APPENDIX I

Hydrology and Hydraulics Technical Report

A.1 Green Valley Creek – Pomerado

Summary of Maintenance Proposed

Pomerado 1 (No. 1-04-030)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 198 to Station 888 and Station 987 to Station 2082. • Remove accumulated sediment/debris in the culvert from Station 888 to Station 987.	
Benefit	• Increases level of service from <10-year storm event (867 cfs) to <25-year storm event (1,375 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the 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.

Pomerado 2 (1-04-033)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 2510 to Station 3510 and Station 3581 to Station 5037. • Remove accumulated sediment/debris in the culvert from Station 2082 to Station 2510 and Station 3510 to Station 3581.	
Benefit	• Increases level of service from >5-year storm event (770 cfs) to >10-year storm event (1,164 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 Green Valley Creek – Pomerado (Pomerado) 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 Pomerado facility group is in the San Dieguito Watershed Management Area. The Pomerado 2 segment (upstream segment) is bordered by Rios Road to the north, by Pomerado Road to the west, and by residential development to the south and the east. The segment turns to the north at Pomerado Road and continues until reaching Rancho Bernardo Road. The Pomerado 1 segment (downstream segment) is bordered by Rancho Bernardo Road and residential development to the south and residential development to the north. The Pomerado 2 segment is a concrete channel with a trapezoidal cross-section as indicated on as-built drawing no. 13623-8-D and drawing no. 10784-D. A portion of the channel has a bottom width of 7.5 to 16.67 feet, a minimum bank height of 6.5 to 14 feet with 1.5:1 (H:V) side slopes, and the longitudinal slope ranges from 0.016 (feet/feet). The Pomerado 1 facility segment is a concrete channel with a trapezoidal cross-section, as indicated on as-built drawing numbers 10556-7-D, 10556-9-D, and 10556-11-D. The channel bottom ranges from 10 to 20.67 feet wide; the banks range from 7.62 to 11 feet high with 1.5:1 (H:V) side slopes, and the longitudinal slope ranges from 0.005-0.03 (feet/feet). A portion of the channel within the Pomerado 1 segment includes longitudinal concrete baffles (max height 6 feet) running parallel to the channel centerline. The baffles are shown in as-built drawing number 10566-D and are located downstream of the culvert outlet at Station 2082 and at the outlet of the concrete ditch near Station 1269

A natural channel, alongside the Poway Horse Trail, discharges into the upstream end of the Pomerado 2 segment (upstream segment), which conveys flows west to the intersection of Rios Road and Pomerado Road before turning northwest. The segment enters an 8-foot-wide by 8-foot-high reinforced concrete box (RCB) culvert beneath Rios Road and continues northwest along the eastern side of Pomerado Road before entering a corrugated metal arch pipe (CMP) culvert (15.84 feet wide by 10.67 feet high) beneath the intersection of Pomerado and Rancho Bernardo Roads at the downstream end of the segment. The Pomerado 1 segment (downstream segment) begins at the downstream end of the CMP culvert, after which it continues west along the northern side of Rancho Bernardo Road before turning northwest and entering a double barrel 10-foot-wide by 8-foot-high RCB culvert beneath Bernardo Oaks Drive. The segment continues downstream of the culvert for approximately 690 feet, after which it continues as a concrete channel that flows through the Rancho Bernardo Inn Golf Course. 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 Pomerado 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 for San Diego County. The Flood Insurance Study provided the 10-, 50-, and 100-year flow rate information for Green Valley Creek. 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
Pomerado 2	520	756	950	1,458	2,050	2,700
Pomerado 1	520	756	950	1,458	2,050	2,700

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 reaches evaluated in the model are 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. In the baseline condition, the bottom of the facility group was assigned Manning's coefficient values ranging from 0.02–0.06. These assignments were based on the site visit conducted by Geosyntec Consultants in May 2017 where light to heavy vegetation and up to 4 feet of sediment deposition was observed. For the recommended maintained condition, the bottom of the facility group was assigned a Manning's coefficient value of 0.015 to reflect the roughness of the originally constructed concrete facility. The banks of the facility group above the concrete lining were assigned Manning's coefficient values ranging from 0.03–0.06 for both the baseline and recommended maintained conditions depending on the type and density of the vegetation along the reach.

Model parameters and velocities for the baseline and maintained conditions for the Pomerado 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
Pomerado 2 (concrete)	5055–2082	Baseline: 0.02–0.06	Baseline: 2.55-10.57	Culverts (Station 3581 to 3510, Station 2510 to 2082)	—
		Maintained: 0.015	Maintained: 5.71-12.99		
Pomerado 1 (concrete)	2082–198	Baseline: 0.02-0.06	Baseline: 3.37-11.42	Culvert (Station 987 to 888)	Normal Depth at Station 198
		Maintained: 0.015	Maintained: 6.61-12.87		

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 Pomerado 2 segment can convey up to 770 cubic feet per second (cfs) (>5-year level of service) in the baseline condition. The capacity of the Pomerado 2 segment is limited by the culvert beneath Rios Road (Station 3510 to 3581). The Pomerado 1 segment can convey up to 867 cubic feet per second (cfs)(<10 level of service) in the baseline condition. The capacity of the Pomerado 1 segment is limited by the culvert beneath Bernardo Oaks Drive (Station 888 to 987).

Recommended Maintained Condition

Removing accumulated sediment/debris and vegetation from the bottom of the Pomerado 2 segment increases the conveyance capacity to 1,164 cfs (>10-year level of service). The capacity of this segment is limited by the culvert beneath Pomerado and Rancho Bernardo Roads (Station 2082 to 2510) in the recommended maintained condition. Removing deposited sediment/debris and vegetation from the bottom of the Pomerado 1 segment increases the conveyance capacity to 1,375 cfs (<25-year level of service). The capacity of this segment continues to be limited by the culvert beneath Bernardo Oaks Drive (Station 888 to 987) 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 (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 the baseline condition the overall facility level of service was restricted by the culvert beneath Rios Road (Station 3510 to 3581). In the recommended maintained condition, the overall facility level of service was restricted by the culvert beneath Pomerado and Rancho Bernardo Roads (Station 2082 to 2510) and the culvert beneath Bernardo Oaks Drive (Station 888 to 987). 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
Pomerado 2	5055–2082	770	1,164	>5-year	>10-year
Pomerado 1	2082–198	867	1,375	<10-year	<25-year

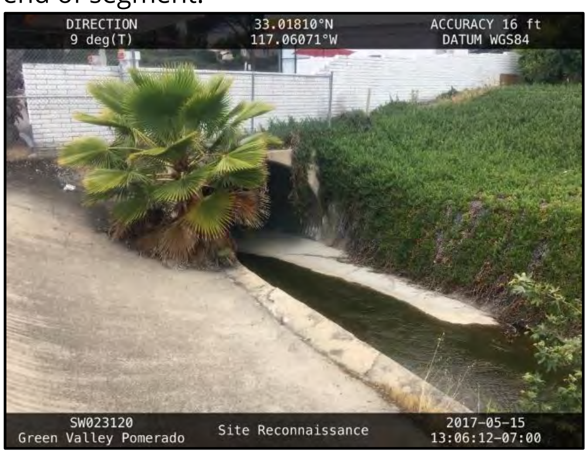
1 A greater than (>) symbol indicates the level of service is between the listed event frequency and the next higher magnitude event evaluated. For example, ">5-year" means greater than a 5-year event level of service but less than a 10-year event level of service.

Representative Photos

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

1. Pomerado 2: Looking upstream at upstream end of segment.

2. Pomerado 2: Looking downstream at double box culvert.



3. Pomerado 2: Looking downstream at CMP culvert at downstream end of segment.

4. Pomerado 1: Looking downstream at double box culvert.

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	MWMP Facility Cross Section
Storm Drain Conveyance	Pomerado 1
Culvert	Pomerado 2

N

Drainage Area: 2,048 acres

Feet
0 100 200 400

The City of SAN DIEGO

Facility Group Name: Green Valley Creek - Pomerado
Segment Name: Pomerado 1 - 2
Facility Nos: 1-04-030, 1-04-033
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

A.2 Green Valley Creek – Paseo del Verano (No. 1-04-200)

Summary of Recommended Maintenance

Facility Type	Desilting Basin: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from basin bottom to restore the as-built condition. • Trim vegetation on side slopes of the basin. • Repair gabion rock-filled barrier walls to as-built condition.	
Benefit	• 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 Green Valley Creek – Paseo del Verano (Paseo del Verano) facility group was classified as a Category 1 desilting basin as described in *Chapter 4, Section 4.3 of the Hydrology and Hydraulics Technical Report*. The facility is a 0.44-acre desilting basin located in the San Dieguito Watershed Management Area and receives runoff from approximately 187 acres of residential land use through two culverts, concrete ditch and sheet flow along the basin slopes. The facility is bordered to the north by Paseo del Verano, and to the south, east, and west by residential development. The basin has a concrete-lined bottom, a crest height of approximately 11 feet (elevation 558 feet) from the basin invert (elevation 547 feet), and discharges to a 9-foot-tall outfall structure (as-built drawing no. 17603-8-D) enclosing two 48-inch-diameter reinforced concrete pipes. The outlet structure is surrounded by 3-foot-wide by 4-foot-tall gabion rock-filled barrier walls.

