EXECUTIVE SUMMARY

Introduction

The Tijuana River Diversion Study (the "Study") provides an analysis of diversion management capabilities for northbound flows in the Tijuana River Watershed shared by Tijuana, Baja California in Mexico, and San Diego County, California. While seventy percent of this watershed lies in Mexico, the mouth of the river is located in the United States (U.S.). During dry-weather, flows in the Tijuana River reach volumes nearing 1,000 liters per second (lps) or 23 million gallons per day (mgd) and consist mainly of treated wastewater effluent along with unmanaged quantities of untreated sewage discharges, percolating groundwater, or other unidentified point or non-point sources from the urban areas of Tijuana. These flows are normally diverted before they cross into the U.S., and pumped to the coast, approximately 6 miles south of the border. During storm events, however, flows in the river exceed the operational capacity of the diversion system (1,000 lps), and the stormwater flows – laden with sewage, sediment and trash – flow into the United States and empty into the Tijuana River Estuary and, depending on the volume of flows and other factors, may reach the Pacific Ocean. Smaller volumes, due to occasional diversion system failures during dry-weather conditions, may also reach the U.S.

Untreated transboundary flows may result in closure of San Diego County beaches due to potential bacteriological impacts. While it is not practical to prevent 100% of the transboundary flows, especially those flows due to significant storm events, the purpose of this study is to evaluate alternatives to enhance the river diversion infrastructure in order to reduce the number of days of transboundary flows during both dry-weather and post-wet-weather.[1] These alternatives include both improvements to the existing diversion system infrastructure in Mexico as well as new infrastructure in Mexico and in the U.S. to prevent flows from reaching the Tijuana River Estuary. Alternatives evaluated in the study include operational improvements to increase the reliability of existing infrastructure, facility improvements, and capacity expansion to enable operation during small wet-weather conditions and mitigation of post-storm event transboundary flows. The study does not result in a recommendation for a single solution and suggests further analysis through a preliminary engineering and feasibility study is necessary for any of the proposed investment options.

The study includes (1) a **transboundary flow analysis**, (2) a **diversion system infrastructure and operations diagnostic**, and (3) an **evaluation of technical alternatives** identified for potential infrastructure investments in Mexico, in the U.S., or in both countries for mitigation of transboundary flows. The study was directed by the North American Development Bank (NADB), with funding provided by the U.S. Environmental Protection Agency (EPA), and in coordination with EPA, the U.S. Section of the International Boundary and Water Commission (IBWC), the Mexican Section of the International Boundary and Water Commission (CILA), the Mexican National Water Commission (CONAGUA), and the Tijuana water utility, Comisión Estatal de Servicios Públicos de Tijuana (CESPT). This group of agencies form the Study's Core Group for review of all study deliverables and participation in periodic meetings held in Tijuana to present study progress and receive agency comments and input.

[1] Dry-weather flows are flows not caused by rainfall and typically include treated effluent from wastewater treatment plants located in Mexico and "fugitive" untreated domestic and industrial wastewater discharges. For purposes of this study, dry-weather flows are defined as flows less than 1,000 lps (23 mgd), while wet-weather flows exceed 23 mgd and are generally associated with rainfall.

In addition, the study involved stakeholder coordination efforts that included four meetings held in San Diego and Tijuana:

- May 2018: Study kick-off Meeting
- August 2018: 30% progress meeting
- December 2018: 60% progress meeting
- June 2019: final meeting

Representatives of fifteen external stakeholder entities attended the kick-off meeting for the study. During and after the meeting, interviews were held with interested stakeholders to gather information on existing data and efforts relevant to the project, and to solicit stakeholder ideas for resolution of present transboundary flow issues. Stakeholder input was valuable in defining existing problems, identifying potential solutions, and emphasizing the need to secure and leverage financial resources from all funding partners.

