FINAL

Technical Memorandum

Saturn Boulevard Feasibility Study

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Acronyms and Abbreviations

Acronym	Definition
City	City of San Diego
County	County of San Diego
DPR	Department of Parks and Recreation
HDPE	high-density polyethylene
IBWC	International Boundary and Water Commission
Navy	U.S. Department of the Navy
TRV	Tijuana River Valley

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1 Study Background and Objectives

The County of San Diego (County) Department of Parks and Recreation (DPR) contracted with Dudek, D-Max, and Dokken (consultants) to provide a technical evaluation of the Saturn Boulevard culvert crossing in the Tijuana River Valley (TRV) as it relates to water quality and potential impacts to public health. The TRV has experienced degraded water quality largely due to private and public management in the tributary watershed to the TRV in both the United States and Mexico. Satellite imagery, observation reports, and air quality monitoring have identified the Saturn Boulevard crossing as a community concern due to foaming and elevated levels of hydrogen sulfide observed around the culvert, which have the potential to aerosolize and spread pollutants from the water to the air. As a key land manager of the TRV, DPR is pursuing opportunities that would result in elimination or reduction of the foaming and air quality issues at Saturn Boulevard and reduce the subsequent impacts on public health. This technical memorandum provides a summary of the analyses conducted in pursuit of the objective, alternatives considered, and recommendations for next steps.

Several potential solutions were identified and evaluated based on foreseen pros and cons relating to the expected constructability, permitting, cost, maintenance, and overall feasibility for long-term success. Through collaboration with the County, City of San Diego (City), and U.S. Department of the Navy (Navy), the alternatives were refined to a list of the most likely projects to move forward. Concept designs, detailed cost estimates, and project descriptions were created for each selected alternative. The hydrology, water quality, and habitat benefits, as well as project permitting considerations and maintenance of the selected project scenarios, are summarized in this memorandum. Detailed fact sheets for each alternative carried forward are presented in appendices.

1.1 Study Area

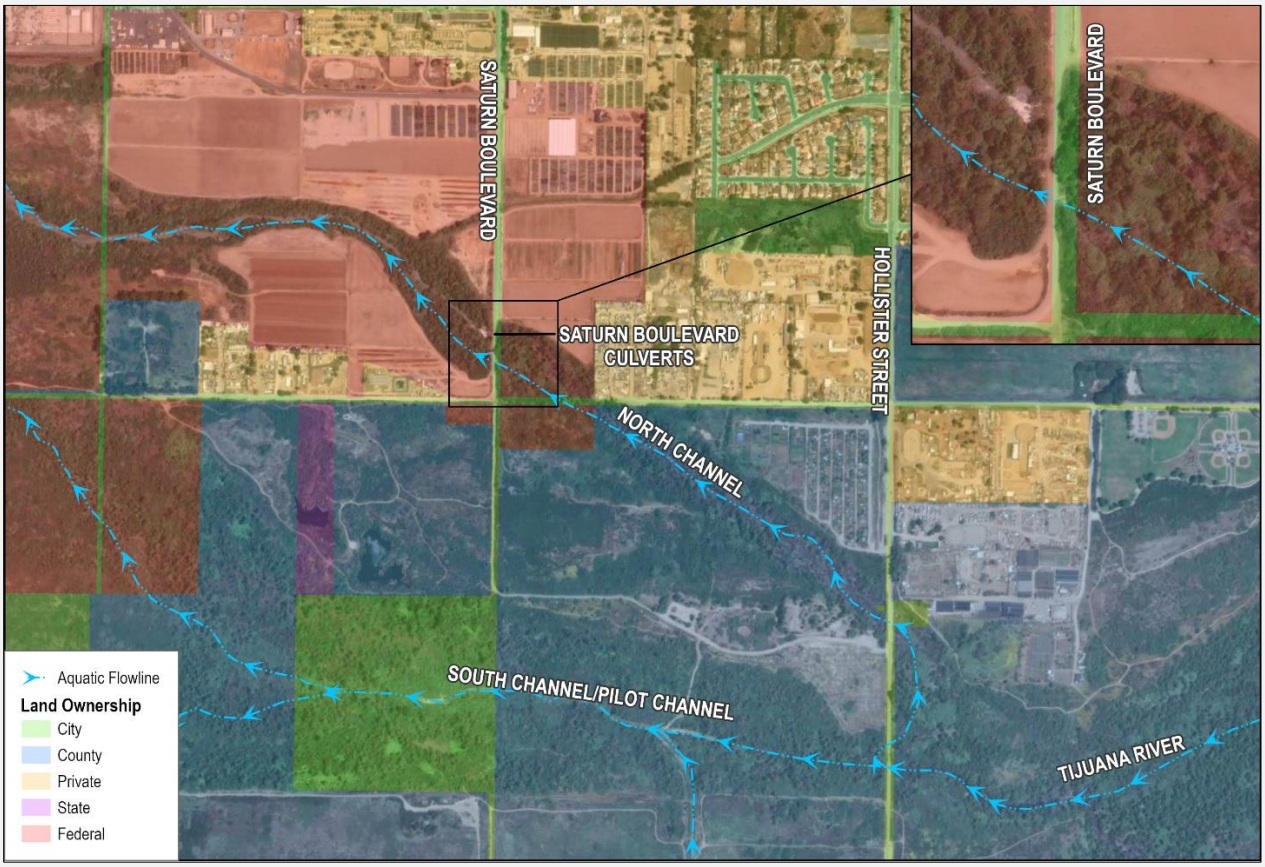
The approximately 120-mile-long Tijuana River is fed by a 1,750-square-mile watershed in the coastal mountains of San Diego County and Baja California, Mexico. Approximately 75% of the watershed is in Mexico, including the majority of the mainstem Tijuana River. The Tijuana River crosses into the United States 6 miles east of the Pacific Ocean and drains through an alluvial plain where the TRV floodplain begins.

The Tijuana River historically meandered seasonally across the TRV before development of berms and channels to direct the river for flood control and agricultural purposes. Where the Hollister Street bridge crosses the TRV, the river splits between a North Channel and South Channel but the river historically drained mostly through the South Channel. In the winter of 1993, a large storm event flooded the TRV and changed the course of the river to flow primarily into the North Channel which created flood concerns and erosion issues for properties along the North side of the TRV. After the 1993 storm, the City of San Diego built a berm (known as the Erodible Berm) to divert flows less than an approximately 10-year storm event away from the North Channel and dredged an approximately 1-mile-long Pilot Channel in the South Channel. This channel extends west from the Hollister Street Bridge to guide flows to the South. Since 1993, increased sediment to the South Channel from the mainstem river and the tributary known as Smuggler's Gulch, combined with maintenance challenges in the upstream reach of the Pilot Channel have blocked the river from flowing to the South as designed under most dry weather and minor storm conditions. As a result, the river today has created a channel that flows into the North Channel around the berm intended to block these flows.

Saturn Boulevard crosses the North Channel approximately ¾ of a mile downstream of the split with the South Channel. The crossing was originally designed as an Arizona crossing when the river primarily drained through the South Channel and the North Channel was normally dry. When the river suddenly shifted to flow into the North Channel in 1993, the City of San Diego revised the crossing under an emergency order and installed culverts under the roadway to handle the majority of flows. The Arizona crossing remained in place for bypassing flows beyond the culverts' capacity. These culverts have effectively conveyed most flows under the roadway but have been damaged (as well as the surrounding roadway) during high flow events that overtop the entire roadway section.

The study area for this evaluation includes where Saturn Boulevard crosses the North Channel, as well as the area where the North and South Channels split and the Pilot Channel. The right-of-way around Saturn Boulevard is owned by the City and the Navy owns the land on either side of the right-of-way, including the river channel. Saturn Boulevard is used as an access point for the public to the County-owned Tijuana River Valley Regional Park, which encompasses a large portion of the TRV, including the Pilot Channel. Saturn Boulevard also provides access to several private properties located between the North and South Channels. Figure 1 presents land ownership in the vicinity of the study area.

Figure 1. Land Ownership in the Vicinity of the Study Area.



1.2 Existing Conditions in the Tijuana River Valley

Prior to modern development in the TRV, the river meandered across the valley, creating multiple braided channels that would change seasonally. Since flood protection berms were constructed to protect development on either side of the river valley, as well as to create protected agricultural land, the river has been confined to the mainstem and North and South Channels, with bias to the North Channel due to sediment buildup in the South Channel. Aside from the flood protection berms, there is minimal human-made infrastructure directly within the flow path of the river including a bridge at Dairy Mart Road, two bridges along Hollister Street, and the Saturn Boulevard crossing.

1.3 Existing Conditions at Saturn Boulevard

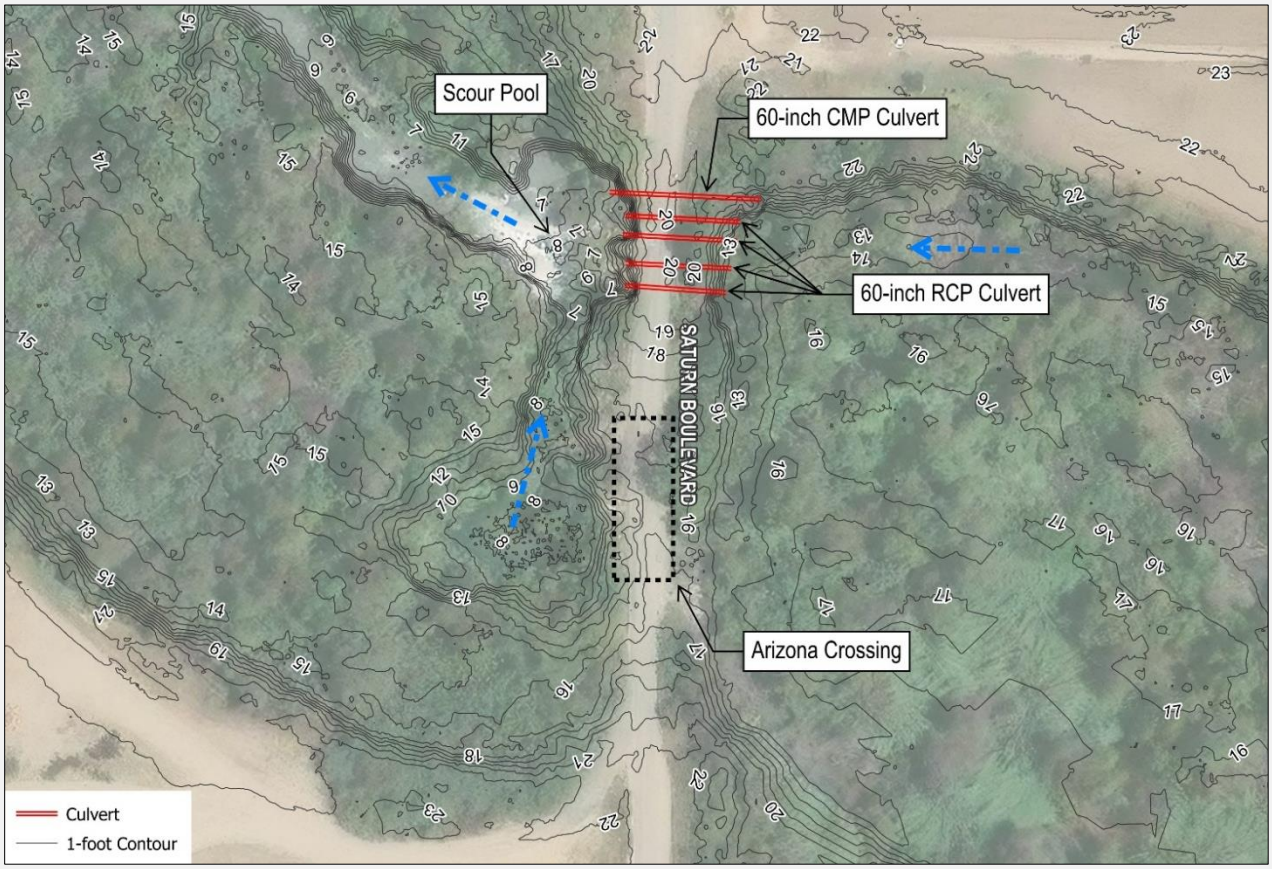
To build an understanding of the existing conditions, a field investigation was conducted in August 2025, and a second site visit was conducted in October 2025. The intent of the field assessment was to observe existing conditions, identify potential site-specific characteristics that may contribute or cause the foam and release of hydrogen sulfide gas occurring around the culvert, verify as-built conditions, and collect measurements of the culverts to inform the project alternatives.

The field measurements collected included the following:

- Approximate depth of water relative to culvert invert at intake (upstream) and outlet (downstream)
- Estimated flow rate using a simplified field assessment method
- Approximate extent of foam upstream (if any) and downstream of the culvert

The river crossing includes a low-flow pipe culvert section and a high-flow Arizona crossing section. The low-flow culvert section includes one 60-inch corrugated metal pipe and four 60-inch reinforced concrete pipes. The Arizona crossing section is a lower section of roadway within the channel where water is designed to overtop the road. Figure 2 presents the existing infrastructure at the Saturn Boulevard crossing.

Figure 2. Saturn Boulevard Crossing of the North Channel.

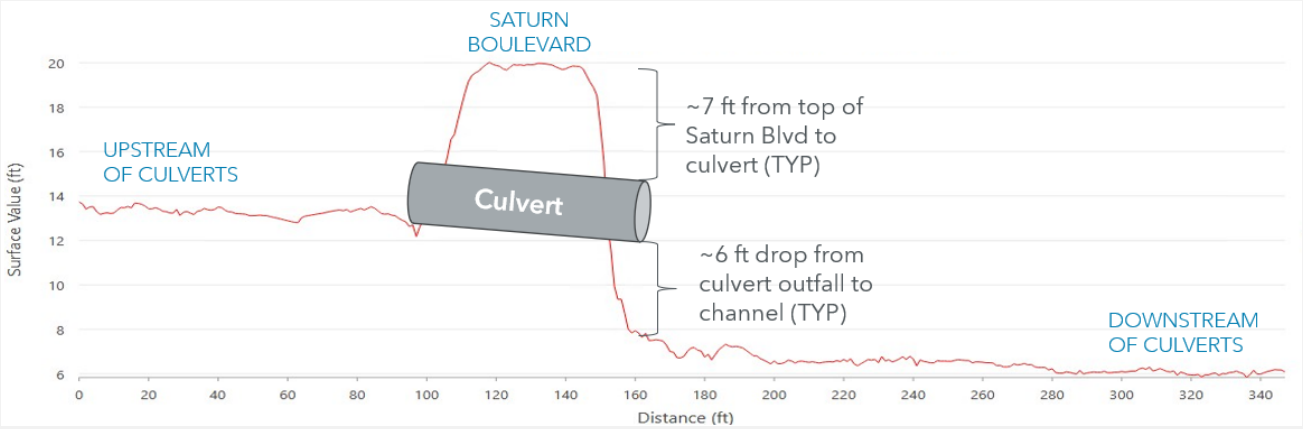


Under dry-weather flow conditions, the river passes under the roadway through the pipe culverts. Under wet-weather conditions, flows passes under the roadway through the pipe culverts until the water surface elevation is high enough for water to also flow around the pipe culverts and over the roadway at the Arizona crossing. Flows through the Arizona crossing connect with the main channel that is downstream of the existing pipe culverts. An as-built or record drawing documenting the design capacity of the culverts is not available; however, DPR staff have indicated that water flows over the Arizona crossing during most storm events, which suggest the culverts are designed or at least currently only have capacity for low-flow or dry-weather flows.

The culverts currently discharge flows approximately 6 feet above the elevation of the river during dry-weather flow conditions. Review of publicly available historical topographic data indicates that scouring of the riverbed downstream of the crossing has occurred over the last 20 years, which is consistent with a process known as undercutting, which occurs when water flows over a hard surface (roadway) and a softer/unprotected surface (riverbed) downstream. The culvert outfalls have some riprap dissipation to help reduce the potential for scour; the City conducted minor riprap repair around and downstream of the culverts in December 2024 in an attempt to re-build the outfall to as-built conditions, reduce the potential for scour, and reducing foaming associated with the turbulence of water flows in that

location. However, the culverts remain elevated above the river channel and create a waterfall into the downstream pool of water. Figure 3 presents a typical cross section profile for one of the culverts under Saturn Boulevard.

Figure 3. Typical cross section of the Saturn Boulevard culvert.



The combination of poor water quality and turbulence from the 6-foot culvert drop likely results in the foam that has been observed at this location. A minor amount of foam was also observed upstream of the culverts where the river moves through a relatively turbulent section, but the predominant area of foam has been consistently observed in the scour pool directly downstream from the culverts. Historical aerial photos from Google Earth show foam occurring in this location since February 2024 (see Exhibit 1). Prior to 2024, the available aerial photos do not indicate the presence of foam at Saturn Boulevard. Based on the International Boundary Water Commission Tijuana River flow gage at the international boundary, January 2024 saw the highest instantaneous daily maximum flow on record, which dates back to 2000. This storm event likely accelerated the amount of erosion downstream of the culverts, increasing the depth of the scour pool below, which, combined with pollution in the water, has likely resulted in the foaming that has occurred in the last couple years.

Exhibit 1. Saturn Boulevard Photos.

Culvert discharge point and foaming downstream in scour pool. Photo date: 8/27/2025.

Minor foam observed upstream of the culverts. Photo date: 8/27/2025.

Exhibit 1. Saturn Boulevard Photos.

Historical aerial photos from Google Earth indicate present of foam in 2024 and 2025. Foam was not visible in aerial photos from 2010 through 2023.

1.4 Analysis Goals

The goal of this analysis is to evaluate potential projects that might contribute to a reduction of the public health hazard that is caused by aerosolization of water pollutants at Saturn Boulevard. Recognizing that source control of water pollutants is beyond the scope of this analysis, potential project ideas include modifications to the existing infrastructure at Saturn Boulevard, new infrastructure, channel modifications, and regional modifications in the TRV that would redirect dry weather flows away from the North Channel. Each project idea is evaluated primarily for its potential to reduce foaming and/or turbulence in the water as it passes through the Saturn Boulevard crossing. However, the feasibility of implementing a project is the primary driver for whether a project moves from the idea stage into being considered and evaluated as a preliminary concept alternative.

This analysis is designed to give DPR, the City, and the Navy the background needed to further advance alternatives from the preliminary concept stage; however, each project will still require extensive planning in addition to this report prior to design and construction. Background information analyzed for each alternative includes the estimated project duration, projected construction cost, probable environmental permitting requirements, and long-term maintenance considerations. These factors, as well as a general project description, pros and cons list, and construction/installation methods, are presented on individual project fact sheets in Appendices A through E.

2 Potential Alternatives Analysis

Potential alternatives initially analyzed for effectiveness and feasibility are presented in this section. Following the initial field investigation; review of existing opportunities being planned in the TRV; evaluation of water quality and air quality monitoring data; and discussions with DPR, the City, and Navy, an initial list of potential short-, mid-, and long-term alternatives was developed. The list includes a preliminary analysis of project components used to gauge effectiveness towards reducing the public health issue and feasibility of project implementation. Each component was qualitatively evaluated and compared to other project alternatives. The final list of project alternatives carried forward into the concept design stage is presented in Section 3.

2.1 Short-Term Alternatives Considered

Short-term alternatives focused on relatively low-cost solutions with shorter implementation/permitting requirements. Since infrastructure improvements will require a significant amount of additional planning and design effort, short-term projects mostly include instream treatment/processes, management changes, and a temporary infrastructure improvement to the culverts at Saturn Boulevard. Table 1 presents the short-term alternatives considered in this analysis.

2.2 Mid-Term Alternatives Considered

Mid-term alternatives can generally be implemented within 10-years and include instream infrastructure improvements to Saturn Boulevard and the adjacent channel. The mid-term alternatives are focused on localized infrastructure improvements intended to reduce the turbulence caused by the current configuration of the culverts. The mid-term alternatives will require a significant amount of additional planning, design, and permitting effort compared to the short-term alternatives. Table 2 presents the mid-term alternatives considered in this analysis.

2.3 Long-Term Alternatives Considered

Long-term alternatives are considered to require 10 or more years to complete and include more substantial projects, including major infrastructure changes to Saturn Boulevard and elsewhere in the TRV. Long-term alternatives address the public health issue by reducing turbulence at Saturn Boulevard through localized infrastructure changes or by diverting dry-weather flows away from the North Channel, which would result in a similar effect. Due to the desire for a long-term solution, one of the two preliminary long-term alternatives has been caried forward into the concept design stage. Table 3 presents the long-term alternatives considered in this analysis.

