A.44 Chollas Creek – 54th Street (No. 5-04-280)

Summary of Recommended Maintenance

Facility Type	Bed: Gunite Banks: Gunite	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 34 to Station 135 and Station 217 to 380. • Remove accumulated sediment/debris in the culvert from Station 135 to 217 and at Station 34.	
Benefit	• Increase level of service from <2-year storm event (40 cfs) to 5-year storm event (93 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the culverts	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Chollas Creek – 54th Street (54th Street) facility group was classified as a Category 1 segment as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulic Technical Report*. The facility is in the Pueblo San Diego Watershed Management Area. The facility is bordered to the north, south, and west by residential development. The facility begins south of Redwood Street and is bound by 54th Street to the east and by Thornton Place to the west, and terminates at the culvert entrance to the storm drain system in 54th Street.

The 54th Street ditch is constructed of gunite with a trapezoidal cross-section as indicated on as-built drawing no. 9373-L. A portion of the ditch has a bottom width of 3 feet, banks that are 3.5 feet high with 1:1 (H:V) side slopes, and a longitudinal slope of 0.0301 (feet/feet). Runoff is conveyed through the 54th Street ditch in a southwesterly direction towards a 48-inch-diameter reinforced concrete pipe (RCP) culvert located at Station 217 to Station 135 that conveys flows beneath a parking lot. From the parking lot culvert, runoff enters the downstream portion of the 54th Street ditch and is conveyed to a 60-inch-diameter reinforced concrete pipe (RCP) located at Station 34 that conveys flows into the storm drain system in 54th Street.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Chollas Creek – 54th Street facility group.

Hydrology

The hydrologic peak flow for the 100-year recurrence interval presented in Table 1 was estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated January 2017*. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.1.4 of the Hydrology and Hydraulic Technical Report*.

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
54th St 1	73	93	108	130	146	163

Hydraulics

A one-dimensional steady flow model was developed for the channel segment using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and recommended maintained conditions. Refer to *Section 3.2.1.1 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the HEC-RAS model. The extent of the reach evaluated in the model is presented in the Hydraulic Reference Map located at the end of this fact sheet.

For the analysis of the baseline condition, the ditch bottom and banks were assigned Manning's coefficient value range of 0.035-0.06 and 0.04-0.05, respectively. These assignments were based the site visit conducted by Geosyntec Consultants in July 2017 where deposited sediment and patches of dense vegetation in the bottom of the ditch was observed. The sediment depth was estimated to be 2 inches in the ditch and 2 feet in the culvert (Station 135 to 217). A Manning's coefficient value for both the bottom and banks for the recommended maintained condition was set at 0.016 to reflect the roughness of the originally constructed facility.

Model parameters and velocities for the baseline and maintained conditions for the Chollas Creek – 54th Street facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the level of service capacity.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
54th St 1	380–34	Baseline: 0.035–0.06	Baseline: 0.92–7.48	Culvert (Station 217 to 135), Culvert (Station 34)	Normal Depth at Station 380
		Maintained: 0.016	Maintained: 1.67–8.13		

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flow rates, summarized in Table 1 in the Hydrology section, were used in determining the level of service. The velocities, summarized in Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall channel conveyance capacities and level of service for the segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained conditions.

Baseline Condition

The facility can convey 40 cubic feet per second (cfs) (<2- year level of service) before overtopping the culvert conveying flows beneath the parking lot at Station 217.

Recommended Maintained Condition

Removing deposited sediment and vegetation from the ditch increases the conveyance capacity from 40 cfs (<2-year level of service) to 93 cfs (5-year level of service) before overtopping the culvert conveying flows beneath the parking lot at Station 217.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition are below the maximum permissible velocities for a concrete ditch (35 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained condition the overall facility level of service was restricted by the capacity of the culvert that conveys flows beneath a parking lot (Station 217) that replaced the ditch that was shown in the as-built drawing. In

the recommended maintained condition, the gunite ditch and culvert at Station 34 were estimated to provide a level of service for the 100-year storm event, but due to the restricted flow condition at the culvert (Station 135 to 217) the combined level of service is only the 5-year storm event. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Table 3. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
54th St 1	380-34	40	93	<2-year	5-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Photos are from the site visit conducted by Geosyntec Consultants in July 2017.

1. 54th St 1: Looking upstream.

2. 54th St 1: Looking downstream towards the culvert; conveys flows beneath parking lot, then discharges back into ditch.

3. 54th St 1: Looking downstream.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.

Field Photo Locations
Storm Drain Conveyance
Culvert
Domain of Analysis Cross Section
MWMP Facility Cross Section
WMP Facility Center Line

Drainage Area: 2,658 acres

Feet
0 30 60

The City of SAN DIEGO

Facility Group Name: Chollas Creek - 54th St
Segment Name: 54th St 1
Facility No: 5-04-280
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.

November 2019

A.45 South Chollas Creek – Southcrest

Summary of Recommended Maintenance

Ocean View 1 (No. 5-05-008)

Facility Type	Bed: Concrete, Earthen Banks: Concrete	Category 1 & 2
Is Maintenance Recommended?	Routine maintenance is not recommended at this time. However, a maintenance area should be identified for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.[1,2]	
Extent of Maintenance	• Not Applicable	
Benefit	• Due to the maintenance downstream within Reach 6 of the Alpha 1 segment, the level of service in Reach 7 increases from a 5-year storm event (1,300 cfs) to a 10-year storm event (2,000 cfs).and the water surface elevation within Reach 8 is reduced during the 100-year storm event by approximately 0.2 feet.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Alpha 1 (No. 5-05-006)

Facility Type	Bed: Earthen Banks: Concrete, Earthen, Riprap	Category 1, 2, & 3
Is Maintenance Recommended?	Yes[1, 2]	
Extent of Maintenance	• In Reach 1, no maintenance is recommended. • In Reach 2, remove accumulated sediment/debris and overgrown vegetation from Station 4788 to Station 4925. • In Reach 3, remove accumulated sediment/debris and overgrown vegetation from Station 4925 to Station 5135. • In Reach 4, trim vegetation from Station 5135 to Station 5316. • In Reach 5, remove accumulated sediment/debris and overgrown vegetation from Station 5613 to Station 5734 and Station 6195 to Station 6277. The remainder of Reach 5 is recommended to be maintained by the private property owners to remove accumulated sediment/debris and overgrown vegetation. • Reach 6 is to be maintained by the private property owners to remove accumulated sediment/debris and overgrown vegetation from Station 6437 to Station 6580. • In Reach 7 (Station 6580 to Station 6624), no maintenance is recommended. • Perform bank repair on the earthen bank from Station 5456 to Station 5556.	
Benefit	• In Reach 1, the level of service remains <25-year storm event (2,100 cfs). • In Reach 2, the water surface elevation is reduced during the 100-year storm event by approximately 0.4 feet. • In Reach 3, the level of service increases from 5-year storm event (1,300 cfs) to 10-year storm event (2,000 cfs). • In Reach 4, the level of service increases from 5-year storm event (1,300 cfs) to 10-year storm event (2,000 cfs). • In Reach 5, the level of service increases from 2-year storm event (550 cfs) to 5-year storm event (1,300 cfs). • In Reach 6, the level of service increases from 5-year storm event (1,300 cfs) to 10-year storm event (2,000 cfs).	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

[2] Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

The report listed in Table 1 and an electronic copy of the hydraulic model file used to produce the report were used to prepare this fact sheet.

Table 1. Completed Reports

Segment	Report	Reach
Ocean View	RICK Engineering Company, 2018. IHHA Report for South Chollas Creek Channel, Maps 95, 97, 97a, 98 and Unmapped Area 302. (2018 RICK IHHA)	Reaches 10 – 7[a]
Alpha (Upstream of Station 3295[b])		Reaches 7[a] – 1[c]
Alpha (Downstream of Station 3295[b])	–	–

[a] Reach 7, as defined in the RICK IHHA, includes the downstream end of the Ocean View segment and the upstream end of the Alpha segment.

[b] Because an additional 3,268 feet of channel downstream of the area evaluated by RICK Engineering was modeled to prepare this fact sheet, the stations in the RICK report were renumbered by adding 3,268 to them and rounding to the nearest integer. For example, Station 3295 in this report, the most downstream cross section in the RICK Engineering model, is labeled as Station 27.04236 in the RICK report.

[c] Reach 1, as used in this fact sheet, stretches from the 38th Street bridge to just past the pedestrian bridge located east of Interstate 5 (I-5). This includes approximately 170 feet of channel downstream of the 38th Street bridge that was referred to as Reach 1 in the RICK IHHA, plus an additional approximately 1,630 feet of channel farther downstream.

General Description

The bed and bank materials and availability of as-built drawings varied for different reaches in the South Chollas Creek – Southcrest (Southcrest) facility group. Due to this variability, reaches were classified as category 1, 2, or 3, as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Southcrest facility group is located in the San Diego Bay Watershed Management Area. The Ocean View segment extends from about 500 feet upstream of the Ocean View Boulevard bridge, where the concrete channel segment begins, to the upstream side of the National Avenue bridge. The Alpha segment extends from the downstream end of the Ocean View segment to the eastern edge of the California Department of Transportation (Caltrans) right-of-way by Interstate 5 (I-5), just downstream of a pedestrian bridge. The Ocean View and Alpha segments are bordered mainly by residential development on both their north and south sides. Southcrest Park is located along the south bank of the Alpha segment between Newton Avenue and 40th Street.

The Ocean View and Alpha segments are trapezoidal channels with bottom widths that vary from 18 feet to 56 feet; flow direction in the channel is from northeast to southwest. The Ocean View segment includes reaches with concrete banks and bottom and with concrete banks and an earthen bottom. The Alpha segment includes a range of bed and bank materials, including fully earthen, fully concrete,

earthen bottom and either one or two concrete banks, and earthen with riprap banks. Due to this variation, the Ocean View and Alpha segments have been broken into several reaches, as follow:

- Ocean View, Reach 10: Stations 8910 to 8339. This reach is a concrete trapezoidal channel extending from the beginning of the concrete channel, north of the Ocean View Boulevard bridge, to the downstream side of the Ocean View Boulevard bridge.
- Ocean View, Reach 9: Stations 8339 to 8200. This reach is a concrete trapezoidal channel extending about 140 feet downstream from Reach 10, where the channel bottom transitions to earthen.
- Ocean View, Reach 8: Stations 8200 to 6942. This reach is a trapezoidal channel with an earthen bottom and concrete banks. It extends downstream to about 250 feet upstream of the National Avenue bridge, where the channel bottom becomes concrete again.
- Alpha/Ocean View, Reach 7: Stations 6942 to 6580. This reach is a concrete trapezoidal channel that includes the downstream end of the Ocean View segment, which ends at the upstream side of the National Avenue bridge and the upstream end of the Alpha segment. The downstream boundary of Reach 7 is the downstream side of the National Avenue bridge.
- Alpha, Reach 6: Stations 6580 to 6437. This reach is a trapezoidal channel with an earthen bottom and riprap banks. It extends about 140 feet downstream from the end of Reach 7, where the channel material changes again. The 2017 RICK IHHA reports that Reach 6 is privately owned, with a flowage easement, meaning the private owners are responsible for maintaining this reach.
- Alpha, Reach 5: Stations 6437 to 5627. This reach is a trapezoidal channel with an earthen bottom, earthen left bank, and concrete right bank. Reach 5 extends to the downstream side of the pedestrian bridge that links the residential area north of the channel to Southcrest Park. Reach 5 is privately owned, and the 2018 RICK IHHA reports that maintenance is the responsibility of the private owners from Station 6437 to Station 6277 and from Station 6195 to Station 5734. The city is responsible for maintenance for the portion of the channel where a right-of-way easement for Newton Avenue crosses over the channel from Station 6277 to 6195, and for the portion of the channel within an easement from Station 5734 to 5627.
- Alpha, Reach 4: Stations 5627 to 5135. This reach is an earthen trapezoidal channel that extends downstream to about 140 feet upstream of the 40th Street bridge, where the channel transitions to having concrete banks.
- Alpha, Reach 3: Stations 5135 to 4925. This reach is a trapezoidal channel with an earthen bottom and concrete banks. It extends to the downstream side of the 40th Street bridge.
- Alpha, Reach 2: Stations 4925 to 3467. This reach is a trapezoidal channel with an earthen bottom and concrete banks that extends to the downstream side of the 38th Street bridge.

- Alpha, Reach 1: Stations 3467 to 1662. This reach is a trapezoidal channel with an earthen bottom, earthen left bank, and concrete right bank. A channel rehabilitation project was completed relatively recently in this reach. Reach 1 ends just downstream of the pedestrian bridge located east of I-5, where the channel continues into the Caltrans right-of-way.

The bulk of the storm flow conveyed through Ocean View and Alpha segments comes from the upstream segment of South Chollas Creek, located to the east of the Ocean View segment. The facility group also receives smaller inflows from storm drains and surface flows along its length. A concrete channel conveys water from the Alpha segment downstream, where it confluences with North Chollas Creek.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Southcrest facility group.

Hydrology

The hydrologic peak flows for the 10-, 50-, and 100-year recurrence intervals presented in Table 2 below were extracted from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for San Diego County dated May 16, 2012. The peak flows for the remaining recurrence intervals (2-, 5-, and 25-year) were interpolated and listed in the 2018 RICK IHHA.

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Ocean View	550	1,300	2,000	3,000	3,900	5,300
Alpha	550	1,300	2,000	3,000	3,900	5,300

Hydraulics

A one-dimensional steady flow model was developed for this facility segment using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and proposed maintained conditions. Refer to *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the detailed HEC-RAS model. The extent of the reach evaluated in the model is presented in the Hydraulic Reference Map.

The upstream and downstream domains of analysis for the Southcrest facility group were identified based on the methodology presented in *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report.* The upstream domain of analysis is the earthen channel upstream of the Ocean View facility group, from Station 9498 to Station 8910. The downstream domain of analysis begins at the eastern side of I-5 and extends down to the confluence with North Chollas Creek, from Station 1662 to

Station 8. Known water surface elevations provided by FEMA were used as the upstream and downstream boundary conditions.

The baseline condition for the Alpha segment was based on the current conditions scenario in the 2018 RICK IHHA for Reaches 10 through 2 and on observations during a July 2017 site visit conducted by DMax Engineering for Reach 1 and the upstream and downstream domains of analysis. Reaches 10 through 2 were also observed during the July 2017 site visit, and conditions were generally consistent with those reported in the 2018 RICK IHHA. As noted earlier, the bed and bank material varies across the different reaches in the Ocean View and Alpha segments. Manning's coefficients ranging from 0.015 (clean concrete) to 0.150 (dense vegetation) were assigned based on field observations made during a site visit in November 2016 to develop the 2018 RICK IHHA and during a July 2017 site visit. See the Representative Photos section below for examples of the condition of the facility as observed during the July 2017 site visit. Table 3 summarizes the bed and bank materials of each reach and the corresponding ranges of Manning's coefficients assigned based on field observations of vegetation density and sediment and debris accumulation.

The recommended maintained condition scenario is based on the following proposed maintenance actions:

- Alpha, Reach 6: The Manning's coefficient values for the recommended maintained condition were set at 0.030 for the earthen bottom and 0.045 for the riprap banks. The 2018 IHHA reports that maintenance within Reach 6 is entirely the responsibility of private parties.
- Alpha, Reach 5: From Station 6437 to Station 5627 the Manning's coefficient value of 0.035 was assigned to reflect channel conditions after removing accumulated sediment and vegetation. The 2018 IHHA reports that maintenance within Reach 5 is primarily the responsibility of private parties. The City is responsible for maintenance of the channel in the area where the Newton Avenue right-of-way crosses the channel from Station 6277 to 6195, and for the portion of the channel within an easement from Station 5734 to 5627.
- Alpha, Reach 4: The recommended maintained condition Manning's coefficient value was set at 0.035 to reflect shorter and less dense vegetation anticipated after trimming activities.
- Alpha, Reach 3: The Manning's coefficient values for the recommended maintained condition were set at 0.030 for the earthen bottom and 0.018 for the concrete banks.
- Alpha, Reach 2: The Manning's coefficient values for the recommended maintained condition were set at 0.030 for the earthen bottom and 0.018 for the concrete banks.

No maintenance is proposed for the Ocean View segment or for Reaches 1 and 7 of the Alpha segment. For the Ocean View segment, the IHHA discussed that maintenance caused an increase in erosive velocities and provided minimal improvements to the conveyance capacity. In Reach 7 of the Alpha segment, the analysis showed the maintenance caused erosive velocities however, the use of

a check dam to control velocities nullified any conveyance capacity benefits. Therefore, maintenance is not recommended in Reach 7.

For Reach 1 of the Alpha segment, the analysis indicated that the increase in level of service following maintenance activities is negligible. A portion of the segment is located within a restoration area and maintenance activities are limited in scope to primarily the removal of any invasive vegetation. Additionally, low bank elevations along a portion of the southerly bank limited the potential capacity improvements provided by the maintenance. Therefore, maintenance activities were not recommended for Reach 1 of the Alpha segment. The Manning's coefficients and sediment/debris depths in segments for which no maintenance is proposed and for the domain of analysis segments were kept the same as in the baseline condition.

Model parameters and velocities for these scenarios are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Upstream Domain of Analysis	9498-8910	Baseline: 0.018-0.05 Maintained:	-	Known Water Surface Elevation
Ocean View 1, Reach 10 (concrete)	8910-8339	Baseline: 0.018-0.05 Maintained: -	Bridge (Station 8395-8343)	-
Ocean View 1, Reach 9 (concrete)	8339-8200	Baseline: 0.018–0.080 Maintained: -	-	-
Ocean View 1, Reach8 (earthen bottom, concrete banks)	8200-6942	Baseline: 0.018–0.090 Maintained: -	-	-
Alpha 1/Ocean View 1, Reach 7[a] (concrete)	6942-6580	Baseline: 0.018–0.065 Maintained: -	Bridge (Station 6686-6624)	-

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Alpha 1, Reach 6 (Earthen Bottom, Rip-Rap Banks)	6580-6437	Baseline: 0.018–0.100 Maintained: 0.018–0.055	-	-
Alpha 1, Reach 5 (earthen bottom, earthen left bank, concrete right bank)	6437-5627	Baseline: 0.018–0.075 Maintained: 0.018–0.075	Bridge (Station 5655-5645)	-
Alpha 1, Reach 4 (earthen)	5627-5135	Baseline: 0.020–0.150 Maintained: 0.020–0.150	-	-
Alpha 1, Reach 3 (earthen bottom, concrete banks)	5135-4925	Baseline: 0.018–0.150 Maintained: 0.018–0.035	Bridge (Station 4987-4935)	-
Alpha 1, Reach 2 (earthen bottom, concrete banks)	4925-3467	Baseline: 0.018–0.150 Maintained: 0.018–0.075	Bridge (Station 3555-3504)	-
Alpha 1, Reach 1 (earthen bottom, earthen left bank, concrete right bank)	3467-1662	Baseline: 0.015–0.075 Maintained:	Bridge (Station 1741-1733)	-
Downstream Domain of Analysis	1662-8	Baseline: 0.015–0.035 Maintained:	Bridges (Stations 1644-1589, 1491-1266, 1163-1123, 721-683, 313-287, and 211-157)	Known Water Surface Elevation

[a] Reach 7, as defined in the IHHA, includes the downstream end of the Ocean View segment and the upstream end of the Alpha segment. The boundary between the two segments is just upstream of the National Avenue bridge, at approximately Station 6709.

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility group flow rates, summarized in Table 1 in the Hydrology section, were used in the determination of the level of service. The overall channel conveyance capacities and level of service for the segment are provided in the Summary Table (Table 4) for both the baseline and recommended maintained conditions.

Baseline Condition

Ocean View Reach 10 is capable of conveying 3,000 cubic feet per second (cfs) (25-year level of service) before flows impact adjacent property. Ocean View Reaches 9 and 8 is capable of conveying 1,300 cfs (5-year level of service) before flows impact adjacent property.

Alpha/Ocean View Reach 7 and Alpha Reaches 6, 4, and 3 is capable of conveying 1,300 cfs (5-year level of service) before flows impact adjacent property. Alpha Reach 5 is capable of conveying 550 cfs (2-year level of service) before flows impact adjacent property. Alpha Reach 2 is capable of conveying 2,000 cfs (10-year level of service) before flows impact adjacent property.

Alpha Reach 1 in the baseline condition is capable of conveying 2,100 cfs (<25-year level of service) before flows impact adjacent property.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from Alpha Reach 6 improves the conveyance capacity to 2,000 cfs, with the level of service increasing to the 10-year storm event. Maintaining Reach 6 also improves the conveyance capacity of Reach 7 to 2,000 cfs, with the level of service increasing to the 10-year storm event. In addition, maintaining Reach 6 reduces the water surface elevation in Reach 8 during the 100-year storm event by approximately 0.2 feet, which decreases the overall limits of flooding in Reach 8. As noted earlier, the 2018 RICK IHHA reports that maintenance within Reach 6 is the responsibility of private parties, not the City.

Removing deposited sediment/debris and vegetation from the bottom of Alpha Reach 5 improves the conveyance capacity to 2,000 cfs, with the level of service increasing to the 10-year storm event from Station 6437 to 6398. The recommended maintenance from Station 6398 to 5627 improves the conveyance to 1,300 cfs, with the level of service increasing to the 5-year storm event.

Trimming vegetation in Alpha Reach 4 improves the conveyance capacity to 2,000 cfs, with the level of service increasing to the 10-year storm event.

Removing deposited sediment/debris and vegetation from Alpha Reach 3 improves the conveyance capacity to 2,000 cfs, with the level of service increasing to the 10-year storm event.

Removing deposited sediment/debris and vegetation from Alpha Reach 2 reduces the water surface elevation during the 100-year storm event by approximately 0.4 feet, which decreases the overall limits of flooding. The level of service remains at the 10-year storm event.

Levels of service in the other reaches remain unchanged from the baseline condition. Maintenance is not recommended for the Oceanview segment. However, for the concrete lined portions of the channel, due to the potential need for access and/or concrete repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Post-Maintenance Erosion Control Measures

The 2018 RICK IHHA proposes a limited amount of maintenance intended to achieve the maximum level of service that does not result in erosive velocities, based on guidance in the *City of San Diego Drainage Design Manual, dated January 2017*. The analysis indicates that additional measures to reduce velocity or otherwise control erosion are recommended for this facility in Reaches 4 and 6, where maintenance is proposed. Refer to Chapter 6 of the Hydrology and Hydraulics Technical Report for additional details on appropriate velocity reduction and erosion control measures.

If maintenance occurs in privately owned sections of the segments, post maintenance erosion control measures are recommended to be evaluated and installed by the private property owners. The 2018 IHHA states that a check dam may be necessary if maintenance is performed in Alpha Reach 6, where maintenance is the responsibility of private parties. If a check dam location is determined to be on City property, it will require coordination with the Transportation & Storm Water Department.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the overall facility group level of service was restricted either by bridges or by low bank elevations. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

The 2018 IHHA suggests that installing a pipe to divert water around Reach 5 or widening Reach 5 could potentially be feasible, but would require additional study. Modeling of Reach 1 suggests that low bank elevations on the south bank contribute to a reduced level of service.

Summary Table

Table 4. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Ocean View 1, Reach 10	8910-8339	3,000	-	25-year	-
Ocean View 1, Reach 9	8339-8200	1,300	-	5-year	-
Ocean View 1, Reach 8	8200-6942	1,300	-	5-year	-
Alpha 1/Ocean View 1, Reach 7[2]	6942-6580	1,300	2,000	5-year	10-year
Alpha 1, Reach 6	6580-6437	1,300	2,000	5-year	10-year
Alpha 1, Reach 5	6437-5627	550	1,300	2-year	5-year
Alpha 1, Reach 4	5627-5135	1,300	2,000	5-year	10-year
Alpha 1, Reach 3	5135-4925	1,300	2,000	5-year	10-year
Alpha 1, Reach 2	4925-3467	2,000	2,000	10-year	10-year
Alpha 1, Reach 1	3467-1662	2,100	-	<25-year	-

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

[2] Reach 7, as defined in the IHHA, includes the downstream end of the Ocean View segment and the upstream end of the Alpha segment. The boundary between the two segments is just upstream of the National Avenue bridge, at approximately Station 6709.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. The site visit was conducted in July 2017.

1. Ocean View 1 (Reach 10): looking downstream toward the Ocean View Boulevard bridge.

2. Ocean View 1 (Reach 8): looking downstream toward the start of the Reach 7 concrete bottom channel.

3. Alpha 1 (Reach 6): looking downstream from the National Avenue bridge.

4. Alpha 1 (Reach 5): looking downstream from the pedestrian bridge at Southcrest Park. Dense vegetation is present in the channel.

5. Alpha 1 (Reach 2): looking downstream, showing concrete banks and vegetation in earthen bottom.

6. Alpha 1 (Reach 1): looking downstream, showing vegetation in the earthen channel bottom and the concrete right bank.

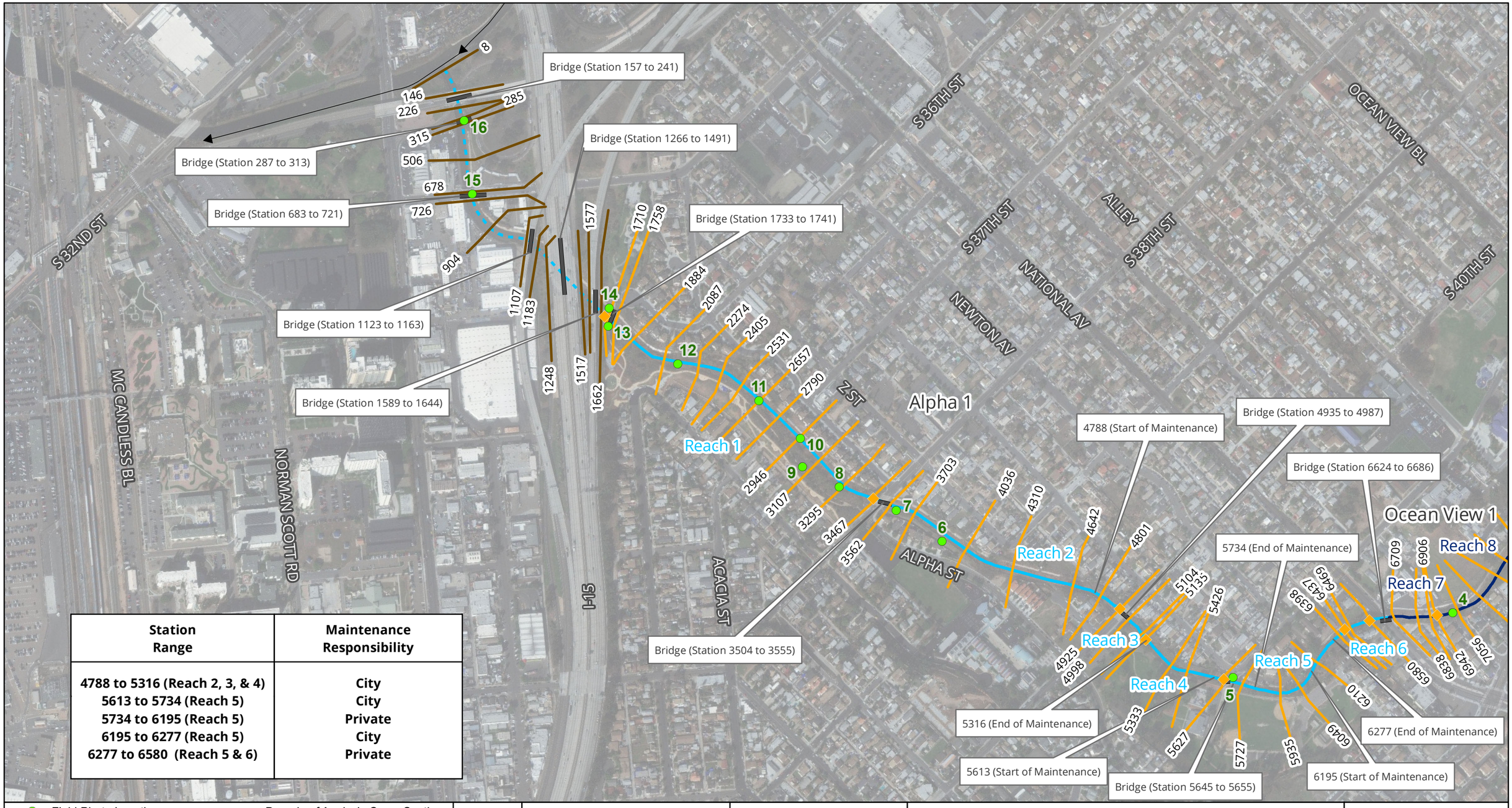
7. Alpha 1 (Reach 1): looking downstream under the pedestrian bridge located just east of I-5.

Analysis Performed By: RICK Engineering, D-MAX Engineering Inc.

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.



Station Range	Maintenance Responsibility
4788 to 5316 (Reach 2, 3, & 4)	City
5613 to 5734 (Reach 5)	City
5734 to 6195 (Reach 5)	Private
6195 to 6277 (Reach 5)	City
6277 to 6580 (Reach 5 & 6)	Private

Field Photo Location
End of Reach
Storm Drain Conveyance
Bridge/Culvert
Domain of Analysis Cross Section
MWMP Facility Cross Section
Domain of Analysis Center Line
Alpha 1
Ocean View 1

Drainage Area: 6,976 acres

Feet
0 145 290 580

The City of SAN DIEGO

Facility Group Name: South Chollas Creek - Southcrest
Segment Name: Alpha 1
Facility Nos: 5-05-006
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

November 2019

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.


Bridge (Station 8337 to 8390)
Bridge (Station 6624 to 6686)
Reach 10
Reach 9
Reach 8
Reach 7
Reach 6
Reach 5
8548
8682
8777
8910
8405
8339
8220
8200
8031
7779
7555
7437
7344
7200
7056
6942
6906
6838
6709
6580
6469
6437
6398
6210
6049
5935
9045
9157
9233
9313
9393
9498
NATIONAL AV
S 42ND ST
SAN PASQUAL ST
IMPERIAL AV
45TH ST
S 41ST ST
OCEAN VIEW BL
Alpha 1
Ocean View 1

A.46 South Chollas Creek - Euclid

Summary of Recommended Maintenance

Euclid 1 (No. 5-05-019)

Channel type	Bed: Earthen Banks: Earthen	Category 3
Is maintenance recommended?	Routine maintenance is not recommended at this time[1, 2]	
Extent of Maintenance	• Not Applicable	
Benefit	• Not Applicable	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 This segment was recently reconstructed and is not anticipated to be included in the Municipal Waterways Maintenance Plan. In the future, if segment performance decreases from design values, the channel hydraulics should be evaluated for potential maintenance needs.

Euclid 2 (No. 5-05-021)

Channel type	Bed: Concrete Banks: Concrete	Category 1
Is maintenance recommended?	Routine maintenance is not recommended at this time. However, a maintenance area should be identified for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.[1, 2]	
Extent of maintenance	• Not Applicable	
Benefit	• Not Applicable	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

General Description

The South Chollas Creek – Euclid (Euclid) facility group was classified as having both a Category 1 and a Category 3 segment as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report.* The Euclid facility group is located in the Pueblo San Diego Watershed Management Area. The facility group starts near Hilltop Road and 51st Street and heads southwest where it ends near 47th Street and Nogal Street. The facility consists of an upstream concrete segment (Euclid 2) and a downstream earthen segment with riprap and cobble bottom (Euclid 1) that was recently reconstructed as part of another project.

The Euclid 2 is a concrete lined segment that begins at the southwest corner of Hilltop Road and 51st Street. The Euclid 2 segment continues south along 51st Street, makes an approximately 90-degree turn at Guymon Street, continues east along Guyman Street, turns south and ends at Market Street, where flows enter a double 10-foot wide by 5-foot-high reinforced concrete box (RCB) culvert beneath Euclid Avenue.

The Euclid 1 segment is an earthen segment which has recently been redesigned as part of a redevelopment project. The segment begins at the outlet of the double 10-foot-wide by 5-foot-high RCB culvert beneath Euclid Avenue. The segment continues west and then south before entering a double 10-foot-wide by 5-foot-high RCB culvert beneath Market Street.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Euclid facility group.