Background

CESPT is responsible for the operation and maintenance (O&M) of the drinking water distribution system, as well as wastewater collection and treatment infrastructure serving the residents of Tijuana and Playas de Rosarito, Baja California. This region, one of the largest urban areas in Mexico, has an estimated population of 1.64 million people. The rapid growth of the region has placed a significant burden on public water and wastewater infrastructure and services. Over the past 20 years, CESPT has focused much of its investment efforts on expanding wastewater collection infrastructure to eliminate unsanitary conditions related to direct discharges or inadequate on-site disposal practices. This effort has increased the number of wastewater connections from 170,916 in 1997 to 569,211 in 2017 and improved service coverage from 61.8% to 89.6% of households. However, the poor condition of critical wastewater collection lines, pumps, and the San Antonio de Los Buenos wastewater treatment plant, which have not been modernized or received sufficient maintenance, result in approximately 30% of Tijuana's wastewater entering the river and/or ocean without treatment.

In 1990, IBWC/CILA Minute 283 was signed to provide proper collection, treatment and final disposal of sewage flows in the Tijuana River prior to crossing into the United States. As part of Minute 283, diversion and treatment systems were implemented in both Tijuana and San Diego County as a binational solution to capture wastewater flows and to provide treatment and final disposal of northbound dry-weather flows. The system was not designed to prevent stormwater-related flows from entering the U.S. The existing diversion system, schematically diagrammed in Figure ES-1, pumps dry-weather river flows via the CILA Pump Station (PBCILA), located just upstream of the border to either (1) the South Bay International Wastewater Treatment Plant (SBIWTP), located in the U.S., for treatment and final disposal to the ocean via the South Bay Ocean Outfall (SBOO), or (2) to a second dual-pump station ("PB1A" and "PB1B") and then toward the San Antonio de Los Buenos Wastewater Treatment Plant (SAB WWTP),[2] both located in Mexico. River flows from PB1B sent to SAB WWTP are conveyed via one of two 10-mile pipelines ("parallel conveyance pipeline system") over a 100-meter grade. River flows reaching the SAB WWTP site bypass the treatment plant and discharge directly to the ocean.

[2] Although the capacity of the SAB WWTP is 1,100 lps, it is currently operating at approximately 450 lps due to deteriorated aeration system and limited treatment capacity in the lagoons due to sludge build-up.