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Table 1. Short-Term Alternatives Considered

Action/ Alternative	Targets		Initial Cost	Maintenance	Environmental Permitting	Likely Effectiveness	Pros	Cons
	Pollution	Turbulence						
Ozonation	X		Low to Medium	Medium to High	Low to Medium	Medium	▪ Likely to reduce H_2S and bacteria/ pathogens	▪ Would not address aerosolization of industrial chemicals
Aeration	X		Low to Medium	Medium	Low	Low	▪ Likely to reduce H_2S	▪ Would not address other pollutants (bacteria/pathogens, industrial chemicals, etc.)
Defoamer	X		Low	Medium	Unclear if allowed	Very Low	▪ Likely to improve aesthetics only (reduce foam)	▪ Would not significantly improve transport of water pollutants to air
Increased diversion of flow at border to IBWC treatment plant	X	X	Currently funded by IBWC	IBWC Responsibility	Underway by IBWC	Low to High	▪ Would eliminate water (and subsequently foam) at Saturn Blvd.	▪ May still have issues at Saturn Blvd. during flows above IBWC intake capacity
Add more riprap immediately downstream of culvert		X	Low to Medium	Low	Medium	Low	▪ Lower cost ▪ Short implementation timeframe	▪ Would still be high-velocity water hitting rocks, which creates turbulence and aerosolizes pollutants
Add pipe extension to outlet flow below water surface downstream of culvert		**X**	**Low to Medium**	**Low to Medium**	**Low to Medium**	**Medium to High**	▪ **Would reduce turbulence by eliminating drop from culvert outlets to downstream water surface**	▪ **May be damaged during storms and potentially need replacement** ▪ **Would slightly reduce capacity of culverts for wet weather/ large events**

Bold text indicates the alternative carried forward into concept design.

Table 2. Mid-Term Alternatives Considered

Action/ Alternative	Targets		Initial Cost	Maintenance	Environmental Permitting	Likely Effectiveness	Pros	Cons
	Pollution	Turbulence						
Add large amount of riprap or other materials across channel downstream of culvert as a dam to create a ponded area with water surface at or just above invert of culvert outlets		X	Medium	Medium to High	Medium to High	Medium	▪ Would reduce turbulence by eliminating drop from culvert outlets to downstream water surface ▪ If sufficiently anchored against large storms, could accumulate sediment between dam and culvert, which would be a more "natural" way of filling back in the scour pond	▪ May need to add a large quantity of material to form a large enough dam to hold back water ▪ May be blown out by large storms ▪ Potential to increase the downstream water surface elevation during storm events which would increase the frequency and duration of floodwaters over the roadway
Non-natives removal and channel restoration to allow the river to spread out within the channel upstream of Saturn Boulevard	X		Medium	High	Medium	Low	▪ No impact to infrastructure at Saturn Boulevard ▪ Removal of non-native plant species	▪ Unlikely to reduce current pollutant concentration to a level that eliminates aerosolized pollutants at the culverts ▪ Long term and challenging maintenance requirements ▪ Multiple landowners within the maintenance area

Table 2. Mid-Term Alternatives Considered

Action/ Alternative	Targets		Initial Cost	Maintenance	Environmental Permitting	Likely Effectiveness	Pros	Cons
	Pollution	Turbulence						
							▪ Habitat restoration that promotes the River to spread out in the channel and filter through native plant species ▪ Potential to reduce velocity	
Add fill to raise elevation in channel downstream of culvert		X	High	Medium to High	High	High	▪ Would reduce turbulence by eliminating drop ▪ Should return to conditions as they were before around 2023, when foam was not reported at this location	▪ Large permitting hurdles and cost ▪ Would need significant maintenance after large storm events to prevent problem from re-occurring
Excavate channel upstream of Saturn crossing to approximately same elevation as present downstream of Saturn		X	High	High	High	Low	▪ No benefit to hydraulics	▪ Culvert pipes would still be at the same elevation, so lowering the channel elevation of Saturn would not have any effect on the elevation drop and high velocity observed downstream of Saturn, which is controlled by the culvert pipe elevations, not the upstream channel elevation
Replace current culvert with new pipes; make pipes steep and then flat to control outlet velocity		X	High	Medium to High	High	Medium to High	▪ Would cause jump inside pipe, where should typically be submerged and therefore aerosolization should be limited	▪ Large road construction project that would impact access
Replace crossing with bridge		X	High	Medium	High	Low to Medium	▪ Would reduce potential for human contact with the water	▪ High cost ▪ Would restrict access for extended period for construction ▪ Would still have a large elevation drop across Saturn Blvd, water would still be high velocity, and would likely still see turbulence
Replace current culvert with bridge and remove channel crossing		X	**High**	**Medium to High**	**High**	**High**	▪ **Bridge has larger cross section, which combined with flattening channel slope would reduce velocity and turbulence**	▪ **High cost** ▪ **Visual impacts** ▪ **Would restrict access for extended period for construction**
Replace current culvert with box culvert/bridge structure		X	**High**	**Low to Medium**	**Medium to High**	**Medium to High**	▪ **Wider cross section would reduce velocity** ▪ **Culvert structure would provide stability for roadway during high-flow events**	▪ **Would restrict access for extended period for construction**

Table 2. Mid-Term Alternatives Considered

Action/ Alternative	Targets		Initial Cost	Maintenance	Environmental Permitting	Likely Effectiveness	Pros	Cons
	Pollution	Turbulence						
Replace current culvert with box or pipes and fill/grade downstream channel		X	High	High	High	Medium to High	▪ Downstream fill reduces elevation drop and turbulence at outfalls ▪ Fill and grading around crossing provides protection for the roadway during high-flow events	▪ High cost ▪ Would restrict access for extended period for construction ▪ Increased maintenance requirement compared to roadway modification only alternatives

Note: Bold text indicates the alternatives carried forward into concept design.

Table 3. Long-Term Alternatives Considered

Action/ Alternative	Targets		Initial Cost	Maintenance	Environmental Permitting	Likely Effectiveness	Pros	Cons
	Pollution	Turbulence						
Divert dry weather flows to Southern Channel		X	High	Medium to High	High	High	▪ If there are no dry weather flows in the north channel, there is no longer a dry weather air/water pollution problem at Saturn. ▪ Would move channel away from residents and further from Navy Landing Strip ▪ Would restore channel's original configuration to that prior to 1993	▪ High cost and environmental impact ▪ Would require dredging of Pilot Channel and likely need to extend the erodible berm across the existing North Channel to cut off flows to the north ▪ The effectiveness of this alternative declines if the Pilot Channel is not maintained regularly. Funding for regular maintenance does not currently exist.
Remove Saturn Blvd		X	Medium	Low	Medium	High	▪ Allows for regrading of channel to reduce turbulence ▪ Habitat restoration	▪ Medium capital cost ▪ Community impacts caused by property acquisition and subsequent removal of Saturn Blvd.

Note: **Bold** text indicates the alternative carried forward into concept design.

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3 Concept Designs

The following section presents a brief summary of the project alternatives that were further analyzed following feedback on the initial list of potential options presented to the County and other stakeholders. As part of this stage of the project, detailed fact sheets for the five alternatives were created (Appendices A through E). Table 4 provides the general sections of information that are included with each project alternative fact sheet.

Table 4. Project Alternative Information

Fact Sheet Section	Description
Project duration	Estimated timeline for completion of the project alternative once funding has been received
Estimated construction cost	An estimated range of construction costs to reflect the planning level of detail
Pros and cons	Advantages and disadvantages of the proposed alternative
Detailed project description	Project scope, objectives, and key features
Opportunities and constraints	Factors that may facilitate or limit project implementation
Construction/installation methods	General steps and methods required for construction
Permitting considerations	Evaluation of potential environmental regulatory permitting requirements for regulatory compliance
Maintenance and monitoring	Long-term maintenance and monitoring needs to ensure sustainability and performance
Concept design figures	Figures outlining the overall concept design
Detailed cost estimate	Cost estimate breakdown including construction items, indirect costs, and escalations for potential annual increases in materials/labor costs and market volatility

The goal of the concept design fact sheets is to provide a standalone description of each alternative for ease of communications with County staff, partner agencies, and other stakeholders including the public. They are intended to be used as a starting point for the next phases of planning and design that are still required for any alternative that gets carried forward. In anticipation of improvements to the design that will likely occur over time for an alternative that gets carried forward, project impacts and cost estimates include contingency and reflect conservative judgement to cover the majority of potential outcomes and unknown conditions that exist at the current planning level.

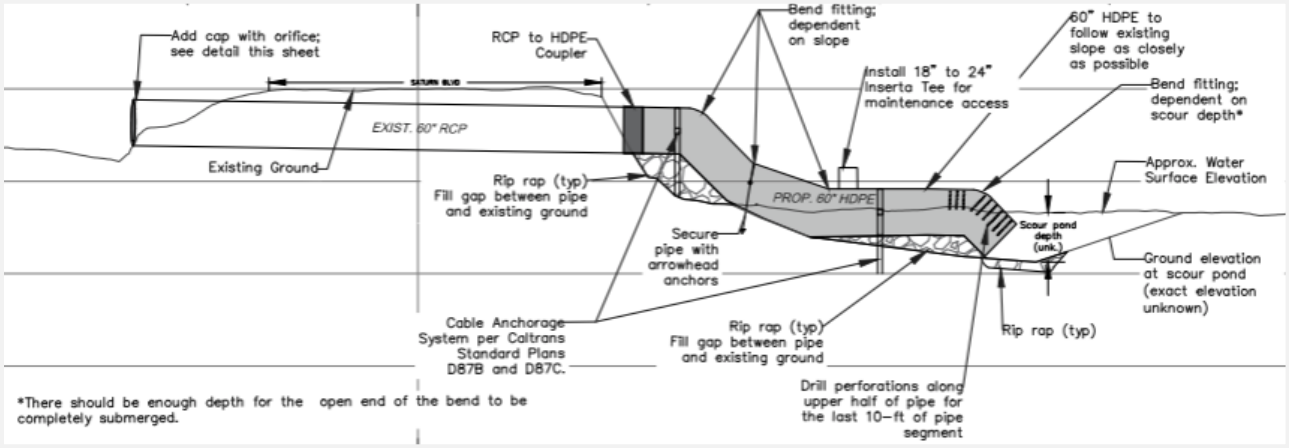
3.1 Short-Term Concept Design

A temporary culvert extension downstream of the existing culverts at Saturn Boulevard was the short-term project alternative that was analyzed further for feasibility. The benefit to the short-term solution is that it can be implemented relatively quickly with minimal complexity.

3.1.1 Temporary Culvert Extension

This proposed alternative would add temporary plastic (high-density polyethylene [HDPE]) pipes that would extend from the end of the existing culvert pipes to the scour pond downstream of the culverts, with the pipe exit located below the water surface. By placing the discharge pipe under water, turbulence and subsequent potential to transport pollutants from water to air are expected to be reduced. Figure 4 presents a typical profile for the pipe extension concept design, and the detailed project fact sheet is presented in Appendix A.

Figure 4. Profile of the Proposed Pipe Extension Concept Design.



3.2 Mid-Term Concept Designs

Three mid-term project alternatives were analyzed further for feasibility. These projects involve significant planning and design efforts, though not as extensive as the long-term concepts. In addition to this, they would also be higher cost and require more extensive environmental permitting compared to the short-term concepts.

The mid-term concepts target improvements located at the existing Saturn Boulevard crossing. At Saturn Boulevard, mid-term concepts include modifications that maintain a crossing within the channel and a concept that includes replacement of the channel crossing with an overhead bridge. Both project types include various levels of channel modifications to improve resiliency and limit turbulence. Both project types will also require further design and technical analysis, especially as related to hydrological studies, to explore any inadvertent impacts from the changes.

Certain assumptions were used in the development of the mid-term concept designs to cover current and future unknown conditions:

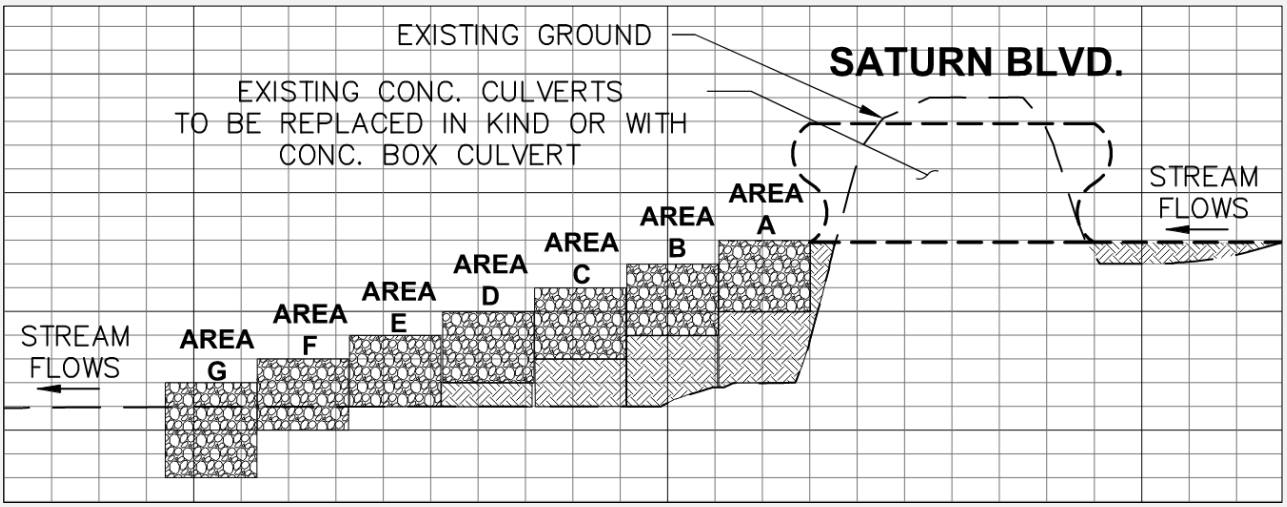
- Any modification to the Saturn Boulevard roadway would at a minimum maintain the current level of service it provides for the public.
- Dewatering of the channel during construction would include pumping dry weather flows around the work area.

- Public access along Saturn Boulevard would be closed during portions of construction, and traffic for the properties south of the crossing would be diverted to the dirt road that connects with Hollister Street to the east or through an alternative route to be decided during design
- Detailed engineering calculations during the design phase will ultimately determine infrastructure size, placement, and other channel modifications such as cut/fill quantities for grading.

3.2.1 Channel Fill and Culvert Replacement

The channel fill and culvert replacement project alternative intends to eliminate turbulence and the subsequent foaming issue at Saturn Boulevard by filling the channel downstream of the culverts. This alternative also includes improvement to the aging infrastructure with either new pipes or replacement of the existing pipes with a box culvert. The primary method proposed to achieve this outcome is to fill the downstream scour pool in the channel with a staircase of gabion mattresses. Replacement of the pipe culverts is recommended primarily due to being in poor condition but there is also an opportunity to realign the culverts to further reduce turbulence. The gabion mattresses would extend across the channel and provide erosion protection on the downstream side of the roadway where scour is most likely to occur. Additionally, the area around the intake to the culverts would be regraded and buildup of sediment and debris would be removed to help direct flows through the culverts. Figure 5 presents a typical profile for the channel fill and culvert replacement project, and the detailed project fact sheet is presented in Appendix B.

Figure 5. Typical Profile for the Proposed Channel Fill and Culvert Replacement Project.

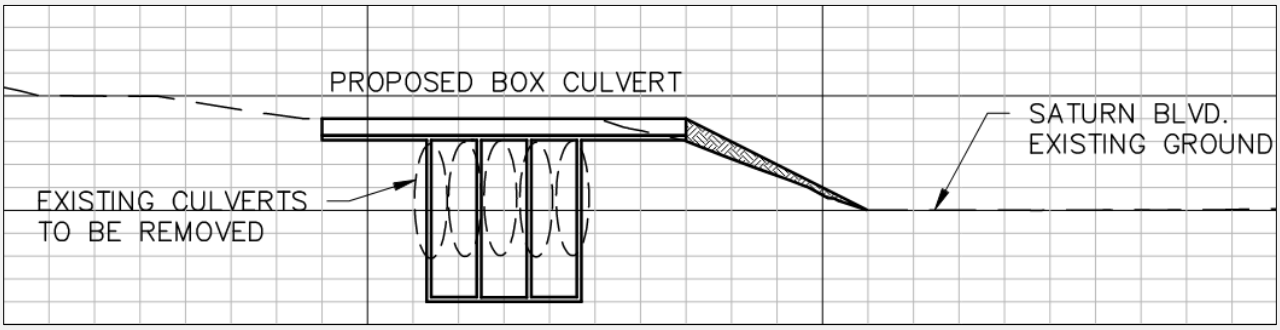


After replacement of the culverts with new pipes or a box, it is also recommended to replace the rest of the existing asphalt roadway through the river crossing with a concrete surface. The City has noted that the section of roadway through the channel, especially at the lower Arizona crossing, is often damaged during overtopping events. Replacing the entire crossing surface from bank to bank with concrete would create a significantly harder surface that is less likely than asphalt to be damaged during overtopping.

3.2.2 Box Culvert/Bridge

The box culvert/bridge project alternative intends to eliminate turbulence and the subsequent foaming issue at Saturn Boulevard by regrading the channel upstream and downstream of the existing culverts and replacing the culverts with a box culvert. The box culvert is estimated to be a 30-foot-wide triple box culvert. Any box structure that is greater than 20 feet wide is technically considered a bridge for registration purposes. Regrading the channel through this section would create a smoother transition across the elevation differential that occurs between the upstream side and downstream side of Saturn Boulevard. Replacement of the existing reinforced concrete pipe and corrugated metal pipe culverts with a box culvert would allow the discharge invert elevation to be dropped to the elevation of the pool downstream, which would reduce the amount of turbulence through the crossing. The box culvert would replace the roadway section where the current culverts are located and would be secured into the surrounding area with wing walls and cutoff walls. Figure 6 presents a typical profile for the box culvert/bridge project, and the detailed project fact sheet is presented in Appendix C.

Figure 6. Profile of the Proposed Box Culvert Replacement.



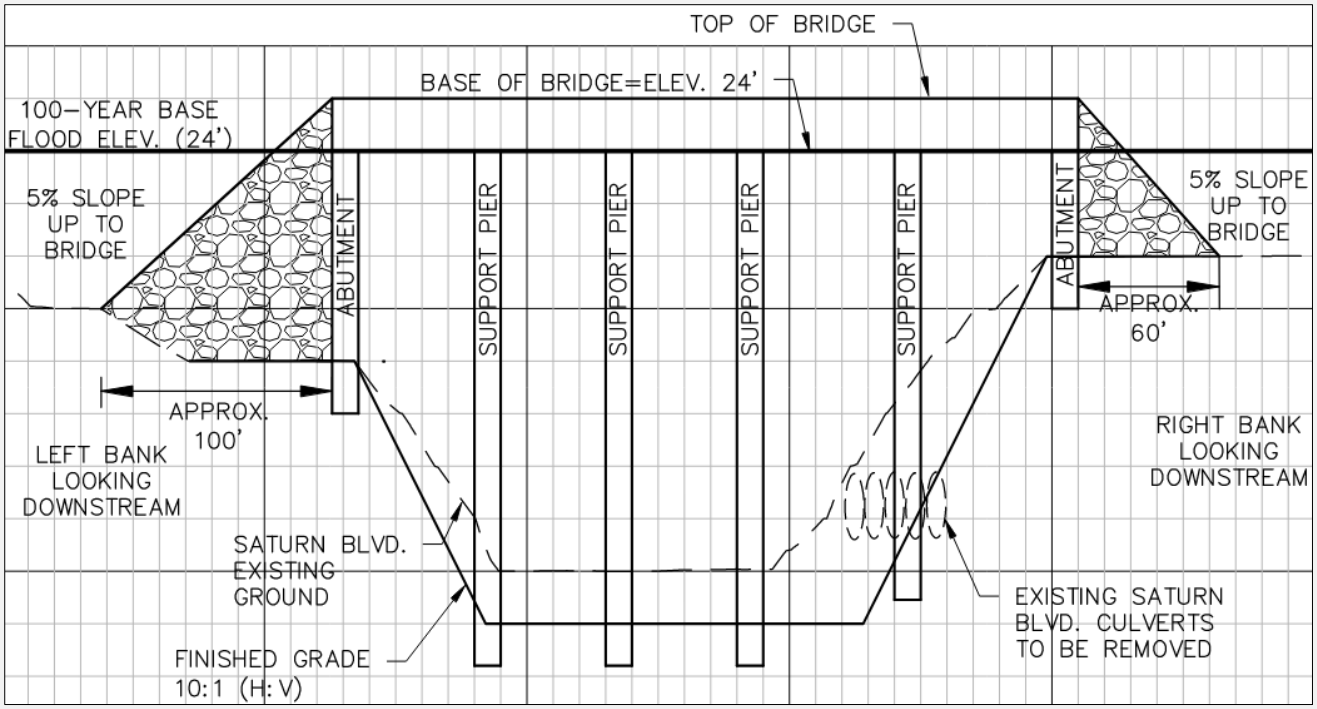
In addition to replacing the culvert section of the crossing with a box culvert, it is also recommended to replace the rest of the existing asphalt roadway through the river crossing with a concrete surface. The City has noted that the section of roadway through the channel, especially at the lower Arizona crossing, is often damaged during overtopping events. Replacing the entire crossing surface from bank to bank with concrete would create a significantly harder surface that is less likely than asphalt to be damaged during overtopping.