The following sections describe the hydrologic analysis, maintenance criteria, and level of service assessment used to develop conclusions and recommendations regarding maintenance specific to the Paseo del Verano facility group.

Baseline Condition

The baseline condition for the Paseo del Verano facility group was determined to be the current condition as observed during a site visit in July 2017. Heavy vegetation, tree growth, and accumulated sediment/debris were observed in the desilting basin. The sediment depth was estimated to be approximately 2 feet deep across the basin. Ponded water was not observed in the basin bottom. The photos in the Representative Photos section below 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 Paseo del Verano facility group was determined to be the as-built condition as reflected in as-built drawing no. 17603-8-D. The accumulated sediment/debris and vegetation within the basin bottom is removed, and the total basin depth is restored to 11 feet. Maintenance is recommend to reduce potential impacts to the adjacent roadway and residential properties.

Recommended Maintenance

This section presents the conclusions and recommendations based on the site visit and identifies whether maintenance is recommended for the facility group and the amount of maintenance recommended.

When applying the 50% maintenance threshold described in Section 4.2.2 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 height of 4 feet (gabion height in front of the outlet structure), approximately 50% of the sediment storage is occupied by sediment, which meets the permanent desilting basin maintenance threshold. Therefore, vegetation and sediment/debris removal from the bottom of the basin is recommended to restore the capacity of the desilting basin. The frequency will be established based on annual inspection of the basin and outlet.

Representative Photos

Photos are from the site visit conducted in July 2017.

1. Paseo del Verano 1: Sediment deposition in the basin.

2. Paseo del Verano 1: Vegetation growth in the basin.

3. Paseo del Verano 1: Gabion wall structure at outlet structure.

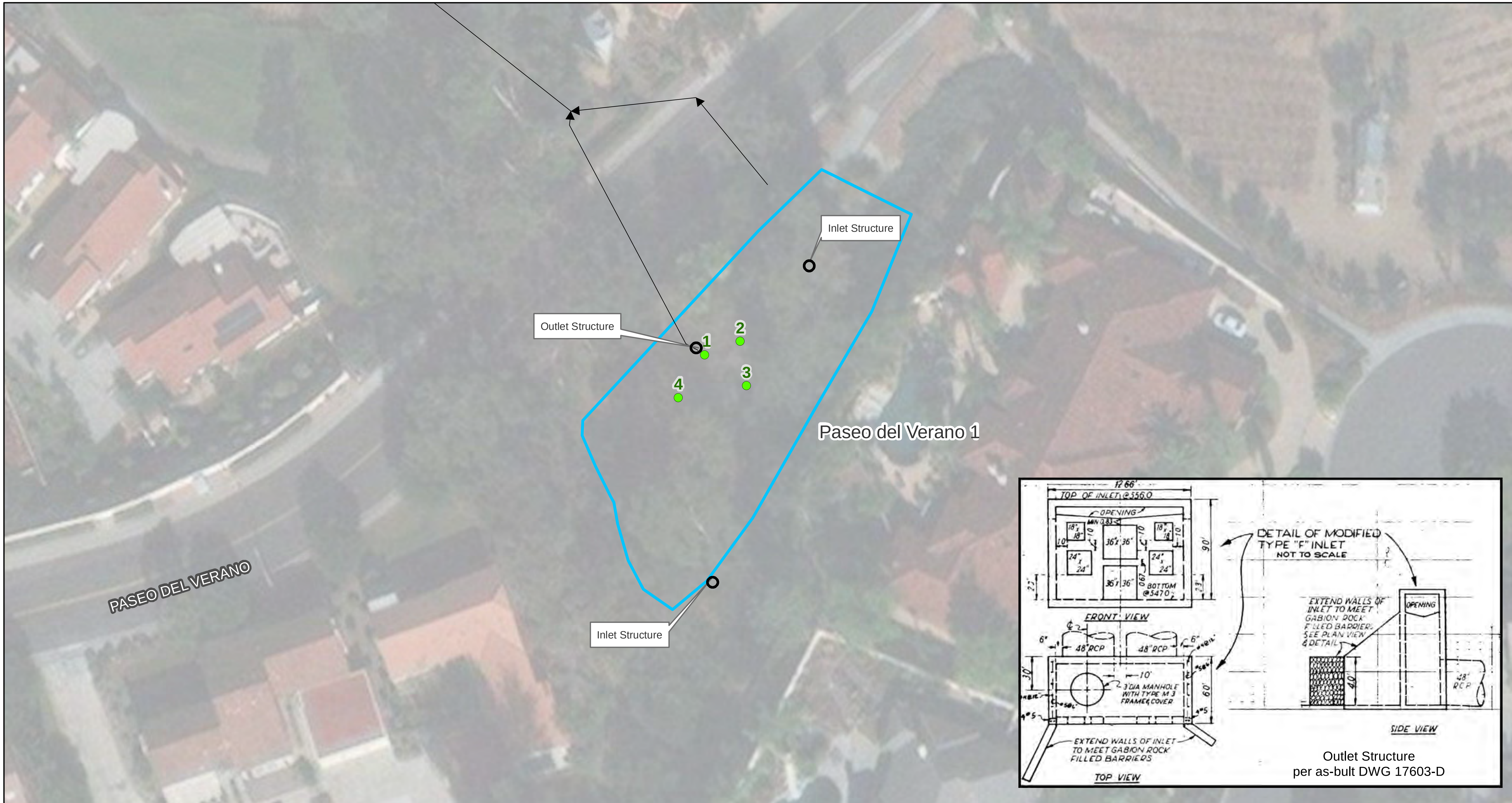
4. Paseo del Verano 1: Basin outlet structure.

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.



Field Photo Location

Storm Drain Conveyance

Top Detention Basin Boundary

N

Drainage Area: 187.4 acres

Feet
0 10 20 40

The City of SAN DIEGO

Facility Group Name: Green Valley Creek - Paseo del Verano

Segment Name: Paseo del Verano 1

Facility No: 1-04-200

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.3 Los Peñasquitos Canyon Creek – Sorrento (Sorrento Valley 1; No. 2-1-000)

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 to generate this fact sheet.

Table 1. Completed Reports

Segment	Report	Reach
Sorrento Valley 1	Rick Engineering Company, 2010. IHHA Report for Soledad Canyon Map Numbers 7, 11, & 12. Job Number 15541-A.	1

General Description

The Los Peñasquitos Canyon Creek – Sorrento - Sorrento Valley 1 (Sorrento Valley) 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 Sorrento Valley facility group is located in the Los Peñasquitos Watershed Management Area. The facility group is located near the Interstate 5/Interstate 805 interchange between the railroad tracks and an industrial development starting at the southerly boundary of the Torrey Pines Preserve to a point approximately 2,300 feet southeast where the Soledad Canyon Creek - Roselle facility group begins.

The Sorrento Valley segment is an earthen channel that begins 215 feet south of the Los Peñasquitos Creek and Soledad Creek confluence. The earthen channel continues from the confluence in a northeasterly direction approximately 2,400 feet, where it discharges to the Los Peñasquitos Lagoon at the boundary to the Torrey Pines Preserve.

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

Hydrology

The hydrologic peak flows presented in Table 2 are from the Federal Emergency Management Agency's (FEMA's) 2006 Flood Insurance Study (FIS) for San Diego County. The FIS provided the 10-, 50, and 100-year flow rate information. The 2-, 5-, and 25-year flow rate information was calculated using log-probability paper to create a flow rate distribution, which was 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
Sorrento Valley 1	680	2,200	4,200	9,000	13,100	19,000

Hydraulics

A one-dimensional steady flow model was developed for the 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 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 the site visit conducted by Rick Engineering in October 2010. The segment's bottom and banks were assigned Manning's coefficient values ranging from 0.045 to 0.10 reflecting moderate to dense vegetation. The assigned Manning's coefficient value for the recommended maintained condition was set at 0.035 to reflect bank to bank vegetation trimming only. 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 Sorrento Valley facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Sorrento Valley 1 (earthen)	30.32- 2376.6995	Baseline: 0.045-0.1	-
		Maintained: 0.035	

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 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 Sorrento Valley facility group can convey 2,200 cubic feet per second (cfs; 5-year level of service) before surrounding infrastructure is impacted.

Recommended Maintained Condition
Trimming vegetation from bank to bank does not have an impact on the overall level of service the Sorrento Valley facility group. In the maintained condition, Sorrento Valley remains at a level of service of the 5-year event (2,200 cfs). Therefore, maintenance is not recommended in the Sorrento Valley facility group.

The results presented in this fact sheet do not take into account the separately permitted Sorrento Valley Creek dredging plan that proposed dredging for approximately 2,750 feet of the Sorrento Valley segment and portion of the Roselle 1 segment. Due to constructability issues and capital improvement project planning, the dredging plan was put on hold; therefore, only maintenance methods involving vegetation management were considered for this facility group.

Post-Maintenance Erosion Control Measures
The estimated velocities of the Sorrento Valley segment are below the maximum permissible velocities for an earthen channel (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 this facility.