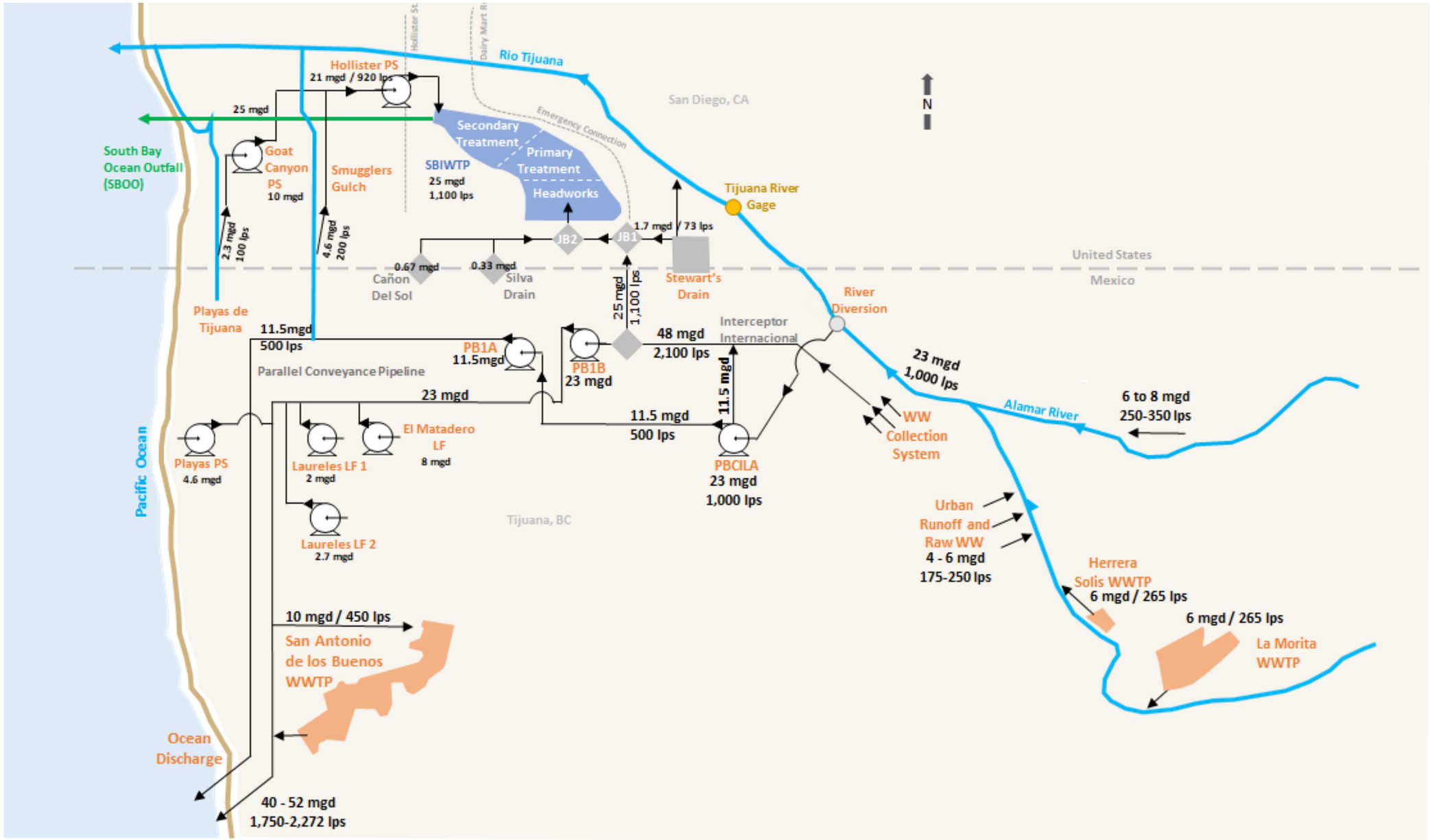

Figure ES- 1. Existing diversion system schematic

The Tijuana River diversion system has been in operation on the Tijuana River (approximately 1,000 feet south of the U.S.-Mexico border) since 1991. CESPT operates the diversion infrastructure through an operations and communication protocol established in coordination with IBWC/CILA. The four-phase protocol defines manual cleanup and monitoring procedures, a required data log for flow volume and pump operations, and communication procedures for service interruption and re-initiation of operations. Although the design capacity of the diversion system is 29 mgd or 1,300 lps, the protocol recommends that pumps be shut down when the river, due to rain, exceeds 23 mgd, or 1000 lps.[3] The purpose of the shut-down is to prevent damage to the pumps from grit and sand carried by stormwater. Once post-wet-weather flows fall back below 23 mgd, CESPT is directed to begin cleaning trash and sediment from the system in order to re-start the pumps. Unfortunately, transboundary flows also occur during dry-weather, due to blockages in the river channel caused by trash and sediment, lift station power outages and/or mechanical failures, and limited O&M practices. Identifying ways to reduce the length of time it takes to get the river diversion system back on-line following a storm event as well as to reduce the transboundary flows associated with these system failures are both goals of this study. However, because the river diversion system cannot be expected to manage all stormwater flows, untreated sewage will continue to reach the U.S. during storm events unless critical improvements are made to Tijuana's wastewater collection and treatment systems.

Transboundary Flow Analysis

The purpose of the **Transboundary Flow Analysis** was to estimate the benefits associated with each alternative by estimating an anticipated reduction in the days of transboundary flows experienced on an annual basis. For the purposes of this study, the number of days of transboundary flows associated with the existing or proposed capacity at the diversion infrastructure was established through a statistical analysis of transboundary flows reported at the IBWC flow gage. It is important to note that the volume of transboundary flows from the Tijuana River can reach levels of up to 9 billion gallons per day due to storm events, making it unrealistic to capture and eliminate all transboundary flows. Additionally, because beach closures/advisories are influenced by a myriad of factors, including flow volume, flow duration, level of river contamination, and direction and strength of currents; it was not possible, during this study, to determine the impacts of each alternative on reducing beach closures.[4] Therefore, findings related to a reduction in days of transboundary flows do not translate to an equal reduction in days of beach closures.