3.2.3 Saturn Boulevard Bridge

The Saturn Boulevard Bridge project alternative intends to eliminate turbulence and the subsequent foaming issue by entirely removing the crossing within the channel and replacing it with an overhead bridge. Removing the crossing, including the culvert and Arizona crossing sections, would allow for the channel to be regraded and returned to a more natural flow regime with less elevation differential across the crossing and thus a reduction in turbulence. The bridge would be sized to provide at a minimum the same level of service that the current crossing provides for the public now. Key components and consideration included in the concept design for the bridge include the 100-year base flood elevation as defined by the Federal Emergency Management Agency, approach ramps to allow traffic onto the bridge, abutments and piers to support the bridge, and channel modifications to

smooth the grade, redirect flows, and protect the bridge infrastructure and banks. Figure 7 presents a profile of the bridge concept, and the detailed project fact sheet is presented in Appendix D.

Figure 7. Profile of the Proposed Bridge.



3.3 Long-Term Concept Designs

One long-term project alternative was analyzed further for feasibility. This long-term project would require the most extensive planning and design. Due to the scope and complexity of the project, it would also be the highest cost and require the most extensive environmental permitting.

The long-term concept focuses on improvements outside of Saturn Boulevard. The long-term alternative selected for concept design is diversion of dry weather flows into the Pilot Channel and away from the North Channel. This project alternative does not include modification to the Saturn Boulevard crossing, but it eliminates the foam source along the north side of the TRV and thus achieves a similar outcome as the other concept designs.

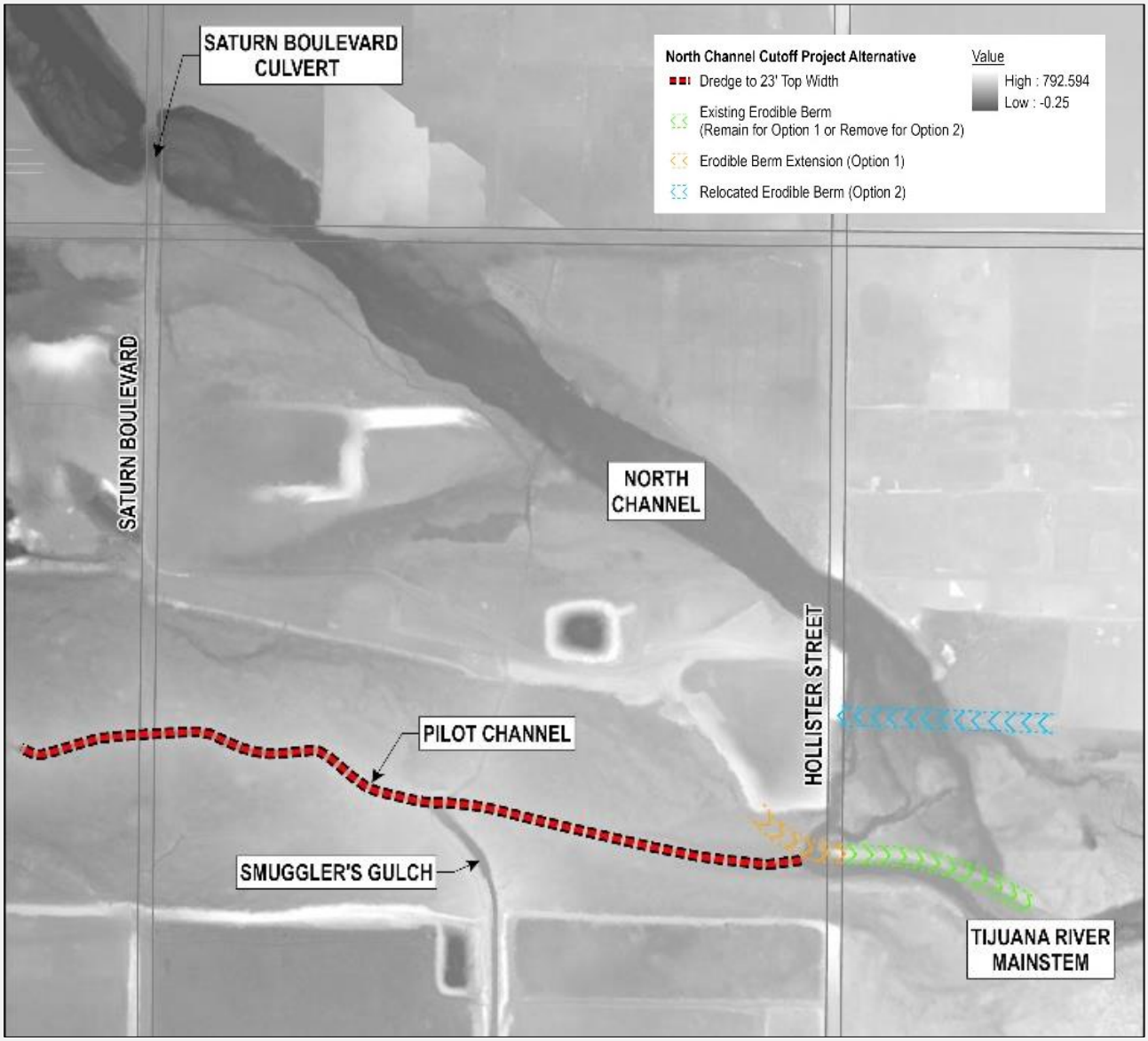
3.3.1 North Channel Cutoff

The North Channel Cutoff project alternative intends to eliminate turbulence and the subsequent foaming issue at Saturn Boulevard by redirecting dry-weather flows away from the North Channel and thus eliminating the source of polluted water. As described in the introduction, the North Channel is a historical route for the Tijuana River that branches to the north off the mainstem of the river just upstream from the Hollister Street Bridge. Prior to the 1993

storm event, the primary route for dry weather and most wet weather flows was through the southern part of the river valley through a channel now known as the Pilot Channel. During the 1993 storm event, the river changed course and cut a route into the historical North Channel, which has since become the primary exit for the river under dry and most wet weather flow conditions.

Two options are proposed for cutting off the North Channel. Option 1 includes extending an existing berm known as the Erodible Berm to create the cutoff across the North Channel adjacent to the Pilot Channel. Option 2 includes removing the Erodible Berm and constructing a new berm further downstream across the North Channel perpendicular and extending east from the wooden Hollister Street Bridge abutment. In combination with a dredged Pilot Channel, preliminary modeling efforts indicate both options eliminate dry-weather flows from going through the North Channel. The two options were evaluated to study if there are any unintended consequences or opportunities as a result of the relatively major change in hydraulics that could occur after reconfiguring berms within the floodplain. Figure 8 presents the North Channel cutoff concept options, and the detailed project fact sheet is presented in Appendix E.

Figure 8. North Channel Cutoff Concept Options.



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4 Conclusion and Recommendations

This section presents the conclusions and recommendations for the concept design alternatives that were developed in this analysis. The primary considerations used to evaluate each project alternative include effectiveness, feasibility, and cost. Detailed analysis for each concept design are presented on the fact sheets in Appendices A through E and a summary of the findings is presented below.

4.1 Concept Design Summaries

Table 5 presents an analysis summary for each concept design. Effectiveness refers to how each concept alternative will help reduce or eliminate the public health issue associated with aerosolized water pollution at Saturn Boulevard, the feasibility for construction, environmental permitting, and long-term maintenance, and the estimated cost for perspective on the scale of each project.

Table 5. Concept Alternative Summaries

Effectiveness	Feasibility	Cost
Temporary Culvert Extension		
▪ Likely to contain foaming issue within pipe extensions as long as dry-weather flows remaining consistent with current conditions ▪ Effectiveness may change with time if extensions fill with debris and are not maintained ▪ Ineffective if disconnected due to damage or concerns with flooding	▪ Construction would be minor and would not require infrastructure improvements or new structures. ▪ Environmental permitting will be minimal assuming the amount of riprap placed in the channel is minimized. ▪ Frequent maintenance is recommended, especially after storm events, to remove debris that could cause a backup in the pipes.	▪ $2.5 million to $4.4 million ▪ Cost includes initial maintenance ▪ Lowest cost alternative but only a temporary solution.
Channel Fill and Culvert Replacement		
▪ Effective at reducing turbulence after filling the downstream scour pond ▪ Effectiveness unlikely to change over time as long as gabions are maintained ▪ Highly effective at reducing future erosion around the channel crossing	▪ Common construction methods can be used to build the gabions with easy access from Saturn Boulevard. ▪ Impacts on the channel from the proposed project will require significant environmental permitting and compensatory mitigation. Planted gabions may reduce the mitigation requirement. ▪ Maintenance activities include repairing or replacing damaged gabions and removal of excessive vegetation/debris. ▪ Gabion repair costs are significantly less expensive than concrete repair on average.	▪ $14 million to $18 million ▪ Cost includes initial maintenance of the facility as well as 5 years of maintenance and monitoring for off-site and on-site mitigation. ▪ Lower cost than the bridge or culvert options but the gabions will likely require more maintenance than a bridge.
Box Culvert/Bridge		
▪ Regrading the channel and lowering the downstream invert elevation should reduce the amount of turbulence compared to existing conditions. ▪ Effectiveness over time may change if scour downstream is not managed through maintenance.	▪ Significant channel grading effort required but box culvert(s) can likely be precast and placed into the channel to limit construction time. ▪ Impacts on the channel from the proposed project will require significant environmental permitting and compensatory mitigation.	▪ $18 million to $23 million ▪ Cost includes initial maintenance of the facility as well as 5 years of maintenance and monitoring for off-site and on-site mitigation. ▪ Similar cost to filling the channel fill and culvert replacement project.

Table 5. Concept Alternative Summaries

Effectiveness	Feasibility	Cost
▪ A large box culvert will have significantly more capacity that the existing reinforced concrete pipe culverts, which will reduce the frequency and duration of overtopping of the roadway.	▪ Maintenance frequency is anticipated to be minimal due to the large opening that can pass more debris than the existing culverts. ▪ Culvert repair may require significant effort if concrete damage occurs.	▪ Less maintenance costs on average but repairs could be significant if the concrete structure is damaged
Saturn Boulevard Bridge		
▪ Returns the channel to a natural flow regime and would be designed to reduce turbulence and limit erosion. ▪ Expected to be highly effective over time once the channel is reshaped to match the existing conditions upstream and downstream. ▪ Removing the channel crossing significantly reduces the likelihood of human contact with the river at this location.	▪ Construction of the bridge will require complex engineering and significant changes to the existing riverbanks to meet minimum flood plain safety requirements. ▪ Impacts on the channel from the proposed project will require significant environmental permitting and compensatory mitigation. On-site mitigation may be an option for the footprint of the removed channel crossing. ▪ Only minor maintenance within the channel is expected to ensure bridge supports are not damaged and channel armoring is intact. ▪ The new bridge structure itself will require more frequent but potentially less significant maintenance. ▪ Limited space on the south approach to the crossing may require extensive modification to the roadway for bridge construction.	▪ $60 million to $75 million ▪ Cost includes initial maintenance of the facility as well as 5 years of maintenance and monitoring for off-site and on-site mitigation. ▪ Highest cost alternative for modifications to Saturn Boulevard. ▪ Significant changes in the bridge design and level of service will likely increase costs.
North Channel Cutoff		
▪ Highest effectiveness since it removes the dry weather flow completely at the Saturn Boulevard crossing. ▪ Effectiveness is expected to be maintained as long as the North Channel cutoff is maintained to direct flow towards the south side of the river valley.	▪ Requires the most construction and earthwork within the floodplain where it has historically been extremely difficult to access. ▪ Redirecting the river away from the North Channel will have implications to hydrology and potential impacts on surrounding properties that will require a significantly	▪ $80 million to $110 million ▪ Includes 5 years of maintenance and monitoring for off-site (or on-site) mitigation, and 5 years of Pilot Channel maintenance ▪ Highest cost for construction and maintenance of all alternatives

Table 5. Concept Alternative Summaries

Effectiveness	Feasibility	Cost
▪ The existing crossing would remain without further modification. ▪ Directing dry-weather flows away from the North Channel has the added effects of increasing the quantity and quality of floodplain habitat in the southern valley through more frequent inundations while also reducing the potential for floodwater to impact properties along the north side of the river valley.	greater level of planning and coordination than the other alternatives. ▪ Impacts to the channel will require significant environmental permitting; however, it is anticipated that the net benefits from improving habitat in the southern part of the river valley with increased river flows will offset the temporary and permanent construction impacts. ▪ The erodible berm will be designed with armoring and designed to require minimal maintenance. However, the Pilot Channel will require significant and frequent maintenance to maintain a clear path for dry weather flows into the southern part of the river valley.	▪ Additional regular funding for maintenance will be needed beyond what is included and is currently being conducted.

4.2 Recommendations

The recommended project alternatives are intended to address aerosolization of pollutants at Saturn Boulevard as quickly as possible with a short-term solution to buy time for planning and designing an effective mid- and long-term solution aligned with stakeholders in the TRV. This approach will require more resources than moving straight into a long-term solution, however, it is recommended in order to quickly address the ongoing issue at Saturn Boulevard and allow adequate time for meaningful consideration of project specific details that can significantly impact mid- and long-term project effectiveness.

4.2.1 Short-term Recommendation

The recommended short-term project alternative is the temporary culvert extension project. No other short-term project alternative advanced to the concept design stage because after assessing the potential effectiveness of each idea, none were deemed reasonable or had too many variables that would impact effectiveness. The culvert extension project combines a relatively inexpensive temporary solution that does not require earthwork or changes to the existing infrastructure. The primary concerns with this project are installation and maintenance crews coming into contact with the water and how the pipe extensions will perform during peak flow events. However, the potential level of effectiveness may serve as a good short-term solution while a long-term project solution is advanced through planning and design.

4.2.2 Mid-term Recommendation

The recommendation for a mid–term solution should be determined in conjunction with the direction and vision of stakeholders in the TRV. No specific mid-term solution is recommended at this time but out of the mid-term projects that modify the area around Saturn Boulevard, it appears that the culvert/bridge option at Saturn Boulevard would have similar effectiveness to the other alternatives presented in Table 5 with potentially fewer channel impacts, less frequent maintenance requirements, and lower cost than the overhead bridge option. The gabion mattresses option may provide more armoring downstream of the crossing and be a similar cost to the culvert/bridge option, but there is potential for it to require more frequent maintenance, which may be difficult to sustain if contact with the river water is necessary. The overhead bridge option is likely the most effective of the infrastructure projects at Saturn Boulevard to solving the foaming issue; however, the significant construction cost, required modification to the surrounding riverbanks, visual impact, and relative benefit to public access are significant reasons to prioritize one of the other options first.

4.2.3 Long-term Recommendation

If the direction from stakeholders in the TRV is to look for a regional project that could have larger benefits than just eliminating the foam at Saturn Boulevard, it is recommended that the North Channel cutoff project be selected as the long-term solution. This project is highly effective at eliminating dry-weather flows at Saturn Boulevard and thus the subsequent foaming issue, and it also has the added benefits of potentially increasing the amount of flow into the southern river valley where there are opportunities for new and existing habitat restoration that would benefit from more frequent inundation. While the cost and length of construction for this project is reason enough to prioritize one of the other options first when considering the immediate issue at Saturn Boulevard, the potential benefits from the North Channel cutoff project to flood control and habitat in addition to solving the issue at Saturn Boulevard presents a substantial opportunity that should be carried forward into further planning and design if the project aligns with the stakeholders' direction and vision.

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Appendix A

Short-Term Project Alternative: Temporary Pipe Extension Fact Sheet

Alternative Name: Temporary Pipe Extension Downstream of Culvert

Project Summary

Project Term	Short-term*
Duration (Design, Permitting and Construction)	<1.5 years
Estimated Construction Cost Range	$2.5 – $4.4M (depends on the number of culverts to which pipe extensions are added). Approximately $2.9M for scenario with two culvert extensions.
Pros	▪ Reduced turbulence and associated foam and transport of pollutants from water to air at Saturn Boulevard ▪ Simple construction/installation that could be completed in relatively short time frame
Cons	▪ Somewhat reduced capacity of culverts during wet weather (i.e., large storm events) ▪ May be damaged during large storms, could require corrective maintenance ▪ Likely would require periodic field visits during wet season to ensure culvert entrances and pipe extensions have not become clogged by storm debris

Note:
* A term of approximately 5-years is estimated for this alternative. Subject to change based on inspection/maintenance efforts.

Background

The Saturn Blvd. river crossing of the North Channel of the Tijuana River includes a low-flow pipe culvert section and high-flow Arizona crossing section. Foam and poor air quality have been observed at this location. Turbulence downstream of the pipe culverts combined with poor water quality in the river appear to be the source of the issues. Under most dry-weather flow conditions, the river passes under the roadway through 2 to 3 of the pipe culverts, while the remaining culverts stay dry. Under wet-weather conditions, flows pass under the roadway through the pipe culverts until the water surface elevation is high enough for water to flow around the pipe culverts and over the roadway at the Arizona crossing located to the south of the pipe culverts.

Project Description

This proposed alternative would add temporary plastic (HDPE) pipes that extend from the end of the existing culvert pipes to the scour pond downstream of the culverts, with the pipe exit located below the water surface. By placing the discharge pipe under water, turbulence and subsequent potential to transport pollutants from water to air are expected to be reduced.

To limit potential for damage during storms, a cap would be installed over the upstream end of each culvert with a pipe extension, with an opening in the cap large enough to convey peak dry weather flow rates as determined from IBWC Tijuana River flow data (available from a station at the international boundary). The reduction in capacity resulting from the cap with orifice would not increase the likelihood of the Arizona crossing overtopping during wet

weather events as the majority of the wet weather flows for existing conditions already go over the Arizona crossing. Furthermore, the proposed caps would be specifically designed to prevent dry weather flows from going over the top of the road by having the openings sized to allow conveyance of peak dry weather flow per the IBWC Tijuana River flow data.

The HDPE pipe extensions would also be installed to follow the existing slope as closely as possible. The slope between the culvert outlets and the downstream scour pond is mainly comprised of riprap or similar material. Where that slope is not even and there would be gaps between the slope and the HDPE pipe, adding riprap to fill those gaps so that the pipe can lay flat against the slope is proposed. Temporary anchoring systems are also proposed to stabilize the HDPE pipes during high flow conditions. Riprap is proposed to be added at the discharge point from the pipe extension into the scour pond to prevent erosion.

Number of Pipe Extensions

Installing a pipe extension on 2 of the existing culverts, rather than all 5, and then partially blocking the other culverts with a weir appears to be a feasible option. Installing fewer pipe extensions would reduce the project cost and also reduce the amount of temporarily installed pipe to be checked and maintained. The cost range presented at the beginning of this fact sheet reflects approximate costs for installing 1 pipe extension (low end) to 5 pipe extensions (high end); the cost for installing 2 pipe extensions is also described at the beginning of this factsheet, as that is the recommended number of extensions to install based on field visit findings, as described below.

