbamate pesticides

Caustic	corrosive
CBOD	carbonaceous biochemical oxygen demand
CDO	Cease and Desist Order
CESPT	Comisión Estatal de Servicios Públicos de Tijuana (State Commission of Public Services, Tijuana)
CFR	Code of Federal Regulations
CFU	Coliform forming units
cm	centimeter
CMA	complete mix aeration
CO	carbon monoxide
Coliform bacteria	bacterial indicator presence of other pathogenic organisms of fecal origin
CFR	Code of Federal Regulations
Cretaceous	geologic period approximately 145.5 to 65.5 mya
CRWQCB	California Regional Water Quality Control Board
CSWRCB	California State Water Resources Control Board
CWA	Clean Water Act
DDT	dichlorodiphenyl-trichloroethane, an organochlorine insecticide
Diazanone	common name for an synthetic organophosphate pesticide
DO	Dissolved oxygen



EA	Environmental Assessment
EID	Environmental Information Document
EIS	Environmental Impact Statement
Enteric	pathogens eliminated from their host
Enterococcus	a genus of bacteria that are part of the normal human intestinal flora
Entisols	soils without a profile development
EPA	(United States) Environmental Protection Agency also US EPA
Epibenthic	region above benthic zone
ESA	Endangered Species Act
Eutrophication	process where a body of water receives excess nutrients
°F	Degrees Fahrenheit
FAR	Federal Acquisition Regulation
FDA	Food and Drug Administration
FEB	Flow Equalization Basin
FeCl <sub>3</sub>	Ferric chloride
FEIS	Final Environmental Impact Statement
Fluvial	sediments transported by water
ft	foot, feet
GAO	US Government Office of Accountability

gpm	gallons per minute
greywater	domestic wastewater generated from uses like laundry, bathing, dishwashing
H <sub>2</sub> S	hydrogen sulfide
HCH	hexachlorocyclohexane
HDPE	high density polyethylene
Hp	horse power
Hypochlorite	chlorate anion, salts of hypochlorous acids, ClO <sup>-</sup>
IBWC	International Boundary and Water Commission
Inceptisol	soils of semi-arid and humid environments that exhibit moderate weathering and development
IWTP	international wastewater treatment plant
Ketones	organic compound with a carbonyl group bonded to two other carbon atoms
Kg/d	kilograms per day
km	kilometer(s)
km <sup>2</sup>	square kilometer(s)
Limitrophe	situated on a border or frontier
lps	liter(s) per second
l/s	liter(s) per second

LLC	Limited Liability Corporation
M	million
m	meter(s)
mg/l	milligrams per liter
mi	mile(s)
mi <sup>2</sup>	square miles
m <sup>3</sup> /sec	cubic meters per second
<i>Maquiladoras</i>	manufacturing operations in duty and tariff-free zones.
µg/L	micrograms per liter
Mediterranean Climate	subtropical, rainy season during the winter months
Mercaptans	thiol group that bonds strongly to mercury
Metasedimentary	sedimentary rock that shows signs of metamorphism
Metavolcanic	metamorphic rock formed from lava or tephra subjected to high pressure
MG	million gallons
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mgd	million gallons per day
Minute	Treaty agreements between the US and Mexico IBWC sections
Miocene	epoch during the Neogene Period, approximately 23.3 to 5.3 mya

ml	milliliters
MLVSS	mixed liquor volatile suspended solids
Mollisols	soil type found in semi-arid to semi-humid areas typically under grass cover
Montmorillonite	microscopic mineral crystals that form clays
MOU	Memorandum of Understanding
MTBE	Methyl Tertiary butyl Ether, a VOC, flammable liquid
MxIBWC	Mexican Section of the International Boundary and Water Commission
Mya	million years ago
NAAQS	National Ambient Air Quality Standards
NADBank	North American Development Bank
NAFTA	North American Free Trade Agreement
NaClO	sodium hypochlorite
NaOH	sodium hydroxide
n.d.	No date
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NOAA	National Oceanic and Atmospheric Administration
NOEC	no observable effect concentration

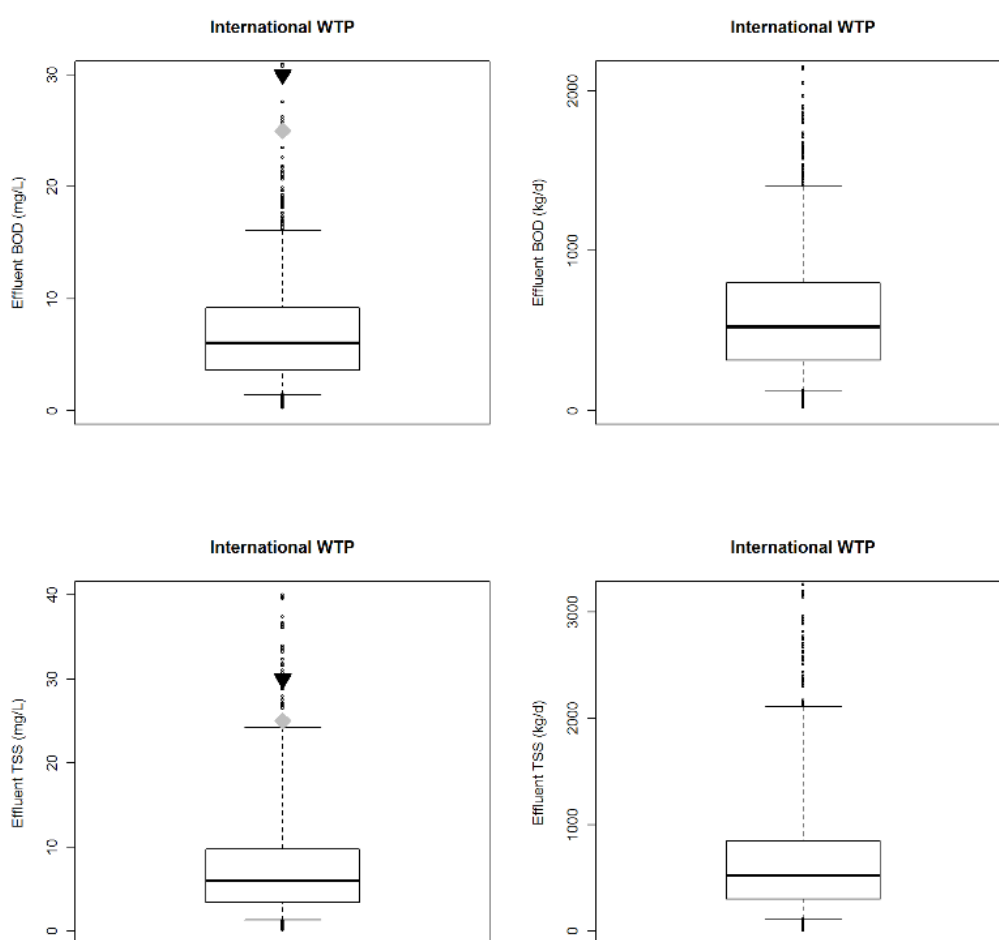
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OCC	Original Conveyance Channel
Oligocene	an epoch during the end of the Paleogene Period, 34 to 23 mya
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PCL	parallel conveyance line
pH	potential of Hydrogen, measurement of the level of acidity or alkalinity of a substance
Pleistocene	a geological epoch of the Quaternary Period 2.588 mya to 11.7k ya
Pliocene	a geological epoch of the Neogene Period that extends from 5.332 to 2.588 mya
PLOO	Point Loma Ocean Outfall
Plutonic rock	intrusive igneous rock formed from magma crystallization
PLWTP	Point Loma Wastewater Treatment Plant
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RECON	Regional Environmental Consultants
ROD	Record of Decision

RWQCB	(California) Regional Water Quality Control Board
SABWTP	San Antonio de los Buenos Wastewater Treatment Plant
SAIC	Science Applications International Corporation
SBIWTP	South Bay International Wastewater Treatment Plant
SBLO	South Bay Land Outfall
SBOO	South Bay Ocean Outfall
SBWRP	South Bay Water Reclamation Plant
SCERP	Southwest Center for Environmental Research & Policy
SEIS	Supplemental Environmental Impact Statement
Semi-arid	steppe climate, between desert and humid
Slope-aspect	the direction that a mountain slope faces
Smectite	a group of phyllosilicate minerals
Sodium	hypochlorate $\text{NaClO}$
SPE	Solid phase extraction
TDS	total dissolved solids
TIE	Toxicity Identification Evaluations
Thiol	organosulfur compound containing a carbon-bonded sulfhydryl
Tidal Estuary	transition zone where river and ocean waters meet where waters are subject to tidal influences