An important finding of the analysis is that improving the operational reliability of the existing diversion system infrastructure can significantly reduce the frequency of transboundary flows (measured by average number of transboundary flow days per year) in comparison to past operations. Coupled with reliability improvements, system capacity expansion could virtually eliminate dry-weather transboundary flows while reducing small wet-weather flows as well, when compared with historical patterns. From November 2009 to March 2016, for example, transboundary flows occurred on average 138 days per year. These flows are mostly associated with wet weather. Improvements in reliability to enable full compliance with the existing operating protocol would reduce this number to about 90 days per year – a 35% reduction. As subsequently described in this report and summarized in Table ES-1,

[3] The analysis of diversion infrastructure technical alternatives presented in this report assumes adjustments to the operational protocol commensurate with the proposed improvements.

[4] Scripps Institution of Oceanography has developed a coastal plume tracking model for the estuary that could be used for such purposes. However, it was not available in time for this study.

storage, treatment, and conveyance system infrastructure investments to increase diversion system capacity provide potential opportunities for further reduction in frequency of transboundary flows from historical conditions.

Table ES - 1. Diversion capacity vs transboundary flow days, November 1, 2009 – March 9, 2016

PBCILA diversion capacity[1]	Average number of transboundary flow days/year
≤ 1,000 lps, no action (historical baseline)	138
≤ 1,000 lps	90
≤ 1,300 lps	69
≤ 1,500 lps	58
≤ 2,600 lps	30

[1]Other than the historical baseline, diversion capacities reflect a protocol-compliant operation, which, when analyzed using existing data (November 1, 2009 – March 9, 2016), result in the average number of transboundary flow days per year shown.

Diversion System Infrastructure and Operations Assessment

The **Diversion system infrastructure and Operations Diagnostic**, presents findings of Arcadis' site visits, interviews, and condition assessment of 170 components of the diversion system. In general, the following contributory factors to transboundary flows were diagnosed:

- **Limited personnel:** For O&M, CESPT has a total of 12 mechanics and two electricians for 148 sites (20 treatment plants, 80 drinking water facilities and 48 lift stations). It is important to note that, while available resources are stretched to operate the system, the existing personnel are very knowledgeable, dedicated and creative in their efforts to maintain the best operating results possible.
- **Limited O&M budget:** It appears that the annual O&M budget is approximately one-third of the amount requested annually.
- **Limited preventive maintenance practices:** Based on site observations and the limited personnel and budget allocated to the system, preventive maintenance of the system appears to be minimal.
- **High-risk physical and performance conditions:** Site visit observations noted deteriorated construction material, evidence of unaddressed mechanical failures, a lack of general site maintenance, as well as the absence of a back-up system in the event of power outages.

Even without an increase in infrastructure capacity, developing and implementing best management practices, hiring sufficient personnel and allocating an adequate budget would improve the reliability of operations and, based on historical data, would **decrease transboundary flow days to less than 95 days/year on average**. The resulting flows would be, by definition, wet-weather flows.

Twenty of the vertical assets evaluated and specific to the diversion system displayed conditions compatible with placement into the two highest risk groups for failure considered in the methodology.[5] Many of the facilities appeared to be in poor states of repair and in need of replacement, including piping, gate, check, plug, and air release valves, pumping, electrical equipment, and motor control

[5] Vertical assets consist of the electrical, mechanical and structural components of facilities typically constructed above ground or accessible from above ground.

centers (MCC) at PBCILA, PB1A and PB1B lift stations. Some of the observed defects at the lift stations include:

- Deteriorated construction materials
- Inefficient intake location and configuration
- Insufficient sediment trapping upstream of the intake
- Inadequate intake screen design for debris
- Lack of mechanical intake debris and sediment removal systems
- Lack of backup power supply
- Lack of stored supplies or equipment and personnel shortages to address mechanical failures in a timely manner
- Inadequate power supply at all lift stations

While some assets may benefit from repairs, this effort would only achieve a short-term solution, with the assets most likely needing to be replaced in the near future. The investment cost to replace those priority assets only on key diversion system facilities is estimated at just over US$8 million as shown in Table ES-2. CESPT has already implemented some of the identified investments, including the purchase of a back-up power supply for PBCILA and two new pumps for PB1.