Multiple field visits to the project site indicated that only 2-3 out of the 5 culverts have flow during dry weather conditions. Total flow rates (i.e., sum of the flows observed in all culverts) during those field visits have been estimated at less than 10 cfs. Data from the IBWC flow gage at the international border shows overnight flows sometimes reach a max of approximately 0.9 m^3/s (about 32 cfs) during dry weather. This flow rate is used as a conservative estimate of maximum dry weather flows at Saturn Boulevard. The existing culverts are 60-inch pipes, and a single 60-inch pipe can easily convey 32 cfs. At a 1% slope, a 60-inch RCP flowing 25% full (15 inches deep) conveys about 35 cfs. Additional analysis of the culvert crossing was performed in HY-8 (i.e., Federal Highway Administration culvert analysis software) to evaluate the performance of a single 60-inch pipe with extension when the outlet is completely submerged. Results indicate that a single pipe is able to convey approximately 50 cfs prior to reaching the Arizona crossing low point even when the tailwater is well above the pipe crown at the outlet (i.e., 3-ft above pipe crown, or an assumption of ~8-ft deep scour pool); with 2 culvert extensions proposed, the system would be able to safely convey peak dry weather flows. Although 2 of the 5 culverts would have smaller openings, the remaining 3 culverts would retain more of the existing wet weather culvert capacity by installing weirs instead of caps over the bottom sections of the culverts that do not have pipe extensions, such that dry weather flows are blocked from entering the pipes, but when flow is higher during wet weather events, some flow can still pass through the culvert pipes. The weir heights would be sized to be slightly higher than the proposed caps with orifice, so that each pipe is able to convey flows immediately after the cap orifice is completely submerged. This would result in an approximate capacity of 22 cfs for each pipe, and a total capacity of 66 cfs; this represents two times the maximum dry weather peak flow; the proposed design would not increase the risk of overtopping of the Arizona crossing or the Saturn Boulevard Crossing for dry weather events.

For large storm events, FEMA's 100-year floodplain indicates a very wide floodplain, with water depths about 4 feet higher than the road where the pipe culverts are located and about 8 feet higher than the part of the road where the Arizona crossing is located. This means the amount of flow conveyed through the pipe culverts during wet weather is likely a small percentage of total flow that passes over Saturn Boulevard, and changes to the floodplain due to temporarily capping existing culverts are unlikely.

As previously mentioned, the 2 culverts with pipe extensions would prevent dry weather flows from overtopping the road by having a large enough orifice to allow for each pipe to convey the peak dry weather discharge, approximately 32 cfs. Additionally, to avoid any dry weather flows from overtopping and reaching the Arizona crossing, the weirs of the culverts without pipe extension will be designed to be lower than the low point leading to the Arizona crossing. A concept design is presented in Figure 1 and Figure 2. The plan view exhibit shows pipe extensions for 2 culverts only.

Opportunities/Constraints

Opportunities

Reduces turbulence and associated foaming and transport of pollutants from water to air by eliminating drop from culvert outlets to downstream water surface.

Constraints

The system may be damaged during storm events and would somewhat reduce the capacity of the culverts during storm events. Will require maintenance to ensure proper functionality after storm events.

Based on multiple site visits, the farthest north and south pipes appear damaged, the former, a CMP showing signs of corrosion while the latter is an RCP broken off at its outlet; pipe extensions along these 2 pipes are not recommended to avoid potential failure of the CMP and/or the road crossing. The 3 middle pipes appear to be in fair condition, and pipe extensions along 2 of these pipes are proposed.

The system would need to be properly anchored with one to two anchorage systems to avoid lateral movement of the proposed extensions and consequently ensure that the joint between the existing culverts and the proposed extension is properly sealed. The proposed connector at this joint would not compromise the structural integrity of the existing culverts by avoiding drilling or other methods that could otherwise negatively impact structural integrity. The connector would instead be attached via several layers of compression bands as well as an external sealing band; see Figure 4 for an example of a dissimilar RCP to HDPE connector. Conversations with vendors indicated that the connector is suitable for the intended use, as long as it is properly anchored, pointing out as the only design consideration for systems above ground using this type of connector, to include a UV film over it for protection against the elements.

Another concern is the lateral movement of the pipe extension during high flow events and how it could act as a lever and exert force on the existing culverts, potentially compromising structural integrity. To address this concern, the pipes will be tightly anchored with one to two cable-with-collar systems; these systems are strong and used as a standard anchorage system by Caltrans. The proposed anchorage systems would be similar to the Caltrans standard design with the caveat that it may need to be modified based on further geotechnical evaluation and consequent recommendations. If the anchors work as intended and keep the pipe extensions from moving, the concern of lateral forces impacting the integrity of the existing pipes is eliminated. Furthermore, if the anchor system were to fail, and given what the pipe connector is made of and how it is attached, it is highly likely that the extension system will break apart rather than exerting enough force to laterally move the existing buried culverts. It is worth mentioning that backfilling the pipes with riprap in place of the cable anchorage systems is an alternative that was considered but not proposed due to the significant environmental permitting resulting from the large fill quantities involved.

Construction/Installation Methods

The general steps and methods for this alternative for each culvert pipe with a pipe extension are as follows:

- Thorough site assessment to be performed prior to start of construction
- Clear culvert of any sediment, debris, and vegetation.
- Install temporary cap on upstream end of culvert pipe (culvert inlet) to prevent flow from entering that culvert pipe while the pipe extension is being installed.
- Install dry weather diversion and dewatering systems if needed.
- Install HDPE pipe extension with dissimilar coupler.
- Extend HDPE pipe from culvert outlet to scour pond, with discharge point below the water surface. Pipe should be installed to follow existing ground as closely as possible. Use bend fittings as needed, and fill in gaps between the pipe and the slope surface with riprap or similar material.
- Drill perforations along upper half of downstream pipe segment (approximately along last 10-ft of pipe extension at the downstream end near the scour pool)
- Place riprap at the downstream discharge location within the scour pond.
- Install cable anchoring system/s, and arrowhead anchors as needed.
- Install Inserta Tee (access/observation port)
- Remove temporary cap from culvert inlet.
- Install cap with orifice at culvert inlet (orifice height to be 15-inches based on 2 pipe extensions; size subject to change based on final number of pipe extensions installed) .

For culvert pipes that will not have a pipe extension installed, complete the following:

- Install cap with weir at culvert inlet to prevent dry weather flows from entering the pipe.

Permitting Considerations

If the pipe extension can be installed without riprap and a temporary diversion system, then environmental permitting is likely not needed for this project. If riprap and/or a temporary diversion system are needed, then the following impacts and subsequent permits are likely applicable.

- **Impacts** – An estimated 0.01-acre of waters/wetlands consisting of open water habitat would be permanently impacted at the outfall of the extended pipe culverts from the placement of riprap. Additional impacts of about 0.01-acre are likely required for temporary diversion during construction. The majority of the impacts would occur on federal land, located within the Coastal Overlay Zone, outside of City of San Diego or County of San Diego land use jurisdiction or Multiple Species Conservation Plan Multi Habitat Planning Area.
- **Permits** – Required authorizations would include:
  - **US Army Corps of Engineers, Section 404 Clean Water Act** – The project would require authorization under one of the following Nationwide Permits (NWP):
    - **NWP 14** – Linear Transportation Projects (impacts are limited to 0.5-acre)
    - **NWP 18** – Minor Discharges (impacts are limited to 25 cubic yards and 0.1-acre)

- NWP 43 – Stormwater Management Facilities (however channel may not be considered a stormwater management facility)
- NWP 27 – Aquatic Ecosystem Restoration, Enhancement, and Establishment Activities (but the culvert extension may not be considered an aquatic ecosystem improvement)
- NWP 37 – Emergency Watershed Protection and Rehabilitation (but this permit requires involvement of National Soil Conservation Services or US Forest Service)
- San Diego Regional Water Quality Control Board, Section 401 Clean Water Act and State Porter-Cologne Water Quality Act – The project would require a 401 Water Quality Certification and is unlikely to qualify for the streamlined Statewide Restoration General Order or procedures for Ecological Restoration and Enhancement Projects, due to the lack of ecological restoration as part of the project.
- US Fish and Wildlife Service, Section 7 Consultation – The project will have potential to adversely affect federally listed species including Bell's vireo and Ridgway's rail. However, given the relatively small size of the proposed infrastructure and assuming work could be seasonally scheduled and conducted with biological monitors to flush birds outside of the work area, a Not Likely to Adversely Affect determination is fairly likely (i.e., no formal consultation, take authorization, or Biological Opinion would be required).
- California Department of Fish and Wildlife, Section 1600 Fish and Game Code– The project will require a Lake and Streambed Alteration Agreement and would not likely qualify for a streamlined Habitat Restoration and Enhancement Act permitting or Restoration Management Permit due to lack of benefits to fish and wildlife resources.
- California Coastal Commission, California Coastal Act and Coastal Zone Management Act – The project would require either a coastal development permit or a federal consistency review.
- Other – The portion of the project within City ROW may require a Site Development Permit or other local authorization.

- Compensatory Mitigation – off-site habitat restoration may be required, but the project is not expected to result in a substantial loss of waters and may provide net improvements to function. It is therefore unlikely that the project would be required to provide re-establishment of waters but may be required to include additional enhancement (i.e., removal and control of invasive species) to offset temporary impacts. The availability of compensatory mitigation credits is highly limited (the only approved mitigation banks are in North San Diego County and would not likely be accepted). Therefore, permittee-responsible mitigation would likely be required and may require development of a separate mitigation project. However, there are opportunities for wetlands mitigation on County of San Diego-owned lands within the Tijuana River Valley. Since mitigation would be primarily for impacts on federal lands, opportunities for mitigation on federal lands should also be evaluated.

Maintenance and Monitoring

Since the system will be exposed to the elements, it is expected that more frequent maintenance would be needed compared to other more permanent solutions. Caps, anchors, and pipe extensions would require routine checks for any signs of displacement, damage, and/or blockages. Routine maintenance frequency would include approximately 15 full-day (8-hour) visits per year which is equivalent to an average of 2 times per month during wet weather season and once during dry weather season, requiring 3 people, as well as applicable equipment and vehicles. To facilitate access for observation and maintenance of the extensions, such as clearing debris and

obstructions/blockages, an Inserta Tee connection is proposed along the pipe extension, near or along the toe of slope where the pipe will be closer to a horizontal position.

Furthermore, the downstream end of the pipe will have drilled perforations along the top half of the pipe for dual purposes. First, to provide an alternative temporary outlet for water in case of blockages, this will be a conservative measure as the upstream opening of each pipe with extension will be sized to allow conveyance of 100% of the peak dry weather flows, and as such, if one extension is blocked, the other extension/s will be able to convey the entirety of the flows without overtopping the Arizona crossing or the Saturn Blvd. Second, to provide venting of gases, as the inflow will most likely contain hydrogen sulfide or other heavy gases that will accumulate at the top of the pipe when not full.

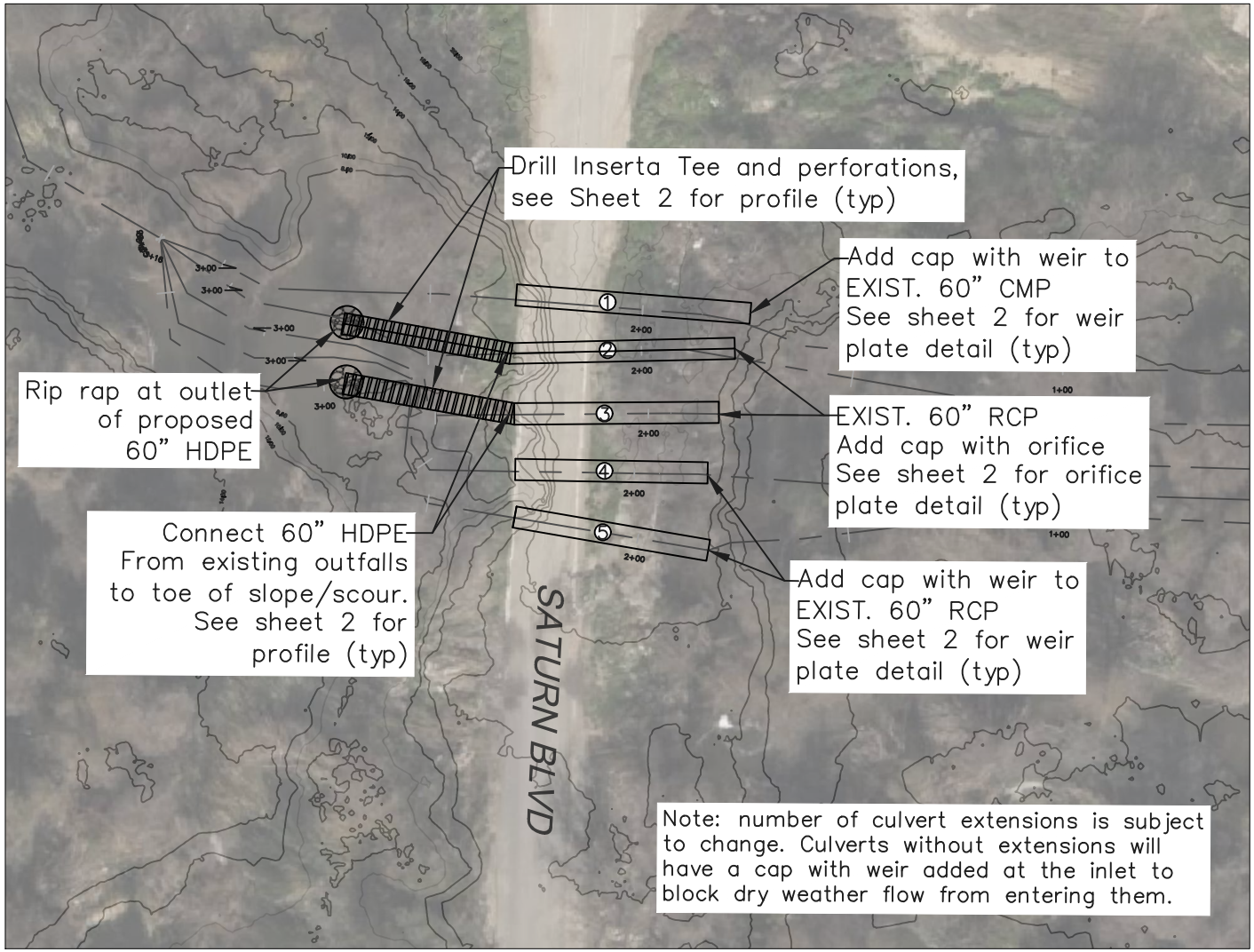
Maintenance costs would also need to account for the replacement of damaged components and cost of re-installation of these components; the costs provided in Figure 3 account for up to 2 replacements of the pipe extension and fittings for every 5 years, assuming that another set of materials will be acquired to have available in case another round of replacement is needed.

The proposed design includes 1 to 2 cable anchorage systems depending on site conditions, noting that although installation costs would increase somewhat if 2 systems are installed, maintenance costs may be reduced with the additional anchoring strength (e.g., less frequent replacement of damaged components).

Next Steps

If this option were to move forward, the steps listed below are recommended for consideration. It is expected that installation and maintenance will be performed by the contractor based on their means, methods, and professional expertise.

- Corresponding agencies are to work with contractor/s to define the details of how the system should be installed.
- Contractor to prepare an Operation and Maintenance plan (O&M plan). The O&M plan would be a key element to ensure the pipe extensions keep functioning as intended. The objectives of the O&M plan would be to:
  - Keep dry weather flow from overtopping the road
  - Allow dry weather flows to travel via the pipe extensions
  - Reduce turbulence, foaming, and aerosolization of water
- The O&M plan would likely describe, at a minimum:
  - A site visit after every storm during the first wet weather season after installation to remove obstructions and/or blockages, repair pipe extensions, and evaluate overall condition of the system
  - After the first wet season, the frequency of visits could potentially be revised based on the experience gained during the first year after installation
- Additional steps that may need to be considered prior to start of contractor work and construction are as follows:
  - Authorization from the City of San Diego and U.S. Navy will need to be coordinated and obtained
  - Geotechnical investigation to determine any cable anchorage system installation considerations and recommendations. Additional design costs have been incorporated onto the detailed cost estimate to account for this work.



LEGEND:

- EXIST. CHANNEL FLOW LINE
- 100 EXIST. MAJOR CONTOUR
- EXIST. MINOR CONTOUR
- EXIST. STORM DRAIN
- PROP. STORM DRAIN
- PROP. RIP RAP

0 80 160 Feet

N

CONCEPT DESIGN, NOT FOR CONSTRUCTION

DRAFT

SHEET __ OF __ SHEETS

I.O. NO.

P.T.S. NO.

APPROVED:

FOR CITY ENGINEER DATE

V.T.M.

DESCRIPTION	BY	APPROVED	DATE	FILMED
ORIGINAL				

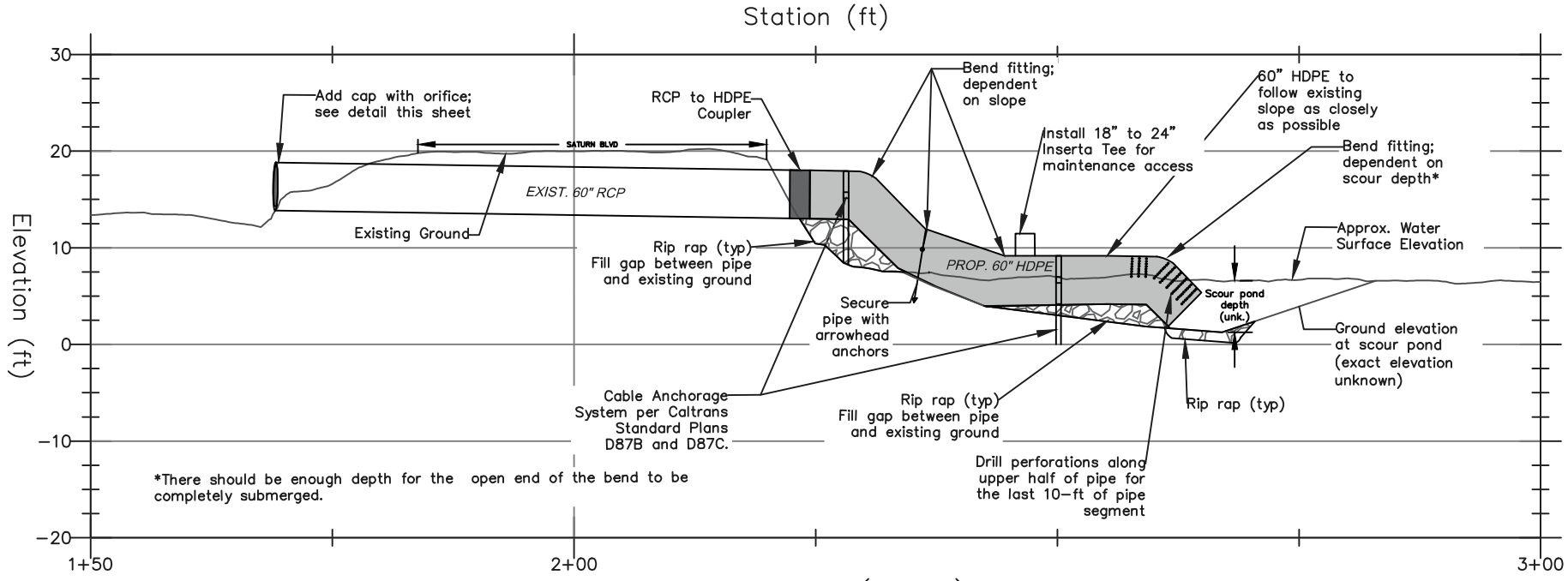
NAD83 COORDINATES

AS-BUILTS

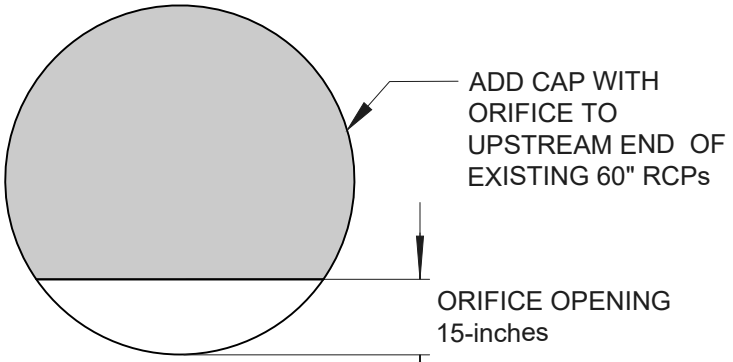
LAMBERT COORDINATES

CONTRACTOR DATE STARTED

INSPECTOR DATE COMPLETED

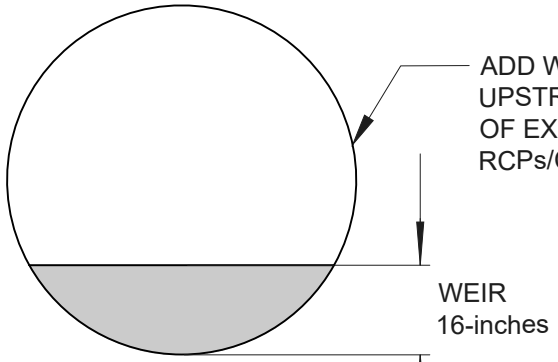


PROFILE (TYP)



ORIFICE PLATE (TYP)

NOT TO SCALE



WEIR PLATE (TYP)

NOT TO SCALE

CONCEPT DESIGN, NOT FOR CONSTRUCTION

DRAFT

SHEET __ OF __ SHEETS

I.O. NO.