Potential Facility Capital Improvements
The HEC-RAS modeling indicated that in both the baseline and recommended conditions, the level of service for the Sorrento Valley segment were restricted by the downstream conditions caused by the Los Peñasquitos Lagoon. Restoration plans for the lagoon are currently in the planning phase and will likely improve the conveyance capacity in the Sorrento Valley segment. Additional analysis is recommended to evaluate potential increases in the levels of service that could be achieved by capital improvements.

Table 4. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Sorrento Valley 1 (earthen)	30.32-2376.7	2,200	2,200	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 selection of photos representative of the baseline condition from the previous IHHA document are included in this fact sheet with the original photo numbers. A site visit was conducted by Rick Engineering in October 2010.

IHHA 1. Sorrento Valley 1: Looking upstream at the vegetation along the banks.

IHHA 2. Sorrento Valley 1: Looking east at vegetation.

IHHA 3. Sorrento Valley 1: Looking east at vegetation.

IHHA 4. Sorrento Valley 1: Looking east at vegetation.

Analysis Performed By: Rick Engineering

Fact Sheet Prepared By: Dudek

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 Sorrento V

alley facility group.

Soledad Canyon, Map Numbers 7, 11 & 12 - Hydraulic Workmap

W:\15541-A\SoledadaCanyon\Exhibits\SoledadCanyon_HydraulicWorkmap_01.mxd

Exhibit Date: November 5, 2010

REC JN: 15541A

0 200 400 800 Feet

Data Sources:
SanGIS Topo 2' Contours: 1999
SanGIS Roads - March 2010
Eagle Aerial Photo: March 2009

RICK ENGINEERING COMPANY

A.4 Los Peñasquitos Lagoon - Industrial 1 & 2

Summary of Recommended Maintenance

Industrial 1 (No. 2-01-120)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[3]	• Remove accumulated sediment/debris and vegetation for a 25-foot length at the box culvert outlet (Station 595 to Station 620[2]) within San Diego Metropolitan Transit Development Board (SDMTBD) right-of-way.	
Benefit	• Increase level of service from 50-year storm event (276.7 cfs) to 100-year storm event (295.2 cfs) in Reach 1. • 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.

[2] Approximate station for the downstream end of the RCB culvert.

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

Industrial 2 (No. 2-01-122)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1, 2]	
Extent of Maintenance[3]	• Remove accumulated sediment/debris and vegetation from Station 741 to Station 1391 in Reach 2 and Reach 3. • Remove accumulated sediment/debris in culvert from Station 620[4] to Station 741. • Maintain/repair existing debris fence as needed.	
Benefit	• Increase level of service from <2-year storm event (142.6 cfs) to 5-year storm event (182.4 cfs) in Reach 2. • The level of service for Reach 3 remains <2-year storm event (142.6 cfs), but portions of the segment increase to 5-year storm event (182.4 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 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.

4 Approximate station for the downstream end of the RCB culvert.

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

Table 1. Completed Report

Segment	Report	Reach
Industrial 1	Rick Engineering Company, 2010. IHHA Report for 300 Industrial Court Channel Map Number 6a. Rick Engineering Company, 2017. IHHA Report for 11689 Sorrento Valley Road Channel (Industrial Court Channel) Map Number 6a.	1
Industrial 2	Rick Engineering Company, 2010. IHHA Report for 300 Industrial Court Channel Map Number 6a. Rick Engineering Company, 2017. IHHA Report for 11689 Sorrento Valley Road Channel (Industrial Court Channel) Map Number 6a.	2, 3

General Description

The Los Peñasquitos Lagoon – Industrial (Industrial) 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 Industrial facility group is in the Los Peñasquitos Watershed Management Area. The facility group is located in a highly industrialized area and is bound by commercial buildings, warehouses, and parking lots. The facility group is located west of the Interstate I-5 Local Bypass and south of Carmel Mountain Road.

The Industrial facility group was divided into two segments (Industrial 1 and Industrial 2) which are further divided into three reaches for the purposes of the hydraulic assessment. Industrial 1 is comprised of Reach 1 and Industrial 2 includes Reaches 2 and 3. Industrial 2 Reach 3 is the furthest upstream segment within the facility group and is a trapezoidal concrete lined channel that begins at the outfall of a 54-inch-diameter reinforced concrete pipe (RCP) culvert and continues southwest for 350 feet. Reach 2 is the subsequent downstream segment, and continues southwest for 300 feet before entering a 140-foot-long, double-barrel 6-foot-wide by 2.75-foot-tall reinforced concrete box (RCB) culvert conveying flows underneath Sorrento Valley Road. Upstream of the culvert entrance is an existing debris fence. Downstream of the culvert outlet, the channel continues as Industrial 1 (Reach 1), and is located within San Diego Metropolitan Transit Development Board (SDMTDB) right-of-way, per as-built drawing no. 10338-D. At the downstream end of the double RCB culvert, the segment turns 90 degrees and continues northwest, before making another 90-degree-bend and conveying flows under the SDMTDB bridge. The channel ultimately confluences downstream with Los Peñasquitos Lagoon.

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

Hydrology

The hydrologic peak flows presented in Table 2 were estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated April 1984*. The Rational Method computer program developed by Advanced Engineering Software, Version 2003, was used for the hydrologic model to determine 2-, 5-, 10-, 25-, 50-, and 100-year flow rate information.

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
Industrial 2	142.6	182.4	212.6	252.4	276.7	295.2
Industrial 1	142.6	182.4	212.6	252.4	276.7	295.2

Hydraulics

A one-dimensional steady flow model was developed for the Industrial 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 is defined as the existing condition of the facility group as observed during a site visit conducted by Rick Engineering in March 2010. The bottom and banks of Industrial 2 were assigned Manning's coefficient values ranging from 0.02 to 0.025 to reflect the sediment/debris and minor vegetation observed within the concrete segment. At the downstream portion of the facility group (Reach 2) and at the inlet of the double RCB (Station 741), dense vegetation was observed, and the depth of silt deposition could not be determined; at the downstream end of the RCB, silt deposition was estimated to have an approximate depth of 1.2 feet. The bottom and banks of Industrial 1 were assigned Manning's coefficient values ranging from 0.06 to 0.15 to reflect the dense vegetation observed within the undefined segment.

The assigned Manning's coefficient values for Industrial 2 in the recommended maintained condition ranged from 0.018 to 0.02 to reflect sediment/debris and vegetation removal where recommended and the poor condition of the existing concrete lining. The upstream 25-foot-long portion of Industrial 1, just downstream of the RCB culvert, was assigned a Manning's coefficient value of 0.035 for the segment bottom to reflect the recommended maintenance. 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 Industrial facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Industrial 2 (concrete)	Reach 3: 1405.926–1057.8542	Baseline: 0.02–0.025	–
		Maintained: 0.018–0.02	
	Reach 2: 1057.8542–620[1]	Baseline: 0.02–0.025	Culvert (Station 620[1])
		Maintained: 0.018–0.02	
Industrial 1 (earthen)	Reach 1: 620[1]–334.8525	Baseline: 0.06–0.15	–
		Maintained: 0.035–0.15	

1 Approximate station for the downstream end of the RCB culvert.

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, Industrial 2 Reach 3 can convey 142.6 cubic feet per second (cfs) (2-year level of service), and Industrial 2 Reach 2 can convey <142.6 cfs (<2-year level of service) before impacting the properties adjacent to the segments and Sorrento Valley Road. The overall segment level of service is limited by the downstream, double-barrel, 6-foot-wide by 2.75-foot-tall RCB culvert (Station 741). Industrial 1 (Reach 1) can convey 276.7 cfs (50-year level of service) before impacting surrounding infrastructure.

Recommended Maintained Condition

In Industrial 2, Reach 3 has minimal vegetation or sediment in the baseline condition, therefore deposited sediment/debris and vegetation removal may not be necessary for the majority of the segment at the time of maintenance. Maintenance is recommended for the downstream portion of Reach 3 between Station 1057.8542 and Station 1098.4454. The overall level of service for the segment remains equal to the 2-year storm event (142.6 cfs), while portions of the segment increase in capacity to 182.4 cfs (5-year storm event) due to the recommended maintenance. Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance within Reach 3 (Station 1057.8542 to Station 1391) is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Following the removal of deposited sediment/debris and vegetation within Reach 2 (Station 1057.8542 to Station 620), the level of service increases to the 5-year storm event and can convey 182.4 cfs before impacting the properties adjacent to the segments and Sorrento Valley Road. The overall segment level of service remains limited by the downstream, double-barrel, 6-foot-wide by 2.75-foot-tall RCB culvert (Station 741 to 620). The existing debris fence should be maintained or repaired as needed based on the conditions at the time of maintenance.

For Industrial 1 (Reach 1), removal of sediment/debris and vegetation for a 25-foot length downstream of the culvert outlet (Station 620) is recommended. In the maintained condition, Industrial 1 can convey 295.2 cfs (100-year level of service) before impacting surrounding infrastructure.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition are below recommended permissible velocities for concrete lined (35 feet per second) channels and for grass-lined (less than 5 feet per second) channels 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 Industrial facility group was restricted by the downstream double-barrel RCB culvert (Station 741 to 620). 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
Industrial 2 (concrete)	Reach 3: 1405.926-1057.8542	142.6	142.6	2-year	2-year
	Reach 2: 1057.8542–620[2]	<142.6	182.4	<2-year	5-year
Industrial 1 (earthen)	Reach 1: 620[2]-334.8525	276.7	295.2	50-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.[2] Approximate station for the downstream end of the RCB culvert.