Table ES - 2. Estimated Replacement Cost of Vertical Assets

Facility	Asset type	Replacement cost (USD)
PBCILA	Electrical	$ 450,000
	Mechanical	$ 2,830,000
	Structural	$ 520,000
PB1A	Structural	$ 400,000
	Mechanical	$ 1,750,000
PB1B	Structural	$ 460,000
	Mechanical	$ 1,750,000
		$ 8,160,000

In addition, more than US$17 million is required to replace linear assets in the diversion system where the remaining useful life is estimated to be less than three years.[6]

[6] Linear assets are those infrastructure components typically constructed at or below ground level in a linear direction and are often not accessible without unearthing materials or using video equipment to assess internal infrastructure conditions.

Table ES - 3. Estimated Replacement Cost of Linear Assets

Location	Remaining useful life	Replacement cost (USD)
PBCILA intake	3	55,000
Gravity main from PBCILA intake	3	2,000,000
International Collector	2.85	15,000,000
		$ 17,055,000

With the exception of the International Collector, the above investment needs are included in the cost estimates of the technical alternatives proposed to address transboundary flows, as presented below. The International Collector, while not a specific component of the diversion infrastructure, is critical to the overall function of the utility's collection and conveyance system and is located adjacent to the border. As a less expensive solution to full replacement of the collector, the Study also estimates a repair cost for this asset of US$9 million based on a "cure-in-place" construction method. Further analysis is required to determine whether this option would be a viable solution for preventing failure of the asset, which could cause a significant spill of raw wastewater into the U.S.[7]

Completing both the Transboundary Flow Analysis and Infrastructure and Operation Assessment was an essential step for defining the baseline information needed to determine potential infrastructure investments that could improve management of the diversion systems for northbound flows in the Tijuana River.

Evaluation of Technical Alternatives

The **evaluation of technical alternatives** documents the performance of fourteen alternatives designed to reduce transboundary flows from the existing (no-action) alternative. The alternatives are categorized as follows:

- **Category 1 – No Action**
  - 1a. No Action (baseline): Historical diversions of Tijuana River flows, November 2009 - March 2016 up to 1,000 lps (23 mgd)

- **Category 2 – Optimize existing diversion facilities in Mexico**
  - 2a. Diversion of all Tijuana River flows up to 1,000 lps
  - 2b. Allow diversions up to 1,300 lps (29 mgd) and improve reliability
  - 2c. Added detention storage upstream of PBCILA in combination with 2b improvements up to 1,300 lps (29 mgd)

[7] The International Collector has been selected for funding from EPA's Border Water Infrastructure Program. Project development activities including an alternative analysis to determine the best option to improve this critical wastewater conveyance infrastructure.

- **Category 3 – Expansion of existing diversion facilities in Mexico**
  - 3a. Diversion system expansion in Mexico up to 2,600 lps (60 mgd)

- **Category 4 – New diversion facilities in the U.S.** up to 1,500 lps (35 mgd)
  - 4a. New lift station to discharge directly to the South Bay Ocean Outfall (SBOO) without treatment
  - 4b. New lift station to discharge at SBIWTP for primary treatment only
  - 4c. New lift station to discharge at SBIWTP for full treatment
  - 4d. New lift station to discharge at Point Loma WWTP
  - 4e. Gravity flow to the SBOO