P.T.S. NO.

APPROVED:

FOR CITY ENGINEER DATE

V.T.M.

DESCRIPTION	BY	APPROVED	DATE	FILMED
ORIGINAL				

NAD83 COORDINATES

LAMBERT COORDINATES

AS-BUILTS

CONTRACTOR DATE STARTED

INSPECTOR DATE COMPLETED

Appendix B

Mid-Term Project Alternative: Channel Fill and Culvert Replacement Fact Sheet

Alternative Name: Channel Fill and Culvert Replacement

Project Summary

Project Term	Mid-term
Duration (Design, Permitting, and Construction)	3 to 5 years after funding is received
Estimated Construction Cost Range	$14m to $18m
Pros	▪ Reduce turbulence and subsequent foam at Saturn Boulevard ▪ Armors downstream
Cons	▪ Large capital cost ▪ Large permitting hurdles ▪ Annual maintenance ▪ Saturn Boulevard out of service during construction

Project Description

The Saturn Boulevard river crossing of the North Channel includes a low-flow pipe culvert section and high-flow Arizona crossing section. Turbulence downstream of the pipe culverts combined with poor water quality appear to be the source of foam observed at this location. Under most dry-weather flow conditions, the river passes under the roadway through the pipe culverts. Under wet-weather conditions, flows pass under the roadway through the pipe culverts until the water surface elevation is high enough for water to flow around the pipe culverts and over the roadway at the Arizona crossing. The area immediately downstream of the Arizona crossing connects with the main channel that is downstream of the existing pipe culverts.

One method being investigated to eliminate turbulence and the subsequent foaming issue at Saturn Boulevard is to reduce the elevation drop at the downstream end of the culverts. The primary method proposed to achieve this outcome is to fill the downstream portion of the channel to reduce the drop. Additionally, replacement of the pipe culverts is recommended as they appear to be in poor condition. The use of gabions as a solution for the large drop is proposed. The gabions should be designed to act as a stairstep to lower the velocity at the downstream end of the culverts. The low-flow water would filter through the gabions and down to the next “level” of the staircase to reduce the turbulence and subsequent foaming issue. The gabions would extend along the downstream edge of the roadway from the pipe culverts to the Arizona crossing to secure the road and prevent unintended scour and pipe damage that could occur during larger storm events. Additionally, the gabions would be vegetated to further reduce turbulence and velocities and help reduce the loss of habitat functions from this infrastructure improvement.

Two options are available for the replacement of the culverts. Option 1 includes replacing the existing pipe culverts with new pipe culverts of equal size. Option 2 includes replacing the existing culverts with box culverts of equal

capacity. Both options include the use of gabions at the downstream outfall of the culverts. A concept design is presented in Figure 1. In addition to the channel fill and culvert replacement, each project option also includes the costs for replacing the roadway that is commonly overtopped within the channel with a concrete surface to reduce the amount of maintenance that is typically needed for the existing asphalt surface.

Opportunities/Constraints

Opportunities

This project is anticipated to reduce turbulence by eliminating drop from culvert outlets to downstream water surface. The gabions would help reduce future scour of the channel and promote sedimentation, which would be a more "natural" way of filling back in the scour pond. Vegetation on the gabions would also provide some treatment for the dry weather flows.

Constraints

Demolition and replacement of the existing roadway and culverts will require closure of Saturn Boulevard during construction. The cost and complexity of permitting this project alternative are a constraint to its feasibility. Gabions may require maintenance to ensure proper functionality after large storm events.

Construction/Installation Methods

The general steps and methods for this alternative are as follows:

- Demo existing roadway and pipe culverts
- Clear the channel for construction of the gabions
- Grade the channel for placement of gabions
- Place gabions and install new culverts
- Replace the roadway
- Vegetate the gabions to further reduce turbulence

Permitting Considerations

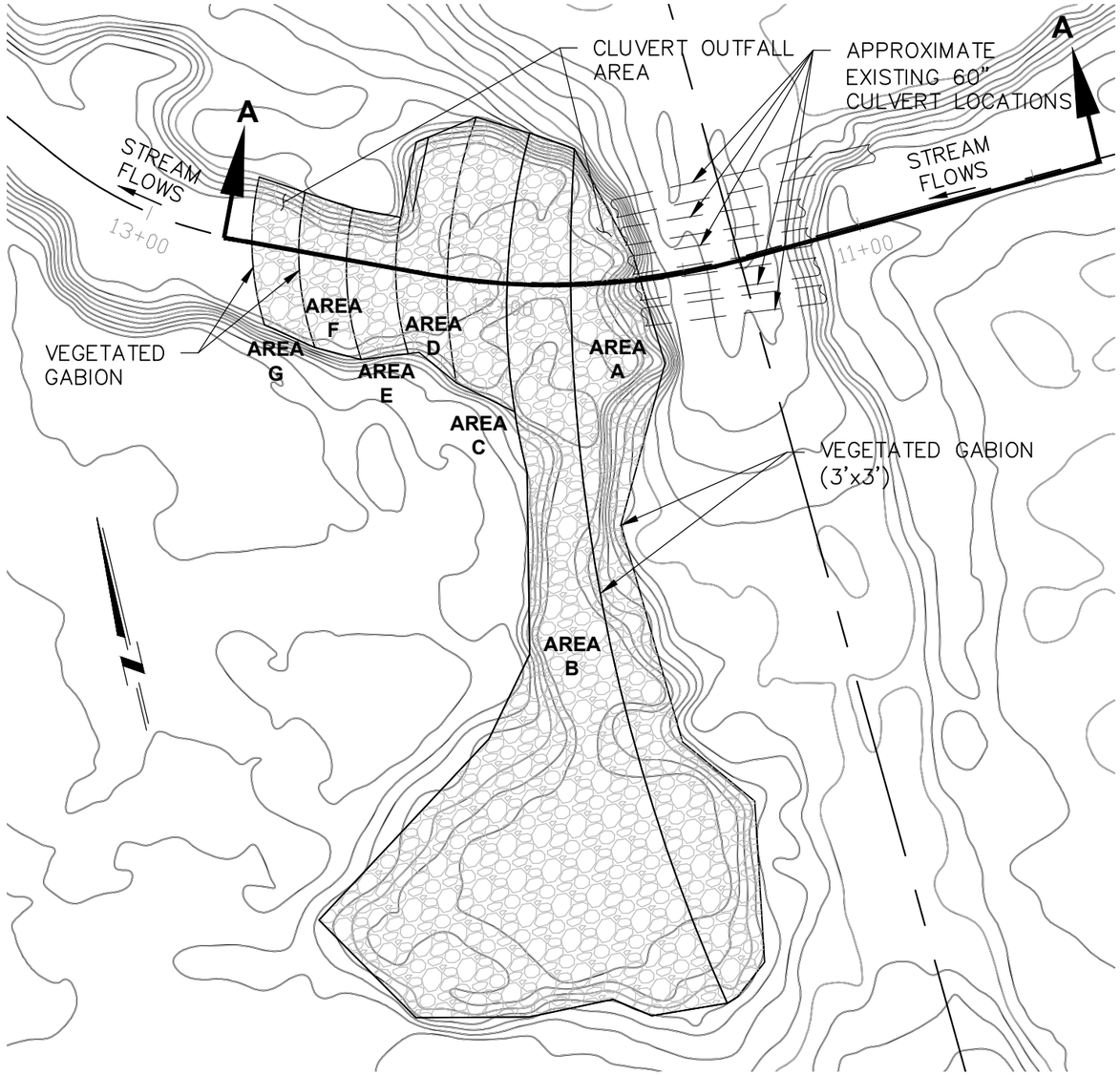
- Impacts – An estimated 0.5 acres of waters/wetlands consisting of open water and riparian habitat would be permanently impacted by gabions. An additional 0.25 acres or more may be temporarily impacted during installation. The majority of the impacts would occur on federal land, located within the Coastal Overlay Zone, outside of City of San Diego or County of San Diego land use jurisdiction or Multiple Species Conservation Plan Multi-Habitat Planning Area. An additional approximately 0.25 acres of impacts are anticipated within City of San Diego right-of-way, but this area is primarily occupied by the existing roadway and culverts and does not support waters/wetlands.

- **Permits –** Required authorizations would include the following:
  - **U.S. Army Corps of Engineers, Section 404 Clean Water Act –** The project may require an Individual Permit. Potential Nationwide Permits (NWP), listed in relative order of likelihood of authorization from most likely to least likely, include the following:
    - **NWP 14 –** Linear Transportation Projects (but impacts are limited to 0.5 acres)
    - **NWP 43 –** Stormwater Management Facilities (However, new structures in perennial waters are prohibited.)
    - **NWP 13 –** Bank Stabilization (but the project extends beyond the banks and likely requires more than 1 cubic yard per linear foot.)
    - **NWP 31 –** Maintenance of Existing Flood Control Facilities (But no maintenance baseline has been established.)
    - **NWP 41 –** Reshaping Existing Drainage and Irrigation Ditches (But uncertain whether Northern Channel of the Tijuana River could be considered a drainage ditch.)
    - **NWP 37 –** Emergency Watershed Protection and Rehabilitation (But this permit requires involvement of National Soil Conservation Services or U.S. Forest Service.)
    - **NWP 27 –** Aquatic Ecosystem Restoration, Enhancement, and Establishment Activities (But structural materials like gabions are generally prohibited.)
  - **San Diego Regional Water Quality Control Board, Section 401 Clean Water Act and State Porter-Cologne Water Quality Act –** The project would require a 401 Water Quality Certification and is unlikely to qualify for the streamlined Statewide Restoration General Order or procedures for Ecological Restoration and Enhancement Projects, due to the use of gabions.
  - **U.S. Fish and Wildlife Service, Section 7 Consultation –** The project will have potential to adversely affect federally listed species, including least Bell's vireo and Ridgway's rail. However, given the relatively small size of the proposed infrastructure and assuming work could be seasonally scheduled and conducted with biological monitors to flush birds outside of the work area, a Not Likely to Adversely Affect determination is fairly likely (i.e., no formal consultation, take authorization, or Biological Opinion would be required).
  - **California Department of Fish and Wildlife, Section 1600 Fish and Game Code –** The project will require a Lake and Streambed Alteration Agreement and would not likely qualify for a streamlined Habitat Restoration and Enhancement Act permitting or Restoration Management Permit due to lack of benefits to fish and wildlife resources.
  - **California Coastal Commission, California Coastal Act and Coastal Zone Management Act –** The project would require either a coastal development permit or a federal consistency review.
  - **Other –** The portion of the project within City right-of-way may require a Site Development Permit or other local authorization.
- **Compensatory Mitigation –** Off-site habitat restoration may be required and may need to include re-establishment of waters of the U.S./state of equal or greater value, as the project could be considered as resulting in a loss of waters. The availability of compensatory mitigation credits is highly limited (the only approved mitigation banks are in North San Diego County and would not likely be accepted). Therefore, permittee-responsible mitigation would likely be required and would require development of a separate mitigation project, estimated to be 1.5 acres in size in addition to the 0.25 acres of on-site temporary impacts that would require restoration. There are opportunities for wetlands mitigation on County of San Diego-owned lands within the Tijuana River Valley. Since mitigation would be primarily for impacts on

federal lands, opportunities for mitigation on federal lands should also be evaluated. Off-site permittee-responsible mitigation would require separate site identification, plan development, design, regulatory approvals, construction, and 5 years of maintenance and monitoring. The on-site temporary impact area would also require similar plan development, approvals, and 5 years of maintenance and monitoring.

Maintenance and Monitoring

- Inspect and maintain gabions annually or as needed to remove accumulated sediment, debris, and vegetation
- Similar culvert maintenance requirements to current conditions at Saturn Boulevard
- Inspect the culverts and gabions after large storm events for signs of displacement, erosion, and integrity of the gabions, consistent with inspection requirements in current conditions
- Remove large plants growing on the gabions that could reduce integrity of the gabions
- If maintenance is limited, due to lack of access and/or presence of polluted runoff, the gabions may be left to naturally degrade overtime with a plan for full replacement, if necessary, at some time in the future



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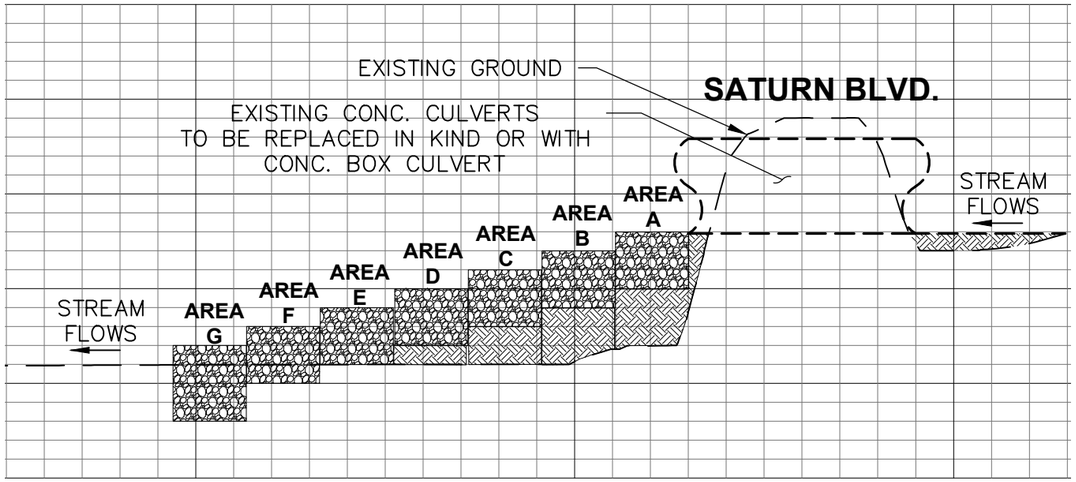

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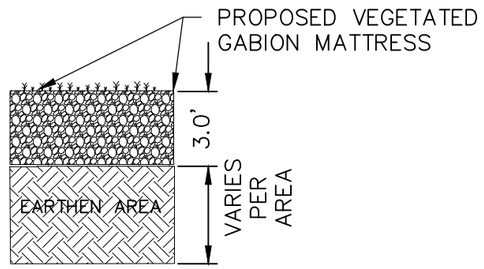


DETAIL
NTS

CHANNEL FILL AND CULVERT REPLACEMENT AT SATURN BLVD.
FIGURE 1

DUDEK

Appendix C

Mid-Term Project Alternative: Box Culvert/ Bridge Fact Sheet

Alternative Name: Box Culvert/Bridge

Project Summary

Project Term	Mid-term
Duration (Design, Permitting, and Construction)	3 to 5 years after funding is received
Estimated Construction Cost Range	$18m to $23m
Pros	▪ Allows for regrading of channel to reduce turbulence ▪ Box culverts spread flow more evenly than pipes and reduce downstream erosion potential
Cons	▪ Medium capital cost ▪ Potential FEMA floodplain impact mitigation measures ▪ Saturn Boulevard out of service during construction

Project Description

The Saturn Boulevard river crossing of the North Channel includes a low-flow pipe culvert section and high-flow Arizona crossing section. Turbulence downstream of the pipe culverts combined with poor water quality appear to be the source of foam observed at this location. Under most dry-weather flow conditions, the river passes under the roadway through the pipe culverts. Under wet-weather conditions, flows pass under the roadway through the pipe culverts until the water surface elevation is high enough for water to flow around the pipe culverts and over the roadway at the Arizona crossing.

One method being investigated to eliminate turbulence and the subsequent foaming issue at Saturn Boulevard is to remove the portion of roadway with the pipe culverts, regrade the channel upstream and downstream to be a smoother transition, and install a box culvert to replace the pipe culverts. Additionally, following the installation of the box culvert, the road will be resurfaced with concrete.

The box culvert would be sized at a minimum to match capacity of the existing pipe culverts but would likely be sized to match the existing width of flow in the channel resulting in a higher capacity than existing conditions. The existing pipe culverts span approximately 50 to 60 feet parallel to the roadway centerline. Any box culvert that is greater than 20 feet measured parallel to the roadway centerline is considered a bridge by Federal Highway Administration standards. The box culvert would be designed to allow overtopping during the 100-year flood event by anchoring the structure with cutoff walls upstream and downstream and potentially placing rock slope protection should it be identified as necessary after modeling. Figure 1 presents a conceptual design for the box culvert option. In addition to the box culvert/bridge replacement, this project also includes the costs for replacing the roadway that is commonly overtopped within the channel with a concrete surface to reduce the amount of maintenance that is typically needed for the existing asphalt surface.

This alternative will require extensive hydraulic modeling. Modeling is necessary to identify existing conditions and document proposed conditions that comply with local and federal floodplain management requirements. Modeling considerations include water velocity, sediment transport, water surface elevation, and potential impacts to the existing floodplain upstream, downstream, and laterally from the proposed project site.