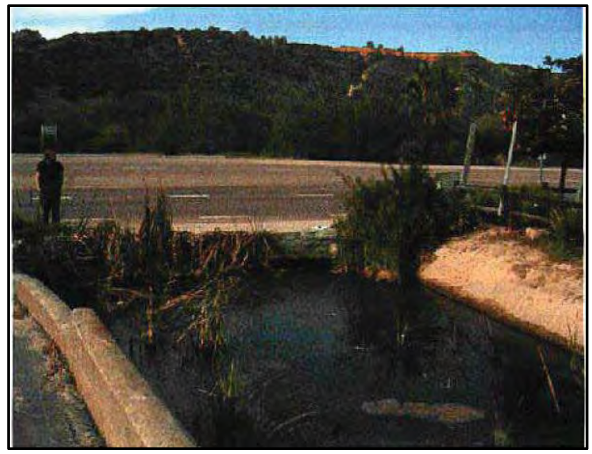
Representative Photos

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 from the previous IHHA document are included in this Fact Sheet with the original photo numbers. Photos are from a site visit conducted by Rick Engineering in October 2009.

1. IHHA 1. Industrial 1, Reach 3: Looking at 54-inch-diameter RCP outlet at upstream end of facility group.

2. IHHA 4. Industrial 1, Reach 3: Looking upstream at minor vegetation and sediment within concrete segment.

3. IHHA 5. Industrial 1, Reach 2: Looking downstream at concrete segment.



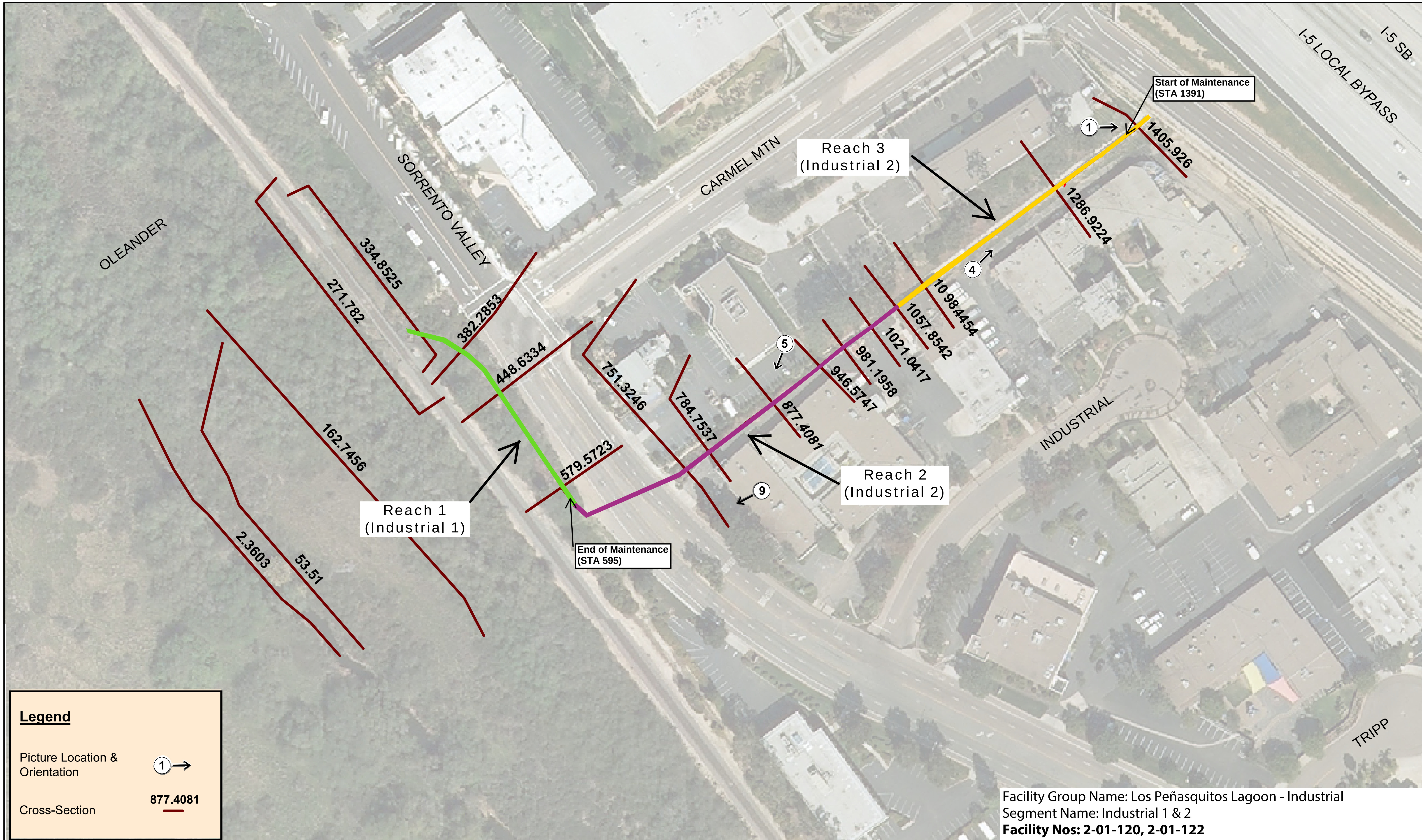
4. IHHA 9. Industrial 1, Reach 2: Looking downstream towards the double-barrel, 6-foot-wide by 2.75-foot-tall RCB culvert near downstream end of Reach 2. Culvert not visible due to dense vegetation.

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 Industrial facility group (Reaches 2 and 3).



Facility Group Name: Los Peñasquitos Lagoon - Industrial
Segment Name: Industrial 1 & 2
Facility Nos: 2-01-120, 2-01-122
Hydraulic Map - Municipal Waterways Maintenance Plan

Industrial Court Channel Workmap

Filepath:W-15541-A\IndustrialCourtChannel\ICWorkmap
Exhibit Date:05-10-2010
REC JN:W-15541_A

0 50 100 200 Feet

Data Sources:
SanGIS Assessor Parcels: April 2006
SanGIS Roads - February 2006
Landiscor Aerial Photo: January 2006

A.5 Los Peñasquitos Lagoon - Tripp (No. 2-01-130)

Summary of Recommended Maintenance

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from Station 658 to Station 2493. • Maintain/repair existing debris fence as needed. • Remove accumulated sediment/debris and vegetation from culvert at Station 658.	
Benefit	Reach 4: • Preserves the level of service equivalent to 100-year. Reach 3: • Increases level of service from 25-year to 100-year; conveyance capacity increases from 220.2 cfs to 263.6 cfs in Reach 3. • Decreases water surface elevations, reducing the limits and frequency of flooding throughout the facility group. • 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 report listed in Table 1 was used to generate this fact sheet.

Table 1. Completed Report

Segment	Report	Reach
Tripp 1	Rick Engineering, 2015. IHHA Report for Tripp Court Channel (11689 Sorrento Valley Road) Map Number 6.	1, 2, 3, 4

General Description

The Los Peñasquitos Lagoon – Tripp (Tripp) 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 Tripp facility group is located in the Los Peñasquitos Watershed Management Area. The Tripp facility group is located west of Interstate 5 (I-5), east of Sorrento Valley Road, and south of Tripp Court, and is bordered by commercial properties.

A 42-inch-diameter reinforced concrete pipe (RCP) discharges into the upstream end of the segment. The facility group conveys flows in a northwesterly direction for approximately 1,460 feet and then transitions through a 90-degree bend and continues in a westerly direction for approximately 375 feet. The facility group continues further west via a double-barrel 57-inch-diameter RCP that is approximately 700 feet in length. The pipe conveys flows under Sorrento Valley Road and the adjacent warehouse parking lots and outlets west of the San Diego Metropolitan Transit Development Board railroad tracks and the confluence with Soledad Canyon, ultimately flowing to the Los Peñasquitos Lagoon.

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

Hydrology

The hydrologic peak flows presented in Table 2 were estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated April 1984*. The Rational Method computer program developed by Advanced Engineer Software (AES 2003) was used as the hydrologic model to determine the 2-, 5-, 10-, 25-, 50- and 100-year peak flows.

Table 2. Hydrology Results

Segment	Reach	Peak Flow Rates by Storm Event Frequency (cfs)					
		2-year	5-year	10-year	25-year	50-year	100-year
Tripp 1	4	13.7	16.8	19.6	22.8	24.7	26.2
	3	134.2	161.2	201.6	220.2	246.5	263.6
	2	228.8	275.2	346.8	378.1	423.5	452.3
	1	268.9	324.8	408.3	446.6	500.1	534.1

Hydraulics

A one-dimensional steady flow model was developed for the Tripp 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 the site visit in August 2014. The segment bottom and banks were assigned Manning's coefficient values ranges from 0.02 to 0.08 reflecting moderate vegetation in the bottom of the concrete segment. At the downstream portion of the facility group and at the inlet of the double-barrel 57-inch-diameter RCP, there was evidence of significant sediment/debris that had an approximate depth of 3 feet.