TOES	Tijuana Oceanographic Engineering Study
Toxicant	human made or introduced poison into the environment
transmissivity	the rate that groundwater flows horizontally through an aquifer
TRNERR	Tijuana River National Estuarine Research Reserve
TRW	Tijuana River Watershed
TSP	total suspended particles
TSS	total suspended solids
TU	Toxic units
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
US IBWC	United States Section, International Boundary and Water Commission
UTEP	University of Texas at El Paso
Vertisols	soil type with a high expansive clay content that undergoes cycles of shrinking and swelling
VOC	volatile organic compound(s)
WTP	wastewater treatment plant
ya	years ago

## APPENDIX A

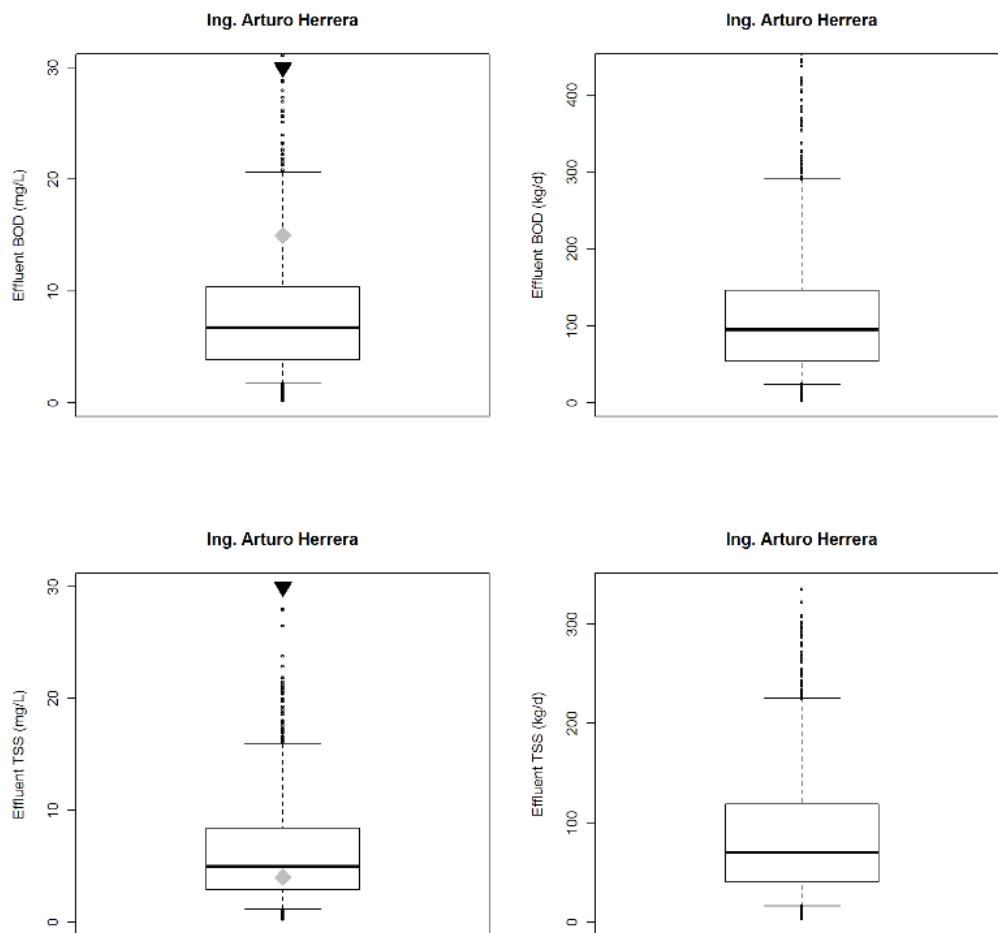
The facilities are arranged according to permit standard, with the stricter standards first and from largest to smallest. The treatment facilities in figures B.1 through B.7 have permit limits for both BOD and TSS at 30 mg/l.



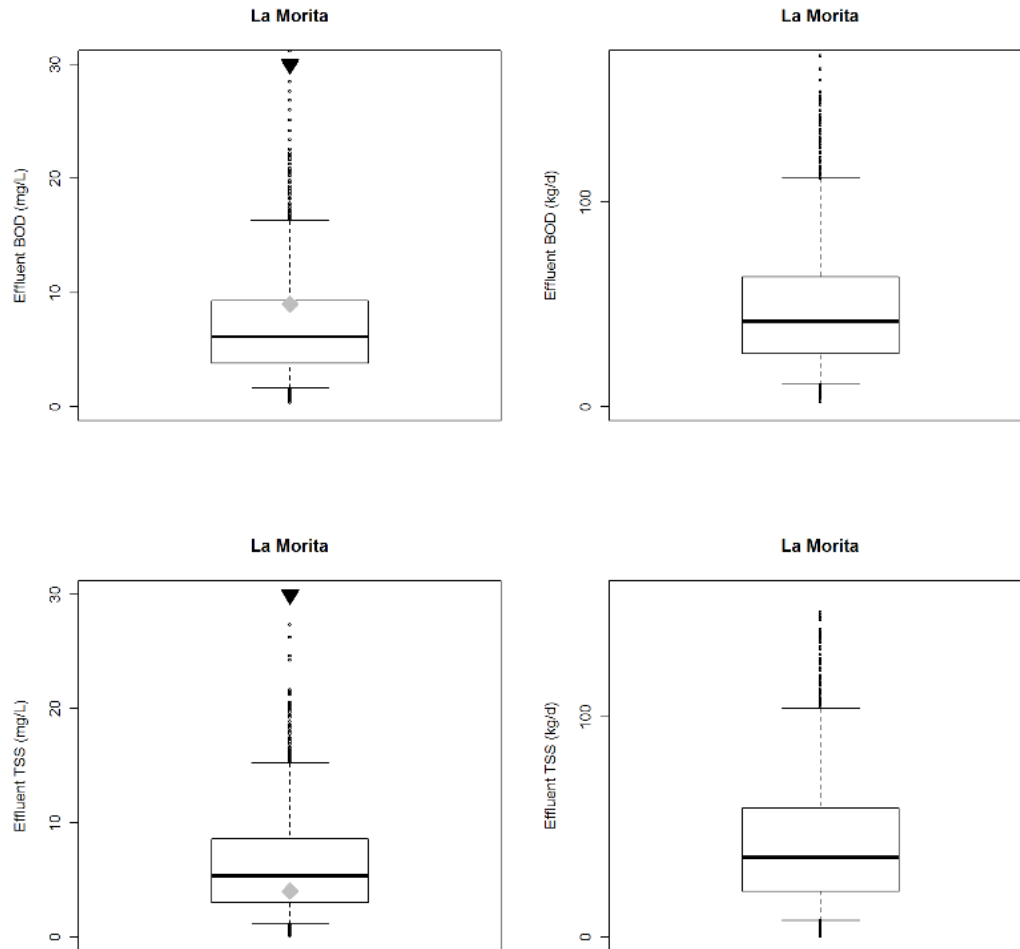
**Figure A.1:** Simulation for the South Bay International Wastewater Treatment Plant. Design capacity is 25 mgd and capacity utilization is 92%. Permit limits for both BOD and TSS is 30 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph



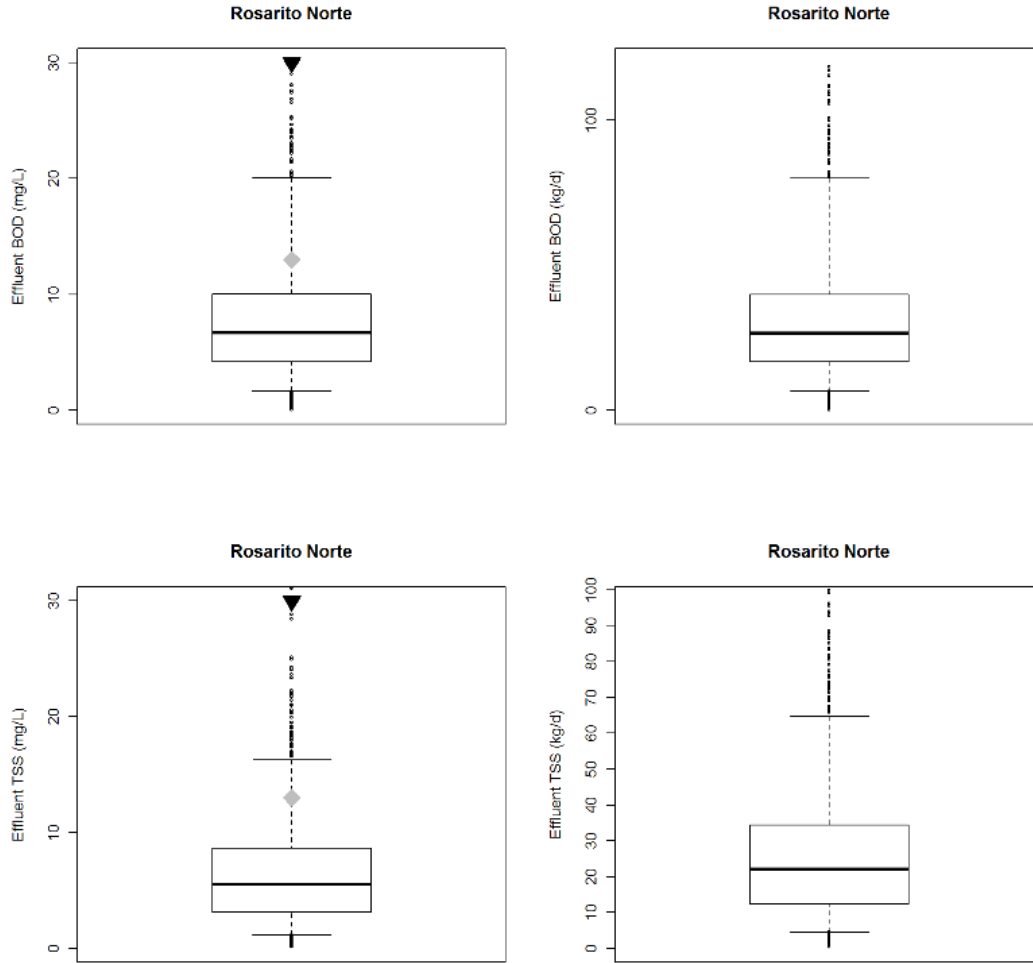
corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



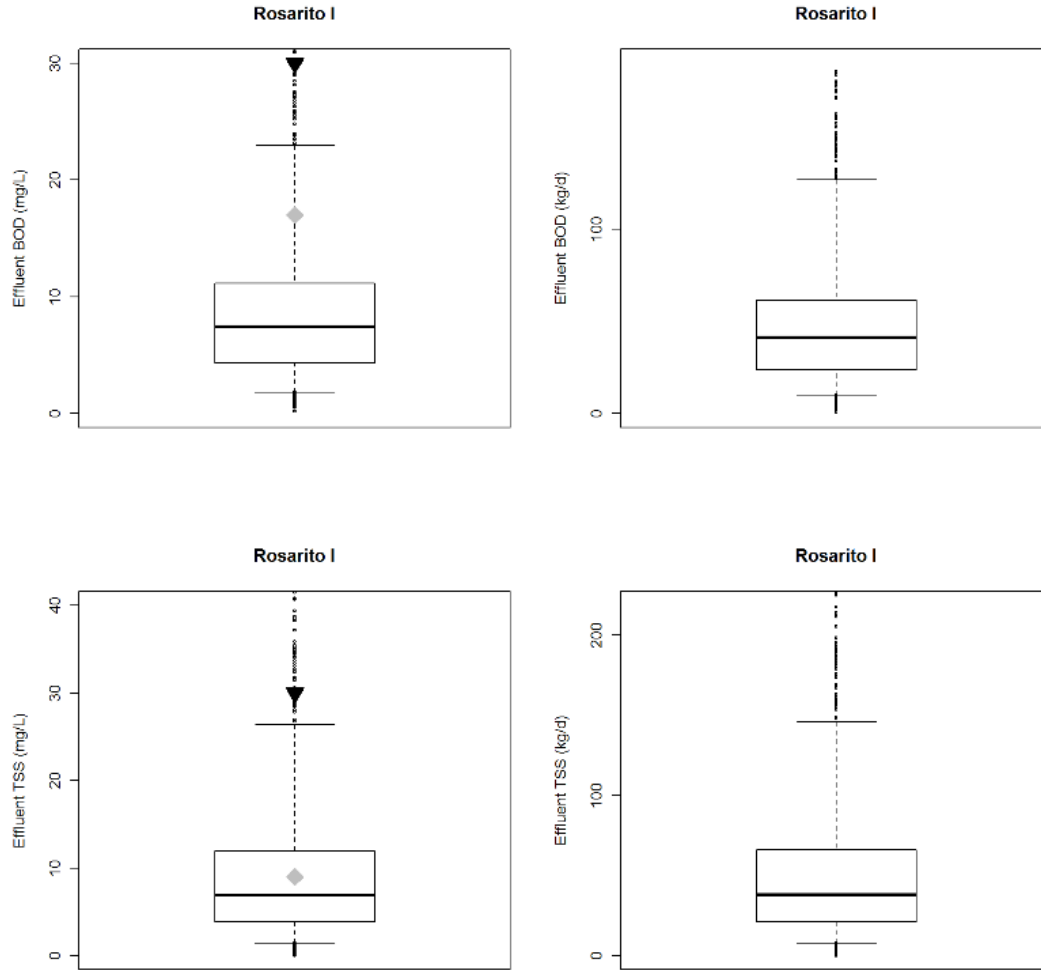
**Figure A.2:** Simulation for the Ing. Arturo Herrera Wastewater Treatment Plant. Design capacity is 10.5 mgd and capacity utilization is 35%. Permit limits for both BOD and TSS is 30 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



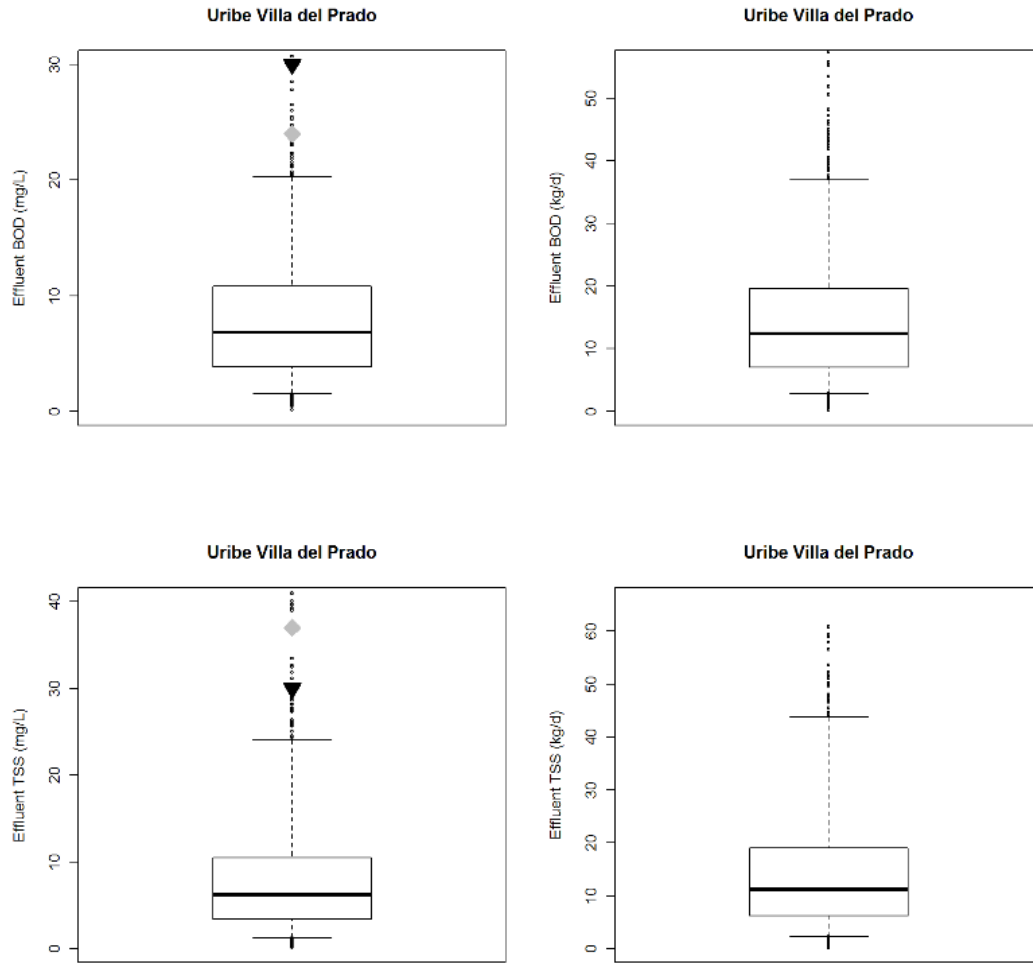
**Figure A.3:** Simulation for the La Morita Wastewater Treatment Plant. Design capacity is 5.8 mgd and capacity utilization is 31%. Permit limits for both BOD and TSS is 30 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