Opportunities/Constraints

Opportunities

- Regrading of the channel to reduce turbulence
- Redesign of the culvert crossing to reduce potential future erosion
- Increase capacity of culvert section
- Reduce use of Arizona crossing and therefore expect fewer road closures throughout the year due to storm events
- Less expensive and fewer construction impacts than a bridge bank to bank over the channel

Constraints

- Medium capital investment
- Full closure of Saturn Boulevard during construction
- Long-duration and high flow dewatering with potentially significant permitting challenges
- Construction in and around potentially contaminated water
- Registration as a bridge, which requires annual inspection and certification

Construction/Installation Methods

The general steps and methods for this alternative are as follows:

- Dewater channel
- Demo existing roadway and pipe culverts
- Regrade channel through proposed box culvert section
- Install box culvert
- Armor channel upstream and downstream of box culvert
- Resurface road
- Channel restoration

Permitting Considerations

- Impacts – An estimated 0.75 acres of waters/wetlands consisting of open water and riparian habitat would be temporarily impacted, primarily downstream of the newly installed box culverts to ensure a smooth channel gradient which will reduce the potential for turbulence and associated foaming. The majority of the

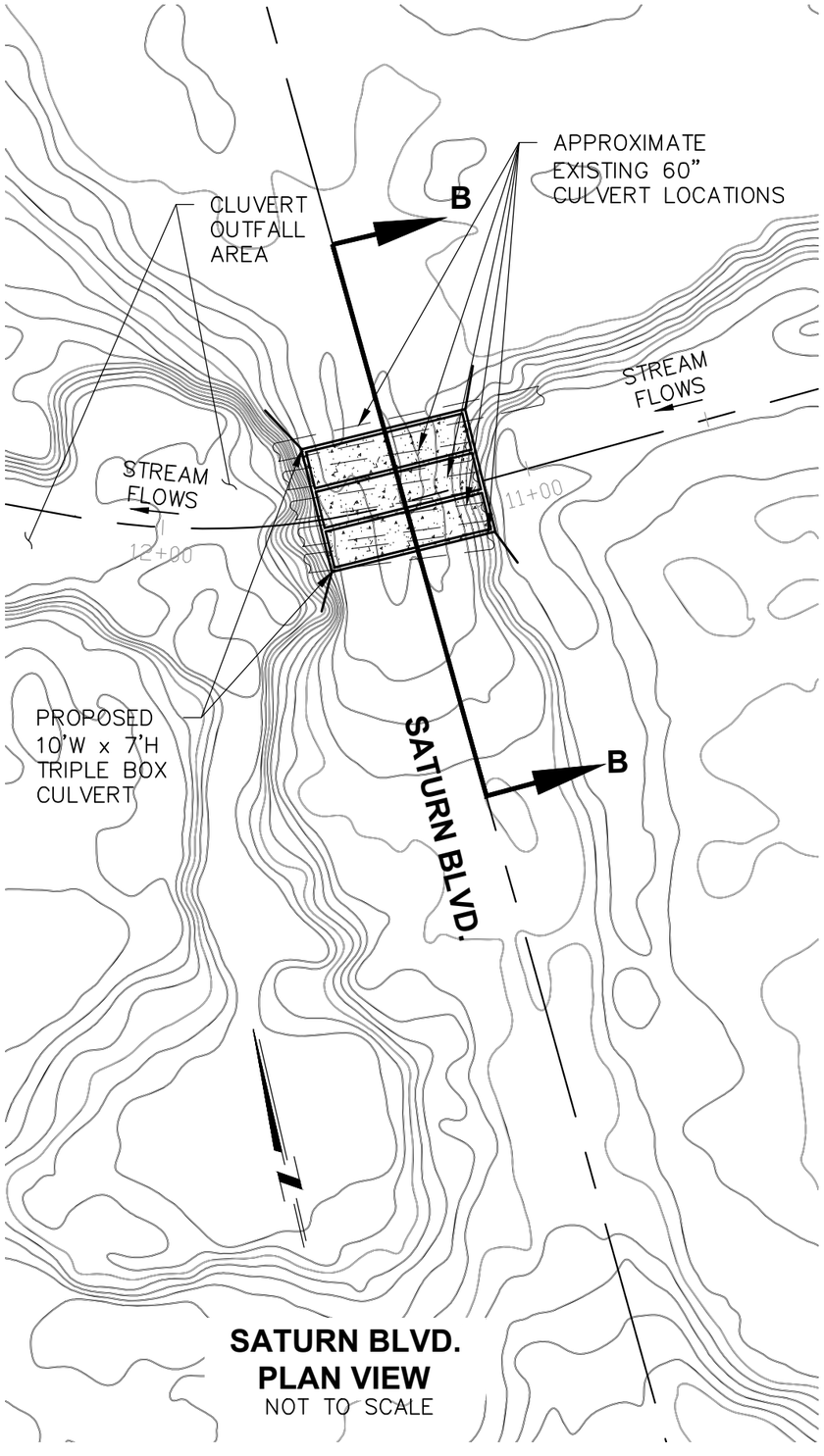
impacts would occur on federal land, located within the Coastal Overlay Zone, outside of City of San Diego or County of San Diego land use jurisdiction or Multiple Species Conservation Plan Multi-Habitat Planning Area. An additional approximately 0.25 acres of impacts are anticipated within City of San Diego right-of-way, but this area is primarily occupied by the existing roadway and culverts and does not support waters/wetlands. Temporary impacts to waters/wetlands would be revegetated following construction.

- Permits – Required authorizations would include the following:
  - U.S. Army Corps of Engineers, Section 404 Clean Water Act – The project may require an Individual Permit. Potential Nationwide Permits (NWP) that be used in combination are listed in relative order of likelihood of authorization from most likely to least likely below:
    - NWP 14 – Linear Transportation Projects (But impacts are limited to 0.5 acres.)
    - NWP 43 – Stormwater Management Facilities (However, channel grading may not be considered a stormwater management facility.)
    - NWP 27 – Aquatic Ecosystem Restoration, Enhancement, and Establishment Activities (But channel grading is associated with the culvert replacement as opposed to being for the purpose of aquatic ecosystem improvement.)
    - NWP 13 – Bank Stabilization (But project extends beyond the banks and likely requires more than 1 cubic yard per linear foot.)
    - NWP 31 – Maintenance of Existing Flood Control Facilities (But no maintenance baseline has been established.)
    - NWP 41 – Reshaping Existing Drainage and Irrigation Ditches (But uncertain whether Northern Channel of the Tijuana River could be considered a drainage ditch.)
    - NWP 37 – Emergency Watershed Protection and Rehabilitation (But this permit requires involvement of National Soil Conservation Services or U.S. Forest Service.)
  - San Diego Regional Water Quality Control Board, Section 401 Clean Water Act and State Porter-Cologne Water Quality Act – The project would require a 401 Water Quality Certification and is unlikely to qualify for the streamlined Statewide Restoration General Order or procedures for Ecological Restoration and Enhancement Projects, due to the culvert replacement being part of the project purpose and need.
  - U.S. Fish and Wildlife Service, Section 7 Consultation – The project will have potential to adversely affect federally listed species, including least Bell's vireo and Ridgway's rail. However, given the relatively small size of the proposed infrastructure and assuming work could be seasonally scheduled and conducted with biological monitors to flush birds outside of the work area, a Not Likely to Adversely Affect determination is fairly likely (i.e., no formal consultation, take authorization, or Biological Opinion would be required).
  - California Department of Fish and Wildlife, Section 1600 Fish and Game Code– The project will require a Lake and Streambed Alteration Agreement and would not likely qualify for a streamlined Habitat Restoration and Enhancement Act permitting or Restoration Management Permit due to lack of benefits to fish and wildlife resources.
  - California Coastal Commission, California Coastal Act and Coastal Zone Management Act – The project would require either a coastal development permit or a federal consistency review.
  - Other – The portion of the project within City right-of-way may require a Site Development Permit or other local authorization.
- Compensatory Mitigation – Off-site habitat restoration may be required, but the project is not expected to result in a loss of waters given that the culvert is expected to be placed within the existing roadway. The

project may provide net improvements to upstream and downstream wetland functions, but temporal loss during construction and revegetation may require approximately 1.5 acres of off-site mitigation. Given that the project would result in no-net-loss, it is unlikely that the project would be required to provide reestablishment of waters but may be required to include additional enhancement (i.e., removal and control of invasive species) to offset temporary impacts. The availability of compensatory mitigation credits is highly limited (the only approved mitigation banks are in North San Diego County and would not likely be accepted). Therefore, permittee-responsible mitigation would likely be required and would require development of a separate mitigation project. However, there are opportunities for wetlands mitigation on County of San Diego-owned lands within the Tijuana River Valley. Since mitigation would be primarily for impacts on federal lands, opportunities for mitigation on federal lands should also be evaluated. Off-site permittee-responsible mitigation would require separate site identification, plan development, design, regulatory approvals, construction, and 5 years of maintenance and monitoring. The on-site temporary impact area would also require similar plan development, approvals, and 5 years of maintenance and monitoring.

Maintenance and Monitoring

- Regular inspection as defined by the National Bridge Inspection Program
- Similar culvert maintenance requirements to current conditions at Saturn Boulevard
- Replacement/repair of channel armoring after large storm events
- Typical roadway maintenance/repair
- Periodic debris removal/culvert repair



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PLAN VIEW
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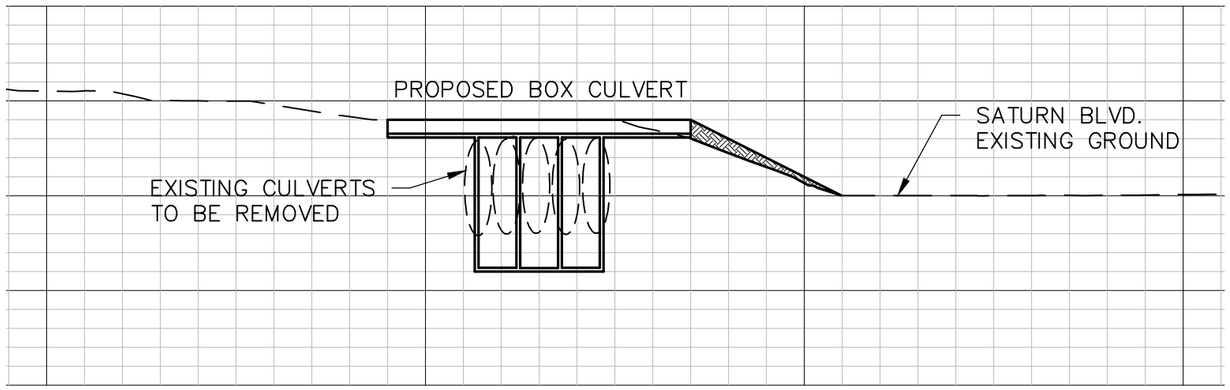

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BOX CULVERT / BRIDGE AT SATURN BLVD.
FIGURE 1

DUDEK

Appendix D

Mid-Term Project Alternative: Bridge Fact Sheet

Alternative Name: Bridge

Project Summary

Project Term	Mid-term
Duration (Design, Permitting, and Construction)	5 to 8 years after funding is received
Estimated Construction Cost Range	$60m to $75m
Pros	▪ Allows for regrading of channel to reduce turbulence ▪ Creates dry crossing for most storm events ▪ Eliminates instream obstruction caused by the existing roadway
Cons	▪ Large capital cost ▪ Potential FEMA floodplain impact mitigation measures ▪ Saturn Boulevard crossing out of service for extended period of time ▪ Visual impact

Project Description

The Saturn Boulevard river crossing of the North Channel includes a low-flow pipe culvert section and high-flow Arizona crossing section. Turbulence downstream of the pipe culverts combined with poor water quality appear to be the source of foam observed at this location. Under most dry-weather flow conditions, the river passes under the roadway through the pipe culverts. Under wet-weather conditions, flows pass under the roadway through the pipe culverts until the water surface elevation is high enough for water to flow around the pipe culverts and over the roadway at the Arizona crossing.

One method being investigated to eliminate turbulence and the subsequent foaming issue at Saturn Boulevard is to remove the roadway crossing entirely, regrade the channel, and build a bridge above the existing crossing.

The bridge option includes complete demolition of Saturn Boulevard and construction of a bridge over the channel. After demolition of the existing roadway, the channel will be regraded to create a smooth transition that reduces turbulence. The bridge would include a similar level of service to existing conditions, including two traffic lanes, shoulders, and a sidewalk for pedestrian/recreation access to the area currently served by Saturn Boulevard. The existing bank elevation at Saturn Boulevard is approximately 21 feet above mean sea level (amsl) and the Federal Emergency Management Agency (FEMA) 100-year Base Flood Elevation is 24 feet amsl. In order for the bridge option to meet minimum Federal Highway Administration design criteria, the bottom of the bridge should be at or above the Base Flood Elevation, which will require modification to Saturn Boulevard on both sides of the channel to get the bottom of the bridge above the Base Flood Elevation. Modifications to the road will likely include approach ramps to and from the elevated bridge surface and installation of bridge abutments. The bridge would be approximately 500 feet and have a total width of 40 feet. In addition to the bridge abutments, it is recommended to have support piers placed approximately every 100 feet under the bridge (five total anticipated). While the bridge

piers will create hydraulic obstruction in the floodplain, it is anticipated that the impact from the piers will be negated by the benefit from removing the existing roadway. Figure 1 presents a conceptual design for the bridge option.

This alternative will require extensive hydraulic modeling. Modeling is necessary to identify existing conditions and document proposed conditions that comply with local and federal floodplain management requirements. Modeling considerations include water velocity, sediment transport, water surface elevation, and potential impacts to the existing floodplain upstream, downstream, and laterally from the proposed project site.

Opportunities/Constraints

Opportunities

- Regrading of the channel to reduce turbulence
- Elimination of potential water contact at Arizona crossing
- Elimination of obstacles (roadway) in the floodplain and potential reduction of flood extent
- Habitat restoration

Constraints

- Large capital investment
- Visible infrastructure that would extend 10 feet to 15 feet above the existing roadway crossing
- Major roadway modification to achieve minimum floodplain clearance
- Long-duration full closure of Saturn Boulevard during construction
- Long-duration and high-flow dewatering with potentially significant permitting challenges
- Construction in and around potentially contaminated water

Construction/Installation Methods

The general steps and methods for this alternative are as follows:

- Dewater channel
- Demo existing roadway and pipe culverts
- Regrade channel
- Install bridge piers and abutments
- Build ramps up to proposed bridge
- Build bridge across the channel
- Armor bridge piers, abutment, and ramps
- Channel restoration

Permitting Considerations

- **Impacts –** An estimated 1.0 acre of waters/wetlands consisting of open water and riparian habitat would be temporarily impacted, primarily downstream of the proposed bridge to ensure a smooth channel gradient, which will reduce the potential for turbulence and associated foaming. The majority of the impacts would occur on federal land, located within the Coastal Overlay Zone, outside of City of San Diego or County of San Diego land use jurisdiction or Multiple Species Conservation Plan Multi-Habitat Planning Area. An additional approximately 0.35 acres of impacts are anticipated within City of San Diego right-of-way, but this area is primarily occupied by the existing roadway and culverts and does not support waters/wetlands. Temporary impacts to waters/wetlands would be revegetated following construction and would require 5 years of maintenance and monitoring to ensure successful revegetation. There would be some re-established waters/wetlands under the new bridge, but these aquatic features would be expected to have limited function and service, due to shading from the bridge.
- **Permits –** Required authorizations would include the following:
  - **U.S. Army Corps of Engineers, Section 404 Clean Water Act –** The project may require an Individual Permit. Potential Nationwide Permits (NWP) that be used in combination are listed in relative order of likelihood of authorization from most likely to least likely below:
    - **NWP 14 –** Linear Transportation Projects (But impacts are limited to 0.5 acres.)
    - **NWP 43 –** Stormwater Management Facilities (However, channel grading may not be considered a stormwater management facility.)
    - **NWP 27 –** Aquatic Ecosystem Restoration, Enhancement, and Establishment Activities (But channel grading is associated with bridge as opposed to being for the purpose of aquatic ecosystem improvement.)
    - **NWP 13 –** Bank Stabilization (But project extends beyond the banks and likely requires more than 1 cubic yard per linear foot.)
    - **NWP 31 –** Maintenance of Existing Flood Control Facilities (But no maintenance baseline has been established.)
    - **NWP 41 –** Reshaping Existing Drainage and Irrigation Ditches (But uncertain whether Northern Channel of the Tijuana River could be considered a drainage ditch.)
    - **NWP 37 –** Emergency Watershed Protection and Rehabilitation (But this permit requires the involvement of the National Soil Conservation Services or U.S. Forest Service.)
  - **San Diego Regional Water Quality Control Board, Section 401 Clean Water Act and State Porter-Cologne Water Quality Act –** The project would require a 401 Water Quality Certification and is unlikely to qualify for the streamlined Statewide Restoration General Order or procedures for Ecological Restoration and Enhancement Projects, due to the culvert replacement being part of the project purpose and need.
  - **U.S. Fish and Wildlife Service, Section 7 Consultation –** The project will have potential to adversely affect federally listed species, including least Bell's vireo and Ridgway's rail. However, given the relatively small size of the proposed infrastructure and assuming work could be seasonally scheduled and conducted with biological monitors to flush birds outside of the work area, a Not Likely to Adversely Affect determination is fairly likely (i.e., no formal consultation, take authorization, or Biological Opinion would be required).
  - **California Department of Fish and Wildlife, Section 1600 Fish and Game Code –** The project will require a Lake and Streambed Alteration Agreement and would not likely qualify for a streamlined Habitat

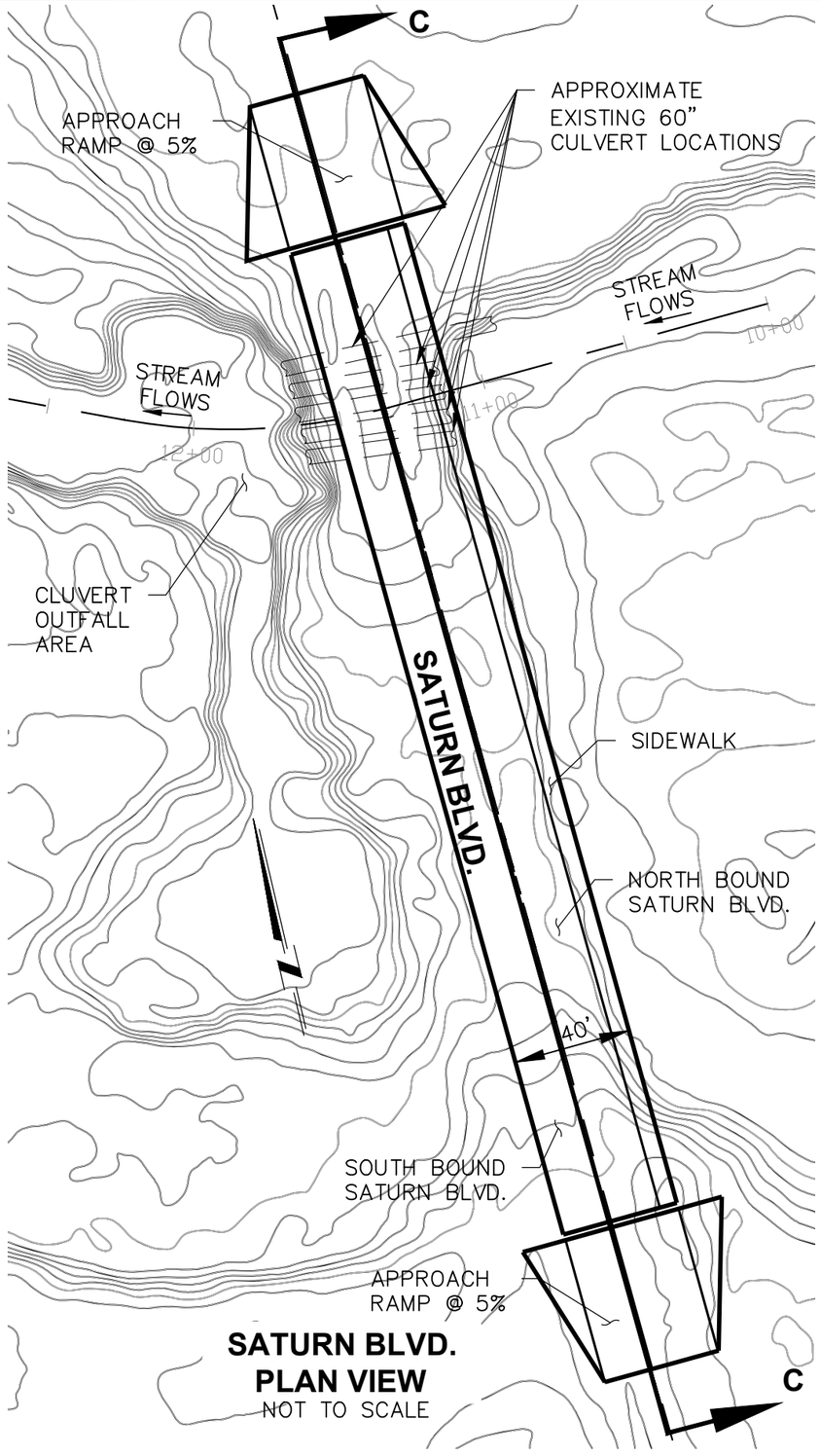
Restoration and Enhancement Act permitting or Restoration Management Permit due to lack of benefits to fish and wildlife resources.

- California Coastal Commission, California Coastal Act and Coastal Zone Management Act – The project would require either a coastal development permit or a federal consistency review.
- Other – The portion of the project within City right-of-way may require a Site Development Permit or other local authorization.

- Compensatory Mitigation – Off-site habitat restoration may be required, but the project is not expected to result in a loss of waters (support piers are located in the former roadway and therefore would not result in a loss of waters) and may provide net improvements to function. It is therefore unlikely that the project would be required to provide reestablishment of waters, but it may be required to include additional enhancement (i.e., removal and control of invasive species) to offset temporary impacts. The availability of compensatory mitigation credits is highly limited (the only approved mitigation banks are in North San Diego County and would not likely be accepted). Therefore, permittee-responsible mitigation would likely be required and would require development of a separate mitigation project. However, there are opportunities for wetlands mitigation on County of San Diego-owned lands within the Tijuana River Valley. Since mitigation would be primarily for impacts on federal lands, opportunities for mitigation on federal lands should also be evaluated. Off-site permittee-responsible mitigation would require separate site identification, plan development, design, regulatory approvals, construction, and 5 years of maintenance and monitoring. The on-site temporary impact area would also require similar plan development, approvals, and 5 years of maintenance and monitoring.