The assigned Manning's coefficient values for the facility group in the recommended maintained condition ranged from 0.02 to 0.035 to reflect the sediment/debris and vegetation removal. 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 Tripp facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Tripp 1 (concrete)	Reach 4: 2477.893-2173.821	Baseline: 0.02-0.08 Maintained: 0.02-0.035	Culvert (Station 2477.893)
	Reach 3: 2173.821-1525.828	Baseline: 0.02-0.08 Maintained: 0.02-0.035	-
	Reach 2: 1525.828-1043.525	Baseline: 0.02-0.08 Maintained: 0.02-0.035	-
	Reach 1: 1043.525-679.8481	Baseline: 0.02-0.08 Maintained: 0.02-0.035	Culvert (Station 679.8481)

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, Reach 4 within the Tripp facility group can convey 26.2 cubic feet per second (cfs) (100-year level of service); Reach 3 conveys 220.2 cfs (25-year level of service); Reach 2 conveys 275.2 cfs (5-year level of service); and Reach 1 conveys 266.9 cfs (2-year level of service) before impacting surrounding infrastructure. The overall facility group level of service is limited by the downstream double-barrel 57-inch-diameter RCP culvert (Station 679.8481).

Recommended Maintained Condition

Following the removal of deposited sediment/debris and vegetation throughout the Tripp facility group, the level of service for Reach 4 remains equal to the 100-year storm event and can convey 26.2 cfs. The level of service for Reach 3 increases to 100-year storm event and can convey 263.6 cfs. The level of service for Reach 2 remains at the 5-year storm event, conveying 275.2 cfs. The level of service for Reach 1 remains the 2-year storm event, conveying 266.9 cfs. Maintenance in Reaches 1 and 2 provide decreases in the water surface elevation and reduces the risk of vegetation dislodging and clogging the downstream culvert. The overall facility group level of service remains limited by the downstream double-barrel 57-inch-diameter RCP culvert (Station 679.8481). The existing debris fence should be maintained or repaired as needed based on the conditions at the time of maintenance.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Tripp facility group are below recommended permissible velocities for concrete lined (35 feet per second) channels 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 Tripp facility group was restricted by the downstream culvert at Station 679.8481. 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
Tripp 1	Reach 4: 2477.893–2173.821	26.2	26.2	100-year	100-year
	Reach 3: 2173.821–1525.828	220.2	263.6	25-year	100-year
	Reach 2: 1525.828–1043.525	275.2	275.2	5-year	5-year
	Reach 1: 1043.525–679.8481	266.9	266.9	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 from the previous IHHA document are included in this fact sheet with the original photo numbers. A site visit was conducted by Rick Engineering in August 2014.

1. IHHA 1. Tripp 1, Reach 4: Looking upstream toward 42-inch RCP outlet.

2. IHHA 3. Tripp 1, Reach 3: Looking downstream.

3. IHHA 4. Tripp 1, Reach 4: Looking upstream at end of reach.

4. IHHA 7. Tripp 1, Reach 3: Looking downstream.

5. IHHA 9. Tripp 1, Reach 2: Looking downstream.

6. IHHA 10. Tripp 1, Reach 2: Looking downstream at 90-degree bend, at downstream end of reach.

7. IHHA 14. Tripp, Reach 1: Looking upstream from double-barrel 57-inch RCP culvert entrance at downstream end of facility group.

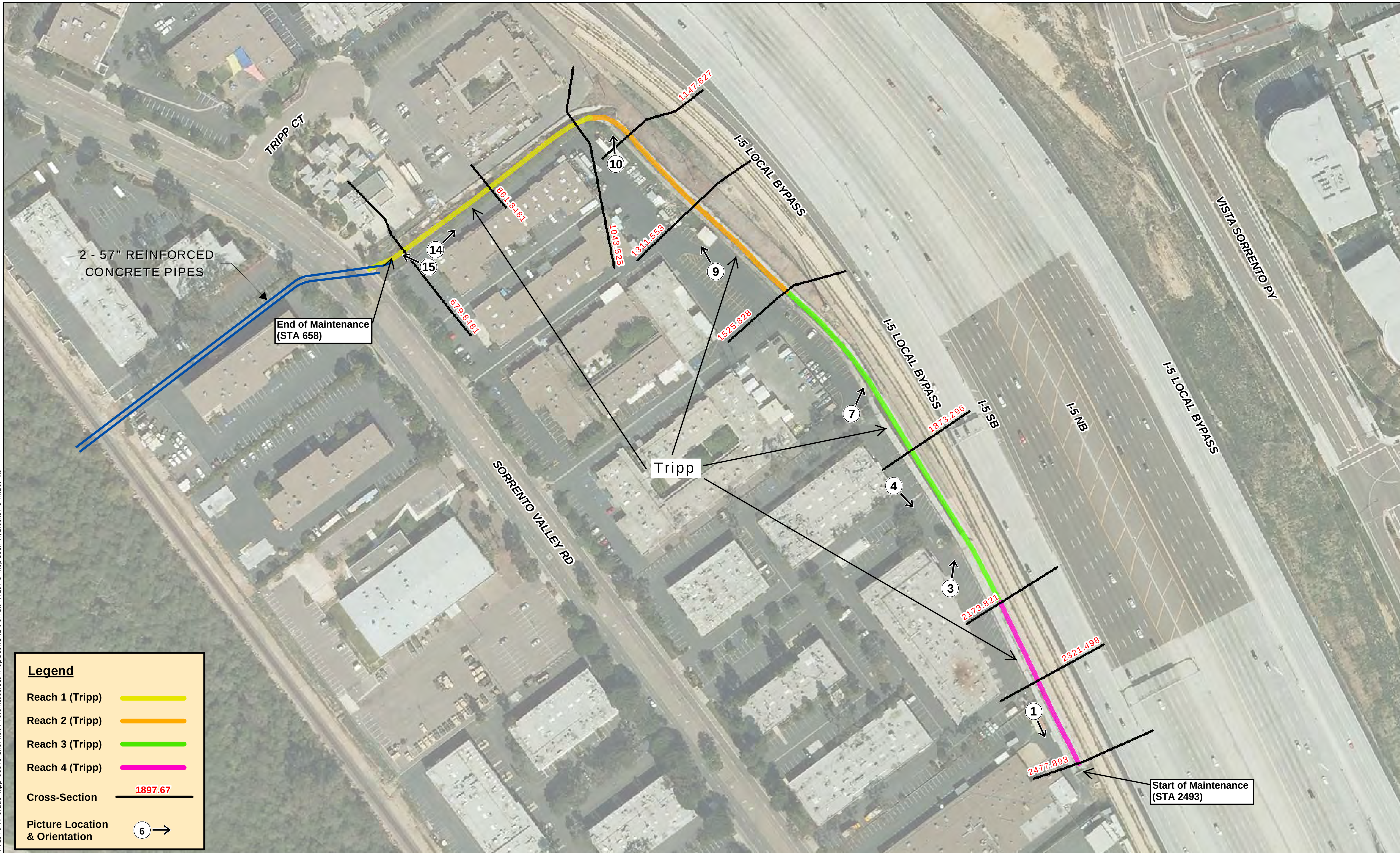
8. IHHA 15. Tripp, Reach 1: Looking downstream at double-barrel 57-inch RCP culvert entrance; downstream end of facility group.

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 Tripp facility group.



W:\17204-B_Alvarado_Tripp_BeaverChannels\WaterResources\TrippCourtChannel\GIS\17204_B_TrippCourt_HydraulicWorkmap.mxd

RICK ENGINEERING COMPANY

Scale in Feet
0 150 300
North

Original Exhibit:
Tripp Court Channel
MMP Map Numbers 06 Hydraulic Workmap (Report J-17204-B)

Date of Exhibit: 08.29.2014
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Los Peñasquitos Lagoon - Tripp
Segment Name: Tripp
Facility No: 2-01-130
Hydraulic Map - Municipal Waterways Maintenance Plan

A.6 Los Peñasquitos Canyon Creek – Black Mountain (Black Mountain 1; No. 2-01-200)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Riprap	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 1092 to Station 1120, from the energy dissipator at Station 1000 to Station 1092, from the drop structures at Station 960 to Station 1000 and Station 827 to Station 869. • Remove accumulated sediment/debris in the culvert between Station 93 and Station 168. • Trim the vegetation from the earthen channel bottom from Station 168 to Station 1120.	
Benefit	• Increases the level of service from a <5-year storm event (470 cfs) to a <25-year storm event (650 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the 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 Los Peñasquitos Canyon Creek – Black Mountain 1 (Black Mountain 1) is a part of the Los Peñasquitos Canyon Creek – Black Mountain facility group. Black Mountain 1 was classified as a Category 2 segment as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The facility group is in the Peñasquitos Watershed Management Area. The segment begins southwest of Black Mountain Road and Truman Street at the downstream end of a culvert, continues southeast along Black Mountain Road, and discharges into Los Peñasquitos Creek.