Hydrology

The hydrologic peak flows presented in Table 1 are based on the Federal Emergency Management Agency's (FEMA's) 2012 Flood Insurance Study (FIS) for San Diego County. The FIS provided the 10-, 50-, and 100-year flow rate information for South Las Chollas Creek above confluence with Las Chollas Creek branch. The peak flows for the remaining recurrence intervals (2-, 5-, and 25-year) were interpolated using the method described in *Section 3.1.1.1 of the Hydrology and Hydraulics Technical Report*.

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Euclid 2	540	1,250	2,000	3,000	3,900	5,300
Euclid 1	540	1,250	2,000	3,000	3,900	5,300

Hydraulics

A one-dimensional steady flow model was developed for the Euclid facility group using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and recommended maintained conditions. Refer to *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the HEC-RAS model. The extents of the reaches evaluated in the model are presented in the Hydraulic Reference Map located at the end of this fact sheet.

The upstream domain of analysis for the Euclid facility group is a concrete segment that has been excluded from this model. The downstream domain of analysis for the Euclid facility group is the earthen channel that continues for approximately 3,000 feet through commercial and residential property before it discharges into the storm drain system. The domain of analysis is located southwest of Market Street and crosses four bridges before ending just east of 47th Street. Based

on the methodology presented in *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report,* the upstream domain of analysis has been excluded from the modeling.

The baseline condition for the Euclid 2 segment is defined as the current condition of the segment. The Euclid 2 segment bottom was assigned Manning's coefficient values ranging from 0.015 to 0.03, and side slopes were assigned a value of 0.10 based on varying vegetation observed in the concrete segment during the site visit conducted by Geosyntec Consultants in April 2017. The baseline condition for the Euclid 1 segment is also defined as the current condition of the segment. The segment channel bottom was assigned a Manning's coefficient value of 0.05, and side slopes were assigned a value of 0.10 based on the light vegetation observed in the riprap and cobble bottomed segment during the site visit. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2017 site visit.

For the recommended maintained condition, the channel bottom and side slopes of the Euclid 2 segment were assigned a Manning's coefficient value of 0.015 to reflect the roughness of the originally constructed concrete facility. The Euclid 1 channel bottom was assigned a Manning's coefficient value of 0.04 to represent the removal of vegetation.

Model parameters and velocities for the baseline and maintained conditions for the Euclid facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the level of service capacity.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Euclid 2 (concrete)	5235-4093	Baseline: 0.015-0.1 Maintained: 0.015-0.1	Baseline: 3.2-11.0 Maintained: 3.2-11.0	Culvert (Station 4190 to 4093)	Critical Depth
Euclid 1 (earthen)	4093-3189	Baseline: 0.04-0.1 Maintained: 0.04-0.1	Baseline: 5.3-10.9 Maintained: 5.3-10.9	Foot Bridge (Station 3554 to 3544), Culvert (Station 3189 to 3095)	-
Downstream Domain of Analysis (earthen)	3189-37	Baseline: 0.05-0.1 Maintained: 0.05-0.1	Baseline: 1.4-12.3 Maintained: 1.4-12.3	Bridges (Station 2785 to 2811, Station 2733 to 2683, Station 2498 to 2485, Station 252 to 182)	Normal Depth

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flow rates, summarized in Table 1 in the Hydrology section, were used in determining the level of service. The velocities, summarized in Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall channel conveyance capacities and level of service for the segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained conditions.

Baseline Condition

The Euclid 2 segment can convey 225 cubic feet per second (cfs) (<2-year level of service), before residential development is inundated. The Euclid 1 segment can convey 1,250 cfs (5-year level of service), before the banks are overtopped.

Recommended Maintained Condition

The level of service and conveyance capacity of the facility group did not improve under the maintained condition which included the removal of deposited sediment/debris and vegetation; therefore, maintenance is not recommended at this time. Additionally, maintenance is not being recommended due to the recent redesign and redevelopment of the downstream Euclid 1 segment. If in the future the design values are exceeded, the facility group will need to be evaluated and maintained. Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance within Euclid 2 is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Post-Maintenance Erosion Control Measures

No maintenance is proposed in the Euclid 2 segment. The baseline condition velocities were noted to be below recommended permissible velocities for concrete lined channels (35 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*.

No maintenance is proposed in the Euclid 1 segment. The baseline condition velocities were noted to be below the recommended permissible velocities for rip-rap lined channels (18 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the overall facility level of service was restricted by low bank elevations, in addition to the capacity of the downstream culverts between Stations 4190 and 4093 and Stations 3189 and 3095. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Table 3. Summary Table

Segment	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Euclid 2	5235-4093	225	225	<2-year	<2-year
Euclid 1	4093-3189	1,250	1,250	<5-year	<5-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. A site visit was conducted by Geosyntec Consultants in April 2017.

1. Euclid 2: Representative of concrete portion of channel.

2. Euclid 1: Double box culvert outlet at Euclid Avenue.

3. Euclid 1: Representative of earthen with cobble portion of channel.

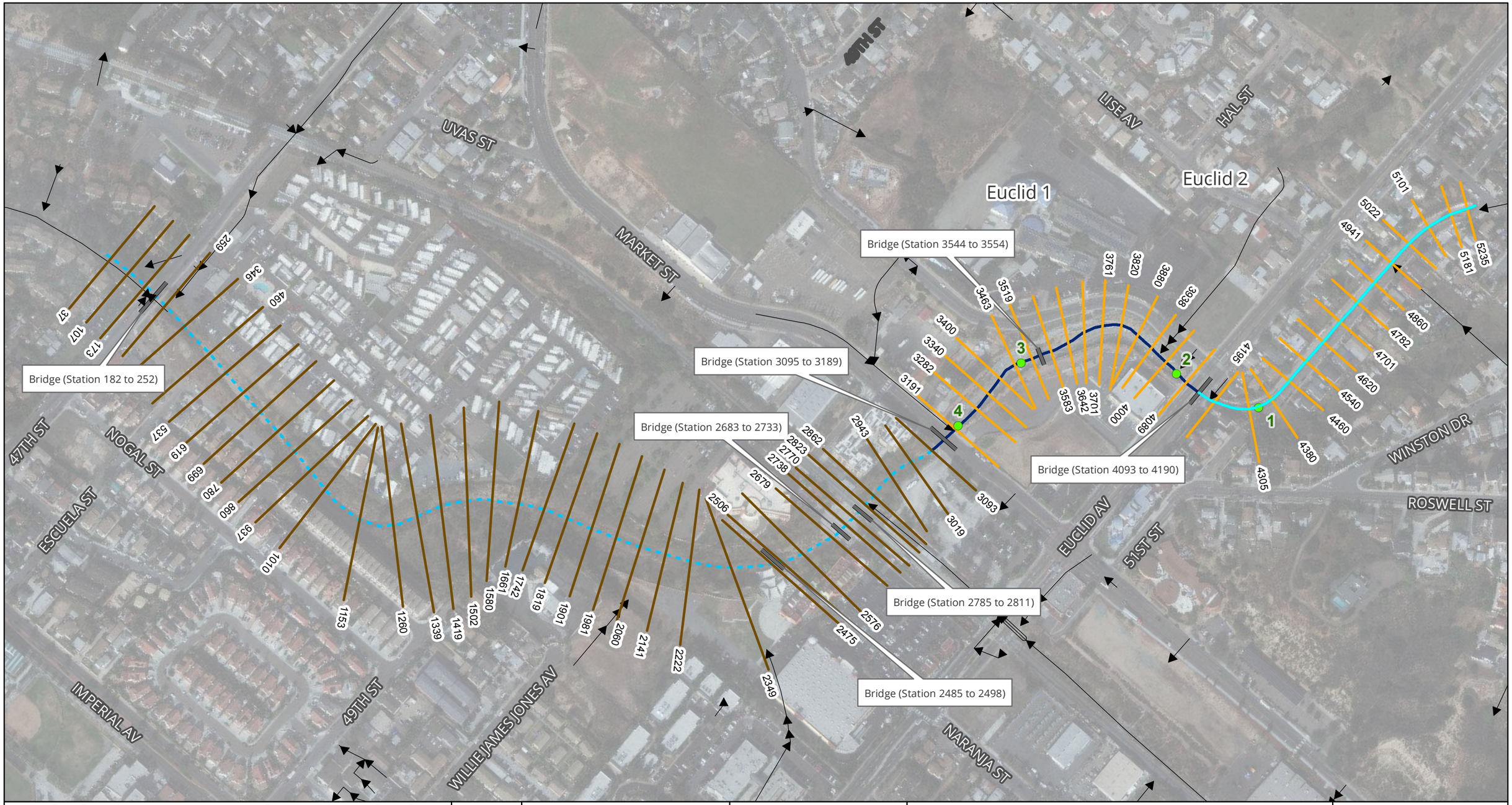
4. Euclid 1: Double box culvert inlet at Market Street.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page for the Euclid facility group.



Field Photo Location
Storm Drain Conveyance
Bridge
Domain of Analysis Cross Section
WMP Facility Cross Section
Domain of Analysis Center Line
Euclid 1
Euclid 2

Drainage Area: 1,050 acres

0 100 200 400 Feet

The City of SAN DIEGO

Facility Group Name: South Chollas Creek - Euclid
Segment Name: Euclid 1 - 2
Facility Nos: 5-05-019, 5-05-021
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.

November 2019

A.47 South Chollas Creek – Federal

Summary of Recommended Maintenance

Federal 1 (No.5-05-035)

Facility Type	Bed: Earthen, Riprap Banks: Earthen, Concrete, Riprap	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from the channel bottom and banks in the riprap portion of the channel from Station 926.7529 to Station 976.670.	
Benefit	• Increase level of service from 10-year storm event (580 cfs) to 25-year storm event (830 cfs).	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Proposed maintenance area stations may differ from IHHA model reference stations.

Federal 2 (No.5-05-037)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove vegetation from channel bottom from Station 976.670 to Station 2306.424.	
Benefit	• Preserves level of service at 100-year storm event (1,500 cfs) and will decease water surface elevation. • Reduces potential clogging/obstruction of the downstream segment and bridge.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Proposed maintenance area stations may differ from IHHA model reference stations.

The reports listed in Table 1 were used to generate this fact sheet.

Table 1. Completed Report

Segment	Report	Reach
Federal 2	Rick Engineering, 2017. IHHA Report for South Chollas Creek Channel – Map Number 101.	3
Federal 1	Rick Engineering, 2017. IHHA Report for South Chollas Creek Channel – Map Number 101.	2

General Description

The South Chollas Creek – Federal (Federal) facility group was classified as having a Category 1 segment and a Category 3 segment as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Federal facility group is located in the Pueblo San Diego Watershed Management Area. The facility parallels the eastbound State Route 94 highway and is bordered by commercial buildings, warehouses, and parking lots on the south side of the facility. The facility group is bordered at the downstream end by Federal Boulevard and at the upstream end by a City of Lemon Grove drainage channel (located in the City of Lemon Grove's jurisdiction).

The facility group is divided into two reaches for the purpose of this assessment. Reach 3 (Federal 2 segment) is the furthest upstream segment within the facility group, and begins as a rectangular channel with a 20-foot bottom width and a minimum depth of 4 feet before it transitions to a trapezoidal concrete lined channel with a bottom width of 8 feet; a minimum depth of 5-feet, 9-inches; and side slopes of 1.5:1 (H:V). The segment begins at the transition from a City of Lemon Grove flood control channel and continues southwest for approximately 1,300 feet until it reaches a 2-ton riprap transition zone. Reach 2 (Federal 1 segment) is the subsequent downstream segment that includes the 50-foot-long riprap transition, and is an earthen channel with bottom width of 24 feet, right side slope (looking downstream) of 1.5:1 (H:V), a vertical concrete retaining wall for the left side slope (looking downstream), and a minimum depth of 6 feet with a retaining wall on the left overbank (when looking downstream). The segment continues from the end of the Federal 2 segment for approximately 600 feet in a southwesterly direction until crossing underneath a single-span bridge, 20-feet-wide by 11-feet-high, at Federal Boulevard. The single-span bridge at Federal Boulevard is the downstream limit of the facility group. South Chollas Creek Channel continues downstream.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Federal facility group.

Hydrology

The hydrologic peak flows presented in Table 2 are based on Federal Emergency Management Agency's (FEMA's) Flood Insurance Study (FIS) for San Diego County (2016). The FIS provided the 10-,

50-, and 100-year flow rate information for Chollas Creek Channel. The peak flows for the remaining recurrence intervals (2-, 5-, 25-year) were extrapolated using log-probability paper.

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Federal 2	167	370	580	830	1,100	1,500
Federal 1	167	370	580	830	1,100	1,500

Hydraulics

A one-dimensional steady flow model was developed for the Federal facility group using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline condition and the recommended maintained condition. The extent of the reaches evaluated in the model are presented in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition for the Federal facility group was defined as the current condition, as observed during the site visit conducted by Rick Engineering in November 2016. The Federal 2 segment was assigned a Manning's coefficient value of 0.018, reflecting no vegetation or deposited sediment in most of the concrete channel, and 0.03 for portions that had minor sediment deposition and light vegetation. The upstream portion of the Federal 1 segment was assigned Manning's coefficient value ranging from 0.09 to 0.10 for the riprap section, reflecting dense vegetation and sedimentation. Photos in the Representative Photos section below provide examples of the baseline facility condition.

The assigned Manning's coefficient value for the Federal 2 segment in the recommended maintained condition was 0.018, reflecting the roughness of the originally constructed concrete facility. The assigned Manning's coefficient value for the Federal 1 segment in the recommended maintained condition was 0.049, reflecting the roughness of the originally constructed facility (riprap).

Model parameters for the baseline and maintained conditions for the Federal facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Federal 2 (concrete)	2306.424-976.670	Baseline: 0.018, 0.03 Maintained: 0.018	-	Normal Depth
Federal 1 (riprap)	976.670-362.8132	Baseline: 0.09-0.10 Maintained: 0.049	Bridge at Federal Boulevard (Station 362.8132)	Normal Depth

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used in determining the level of service. The overall conveyance capacity and level of service for the segment are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition

In the baseline condition, The Federal 2 segment can convey 1,500 cubic feet per second (cfs) (100-year level of service). The Federal 1 segment conveys 580 cfs (10-year level of service) before the adjacent property is impacted.

Recommended Maintained Condition

In the recommended maintained condition, the level of service for the Federal 2 segment remains equal to the 100-year storm event and can convey 1,500 cfs. While vegetation and sediment removal maintenance will result in an improved level of service of the 100-year storm event, the increased velocities in the Federal 1 segment (up to a maximum of 20 feet per second (fps)) exceed the recommended permissible velocity for an unlined channel of this type (6 fps). Therefore, removal is only recommended for the riprap portion (upper 50 feet), which will increase the level of service to the 25-year storm event (830 cfs), while not increasing downstream velocities above the permissible velocities for earthen channels.

Post-Maintenance Erosion Control Measures

In the recommended maintained condition, the estimated velocities in the Federal facility are below recommended permissible velocities for concrete lined (fps) and earthen channels (5 fps) as defined

in the *City of San Diego Drainage Design Manual, dated January 2017*. The recommended maintenance was scaled back to keep the velocities within the permissible range. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for either facility.

If permanent erosion control measures can be implemented in the future, additional capacity gains may be achieved in the Federal 1 segment.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the level of service for the Federal facility group was restricted by the downstream bridge at Federal Boulevard (Station 362.8132). Additional analysis is recommended to evaluate potential increases in the levels of service that could be achieved by capital improvements to address these restrictions.

Table 4. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Federal 2	2306.424-976.670	1,500	1,500	100-year	100-year
Federal 1	976.670-362.8132	580	830	10-year	25-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map indicated. A selection of photos representative of the baseline condition from the previous IHHA are included in this fact sheet with the original photo numbers. A site visit was conducted by Rick Engineering in November 2016.

IHHA 8. Federal 1: Downstream portion of Reach 2 looking south at the vegetation left bank (looking downstream).

IHHA 14. Federal 1: Upstream portion of Reach 2 looking southwest at the 2-ton riprap channel lining and vegetation within the channel (palm trees and arundo).

IHHA 15. Federal 2: Downstream portion of Reach 3 looking northeast at the concrete lined channel. Note the minimal vegetation established within the channel.

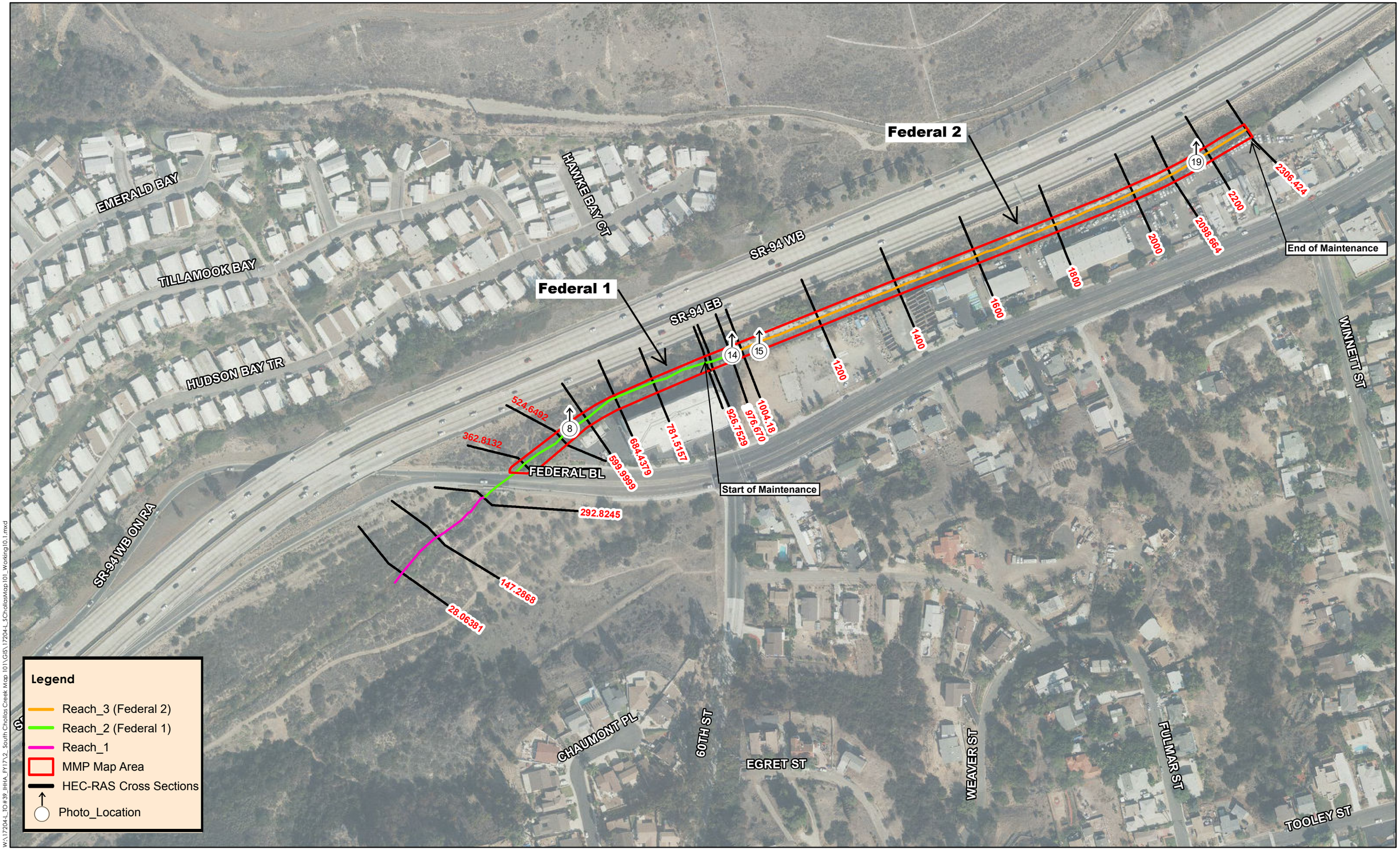
IHHA 19. Federal 2: Upstream portion of Reach 3 looking northeast at the rectangular concrete channel. Note the minimal vegetation established in channel.

Analysis Performed By: Rick Engineering

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following pages for the Federal facility group.



W:\17204-L_TO#39_JHHA_FY17\2_South Chollas Creek Map 101\GIS\17204-L_SChollasMap101_Working10.1.mxd

RICK ENGINEERING COMPANY

Scale in Feet
0 150 300
North

Original Exhibit:
South Chollas Creek Channel
MMP Map Number 101 Hydraulic Workmap (Report J-17204-L)

Date of Exhibit: 3/14/2017
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: South Chollas Creek - Federal
Segment Names: Federal 1 - 2
Facility Nos: 5-050-35, 5-05-037
Hydraulic Map - Municipal Waterways Maintenance Plan

A.48 South Chollas Creek Encanto Branch– Castana (No. 5-05-205)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Gunite, Earthen	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time. However, a maintenance area should be identified for access and/or potential gunite repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs[1,2]	
Extent of Maintenance	• Not applicable	
Benefit	• Not applicable	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

[2] Due to the potential need for access and/or gunite repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

General Description

The South Chollas Creek Encanto – Castana (Castana) facility group was classified as a Category 3 facility segment as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Castana facility group is located in the San Diego Bay Watershed Management Area. The facility is located east of Euclid Avenue, south of Groveland Drive, west of San Jacinto Drive, and north of Castana Street. The facility begins north of Castana Street, approximately 170 feet west of the intersection of San Jacinto Drive and Castana Street, and flows west-northwesterly toward Euclid Avenue.

The Castana facility group receives flows from a 24-inch-diameter reinforced concrete pipe (RCP) outfall. At the upstream end of the facility, the left bank, facing downstream, is reinforced by gunite for approximately 60 feet (between Station 382 and Station 316), while the right bank is earthen. The rest of the facility downstream from Station 316 to Station 122 is earthen. At Station 122, the flows enter a 24-inch-diameter RCP inlet to the downstream storm drain system. The facility is bounded on all sides by private residential and commercial developments. Refer to the Hydraulic Reference Map, located at the end of this fact sheet, for station references.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Castana facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval presented in Table 1 were estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated January 2017*. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.1.3 of the Hydrology and Hydraulics Technical Report.*

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Castana 1	25	32	38	45	51	56

Hydraulics

A one-dimensional steady flow model was developed for this facility group using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and proposed maintained conditions. Refer to *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the detailed HEC-RAS model. The extent of the reaches evaluated in the model is presented in the Hydraulic Reference Map.

The upstream domain of analysis consists of City-owned and operated storm drain system up to the 24-inch-diameter RCP outfall, and the downstream domain of analysis consists of the existing 24-inch-diameter RCP culvert and City storm drain at the end of the facility. Based on the methodology presented in *Section 3.2.1.3 of Hydrology and Hydraulics Technical Report,* the upstream domain of analysis has been excluded from the modeling.

The baseline condition for the Castana facility group was established based on the conditions observed during an April 2017 conducted by DMax Engineering site visit. The banks and bottom of the Castana facility group were assigned Manning's coefficient values ranging from 0.022 to 0.05, which represents the density of the vegetation and channel substrate observed within the facility, as well as the roughness of the gunite lining near the upstream end of the facility. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2017 site visit.

The assigned Manning's coefficient values for the earthen portions of the Castana facility group in the recommended maintained condition were reduced to 0.03 to represent removal/trimming of vegetation in the facility.

Model parameters and velocities for the baseline and maintained conditions for the Castana facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity for each analyzed segment.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Castana 1	382-122	Baseline: 0.022–0.05	Baseline: 0.2 – 8.7	-	-
		Maintained: 0.022-0.03	Maintained: 0.2 – 10.8		
Downstream Domain of Analysis	122-0	0.015	Baseline: 14.3 – 24.0	Culvert (Station 122)	Normal Depth at Station 0
			Maintained: 14.3 – 24.0		

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flow rates, summarized in Table 1 in the Hydrology section, were used to determine the level of service. The velocities, summarized Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall channel conveyance capacities and level of service for each segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained condition.

Baseline Condition

The baseline condition for the Castana facility group is capable of conveying up to 49 cubic feet per second (cfs) (>50-year level of service) before flows impact the adjacent residential and commercial properties. The capacity of the facility group is limited by the downstream culvert at Station 122.

Recommended Maintained Condition

The level of service and conveyance capacity of the facility group did not improve in the recommended maintained condition (49 cfs, >50-year level of service); therefore, maintenance is not recommended to provide capacity improvements. However, due to the potential need for access

and/or gunite repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Post-Maintenance Erosion Control Measures

No maintenance is proposed in the Castana facility group to provide capacity improvements. However, if access for gunite bank repair is required through a portion of Castana in the future, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility. The baseline condition velocities were noted to be above the recommended permissible velocities for earthen lined channels (5 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017,* in the upstream portion of the facility group. Refer to Chapter 6 of the Hydrology and Hydraulics Technical Report for additional details on appropriate velocity reduction and erosion control measures.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions, the overall facility level of service was restricted by the inlet capacity of the 24-inch-diameter RCP culvert inlet. Due to the presence of minor scouring and higher velocities in the baseline condition modeling from Station 382 to 347, a capital improvement project to address potentially erosive velocities needs to be further investigated. Additional analysis is recommended to evaluate potential increases in the level of service and reduction in scour that could be achieved by capital improvements.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Castana 1	382-122	49	-	<50-year	-

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Site visit conducted by DMax Engineering in April 2017.

1. Castana 1: Looking upstream at vegetation near 24-inch-diameter RCP outfall.

2. Castana 1: Looking downstream at vegetation and gunite lining on left bank.

3. Castana 1: Looking downstream at vegetation.

4. Castana 1: Looking downstream at 24-inch-diameter RCP culvert inlet.

Analysis Performed By: D-MAX Engineering Inc.

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.

Field Photo Location
Storm Drain Conveyance
Culvert
Domain of Analysis Cross Section
MWMP Facility Cross Section
MWMP Facility Center Line

N

Drainage Area: 26.4 acres

Feet
0 12.5 25 50

The City of SAN DIEGO

November 2019

Facility Group Name: South Chollas Creek Encanto Branch - Castana
Segment Name: Castana 1
Facility No: 5-05-205
Hydraulic Map - Municipal Waterways Maintenance Plan

DUDEK
Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.

A.49 South Chollas Creek Encanto Branch – Imperial

Summary of Recommended Maintenance

Imperial 1 (No. 5-05-304)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time[1]	
Extent of Maintenance	• Not Applicable.	
Benefit	• Not Applicable.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Imperial 2 (No. 5-05-306)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Routine maintenance is not recommended at this time. However, a maintenance area should be identified for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs[1,2]	
Extent of Maintenance	• Not Applicable.	
Benefit	• Not Applicable.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

[2] Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

General Description

The South Chollas Creek Encanto Branch – Imperial (Imperial) facility group was classified as having both Category 1 and Category 3 facility segments as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Imperial facility group is located in the San Diego Bay Watershed Management Area. The facility is bordered by Imperial Avenue to the south, by residential and commercial developments to the north, 60th Street to the east, and Euclid Avenue to the west.

The facility group flows from east to west along Imperial Avenue. Imperial 2 is a trapezoidal concrete lined channel beginning at Station 5382 on the west side of 60th Street and receives flow from a trapezoidal concrete channel upstream of the facility. Imperial 2 conveys flow along the north side of the San Diego Metropolitan Transit System Orange Line light rail tracks (Orange Line), crossing under Merlin Drive (between Station 4482 and Station 4442). After Merlin Drive the channel widens to a 30-foot wide rectangular concrete-lined channel and turns south to cross under the Orange Line (Station 4348 to Station 4308). The channel transitions to a trapezoidal earthen channel at Station 4308 where Imperial 1 begins. Imperial 1 continues westerly and crosses under Stevens Way between Station 3741and Station 3649 before conveying flow to the end of the facility at Station 1670. Flows leaving the facility continue downstream via earthen and concrete channels to the confluence with South Chollas Creek. See the Hydraulic Reference Map located at the end of this fact sheet.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Washington Canyon Creek – Washington facility group.

Hydrology

The hydrologic peak flows presented in Table 1 below are based on the Federal Emergency Management Agency's (FEMA) Flood Insurance Study (FIS) for San Diego County. The FIS provided the 10-, 25-, 50-, and 100-year flow rate information. The peak flows for the remaining recurrence intervals (2-year and 5-year) were interpolated using the method described in *Section 3.1.1.1 of the Hydrology and Hydraulics Technical Report.*

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Imperial 2	563	851	1100	1762	2600	3400
Imperial 1	626	932	1200	1873	2700	3500

Hydraulics

A one-dimensional steady flow model was developed for these facility segments using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and proposed maintained conditions. Refer to *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the detailed HEC-RAS model. The extent of the reaches evaluated in the model is presented in the Hydraulic Reference Map.

The upstream domain of analysis for the Imperial facility group is the existing Imperial 2 concrete channel based on the methodology presented in *Section 3.2.1.3 of the Hydrology and Hydraulics*

Technical Report. The downstream domain of analysis consists of the earthen and concrete channel downstream of the facility modeled from Station 1670 to Station 2.

The baseline condition for the Imperial 1 was based on observations during an April 2017 site visit conducted by DMax Engineering and consultation with the biological assessment team determined that Imperial 1 is considered at its ultimate vegetated condition. Imperial 2 was modeled with a Manning's coefficient of 0.015 to reflect the roughness of the originally constructed facility; since no evidence of sediment/debris deposition or vegetation growth in the channel was observed. Imperial 1 was modeled with a Manning's coefficient of 0.1 to represent dense vegetation growth in the earthen channel. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2017 site visit.

The maintained condition model does not change the Manning's coefficient for Imperial 2, while the Manning's coefficient for Imperial 1 was adjusted to 0.03 to simulate trimmed vegetation in the facility.

Model parameters and velocities for the baseline and maintained conditions for the Imperial facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity for each analyzed segment.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Imperial 2 (concrete)	5382 – 4308	Baseline: 0.015	Baseline: 7.3 – 32	Bridge (Station 4482-4442), Bridge (Station 4348-4308)	Normal Depth at Station 5382
		Maintained: 0.015	Maintained: 7.3 – 32		
Imperial 1 (earthen)	4308 - 1670	Baseline: 0.1	Baseline: 4 – 11	Culvert (Station 3741-3649)	-
		Maintained: 0.03	Maintained: 6 – 19.6		
Downstream Domain of Analysis	1670 - 2	0.015 – 0.06	Baseline: 2.8 – 23	Bridge (Station 1662-1614), Culvert (Station 1109-1075)	Normal Depth at Station 2
			Maintained: 2.8 – 23		

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flow rates, summarized in Table 1 in the Hydrology section, were used to determine the level of service. The velocities, summarized Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall facility conveyance capacities and level of service for each segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained condition.

Baseline Condition

The baseline condition is the ultimate vegetated condition for Imperial 1. Imperial 2 conveys 3,400 cfs (100-year level of service). Imperial 1 conveys a maximum of 1,873 cfs (25-year level of service) before flows impact the roadway and the private property to the north of the channel.

Recommended Maintained Condition

Trimming vegetation in Imperial 1 does not have an impact on the overall level of service of the Imperial facility group. In the baseline and recommended maintained conditions, Imperial 1 provides a level of service of the 25-year storm (1,873 cfs). In addition, the increase in velocity in Imperial 1 in the recommended maintained condition, is likely to cause erosive conditions within the segment. Therefore, maintenance is not recommended in the Imperial 1 segment.

In the maintained condition Imperial 2 remains at a level of service of the 100-year event (3,400 cfs). Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance within Imperial 2 (Station 5382 to Station 4302) is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Post-Maintenance Erosion Control Measures

The baseline condition estimated velocities in Imperial 1 are above the recommended permissible velocities for vegetation lined channels as defined in the *City of San Diego Drainage Design Manual, dated January 2017*, from Station 4302 to Station 3769. The modeling results also demonstrate that the estimated velocities would increase significantly in the maintained condition in Imperial 1. Since maintenance is not being recommended and there was no evidence of significant erosion observed during the April 2017 site visit, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for either facility.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that the overall facility level of service was restricted by the bridge at 54th Street. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Imperial 2 (concrete)	5382-4308	3,400		100-year	100-year
Imperial 1 (earthen)	4308-1670	1,873		25-year	25-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. The photos were taken by DMax Engineering during site visit April 2017.