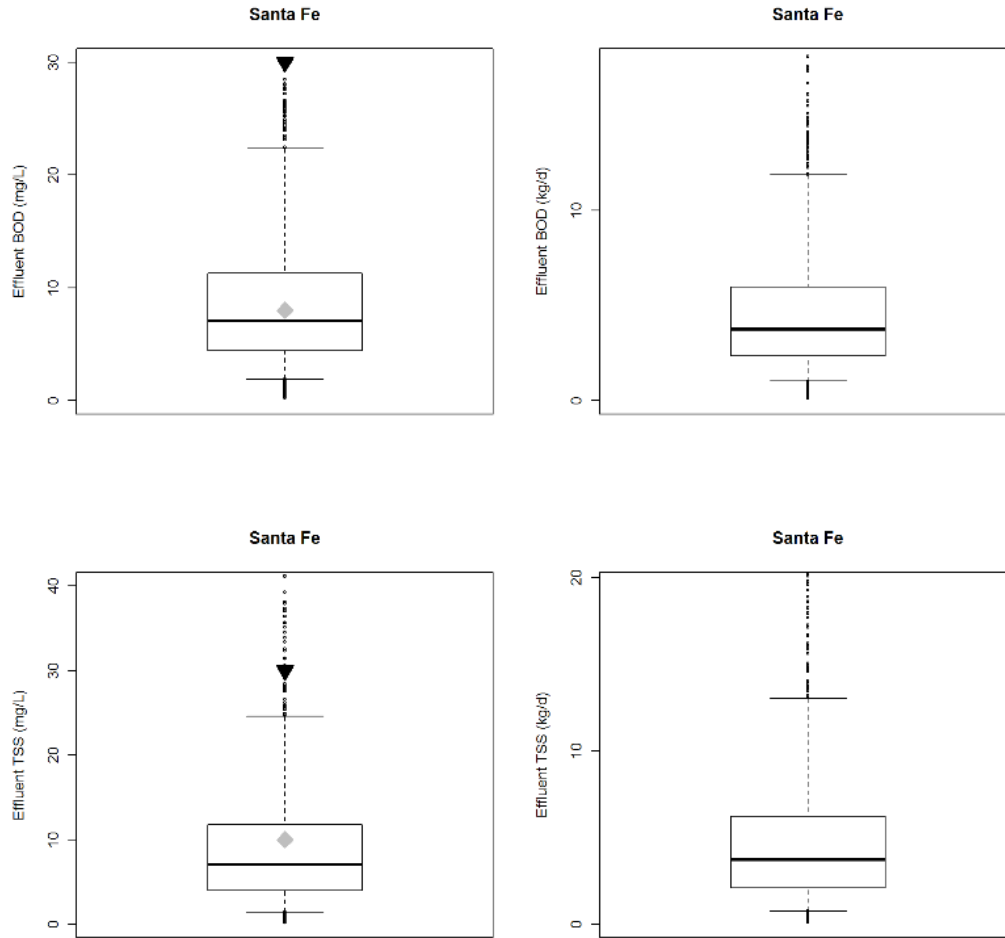
**Figure A.4:** Simulation for the Rosarito Norte Wastewater Treatment Plant. Design capacity is 4.8 mgd and capacity utilization is 22%. Permit limits for both BOD and TSS is 30 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



**Figure A.5:** Simulation for the Rosarito I Wastewater Treatment Plant. Design capacity is 1.37 mgd and capacity utilization is 107%. Permit limits for both BOD and TSS is 30 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.

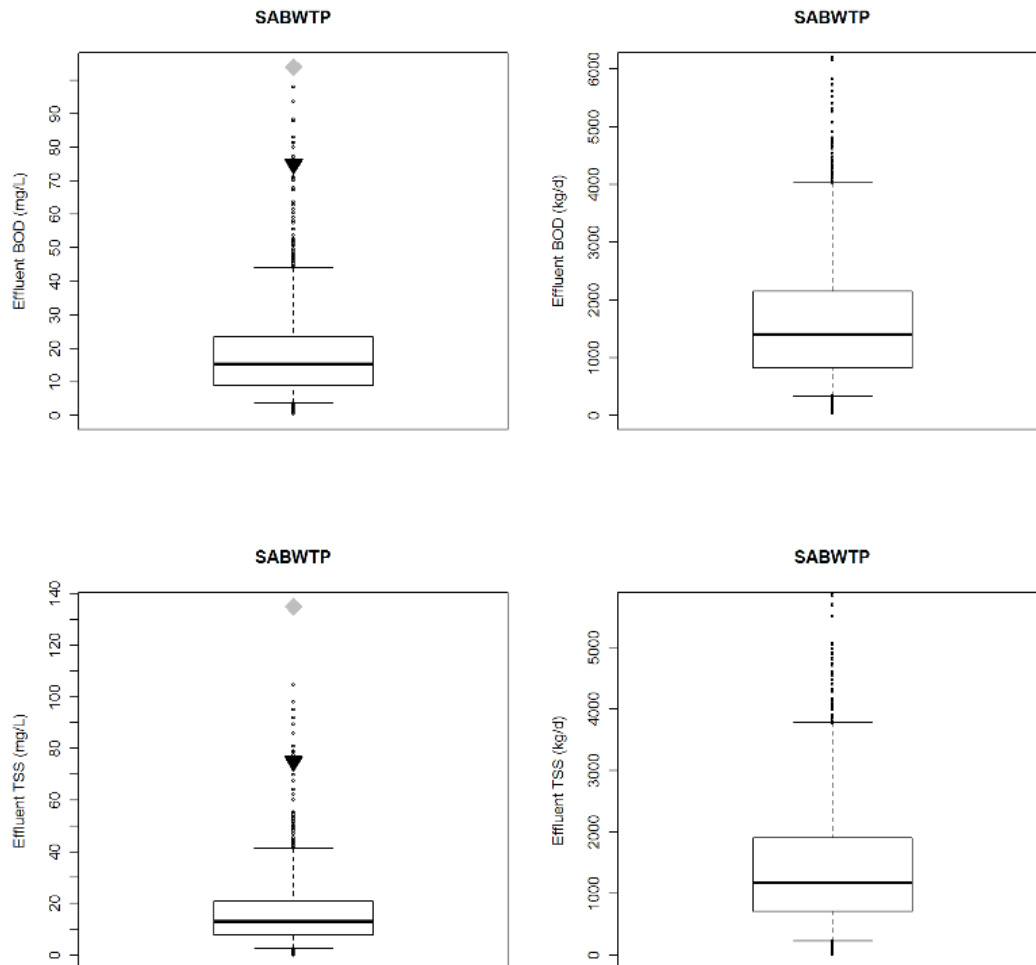


**Figure A.6:** Simulation for the Uribe Villa del Prado Wastewater Treatment Plant. Design capacity is 1.28 mgd and capacity utilization is 37.5%. Permit limits for both BOD and TSS is 30 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.