- **Category 5 – Combination of diversion facilities in the U.S. and Mexico** up to 1,300 lps (29 mgd)
  - 5a. Gravity reclaimed water pipeline from Tijuana's WWTP to SBOO
  - 5b. Gravity reclaimed water pipeline system from Tijuana's WWTPs to Point Loma WWTP
  - 5c. Gravity reclaimed water pipeline system from Tijuana's WWTPs to Punta Bandera
  - 5d. New lift station to divert flows in the U.S. to the Primary Effluent Return Connection (PERC) and treatment at SAB WWTP up to 1,500 lps (35 mgd)

For each alternative, required improvements and equipment were defined, capital[8] and O&M[9] costs estimated, and reduction of transboundary flow days calculated and compared with historical operational data from November 2009-March 2016. To invite input from interested parties, the technical alternatives were presented to the public stakeholders and Core Group on August 28, 2018. Proposed performance measures for evaluation of technical alternatives were also presented and explained, including cost, number of transboundary flow-day reductions, complexity, and public perception.

Considering stakeholder input and after further analysis of the alternatives, in December 2018, updated information related to the investment options was presented to the Core Group. In addition to refining cost and technical definitions, the following changes were made to the list of alternatives:

- Alternative 4e, using a gravity line in the U.S. to convey flows from Mexico to the South Bay Ocean Outfall (SBOO), was eliminated because it would not be technically feasible to meet the required grade for gravity conveyance given the topography for the infrastructure alignment.
- Alternative 2c, using inflatable dams in the Tijuana River channel in Mexico to manage the volume and release rate of flow past the PBCILA intake, was eliminated because the Core Group determined that this alternative would most likely face insurmountable obstacles for implementation, including safety concerns.

[8] Capital costs are planning-level estimates, include 30% contingency and reflect regional labor and material costs.

[9] U.S.-side options are anticipated to operate only during failures of the diversion system in Mexico or when wet-weather flows are up to 1,500 lps (35 mgd). O&M costs assume the diversion infrastructure in Mexico will continue to divert dry-weather flows, as currently operated; therefore, O&M costs for the technical alternatives located in the U.S. include the existing O&M costs for the No Action alternative plus the O&M costs for the new U.S.-side infrastructure, which is estimated to be in operation for an average of 140 days per year.

- An additional technical alternative was identified and added to the list. This option (4f) would use a single inflatable dam on the U.S. side of the Tijuana river, which would formalize an existing practice of using sandbags/soil for the same purpose; a practice that has been found to be effective in controlling relatively low excess dry-weather flows not captured by the existing diversion infrastructure in Mexico.[10]
- An additional option to Alternative 4b was identified and included in the final evaluation. This component involves treatment of wastewater flows at the South Bay Water Reclamation Plant (SBWRP), with a limited available capacity of 2.5 mgd. Flows up to 2.5 mgd from a new U.S.-based lift station could be conveyed to SBWRP.

Further screening of the fourteen alternatives reduced the list to the six shown in Table ES-4, which appear to be the most cost-effective options for investments in either or both Mexico and the U.S. to divert flows most successfully. These alternatives will reduce the percent of time exceedance between 75 and 92% of Tijuana River flows and reduce the frequency of transboundary flows from 138 per year for the historical baseline to between 30 and 90 days per year.

The purpose of this study is to provide decision-makers on both sides of the border with technically feasible alternatives that have the potential to reliably address the dry-weather flows in the Tijuana River, in accordance with the binational agreement established by Minute 283. It is important to note that the study does not offer a single recommendation and that the selection of any of these alternatives must be followed with a detailed feasibility study, preliminary engineering, environmental assessment, final design, specifications and opinion of probable construction cost.

[10] Locating this alternative in Mexico may be a preferred option. A permanent dam could also be evaluated.