1. Imperial 2: Looking downstream at concrete channel near 60th street.

2. Imperial 2: Looking downstream at Merlin Drive Bridge.

3. Imperial 2: Looking upstream at MTS Orange Line Bridge

4. Imperial 1: Looking downstream of Orange Line bridge at vegetation.

5. Imperial 1: Looking downstream at Stevens Way Culvert.

6. Imperial 1: Looking downstream at vegetation in channel.

7. Imperial 1: Looking downstream at vegetation in channel

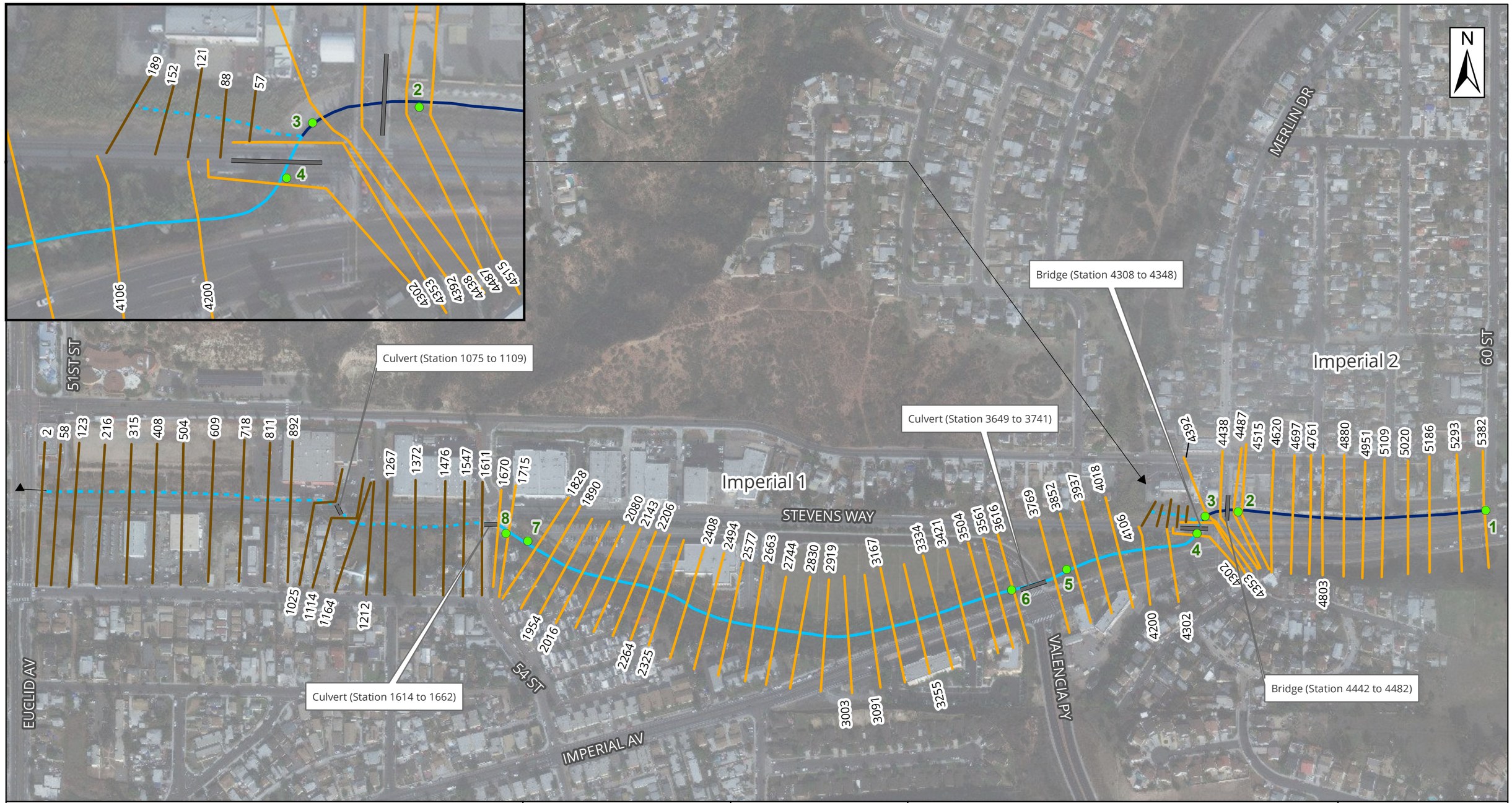
8. Imperial 1: looking downstream at transition to concrete channel at the 54th Street bridge.

Analysis Performed By: D-MAX Engineering Inc.

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.



Field Photo Location
Storm Drain Conveyance
Bridge/Culvert
Domain of Analysis Cross Section
WMP Facility Cross Section
Domain of Analysis Center Line
Imperial 1
Imperial 2

Drainage Area: 3,840 acres

Feet
0 125 250 500

The City of SAN DIEGO

Facility Group Name: South Chollas Creek Encanto Branch - Imperial
Segment Name: Imperial 1 - 2
Facility Nos: 5-05-304, 5-05-306
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

November 2019

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.

A.50 South Chollas Creek Encanto Branch – Jamacha

Summary of Recommended Maintenance

Jamacha 1 (No. 5-05-603)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from bottom of segment from Station 1441 to Station 1457, Station 1523 to Station 1996, and Station 2110 to Station 2324. • Remove accumulated sediment/debris in culverts from Station 1457 to Station 1523 and Station 1996 to Station 2110.	
Benefit	• Increase conveyance capacity from 244 cfs to 440 cfs between Station 4782 and Station 1633. • Increase conveyance capacity from 250 cfs to 490 cfs between Station 1633 and Station 725. • Level of service remains <2-year storm throughout segment. • Reduces potential clogging of the downstream culvert and prevents further erosion of channel.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Jamacha 2 (No. 5-05-606)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time [1]	
Extent of Maintenance	• Not Applicable	
Benefit	• Not Applicable	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Jamacha 3 (No. 5-05-610)

Facility type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time [1]	
Extent of Maintenance	• Not Applicable	
Benefit	• Not Applicable	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Cadman 1 (No. 5-05-802)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time [1]	
Extent of Maintenance	• Not Applicable	
Benefit	• Not Applicable	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The South Chollas Creek Encanto Branch – Jamacha (Jamacha) facility group was classified as four Category 3 segments as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulic Technical Report*. The Jamacha facility group is located in the San Diego Bay – Pueblo Watershed Management Area. The facility group is located within a City-owned parcel that is bordered by residential development to the north and south. Jamacha extends southwest beginning from the southwest corner of the Jamacha Road and Cardiff Road intersection and ending near the intersection of Imperial Avenue and Woodman Street. Jamacha is separated into three segments, from upstream to downstream: Jamacha 3, Jamacha 2, and Jamacha 1. There is also a northwesterly flowing tributary segment (Cadman 1) that connects to the Jamacha 1 segment near Station 4782.

Jamacha 3 is an earthen segment located at the upstream end of the facility group that begins southwest of the intersection of Jamacha Road and Cardiff Street, and is bound by residential properties bordering the City-owned parcel. The segment continues west before entering a 36-inch-diameter reinforced concrete pipe (RCP) culvert beneath Beacon Drive that is approximately 1,400 feet in length.

Jamacha 2 is an earthen segment located within the City-owned parcel, and begins at the downstream outlet of the 36-inch-diameter RCP culvert beneath Beacon Drive. The segment continues west, entering a 72-inch-diameter RCP culvert beneath Meadow Brook Drive.

Jamacha 1 is an earthen segment located within the City-owned parcel and the furthest downstream segment. The segment begins at the downstream outlet of the 72-inch-diameter RCP culvert beneath Meadow Brook Drive, and continues southwest before entering a 54-inch-diameter CMP culvert beneath Cadman Street. Immediately downstream of the culvert, the Cadman 1 confluences with the main Jamacha segment near Station 4782. The segment continues flowing west, and enters a 10-foot-wide by 5-foot-high RCB culvert beneath 69th Street, and a double 10-foot-wide by 5-foot-high RCB culvert beneath 68th Street. A pedestrian bridge crosses the segment between Station 975 and Station 969. The Jamacha channel continues through Encanto Park and enters a double-barrel 60-inch-diameter RCP culvert beneath Imperial Avenue.

Cadman 1 is an earthen segment located within the City-owned parcel and confluences with Jamacha 1 downstream of Cadman Drive. The segment begins at the outlet of the double-barrel 36-inch-diameter corrugated metal pipe (CMP) culvert located under a. private road and conveys flows to the northwest toward the Jamacha 1 segment. Flows enter a 42-inch-diameter RCP culvert at Lausanne Drive and then confluence with the Jamacha 1 segment at the culvert outlet. The facility bottom width ranges from 7 to 21 feet and ranges in depth from 2 to 7 feet.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Jamacha facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval presented in Table 1 were estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated January 2017*. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.1.3, Hydrology and Hydraulics Technical Report*.

Table 1. Hydrology Results

Segment	Station of Flow Change Location	Peak Flow Rates by Storm Event Frequency (cfs)					
		2-year	5-year	10-year	25-year	50-year	100-year
Jamacha 3	10845	178	227	266	320	362	403
Jamacha 2	7137	200	256	300	361	408	455
Jamacha 1	6096	232	297	347	418	472	527
	4782	507	648	758	913	1,031	1,150
	3992	566	720	844	1,019	1,147	1,281
	3030	572	728	853	1,030	1,160	1,295
	1633	612	779	913	1,102	1,241	1,386
Cadman 1	1209	275	351	411	495	559	623

Hydraulics

A one-dimensional steady flow model was developed for the facility group using the U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline condition and the proposed maintained conditions. The extents of the reaches evaluated in this model are shown in the Hydraulic Reference Maps located at the end of this fact sheet.

The upstream domain of analysis for the Jamacha facility group is a City parcel where sheet flow occurs before being channelized downstream within the facility group. The upstream domain of analysis has been included for this modeling for a length of approximately 1,550 feet. At the downstream domain of analysis, the channel continues through Encanto Park and enters a double-barrel 60-inch-diameter RCP culvert beneath Imperial Avenue before discharging into the South Chollas Creek Encanto Branch – Imperial concrete lined channel. The downstream domain of analysis was included for a length of 725 feet. Additionally, a tributary was included in the modeling, which flows northwest and confluences with the upstream end of the Jamacha 1 segment. A tributary length of approximately 1,200 feet was included in the modeling.

The baseline condition for the Jamacha 3 and Jamacha 2 segments is defined as the current condition, as observed during a site visit in July 2017. Patches of heavy vegetation were observed throughout the facility group. The bottom and overbanks of Jamacha 3 were assigned Manning's coefficient values ranging from 0.04–0.06, which represent the dense vegetation observed. The bottom and overbanks of Jamacha 2 were assigned Manning's coefficient values ranging from 0.04–0.06, which represent the density of the vegetation and sediment/debris observed. Photos in the Representative Photos section below provide examples of the condition of the facility as observed during the July 2017 site visit.

The baseline condition for the Jamacha 1 segment is defined as the pre-maintenance condition, as observed during a site visit conducted by Dudek in April 2016. Emergency maintenance was completed within the Jamacha 1 segment in April 2016. As observed during the site visit, Jamacha 1 was vegetated with 1–2 feet of sediment deposition at the 68th and 69th Street culverts. Patches of heavy vegetation, mostly consisting of invasive species, were located throughout the channel, but large patches were found at the 68th and 69th Street culverts. The facility bottom width was approximately 6 to 21 feet with a 1 to 8-foot depth. At 69th Street, a 10-foot-wide by 5-foot-high reinforced concrete box (RCB) culvert conveys flows beneath the roadway. At 68th Street, a double 10-foot-wide by 5-foot-high RCB culvert conveys flows. The bottom and overbanks of Jamacha 1 were assigned Manning's coefficient values ranging from 0.03–0.08, which represent the density of the vegetation and sediment/debris observed. Photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2016 site visit. During the July 2017 site visit to Jamacha 1, the 68th and 69th Street culverts were relatively clean with minor amounts of vegetation and accumulated sediment present.

The baseline condition for the Cadman 1 segment is defined as the current condition, as observed during a site visit in July 2017. Patches of heavy vegetation, mostly consisting of invasive species, were located throughout the channel, but the Lausanne Drive and private road culverts were relatively clean with minor amounts of vegetation present. The bottom and overbanks of Cadman 1 were assigned Manning's coefficient values ranging from 0.03–0.045, which represent the density of the vegetation observed. Photos in the Representative Photos section below provide examples of the condition of the facility as observed during the July 2017 site visit.

The assigned Manning's coefficient values for Jamacha 3 in the recommended maintained condition ranged from 0.03–0.04 to reflect the removal of sediment/debris and vegetation from the segment bottom. The assigned Manning's coefficient values for Jamacha 2 in the recommended maintained condition ranged from 0.03–0.06 to reflect the removal of sediment/debris and vegetation from the segment bottom. The assigned Manning's coefficient values for Jamacha 1 in the recommended maintained condition ranged from 0.03–0.06 to reflect the removal of sediment/debris and vegetation from the segment bottom. The assigned Manning's coefficient values for Cadman 1 in the recommended maintained condition ranged from 0.03–0.04 to reflect the removal of vegetation from the segment bottom.

Model parameters and velocities for the baseline and maintained conditions for the Jamacha facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity for the analyzed segment.

Table 2. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Upstream Domain of Analysis (earthen)	10845-9291	Baseline: 0.04-0.1 Maintained: 0.03-0.06	Baseline: 1.3 – 7.0 Maintained: 2.7 – 9.6	-	Critical Depth
Jamacha 3 (earthen)	9291-7142	Baseline: 0.04-0.06 Maintained: 0.03-0.04	Baseline: 1.4 – 5.0 Maintained: 1.4 – 7.0	Culvert (Station 8539 to 7142)	-
Jamacha 2 (earthen)	7142-6111	Baseline: 0.04-0.06 Maintained: 0.03-0.06	Baseline: 0. 9-9.7 Maintained: 1.0 – 13.7	Culvert (Station 6326 to 6111)	-
Jamacha 1 (earthen)	6111-4782	Baseline: 0.04-0.06 Maintained: 0.03-0.06	Baseline: 0.6 – 7.7 Maintained: 0.8 – 9.7	Culvert (Station 4881 to 4816)	Junction between Upstream & Downstream reaches of Jamacha Branch (Station 4782)
	4782-1633	Baseline: 0.035-0.08 Maintained: 0.03-0.04	Baseline: 0.9 – 7.5 Maintained: 2.0 – 12.4	Culvert (Station 2110 to 1996)	-
	1633-725	Baseline: 0.03-0.06 Maintained: 0.03-0.06	Baseline: 1.3 – 6.0 Maintained: 2.0 – 10.4	Culvert (Station 1523 to 1457), Pedestrian Bridge (Station 975 to 969)	-
Downstream Domain of Analysis (earthen)	725-6	Baseline: 0.013-0.045 Maintained: 0.013-0.03	Baseline: 3.0 – 8.6 Maintained: 1.9 – 10.8	Bridge (Station 367 to 362), Culvert (Station 278)	Normal Depth
	1209-398	Baseline: 0.03-0.06	Baseline: 2.1 – 7.3	-	Critical Depth

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Upstream Domain of Analysis (earthen)		Maintained: 0.03-0.06	Maintained: 2.1-12.1		
Cadman 1 (earthen)	398-0	Baseline: 0.03-0.045	Baseline: 1.1-6.1	Culvert (Station 392 to 372), Culvert (Station 90 to 17)	Junction with Jamacha Branch (Station 4782)
		Maintained: 0.03-0.04	Maintained: 0.8 – 8.7		

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used to determine the level of service. The overall conveyance capacity and level of service for the segment are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition

In the baseline condition, the Jamacha 3 segment can convey 40 cubic feet per second (cfs) equivalent to less than the 2-year storm before residential development is impacted.

In the baseline condition, the Jamacha 2 segment can convey 250 cfs equivalent to <5-year storm before residential development is impacted.

In the baseline condition, the Jamacha 1 segment can convey 135 cfs equivalent to <2-year storm before impacting the roadway. The channel can convey 244 cfs near the 69th Street culvert (Station 2110 to Station 1996), and 250 cfs near the 68th Street culvert (Station 1523 to Station 1457).

In the baseline condition, Cadman 1 can convey 125 cfs equivalent to <2-year storm before impacting the roadway.

Recommended Maintained Condition

Jamacha 2 and 3 and Cadman 1 are not being recommended for maintenance due to the increase in erosive velocities resulting from the modeled recommended maintenance conditions and there are minimal improvements to the conveyance capacity with the recommended maintenance. In addition, a restoration project is currently in the design phase for the Jamacha facility group. It is recommended that the culverts be routinely monitored for obstructions or a buildup of sediment/debris.

Jamacha 1 is recommended for maintenance, which includes the removal of deposited sediment/debris and vegetation from the segment bottom and from culverts from Station 1441 to Station 2324. In April 2016, emergency maintenance was conducted within Jamacha 1 to alleviate flooding impacts and increase the conveyance capacity of the segment. The recommended maintenance for Jamacha 1 will maintain the conveyance capacity that resulted from the emergency maintenance. In the recommended maintenance condition, Jamacha 1 can convey 135 cfs between Station 6221 and Station 4782, equivalent to <2-year storm. The channel capacity of the segment is limited by low bank heights resulting in inundation of the roadway and surrounding infrastructure. The channel capacity increases downstream in the segment where the channel can convey 440 cfs between Station 4782 and Station 1633, near the 69th Street culvert (Station 2110 to Station 1996). The channel capacity increases further between Station 1633 and Station 725, and can convey 490 cfs near the 68th Street culvert (Station 1523 to Station 1457). The overall segment capacity remains <2-year storm. Ultimately, the segment capacity is limited by low bank heights between and the culverts capacities.

Post-Maintenance Erosion Control Measures

During the site visit in July 2017, evidence of erosion was observed throughout the facility group. The sides of the channel were incised throughout portions of the three Jamacha segments, as well as within the Cadman segment. Grasses were observed to be bent over within Jamacha 1, indicative of high flow velocities. Additionally, a large eroded side wall was observed along Cadman 1, located immediately upstream of where the segment discharges into Jamacha 1.

The estimated velocities for the facility group in the baseline and recommended maintained condition exceed the maximum permissible velocities for unlined channels as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Velocities are shown to exceed 10 feet per second (fps) within Jamacha 2, Jamacha 1, and Cadman 1 following recommended maintenance. Therefore in the recommended maintained area in Jamacha 1, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended. Refer to *Chapter 6 of the Hydrology and Hydraulics Technical Report* for additional details on appropriate velocity reduction and erosion control measures.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the overall facility group level of service was restricted by downstream culverts as well as low bank heights along portions of the facility group. In addition, a restoration project is currently in the design phase for the Jamacha facility group. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address these restrictions.

Table 3. Summary Table

Segment	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Jamacha 3	9291-7142	40	-	<2-year	-
Jamacha 2	7142-6111	250	-	5-year	-
Jamacha 1	6111-4782	135	-	<2-year	-
	4782-1633	244	440	<2-year	<2-year
	1633-725	250	490	<2-year	<2-year
Cadman 1	398-0	125	-	<2-year	-

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Site visits were conducted by Dudek in April 2016 (Jamacha 1) and by Geosyntec Consultants in July 2017 (Jamacha 2 and 3).

1. Jamacha 3: Looking upstream from Beacon Drive culvert (36-inch-diameter RCP).

2. Jamacha 2: Downstream of Beacon Drive culvert (36-inch-diameter RCP), looking west. Riprap apron and dense vegetation present.

3. Jamacha 2: Upstream of the Cadman Street culvert (54-inch-diameter corrugated metal pipe), facing west.

4. Jamacha 1: Upstream of 10-foot-wide by 5-foot-high RCB culvert beneath 69th Street facing west.

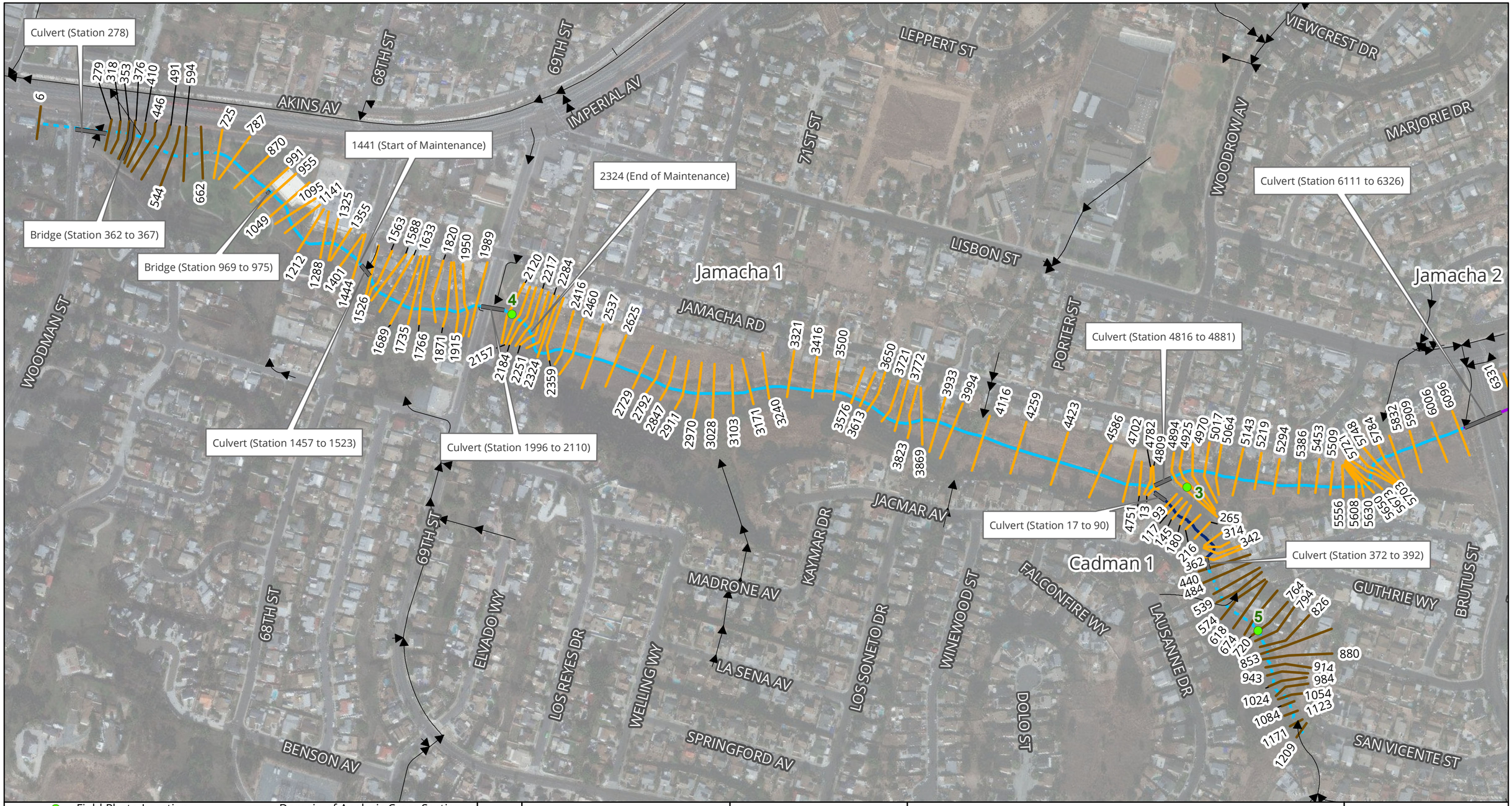
5. Cadman 1: Looking downstream at the dense vegetation present in the channel, facing northwest.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

Maps illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following pages for the Jamacha facility group.



Field Photo Location
Storm Drain Conveyance
Bridge/Culvert
Domain of Analysis Cross Section
MWMP Facility Cross Section
Domain of Analysis Center Line
Cadman 1
Jamacha 1
Jamacha 2

N

Drainage Area: 1,099 acres

0 115 230 460 Feet

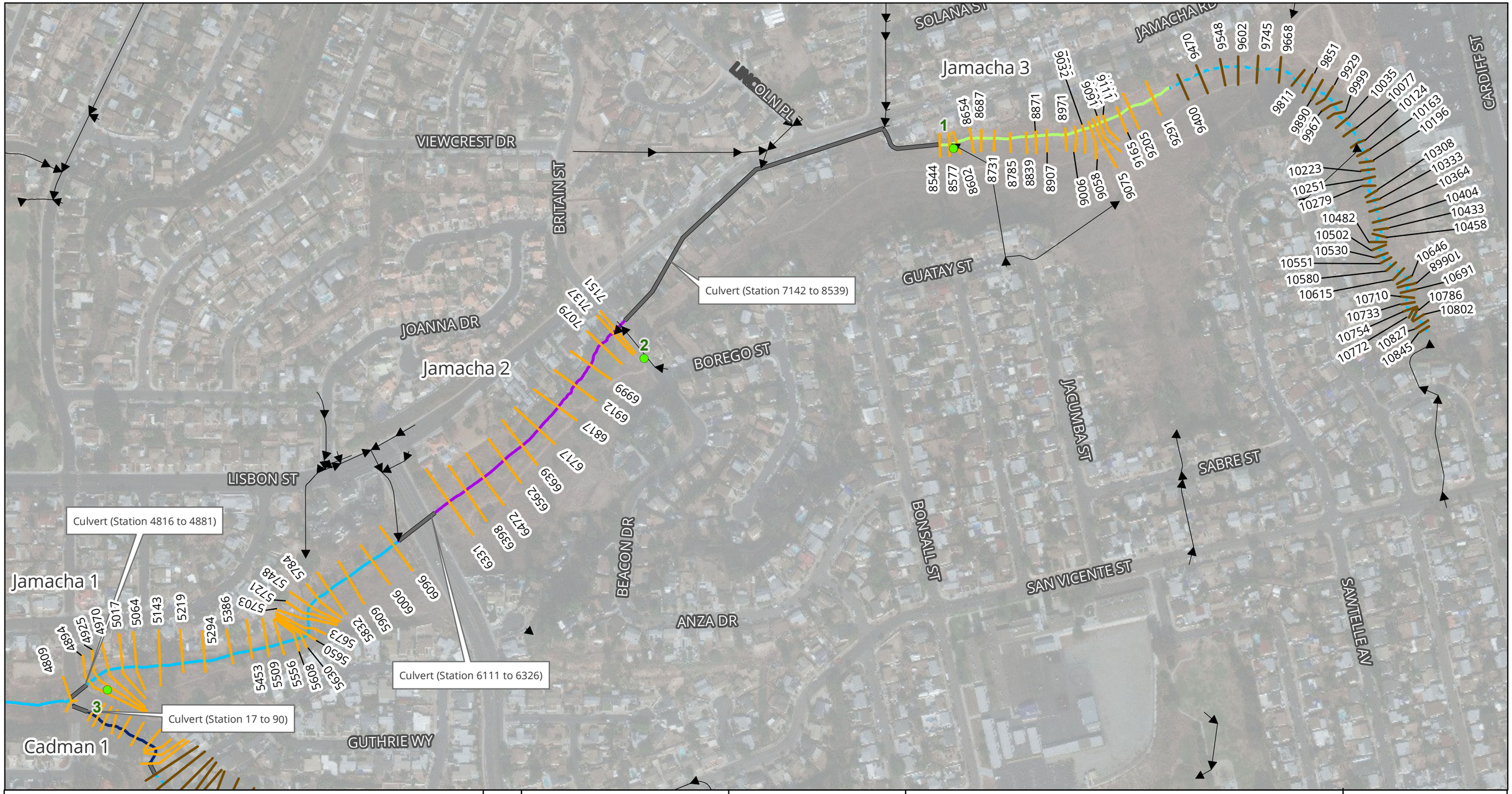
The City of SAN DIEGO

Facility Group Name: South Chollas Creek Encanto Branch - Jamacha (Downstream)
Segment Name: Jamacha 1, Cadman 1
Facility Nos: 5-05-603, 5-05-802
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet. Storm drain conveyance line is approximate.

November 2019



Field Photo Location
Storm Drain Conveyance
Culvert
Domain of Analysis Cross Section
MWMP Facility Cross Section
Domain of Analysis Center Line
Cadman 1
Jamacha 1
Jamacha 2
Jamacha 3

N

Drainage Area: 1,099 acres

0 75 150 300 Feet

The City of SAN DIEGO

November 2019

Facility Group Name: South Chollas Creek Encanto Branch - Jamacha (Upstream)
Segment Name: Jamacha 1 - 3
Facility Nos: 5-05-603, 5-05-606, 5-05-610
Hydraulic Map - Municipal Waterways Maintenance Plan

DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet. Storm drain conveyance line is approximate.

A.51 South Chollas Creek Encanto Branch – Jamacha (Lobrico 1; No. 5-05-702)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time[1]	
Extent of Maintenance	• Not Applicable	
Benefit	• Not Applicable	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

The reports listed in Table 1 were used as supplementary information to generate this fact sheet.

Table 1. Completed Reports

Segment	Report	Reach
Lobrico	RICK Engineering Company, 2017. Erosion Control Memo for Lobrico Channel Unmapped Area Number 301. Job Number 17204-L.	1 & 2

General Description

The South Chollas Creek Encanto Branch – Jamacha – Lobrico (Lobrico) facility group was classified as a Category 3 segment as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulic Technical Report*. The facility group is located in the San Diego Bay – Pueblo Watershed Management Area. The segment is bordered by residential development to the east and west.

The Lobrico segment is an earthen ditch that begins at the downstream outlet of the 48-inch-diameter Reinforced Concrete Pipe (RCP) culvert extending beneath Lisbon Street. The segment continues south for approximately 330 feet before entering a 48-inch RCP that crosses Jamacha Road. In the upstream portion of the segment (Reach 2), the bottom width ranges from 2 to 8 feet and has a minimum depth of 1.25 foot. The left bank ranges from a 2:1 (H:V) side slope to a 1:1 (H:V) side slope and the right bank ranges from a 2:1 (H:V) side slope to a vertical side slope. In the downstream portion of the segment (Reach 1), the bottom width ranges from 2 to 11 feet and a minimum depth of 0.75 feet. The right bank ranges from a 2:1 (H:V) side slope to a vertical side slope and has a 3 foot high masonry wall along a portion of the bank. The left bank ranges from a 3:1 (H:V) side slope to a vertical side slope and has a 3 foot high wall along a portion of the bank. The segment is partially within a City-owned drainage easement to the east and is partially within the adjacent landowner's property to the west.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Lobrico facility group.

Hydrology

The hydrologic peak flow for the 100-year recurrence interval for the facility group presented in Table 2 was estimated based on the size of the watershed tributary to the channel, as described in *Section 3.1.1.4 of the Hydrology and Hydraulics Technical Report***.** The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.1.3 of the Hydrology and Hydraulics Technical Report.*

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Lobrico	244	325	365	426	487	548

Hydraulics

A one-dimensional steady flow model was developed for the facility group using the U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline condition and the proposed maintained conditions. The extents of the reaches evaluated in this model are shown in the Hydraulic Reference Maps located at the end of this fact sheet.

The upstream and downstream domains of analysis for the Lobrico facility group is the existing storm drain systems (48-inch RCP pipes) located north of the channel at the upstream end and south of the channel at the downstream end.

Due to the changes in channel geometry observed between Stations 443 and 449, for hydraulic analysis purposes the Lobrico segment was broken into two reaches as follow:

- Lobrico 1, Reach 2 (earthen): Stations 592 to 449.
- Lobrico 1, Reach 1 (earthen): Stations 449 to 262.

The baseline condition for Lobrico 1 was determined to be the existing condition, as observed during the site visits conducted by Rick Engineering in November 2016 and by Geosyntec Consultants in July 2019. The segment bottom and banks of Lobrico 1, Reach 2 were assigned Manning's coefficient values ranging from 0.045-0.1, which represents the density of the vegetation observed within the earthen segment. The sediment depth was estimated to be 3 feet along the segment bottom immediately at the outlet of the 48-inch RCP culvert beneath Lisbon Street. Additionally, erosion was observed along the right bank of the segment beginning at the outlet of the 48-inch RCP and extending for 20-feet downstream. Photos in the Representative Photos section

below provide examples of the condition of the facility as observed during the November 2016 and July 2019 site visits.

The segment bottom and banks of Lobrico 1, Reach 1 were assigned Manning's coefficient values ranging from 0.045-0.1, which represent the density of the vegetation observed within the earthen segment. Two steep erosion head cuts were observed within the bottom of Lobrico 1, Reach 1 at Station 394 and Station 333 measuring 3 feet and 2 feet vertically, respectively. Additionally, a scour hole undercutting the foundations of the masonry wall was observed at Station 322 during the site visit. The sediment depth was estimated to be 1.5 feet just upstream of the first head cut near Station 394. Photos in the Representative Photos section below provide examples of the condition of the facility as observed during the November 2016 and July 2019 site visits.