Maintenance and Monitoring

- Regular inspection as defined by the National Bridge Inspection Program
- Replacement/repair of channel armoring after large storm events
- Typical roadway maintenance/repair



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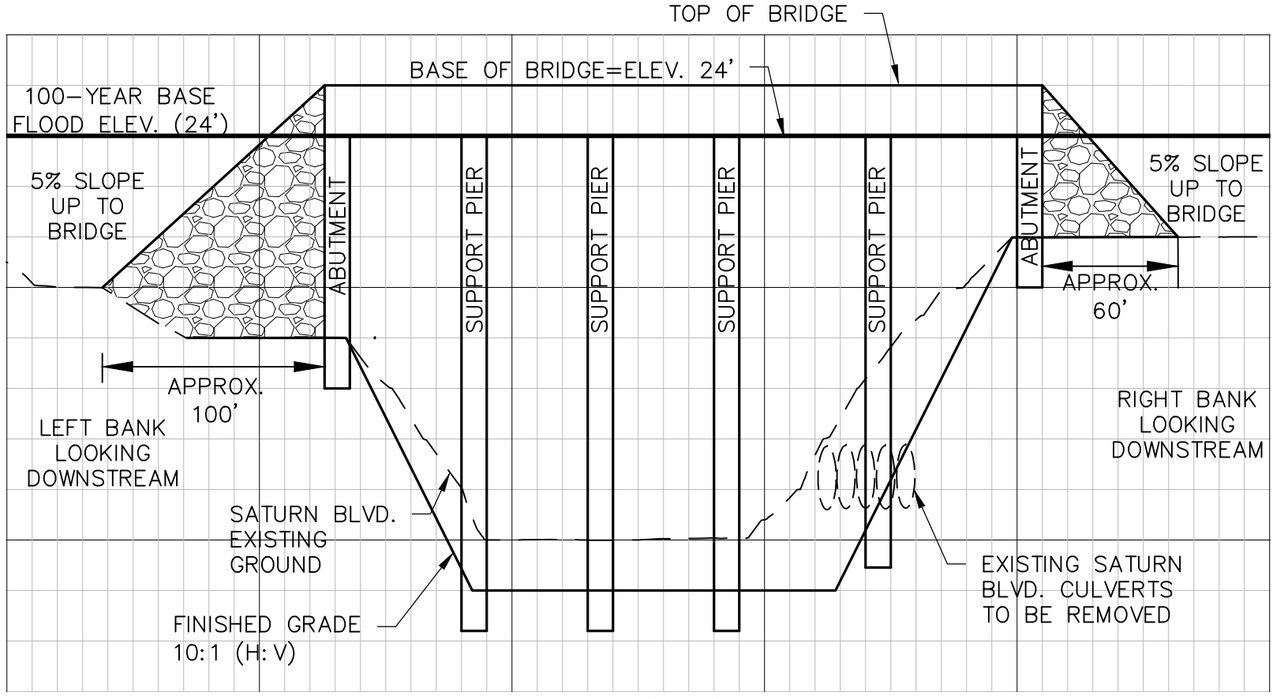

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BRIDGE AT SATURN BLVD.
FIGURE 1

DUDEK

Appendix E

Long-Term Project Alternative:
North Channel Cutoff Fact Sheet

Alternative Name: North Channel Cutoff

Project Summary

Project Term	Long-term
Duration (Design, Permitting, and Construction)	10 to 15 years after funding is received
Estimated Construction Cost Range	$80m to $110m
Pros	▪ Eliminate dry-weather flows at Saturn Boulevard ▪ Increase in flooded wetland habitat ▪ Reduction in flood risk on north side of the river valley
Cons	▪ Large capital cost and long project duration ▪ Significant permitting hurdles ▪ Annual maintenance of Pilot Channel

Project Description

Saturn Boulevard crosses a section of the Tijuana River known as the North Channel. The North Channel is a historical route for the Tijuana River that branches to the North off the mainstem of the river just upstream from the Hollister St. Bridge. Prior to a large storm event in 1993, the primary route for dry-weather and most wet-weather flows was through the southern part of the river valley through a channel now known as the Pilot Channel. During the 1993 storm event, the river changed course and cut a route into the historical North Channel, which has since become the primary exit for the river under dry-weather and most wet-weather flow conditions.

One method being investigated to eliminate turbulence and the subsequent foaming issue at Saturn Boulevard is to direct flows away from the North Channel and into the southern part of the river valley. The primary method proposed to achieve this outcome is to place a berm across the North Channel that would force dry-weather and most wet-weather flows into the Pilot Channel. The height of the berm should be low enough to allow bypass during larger storm events so the river would still be able to utilize the North Channel for flood control.

The Pilot Channel has historically been dredged to promote flow into the southern part of the river valley. However, in recent years, it has not been maintained due to funding and access constraints. To maintain a flowing river into the southern part of the river valley and reduce the possibility of inadvertent flooding due to berm construction/relocation, it is recommended to periodically dredge and maintain the Pilot Channel as part of this project alternative.

Two options are available for cutting off the North Channel. Option 1 includes extending an existing berm known as the Erodible Berm to create the cutoff. Option 2 includes removing the Erodible Berm and constructing a new berm across the North Channel, perpendicular and extending east from the wood Hollister Street bridge abutment. Both

options include dredging the Pilot Channel and are presented in Figure 1. Figure 2 and Figure 3 present hydraulic modeling results that demonstrate the floodplain impacts from each option compared to existing conditions.

Model results indicate that both options prevent flow into the North Channel for dry-weather flow and most wet-weather flow events. During a 2-year storm, water flows into the North Channel under both options but is limited compared to the existing condition. Option 1 reduces flow in the North Channel by 13% for the 2-year storm, and Option 2 reduces the flow by over 45%. Because the foaming issue seen at Saturn Boulevard is likely due to dry-weather flow polluted with raw sewage, both options are successful at eliminating dry-weather flows and the observed foaming issue. Option 2 has the added benefit of sending more floodwaters into the southern part of the river valley, which further reduces potential flood impacts to the City of Imperial Beach and the Naval Outlying Landing Field Imperial Beach (NOLF IB). The location of the new berm under Option 2 may create a sink immediately upstream of the berm where floodwater could get temporarily stuck until it infiltrates or evaporates. However, this would only occur under larger flood conditions as the model shows there is a positive flow into the southern part of the river valley because the maintained channel elevation in the Pilot Channel is lower than at the relocated berm. Additionally, it is anticipated that after a few years, sediment buildup will occur upstream of the relocated berm and will eventually fill the sink. For these reasons, Option 2 is the preferred North Channel cutoff project alternative.

Opportunities/Constraints

Opportunities

The North Channel allows the river to flow close to developments on the North side of the river valley. Developments include residential neighborhoods in the City of Imperial Beach and NOLF IB. At NOLF IB, the North Channel causes erosion that is threatening the integrity of a security fence that surrounds the airfield. Directing flows into the southern part of the river valley will reduce the potential for flooding and erosion concerns around Imperial Beach and NOLF IB.

Directing flows through the Pilot Channel and into the southern part of the river valley has potential benefits to flood control and water quality. Berms were built along the southern part of the river valley in the twentieth century to create agricultural land hydrologically disconnected from the river valley. For the most part, agriculture has been discontinued in this area, leaving large plots of vacant land in the floodplain disconnected from the river. With more flows through the southern part of the river valley, there is an opportunity to remove sections of the berms that surround vacant agricultural land and restore native habitats. The restored land would create an additional environmental buffer that can lead to improved water quality in the Tijuana River and open up more floodplain for the river to flow during storm events.

Constraints

Constructing a new berm across the North Channel, dredging the Pilot Channel, and ongoing maintenance have significant logistical constraints and financial impacts due to the challenges with working in this part of the river valley. Equipment access into the unimproved floodplain will require significant vegetation removal, excavation, grading, and creation of temporary access roads. These activities have not been permitted previously or studied as part of a prior California Environmental Quality Act document. Ongoing maintenance of the Pilot Channel has been

permitted; however, issues with high groundwater and access have limited maintenance for logistical and financial reasons.

Construction of a new berm will require a permit for fill within the waterway and a potential increase to the water surface elevation above the existing Federal Emergency Management Agency Base Flood Elevation in the southern part of the river valley. The length of time, cost, and complexity of permitting this project alternative are a substantial constraint to its feasibility. Additionally, reduction of water in the North Channel may change the habitat downstream of the berm, which could have an impact that needs to be addressed through the permitting process. Finally, moving the river to a primarily southern route could change the extent of the floodway and floodplain in the area, which would need to be modeled to determine if there could be additional or different flood-related impacts compared to current conditions.

Construction/Installation Methods

The general steps and methods for this alternative are as follows:

- Dredge the pilot channel to direct dry-weather flows into the southern part of the river valley
- Clear a path into the North Channel for construction of the berm
- Excavate sediment and other debris down to level that will create a secure footing for the berm
- Depending on the berm construction method selected during design, install an engineered core that will be resilient to erosion in the event that flows need to go into the North Channel
- Cover the engineered core with earthen material to allow revegetation
- Place rock slope protection on the berm to prevent erosion
- Revegetate the berm to further reduce erosion

Permitting Considerations

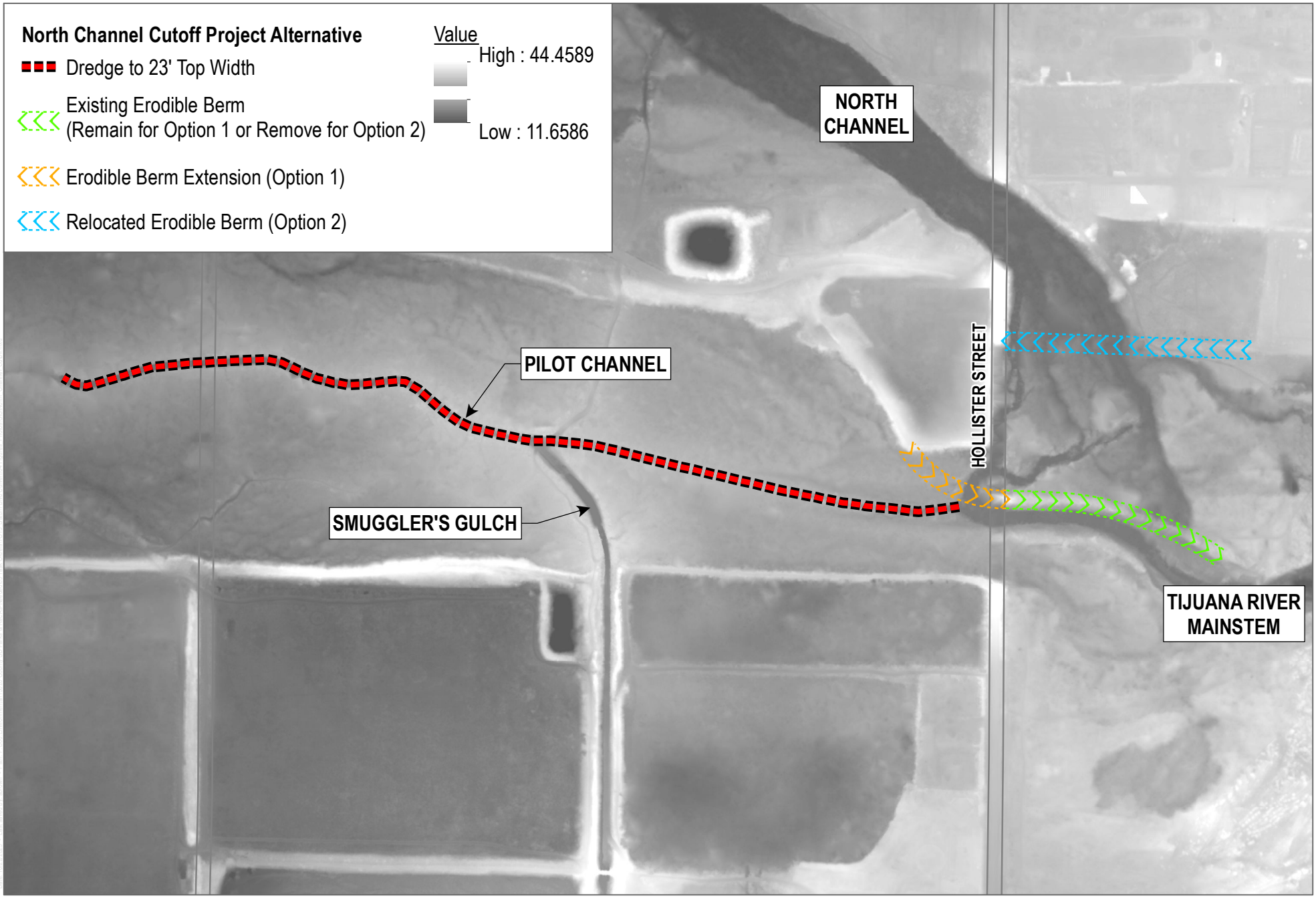
- Impacts – An estimated 1.0 acres of waters/wetlands consisting of open water and riparian habitat would be permanently impacted by construction of a new (relocated) berm (Option 2). This could be partially offset by the 1.0-acre removal of the existing berm (Option 2), but the project would also likely require temporary impacts of an additional approximately 2.0 acres of waters/wetlands. Impacts would primarily occur around Hollister Street on lands owned by the County of San Diego. These impacts are located within the Coastal Overlay Zone, in of City of San Diego land use jurisdiction and Multiple Species Conservation Plan Multi-Habitat Planning Area. Temporary impacts to waters/wetlands and the berm removal area would be revegetated following construction.
- Permits – Required authorizations would include the following:
    - U.S. Army Corps of Engineers, Section 404 Clean Water Act – The project may require an Individual Permit. Potential Nationwide Permits (NWP) listed in relative order of likelihood of authorization from most likely to least likely, include the following:
        - NWP 27 – Aquatic Ecosystem Restoration, Enhancement, and Establishment Activities (But construction of the new berm may not be found to have sufficient ecosystem benefit.)
        - NWP 43 – Stormwater Management Facilities (However, channel grading may not be considered a stormwater management facility.)

  - NWP 31 – Maintenance of Existing Flood Control Facilities (But no maintenance baseline has been established.)
  - NWP 37 – Emergency Watershed Protection and Rehabilitation (But this permit requires the involvement of the National Soil Conservation Services or U.S. Forest Service.)
- San Diego Regional Water Quality Control Board, Section 401 Clean Water Act and State Porter-Cologne Water Quality Act – The project would require a 401 Water Quality Certification and may not qualify for the streamlined Statewide Restoration General Order or procedures for Ecological Restoration and Enhancement Projects, depending on whether the new berm can be shown to be an ecological benefit and not primarily a flood control feature.
- U.S. Fish and Wildlife Service, Section 7 Consultation – The project will have potential to adversely affect federally listed species, including least Bell's vireo and Ridgway's rail. Given the size of grading and the new berm feature, take of vireo would likely be required through a Biological Opinion.
- California Department of Fish and Wildlife, Section 1600 Fish and Game Code – The project will require a Lake and Streambed Alteration Agreement and may not qualify for a streamlined Habitat Restoration and Enhancement Act permitting or Restoration Management Permit because elements are designed for flood control purposes as opposed to for the benefit of fish and wildlife resources.
- California Coastal Commission, California Coastal Act, and Coastal Zone Management Act – The project would require a coastal development permit.
- City of San Diego, Municipal Code – The project would require a Site Development Permit or other local authorization.

- Compensatory Mitigation – Off-site habitat restoration may be required, but the project is not expected to result in a loss of waters and would net improvements to function. It is therefore unlikely that the project would be required to provide reestablishment of waters, but it may be required to include additional enhancement (i.e., removal and control of invasive species) to offset temporary impacts. The availability of compensatory mitigation credits is highly limited (the only approved mitigation banks are in North San Diego County and would not likely be accepted). Therefore, permittee-responsible mitigation would likely be required and likely would be developed as part of this project on adjacent County of San Diego-owned lands within the Tijuana River Valley. Off-site permittee-responsible mitigation would require site identification, plan development, design, regulatory approvals, construction, and 5 years of maintenance and monitoring. The on-site temporary impact area would also require similar plan development, approvals, and 5 years of maintenance and monitoring.

Maintenance and Monitoring

- Maintain the Pilot Channel annually or as-needed to remove accumulated sediment, debris, and vegetation
- Inspect the North Channel cutoff berm after large storm events for signs of erosion, leakage, or overtopping and make necessary repairs
- Remove large trees growing on the berm that could reduce integrity and/or create pathways for leakage through the berm



DUDEK

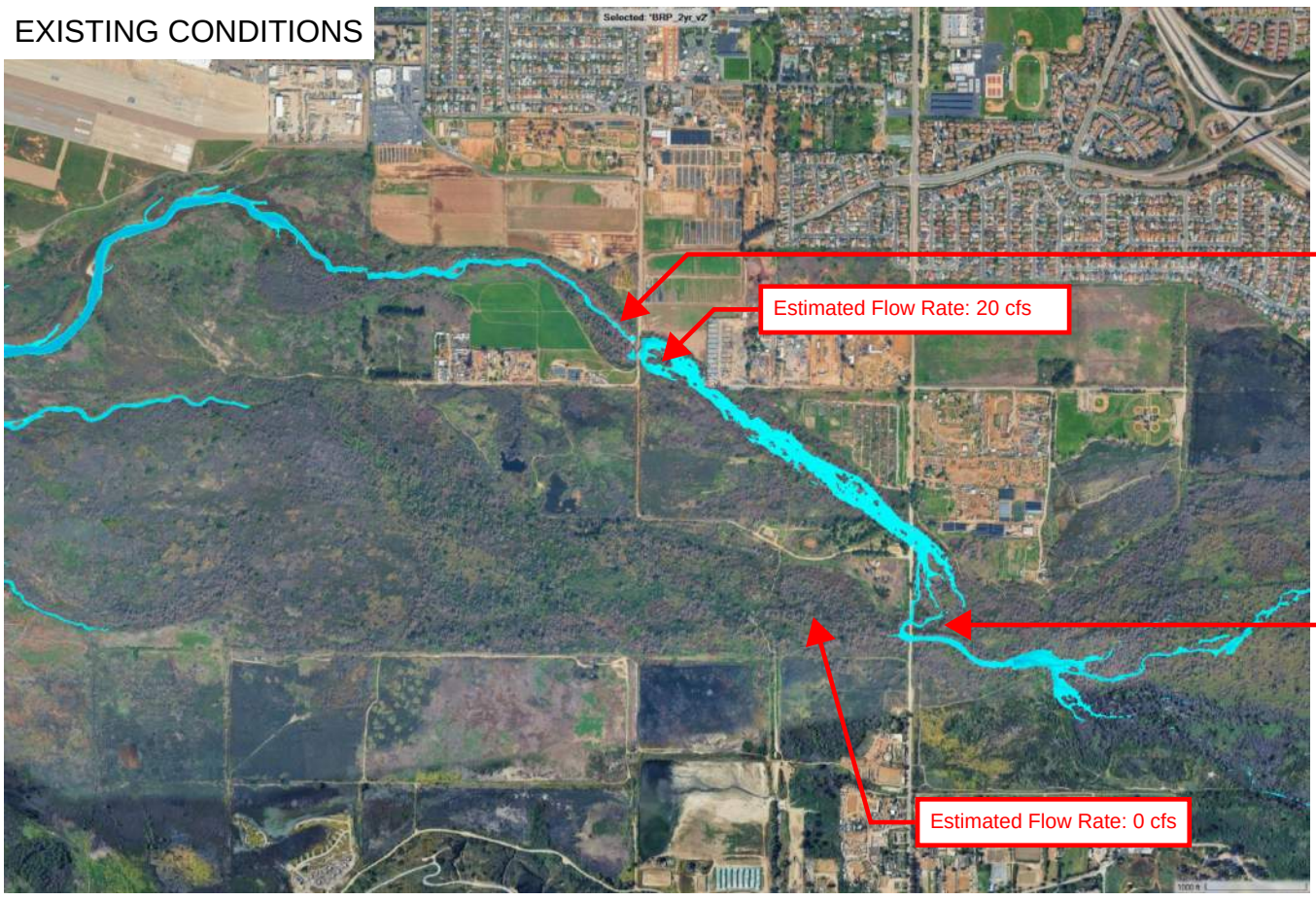
0 250 500 Feet

North Channel Cutoff Project Alternative
Saturn Boulervard Culvert Analysis
San Diego County Department of Parks and Recreation

Figure 2 - Dry Weather Flow Modeling Results

Dry Weather flow based on IBWC Tijuana River Gage 11013300 at International Boundary