Table ES – 4. Refined alternatives benefits, advantages and disadvantages

Category		Alternative	Description	Targeted diversion flow capacity[1]	Capital cost	O&M cost	Average trans-boundary flow days/yr	Comments
No Action	1a	No Action (baseline): Historical diversions of Tijuana River flows, November 2009 - March 2016	Existing facilities and historical diversions	23 mgd 1,000 lps	**$0**	**$2.7 M/yr**	**138**	
INFRASTRUCTURE IMPROVEMENTS IN MEXICO	2a	Optimize Existing Facilities: Diversion of all Tijuana River flows up to 1,000 lps, no diversion when flow exceeds 1,000 lps	River intake and lift station systems improvements (PBCILA, PB1A&1B) for reliable diversion of Tijuana River flows in accordance with existing operational protocol	23 mgd 1,000 lps	**$16 M**	**$4.35 M/yr**	**90**	- Improves capacity for full system operations - Built-up sludge and sediment will be removed from wet wells and influent channels, restoring needed capacity. - Improves operational flexibility. - Increases reliable operations for diversion of all dry-weather transboundary wastewater flows.
	2b	Optimize Existing Facilities with Improvements: Allow diversions up to 1,300 lps and improve reliability	River intake and lift stations (PBCILA, PB1A&1B) additional equipment, backup power supply, removal of silt and trash, and operational protocol modified to allow diversion of Tijuana River flows up to 1,300 lps	29 mgd 1,300 lps	**$23.5 M**	**$4.95 M/yr**	**69**	- Increase the reliability of the diversion system. - Adds NEW capability to continue operations during small storm events and quick start-up of equipment post-storm - In-take improvements for sediment and debris removal protect upstream equipment and reduce manual labor . - New generators mitigate interruptions in electricity service
	3a	Diversion Capacity Expansion: Diversion system expansion in Mexico	Double the nominal capacity of diversion intake, PBCILA, and PB1A&1B lift stations, and modify operational protocol to allow diversion of Tijuana River flows up to 2,600 lps	60 mgd 2,600 lps	**$108 M**	**$6.59 M/yr**	**30**	- In-take improvements for sediment and debris removal protect upstream equipment and reduce manual labor. - New generators mitigate interruptions in electricity service. - Provides additional flexibility in operation. - Additional capacity is only required during storm events (approximately 50 days average per year), resulting in O&M challenges.
NEW INFRASTRUCTURE IN U.S.	4a	New U.S. Diversion Infraestructure: New lift station to discharge directly to SBOO without treatment	New concrete diversion structure, a 35-MGD lift station to tie into SBOO without additional treatment.	35 mgd 1,500 lps	**$27.5 M**	**$5.0 M/yr**	**58**	- Establishes a redundant diversion capacity. - To be used if operations fail in Mexico and/or for small storm events, upto 1,500 lps. - Typical lift station design with familiar operation requirements. Designed for improved water quality. - Includes physical and chemical removal of some sediment. - Undefined terms: Owner/operator? Income source to support operations? Regulatory compliance (CWA) / exception for water quality exceedances?
	4b	New U.S. Diversion Infrastructure: New lift station to discharge at SBIWTP for primary treatment only OPTION: Discharge at South Bay Reclamation Plant	New concrete diversion structure, a 35-MGD lift station with primary treatment at SBIWTP, blending with full treatment discharges.	35 mgd 1,500 lps	**$48 M**	**$7.0 M/yr**	**58**	- Same benefits and concerns as 4a. - Flows receive chemically enhanced primary treatment at SBIWTP, most likely avoiding water quality concerns for discharge; requires upgrades at SBIWTP. - Technical Feasibility: Will mix of water low in food sources affect the biological process? - Regulatory approval may be more favorable due to primary treatment.
	4f	New U.S. Diversion Infrastructure: Single inflatable dam or permanent weir on US-side of Tijuana River OPTION: To be located in Mexico	Detention of small transboundary flows up to 100 lps (2.3 mgd). Flows will be pumped back to PBCILA once the diversion system goes back on-line.	< 2.3 mgd < 100 lps	**$8 M**	**$3.5 M/yr**	**122**	- To control dry-weather transboundary flows due to failure at diversion infrastructure - Formalizes a similar practice implemented by IBWC with effective results (temporary soil berm). - Detention of dry-weather flows to prevent small transboundary discharges due to breakdowns of system in Mexico. - Storage capacity of up to 16 MG or 60,000 m3. - Yearly maintenance required, includes sediment removal - Undefined terms: Owner/operator?