In the recommended maintained condition, the segment bottom and banks for the facility group were assigned Manning's coefficient values of 0.035 to reflect the removal of accumulated sediment/debris and vegetation along the segment bottom and banks and returning the longitudinal slope to that shown as existing in drawing number 27667-D. There was no as-built drawing available for the facility group with a detailed channel cross section or slope profile.

Model parameters and velocities for the baseline and recommended maintained conditions for the facility group are summarized in Table 3. Velocities reported below are the output velocities for the flow associated with the level of service capacity for the analyzed segments.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Upstream Domain of Analysis	842 - 592	Baseline: 0.013 Maintained: 0.013	Baseline: 3.26-6.91 Maintained: 9.87	Storm Drainage System	Normal Depth
Lobrico, Reach 2 (earthen)	592 - 449	Baseline: 0.045-0.10 Maintained: 0.035	Baseline: 0.93-5.90 Maintained: 3.09-11.31	Culvert (Station 592)	-
Lobrico, Reach 1 (earthen)	449 - 262	Baseline: 0.045-0.10 Maintained: 0.035	Baseline: 1.42-7.68 Maintained: 1.52-10.20	Culvert (Station 262)	-
Downstream Domain of Analysis	262 - 135	Baseline: 0.013 Maintained: 0.013	Baseline: 11.39-21.09 Maintained: 11.39-21.09	Storm Drainage System	Normal Depth

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used to determine the level of service. The overall conveyance capacity and level of service for the segment are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition

In the baseline condition, the Lobrico 1, Reach 2 segment can convey 41 cubic feet per second (cfs), equivalent to less than the 2-year storm event. The Lobrico 1, Reach 1 segment can convey 130 (cfs), equivalent to less than the 2-year storm event.

Recommended Maintained Condition

The recommended maintained condition for the facility group includes removing accumulated sediment/debris and vegetation along the segment bottom and banks and returning the longitudinal slope to that shown as existing in drawing number 27667-D. In the recommended maintained condition for Lobrico 1, Reach 2, the conveyance capacity increases to 124 cfs, but the level of service remains less than the 2-year storm eventIn the recommended maintained condition for Lobrico 1, Reach 1, the level of service remains less than the 2-year storm event and can convey up to 130 cfs. There is an increase in erosive velocities in both reaches in the recommended maintained condition, therefore no maintenance is recommended for this facility group.

Post-Maintenance Erosion Control Measures

During the site visit in November 2016 and in July 2019, evidence of erosion was observed throughout the facility group. A scour hole undercutting the foundations of the masonry wall was observed at Station 322 and erosion was observed along the right bank of the segment beginning at the outlet of the 48-inch RCP beneath Lisbon Street and extending for 20-feet downstream. Additionally, two steep erosion head cuts were observed within the segment bottom at Station 394 and Station 333.

No maintenance is proposed in the Lobrico segment due to erosive velocities in the baseline and recommended maintained condition and no level of service increase from maintenance. The estimated velocities for the facility group in the baseline and recommended maintained condition exceed the maximum permissible velocities for unlined channels (5 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. However, since no maintenance is proposed, no post-maintenance measures are proposed.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the overall facility group level of service was restricted by the downstream culvert beneath Jamacha Road as well as low bank heights along portions of the facility group. A Capital Improvement project is currently in progress to convey the runoff through the channel via a storm drain pipe. Additional analysis is recommended to evaluate potential increases in the level of service and reduction in scour that could be achieved by capital improvements.

Table 4. Summary Table

Segment	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Lobrico, Reach 2	592-449	41	124	<2-year	<2-year
Lobrico, Reach 1	449-262	130	130	<2-year	<2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Site visits were conducted by Rick Engineering Company in November 2016 and by Geosyntec Consultants in July 2019. Photos from both site visits are included due to the lack of visibility caused by the dense vegetation observed during the July 2019 site visit.

1. Lobrico 1, Reach 2: Dense vegetation present in channel at outlet of 48-inch RCP beneath Lisbon Street, looking southeast (July 2019).

2. Lobrico 1, Reach 2: Beginning of Lobrico 1 at outlet of 48-inch RCP beneath Lisbon Street, looking south (November 2016).

3. Lobrico 1, Reach 2: Erosion along right bank, at outlet of 48-inch RCP beneath Lisbon Street, looking southwest (November 2016).

4. Lobrico 1, Reach 2: Typical section of downstream portion of Reach 2 with short left bank height, looking north (July 2019).

5. Lobrico 1, Reach 1: Dense vegetation present in channel and start of the 3-foot high private masonry wall along right bank, looking north (July 2019).

6. Lobrico 1, Reach 1: Middle portion of Lobrico 1 channel viewing the 3-foot high private wall along left bank, looking northeast (November 2016).

7. Lobrico 1, Reach 1: First head cut erosion along bottom of channel, measuring 3 feet in height, looking northeast (July 2019).

8. Lobrico 1, Reach 1: Dense vegetation present in typical section of middle portion of Reach 1, looking southwest (July 2019).

9. Lobrico 1, Reach 1: Second head cut erosion along bottom of channel, measuring 2 feet in height, looking southwest (July 2019).

10. Lobrico 1, Reach 1: Scour hole underneath the private masonry wall on right channel bank, looking southwest (November 2016).

11. Lobrico 1, Reach 1: Dense vegetation present in typical section of downstream portion of Reach 1, looking southwest (July 2019).

12. Lobrico 1, Reach 1: End of Lobrico 1 at inlet of 48-inch RCP beneath Jamacha Road, looking southwest (November 2016).

Analysis Performed By: Rick Engineering Company & Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following page for the Jamacha (Lobrico) facility group.

End of Reach
Field Photo Location
Bridge/Culvert
Storm Drain Conveyance
Domain of Analysis Cross Section
MWMP Cross Section
MWMP Center Line

N

Drainage Area: 137 acres

0 15 30 60 Feet

The City of SAN DIEGO

Facility Group Name: South Chollas Creek Encanto Branch - Jamacha
Segment Name: Lobrico 1
Facility No.: 5-05-702
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.

November 2019

A.52 Paleta Creek - Cottonwood

Summary of Recommended Maintenance

Cottonwood 1 (No. 5-06-005)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 1006 to Station 1091 and Station 1163 to Station 1578. • Remove accumulated sediment/debris in culverts from Station 1091 to Station 1163 and at Station 1006.	
Benefit	• Increases conveyance capacity from 630 cfs to 678 cfs. Level of service remains <2-year storm event. • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the culverts.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Cottonwood 2 (No. 5-06-008)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 1765 to Station 1892, Station 1951 to Station 3095, and Station 3152 to Station 3782. • Remove accumulated sediment/debris in culverts from Station 1578 to Station 1765, Station 1892 to Station 1951, and Station 3095 to Station 3152.	
Benefit	• Increases conveyance capacity from 519 cfs to 522 cfs. Level of service remains <2-year storm event. • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the culverts.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Paleta Creek – Cottonwood (Cottonwood) facility group was classified as two Category 1 segments, as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The facility group is located in the San Diego Bay Watershed Management Area. The Cottonwood facility group is bordered by residential development from Highland Avenue to the east and Interstate 5 (I-5) to the west. The channel continues to the west, passing beneath I-5 within California Department of Transportation (Caltrans) property and continues towards Naval Base San Diego.

The Cottonwood 2 segment is a concrete channel with a trapezoidal cross-section, as indicated on as-built drawing nos. 3019-D and 3021-D, that receives flow from a triple 72-inch-diameter reinforced concrete pipe (RCP) culvert underneath Highland Avenue from the east and south of Nordica Avenue. The channel bottom is 12 feet wide; the banks are 5.5 feet high with 1.5:1 (H:V) side slopes. Runoff is conveyed through the Cottonwood 2 segment in a southwesterly direction along Nordica Avenue and Cottonwood Street, and enters a double 9-foot-wide by 5-foot-tall RCB culvert beneath 42nd Street, a double 9-foot-wide by 5-foot-tall RCB culvert beneath 40th Street, and a double 9-foot-wide by 5-foot-tall RCB culvert beneath residences near Cottonwood Street. The Cottonwood 1 segment continues southwest and enters a double 9-foot-wide by 5-foot-tall RCB culvert beneath Osborn Street. Downstream of the Cottonwood facility group, the channel enters a triple 6-foot-wide by 6-foot-tall RCB culvert beneath the Northbound I-5 on-ramp. See the Hydraulic Reference Map located at the end of this fact sheet.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Cottonwood facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval presented in Table 1 were estimated using the unit area method and the peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.1.4 of the Hydrology and Hydraulics Technical Report*.

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Cottonwood 2	1,104	1,406	1,646	1,979	2,229	2,479
Cottonwood 1	1,116	1,422	1,664	2,001	2,254	2,507

Hydraulics

A one-dimensional steady flow model was developed for the segment using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and recommended maintained conditions. Refer to *Section 3.2.1.2 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the HEC-RAS model. The extents of the reaches evaluated in the model is presented in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition is defined as the pre-maintained condition of the channel. Emergency maintenance was performed for the facility group during December 2015 and January 2016. For the analysis of the baseline condition, photos taken of the Cottonwood 2 segment in May 2015 by the City of San Diego were used to assign Manning's coefficient values to the facility group. For the Cottonwood 1 and 2 segments, the channel bottom was assigned Manning's coefficient values of 0.04 to 0.03, respectively. Side slopes were assigned values ranging from 0.05 to 0.07 based on the observed moderate to dense vegetation in the bottom of the channel and many trees. The sediment depth in the channel bottom was estimated to be 0.2 feet along the length of the facility group. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2015 site visit.

For the recommended maintained condition, the channel bottom was assigned a Manning's coefficient value of 0.015 to reflect the roughness of the originally constructed concrete facility. The Manning's coefficient values for the banks outside of the concrete lined portion of the channel remain unchanged. In determining the recommended maintained condition for the upstream Cottonwood facility group, the channel and culverts within the Caltrans jurisdiction were assumed to be maintained.

Model parameters and velocities for the baseline and recommended maintained conditions for the Cottonwood facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the level of service capacity.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Cottonwood 2 (concrete)	3782 -1578	Baseline: 0.03-0.07	Baseline: 5.95-9.14	Culverts (Stations 3152 to 3095, 1951 to 1892, 1765 to 1578)	-
		Maintained: 0.015-0.07	Maintained: 5.85-9.16		
Cottonwood 1 (concrete)	1578-1006	Baseline: 0.04-0.07	Baseline: 3.88-8.20	Culverts (Stations 1163 to 1091, 1006)	-
		Maintained: 0.015-0.07	Maintained: 4.33-9.72		

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility group flows rates, summarized in Table 1 in the Hydrology section, were used in determining the level of service. The velocities, summarized in Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall channel conveyance capacities and level of service for the segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained conditions.

Baseline Condition

The baseline condition is based on the pre-maintained condition of the channel in 2014. The Cottonwood 2 channel can convey 519 cubic feet per second (cfs), (<2-year level of service), before the roadway is impacted. The Cottonwood 1 channel can convey 630 cfs, (<2-year level of service), before the roadway is impacted.

Recommended Maintenance Condition

Removing deposited sediment/debris and vegetation from the facility group improves the conveyance capacity in Cottonwood 2 to 522 cfs, (<2-year level of service). The conveyance capacity in Cottonwood 1 improves to 678 cfs, (<2-year level of service). The recommended maintenance reduces the risk of vegetation and sediment/debris flowing downstream and clogging the culverts from Station 3152 to 3095, Station 1951 to 1892, Station 1765 to 1578, and Station 1006 to 862.

The benefits to the Cottonwood facility group due to the recommended maintenance are dependent on the assumption that the downstream channel and culverts within the Caltrans jurisdiction, between Stations 1006 and 304, have been maintained.

Recommended Temporary Velocity Reduction Measures

The estimated velocities in the recommended maintained condition (Table 2) are below the maximum permissible velocities for concrete channels (35 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility group.

Recommended Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the facility group level of service was restricted by downstream culverts at Station 3152 and Station 1091. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Table 3. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[2]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Cottonwood 2	3782-1578	519	522	<2-year	<2-year
Cottonwood 1	1578-1006	630	678	<2-year	<2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. A site visit was conducted by the City of San Diego in May 2015.

1. Cottonwood 2: Looking downstream of triple 72-inch-diameter RCP culvert beneath Highland Avenue at start of channel.

2. Cottonwood 2: Looking downstream from double 9-foot-wide by 5-foot-tall RCB culvert at 42nd Street; heavy vegetation and trees visible in segment.

3. Cottonwood 2: Looking downstream at segment; vegetation and palm trees visible.

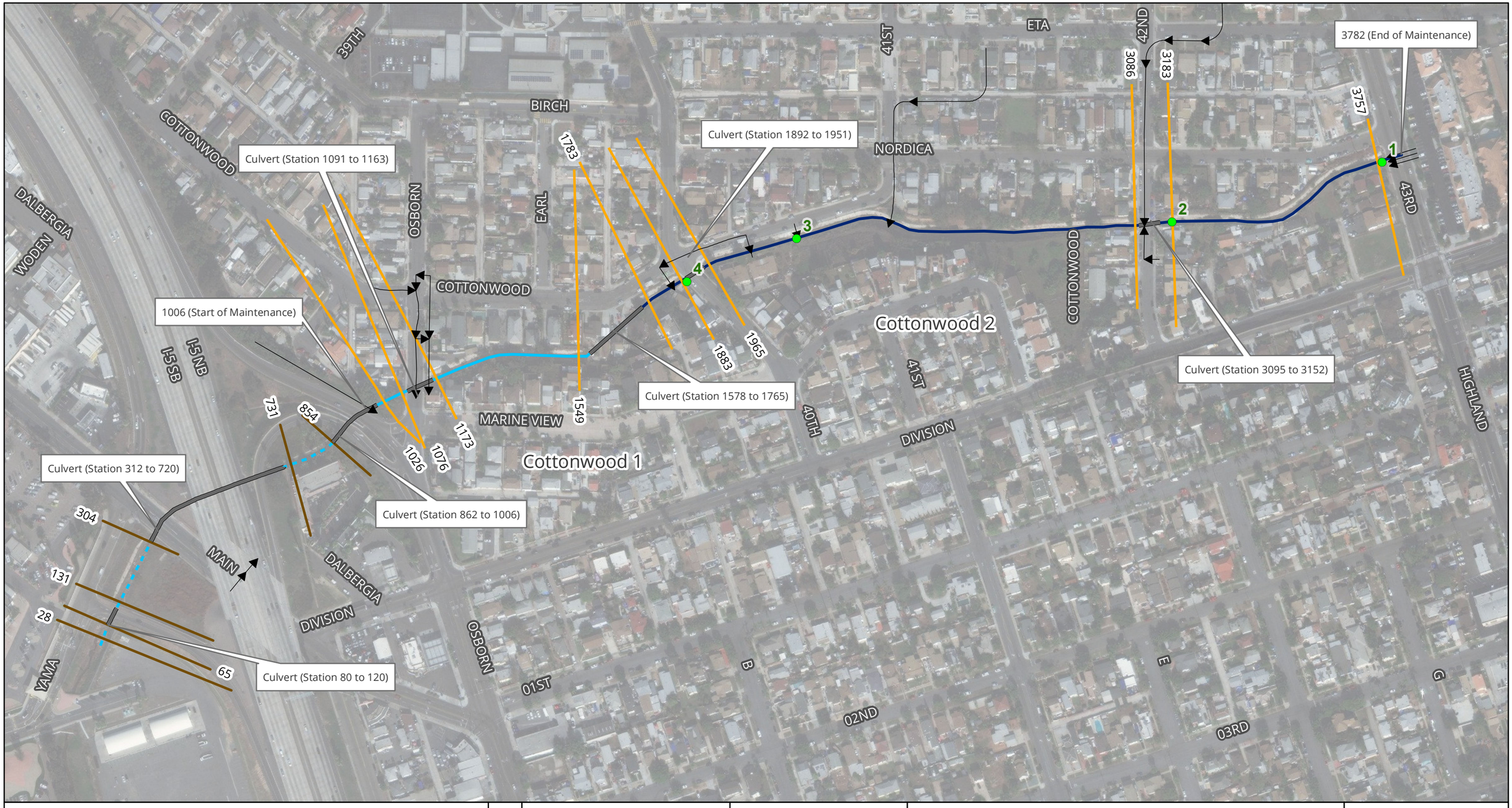
4. Cottonwood 2: Looking upstream from double 9-foot-wide by 5-foot-tall RCB culvert at 40th Street.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following page for the Cottonwood facility group.



Field Photo Locations
Storm Drain Conveyance
Culvert
MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Center Line
Cottonwood 1
Cottonwood 2

N

Drainage Area: 916 acres

Feet
0 50100 200

The City of SAN DIEGO

Facility Group Name: Paleta Creek - Cottonwood
Segment Name: Cottonwood 1 - 2
Facility Nos: 5-06-005, 5-06-008
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.

November 2019

A.53 Paleta Creek – Solola

Summary of Recommended Maintenance

Cervantes 1 (No. 5-06-025)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time [1]	
Extent of Maintenance	• Not Applicable	
Benefit	• Not Applicable	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Solola 1 (No. 5-06-020)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove the deposited sediment/debris and vegetation between Station 39 and Station 2664.	
Benefit	• Maintains a 100-year level of service (470 cfs) in the Solola 1 segment and increases freeboard by 1 foot. • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the downstream culverts.	

[1.] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Solola 2 (No. 5-06-023)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove the deposited sediment/debris and vegetation from Station 2734 to Station 4122 and Station 4172 to Station 4691. • Remove the accumulated sediment/debris in culverts from Station 2664 to Station 2734 and Station 4122 to Station 4172.	
Benefit	• Maintains a <50-year level of service (325 cfs) and increases freeboard in the upstream portion (Reach 2) of the Solola 2 segment by 0.3 feet. • Maintains a 100-year level of service (470 cfs) in the downstream portion (Reach 1) of the Solola 2 segment. • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the downstream culverts. • Concrete repair mitigates potential for ditch failure and erosion.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

The reports listed in Table 1 were used to generate this fact sheet.

Table 1. Completed Reports

Segment	Report
Cervantes 1	-
Solola 2	RICK Engineering Company, 2017. IHHA for Solola Creek Channel Map Numbers 117 and 118. Job Number 17204-L.
Solola 1	-

General Description

The Paleta Creek – Solola (Solola) facility group was classified as having both Category 1 and Category 3 segments as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The facility group is located in the San Diego Bay Watershed Management Area. The facility group is separated into three segments from upstream to downstream: Cervantes, Solola 2, and Solola 1.

The Cervantes segment is an earthen channel that begins about 250 feet west of the intersection of South Radio Drive and Cervantes Avenue. A 60-inch-diameter cast-in-place concrete pipe discharges

to the upstream end of the channel. Flow in the earthen channel is conveyed to the west until reaching a dual 18-inch-diameter corrugated metal pipe (CMP) culvert at Cervantes Avenue. The Cervantes Road culvert crossing (Stations 5670 to 5652) is an Arizona Crossing, or low-water crossing, where flows are intended to flow over the roadway within the extents of the crossing. The earthen channel continues downstream of the culvert for about 800 feet, at which point it transitions to a trapezoidal concrete ditch (Solola 2) with a bottom width of 4.5 feet.

The Solola 2 segment continues west until it reaches a 10-foot-wide by 5.5-foot-high reinforced concrete box culvert (RCB) that crosses under Bonita Drive. Downstream of the culvert the conveyance is also a concrete ditch, which runs for about 1,300 feet. There are three drop structures (located at Station 3706 to Station 3700, Station 3449 to Station 3443, and Station 2868 to Station 2862) in this portion of the ditch. The Solola 2 segment ends at the inlet to a triple 6-foot-wide by 4-foot-high RCB culvert at Euclid Avenue.

After the triple box culvert at Euclid Avenue the facility continues through Solola 1 segment. From Station 2664 to 2256, the Solola 1 segment transitions from a rectangular concrete channel with a 19-foot bottom width to a trapezoidal concrete channel with a 10-foot bottom width, and from Station 2256 to 39 continues as a trapezoidal concrete channel with a 10-foot bottom width. The Solola 1 segment contains one drop structure from Station 2069 to Station 2024. Solola 1 ends at a double 6-foot-wide by 6-foot high RCB culvert at 47th street where flow continues into a storm drain system.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Solola facility group.

Hydrology

The hydrologic peak flows presented in Table 2 are based on the Federal Emergency Management Agency's (FEMA) Flood Insurance Study (FIS) for San Diego County. The FIS provided the 10-, 50-, and 100-year flow rate information. The peak flows for the remaining recurrence intervals (2-, 5-, and 25-year) were interpolated using the method described in *Section 3.1.1.1 of the Hydrology and Hydraulics Technical Report*. Note that in the FEMA FIS Paleta Creek is referred to as Las Puleta Creek.

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Cervantes 1	43	100	160	250	390	470
Solola 2	43	100	160	250	390	470
Solola 1	43	100	160	250	390	470

Hydraulics

A one-dimensional steady flow model was developed for this facility segment using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and proposed maintained conditions. A HEC-RAS model for Solola 2 was provided by RICK Engineering Company (RICK). D-MAX Engineering prepared a model for the Cervantes segment and the Solola 1 segment and linked them to both ends of the RICK Solola 2 model in one HEC-RAS file. Refer to *Section 3.2.2.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the detailed HEC-RAS model. The extent of the reaches evaluated in the model is presented in the Hydraulic Reference Map.

The upstream and downstream domains of analysis consist of storm drain pipes; to the east of the channel upstream, and continuing west of the channel downstream. Based on the methodology presented in *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report*, the upstream domain of analysis consists solely of storm drains and has been excluded from the modeling.

The baseline condition for the Cervantes segment was based on observations by DMax Engineering during an April 2017 site visit and consultation with the biological assessment team to determine that the facility group is considered at its ultimate vegetated condition. The channel bottom for the Cervantes segment was assigned a Manning's coefficient value ranging from 0.03 to 0.15. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2017 site visit.

Due to the presence of a drop structure between Station 3706 and Station 3700, for hydraulic analysis purposes the Solola 2 segment was broken into two reaches as follows:

- Solola 2, Reach 2 (concrete): Stations 4691 to 3706.
- Solola 2, Reach 1 (concrete): Stations 3706 to 2734.

Solola 2 Reach 2 is upstream of the drop structure at Station 3706. Solola 2 Reach 1 includes the drop structure and continues downstream to the culvert inlet under Euclid Avenue. Solola 2 Reaches 1 and 2 were assigned Manning's coefficient values ranging from 0.018 to 0.05 based on observations of vegetation and deposited sediment/debris in the concrete ditch. The channel bottom for the Solola 1 segment was assigned a Manning's coefficient value ranging from 0.018 to 0.04 based on observations of vegetation and deposited sediment/debris in the concrete channel. The photos in the Representative Photos section below provide examples of the condition of the facility as observed by DMax Engineering during the April 2017 and November 2017 site visits.

The assigned Manning's coefficient values for the Cervantes segment in the recommended maintained condition are the same as those in the baseline condition since no maintenance is proposed for the Cervantes segment. The Manning's coefficient value for the Solola 2 and Solola 1 segments in the maintained condition were set at 0.018 to reflect the roughness of the originally constructed concrete facility.

Model parameters and velocities for the baseline and maintained conditions for the Solola facility group are summarized in Table 3. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity.

Table 3. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Cervantes 1 (earthen)	7272–4691	Baseline: 0.03-0.08 Maintained: 0.03-0.08	Baseline: 3.3–11.7 Maintained: 3.3–11.7	Culvert (Stations 5670 to 5652)	Normal depth at Station 7273
Solola 2, Reach 2 (concrete)	4691-3706	Baseline: 0.018-0.05 Maintained: 0.018	Baseline: 5.0–12.7 Maintained: 4.6–15.1	Culvert (Stations 4172 to 4122)	-
Solola 2, Reach 1 (concrete)	3706–2734	Baseline: 0.018-0.05 Maintained: 0.018	Baseline: 4.3–29.3 Maintained: 5.1–28.5	Drop structures (Stations 3706 to 3700, 3449 to 3443, 2868 to 2862)	-
Solola 1 (concrete)	2664-51	Baseline: 0.018-0.04 Maintained: 0.018	Baseline: 6.1–22.3 Maintained: 6.1–22.3	Drop structure (Stations 2069 to 2024)	-
Downstream domain of analysis	39-3	Baseline: 0.018 Maintained: 0.018	Baseline: 10.7–11.2 Maintained: 10.7–11.2	Culvert (Stations 39 to 24)	Normal depth at Station 3

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used to determine the level of service. The overall conveyance capacity and level of service for the segment are summarized in the Summary Table (Table 4) for both the baseline and recommended maintained conditions.

Baseline Condition

The Cervantes segment can convey up to 470 cubic feet per second (cfs) (100-year level of service) in the baseline condition. Note that during storms larger than the 2-year event flows will cross over the road at the Cervantes Road Arizona crossing.

Solola 2, Reach 2 can convey up to 325 cfs (<50-year level of service) in the baseline condition before flows impact the adjacent residential property. Solola 2, Reach 1 can convey up to 470 cfs (100-year level of service) in the baseline condition. Solola 1 can convey up to 470 cfs (100-year level of service) in the baseline condition.

Recommended Maintained Condition

The Cervantes segment has a 100-year storm event level of service in its ultimate vegetated condition; therefore, no maintenance is recommended.

Removing the deposited sediment/debris and vegetation from the Solola 2, Reach 2 results in no change in the level of service, the <50-year storm event (325 cfs), but gains 0.3 feet of additional freeboard. Removing the deposited sediment/debris and vegetation from the Solola 2, Reach 1 is also recommended to reduce the risk of vegetation flowing downstream and clogging the downstream culverts or reducing the level of service if left unmaintained.

Removal of deposited sediment/debris and vegetation in Solola 1 results in an increase freeboard of up to 1 foot during the 100-year event in locations where deposited sediment/debris was modeled and is also recommended to reduce the risk of vegetation flowing downstream and clogging the downstream culverts.

Post-Maintenance Erosion Control Measures

No maintenance is proposed for the Cervantes segment, so no measures to reduce velocity or control erosion are proposed. The estimated post-maintenance velocities in the Solola 2 and Solola 1 segments are below recommended permissible velocities for concrete-lined channels (35 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for the facility group.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the level of service for the Solola 2 segment was restricted by low bank heights. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Table 4. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Cervantes 1	7273-4691	470	-	100-year	-
Solola 2, Reach 2	4691-3706	325	325	<50-year	<50-year
Solola 2, Reach 1	3706-2683	470	470	100-year	100-year
Solola 1	2683-51	470	470	100-year	100-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map indicated. The site visits were conducted in April 2017 and November 2017.

1. Cervantes 1: Looking downstream at vegetation.

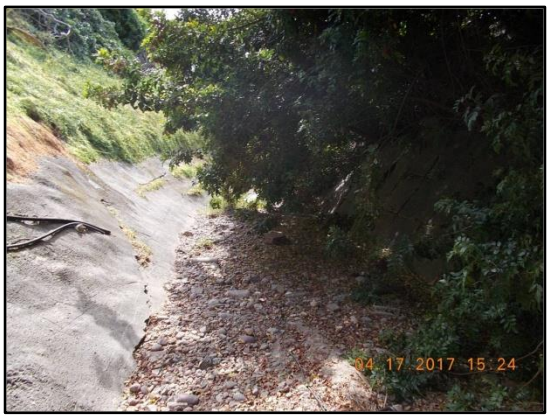
2. Cervantes 1: Looking upstream at double 18-inch-diameter CMP culvert and Arizona crossing at Cervantes Road.

3. Cervantes 1: Looking downstream at vegetation.

4. Solola 2 (Reach 2): Looking downstream at concrete ditch.

5. Solola 2 (Reach 2): Looking downstream at first drop structure.

6. Solola 2 (Reach 1): Looking downstream at second drop structure and sediment accumulated at bottom of structure.



7. Solola 2 (Reach 1): Looking downstream at broken concrete.

8. Solola 1: Looking downstream at accumulated sediment/debris in concrete channel. (November 2017)

Analysis Performed By: D-MAX Engineering Inc.; RICK Engineering Company

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Maps

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.

Field Photo Location
End of Reach
Storm Drain Conveyance
Culvert

MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Center Line
Solola 1
Solola 2
Cervantes 1

N

Drainage Area: 512 acres

Feet
0 125 250 500

The City of SAN DIEGO

Facility Group Name: Paleta Creek - Solola
Segment Name: Solola 1 - 2, and Cervantes 1
Facility Nos: 5-06-020, 5-06-023, 5-06-025
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.

November 2019

A.54 Sweetwater River – Parkside (No. 5-11-003)

Summary of Recommended Maintenance

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and overgrown vegetation from Station 298 to Station 1495.	
Benefit	• The level of service remains >2-year storm event and the conveyance capacity (735 cfs) remains unchanged, but reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert at Station 298. • The water surface elevation (WSE) at the upstream end of the channel (Station 1495) improves from the 2-year WSE in the baseline condition to the 100-year WSE in the recommended maintained condition.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Sweetwater River – Parkside (Parkside) facility group was classified as a Category 1 segment as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The facility is in the San Diego Bay Watershed Management Area. The facility is bordered by Parkside Avenue to the north, by residential development to the south and the east, and by Rhoades Road to the west.

The facility group is a concrete channel with a trapezoidal cross-section, as indicated on as-built drawing no. 7498-D. The channel bottom ranges from 10-16.5 feet wide with banks 5-6.5 feet high with 1.5:1 (H:V) side slopes. The Parkside facility group receives runoff from the northeast via a 72-inch-diameter reinforced concrete pipe (RCP) culvert and conveys flows in a southwesterly direction to a double barrel rectangular box culvert (5-foot x 8-foot openings) located at Station 298, where flows are conveyed beneath Rhoades Road and into the storm drain system. See the Hydraulic Reference Map located at the end of this fact sheet.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Sweetwater River – Parkside facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval presented in Table 1 were estimated using the unit area method and the peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-,

and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.1.4 of the Hydrology and Hydraulics Technical Report*.

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Parkside 1	709	886	1,034	1,241	1,477	1,536

Hydraulics

A one-dimensional steady flow model was developed for the channel segment using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and recommended maintained conditions. Refer to *Section 3.2.1.2 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the HEC-RAS model. The extent of the reach evaluated in the model is presented in the Hydraulic Reference Map located at the end of this fact sheet.

Emergency maintenance was performed on this channel segment in December 2015. Therefore, the baseline condition was assumed to be the pre-maintenance condition of the channel. In the baseline condition, the channel bottom and banks were assigned Manning's coefficient values of 0.075 and 0.06, respectively. These assignments were based on the field photos, located in the Representative Photos section, taken during a site visit conducted by Rick Engineering in May 2015, before the emergency maintenance was performed. The photos show dense vegetation in the bottom of the channel with many large trees. The sediment depth for these trees to grow was assumed to be 0.2 feet. For the recommended maintained condition, the Manning's coefficient value assigned for both the bottom and banks of the channel was 0.015 to reflect the roughness of the originally constructed concrete facility.

Model parameters and velocities for the baseline and maintained conditions for the Parkside facility are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the level of service capacity.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Parkside 1 (concrete)	1495-298	Baseline: 0.06 -0.075	Baseline: 5.02-6.90	Culvert (Station 298)	Normal Depth at Stations 1495 & 298
		Maintained: 0.015	Maintained: 4.93-20.59		

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of

the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flows rates, summarized in Table 1 in the Hydrology section, were used in determining the level of service. The velocities, summarized in Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall channel conveyance capacities and level of service for the segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained conditions.

Baseline Condition

The baseline condition is based on the pre-maintenance condition of the channel. The channel segment can convey 735 cubic feet per second (cfs) (>2-year level of service) before the roadway and culvert are inundated at Station 298.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the facility group does not improve the level of service or conveyance capacity of the segment. The channel segment can convey 735 cubic feet per second (cfs) (>2-year level of service) before the roadway and culvert are inundated at Station 298. The recommended maintenance reduces the risk of vegetation and sediment/debris flowing downstream and clogging the culvert at Station 298. In addition, the WSE at the upstream end of the segment improves from the 2-year WSE in the baseline condition to the 100-year WSE in the recommended maintained condition.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition (Table 2) are below the maximum permissible velocities for a concrete channel as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the overall facility level of service was restricted by the culvert at the downstream end of the channel conveying flow beneath Rhoades Road. In the recommended maintained condition, the concrete channel was estimated to provide a level of service for the 100-year storm event, but due to the restricted flow condition observed at the downstream culvert (Station 298), the combined level of service is only >2-year storm event. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Table 3. Summary Table

Segment	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Parkside 1	1495-298	735	735	>2-year	>2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Pre-emergency maintenance photos are from a site visit conducted by Rick Engineering in May 2015.