The Black Mountain 1 segment is a trapezoidal earthen channel with riprap slope protection, drop structures, and an energy dissipater at the upstream end, as indicated on as-built drawing no. 20575-D. A portion of the channel has a bottom width of 8 - 26 feet and banks that are 5 to 11 feet high with 2:1 (H:V) to 3:1 (H:V) side slopes. Runoff is conveyed through the Black Mountain 1 facility group in a southeasterly direction to a double-barrel, 72-inch-diameter culvert (Station 168 to Station 93) that conveys flows to Los Peñasquitos 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 Los Peñasquitos Canyon Creek – Black Mountain 1 segment.

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 3.1.1.3 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
Black Mountain 1	378	481	561	670	750	833

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 baseline condition, the channel bottom was assigned a Manning's coefficient value of 0.07, and banks were assigned a Manning's coefficient value of 0.05. These assignments were based on the site visit conducted by Geosyntec Consultants in April 2017 where accumulated sediment and vegetation in the bottom of the channel was observed and the overbank cover varied along cross sections from asphalt to grass lawn to dense vegetation. The sediment depth was estimated to be 1–2 feet at the drop structures, the energy dissipater, and in the culvert (Station 168 to Station 93).

For the recommended maintained condition, the Manning's coefficient value assigned for the bottom of the channel was 0.05–0.033 to reflect trimmed vegetation and riprap, respectively, and the Manning's coefficient value assigned to the banks remained the same: 0.05 to reflect the overbank cover that varied along cross-sections from asphalt to grass lawn to dense vegetation.

Model parameters and velocities for the baseline and maintained conditions for the Black Mountain 1 segment 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
Black Mountain 1 (riprap)	1120-1000	Baseline: 0.07	Baseline: 5.4-8.4	Energy Dissipator (Station 1092)	Critical Depth
		Maintained: 0.033	Maintained: 8.9-13.9		
Black Mountain 1 (riprap)	1000-960	Baseline: 0.07	Baseline: 7.6-8.4	Drop Structure	-
		Maintained: 0.033	Maintained: 13.9-15.6		
Black Mountain 1 (earthen)	960-869	Baseline: 0.07	Baseline: 5.8-7.6	-	-
		Maintained: 0.04	Maintained: 11.6-15.6		
Black Mountain 1 (riprap)	869-827	Baseline: 0.07	Baseline: 4.8-5.8	Drop Structure	-
		Maintained: 0.033	Maintained: 7.2-12.1		
Black Mountain 1 (earthen)	827-168	Baseline: 0.07	Baseline: 1.4-9.2	-	-
		Maintained: 0.05	Maintained: 2.1-7.2		
Black Mountain 1 (concrete)	168-93	Baseline: 0.07	Baseline: 1.4-2.8	Culvert (Station 168 to 93)	-
		Maintained: 0.05	Maintained: 2.1-3.4		
Domain of Analysis	93-7	Baseline: 0.07	-	-	Known water surface elevation
		Maintained: 0.07	-		

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 facility can convey 470 cubic feet per second (cfs) (<5-year level of service) before the parking lot is inundated at Station 522.

Recommended Maintained Condition

Removing deposited sediment/debris from the energy dissipator, drop structures, and the culvert and trimming the vegetation along the channel bottom to thin the density of the vegetation increases the conveyance capacity from 470 cfs (<5-year level of service) to 650 cfs (<25-year level of service) before the parking lot is inundated at Station 522.

Post-Maintenance Erosion Control Measures

The estimated velocities in both the baseline and recommended maintained condition (Table 2) are above the maximum permissible velocities for the earthen portions of the channel (5 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility. 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 for the Black Mountain 1 facility was restricted by low bank heights and the downstream culvert at Station 168 to 93. 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
Black Mountain 1	1120–93	470	650	<5-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. Photos are from the site visit conducted by Geosyntec Consultants in April 2017.

1. Black Mountain 1: Looking towards the upstream end of the segment.

2. Black Mountain 1: Looking downstream at segment.

3. Black Mountain 1: Looking upstream near mid-distance along the segment length.

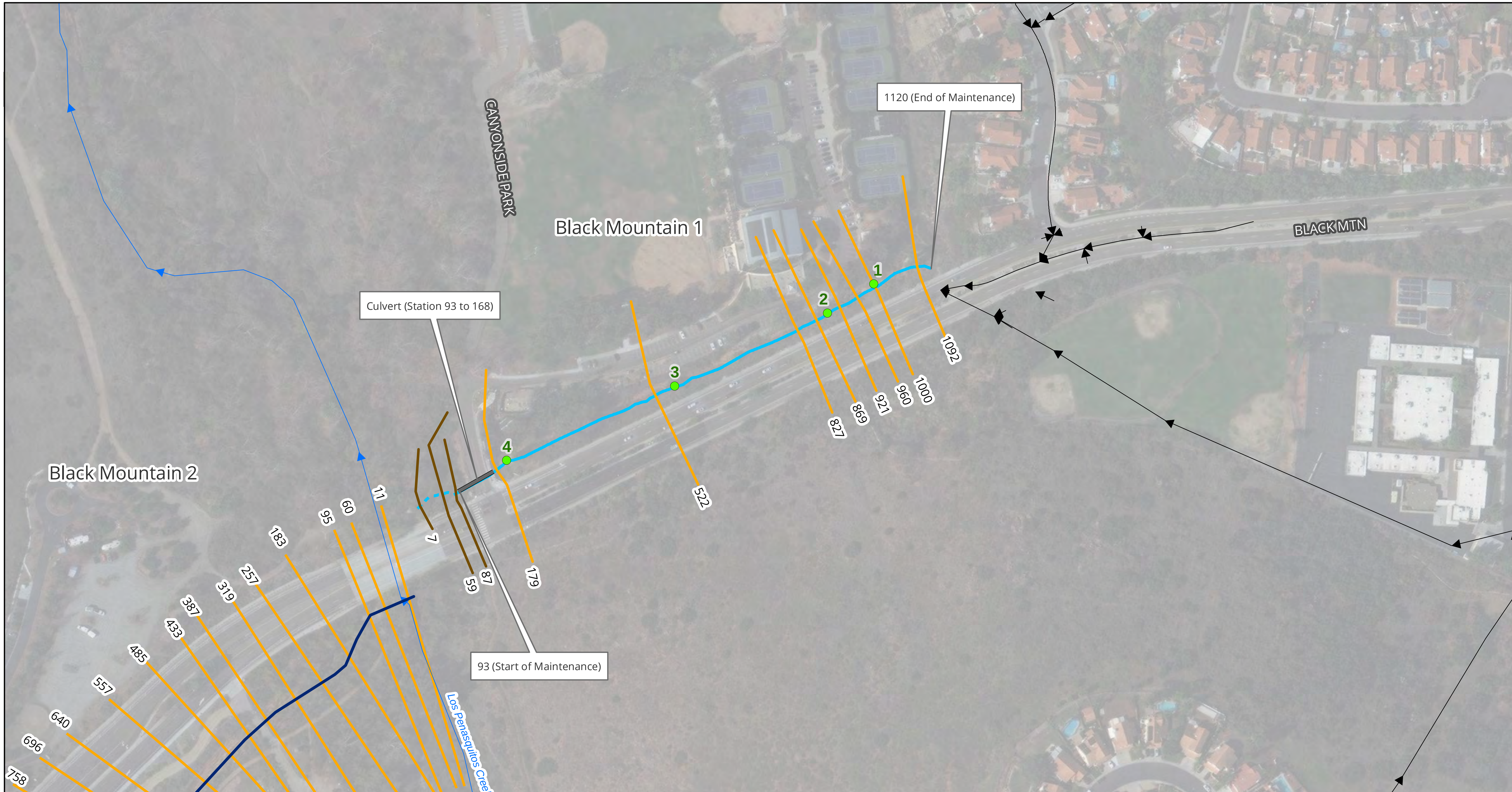
4. Black Mountain 1: Looking downstream at the double barrel 72-inch-diameter RCP culvert.

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
Creek
Culvert
MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Center Line
Black Mountain 1
Black Mountain 2

N

Drainage Area: 1,585 acres

0 50 100 200 Feet

The City of SAN DIEGO

Facility Group Name: Los Peñasquitos Canyon Creek - Black Mountain
Segment Name: Black Mountain 1
Facility No: 2-01-200
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 line is approximate.

November 2019

A.7 Los Peñasquitos Canyon Creek –Black Mountain (Black Mountain 2; No. 2-01-210)

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 bottom of earthen segment from Station 87 to Station 422 and Station 433 to Station 1057. • Trim vegetation on banks from Station 87 to Station 422 and Station 433 to Station 1057. • Remove accumulated sediment/debris in culverts from Station 78 to Station 87 and from Station 422 to Station 433.	
Benefit	• Increases level of service from >2-year storm event (1,000 cfs) to <10-year storm event (1,295 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 Los Peñasquitos Canyon Creek – Black Mountain 2 (Black Mountain 2) is a part of the Los Peñasquitos Canyon Creek – Black Mountain facility group. Black Mountain 2 was classified as a Category 3 segment, as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Black Mountain 2 segment is an earthen channel located in the Peñasquitos Watershed Management Area. The segment is bordered by Mercy Road to the south, Black Mountain Road to the west, and Canyonside Ranch horse stables to the east; Black Mountain 2 discharges into Los Peñasquitos Creek to the north.