Conclusions

The study highlights the following facts about the existing conditions of wastewater infrastructure in Tijuana and the River Diversion System:

- The condition of critical wastewater collection and conveyance infrastructure in Tijuana is poor. This has resulted in frequent pump failures and line breaks causing raw sewage to flow into the Tijuana River and adjacent canyons.
- Continued investment in Tijuana's wastewater infrastructure and O&M is critical to address the aged and deteriorated infrastructure vulnerable to pipe and pump failures, and inadequate wastewater treatment.
- Operation of the diversion infrastructure in Mexico has been unreliable, with frequent service interruptions due to blockages in the intake structure, lift station power outages, mechanical failures, limited operation and maintenance practices, and an inability to accommodate high trash- and sediment-laden flows associated with rain events.
- Dry-weather flows in the river are approaching the capacity of the diversion system. The raw sewage from infrastructure failures mixes in the river with natural flow from groundwater and treated effluent from upstream wastewater treatment plants. The system that diverts the combined flows into Tijuana's wastewater collection and treatment system is approaching its capacity. Without reuse of Tijuana's treated effluent, continued growth of wastewater generation will continue to exacerbate the problem.
- Temporary soil berms built by IBWC to contain flows in Mexico have been effective in reducing dry-weather transboundary flows caused by mechanical breakdowns, power outages, trash blockages at the diversion system. Similarly, permanent debris traps built by CESPT to contain trash and large items along the river prior to the diversion system have helped to avoid blockages at the in-take infrastructure.
- Beach closures are more likely influenced by the volume of the transboundary flow and not simply due to the number of days of transboundary flow. This study identifies options to reduce the number of days with transboundary flows as well as to address smaller flows in the river that result at the tail end of storms or when there is a breakdown in equipment. The study did not identify any feasible options to prevent transboundary flows above 60 mgd from crossing the border.

The following conclusions may be drawn from the study regarding opportunities for reduction of transboundary flows:

- Mexican-side alternatives for capture and diversion of river flows are typically more cost-effective.
- Due to obstacles related to permitting and O&M in the U.S., Mexican-side alternatives are likely more feasible to implement at a quicker pace.
- Reliable operation of the diversion system in Mexico along with investments to enhance the existing infrastructure provide the lowest-cost approach and reduce annual transboundary flow days by 35% with Alternative 2a and by 50% with Alternative 2b.
- Projected O&M budgets for U.S.-side alternatives assume that Mexico will still be operating their system at capacity and that the U.S.-side alternatives would only be operated on an as-needed emergency basis.

- Upstream wastewater recycling would reduce the need to increase capacity of the diversion system. Diverting treated effluent, from both La Morita and Herrera-Solis WWTPs for reuse would reduce the dry-weather flow in the river.
- Diverted river flows and outflows at all lift stations should be metered continuously with a new SCADA system and new central control room, with a commitment to share this data with the Core Group entities.
- Backup power supply is needed for reliable operation of the PBCILA, PB1A and PB1B lift stations.

It is also crucial that the following inter-related investments be made in Tijuana's wastewater system:

- Repairs to prevent pipeline failures, uncontrolled discharges, and inadequate treatment within the collection, conveyance and treatment infrastructure
- Investigations to identify causes and measures to mitigate fugitive flows to the river or other low-lying areas
- Adequate and sustained O&M budgets and programs

Finally, a comprehensive solution to reducing transboundary flows must include actions related to stormwater and waste management; however, neither is the responsibility of CESPT, nor will they be improved by the infrastructure investment options identified in this study.

Overall, the study presents the top six investment options to improve the effectiveness of the diversion system at the U.S.-Mexico border for management of dry-weather flows in the Tijuana River. Some of these options also offer the potential for diversion and treatment of small wet-weather flows resulting from storm events, as well as a more rapid response to post-storm event conditions. Implementation of diversion system operational and/or capacity improvements in conjunction with other collection, conveyance and treatment system improvements are needed to maximize the effectiveness of the diversion system.