1. Parkside 1: Looking downstream from the inlet of the channel.

2. Parkside 1: Representative of channel (with moderate vegetation), looking upstream.

3. Parkside 1: Representative of channel (with dense vegetation), looking upstream.

4. Parkside 1: Double box culvert at downstream end of channel, looking southwest.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.

Field Photo Location
Storm Drain Conveyance
Culvert
Domain of Analysis Cross Section
MWMP Facility Cross Section
Domain of Analysis Center Line
MWMP Facility Center Line

N

Drainage Area: 768 acres

0 30 60 120 Feet

The City of SAN DIEGO

Facility Group Name: Sweetwater River - Parkside
Segment Name: Parkside 1
Facility No: 5-11-003
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.

November 2019

A.55 Nestor Creek - Nestor

Summary of Recommended Maintenance

Cedar 1 (No. 5-22-008)

Facility Type	Bed: Earthen, Riprap Banks: Earthen, Riprap	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from segment bottom and culverts from Station 790 to Station 855.4912. • Assessment continues on the remainder of Cedar 1 (Station 428.4604 to Station 790) to determine if future maintenance will benefit the associated areas.	
Benefit	• Level of service remains <2-year storm event and the conveyance capacity remains unchanged (160 cfs). • If maintenance was neglected, the frequency of flooding would increase and the conveyance capacity of the segment would be reduced to 10 cfs in the ultimate vegetated condition.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Proposed maintenance area stations may differ from IHHA model reference stations.

Cedar 2 (No. 5-22-010)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment and vegetation from segment bottom and culverts from Station 855.4912 to Station 1415.	
Benefit	• Increase level of service from <100-year storm event (980 cfs) to 100-year storm event (1,093 cfs).	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Proposed maintenance area stations may differ from IHHA model reference stations.

Dahlia 1 (No. 5-22-013)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Routine maintenance is not recommended at this time. However, a maintenance area should be identified for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.[1, 2]	
Extent of Maintenance[3]	• N/A	
Benefit	• N/A	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

3 Proposed maintenance area stations may differ from IHHA model reference stations.

Cerrissa 1 (No. 5-22-016)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from segment bottom from Station 3056.694 to Station 3197 and Station 4167.329 to Station 5493.50. • Remove accumulated sediment/debris from the culvert from Station 2260 to Station 3056.694. • The remainder of Cerrissa 1 is recommended to be maintained by the private property owners to remove accumulated sediment/debris and overgrown vegetation.	
Benefit	• Increase level of service from >10-yearstorm event (340 cfs) to <25-year storm event (420 cfs). • Reduces potential clogging of the downstream culverts.	

1. Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Proposed maintenance area stations may differ from IHHA model reference stations.

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Grove 1 (No. 5-22-023)

Facility Type	Bed: Earthen Banks: Earthen, Concrete	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Removal of vegetation from segment bottom from Station 8660 to Station 9228 and Station 9261 to Station 9732. • Remove accumulated sediment/debris and vegetation from culverts from Station 9228 to Station 9261 and Station 9732 to 9801.695.	
Benefit	• Increases conveyance capacity from 456 cfs to 510 cfs; preserves 100-year storm event level of service. • Reduces potential clogging of the downstream culverts.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Proposed maintenance area stations may differ from IHHA model reference stations.

30th St 1 (No. 5-22-028)

Facility Type	Bed: Concrete, Earthen Banks: Concrete, Earthen	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from from Station 10653 to Station 11830. • Remove accumulated sediment/debris and vegetation from culverts from under gabion dam and at Station 10680 and at Station 11830. • Perform bank repair on the north concrete bank near Station 11547.03.	
Benefit	• The overall level of service remains <10-year storm event (165 cfs). • The conveyance capacity of the downstream portion (Station 10553.02 to Station 11208.47) increases from 260 cfs to 270 cfs, having a level of service of 25-year storm event. • Reduces potential clogging of the downstream culverts.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Proposed maintenance area stations may differ from IHHA model reference stations.

The reports listed in Table 1 were used to generate this fact sheet.

Table 1. Completed Report

Segment	Report	Reach
30th St 1	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	11, 12
-	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	10
Grove 1	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	9
-	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	8
-	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	7
-	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	6
-	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	5
Cerrissa 1	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	3, 4
Dahlia 1	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	2
Cedar 2	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	1b
Cedar 1	Rick Engineering, 2017. IHHA Report for Nestor Creek Channel Map Numbers 131, 132, 133, & 134.	1a

General Description

The Nestor Creek - Nestor (Nestor) facility group was classified as having both Category 1 and Category 3 segments, as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Nestor Creek facility group is located in the Otay Watershed Management Area. Nestor Creek is bordered by residential and commercial properties, and Mendoza Elementary School. The facility group is separated into seven segments, from upstream to downstream: 30th, Grove 2, Grove 1, Cerrissa, Dahlia, Cedar 2, and Cedar 1.

The 30th Street segment is a concrete trapezoidal segment located at the upstream end of the facility group that begins west of 30th Street and extends west for approximately 540 feet before entering a 42-inch-diameter reinforced concrete pipe (RCP) culvert in the gabion dam structure. The segment continues downstream of the gabion dam for approximately 430 feet, after which the segment transitions to an earthen portion for 130 feet and then transitions a concrete rectangular channel before entering a double-barrel 36-inch-diameter RCP culvert beneath the San Diego and Imperial Valley Railroad crossing.

The Reach 10 segment is the subsequent downstream segment and is a trapezoidal segment with an earthen bottom, a concrete right side slope, and an earthen left side slope (facing downstream). The segment begins at the outlet of the double-barrel 36-inch-diameter RCP culvert beneath the San Diego and Imperial Valley Railroad crossing. The segment continues west for approximately 750 feet before entering a triple 8-foot-wide by 4-foot-high reinforced concrete box (RCB) culvert beneath 27th Street. The Reach 10 segment is privately owned.

The Grove 1 segment is the subsequent downstream segment that begins at the outlet of the triple 8-foot-wide by 4-foot-high RCB culvert beneath 27th Street. The segment continues west for approximately 470 feet as a trapezoidal segment with an earthen bottom and concrete sides before entering a triple 8-foot-wide by 4-foot-high RCB culvert beneath Caminito Avellano Street. The segment continues as rectangular with an earthen bottom and concrete sides for approximately 570 feet before entering a double 7-foot-wide by 5-foot-high RCB culvert beneath Interstate 5 (I-5).

The subsequent downstream reach is referred to as Reach 8 in the 2017 Individual Hydrologic and Hydraulic Assessment (IHHA) completed by Rick Engineering and is privately owned. The reach begins at the outlet of the double 7-foot-wide by 5-foot-high RCB culvert beneath I-5, and continues as an earthen trapezoidal channel for approximately 300 feet before entering a double 11.5-foot-wide by 5-foot-high RCB culvert beneath Tesoro Grove Way.

The subsequent downstream reach is referred to as Reach 7 in the 2017 IHHA completed by Rick Engineering and is privately owned. The reach begins at the outlet of the double 11.5-foot-wide by 5-foot-high RCB culvert beneath Tesoro Grove Way, and continues as an earthen trapezoidal channel for approximately 190 feet before entering a double 10-foot-wide by 5-foot-high RCB culvert beneath a private street in Country Airre Subdivision.

The subsequent downstream reach is referred to as Reach 6 in the 2017 IHHA completed by Rick Engineering and is privately owned. The reach begins at the outlet of the double 10-foot-wide by 5-foot-high RCB culvert beneath a private street in Country Airre Subdivision. The reach continues northwest as an earthen trapezoidal channel for approximately 650 feet before entering a 90-inch-diameter corrugated metal pipe (CMP) culvert beneath Hollister Street.

The subsequent downstream reach is referred to as Reach 5 in the 2017 IHHA completed by Rick Engineering and is privately owned. The reach begins at the outlet of the 90-inch-diameter CMP culvert and continues as an earthen trapezoidal channel for approximately 1,145 feet northwest. The reach transitions to a concrete rectangular channel for 160 feet at the downstream end before entering a triple 10-foot-wide by 4-foot-high RCB culvert beneath Coronado Avenue. The RCB culvert beneath Coronado Avenue is located within a City of San Diego right-of-way and is assumed to be the City of San Diego's responsibility to maintain.

The Cerrissa segment is the subsequent downstream segment and is an earthen segment which begins at the outlet of the triple 10-foot-wide by 4-foot-high RCB culvert beneath Coronado Avenue. The segment continues northwest for approximately 1,970 before entering a triple RCB culvert beneath Cerrissa Court, consisting of two openings which are 12-feet-wide by 7-feet-high and one

opening which is 12 feet wide and 6 feet high. The earthen trapezoidal segment continues for approximately 465 feet before entering an underground triple 10-foot-wide by 5-foot-high RCB culvert, 782 feet in length, which is aligned beneath Playa Parque Subdivision, Avenida Del Mexico, and Saturn Boulevard. A portion of the segment is privately owned (Station 3195.799 to Station 4167.329).

The Dahlia segment is the subsequent downstream segment and begins at the outlet of the triple 10-foot-wide by 5-foot-high RCB culvert, west of Saturn Boulevard. The segment continues for 600 feet before entering an underground triple 10-foot-wide by 4-foot-high RCB culvert beneath Palm Avenue.

The Cedar 2 segment is the subsequent downstream segment and begins at the outlet of triple 10-foot-wide by 4-foot-high RCB culvert beneath Palm Avenue. The concrete rectangular segment continues 560 feet northwest until the segment ends at the transition to earthen lining.

The Cedar 1 segment is the furthest downstream segment within the facility group and begins at the transition from concrete rectangular to earthen trapezoidal. The segment has riprap side slopes at its upstream end for 65 feet, which is within a City of San Diego easement. The slopes are unlined for the remaining 360 feet of the segment.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Nestor facility group.

Hydrology

The hydrologic peak flows presented in Table 2 are based on Federal Emergency Management Agency's (FEMA's) Flood Insurance Study (FIS) for San Diego County (2012). The FIS provided the 10-, 50-, and 100-year flow rate information for Nestor Creek at the San Diego and Arizona Eastern Railroad location (at the upstream limits of this study). These flows were plotted on log-probability paper to determine the approximate slope/distribution. This slope/distribution was utilized for the remaining six locations where only 100-year information was provided. From this distribution, flow rates of the channel were determined and equated to a return frequency storm event.

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
30th St 1	20	88	180	270	365	456
Grove 1	20	88	180	270	365	456
Cerrissa 1	215	260	330	470	640	796
Dahlia 1	243	300	365	520	690	864
Cedar 2	300	360	440	640	840	1,093
Cedar 1	300	360	440	640	840	1,093

Hydraulics

A one-dimensional steady flow model was developed for the Nestor Creek facility group using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline condition and the recommended maintained condition. The extents of the reaches evaluated in the model are presented in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition for the 30th, Reach 10, Reach 8, Reach 7, Reach 6, Reach 5, Cerissa, Dahlia, Cedar 2, and Cedar 1 segments were each determined to be the current condition. During the site visit conducted by Rick Engineering in April 2015, May 2015, and November 2016 to assign Manning's coefficient values, segment conditions, and segment properties within the Nestor Creek facility group. The baseline condition for Grove 1 was determined to be the ultimate vegetated condition. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the various site visits.

For the analysis of the baseline condition, the 30th Street segment was assigned a Manning's coefficient value of 0.15 for the concrete bottom in the upstream portion of the segment, and values ranging from 0.045–0.085 were assigned to the earthen bottom in the downstream portion of the segment. For the side slopes, Manning's coefficient values ranging from 0.018–0.02 were assigned to the concrete lined side slopes. For the recommended maintained condition, a Manning's coefficient value of 0.018 was assigned to the segment bottom.

For the analysis of the baseline condition, the Reach 10 segment was assigned Manning's coefficient values ranging from 0.045–0.08 for the concrete and earthen bottom to reflect light to moderate vegetation. For the side slopes, a Manning's coefficient value of 0.018 was assigned to the concrete lined side slopes. For the recommended maintained condition, a Manning's coefficient value of 0.018 or 0.03 was assigned to the segment bottom.

For the analysis of the baseline condition, the Grove 1 segment was assigned a Manning's coefficient value of 0.15 for the segment bottom, and values ranging from 0.018–0.02 for the concrete lined side slopes. The ultimate vegetated condition reflects dense vegetation in the earthen or silted portions of the segment. This condition assumes that in absence of maintenance, the vegetation that currently exists will become denser; increased sediment deposition will occur; and vegetation growth will occur throughout the fully concrete lined portion. For the recommended maintained condition, a Manning's coefficient value of 0.035 was assigned to the segment bottom to reflect the removal of vegetation.

For the analysis of the baseline condition, Reach 8 was assigned Manning's coefficient values ranging from 0.02–0.15 for the earthen segment bottom and side slopes. Sediment was added throughout the segment length, based on observations from the site visit. Additionally, standing water was observed at the downstream culvert (Station 7906), and the culvert was shown to be blocked with sediment for a depth of 3 feet, which was incorporated into the model. For the recommended

maintained condition, a Manning's coefficient value of 0.03 was assigned to the segment bottom to reflect the removal of sediment/debris and vegetation.

For the analysis of the baseline condition, Reach 7 was assigned Manning's coefficient values ranging from 0.02–0.15 for the earthen segment bottom and side slopes. Sediment was added throughout the segment length, based on observations from the site visit. Additionally, standing water was observed at the downstream culvert (Station 7661), and the culvert was shown to be blocked with sediment for a depth of 2 feet, which was incorporated into the model. For the recommended maintained condition, a Manning's coefficient value of 0.03 was assigned to the segment bottom to reflect the removal of sediment/debris and vegetation.

For the analysis of the baseline condition, Reach 6 was assigned Manning's coefficient values ranging from 0.035–0.15 for the earthen segment bottom and side slopes. For the recommended maintained condition, a Manning's coefficient value of 0.035 was assigned to the segment bottom to reflect the removal of vegetation.

For the analysis of the baseline condition, Reach 5 was assigned a Manning's coefficient value of 0.018 for the segment bottom and side slopes in the concrete portion of the segment, and values ranging from 0.045–0.15 for the bottom and side slopes in the earthen portion of the segment. For the recommended maintained condition, a Manning's coefficient value of 0.018 was assigned for the segment bottom in the concrete portion, and a value of 0.035 was assigned to the segment bottom to reflect the removal of vegetation from the earthen portion.

For the analysis of the baseline condition, the upstream portion of the Cerrissa segment (Station 3521.29 to Station 5493.50) was assigned Manning's coefficient values ranging from 0.035–0.15 for the concrete bottom to reflect light to dense vegetation. In the downstream portion of the Cerrissa segment (Station 2241.34 to Station 3521.29), Manning's coefficient values ranging from 0.035–0.045 were assigned to the concrete bottom to reflect light vegetation. For the recommended maintained condition, a Manning's coefficient value of 0.018 was assigned to the segment bottom to reflect the removal of vegetation.

For the analysis of the baseline condition, the Dahlia segment was assigned a Manning's coefficient value of 0.018 for the concrete bottom to reflect light to moderate vegetation. For the side slopes, a Manning's coefficient value of 0.03 was assigned to the concrete lined side slopes. For the recommended maintained condition, a Manning's coefficient value of 0.018 was assigned to the segment bottom.

For the analysis of the baseline condition, the Cedar 2 segment was assigned Manning's coefficient values ranging from of 0.018–0.05 for the concrete bottom and side slopes to reflect light to moderate vegetation. Sediment was observed in patches of approximately 6 inches in depth throughout the segment. For the recommended maintained condition, a Manning's coefficient value of 0.018 was assigned to the segment bottom.

For the analysis of the baseline condition, the Cedar 1 segment was assigned Manning's coefficient values ranging from 0.02–0.15 for the earthen bottom to reflect light to dense vegetation. For the side slopes, Manning's coefficient values ranging from 0.05–0.09 were assigned to the riprap lined side slopes to reflect light to dense vegetation. For the recommended maintained condition, a Manning's coefficient value of 0.03 was assigned to the segment bottom to reflect the removal of vegetation within the riprap lined side slope portion of the segment.

Model parameters for the baseline and maintained conditions for the Nestor Creek facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
30th St 1 (concrete, earthen)	11800.64-10553.03	Baseline: 0.018, 0.03 Maintained: 0.018	Culverts (Stations 11378, 10600)	-
Reach 10 (concrete)	10553.03-9705.228	Baseline: 0.09-0.10 Maintained: 0.018	Culvert (Station 9750)	-
Grove 1 (earthen)	9705.228-8250.62	Baseline: 0.018-0.15 Maintained: 0.035	Culverts (Stations 9239, 8465)	-
Reach 8 (earthen)	8250.62-7880.71	Baseline: 0.02-0.15 Maintained: 0.03	Culvert (Station 7906)	-
Reach 7 (earthen)	7880.71-7635.35	Baseline: 0.02-0.15 Maintained: 0.03	Culvert (Station 7661)	-
Reach 6 (earthen)	7635.35-6904.37	Baseline: 0.035-0.15 Maintained: 0.035	Culvert (Station 6950)	-
Reach 5 (concrete, earthen)	6904.37-5493.50	Baseline: 0.018-0.15 Maintained: 0.018-0.035	Culvert (Station 5550)	-

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Cerrissa 1 (earthen)	5493.50-2241.34	Baseline: 0.018-0.03 Maintained: 0.03	Culverts (Stations 3557, 2650)	-
Dahlia 1 (concrete)	2241.34-1397.676	Baseline: 0.018-0.03 Maintained: 0.018-0.03	Culvert (Station 1518)	-
Cedar 2 (concrete)	1397.676-855.4912	Baseline: 0.018-0.05 Maintained: 0.018	-	-
Cedar 1 (earthen)	855.4912-428.4604	Baseline: 0.02-0.15 Maintained: 0.03	-	Known Water Surface Elevation/ Normal Depth/ Critical Depth

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the facility where maintenance is proposed and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used in determining the level of service. The overall channel conveyance capacities and level of service for each segment are summarized in the Summary Table (Table 4) for both the baseline and recommended maintained condition.

Baseline Condition

The 30th segment has a level of service equal to the <10-year storm and can convey up to 140 cubic feet per second (cfs) in the baseline condition before flows impact the adjacent property.

Grove 1 has a level of service equal to the 100-year storm and can convey up to 456 cfs in the baseline condition before flows impact the adjacent property.

Cerrissa has a level of service >10-year storm and can convey up to 340 cfs in the baseline condition before flows impact the adjacent property.

Dahlia has a level of service equal to the 100-year storm and can convey up to 864 cfs in the baseline condition before flows impact the adjacent property.

Cedar 2 has a level of service <100-year storm and can convey up to 980 cfs in the baseline condition before flows impact the adjacent property.

Cedar 1 both has a level of service <2-year storm and can convey up to 160 cfs in the baseline condition before flows impact the adjacent property.

Recommended Maintained Condition

Removing the deposited sediment/debris and vegetation from the 30th Street segment preserves the overall segment level of service at the <10-year event, with the conveyance capacity increasing to 165 cfs. . In addition, concrete bank repair activities are recommended near Station 11547.03 along the north concrete bank.

Removing the deposited sediment/debris and vegetation from the Grove 1 will increase capacity to 456 cfs, preserving the 100-year level of service, and the overall facility group will benefit.

It is important to note that Reaches 8, 7, 6, and 5 are privately owned or are the responsibility of other City departments and are not maintained by the City Transportation & Stormwater Department. However, maintenance is recommended within these reaches since the overall facility group will benefit. It is also important to note that maintenance should be performed in the culvert (Station 7661) under the private street at Country Airre Subdivision, owned by Unison Investment.

Removing the deposited sediment/debris and vegetation from the Cerrissa segment increases the level of service to the 25-year event, with the conveyance capacity increasing to 420 cfs. A portion of the segment is privately owned (Station 3195.799 to Station 4167.329).

The Dahlia segment has a 100-year storm event level of service in its current condition; therefore, maintenance is not currently recommended for the segment. Due to the potential need for infrastructure repair (e.g., concrete-lining), developing a plan for potential maintenance within the Dahlia segment is recommended.

Removing the deposited sediment/debris and vegetation from the Cedar 2 segment increases the level of service to the 100-year event, with the conveyance capacity increasing to 1,093 cfs.

Removing the deposited sediment/debris and vegetation from the riprap lined side slope portion of the Cedar 1 segment (Station 790 to Station 855.4912) does not improve the conveyance capacity or level of service from the baseline condition (<2-year, 160 cfs). If maintenance was neglected in this segment, it was estimated that the conveyance capacity would reduce to 10 cfs in the ultimate vegetated condition; therefore maintenance is recommended maintain the baseline conveyance capacity.

It is important to note that the benefits to the Nestor facility group due to the recommended maintenance are dependent on the assumption that the segments and culverts that are not owned by the City of San Diego have been maintained.

Post-Maintenance Erosion Control Measures

No measures to reduce velocities or otherwise control erosion in the post-maintenance condition are recommended, due to the non-erosive velocities observed in the concrete and earthen segments.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the level of service for the facility group is restricted by downstream culverts and low bank elevations. Culvert improvements should also be considered when evaluating the bank elevations. Additional analysis is recommended to evaluate potential increases in the levels of service that could be achieved by capital improvements to address these restrictions.

Table 4. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
30th St 1	11800.64-10553.02	140	165	<10-year	<10-year
Grove 1	9705.227-8250.62	456	456	100-year	100-year
Cerrissa 1	5493.50-2241.34	340	420	>10-year	25-year
Dahlia 1	2241.34-1397.676	864	-	100-year	-
Cedar 2	1397.676-855.4912	980	1,093	<100-year	100-year
Cedar 1	855.4912-428.4604	160	160	<2-year	<2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map indicated. A selection of photos representative of the baseline condition from the previous IHHA document are included in this fact sheet with the original photo numbers. Site visits were conducted by Rick Engineering in April 2015, May 2015, and November 2016.

IHHA 2. Cedar 1: Looking downstream from the upstream end of the segment (November 2016).

IHHA 4. Cedar 2: Looking upstream at the Palm Avenue triple RCB culvert (November 2016).

IHHA 5. Cedar 2: Looking downstream from the upstream end of the segment (November 2016).

IHHA 6. Dahlia 1: Looking upstream (April 2015).

IHHA 7. Cerrissa 1: Looking upstream (April 2015).

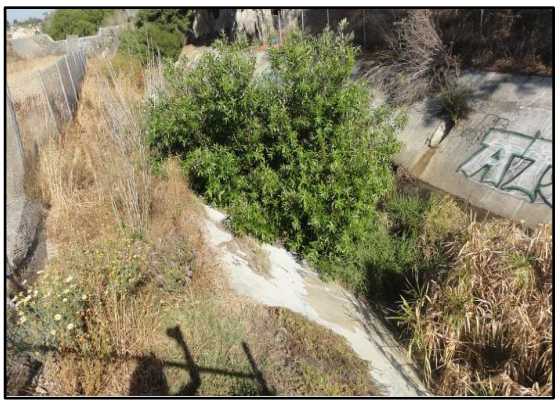
IHHA 8. Cerrissa 1: Looking downstream at the Cerrissa Court triple RCB culvert (April 2015).

IHHA 9. Cerrissa 1: Looking upstream at the downstream end of the segment (April 2015).

IHHA 11. Cerrissa 1: Looking upstream (April 2015).

IHHA 21. Grove 1: Looking upstream at the downstream portion of the segment (May 2015).

IHHA 24. 30th St 1: Looking downstream at the double-barrel 36-inch-diameter RCP culvert at the San Diego Railroad crossing (May 2015).



IHHA 25. 30th St 1: Looking upstream from a location further downstream of the 42-inch-diameter RCP culvert (May 2015).

IHHA 28. 30th St 1: Looking upstream from the 42-inch-diameter RCP culvert at the middle of the segment (May 2015).

Analysis Performed By: Rick Engineering

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following pages for the Nestor Creek facility group.

Start of Maintenance (STA 790)

Cedar 1

Cedar 2

End of Maintenance (STA 1415)

Dahlia

Start of Maintenance (STA 3056.694)

End of Maintenance (STA 3197)

Cerrissa

Start of Maintenance (STA 4167.329)

End of Maintenance (STA 5493.499)

Legend

- Photo Locations
- Cross Sections Channel
- MMP Boundary

Reaches

- Reach 1a (Cedar 1)
- Reach 1b (Cedar 2)
- Reach 2 (Dahlia)
- Reach 3 (Cerrissa)
- Reach 4 (Cerrissa)
- Reach 5
- Reach 6
- Reach 7
- Reach 8
- Reach 9 (Grove 1)
- Reach 10 (Grove 2)
- Reach 11 (30th)
- Reach 12 (30th)

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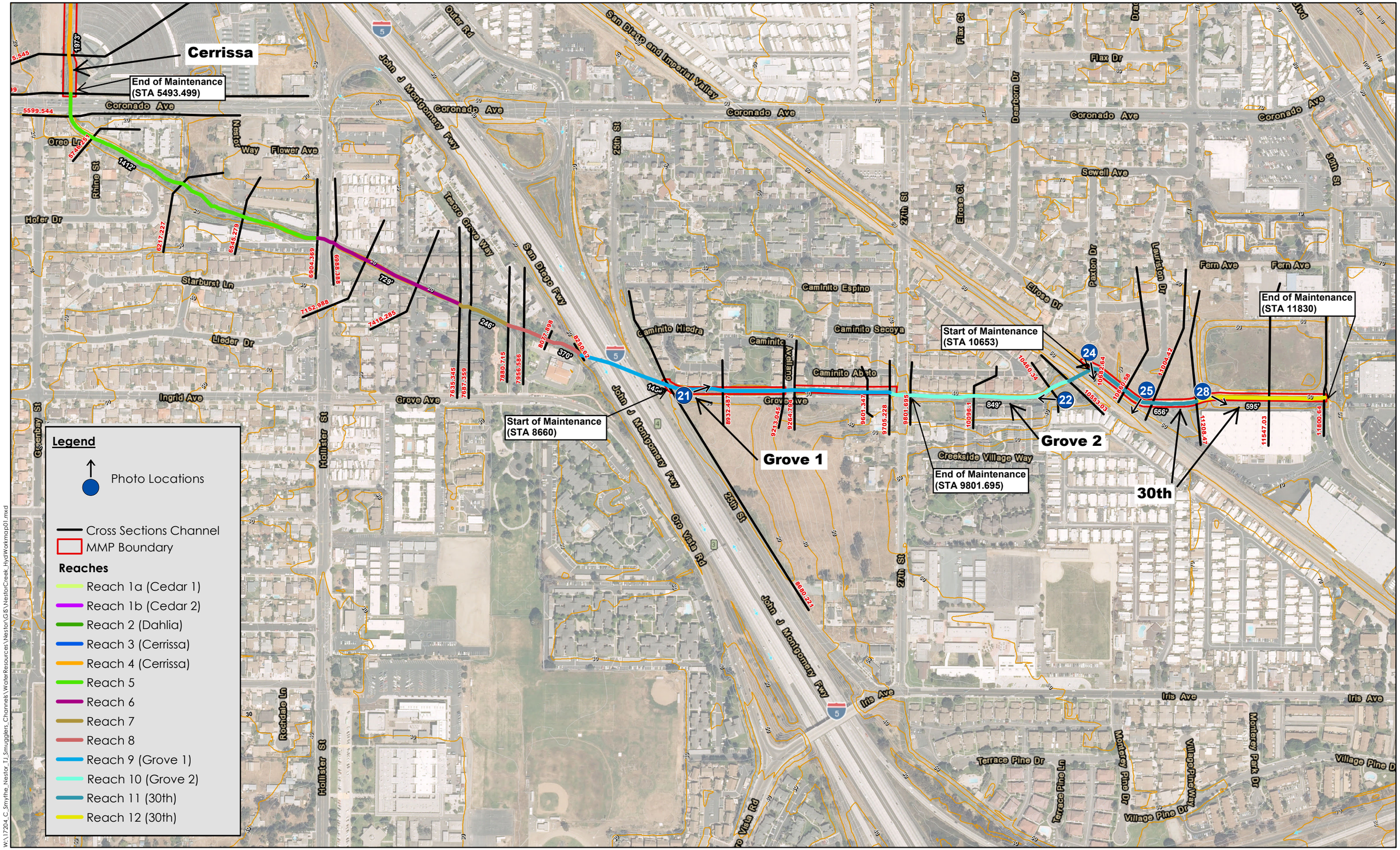
RICK ENGINEERING COMPANY

Scale in Feet: 0 400 800 — North

Original Exhibit:
Nestor Creek Channel
IHHA Report - Hydraulic Workmap, Sheet 1 of 2 (Report J-17204-K)

Date of Exhibit: 06.02.2015
SANGIS Topo 2' Contours: 1999
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Nestor Creek - Nestor
Segment Names: Cedar 1, Cedar 2, Dahlia, Cerrissa
Facility Nos: 5-22-008, 5-22-010, 5-22-013, 5-22-016
Hydraulic Map - Municipal Waterways Maintenance Plan



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RICK ENGINEERING COMPANY

Scale in Feet
0 400 800
North

Original Exhibit:
Nestor Creek Channel
IHHA Report - Hydraulic Workmap, Sheet 2 of 2 (Report J-17204-K)

Date of Exhibit: 06.02.2015
SANGIS Topo 2' Contours: 1999
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Nestor Creek - Nestor
Segment Names: Cerrissa, Grove 1, Grove 2, 30th
Facility Nos: 5-22-016, 5-22-023, 5-22-025, 5-22-028
Hydraulic Map - Municipal Waterways Maintenance Plan

A.56 Nestor Creek – Outer

Summary of Recommended Maintenance

Outer 1 (No. 5-22-110)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Trim vegetation from Station 228 to Station 613.	
Benefit	• The level of service remains <2-year storm event, but the conveyance capacity increases from 53 cfs to 80 cfs. • Preserves inlet capacity at the downstream culvert.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Outer 2 (No. 5-22-112)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and removal of overhanging vegetation from bottom and sides of concrete ditch from Station 0 to Station 176.	
Benefit	• Increases level of service from 2-year storm event (4.7 cfs) to >2-year storm event (5 cfs). • Reduces potential clogging of the downstream culvert.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Nestor Creek – Outer (Outer) facility group was classified as having both Category 1 and Category 3 facility segments as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Outer facility group is located in the Otay Watershed Management Area. The facility is bordered by Outer Road to the east and northeast, by a commercial development to the northwest, by Coronado Avenue to the south, and by the Interstate (I-) 5 highway to the west.

The facility group is y-shaped and split into two segments (Outer 1 and Outer 2) that join together just before discharging into a quadruple 30-inch-diameter reinforced concrete pipe (RCP) culvert. Outer 2 is a concrete-lined ditch that receives runoff from a drop inlet on Outer Road and conveys runoff in a southwesterly direction toward Outer 1. Outer 1 is an earthen ditch that receives flows from Outer 2 from the northwest and from a 21-inch-diameter corrugated metal pipe (CMP) from the east. Runoff from Outer 1 is conveyed in a westerly direction that feeds into the RCP culvert that is 200 feet long, which in turn discharges into the California Department of Transportation's (Caltrans) I-5 northbound on-ramp. See Hydraulic Reference Map located at the end of this fact sheet.

For the purposes of analysis, segment Outer 1 was further divided into the following reaches:

- Outer 1, Reach 2 (earthen): Stations 613 to 277.
- Outer 1, Reach 1 (earthen): Stations 277 to 228.

Outer 2 has stationing independent from Outer 1 and flows from Station 176 to Station 0 where it joins Outer 2 (at Station 277).

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Outer facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval presented in Table 1 below were estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated 2017*. Each of the two segments have a distinct drainage area; therefore, hydrologic peak flows were estimated separately for Outer 1 and Outer 2. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.1.3 of the Hydrology and Hydraulics Technical Report.* The combined peak flows downstream of the junction where the two segments meet was calculated using the modified rational method as described in the *City of San Diego Drainage Design Manual, dated 2017*.

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Outer 1, Reach 2	101	129	151	181	203	225
Outer 2	4.7	6.1	7.1	8.5	9.5	10.6
Outer 1, Reach 1	105.7	135.1	158.1	189.5	212.5	235.6

Hydraulics

A one-dimensional steady flow model was developed for these facility segments using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and proposed maintained conditions. Refer to *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the detailed HEC-RAS model. The extent of the reaches evaluated in the model is presented in the Hydraulic Reference Map.