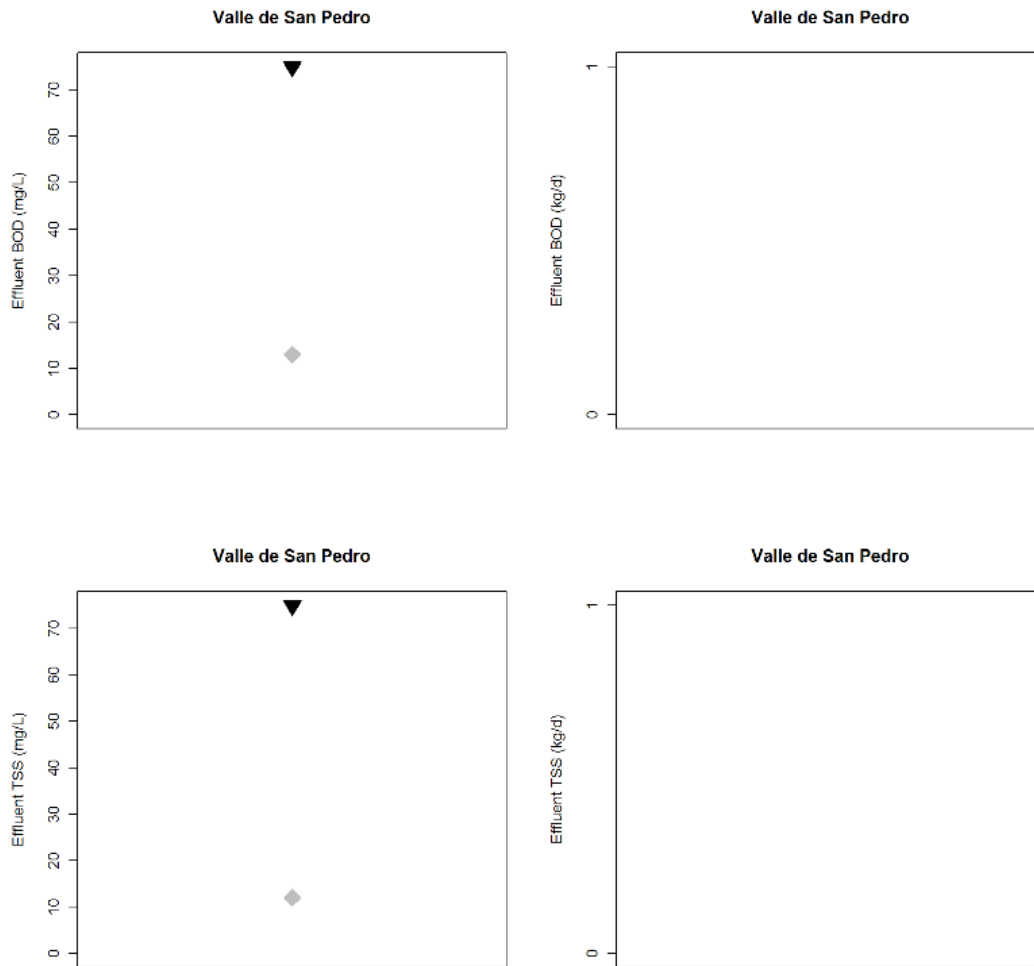


**Figure A.7:** Simulation for the Santa Fe Wastewater Treatment Plant. Design capacity is 0.43 mgd and capacity utilization is 33%. Permit limits for both BOD and TSS is 30 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.

The treatment facilities with less stringent treatment standards are shown in figures A.8 through A.17. The following facilities have permit standards for BOD and TSS at 75 mg/l. Because of the difference in permit standards from the previous set of figures, the effluent scale (y- axis) was changed higher rates.

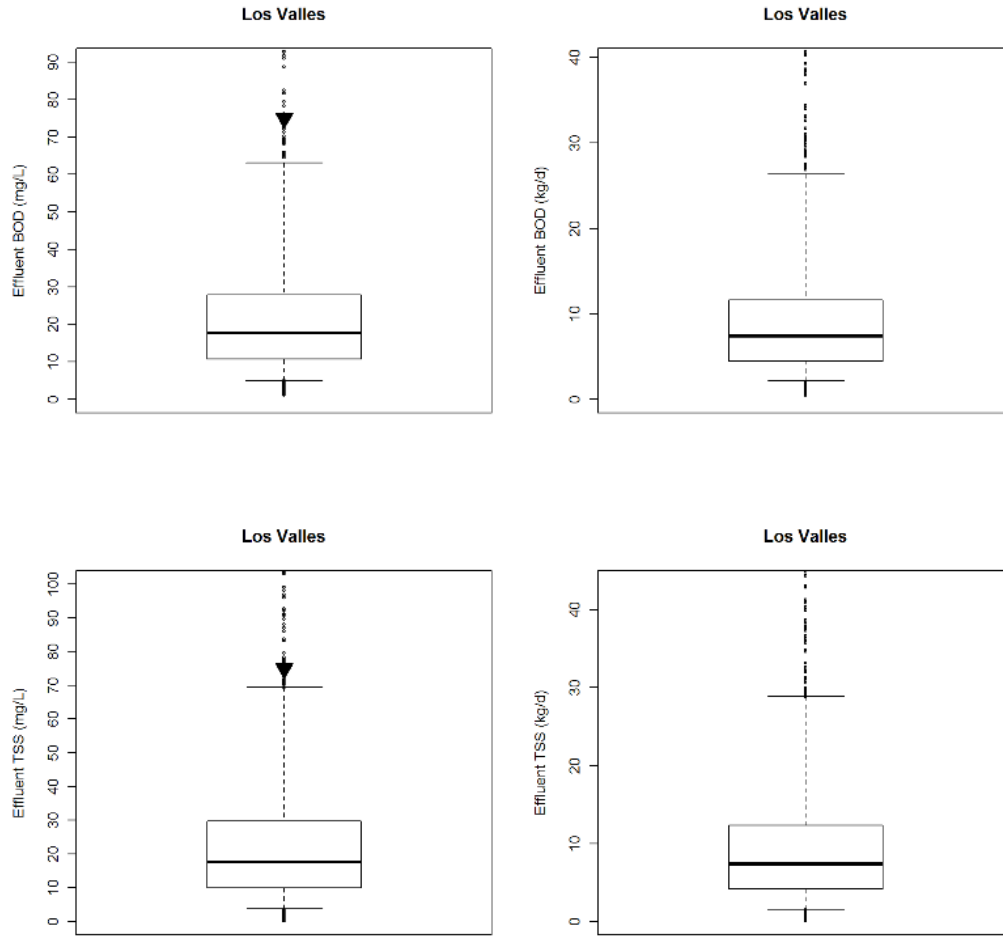


**Figure A.8:** Simulation for the San Antonio de los Buenos Wastewater Treatment Plant. Design capacity is 25 mgd and capacity utilization is 97%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.