The Black Mountain 2 facility group is an earthen segment that receives runoff from the quadruple barrel 72-inch-diameter reinforced concrete pipe (RCP) storm drain system outlet north of Mercy Road (Station 1057) and conveys flows in a northerly direction before entering a seven barrel 54-inch-diameter RCP culvert (Stations 433 to 422) beneath the Canyonside Ranch driveway. The segment continues north before entering a triple barrel 24-inch-diameter RCP beneath the Los Peñasquitos Canyon trail (Stations 87 to 78) which in turn discharges to Los Peñasquitos Creek. See 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 Black Mountain 2 facility group.

Hydrology

The hydrologic peak flow for the 100-year recurrence interval presented Table 1 was estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated 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 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
Black Mountain 2	913	1,151	1,348	1,603	1,792	1,982

Hydraulics

A one-dimensional steady flow model was developed for the Black Mountain 2 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. 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 located at the end of this fact sheet.

The upstream domain of analysis for Black Mountain 2 is the existing quadruple-barrel 72-inch-diameter RCP storm drain system. The downstream domain of analysis is Los Peñasquitos Creek, and known water surface elevations provided by the Federal Emergency Management Agency (FEMA) were used as the downstream boundary condition. 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 Black Mountain 2 was determined to be the existing condition, as observed during the site visit conducted by Geosyntec Consultants in April 2017. Black Mountain 2 was observed to be heavily vegetated with sediment deposition varying from 1 to 3 feet throughout the segment. The bottom of the facility was assigned a Manning's coefficient value of 0.07, which represents the density of the vegetation observed within the earthen segment. The banks were assigned a Manning's coefficient value of 0.05. 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 Black Mountain 2 facility group was assigned a Manning's coefficient value of 0.05 in the recommended maintained condition to reflect sediment/debris and vegetation removal from the earthen bottom. The banks were assigned a Manning's coefficient value of 0.035. The maintenance includes the removal of a built-up area of sediment/debris located between Station 433 and Station 1057 to reestablish a consistent slope between the culvert at Station 1057 to the culvert at Station 433.

Model parameters for the baseline and maintained conditions for the Black Mountain 2 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

Segment Name	Reference Stations	Manning's Coefficients	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Black Mountain 2	1067-11	Baseline: 0.05-0.07	Baseline: 0.89-8.24	Culverts (Station 1057, Station 433 to 422, Station 87 to 78)	Known Water Surface Elevation
		Maintained: 0.035 - 0.05	Maintained: 0.88-8.36		

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 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 Black Mountain 2 facility group can convey up to 1,000 cubic feet per second (cfs) (>2-year level of service) in the baseline condition. The capacity of the facility group is limited by the downstream culvert between Stations 433 and 422. Additionally, the right banks are overtopped by <5-year storm, which impacts the adjacent Canyonside Ranch horse stables.

Recommended Maintained Condition

Removing the deposited sediment/debris and vegetation from the channel bottom and trimming the vegetation along the banks throughout the Black Mountain 2 facility group increases the conveyance capacity to 1,295 cfs (<10-year level of service). Additionally, the water surface elevation (WSE) improves throughout the segment and overtops the right banks during the 100-year storm. This decrease in WSE provides benefits to the Canyonside Ranch horse stables, which have a history of flooding.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition (Table 2) exceed the maximum permissible velocities for an earthen channel (5 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility. 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 capacity of the downstream culvert at Station 409. 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
Black Mountain 2	1067-11	1,000	1,295	>2-year	<10-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. Black Mountain 2: Looking upstream at quadruple-barrel 72-inch-diameter RCP storm drain outlet at Mercy Road.

2. Black Mountain 2: Gravel bags at location of historic flooding.

3. Black Mountain 2: Looking downstream at the seven-barrel 54-inch-diameter RCP culvert beneath the Canyonside Ranch driveway.

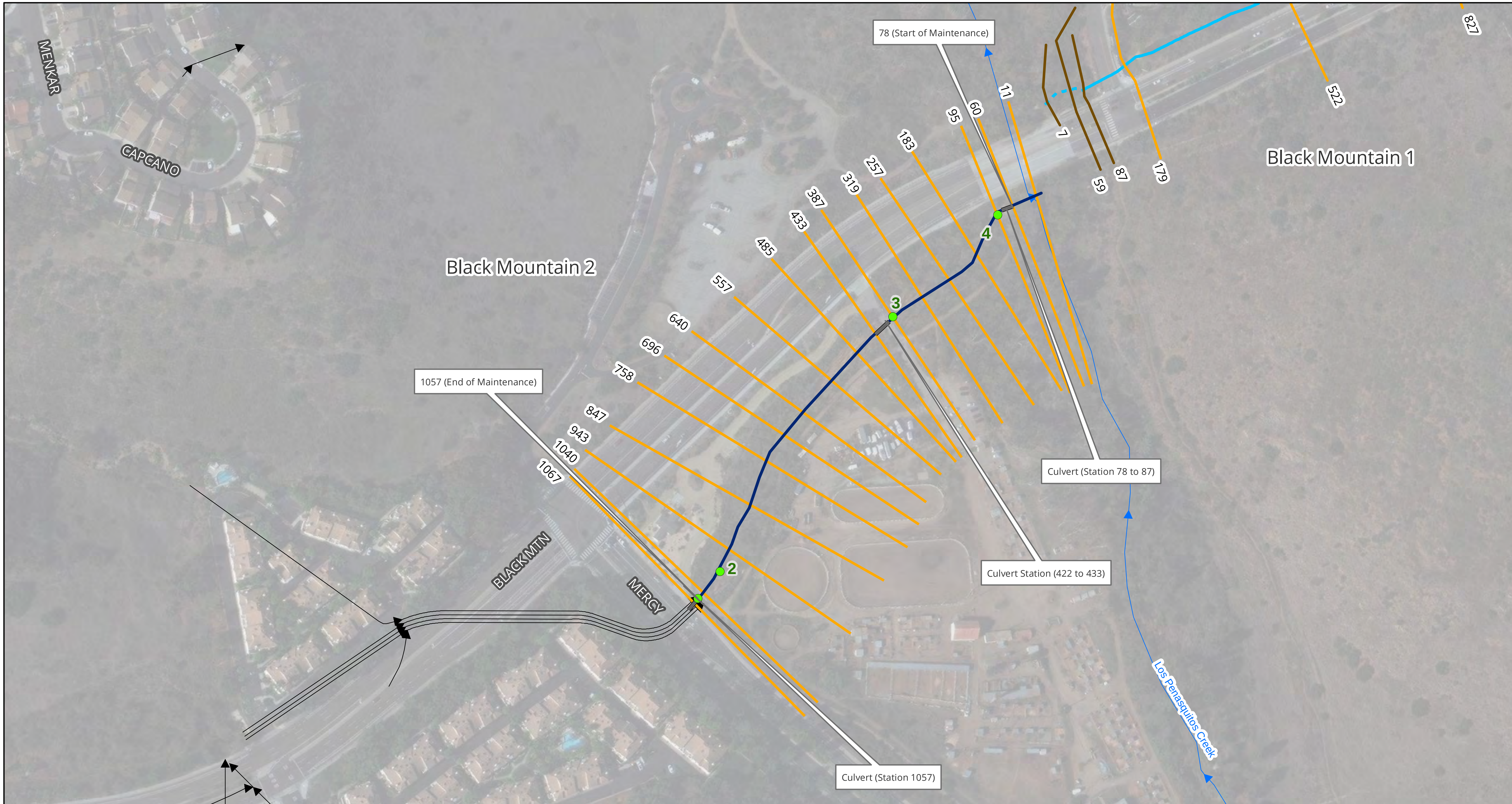
4. Black Mountain 2: Looking downstream at triple barrel 24-inch-diameter RCP beneath the Los Peñasquitos Canyon Trail.

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 Black Mountain 2 facility group.



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

N

Drainage Area: 1,585 acres

Feet
0 50 100 200

The City of SAN DIEGO

November 2019

Facility Group Name: Los Peñasquitos Canyon Creek - Black Mountain
Segment Name: Black Mountain 2
Facility No: 2-01-210
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.8 Los Peñasquitos Canyon Creek – 5-805 Basins (5-805 Fwys 1; No. 2-01-900)

Summary of Recommended Maintenance

Facility Type	Desilting Basin: Earthen	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove any accumulated sediment/debris and vegetation from basin bottom to restore the as-built condition. • Remove vegetation from basin inlet and side weir to restore the as-built condition.	
Benefit	• Preserves basin's ability to capture sediment thereby assisting with sediment TMDL compliance.	

[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 Los Peñasquitos Canyon Creek – 5-805 Basin (5-805) facility group was classified as a Category 2 desilting basin as described in *Chapter 4, Section 4.3 of the Hydrology and Hydraulics Technical Report*. The facility is a 1.4-acre basin located in the Los Peñasquitos Watershed Management Area and receives a portion of the runoff from approximately 50 square miles of upland watershed (see figure below). The Los Peñasquitos Creek channel abuts the south side of the facility with undeveloped hillside slopes along the north side of the facility. Pursuant to as-built drawings no. 33927-4-D, the earthen basin has a trapezoidal geometry consisting of a bottom width of ranging from 40 feet to 100 feet, depth of 6 feet, and side slopes of 2H:1V.