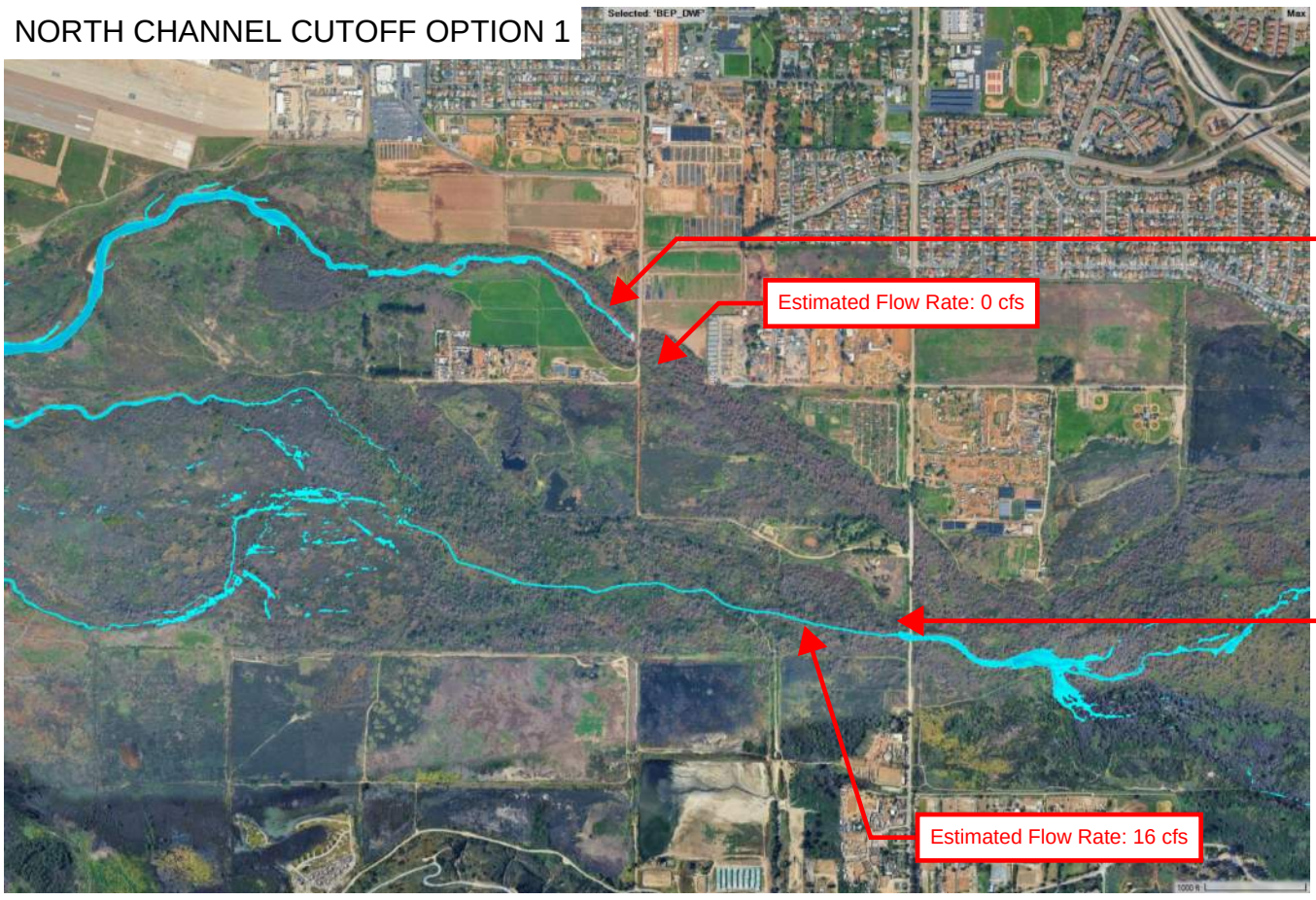
EXISTING CONDITIONS



Water surface downstream of Saturn Blvd. in existing condition due to dry weather flow and tidal influence

Flow bypasses the Erodible Berm and goes into the North Channel

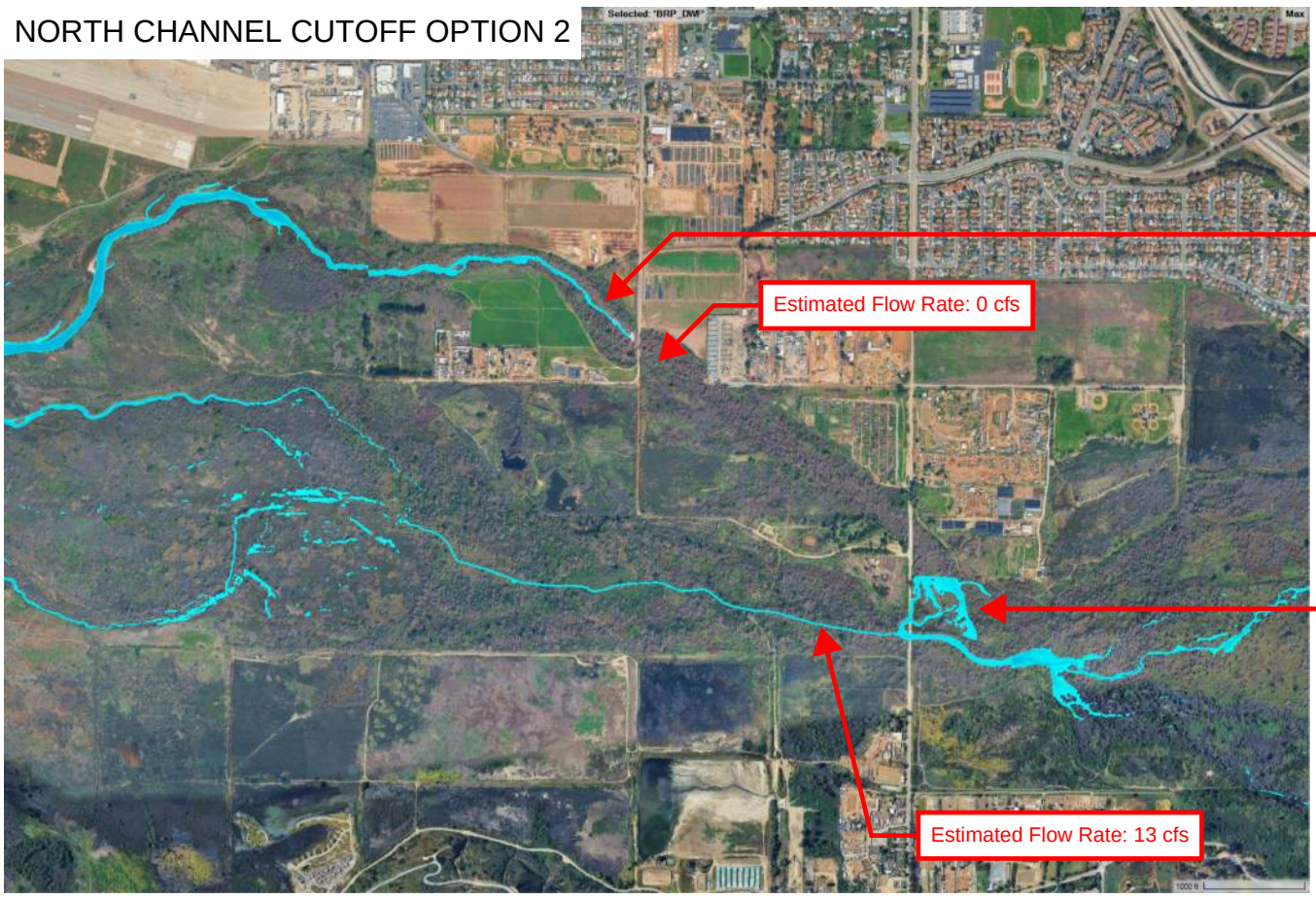
NORTH CHANNEL CUTOFF OPTION 1



Water surface downstream of Saturn Blvd. in proposed condition is due to tidal influence

Extension of the Erodible Berm and dredging of Pilot Channel allows dry weather flow to stay in South Channel

NORTH CHANNEL CUTOFF OPTION 2



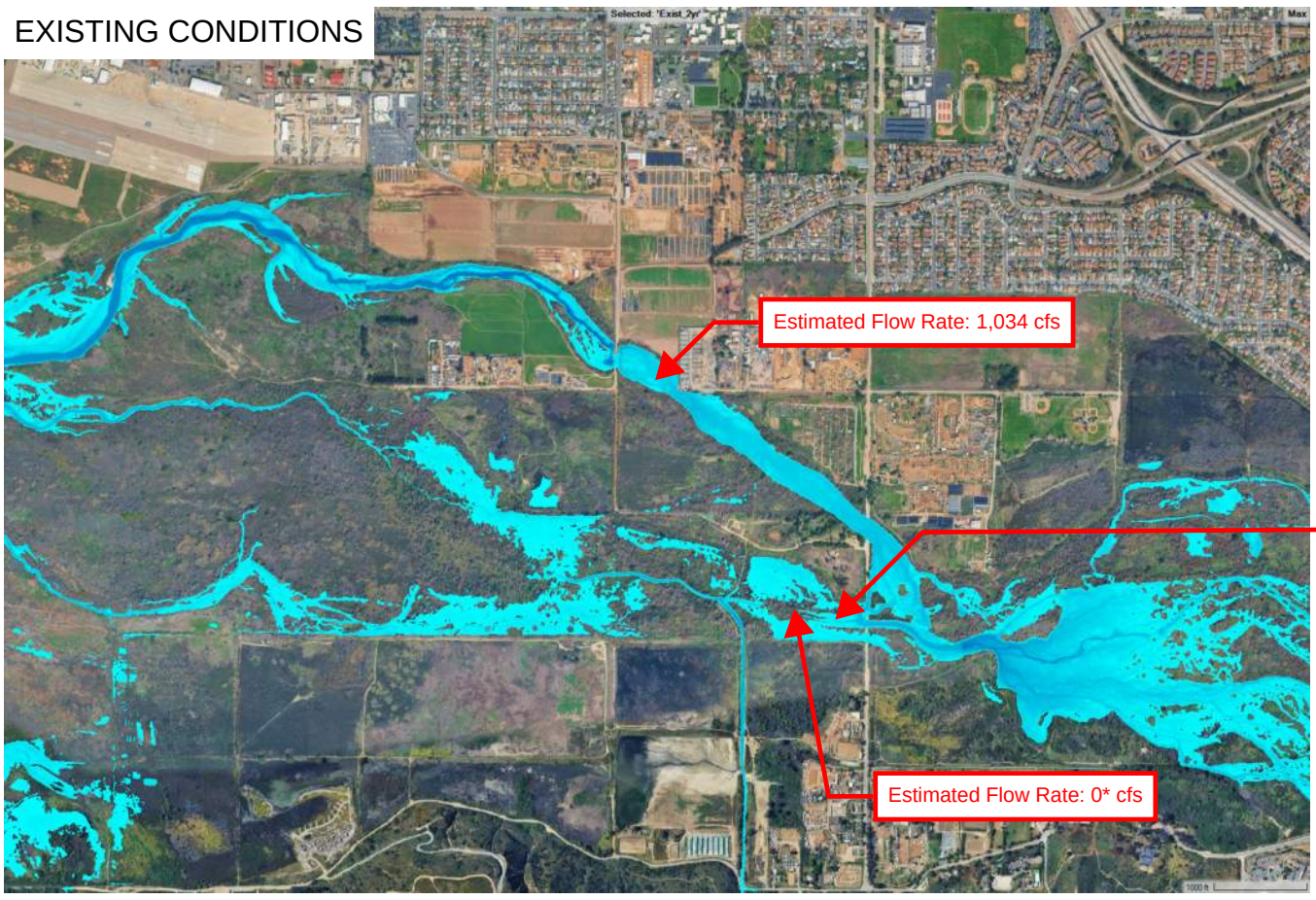
Water surface downstream of Saturn Blvd. in proposed condition is due to tidal influence

Relocated Erodible Berm and dredging of the Pilot Channel allows dry weather flow to stay in South Channel. Water builds up behind relocated berm.

Figure 3 - 2-year Storm Event Modeling Results

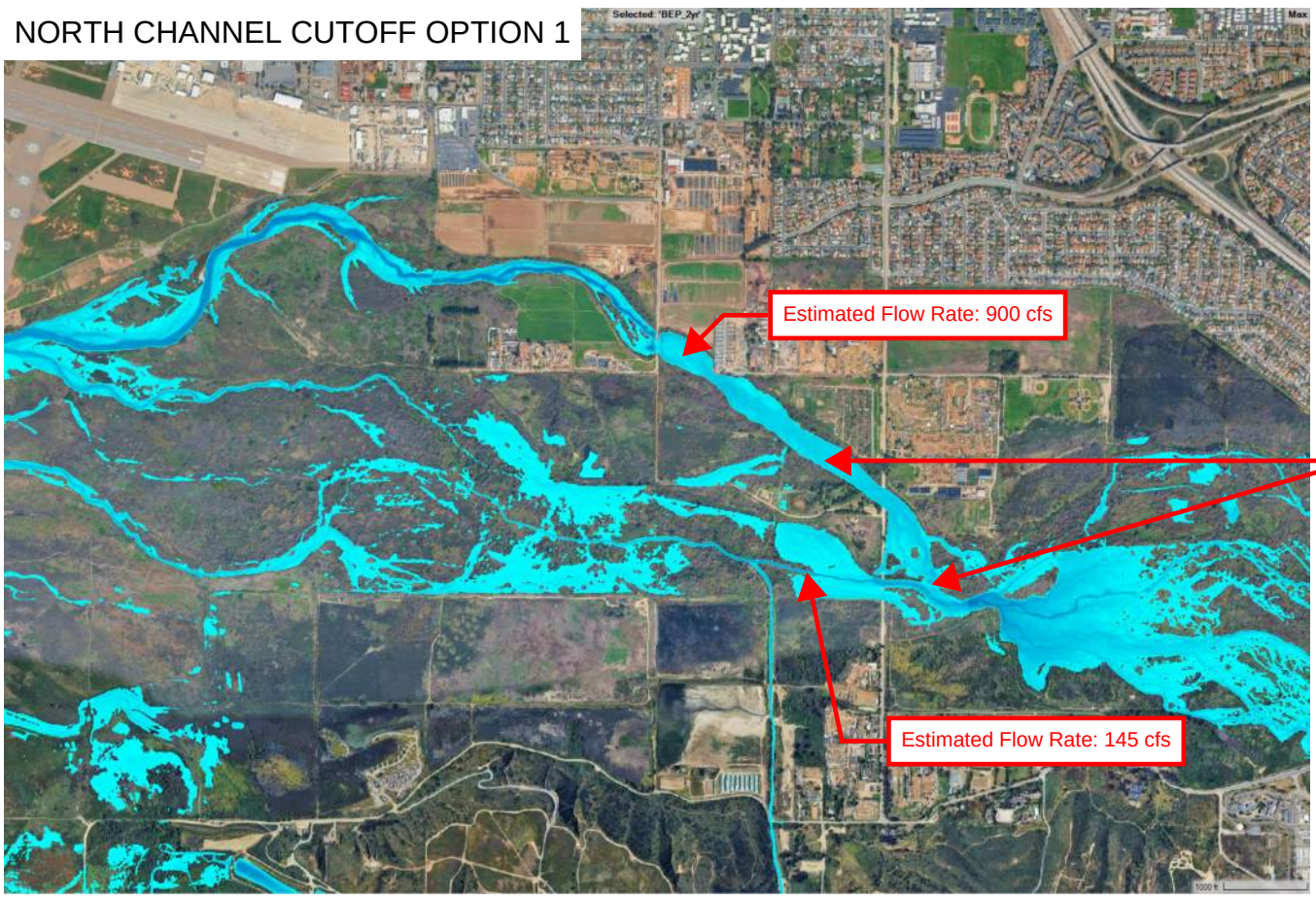
2-year hydrograph from Army Corps of Engineer's Phase 2 Hydrology, Floodplain, and Sediment Transport Report Final (2020)

EXISTING CONDITIONS



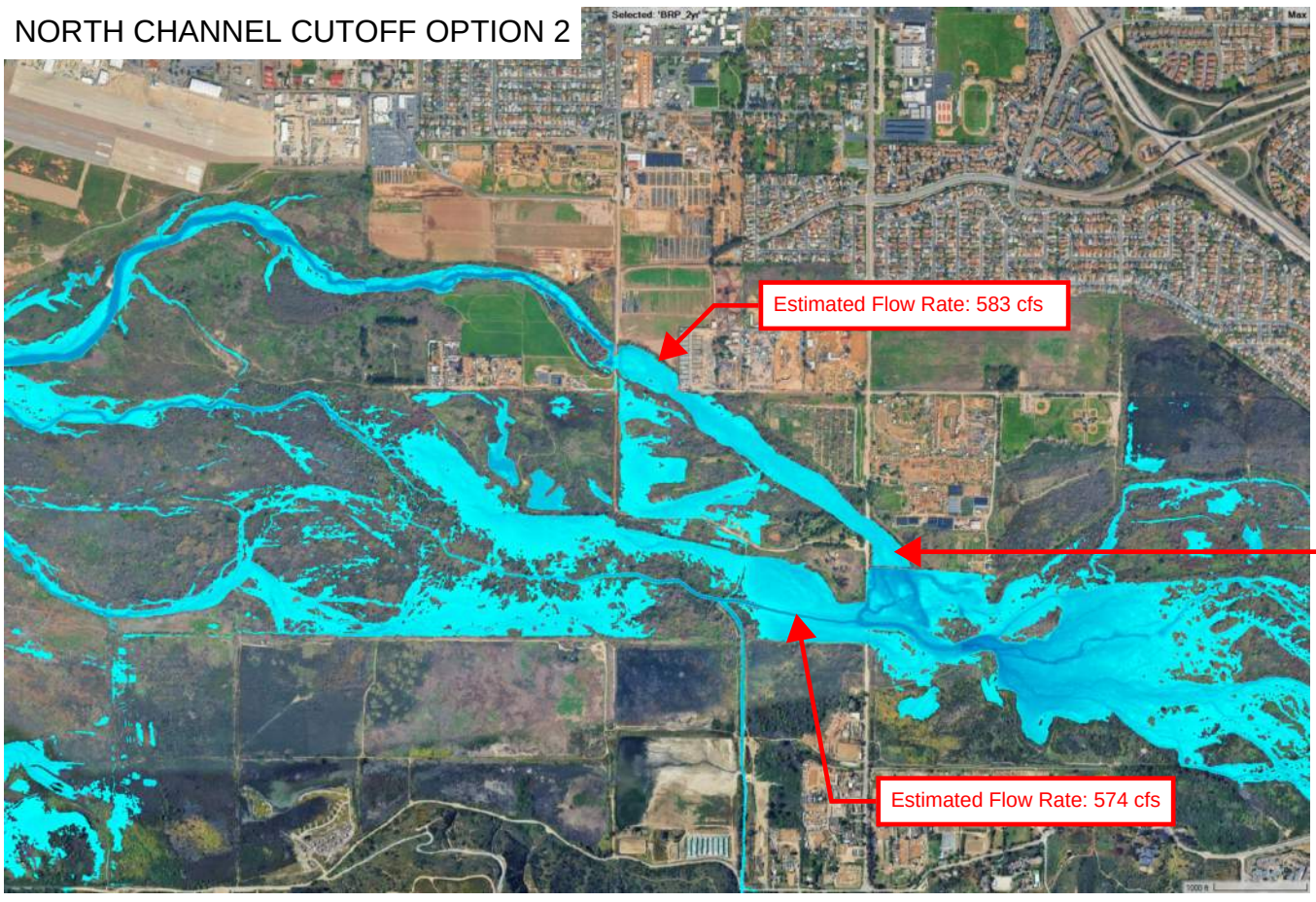
*Flow bypasses the Erodible Berm and goes into the North Channel. Modeling shows flow in Pilot Channel but due to flow coming in from Smuggler's Gulch, not Mainstem Tijuana River

NORTH CHANNEL CUTOFF OPTION 1



Option 1 allows flow into the North Channel due to bypass on the east side of the Erodible Berm

NORTH CHANNEL CUTOFF OPTION 2



Option 2 allows less flow than Option 1 into the North Channel due to the relocated berm being further downstream in the North Channel