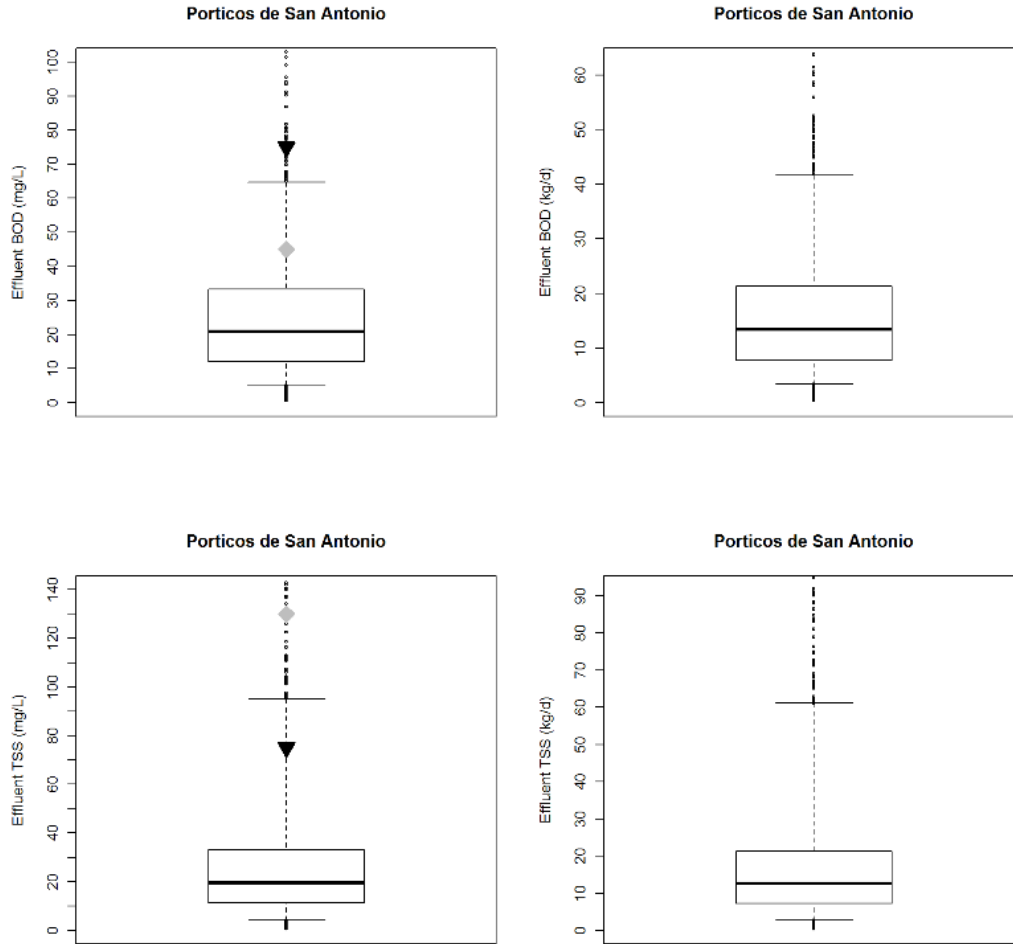


**Figure A.9:** Simulation for the Valle de San Pedro Wastewater Treatment Plant. Design capacity is 1.53 mgd and capacity utilization is unknown. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.

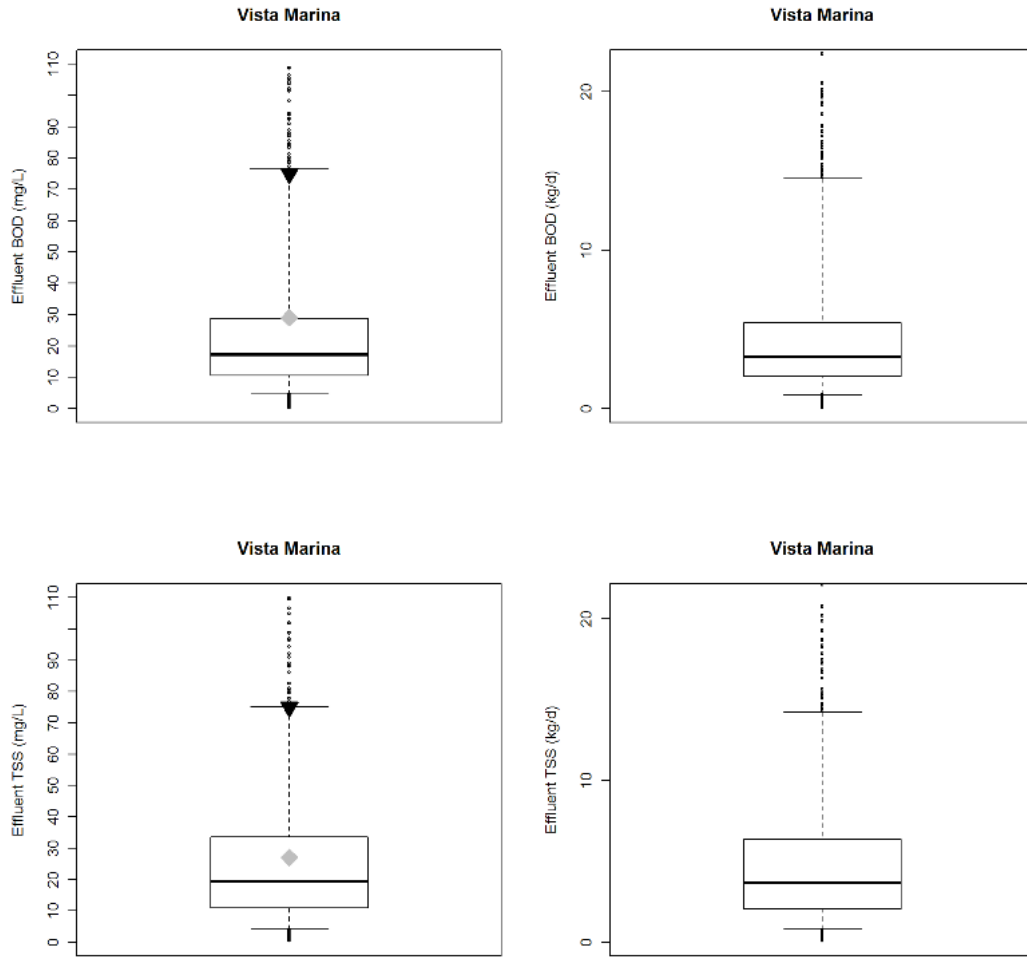




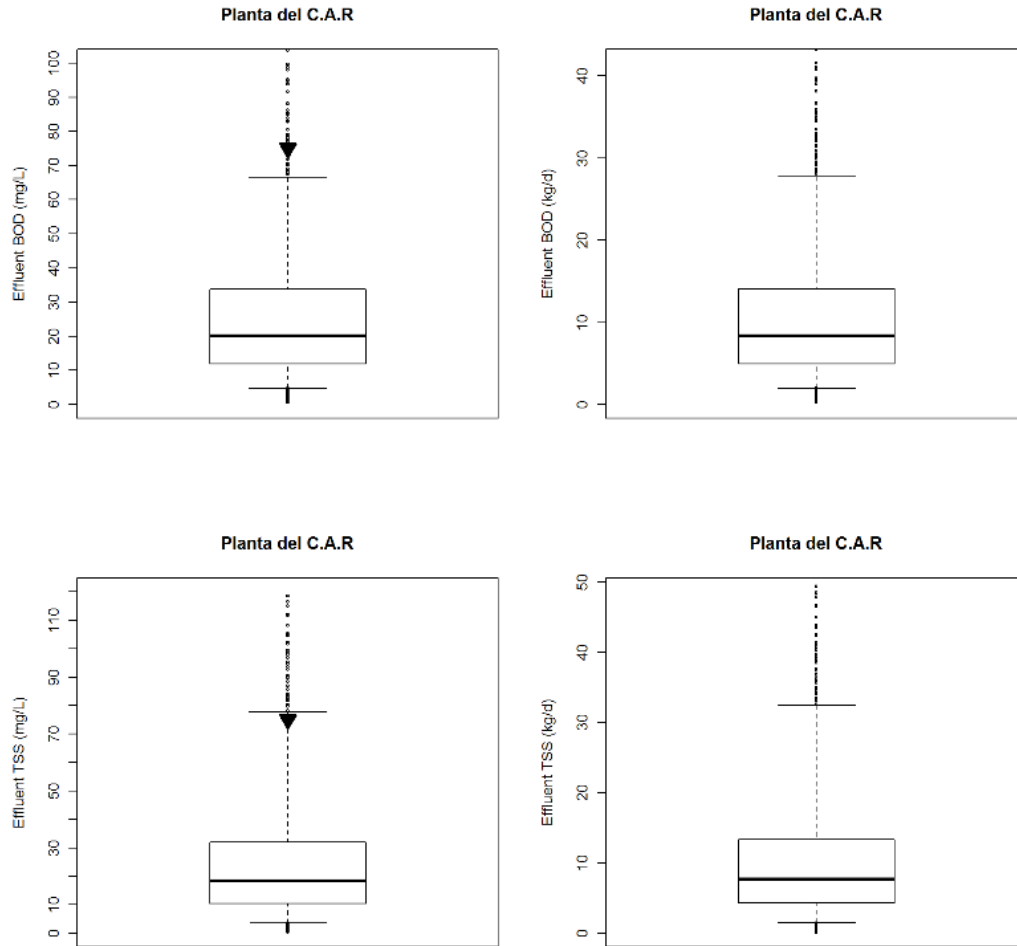
**Figure A.10:** Simulation for the Los Valles Wastewater Treatment Plant. Design capacity is 0.34 mgd and capacity utilization 32%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