The upstream domains of analysis for Outer 1 and Outer 2 are existing storm drain systems that discharge into the Outer facility group. The downstream domain of analysis consists of an existing quadruple 30-inch-diameter, 200-foot-long RCP culvert located within Caltrans jurisdiction. Based on the methodology presented in *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report,* the upstream domain of analysis has been excluded from the modeling.

The baseline condition for the Nestor Creek – Outer facility group was determined to be the current condition as observed during a site visit conducted by D-Max Engineering in April 2017. The banks and bottom of Outer 1, Reaches 1 and 2 were assigned Manning's coefficient values ranging from 0.040 to 0.050, which represents the density of the vegetation observed within the earthen ditch. Outer 2 was assigned Manning's coefficient values ranging from 0.015 to 0.030 based on observations of vegetation and deposited sediment/debris within the concrete ditch. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2017 site visit.

The assigned Manning's coefficient values for Outer 1, Reaches 1 and 2 in the recommended maintained condition were set at 0.025 or 0.030, reflecting shorter and less dense vegetation anticipated after trimming activities. A Manning's coefficient value of 0.015 was assigned for Outer 2 to reflect the roughness of the originally constructed facility.

Model parameters and velocities for the baseline and maintained conditions for both Nestor Creek – Outer facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the level of service capacity for each analyzed segment.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures / Transitions	Boundary Conditions
Outer 1, Reach 2 (earthen)	613 - 277	Baseline: 0.04-0.05 Maintained: 0.025-0.03	Baseline: 1.3 – 3.2 Maintained: 1.9 – 5	-	Normal Depth at Station 613
Outer 2 (concrete)[1]	176 - 0	Baseline: 0.015–0.030 Maintained: 0.015	Baseline: 0.69 – 2.3 Maintained: .062 – 2.45	-	Normal Depth at Station 176
Outer 1, Reach 1 (earthen)	277- 228	Baseline: 0.04 Maintained: 0.025-0.03	Baseline: 1.1 – 2.2 Maintained: 1.1 – 2.3	Culvert (Station 228)	-
Downstream Domain of Analysis	228 - 1	0.025-0.03	3.3 – 5.2	Caltrans Drainage System	Normal Depth at Station 1

[1] The stationing for Outer 2 is independent from the stationing for Outer 1. Outer 2 Station 0 is equal to Outer 1, Reach 2 Station 277. See Hydraulic Reference Map.

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flow rates, summarized in Table 1 in the Hydrology section, were used to determine the level of service. The velocities, summarized Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall channel conveyance capacities and level of service for each segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained condition.

Baseline Condition

The capacity of Outer 1, Reach 2 is limited by the northern bank elevation near the neighboring parking lot at Station 376. The ditch is only capable of conveying up to 53 cubic feet per second (cfs) (<2-year level of service) in the current condition. Outer 2 is capable of conveying 4.7 cfs (2-year level of service). Outer 1, Reach 1 is limited by the western bank elevation at Station 259; and can convey 65 cfs (<2-year level of service) before flows impact the adjacent commercial property. The culvert entrance capacity located at Station 228 is also limited by the western bank. It can convey 144 cfs (>10-year level of service) before the facility overflows onto the I-5 right-of-way.

Recommended Maintained Condition

Trimming vegetation in Outer 1, Reach 2 increases the conveyance capacity to 80 cfs; however, the level of service remains at less than the 2-year event. Removing the deposited sediment/debris and overhanging vegetation in Outer 2 improves the level of service to greater than the 2-year event, with conveyance capacity increasing to 5 cfs. Trimming vegetation in Outer 1, Reach 1 does not affect the level of service or the capacity. Based on the April 2017 field visit, vegetation was not observed to obstruct the culvert openings; however, vegetation was observed close to the culvert inlet and throughout Reach 1. Trimming this vegetation in Reach 1 does not increase the level of service or conveyance capacity per the modeling, but it is recommended to preserve the performance of the culvert by preventing future obstruction of the culvert openings.

Post-Maintenance Erosion Control Measures

The estimated velocities in Outer 1 are within the recommended permissible velocities for natural grass-lined channels (5 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017,* for both baseline and recommended maintained conditions and are not expected to cause erosion. Based on the above reference for concrete-lined channels, the velocities estimated in Outer 2 are well below the threshold identified (35 fps) as possibly causing erosion. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for either facility.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions, the overall facility level of service was restricted by low bank heights along Outer 1. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction. Also note that if the banks are raised, the capacity of the culvert at the downstream end of the facility may then become the main factor limiting the maximum level of service that could be attained. For that reason, culvert improvements should also be considered when evaluating the bank elevations.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Outer 1, Reach 2 (earthen)	613-277	53	80	<2-year	<2-year
Outer 2 (concrete)	176-0	4.7	5	2-year	>2-year
Outer 1, Reach 1 (earthen)	277-228	65	65	<2-year	<2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Site visit conducted by D-Max Engineering in April 2017.

1. Outer 1, Reach 2: Looking upstream at 21-inch CMP outfall.

2. Outer 1, Reach 2: Looking downstream at vegetation.

3. Outer 1, Reach 2: Looking downstream at vegetation upstream of Outer 1 and Outer 2 junction.

4. Outer 2: Looking downstream at debris/sediment and overhanging vegetation upstream of Outer 1 and Outer 2 junction.

5. Outer 1, Reach 1: Looking downstream at vegetation downstream of Outer 1 and Outer 2 junction.

6. Outer 1, Reach 1: Looking downstream at entrance to quadruple 30-inch-diameter RCP culvert inlet.

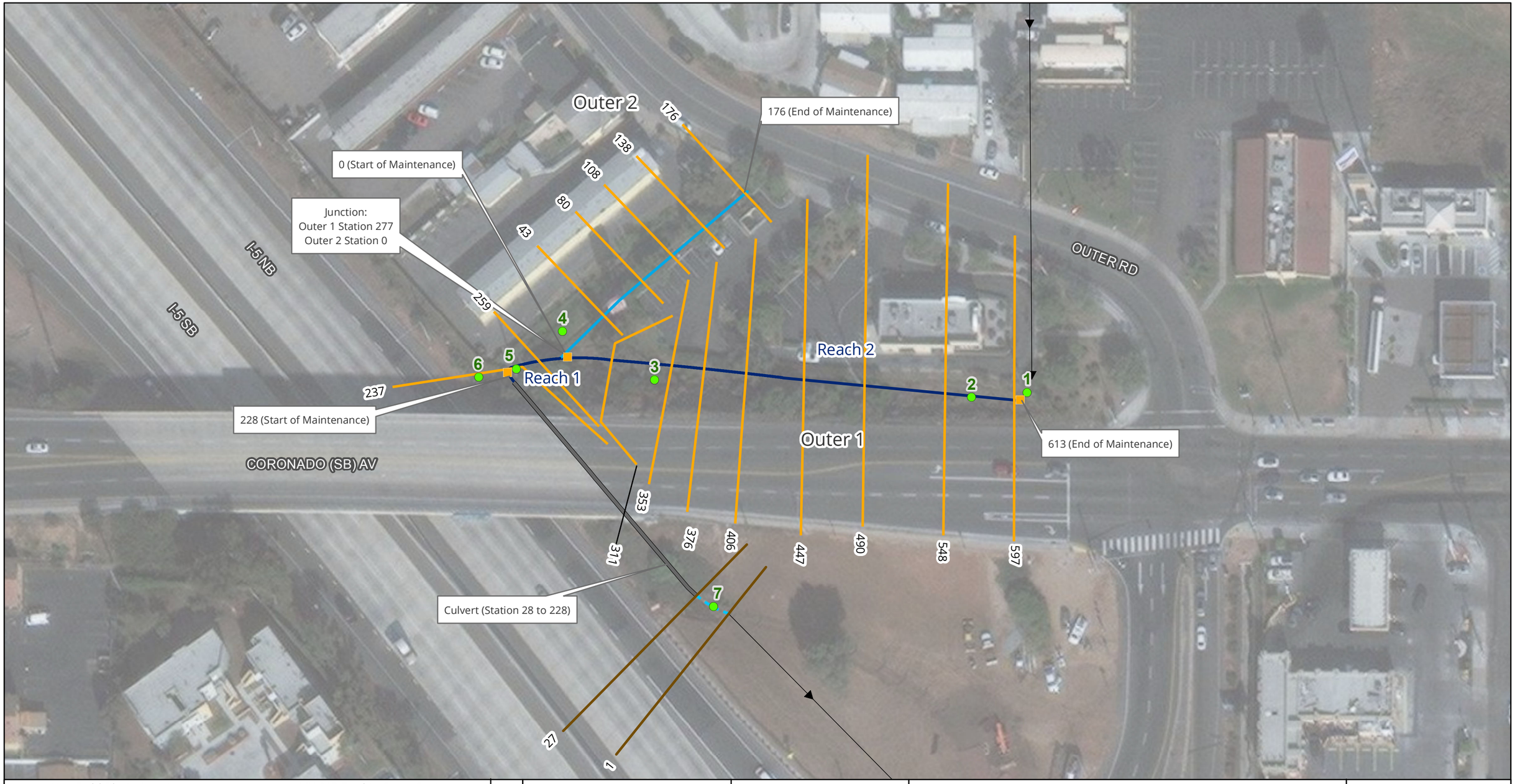
7. Downstream domain of analysis: Looking upstream at quadruple 30-inch-diameter culvert outlet.

Analysis Performed By: D-MAX Engineering Inc.

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.



Field Photo Location
End of Reach
Storm Drain Conveyance
Culvert
MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Center Line
Outer 1
Outer 2

N

Drainage Area: 129 acres

0 20 40 80 Feet

The City of SAN DIEGO

November 2019

Facility Group Name: Nestor Creek - Outer
Segment Name: Outer 1 - 2
Facility Nos: 5-22-110, 5-22-112
Hydraulic Map - Municipal Waterways Maintenance Plan

DUDEK
Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.

A.57 Tijuana River – Pilot & Smugglers (Pilot Channel; No. 6-01-020)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from Station 93 to Station 14956. The maintenance length of the segment is 5,550 feet.	
Benefit	• The level of service remains <2-year storm event, but the conveyance capacity increases from 10 cfs to 200 cfs.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2. Proposed maintenance area stations may differ from IHHA model reference stations

The reports listed in Table 1 were used to generate this fact sheet.

Table 1. Completed Report

Segment	Report	Reach
Pilot Channel 1	URS Corporation, 2012. IHHA Report for Tijuana River Pilot and Smuggler's Gulch Channels Map Numbers 138a-138c & 138-139.	Pilot Channel
Pilot Channel 1	Rick Engineering, 2015. City of San Diego Channel Maintenance 2015 – IHHA Report for Tijuana River Pilot Channel and Smuggler's Gulch	Pilot Channel

General Description

The Tijuana River – Pilot & Smugglers - Pilot Channel (Pilot Channel) facility group was classified as a Category 3 facility segment as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Pilot Channel facility is located in the Tijuana River Watershed Management Area and within the boundaries of the County of San Diego Tijuana River Valley Regional Park. The facility is also within the City of San Diego Multiple Species Conservation Program's Multi-Habitat Planning Area. The Tijuana River National Estuarine Research Reserve is generally west of the facility, located adjacent to the discharge of the Tijuana River to the Pacific Ocean.

The facility group is generally bounded by Hollister Street to the east, Monument Road to the south, and Saturn Boulevard to the north. The Tijuana River splits into what are commonly referred to as the Northern and Southern Channels approximately 800 feet east of the Hollister Street bridge. The facility group is located in the Southern Channel, and was originally constructed in 1993. The facility

group was constructed to divert wet-weather flows from 2- to 5-year storm events into the Southern Channel, and stretches from 100 feet east to 5,300 feet west of Hollister Street for a total length of 5,400 feet. Past studies for the Tijuana River Valley, as well as knowledge of past maintenance conditions, indicate that large amounts of sediment are deposited in this region. The facility group has been irregularly maintained since being constructed as an earthen trapezoidal channel that is approximately 5 feet deep with a 23-foot top width and a 15-foot streambed width. A separate facility, Smuggler's Gulch, is tributary to the Pilot Channel from the south and enters the Pilot Channel between Station 134.5 and Station 127.5.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Pilot Channel facility group.

Hydrology

The hydrologic peak flows presented in Table 2 were obtained from the referenced Individual Hydrologic and Hydraulic Assessment (IHHA) report. It is important to note that the storm flows listed in Table 2 may not flow entirely through Tijuana River facility and/or the Southern Channel, as the storm flows normally spread across the Tijuana River Valley, particularly during larger storm events. In the hydraulic model prepared, all of the storm flow was "forced" to flow through the Tijuana River facility only to evaluate the channel capacity as the only drainage facility under the various conditions to provide a baseline for comparison purposes. To gain a basic understanding of how the stormwater flows split between the Northern and Southern Channels, a Hydraulic Engineering Center–River Analysis System (HEC-RAS) flow distribution analysis was performed for the various storm events. Refer to the Hydraulics section for a discussion on the flow distribution analysis.

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Pilot Channel 1	705	3,248	7,612	15,819	37,163	66,894

Hydraulics

A one-dimensional steady flow model was developed for the Pilot Channel facility using U.S. Army Corps of Engineers (USACE) HEC-RAS software to determine the level of service in the baseline condition and the recommended maintained condition. The extent of the reach evaluated in this model is presented in the Hydraulic Reference Map located at the end of this fact sheet.

As referenced in the Hydrology section, the storm flows listed in Table 2 may not flow entirely through the facility and/or the Southern Channel, as the storm flows normally spread across the Tijuana River Valley, particularly during larger storm events. To gain a basic understanding of how the stormwater flows split between the Northern and Southern Channels, a HEC-RAS flow

distribution analysis was performed for the various storm events. Table 3 summarizes the flow distribution analysis for the 2-, 5-, and 10-year storm events.

Table 3. Flow Distribution Analysis

Segment	Peak Flow Rates by Storm Event Frequency (cfs)		
	2-year	5-year	10-year
Pilot Channel 1	278	669	1,364

The baseline condition for the channel was defined as the current condition, as observed during the site visit in September 2012. The sections of the channel that were determined to have a high vegetation density were assigned a Manning's coefficient value of 0.08, and sections of the channel that contained ponded water were assigned a Manning's coefficient value of 0.03. It was estimated that the channel contained up to 4.5 feet of sediment deposition from Station 93 to Station 108, while the rest of the channel was assumed to contain 3 feet of sediment deposition. The assigned Manning's coefficient value in the recommended maintained condition was 0.025 to reflect sediment/debris and vegetation removal throughout the channel. In June 2018, Dudek conducted a current conditions assessment (see Attachment A) for facilities with IHHAs prepared prior to 2015 to verify that baseline conditions associated with this facility were still applicable and the extent of recommended maintenance remains unchanged.

Model parameters for the baseline and maintained conditions for the Pilot Channel facility are summarized in Table 4.

Table 4. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Pilot Channel 1 (earthen)	14956–93	Baseline: 0.03, 0.08 Maintained: 0.025	Bridge (Station 148.56)

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used in determining the level of service. The overall conveyance capacities and level of service for each segment are summarized in Table 5 for both the baseline and recommended maintained condition.

Baseline Condition

The capacity of the facility is limited due to the high levels of sediment deposition present, which is characteristic of the Tijuana River Valley region. The channel can convey up to 10 cubic feet per second (cfs) (<2-year level of service) in the baseline condition.

Recommended Maintained Condition

Removing the deposited sediment/debris and vegetation from the channel per the estimated original design dimensions and for an approximate length of 5,550 feet increases the conveyance capacity from 10 cfs to 200 cfs, however it does not increase the level of service of the channel (<2-year storm).

Post-Maintenance Erosion Control Measures

The estimated velocities in the facility are below the recommended permissible velocities for earthen channels (5 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended.

Potential Facility Capital Improvements

To further understand the complexities of this channel, a detailed study with ground cross-sectional survey data and updated topography, the amount and types of sediment and debris that are deposited in this channel, and a detailed Northern and Southern Channel split flow analysis may result in recommendations for future capital improvement projects. Additionally, other efforts are being explored in this watershed to address a variety of water quality issues that may inform or impact studies to better understand this facility.

Table 5. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Pilot Channel 1	14956–93	10	200	<2-year	<2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and locations correspond to the photo points shown on the Hydraulic Reference Map. A selection of photos representative of the baseline condition are included in this fact sheet. A site visit was conducted by URS Corporation in September 2012.

6. Pilot Channel 1: Immediately downstream of the Hollister Street Bridge.

8. Pilot Channel 1: Looking north at the confluence point with the Smuggler's Gulch.

11. Pilot Channel 1: Looking south at the confluence point with the Smuggler's Gulch.

13. Pilot Channel 1: Looking east at the confluence point with the Smuggler's Gulch.

Analysis Performed By: URS Corporation

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following page for the Tijuana River facility group.

LEGEND

- 97.5 — Cross Section Number & Location
- Pilot Channel
- Southern Channel Limits*
- 3 — Photo Location & Orientation
- Direction of Channel Flow

*Approximate Southern Channel Limits as defined for purposes of this project only. The Southern Channel actual limits extend beyond those shown in this exhibit.

End of Maintenance

Pilot Channel

SOUTHERN

CHANNEL

Saturn Blvd

Saturn Blvd

77.5 85 90 93 97.5 103 119 120 122 127.5

MATCHLINE - SEE FIG. NO. 3

Facility Group Name: Tijuana River - Pilot & Smuggler's
Segment Name: Pilot Channel
Facility No: 6-01-020
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES: Aerial Imagery, Streets (Esri, 2010); Cross Sections, Pilot Channel, Southern Channel Limits (URS, 2012).

TIJUANA RIVER PILOT CHANNEL
HYDRAULIC WORKMAP
SAN DIEGO, CA

URS

200 0 200 400 Feet
SCALE: 1" = 400' (1:4,800)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: DA	DATE: 11/7/2012	FIG. NO: 2
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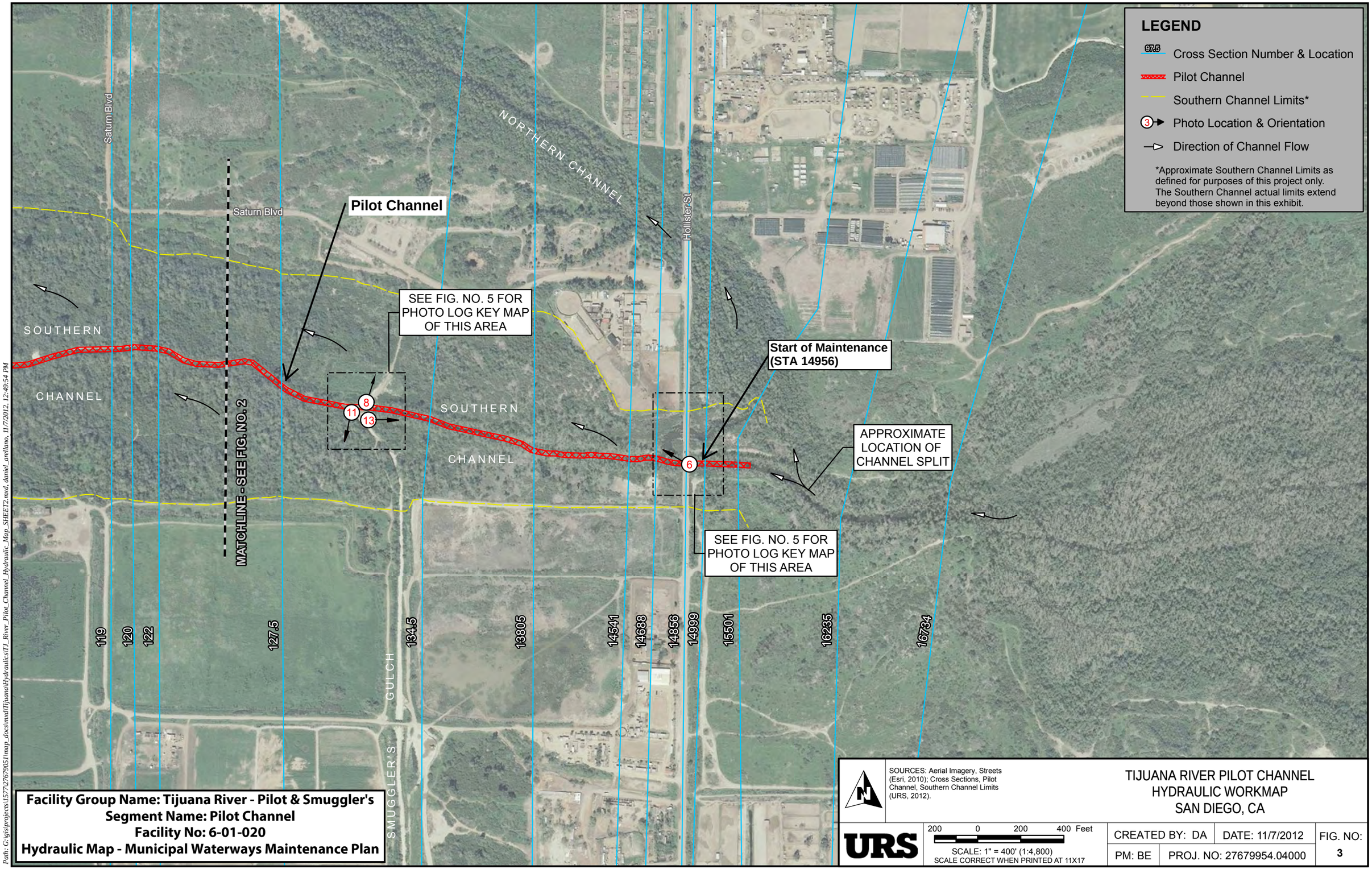

Facility Group Name: Tijuana River - Pilot & Smuggler's
Segment Name: Pilot Channel
Facility No: 6-01-020
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES: Aerial Imagery, Streets (Esri, 2010); Cross Sections, Pilot Channel, Southern Channel Limits (URS, 2012).

TIJUANA RIVER PILOT CHANNEL HYDRAULIC WORKMAP SAN DIEGO, CA

URS

200 0 200 400 Feet

SCALE: 1" = 400' (1:4,800)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: DA	DATE: 11/7/2012	FIG. NO:
PM: BE	PROJ. NO: 27679954.04000	3

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Facility Group Name: Tijuana River - Pilot & Smuggler's
Segment Name: Pilot Channel
Facility No: 6-01-020
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES: Aerial Imagery, Streets (Esri, 2010); Channels, Photo Locations (URS, 2012).

TIJUANA RIVER PILOT CHANNEL
PHOTO LOG KEY MAP
SAN DIEGO, CA

URS

25 0 25 50 Feet
SCALE: 1" = 50' (1:600)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: DA	DATE: 11/7/2012	FIG. NO: 5
PM: BE	PROJ. NO: 27679954.04000	

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A.58 Tijuana River – Pilot & Smugglers (Smuggler's Gulch; No. 6-01-100)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from channel bottom from Station 1000 to Station 2530 and Station 2549.85 to Station 4046. • Remove accumulated sediment/debris and vegetation from the culvert from Station 2530 to Station 2550. • Repair/replace concrete grout near the outlet of the 52-inch CMP culvert at Station 4046.	
Benefit	• Increases level of service from <2-year storm event (653 cfs) to >2-year storm event (900 cfs). • Repair/replace concrete grout near the outlet of CMP prevents potential undermining of culvert by flows.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2. Proposed maintenance area stations may differ from IHHA model reference stations

The report listed in Table 1 was used to generate this fact sheet.

Table 1. Completed Report

Segment	Report	Reach
Smuggler's Gulch 1	URS Corporation, 2012. IHHA Report for Tijuana River Pilot and Smuggler's Gulch Channels Map Numbers 138a-138c & 138-139.	SG Channel

General Description

The Tijuana River – Pilot & Smugglers - Smuggler's Gulch (Smuggler's Gulch) facility group was classified as a Category 3 segment as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Smuggler's Gulch facility group is located in the Tijuana River Watershed Management Area and within the boundaries of the County of San Diego Tijuana River Valley Regional Park. The facility group is also within the City of San Diego Multiple Species Conservation Program's Multi-Habitat Planning Area. The Tijuana River National Estuarine Research Reserve is generally west of the facility group, located adjacent to the discharge of the Tijuana River to the Pacific Ocean.

The facility is an existing historical agricultural channel with manufactured berms. The contributing sub-watershed area is approximately 6.7 square miles, primarily located south of the international border within Cañon del Matadero. The earthen channel, as originally constructed, is approximately 20 feet wide and 15 feet deep. The channel begins at the international border and flows in a northerly direction, crossing Monument Road and Disney Crossing before discharging to a separate facility, the Tijuana River, also referred to as the Pilot Channel. The Smuggler's Gulch facility group crosses Monument Road via a 110-foot-long, 52-inch-diameter corrugated metal pipe (CMP) culvert, and at Disney Crossing via a set of triple 72-inch-diameter CMP culverts. The portion of the channel maintained by the City of San Diego extends for a distance of approximately 3,040 feet.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Smuggler's Gulch facility group.

Hydrology

The hydrologic peak flows presented in the Table 2 below were obtained from the referenced Individual Hydrologic and Hydraulic Assessment (IHHA) report.

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Smuggler's Gulch 1	653	1,479	1,668	2,520	3,081	3,626

Hydraulics

A one-dimensional steady flow model was developed for the Smuggler's Gulch facility using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline condition and the recommended maintained condition. The extent of the reach evaluated in the model is presented in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition for the channel was defined as the current condition, as observed during the site visit conducted by URS Corporation in September 2012. The channel bottom was assigned a Manning's coefficient value of 0.03, as the streambed was fully covered in debris and sediment deposition. The channel side slopes were heavily vegetated and were assigned a Manning's coefficient value of 0.08. The sediment deposition was estimated to be 2 feet throughout the length of the channel, and 1 foot within the triple-barrel 72-inch-diameter CMP culverts at Disney Crossing. The middle pipe was also observed to be covered with trash, debris, and vegetation at its entrance and exit. In June 2018, Dudek conducted a current conditions assessment (see Attachment A) for facilities with IHHAs prepared prior to 2015 to verify that baseline conditions associated with this facility were still applicable and the extent of recommended maintenance remains unchanged.

The assigned Manning's coefficient value for the channel bed in the recommended maintained condition was 0.025 to reflect the sediment/debris removal. The set of triple 72-inch-diameter CMP culverts at Disney Crossing were assumed to be completely clear of vegetation, trash, and debris at the entrances and exits.

Model parameters for the baseline and maintained conditions for the Smuggler's Gulch facility are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Smuggler's Gulch 1 (earthen)	4028.11-0	Baseline: 0.03, 0.08 Maintained: 0.025	Culverts (Stations 4028.11 and 2549.85)

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used in determining the level of service. The overall conveyance capacity and level of service for the segment are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition

Smuggler's Gulch channel has a level of service equal to the 2-year storm and can convey up to 653 cubic feet per second (cfs) in the baseline condition. The capacity of the Smuggler's Gulch channel is limited by the elevation of Monument Road at Station 4099, and of the constructed berm on the east side of the channel at Station 2623, approximately 90 feet upstream of the Disney Crossing.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the channel bottom increases the level of service to a >2-year event, with the conveyance capacity increasing to 900 cfs. Repair/replacement of the concrete grout near the outlet of the 52-inch-diameter CMP culvert (Station 4046) is also recommended to prevent flows from undermining structure.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Smuggler's Gulch channel are below recommended permissible velocities for earthen channels (5 feet per second) as defined in the *City of San Diego Drainage Design Manual*, dated January 2017. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions, the level of service for the channel was restricted by the elevation of Monument Road at Station 4099, and the constructed berm on the east side of the channel at Station 2623, approximately 90 feet upstream of the Disney Crossing. Additional analysis is recommended to evaluate potential increases in the levels of service that could be achieved by capital improvements to address these restrictions. The capacity of the facility is known to be subject to the high levels of sediment deposition present, which is characteristic of the Tijuana River Valley region. Additionally, other efforts are being explored in this watershed to address a variety of water quality issues that may inform or impact studies to better understand this facility.

Table 4. Summary Table

Segment	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Smuggler's Gulch 1	4028.11-0	653	900	<2-year	>2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. A site visit was conducted by URS Corporation in September 2012.

16. Smuggler's Gulch 1: Looking downstream (north) at culvert outlet near Monument Road.

18. Smuggler's Gulch 1: Looking downstream (north) from Monument Road.

19. Smuggler's Gulch 1: Looking south (upstream) from atop the Disney Crossing.

21. Smuggler's Gulch 1: Looking north (downstream) from atop the Disney Crossing.

Analysis Performed By: URS Corporation

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following page for the Smuggler's Gulch facility group.

LEGEND

100 — Cross Section Number & Location

Pilot Channel

Southern Channel Limits*

*Approximate Southern Channel Limits as defined for purposes of this project only. The Southern Channel actual limits extend beyond those shown in this exhibit.

Hollister St

Monument Rd

Smuggler's Gulch

PILOT CHANNEL

1551.02

2408.40

2489.75

2549.85

2623.27

3774.45

3863.17

4011.72

4028.11

4179.24

4289.33

5269.88

21

19

18

16

End of Maintenance (STA 4046)

Start of Maintenance (STA 1000)

SEE FIG. NO. 6 FOR PHOTO LOG KEY MAP OF THIS AREA

Repair/replace concrete grout near outlet of culvert.

SEE FIG. NO. 6 FOR PHOTO LOG KEY MAP OF THIS AREA

Saturn Blvd

Facility Group Name: Tijuana River - Pilot & Smuggler's
Segment Name: Smuggler's Gulch
Facility No: 6-01-100
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES: Aerial Imagery, Streets (Esri, 2010); Cross Sections, Pilot Channel, Southern Channel Limits (URS, 2012).

SMUGGLER'S GULCH CHANNEL
HYDRAULIC WORKMAP
SAN DIEGO, CA

URS

200 0 200 400 Feet

SCALE: 1" = 400' (1:4,800)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: DA	DATE: 11/7/2012	FIG. NO:
PM: BE	PROJ. NO: 27679954.04000	4

Path: G:\gis\projects\1577\27679051\map_docs\mxd\Tijuana\Hydraulics\Smugglers_Gulch_Hydraulic_Map.mxd, daniel_arellano, 11/7/2012, 12:47:54 PM

Facility Group Name: Tijuana River - Pilot & Smuggler's
Segment Name: Smuggler's Gulch
Facility No: 6-01-100
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES: Aerial Imagery, Streets (Esri, 2010); Channels, Photo Locations (URS, 2012).

SMUGGLER'S GULCH CHANNEL
PHOTO LOG KEY MAP
SAN DIEGO, CA

URS

25 0 25 50 Feet
SCALE: 1" = 50' (1:600)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: DA	DATE: 11/7/2012	FIG. NO:
PM: BE	PROJ. NO: 27679954.04000	6

Path: C:\gis\projects\1577\27679051\map_docs\mxd\TijuanaHydraulics\Smugglers_Gulch_Photo_Log_Split.mxd, daniel_arellano, 11/7/2012, 1:50:26 PM

A.59 Tijuana River– Tocayo

Summary of Recommended Maintenance

Tocayo 1 (No. 6-02-115)

Facility Type	Bed: Earthen, Riprap Banks: Earthen, Riprap	Category 3
Is Maintenance Recommended?	Routine maintenance is not recommended at this time.[1]	
Extent of Maintenance	• Not Applicable	
Benefit	• Not Applicable	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Tocayo 2 (No. 6-02-118)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 1702 to Station 2725 and Station 2804 to Station 4279. • Remove accumulated sediment/debris in culverts from Station 1424 to Station 1702 and Station 2725 to Station 2804. • A maintenance area from Station 1414 to 1424 has been identified for maintenance of the culvert at Station 1424.	
Benefit	• Conveyance capacity improves from 180 cfs to 220 cfs; the level of service remains <2-year storm event	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Tijuana River– Tocayo (Tocayo) facility group was classified as having both Category 1 and Category 3 facility segments as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Tocayo facility group is located in the Tijuana River Watershed Management Area. The facility is bordered by Tocayo Avenue to the north and residential developments to the south.