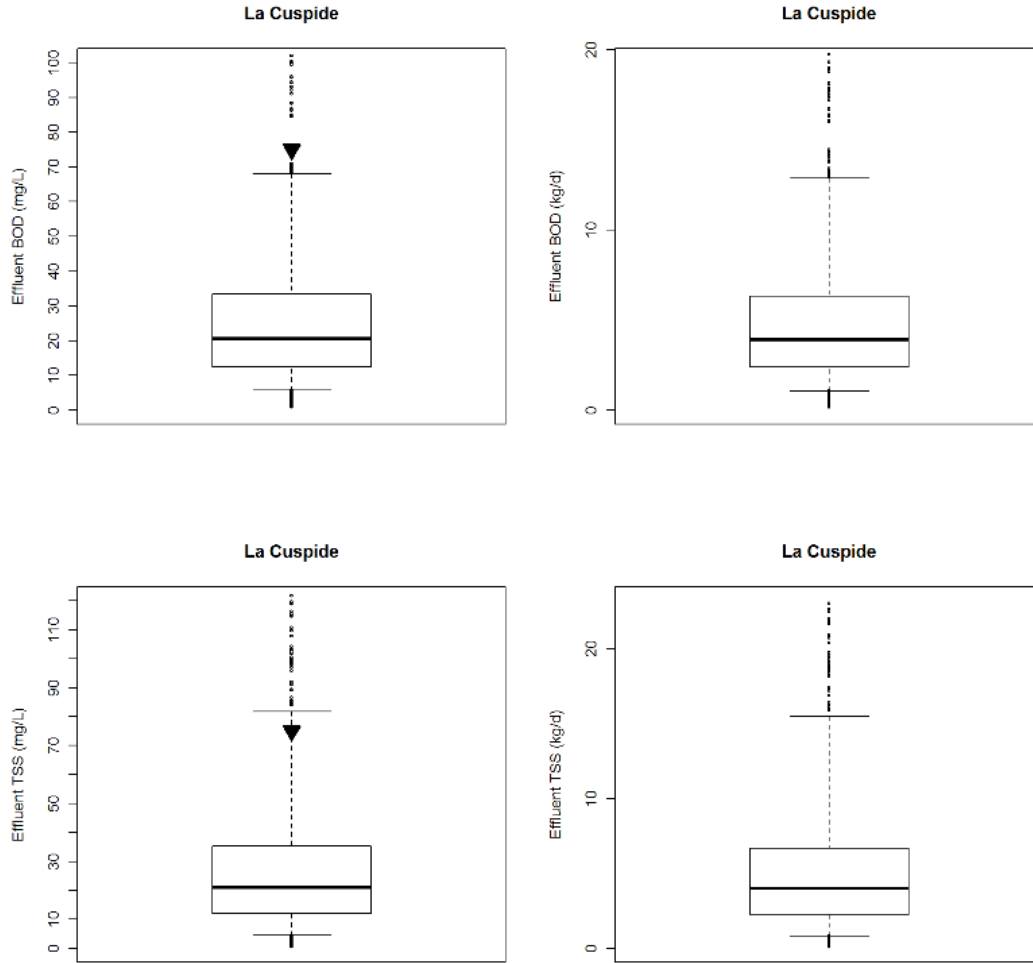
**Figure A.11:** Simulation for the Porticos de San Antonio Wastewater Treatment Plant. Design capacity is 0.17 mgd and capacity utilization 100%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



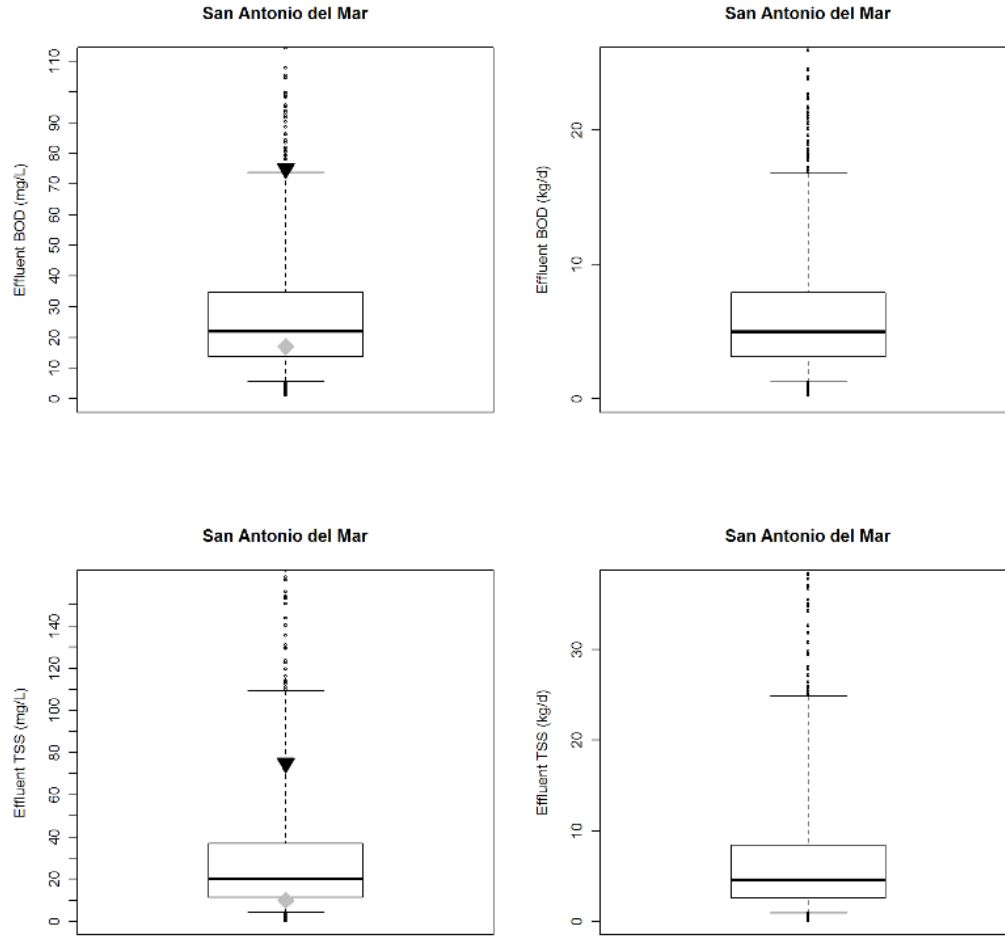
**Figure A.12:** Simulation for the Vista Marina Wastewater Treatment Plant. Design capacity is 0.137 mgd and capacity utilization 36%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