The Tocayo facility group flows from east to west along the south side of Tocayo Avenue. Tocayo 2 begins west of Oro Vista Road, receiving flow from a trapezoidal concrete ditch upstream of the facility. Tocayo 2 flows from Station 4279 as a trapezoidal concrete ditch (6-foot-wide bottom) to Station 2804, where the facility passes through the double 9-foot by 4-foot reinforced concrete box (RCB) culvert at Hollister Street. Downstream of the Hollister Street culvert, beginning at Station 2725, Tocayo 2 widens to become a trapezoidal concrete channel with an 8-foot-wide bottom and flows to Station 1702 where flow enters a double 10-foot by 4-foot RCB culvert. Tocayo 1 begins at the outlet of the double 10-foot by 4-foot RCB culvert at Station 1424 and continues to Station 1328 as an earthen channel. From Station 1328, flows continue downstream via earthen channel into the Tijuana River floodplain. See the Hydraulic Reference Map located at the end of this fact sheet.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Tocayo facility group.

Hydrology

The hydrologic peak flow for the 100-year recurrence interval presented in Table 1 below was estimated based on the size of the watershed tributary to the channel, as described in *Section 3.1.1.3 of the Hydrology and Hydraulics Technical Report*. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.2.3 of the Hydrology and Hydraulics Technical Report.*

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Tocayo 1 & 2	684	875	1,023	1,227	1,375	1,523

Hydraulics

A one-dimensional steady flow model was developed for these facility segments using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and proposed maintained conditions. Refer to *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the detailed HEC-RAS model. The extent of the reaches evaluated in the model is presented in the Hydraulic Reference Map.

The upstream domain of analysis for the Tocayo facility group is an existing trapezoidal concrete ditch. The downstream domain of analysis consists of the earthen channel modeled from Station 1328 to Station 21. Based on the methodology presented in *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report*, the upstream domain of analysis has been excluded from the modeling.

The baseline condition for the Tocayo facility group was determined to be the current condition. Modeling parameters for the Tocayo facility group are based on observations from the April 2017 site visit conducted by D-MAX Engineering. Tocayo 2 was modeled with Manning's coefficients ranging from 0.015 to 0.025 to represent both clean concrete lining and areas where vegetation is growing in the concrete facility. Low grasses were observed growing intermittently throughout Tocayo 2 from Station 4279 to Station 2701, with a small stand of willows growing downstream of the Hollister Street culvert. Shortly after Station 2701, the concrete channel supports very little vegetation and is modeled as clean concrete. Tocayo 1 was modeled with a Manning's coefficient ranging from 0.025 to 0.035 representative of the earthen channel with limited vegetation in the bottom. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2017 site visit.

In the recommended maintained condition, the vegetation in Tocayo 2 is removed from Station 4279 to 2701 and the Manning's coefficients were set to 0.015 for the entire segment to match the roughness of the originally constructed concrete facility. Manning's coefficients in Tocayo 1 are unchanged because no maintenance is recommended in this segment since there was limited vegetation growth and sediment accumulation observed within the segment.

Model parameters and velocities for the baseline and maintained conditions for the Tocayo facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity for each analyzed segment.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Tocayo 2 (concrete)	4279-1424	Baseline: 0.015–0.025	Baseline: 1.1–7.0	Culvert (Station 2804-2725) Culvert (Station 1702-1424)	Normal Depth at Station 4279
		Maintained: 0.015	Maintained: 1.4–10		
Tocayo 1 (earthen)	1424-1328	Baseline: 0.025–0.035	Baseline: 1.5	-	-
		Maintained: 0.025–0.035	Maintained: 1.5		
	1328-21	0.025–0.07	Baseline: 1.4–2.9		

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Downstream Domain of Analysis			Maintained: 1.4-2.9	Culvert (Station 1164-1144, Station 1010-990)	Known Water Surface Elevation at Station 21

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flow rates, summarized in Table 1 in the Hydrology section, were used to determine the level of service. The velocities, summarized Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall facility conveyance capacities and level of service for each segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained condition.

Baseline Condition

In the baseline condition Tocayo 2 conveys 180 cubic feet per second (cfs) (<2-year level of service) before flows impact Tocayo Avenue and Hollister Street. Tocayo 1 conveys 220 cfs (<2-year level of service) before the private driveway north of the facility is impacted.

Recommended Maintained Condition

Removal of the vegetation in Tocayo 2 does not change the level of service, which remains at less than the 2-year event, but the capacity increases to 220 cfs. No maintenance is proposed in Tocayo 1 as there will be no change in level of service or capacity.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Tocayo 2 segment are below the recommended permissible velocities for the channel linings (35 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. The estimated velocities in the Tocayo 1 segment are below the recommended permissible velocities for the earthen channel linings (<5 fps) as defined in the above reference for both the baseline and recommended maintained condition. No measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended within the Tocayo facility group.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that the overall facility level of service was restricted by the double 9-foot by 3-foot culvert (Hollister Street) and the double 10-foot by 4-foot RCB culvert (Rodear Road) capacities. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Tocayo 2 (concrete)	4279-1424	180	220	<2-year	<2-year
Tocayo 1 (earthen)	1424-1328	220	-	<2-year	-

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. The photos were taken during a site visit conducted in April 2017.

1. Tocayo 2: Looking downstream at inlet to Oro Vista Road culvert.

2. Tocayo 2: Looking downstream at inlet to Hollister Street bridge.

3. Tocayo 2: Looking upstream at vegetation on downstream side of Hollister Street Bridge.

4. Tocayo 2: Looking upstream at vegetation.

5. Tocayo 2: Looking downstream at inlet to double 10-foot by 4-foot RCB culvert.

6. Tocayo 1: Looking upstream vegetation and outlet of double 10-foot by 4-foot RCB culvert.

Analysis Performed By: D-MAX Engineering Inc.

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.

Field Photo Location
Storm Drain Conveyance
Culvert
MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Center Line
Tocayo 1
Tocayo 2

N

Drainage Area: 777 acres

0 125 250 500 Feet

The City of SAN DIEGO

Facility Group Name: Tijuana River - Tocayo
Segment Name: Tocayo 1 - 2
Facility Nos: 6-02-115, 6-02-118
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.

November 2019

A.60 Tijuana River – Smythe

Summary of Recommended Maintenance

Via de La Bandola 1 (No. 6-03-150)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment and vegetation from bottom and sides of concrete ditch from Station 1418 to Station 2134. • Remove accumulated sediment/debris in the culvert from Station 148 to Station 1418.	
Benefit	• The level of service remains <2-year storm event (295 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert. • The WSE at the upstream end of the channel (Station 2092) improves from <2-year WSE in the baseline condition to the 100-year WSE in the recommended maintained condition.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

Smythe 1 (No. 6-03-147)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment and vegetation from bottom and sides of segment from Station 4122 to Station 5477.	
Benefit	• Increase level of service from <2-year storm event (<550 cfs) to 25-year storm event (935 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the downstream culvert.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2. Proposed maintenance area stations may differ from IHHA model reference stations

Via Encantadoras 1 (No. 6-03-135)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Trim the vegetation from channel bottom from Station 310 to Station 430.4435. • Removed sediment/debris in culvert from Station 430.4435 to Station 558.	
Benefit	• Increase level of service from 50-year storm event (1,182 cfs) to 100-year storm event (1,314 cfs).	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2. Proposed maintenance area stations may differ from IHHA model reference stations

Via Encantadoras 2 (No. 6-03-138)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Routine maintenance is not recommended at this time. However, a maintenance area should be identified for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.[1, 2]	
Extent of Maintenance[3]	N/A	
Benefit	• Due to recommended maintenance downstream within Via Encantadoras 1, the level of service will increase from 50-year storm event (1,182 cfs) to 100-year storm event (1,314 cfs).	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2 Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

3. Proposed maintenance area stations may differ from IHHA model reference stations

Via Encantadoras 3 (No. 6-03-143)

Facility Type	Bed: Concrete, Earthen Banks: Concrete, Earthen	Category 1 & 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment and vegetation from Station 1876 to Station 2762.	
Benefit	• The level of service remains 2-year storm event (610 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the downstream culvert.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2. Proposed maintenance area stations may differ from IHHA model reference stations

The reports listed in Table 1 were used to generate this fact sheet.

Table 1. Completed Reports

Segment	Report	Reach
Via de La Bandola 1	N/A	-
Smythe 1	Rick Engineering Company, 2015. IHHA Report for Smythe Channel Map Numbers 129 & 130. Job Number 17204-C.	3
Via Encantadoras 3	Rick Engineering Company, 2015. IHHA Report for Smythe Channel Map Numbers 129 & 130. Job Number 17204-C.	2
Via Encantadoras 2	Rick Engineering Company, 2015. IHHA Report for Smythe Channel Map Numbers 129 & 130. Job Number 17204-C.	1
Via Encantadoras 1	Rick Engineering Company, 2015. IHHA Report for Smythe Channel Map Numbers 129 & 130. Job Number 17204-C.	1

General Description

The Tijuana River – Smythe (Smythe) facility group was classified as having both Category 1 and Category 3 segments as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Smythe facility group is located in the Tijuana Watershed Management Area and discharges into the Tijuana River at its downstream end. The Smythe facility group is separated into five segments, in order of upstream to downstream: Via de La Bandola, Smythe, Via Encantadoras 3, Via Encantadoras 2, and Via Encantadoras 1.

The Via de La Bandola segment is a concrete trapezoidal ditch as indicated on as-built drawing no. 17307-D and drawing no. 14427-D. The ditch bottom is 6 feet wide; the banks are 6 feet high with 1.5:1 (H:V) side slopes; and the segment has longitudinal slopes ranging from 0.012 to 0.0303 (feet/feet). The ditch is located at the upstream end of the facility group, which runs parallel to Via de

La Bandola and flows to the west before entering an 8-foot-wide by 4-foot-high reinforced concrete box (RCB) culvert that extends underneath residential properties. The segment is bound by State Route 905 to the north and residential development to the south.

The Smythe segment is an earthen segment that begins at the outlet of a triple barrel 8-foot-wide by 5-foot-high RCB culvert after it crosses beneath Smythe Avenue. The segment continues to the west before entering a concrete drop structure which discharges into an underground storm drain system. There are three concrete check dams located within the reach, which generally consist of 30 longitudinal feet of concrete along the channel bottom and banks. The segment is bound by State Route 905 to the north, Smythe Avenue to the east, Del Sur Boulevard to the west, and residential development to the south.

The Via Encantadoras 3 segment begins as an earthen segment at the outlet of a quadruple barrel 72-inch-diameter reinforced concrete pipe (RCP) culvert that crosses beneath the San Diego Metropolitan Transit Development Board railroad tracks south of Beyer Boulevard. The segment continues south for approximately 140 feet where it transitions to a concrete channel. The concrete channel continues to the south before entering a double barrel 72-inch-diameter RCP culvert beneath Vista Lane. The Via Encantadoras 2 segment is a concrete segment that begins at the outlet of the double barrel 72-inch-diameter RCP culvert that crosses beneath Vista Lane. The concrete channel continues to the south before entering a quadruple barrel 12-foot wide by 4-foot high RCB culvert beneath West San Ysidro Boulevard. The Via Encantadoras 1 segment is an earthen segment located at the downstream end of the facility group. The segment begins at the outlet of the quadruple barrel 12-foot wide by 4-foot high RCB culvert beneath West San Ysidro Boulevard and continues south for approximately 120 feet before entering a second quadruple barrel 12-foot-wide by 4-foot-high RCB culvert beneath Interstate 5.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Smythe facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval are provided for the Via Encantadoras 1, Via Encantadoras 2, Via Encantadoras 3, and Smythe segments from as-built drawing no. 19218-D, 11-086034, 16916-D 14427-D, and 14427-D, and are presented in Table 2. The hydrologic peak flow for the 100-year recurrence interval for the Via de La Bandola segment presented in Table 2 was assumed to be the same as for Smythe, the immediate downstream segment, which is provided from as-built drawing no. 14427-D. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation, as described for the Unit Area Method in *Section 3.1.1.4 of the Hydrology and Hydraulics Technical Report.*

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Via de La Bandola 1	550	715	880	935	990	1,100
Smythe 1	550	715	880	935	990	1,100
Via Encantadoras 3	610	793	976	1,037	1,098	1,220
Via Encantadoras 2	657	854	1,051	1,116	1,182	1,314
Via Encantadoras 1	657	854	1,051	1,116	1,182	1,314

Hydraulics

Via de La Bandola Segment

A one-dimensional steady flow model was developed for the Via de La Bandola segment using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline condition and the recommended maintained condition. The extent of the reach evaluated in the model is presented in Hydraulic Reference Map 1 located at the end of this fact sheet.

The baseline condition for the Via de La Bandola segment is determined to be the pre-maintenance condition as observed during a site visit conducted by the City of San Diego in December 2014. Emergency maintenance was performed on the facility in early December 2015. The bottom of the ditch was assigned a Manning's coefficient value of 0.075, which represents the density of the vegetation observed in 2014 within the concrete segment. The banks of the facility were assigned a Manning's coefficient value of 0.03 for both the baseline and recommended maintained conditions. The assigned Manning's coefficient value for Via de La Bandola in the recommended maintained condition was set at 0.015 to reflect the roughness of the originally constructed concrete facility.

Via Encantadoras and Smythe Segments

A one-dimensional steady flow model was developed under a separate effort for the Via Encantadoras 1, Via Encantadoras 2, Via Encantadoras 3, and Smythe segments using HEC-RAS software to determine the level of service in the baseline condition and the recommended maintained condition. The extents of the reaches evaluated in the model are presented in Hydraulic Reference Map 2 located at the end of this fact sheet.

The baseline condition for the Smythe segment was determined to be the ultimate vegetated condition. The bottom and banks of this segment were assigned Manning's coefficient values ranging from 0.015–0.15, which represent the varying density of the vegetation observed within the earthen segment and the concrete check dams. The baseline condition for the Via Encantadoras 3 segment was determined to be the current condition as observed during a site visit conducted by Rick Engineering in April 2015. The bottom and banks of the Via Encantadoras 3 segment were assigned Manning's coefficient values ranging from 0.015–0.10, which represent the varying density of the vegetation observed within the concrete segment. The baseline condition for the Via

Encantadoras 2 segment was determined to be the current condition as observed during the site visit in April 2015. The bottom and banks of the Via Encantadoras 2 segment were assigned Manning's coefficient values ranging from 0.015–0.06, which represent the varying density of the vegetation observed within the concrete segment. The baseline condition for the Via Encantadoras 1 segment was determined to be the ultimate vegetated condition as observed during the site visit in April 2015. The bottom and banks of the Via Encantadoras 1 segment were assigned a Manning's coefficient value of 0.15, which represents dense vegetation within the earthen segment.

The assigned Manning's coefficient values for the Smythe segment in the recommended maintained condition ranged from 0.015–0.03 to reflect the removal of vegetation in the earthen segment and concrete check dams. The assigned Manning's coefficient value for the Via Encantadoras 2 and 3 segments in the recommended maintained condition were set at 0.015 to reflect the roughness of the originally constructed concrete facility. The assigned Manning's coefficient values for the Via Encantadoras 1 segment in the recommended maintained condition ranged from 0.035–0.044 to reflect the removal of vegetation in the earthen segment.

Model parameters for the baseline and maintained conditions for the Smythe facility group is summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations[1,2]	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Via de La Bandola 1 (concrete)	2134-148	Baseline: 0.03-0.075 Maintained: 0.015-0.03	Culvert (Station 148 to 1418)	Normal Depth at Station 2092 and Station 147
Smythe 1 (earthen)	4142.029–5466.368	Baseline: 0.015-0.15 Maintained: 0.015-0.03	Culvert (Station 5466.368)	Known Water Surface Elevation
Via Encantadoras 3 (concrete)	1879.68–2758.327	Baseline: 0.015-0.10 Maintained: 0.015	Culvert (Station 2758.327)	Computed Water Surface Elevations
Via Encantadoras 2 (concrete)	562.4349–1509.864	Baseline: 0.015-0.06 Maintained: 0.015	Culvert (Station 1509.864)	-
Via Encantadoras 1 (earthen)	314.2184– 430.4435	Baseline: 0.15 Maintained: 0.035-0.044	Culvert (Station 430.4435)	Known Water Surface Elevation

[1] The stationing for the Via de La Bandola segment does not align with the stationing of the other facility segments due to Via de La Bandola being modeled separately from the others.

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the ditch where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used in determining the level of service. The overall conveyance capacity and level of service for the segment are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition

The baseline condition is based on the existing condition of the facility group. The Via de La Bandola segment can convey 295 cubic feet per second (cfs) (<2-year level of service) before overtopping the bank adjacent to the residential properties. The Smythe segment can convey up to 550 cfs

corresponding to a <2-year level of service storm before overtopping the banks. The Via Encantadoras 3 segment can convey up to 610 cfs (2-year level of service) due to the culvert capacity at the downstream end. The combined capacity of Via Encantadoras 1 and 2 (combined as Reach 1 in the Individual Hydrologic and Hydraulic Assessment (IHHA) Report) segments convey up to 1,182 cfs (50-year level of service) before overtopping the banks downstream of the culvert between Station 562.4349 and Station 430.4435.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the in Via de La Bandola segment does not improve the conveyance capacity or level of service from the baseline condition (295 cfs, <2-year level of service, respectively) before overtopping the banks. However, the recommended maintained condition reduces the risk of vegetation flowing downstream and clogging the downstream culvert. In addition, the recommended maintenance would decrease the water surface elevation (WSE) at the upstream end of the segment. In the baseline condition, the WSE at Station 2092 corresponds to <2-year level of service before impacting the adjacent residential properties. Following the recommended maintenance, the WSE decrease at the upstream end corresponds to the 100-year level of service before impacting the adjacent residential properties.

Removing the sediment and vegetation from the Smythe segment increases conveyance capacity to 935 cfs (25-year level of service).

Removing the sediment and vegetation in the Via Encantadoras 3 segment, a concrete channel, preserves the conveyance capacity at 610 cfs (2-year level of service). The maintenance is recommended in concrete lined segments to preserve the performance of the culvert by preventing future obstruction of the culvert opening.

Although there is no maintenance recommended for the Via Encantadoras 2 segment, the recommended maintenance for the downstream segment, Via Encantadoras 1, will increase the conveyance capacity increasing to 1,314 cfs (100-year level of service). No maintenance was recommended for Via Encantadores 2 because the segment was documented to have little to no sediment/debris or vegetation within the channel. A maintenance area should be identified for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Trimming the vegetation along the earthen channel bottom of the Via Encantadoras 1 segment increases the conveyance capacity increasing to 1,314 cfs (100-year level of service).

Post-Maintenance Erosion Control Measures

The estimated velocities in all segments of the Smythe facility group are below recommended permissible velocities for their respective channel lining. Concrete-lined channels are below 35 feet per second (fps) and earthen channels are below 5 fps as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for either facility.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the level of service for the Smythe facility group was restricted by either the low bank elevations, downstream culverts, or both. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Table 4. Summary Table

Segment Name/Number	Reference Stations[1]	Conveyance Capacity (cfs)		Level of Service[2]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Via de La Bandola 1 (concrete)	2134–147	295	295	<2-year	<2-year
Smythe 1 (earthen)	4142.029–5466.368	<550	935	<2-year	25-year
Via Encantadoras 3 (concrete)	1879.68–2758.327	610	610	2-year	2-year
Via Encantadoras 2 (concrete)	562.4349–1509.864	1,182	1,314	50-year	100-year
Via Encantadoras 1 (earthen)	314.2184–430.4435	1,182	1,314	50-year	100-year

[1] The stationing for the Via de La Bandola segment does not align with the stationing of the other facility segments due to Via de La Bandola being modeled separately from the others.

[2] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map indicated. A selection of photos representative of the baseline condition from the previous IHHA document are included in this fact sheet with original photo numbers. Site visits were conducted by Rick Engineering in April 2015 (Smythe and Via Encantadoras) and by the City of San Diego in December 2014 (Via de La Bandola).

2. Via de La Bandola 1, Map 1: Looking downstream at dense vegetation throughout channel.

3. Via de La Bandola 1, Map 1: Looking upstream at dense vegetation and sediment/debris within channel.

4. Via de La Bandola 11, Map 1: 8-foot-wide by 4-foot-high RCB culvert at downstream end of channel (Station 1418); no observed sediment or vegetation in culvert.

IHHA 1. Smythe 1, Map 2 (Reach 3): Looking upstream toward outlet of triple barrel 8-foot wide by 5-foot high RCB culvert (Station 4127.051).

IHHA 4. Smythe 1, Map 2 (Reach 3): Upstream side of concrete check dam from northern bank.

IHHA 5. Smythe 1, Map 2 (Reach 3): Looking upstream near HEC-RAS cross-section 4313.02.

IHHA 6. Smythe 1, Map 2 (Reach 3): Downstream side of drop inlet structure.

IHHA 8. Via Encantadoras 3, Map 2 (Reach 2): Looking upstream from double 72-inch-diameter RCP culvert.

IHHA 9. Via Encantadoras 3, Map 2 (Reach 2): Entrance to double-barrel 72-inch-diameter RCP culvert under Vista Lane.

IHHA 11. Via Encantadoras 2, Map 2 (Reach 1): Looking downstream at entrance to quadruple 12-foot-wide by 4-foot-high RCB culvert beneath West San Ysidro Boulevard.

IHHA 14. Via Encantadoras 1, Map 2 (Reach 1): Looking downstream at entrance to quadruple 12-foot-wide by 4-foot-high RCB culvert beneath Interstate 5.

Analysis Performed By: Rick Engineering Company, Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Maps

Two maps illustrating the facility locations, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following pages for both the Via de La Bandola facility (Map 1), and the Smythe, Via Encantadoras 3, Via Encantadoras 2, and Via Encantadoras 1 segments (Map 2).

Field Photo Location
Storm Drain Conveyance
Culvert
Domain of Analysis Cross Section
MWMP Facility Cross Section
Domain of Analysis Center Line
MWMP Facility Center Line

N

Drainage Area: 1,152 acres

0 50 100 200 Feet

The City of SAN DIEGO

Facility Group Name: Tijuana River - Smythe
Segment Name: Via de la Bandola 1
Facility No: 6-03-150
Hydraulic Map - Municipal Waterways Maintenance Plan

DUDEK
Geosyntec consultants

November 2019

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.

Legend

- Stream Centerline
- Reach 1 (Via Encantadoras 1 & 2)
- Reach 2 (Via Encantadoras 3)
- Reach 3 (Smythe)
- Cross-Section 1897.67
- Picture Location & Orientation 6

Start of Maintenance (STA 310)

End of Maintenance (STA 558)

Via Encantadoras 1

Via Encantadoras 2

I-5 NB ON RA

I-5 SB

I-5 NB

I-5 NB OFF RA

W SAN YSIDRO BL

SUNSET LN

VIA ENCANTADORAS

CTE AMALIA

VISTA (SB) LN

314.2184

353.6883

407.7437

430.4435

562.4349

656.84

830.8849

858.514

962.3684

1024.48

1097.669

1117.022

1382.978

1432.23

1491.424

1509.864

KEYMAP

Reach 1

Reach 2

Reach 3

W:\17204-C_Smythe_Nestor_TJ_Smugglers_Channel_Maintenance\WaterResources\Smythe\GIS\17204_C_Smythe_HydraulicWorkmap.mxd

RICK ENGINEERING COMPANY

Scale in Feet: 0 100 200 — North

Original Exhibit:
Smythe Avenue Channel
MMP Map Numbers 129 & 130 Hydraulic Workmap (Reach 1 of 3)

J-17204 C
Date of Exhibit: 06.02.2015
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Tijuana River - Smythe
Segment Names: Via Encantadoras 1 - 2
Facility No: 6-03-135, 6-03-138
Hydraulic Map - Municipal Waterways Maintenance Plan

Legend

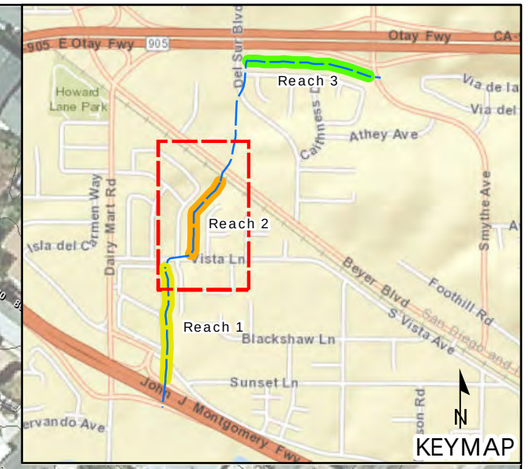
- Stream Centerline
- Reach 1 (Via Encantadoras 1 & 2)
- Reach 2 (Via Encantadoras 3)
- Reach 3 (Smythe)
- Cross-Section (1897.67)
- Picture Location & Orientation (6 →)

Via Encantadoras 3

VIA ENCANTADORAS
VISTA (SB) LN
TEQUILA WY
VIA DEL TANIDO
CTE LORO
CTE AMALIA
VIA LAS TONADAS
BEYER BL

Start of Maintenance (STA 1876)
End of Maintenance (STA 2762)

1879.68
1899.68
1911
1933.64
2083.525
2276.256
2318.437
2358.4
2561
2617.372
2689.968
2742.429
2758.327



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RICK ENGINEERING COMPANY

Scale in Feet: 0 — 100 — 200

North

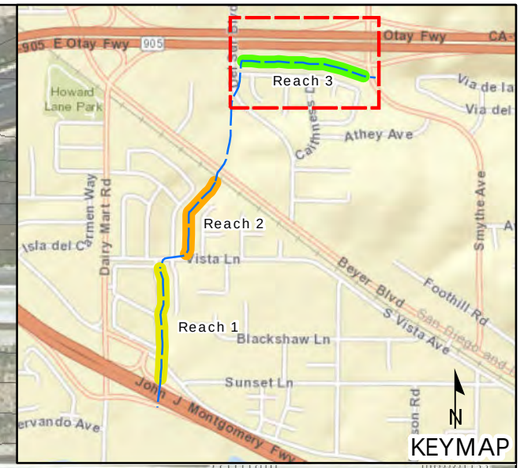
Original Exhibit:
Smythe Avenue Channel
MMP Map Numbers 129 & 130 Hydraulic Workmap (Reach 2 of 3)

J-17204 C
Date of Exhibit: 06.02.2015
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Tijuana River - Smythe
Segment Name: Via Encantadoras 3
Facility No: 6-03-143
Hydraulic Map - Municipal Waterways Maintenance Plan

Legend

- Stream Centerline
- Reach 1 (Via Encantadoras 1 & 2)
- Reach 2 (Via Encantadoras 3)
- Reach 3 (Smythe)
- Cross-Section — 1897.67
- Picture Location & Orientation — 6 →



SR-905 WB ON
SR-905 WB
SR-905 EB
SR-905 EB OFF RA
SR-905 EB ON RA
DEL SUR BL
Smythe
SHOOTING STAR DR
BIG DIPPER WY
SHOOTING STAR CT
CAITHNESS DR
LITTLE DIPPER WY
ANTARES DR
SMYTHE AV

Start of Maintenance (STA 4122)
End of Maintenance (STA 5477)

4142.029 4313.02 4494.06 4526.749 4656.773 4800.536 4830.437 4896.191 5009.426 5038.982 5155.179 5291.067 5407.649 5466.368

4508.534 4509.534 4510.534 4511.534

4812.951 4813.951 4814.951 4815.951

5022.29 5023.29 5024.29 5025.29

W:\17204-C_Smythe_Nestor_TJ_Smugglers_Channel_Maintenance\WaterResources\Smythe\GIS\17204_C_Smythe_HydraulicWorkmap.mxd

RICK ENGINEERING COMPANY

Scale in Feet: 0 100 200 — North

Original Exhibit:
Smythe Avenue Channel
MMP Map Numbers 129 & 130 Hydraulic Workmap (Reach 3 of 3)

J-17204 C
Date of Exhibit: 06.02.2015
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Tijuana River - Smythe
Segment Name: Smythe
Facility No: 6-03-147
Hydraulic Map - Municipal Waterways Maintenance Plan

A.61 Spring Canyon Creek – Cactus (Cactus 1; No. 6-04-251)

Summary of Recommended Maintenance

Facility Type	Detention Basin: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation throughout the basin to restore the as-built condition.	
Benefits	• Reduces flood risk associated with outlet structure clogging. • Restores capacity of the basin and potential water quality benefits.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Spring Canyon Creek – Cactus 1 (Cactus 1) facility group was classified as a Category 1 detention basin as described in *Chapter 4, Section 4.3, of the Hydrology and Hydraulics Technical Report*. The facility is a 0.16-acre detention basin located in the Tijuana Watershed Management Area and receives runoff from approximately 5.6 acres of upstream commercial park area. The facility is bordered on all sides by commercial and industrial development, and to the far east by the Spring Canyon Creek – Cactus 2 facility group. Pursuant to as-built drawings no. 23327-10-D and no. 23327-12-D, the concrete-lined basin has a trapezoidal geometry consisting of a bottom width of 2 feet, depth of 6.6 feet, and side slopes of 1.5:1 (H:V).

Cactus 1 receives flows from a 21-inch-diameter reinforced concrete pipe (RCP) storm drain that enters the north end of basin from the northwest. Flows exit the detention basin via an outflow structure that encloses a 27-inch-diameter RCP. The outflow structure is located at the southwest corner of the basin.

The operational volume of Cactus 1 is located between the elevations of 496.3 feet and 502.9 feet. At elevations above 502.9 feet, water begins to overflow onto adjacent properties. Water ponding higher than 496.3 feet enters the basin's outflow structure. The outflow structure consists of a low-flow orifice and an overflow weir that discharges to a 27-inch-diameter RCP. The low-flow orifice is an 8-inch-diameter RCP at an invert elevation of 496.7 feet. The overflow weir is 15 feet wide. The invert elevation of the weir is 500 feet.

The following sections describe the maintenance criteria used to develop conclusions and recommendations regarding maintenance specific to the Cactus 1 facility group.

Baseline Condition

The baseline condition for the Cactus 1 facility group was determined to be the current condition as observed by Geosyntec Consultants during a site visit in July 2017. Dense vegetation, tree growth, and accumulated sediment/debris were observed in the detention basin. The sediment depth was estimated to be approximately 2 feet deep across the basin. All inlets and outlets were fully covered by vegetation. Ponded water was not observed in the basin bottom. The photos in the Representative Photos section at the end of this fact sheet provide examples of the condition of the facility as observed during the July 2017 site visit.

Recommended Maintained Condition

The recommended maintained condition for the Cactus 1 facility group was determined to be the as-built condition as reflected in the as-built drawings no. 23327-10-D and no. 23327-12-D. If the deposited sediment/debris and vegetation within the basin bottom is removed, the total basin depth will be restored to 6.6 feet. Maintenance is recommend to reduce potential impacts to the adjacent commercial properties.

Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the change in basin volume analysis, and identifies whether maintenance is recommended for the facility group and the amount of maintenance recommended.

When applying the 10% maintenance threshold described in Section 4.2.3 of the *Hydrology and Hydraulics Technical Report*, maintenance is necessary. Sediment deposition is approximately 2 feet deep in the baseline condition, and when compared to the overflow weir height of 3.7 feet, approximately 50% of the basin volume is occupied by sediment, which meets the detention basin maintenance threshold. Therefore, removal of vegetation and deposited sediment/debris from the bottom of the basin is recommended to restore the capacity of the detention basin. The frequency will be established based on annual inspection of the basin and outlet works.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map indicated. A site visit was conducted by Geosyntec Consultants in July 2017.

1. Cactus 1: Tree growth in basin.

2. Cactus 1: Dense vegetation in basin.

3. Cactus 1: Sediment/debris deposition and vegetation growth in basin.

4. Cactus 1: Vegetation growth at outflow structure.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location is included on the following page.