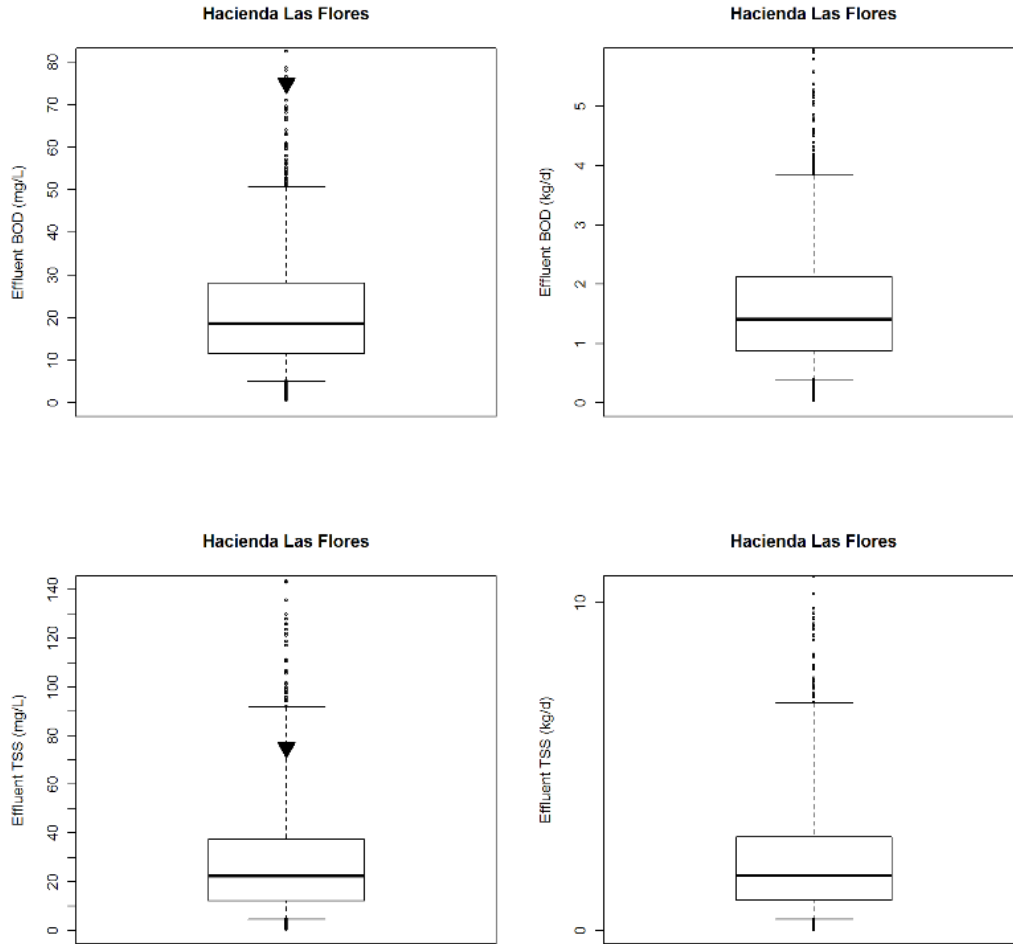
**Figure A.13:** Simulation for the Planta CAR Wastewater Treatment Plant. Design capacity is 0.11 mgd and capacity utilization 100%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



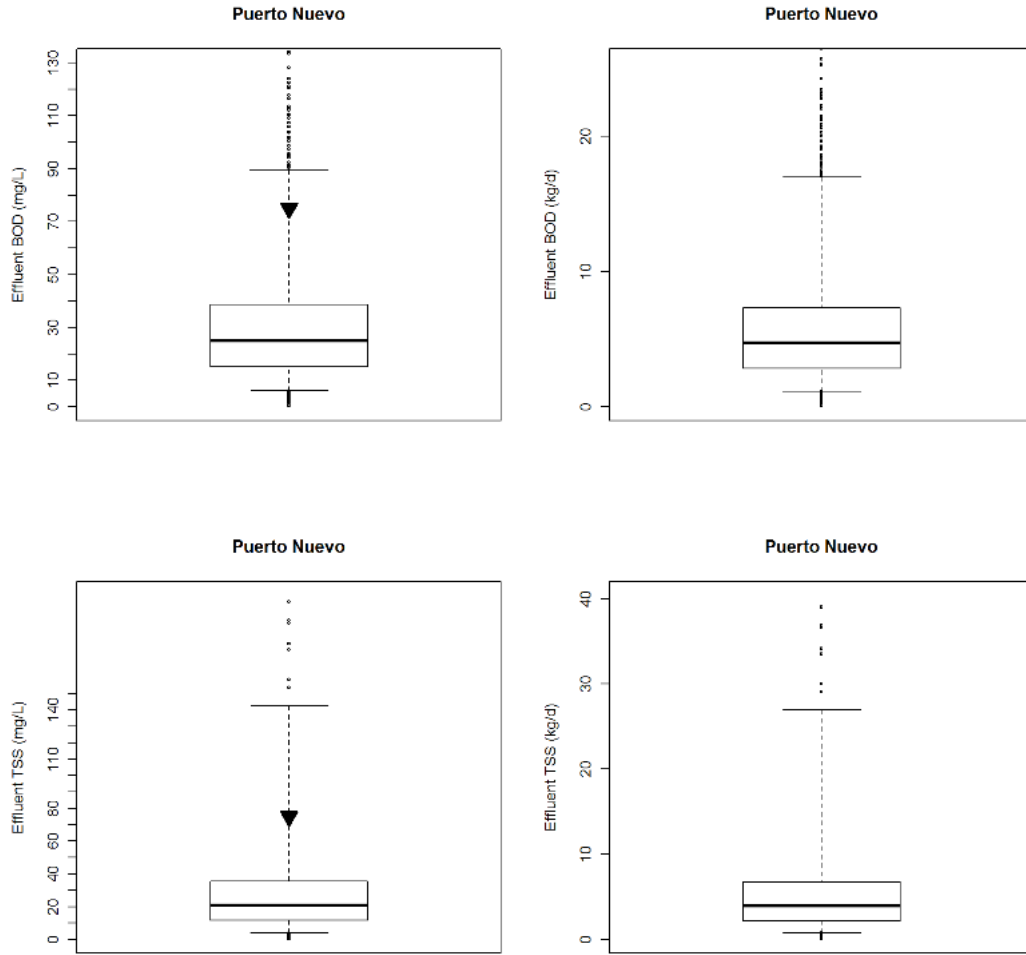
**Figure A.14:** Simulation for the La Cuspide Wastewater Treatment Plant. Design capacity is 0.068 mgd and capacity utilization 73.5%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



**Figure A.15:** Simulation for the San Antonio del Mar Wastewater Treatment Plant. Design capacity is 0.057 mgd and capacity utilization 105%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. Grey diamonds are the actual effluent concentration. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



**Figure A.16:** Simulation for the Hacienda las Flores Wastewater Treatment Plant. Design capacity is 0.046 mgd and capacity utilization 43%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



**Figure A.17:** Simulation for the Puerto Nuevo Wastewater Treatment Plant. Design capacity is 0.046 mgd and capacity utilization 109%. Permit limits for both BOD and TSS is 75 mg/l. Effluent concentration is on the left and effluent quantity is on the right. Black triangles indicate the present permit limit. The upper left graph corresponds to BOD effluent concentration, Figure 4.2 on page 117. The lower left graph corresponds to TSS effluent concentration, Figure 4.3 on page 119. The upper right graph corresponds to BOD effluent quantity, Figure 4.4 on page 120. The lower right graph corresponds to TSS effluent quantity, Figure 4.5 on page 121.



## VITA

Gloria A. Villaverde was born in El Paso, Texas, the youngest child of Pedro P. Villaverde, Jr. and Josephine Villaverde. She graduated from Eastwood High School in El Paso. After pursuing several interests, she finally found biology and graduated *Summa Cum Laude*, earning the Dean's Medal for Excellence in the Sciences from the University of San Francisco. While working toward her Bachelor of Science, her studies focused on intertidal marine invertebrates and transmission electron microscopy, and she presented her research at California Institute of Technology and Occidental College and was invited to membership in Sigma Xi, The Scientific Research Society.

Soon after returning to the Desert Southwest to raise her young son, Gloria began work on her MS degree at New Mexico State University while also teaching at El Paso Community College. Under the direction of Dr. Naida Zucker at New Mexico State University, Gloria studied the reproductive behavior of the common tree lizard *Urosaurus ornatus*. Dr. Zucker and Gloria published a note in the *Southwestern Naturalist*, which was reference so often that Gloria received a request from the herpetological collections curator at the Smithsonian for a copy of the note for their reprint library.

After 12 years of teaching at El Paso Community College, Gloria went to work at the Dean's Office at the University of Texas at El Paso. Subsequently, that environment influenced her to pursue her Doctorate in Environmental Science and Engineering. In addition to academics, Gloria has been an active volunteer for area organizations like the Friends of the Rio

Bosque, Trans-Pecos Chapter of the Texas Master Naturalists, Chihuahuan Desert Wildlife Rescue, and El Paso Rock and Cactus Club. Furthermore, Gloria has created and sold art work at regional, juried art shows and even had a solo exhibit at the Chamizal National Memorial. For several years, Gloria also chaired and organized *Las Artistas Art Show and Sale*, an annual art show that benefits UTEP art students.

Gloria is currently an Assistant Professor at New Mexico State University Alamogordo where she teaches biology and environmental science.

This dissertation was typed by Gloria A. Villaverde