PACIFIC RIM CT

Inlet Structure

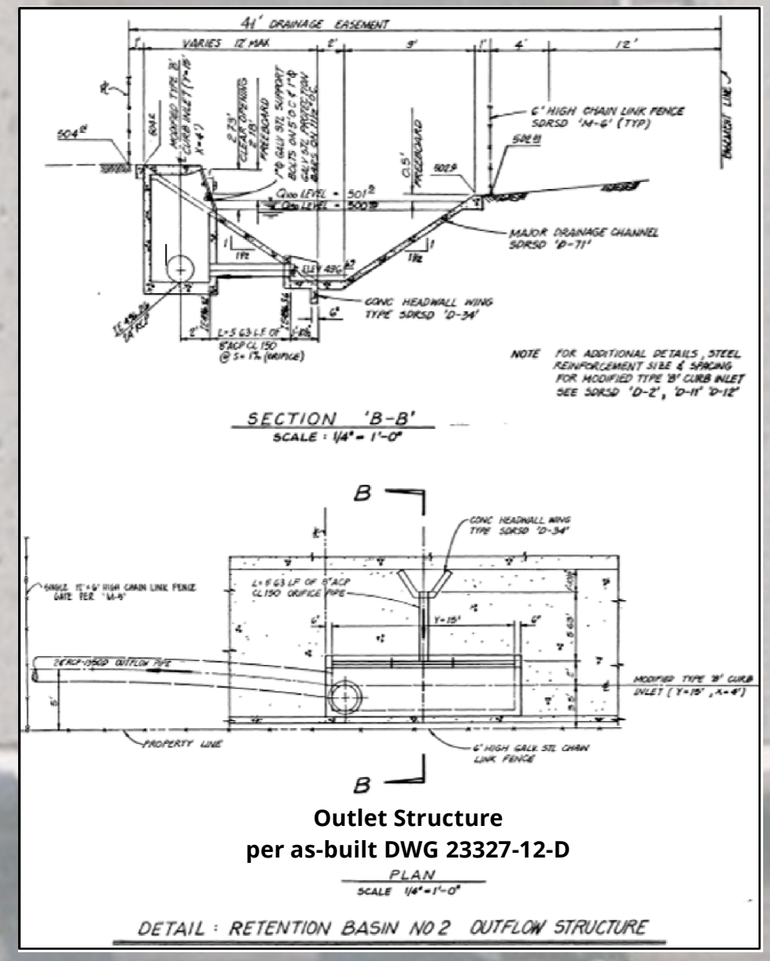
1/3

Cactus 1

4

2

Outlet Structure



Field Photo Location

Storm Drain Conveyance

Top Detention Basin Boundary

N

Drainage Area: 5.6 acres

Feet

0 10 20 40

The City of SAN DIEGO

November 2019

Facility Group Name: Spring Canyon Creek - Cactus
Segment Name: Cactus 1
Facility No: 6-04-251
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.

A.62 -Spring Canyon Creek – Cactus (Cactus 2; No. 6-04-253)

Summary of Recommended Maintenance

Facility Type	Detention Basin: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation throughout the basin to restore the as-built condition.	
Benefits	• Reduces flood risk associated with outlet structure clogging. • Restores capacity of the basin and potential water quality benefits.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Spring Canyon Creek – Cactus 2 (Cactus 2) facility group was classified as a Category 1 detention basin as described in *Chapter 4, Section 4.3, of the Hydrology and Hydraulics Technical Report*. The facility is a 0.65-acre detention basin located in the Tijuana Watershed Management Area and receives runoff from approximately 16 acres of upstream commercial park area. The facility is bordered to the north and south by commercial and industrial development, to the east by Cactus Road, and to the west by the Spring Canyon Creek – Cactus 1 facility group. Pursuant to as-built drawings no. 23327-8-D and no. 23327-12-D, the concrete-lined basin has a trapezoidal geometry consisting of a bottom width that varies from 6.95 feet to 9.75 feet, depth of 5.2 feet, and side slopes of 1.5:1 (H:V).

Cactus 2 receives flows from a 36-inch-diameter reinforced concrete pipe (RCP) storm drain that enters from the north. The inlet is located centrally within the basin. Flows exit the detention basin via an outflow structure that encloses a 36-inch-diameter RCP. The outflow structure is located directly west of the inlet.

The operational volume of Cactus 2 is located between the elevations of 496 feet and 501.2 feet. At elevations above 501.2 feet, water begins to overflow onto adjacent properties. Water ponding higher than 496 feet enters the basin's outflow structure. The outflow structure consists of a low-flow orifice and an overflow weir that discharges to a 36-inch-diameter RCP. The low-flow orifice is an 18-inch-diameter RCP at an invert elevation of 496 feet. The overflow weir is 12 feet wide. The invert elevation of the weir is 498.8 feet.

The following sections describe the maintenance criteria used to develop conclusions and recommendations regarding maintenance specific to the Cactus 2 facility group.

Baseline Condition

The baseline condition for the Cactus 2 facility group was determined to be the current condition as observed during a site visit in July 2017. Heavy vegetation and accumulated sediment/debris were observed in the detention basin. The sediment depth was estimated to be approximately 6 inches deep across the bottom of the basin. All inlets and outlets were fully covered by vegetation, and approximately 6 inches of standing water was observed west of the outflow structure. The photos in the Representative Photos section at the end of this fact sheet provide examples of the condition of the facility as observed during the July 2017 site visit.

Recommended Maintained Condition

The recommended maintained condition for the Cactus 2 facility group was determined to be the as-built condition as reflected in as-built drawings no. 23327-8-D and no. 23327-12-D. If the deposited sediment/debris and vegetation within the basin bottom is removed, the total basin depth will be restored to 5.2 feet. Maintenance is recommend to reduce potential impacts to the adjacent commercial properties.

Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the change in basin volume analysis, and identifies whether maintenance is recommended for the facility group and the amount of maintenance recommended.

When applying the 10% maintenance threshold described in Section 4.2.3 of the *Hydrology and Hydraulics Technical Report*, maintenance is necessary. Sediment deposition is approximately 0.5 feet deep in the baseline condition, and when compared to the overflow weir height of 2.8 feet, approximately 18% of the sediment storage is occupied by sediment, which meets the detention basin maintenance threshold. Therefore, removal of deposited vegetation and sediment/debris from the bottom of the basin is recommended to restore the capacity of the detention basin. The frequency will be established based on annual inspection of the basin and outlet works.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map indicated. A site visit was conducted by Geosyntec Consultants in July 2017.

1. Cactus 2: Sediment deposition and vegetation growth at inlet.

2. Cactus 2: Standing water and vegetation growth in the basin.

3. Cactus 2: Sediment deposition in basin.

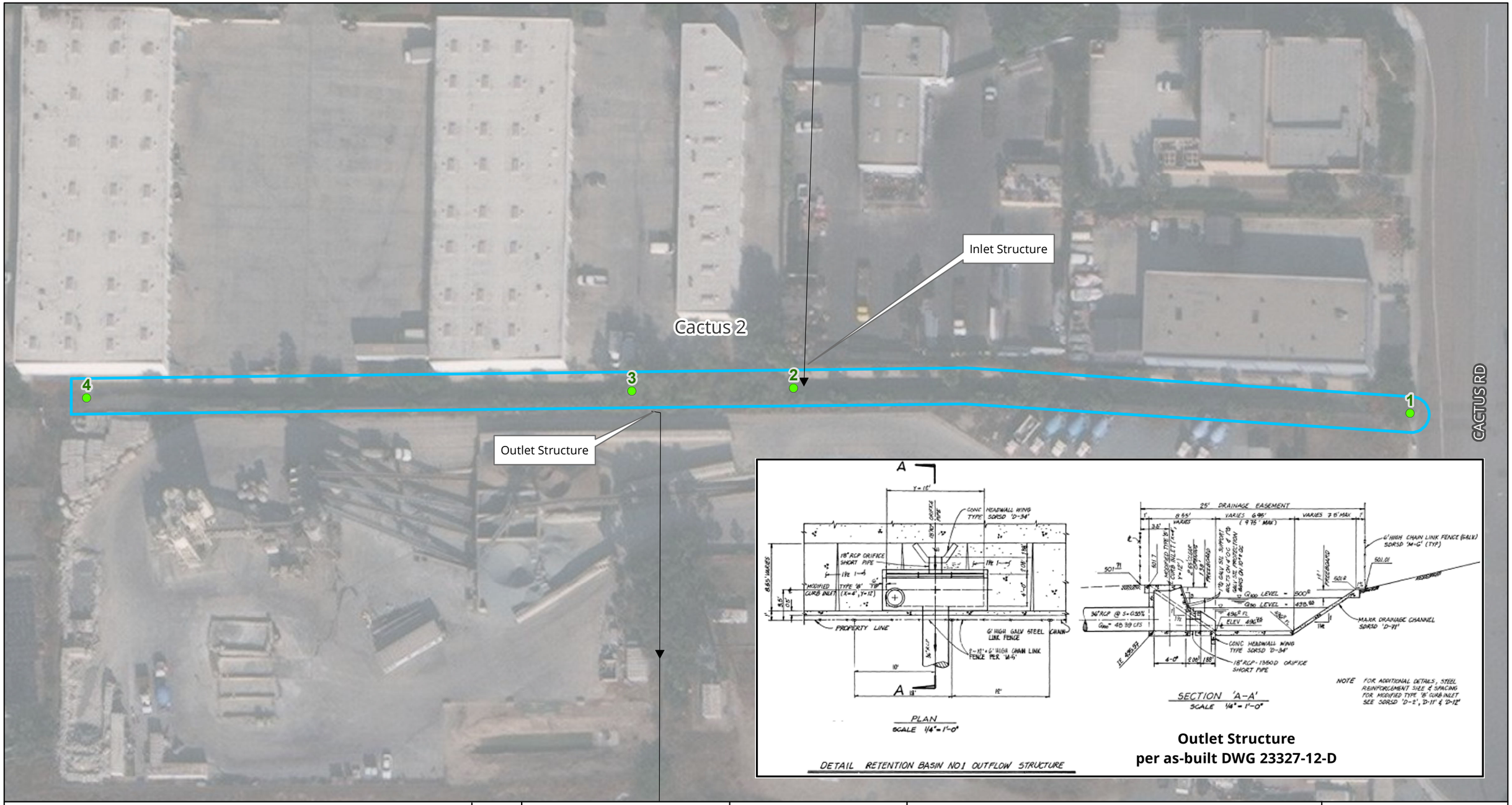
4. Cactus 2: Vegetation growth at outlet.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location is included on the following page.



Outlet Structure
per as-built DWG 23327-12-D

Field Photo Location
Storm Drain Conveyance
Top Detention Basin Boundary

N

Drainage Area: 15.6 acres

Feet
0 15 30 60

The City of SAN DIEGO

Facility Group Name: Spring Canyon Creek - Cactus
Segment Name: Cactus 2
Facility No: 6-04-253
Hydraulic Map - Waterways Maintenance Plan

DMAX
DUDEK
Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.

November 2019

A.63 Tijuana River – Siempre Viva (No. 6-05-110)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from ditch bottom and banks from Station 174.488 to Station 735.8522 in Reach 1. • Remove accumulated sediment/debris and vegetation from ditch bottom and banks from Station 735.8522 to Station 1459.6140 in Reach 2. • Remove accumulated sediment/debris and vegetation from ditch bottom and banks from Station 770.7793 to Station 1311.2390 in Reach 3. • Remove accumulated sediment/debris and vegetation from detention basin in Reach 3 (Siempre Viva Channel Detention Basin) from Station 0 to Station 770.7793. • Remove accumulated sediment/debris and vegetation from detention basin in Reach 1 (Bristow Channel Detention Basin) from Station 0 to Station 174.488. The existing wet well (Station 0 to Station 45) is recommended to be maintained by private property owners.	
Benefit	• Increases the static storage capacity of the detention basin at the downstream end from 57,000 ft^3 to 100,000 ft^3; decreases the overall limits of flooding in Reach 1. • Level of service remains the same (<2-year), while the water surface elevation decreases approximately 0.5 feet for the 100-year storm event, decreasing the overall limits of flooding in Reach 2. • Increases the static storage capacity of the detention basin at the downstream end from 37,000 ft^3 to 59,000 ft^3; decreases the overall limits of flooding in Reach 3.	

1 Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

2. Proposed maintenance area stations may differ from IHHA model reference stations. Length of segment varies from stationing length.

The report listed in Table 1 was used to generate this fact sheet.

Table 1. Completed Report

Segment	Report	Reach
Siempre Viva	Rick Engineering Company, 2017. IHHA Report for Siempre Viva and Bristow Channels Map Numbers 126 & 127.	1 & 2 (Bristow Channel), 3 (Siempre Viva Channel)

General Description

The Tijuana River – Siempre Viva (Siempre Viva) facility group was classified as a Category 3 facility segment, as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Siempre Viva facility group is located in the Tijuana Watershed Management Area. The facility group is divided into two segments that serve the Britannia Commerce Center, formerly referred to as the Bristow Channel (Reaches 1 and 2) and the Siempre Viva Channel (Reach 3). The facility group is bound by Via de la Juventud Oriente (Tijuana, Mexico) to the south, Siempre Viva Road to the north, Britannia Boulevard to the west, and the Otay Pacific Business Park to the east.

The Bristow (Reaches 1 and 2) and Siempre Viva (Reach 3) ditches terminate at detention basins at the downstream end of each ditch. The detention facilities are connected by an 18-inch-diameter reinforced concrete pipe (RCP), allowing water surface elevations to equalize within both detention basins. Outflow from the shared detention facility is via a pump in the private wet well and via weir flow over the eastern banks of the facility. Based on the as-built condition, the eastern banks of the facility are designed lower (2–3 feet) than the western banks of the facility, allowing overflow to drain easterly away from Britannia Commerce Center.

Reach 2 is a trapezoidal earthen ditch bound at the downstream end by the upstream end of Reach 1 and extends upstream approximately 724 feet to the outfall of the 6-foot-wide by 3-foot-high reinforced concrete box (RCB) underneath Britannia Boulevard as indicated on as-built drawing no. 22611-22-D. The reach has a base width of 4 feet and 2:1 (H:V) side slopes with a depth of 6 feet. The reach ends at two pairs of culverts located underneath the driveways at the eastern terminus of Bristow Court that are approximately 130 feet in length. As-built drawings were not available for this pair of culverts. However, during the site visit conducted by Rick Engineering in December 2016, the culvert was observed to consist of two elliptical high-density polyethylene (HDPE) pipes. The northern pipe is approximately 7.5 feet wide by 5.5 feet tall. The southern pipe is approximately 6.5 feet wide by 5.5 feet tall. The upstream pair of culverts, located underneath a driveway in the middle of Reach 2 (Stations 1112.5730 to 1170.5770), also consists of two HDPE pipes and is approximately 50 feet in length. Both pipes were observed to be elliptical with a width of approximately 6.5 feet and a height of approximately 5.5 feet.

Reach 1 is a trapezoidal earthen ditch bound at the downstream end by the shared detention facility and extends upstream approximately 735 feet to the outfall of the pair of culverts underneath the

driveways at the eastern end of Bristow Court (downstream end of Reach 2), as indicated on as-built drawing no. 22611-12-D. The majority of Reach 1 (Stations 174.4880 to 735.8522) has a base width of 4 feet and 2:1 (H:V) side slopes with a depth of 6 feet. Pursuant to as-built drawing no. 22611-15-D, the downstream portion of the reach (Stations 0 to 174.4880) has a base width of 8 feet and 2:1 (H:V) side slopes. Spot elevation on this as-built plan show that the eastern side slopes are approximately 5 to 5.5 feet deep.

Reach 3 is a trapezoidal earthen ditch bound at the downstream end by the shared detention facility and extends approximately 1311 feet upstream to the outfall of the 18-inch-diameter RCP located at the eastern end of Britannia Court, as indicated as-built drawing no. 22611-12-D. The reach has a 4-foot base width and has 2:1 (H:V) side slopes. The upstream portion of Reach 3 (Station 770.7793 to 1311.2390) is 6 feet deep. Pursuant to spot elevation shown on as-built drawing no. 22611-15-D, the eastern side slope is approximately 5 to 5.5 feet deep at the downstream portion of the reach (Station 0 to 770.7793).

The following sections describe the hydrologic analysis, hydraulic assessment and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Siempre Viva facility.

Hydrology

The Bristow Channel (Reaches 1 and 2) and Siempre Viva Channel (Reach 3) together comprise the Siempre Viva facility group, which include two separate drainage basins that discharge to a single shared detention facility. In support of the two hydraulic analyses performed, the peak flow rates and total runoff volumes were calculated for each basin. The peak flow rates were determined using available as-built drawings and 6-hour precipitation data from the *San Diego County Hydrology Manual, dated 2003*. The 100-year peak flow rates are shown on as-built drawing no. 22611-33-D. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation, as described for the Unit Area Method in *Section 3.1.1.4, Hydrology and Hydraulic Technical Report*.

Table 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Siempre Viva: Bristow Channel (Reach 2)	69	92	107.4	130.4	153.4	176.4
Siempre Viva: Bristow Channel (Reach 1)	69	92	107.4	130.4	153.4	176.4
Siempre Viva: Siempre Viva Channel (Reach 3)	41	54.6	63.7	77.4	91	104.7

Hydraulics

The upper portions of Reaches 1, 2, and 3 function as free-flowing open channels where the water surface elevation is controlled by open channel hydraulics. The lower portions of these reaches function as detention basins where the water surface elevation is controlled by stage-storage relations. Therefore, two separate hydraulic analyses were performed as part of this assessment. The first analysis determined the capacity of the upper portions of the ditches to convey peak flows, assuming a constant discharge. The second analysis determined the capacity of the detention basins at the downstream end of the ditches to store the total runoff volume.

A one-dimensional steady flow model was developed for the Siempre Viva facility group using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline condition and the recommended maintained condition. The extent of the reach evaluated in the model is presented in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition is defined as the existing condition of the facility group as observed during site visit conducted by Rick Engineering in December 2016. For portions of Reach 2 where weeds and light brush were observed, a Manning's coefficient value of 0.04 was assigned and a Manning's coefficient value of 0.035 was assigned where the ditch was unvegetated or lined with short grasses. For portions of Reach 1 where weeds and light brush were observed, a Manning's coefficient value of 0.04 was assigned and 0.06 was assigned where the ditch had dense brush along the banks. Dense trees with submerged branches at the far upstream end of the reach and dense stands of willows and palm trees throughout the middle and downstream portion of the reach were modeled using a Manning's coefficient value of 0.15. The sediment depth in the Reach 1 detention basin was estimated to be 1 foot.

A Manning's coefficient value of 0.035 was used to represent portions of the left bank of Reach 3 that are unvegetated or lined with short grasses; 0.09 was used for dense reeds along the ditch bottom and the lower portion of the right bank; 0.15 was used for portions of the ditch with dense

willows; and finally, 0.04 was used for areas of light brush along the upper right bank and in the detention basin at the downstream end of Reach 3. The sediment depth in the Reach 3 detention basin was estimated to be 1.5 feet.

In the recommended maintained condition, a Manning's coefficient value of 0.03 was used to reflect earthen ditch bottoms and side slopes with no vegetation for all three reaches. Per as-built drawing no. 22611.33-D, the Reach 1 detention basin will require maintenance after each rain event or when the sediment depth at the riser reaches 1 foot (Elevation 460). The Reach 3 detention basin will require maintenance after each rain event or when the sediment depth at the riser reaches 1.4 feet (Elevation 460).

Model parameters for the baseline and maintained conditions for the Siempre Viva facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Siempre Viva (earthen)	Reach 2: 1459.614- 735.8522	Baseline: 0.035 -0.04	Culvert (Station 1170.577,Station 877.6657)
		Maintained: 0.03	
	Reach 1: 735.8522- 0	Baseline: 0.04- 0.15	Channel (Station 735.8522 to 174.488) Detention Basin (Station 174.488 to 0)
		Maintained: 0.03	
	Reach 3: 1311.2390- 0	Baseline: 0.035- 0.15	Channel (Station 1311.2390 to 770.7793) Detention Basin (Station 770.7793 to 0)
		Maintained: 0.03	

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility group, the portion of the ditch where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The flow rates, summarized in Table 2 in the Hydrology section, were used in determining the level of service. The overall conveyance capacity and level of service for the segment are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition

In the baseline condition, Reach 2 can convey 137.2 cubic feet per second (cfs) (25-year level of service); Reach 1 can convey 5 cfs (<2-year level of service); and Reach 3 can convey 10 cfs (<2-year level of service). The Bristow (Reaches 1 and 2) and Siempre Viva (Reach 3) ditches terminate at detention basins at the downstream end of each ditch. The volumetric capacity of the detention ponds in the baseline condition is 57,000 cubic feet (ft^3) (<2-year level of service) and 38,000 ft^3 (<2-year level of service), respectively.

Recommended Maintained Condition

Removing deposited vegetation and deposited sediment/debris from the ditches (Reaches 1, 2 and 3) and the detention basins for an approximate length of 2,940 feet does not improve the conveyance capacities or levels of service; however, it will decrease the water surface elevation by approximately 0.5 feet for the 100-year storm event, thus decreasing the overall limits of flooding. In addition, the recommended maintenance improves the volumetric capacity of the detentions basins at the end of each ditch. The Bristow (Reach 1) and Siempre Viva (Reach 3) detention basin volumes in the recommended maintained condition are 100,000 ft^3 (<2-year level of service) and 59,000 ft^3 (<2-year level of service), respectively.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Siempre Viva facility group are below recommended permissible velocities for earthen channels (5 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017.* Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for either facility.

Potential Facility Capital Improvements

The eastern bank of the detention ponds is approximately 2 to 4 feet higher than the as-built condition. Water surface elevations are controlled by the tailwater condition formed by the eastern banks of the detention basins; lowering the eastern banks of the detention basins lowers water surface elevations by approximately 1 to 1.5 feet. This significantly increases the capacity of all reaches and avoids flooding developed properties to the west of the basins. Therefore, additional analysis is recommended to evaluate potential increases in the levels of service that could be achieved by capital improvements to address these restrictions.

Table 4. Summary Table

Segment Name	Reference Stations	Channel Conveyance Capacity (cfs)		Detention Pond Capacity (ft^3)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained	Baseline	Recommended Maintained
Siempre Viva	Reach 2 1459.6140-735.8522	137.2	137.2	-	-	25-year	25-year
	Reach 1: 735.8522 – 0	5	5	57,000	100,000	< 2-year	< 2-year
	Reach 3: 1311.2390 – 0	10	10	37,000	59,000	< 2-year	< 2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, "> 5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. A selection of photos representative of the baseline condition are included in this fact sheet. A site visit was conducted by Rick Engineering in December 2016.

IHHA 2. Siempre Viva 1, Reach 1 (Bristow Channel): 24-inch-diameter CMP riser at the downstream end of Reach 1 (Bristow Channel) looking north (upstream) towards downstream end of dense vegetation.

IHHA 3. Siempre Viva 1, Reach 1 (Bristow Channel): looking east towards upstream end of dense vegetation.

IHHA 5. Siempre Viva 1, Reach 2 (Bristow Channel): Looking west towards the inlet of the downstream pair of culverts.

IHHA 8. Siempre Viva 1, Reach 2 (Bristow Channel): Looking west towards the outlet of the upstream pair of culverts.

IHHA 15. Siempre Viva 1, Reach 3 (Siempre Viva Channel): Looking east along a typical section of vegetated channel.

IHHA 18. Siempre Viva 1, Reach 3 (Siempre Viva Channel): Middle portion of Reach 3 looking north towards the lightly vegetated section in the middle of the reach.

IHHA 21. Siempre Viva 1, Reach 3 (Siempre Viva Channel): Downstream portion of Reach 3 looking south towards the shared detention facility.

IHHA 22. Detention Basins: 18-inch-diameter RCP connecting the two detentions basins in the shared detention facility.

Analysis Performed By: Rick Engineering

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page for the Siempre Viva facility group.

Britannia Boulevard

Bristow Court

Bristow Court

Britannia Boulevard

Britannia Court

End of Maintenance*

Siempre Viva

Note: Side channel was included in the 2011 MMP Maps but has been replaced by a 24-inch Reinforced Concrete Pipe (RCP) per As-Built Sheet 31066-7-D

Limits of Bristow Channel Detention Basin

Limits of Siempre Viva Channel Detention Basin

Siempre Viva

Start of Maintenance* (STA 0)

Siempre Viva

End of Maintenance*

Otay Pacific Drive

1459.614
1370.583
1270.58
1170.577
1112.573
1012.57
871.6693
735.8522
639.5066
539.4938
427.2193
301.9247
174.488
72.6711
4.8674
54.279
222.0471
322.0501
422.0532
522.0566
622.0599
727.9443
710.7793
1311.239
1211.239
1111.238
1011.238
901.7494
802.5478

5
8
3
2
22
21
18
15

Legend

Photo Locations

*Difference between stationing does not match channel maintenance length

MMP Mapped Channel Area

Reach 1, Bristow Channel (Siempre Viva)

Reach 2, Bristow Channel (Siempre Viva)

Reach 3, Siempre Viva Channel (Siempre Viva)

W:\17204-L_TO#39_IHHA_FY17\S_Siempre Viva & Bristow Map 126, 127\GIS\17204-L_Siempre_PhotoLocation_v10.1.mxd

RICK ENGINEERING COMPANY

Scale in Feet

0 150 300

North

Original Exhibit:
Siempre Viva and Bristow Channels
MMP Map Numbers 126 & 127 Hydraulic Workmap (Report J-17204-L)

Date of Exhibit: 2/27/2017
SANGIS/USGS Aerial Imagery: 11/2014

Facility Group Name: Tijuana River - Siempre Viva
Segment Name: Siempre Viva
Facility No: 6-05-110
Hydraulic Map - Municipal Waterways Maintenance Plan

A.64 Tijuana River– La Media (No. 6-06-011)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from north side of culvert at Airway Road and extending 4.5 feet upstream. • Remove accumulated sediment/debris in culvert from Station 4030 to Station 4080.	
Benefit	• The level of service remains <2-year storm event and conveyance capacity remains unchanged (19 cfs), but reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert. • Clears Airway Road culvert of sediment/debris. • The water surface elevation (WSE) at the culvert improves slightly in the recommended maintained condition.	

[1] Recommendations may be modified when factoring in other environmental constraints, such as biological and cultural resources, which may exclude or limit the maintenance recommended from this report.

General Description

The Tijuana River– La Media (La Media) facility group was classified as a Category 3 facility as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The La Media facility group is located in the Tijuana River Watershed Management Area. The facility is bordered by La Media Road to the east, Airway Road to the south, and a conservation area to the west and north.

The facility group is a trapezoidal earthen ditch beginning along the west side of La Media Road approximately 270 feet north of the intersection of La Media Road and Airway Road and flows to the south toward Airway Road. The La Media facility receives flow from an earthen ditch north of the facility and from a culvert across La Media Road consisting of three 24-inch-diameter reinforced concrete pipes (RCP). The ditch turns west at Airway Road to join a larger conveyance running through the conservation area. Immediately downstream of this confluence, the flows enter a culvert crossing Airway Road consisting of nine 12-inch-diameter RCPs. The Airway Road culvert is part of the Arizona Crossing and is designed to convey the low flows while larger storm event flows go over the roadway. At the downstream end of the Airway Road culvert/Arizona Crossing, the flows discharge into a privately maintained channel as it continues toward the Tijuana River. See the Hydraulic Reference Map located at the end of this fact sheet.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the La Media facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval for the La Media facility presented in Table 1 below was estimated based on the size of the watershed tributary to the channel, as described in *Section 3.1.2.3 of the Hydrology and Hydraulics Technical Report.* The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation described in *Section 3.1.2.3 of the Hydrology and Hydraulics Technical Report.*

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
La Media 1	1,351	1,952	2,252	2,702	3,153	3,453

Hydraulics

A one-dimensional steady flow model was developed for these facility segments using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center–River Analysis System (HEC-RAS) software to determine the level of service in the baseline and proposed maintained conditions. Refer to *Section 3.2.2.3 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the detailed HEC-RAS model. The extent of the reaches evaluated in the model is presented in the Hydraulic Reference Map.

The upstream domain of analysis for La Media is the facility modeled from Station 4229 to Station 4303. Since proposed maintenance is limited to the 4.5 feet directly in front of (north of) the Airway Road, the rest of the modeled facility upstream of Airway Road serves as the upstream domain of analysis. The downstream domain of analysis consists of the earthen channel modeled from Station 4010 to Station 9.

The baseline condition for the La Media facility group was determined to be the current condition as observed during a site visit in April 2017 conducted by DMax Engineering. Based on the observations made during the site visit, sediment/debris depositions of approximately 1.5 feet was modeled on either side of the Airway Road culvert. The banks and bottom of the La Media facility were assigned a Manning's coefficient value of 0.08, which represents the density of the vegetation observed within the facility. Photos in the Representative Photos section below provide examples of the current facility condition.

In the recommended maintained condition, the sediment/debris was removed from the upstream side of the Airway Road culvert (the downstream side of the culvert is on privately maintained

property) for a length of 4.5 feet, and the Manning's coefficient values were reduced to 0.03 in this part of the facility to represent the reduced vegetation density associated with removing sediment/debris and vegetation. A conservation easement restricts maintenance within a majority of the segment so only the most downstream 4.5 feet can be maintained.

Model parameters and velocities for the baseline and maintained conditions for the La Media facility group are summarized in Table 2. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity for each analyzed segment.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
La Media 1 (earthen)	4303-4030	Baseline: 0.08	Baseline: 0.3–1.0	Culvert (Station 4080-4030)	Normal Depth at Station 4300
		Maintained: 0.03	Maintained: 0.4–1.0		
Downstream Domain of Analysis	4030-9	0.035-0.06	Baseline: 0.5–3.8 Maintained: 0.5–3.8	Culvert (Station 1021-983)	Normal Depth at Station 9

Conclusions and Recommended Maintenance

This section presents the conclusions and recommendations based on the results of the hydraulic modeling. It identifies whether maintenance is recommended for the facility, the portion of the channel where maintenance is proposed, and if post-maintenance erosion control measures should be implemented. This section also identifies locations where further studies are recommended for potential capital improvements.

The facility flow rates, summarized in Table 1 in the Hydrology section, were used to determine the level of service. The velocities, summarized Table 2 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall channel conveyance capacities and level of service for each segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained condition.

Baseline Condition

For the purposes of this analysis, the level of service focused on the function of the low flow culvert under Airway Road. The culvert is only capable of conveying 19 cubic feet per second (cfs) (< 2-year level of service) in the current condition before Airway Road is flooded.

Recommended Maintained Condition

Because of the segment's proximity to the mitigation area, maintenance was limited to maintaining the area upstream of the culvert inlet. Removal of sediment/debris and vegetation in the 4.5 feet upstream of the culvert inlet does not improve the level of service or the overall capacity of the ditch. In the maintained condition, the facility remains at a level of service of less than the 2-year storm, only conveying 19 cfs. The maintenance does provide a small increase in the freeboard (0.1 feet) in the facility at the 19 cfs flow rate.

The hydraulic analysis showed that the privately maintained portion of channel immediately downstream of Airway Road contributes to the limited capacity in the facility. The April 2017 site visit revealed that a significant accumulation of sediment on the downstream side of the Airway Road culvert is impeding flow through the facility (see Photo 4 in the Representative Photos section below). An additional scenario was analyzed in which this sediment blockage was removed, and the channel from Station 4030 to Station 3758 was restored to a trapezoidal earthen channel. This scenario showed that performing maintenance in this portion of privately owned channel could increase the flow capacity of the La Media facility group culvert to 36 cfs (still less than the 2-year storm).

Post-Maintenance Erosion Control Measures

The estimated velocities in the La Media facility group are within the recommended permissible velocities for vegetation-lined channels (less than 5 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017,* for both baseline and recommended maintained conditions and are not expected to cause erosion. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for the facility.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that, even with full maintenance conducted downstream of the facility, the overall facility level of service is limited by the capacity of the culvert (nine 12-inch-diameter RCPs) in Airway Road. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
La Media 1	4303-4030	19	19	<2-year	<2-year

[1] A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Site visit conducted in April 2017.

1. La Media 1: Looking downstream at vegetation in the ditch from La Media Road.

2. La Media 1: Looking downstream over headwall and three 24-inch-diameter RCP culvert outlet.

3. La Media 1: Looking upstream at conservation area from Airway Road.

4. Downstream Domain of Analysis: Looking east at sediment and vegetation.

5. Downstream Domain of Analysis: Looking downstream at naturally occurring bypass of sediment obstruction.

Analysis Performed By: D-MAX Engineering Inc.

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Map

A map illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations is included on the following page.

Field Photo Location
Storm Drain Conveyance
Culvert
MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Center Line
MWMP Facility Center Line

Drainage Area: 1,669 acres

Feet
0 100 200 400

The City of SAN DIEGO

November 2019

Facility Group Name: Tijuana River - La Media
Segment Name: La Media 1
Facility No: 6-06-011
Hydraulic Map - Municipal Waterways Maintenance Plan

DMAX DUDEK Geosyntec consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USGS, AeroGRID, IGN, the GIS User Community, SanGIS, and the City of San Diego.
Notes: River Stationing begins at the downstream culvert and is in feet.