The 5-805 basin diverts flow from the Los Peñasquitos Creek at a constructed riprap inlet bench and it also receives flows through two downdrains. Flows exit the basin via an outflow structure that encloses a 36-inch-diameter corrugated metal pipe (CMP). The outflow structure is located at the west end of the basin. The basin is designed to be inundated during the 2-year storm event and to allow sediment from the creek to settle in the basin to reduce the amount of sediment in the lagoon.

The operational volume of Los Peñasquitos is below elevations of 35.0 feet, above which flow will discharge over the riprap side weir directly into the creek channel. Water ponding higher than 29.0 feet enters the basin's outflow structure. The outflow structure consists of a 60-inch CMP riser.

The following sections describe the maintenance criteria, and assessment used to develop conclusions and recommendations regarding maintenance specific to the Los Peñasquitos facility group.

Baseline Condition

The baseline condition for the Los Peñasquitos facility group was determined to be the current condition as observed during a site visit in May 2018. Vegetation was observed covering the bottom of the basin, with insignificant accumulation of sediment. Vegetation growth was also observed at the basin inlet which appears to restrict the amount of flow into the basin and on the side weir. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2018 site visit.

Recommended Maintained Condition

The recommended maintained condition for the 5-805 facility group was determined to be the as-built condition as reflected in the as-built drawing no. 33927-4-D. The primary purpose for maintenance is to remove the sediment that settles in the basin so that it does not re-suspend and discharge to the lagoon. Maintenance is recommend to meet the intended purpose of the basin to assist in meeting sediment TMDL numeric limits in Los Peñasquitos Creek by preventing the resuspension and discharge of the sediment back into the creek and the lagoon.

Recommended Maintenance

This section presents the conclusions and recommendations based on the site visit and identifies whether maintenance is recommended for the facility group and the amount of maintenance recommended.

To maintain the intended function of the basin since the primary purpose of the basin is to remove sediment from Los Peñasquitos Creek, it is recommended that sediment be removed when sediment accumulation reaches 1 foot at the basin outlet. This level will was determined so sediment does not re-suspend and discharge to the lagoon. Vegetation removal is recommended at the inlet of the basin to allow for flows/sediment to enter the basin as designed and vegetation removal along the side weir is also recommended to maintain the as-built condition. Vegetation removal should be conducted in general within the project limits of work including at the basin outlet per the as-built drawings. The frequency of maintenance will be established based on annual inspection of the basin and outlet works.

Representative Photos

Photos are from the site visit conducted in May 2018.

1. 5-805 Basin: Looking downstream at heavily vegetated inlet to basin from upstream end.

2. 5-805 Basin: Looking at downdrain outfall into basin on north side.

3. 5-805 Basin: Vegetation observed throughout basin.

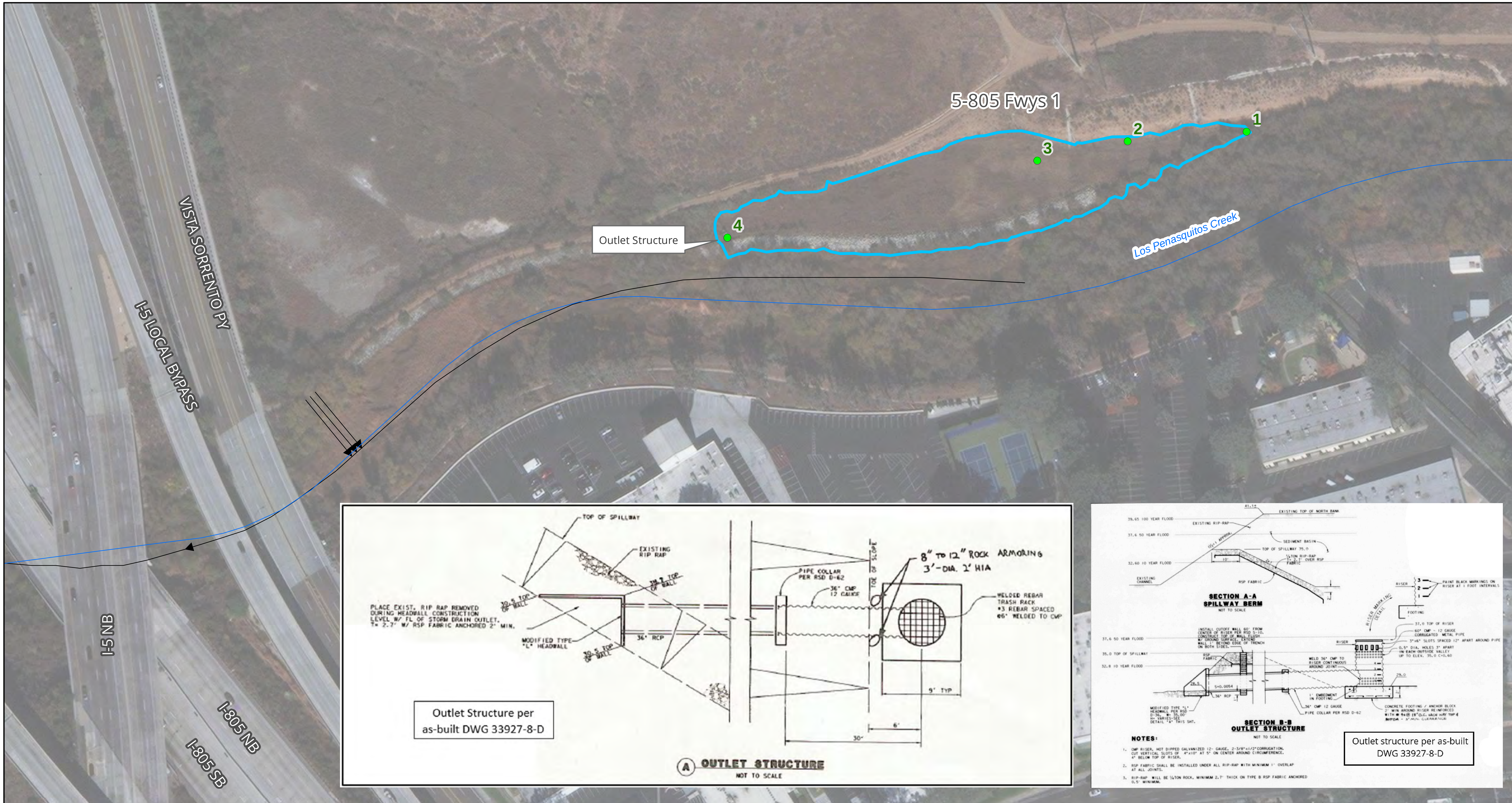
4. 5-805 Basin: Basin outlet structure and rip rap embankment.

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.



●	Field Photo Locations
→	Storm Drain Conveyance
—	Creek
▭	Top Detention Basin Boundary

N

Drainage Area: 36,755 acres (6% of flow diverted to the basin)

Feet

0 180 360

The City of SAN DIEGO

Facility Group Name: Los Peñasquitos Canyon Creek - 5-805 Basin
Segment Name: 5-805 Fwys 1
Facility No: 2-01-900
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.9 Soledad Canyon Creek – Sorrento (Roselle 1 & 2)

Summary of Recommended Maintenance

Roselle 1 (No. 2-03-000)

Facility Type	Bed: Earthen Banks: Earthen, Riprap	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from the 215-foot transition zone (Station 3716 to Station 3930.989).	
Benefit	• The level of service remains at a 10-year storm event and the conveyance capacity remains unchanged (1,500 cfs). • The WSE at the upstream end of the channel (Station 3930.989) improves slightly to mostly contain flows within the roadway near the 10900 block of Roselle Street in the recommended maintained condition. This provides benefits to properties immediately adjacent with a history of flooding.	

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.

Roselle 2 (No. 2-03-002)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from Station 3930.989 to Station 6245.	
Benefit	• Increase level of service from 10-year storm event (1,500 cfs) to >10-year storm event (1,900 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging Roselle 1.	

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
Roselle 1	ESA, 2016. Sorrento Valley Channel Emergency Maintenance Analysis Memorandum.	2
	Rick Engineering Company, 2010. IHHA Report for Soledad Canyon Map Numbers 7, 11, &12. Job Number 15541-A.	2
Roselle 2	ESA, 2016. Sorrento Valley Channel Emergency Maintenance Analysis Memorandum.	3
	URS Corporation, 2013. IHHA Report for Sorrento Creek-Flintkote-Soledad-Los Peñasquitos Channel Map Numbers 7, 8, 9, 10, 11 & 12.	3

General Description

The Soledad Canyon Creek – Roselle (Roselle) 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 Roselle facility is located in the Los Peñasquitos Watershed Management Area. The facility group is located near the Interstate 5/Interstate 805 interchange between the railroad tracks and Roselle Street and an industrial development is located along portions of the west side of the facility group. This facility group is the continuation of Soledad Canyon Creek with the Soledad Canyon Creek - Sorrento Valley Road facility group at the upstream end and the Los Peñasquitos – Sorrento Valley facility group at the downstream end.

The Roselle 2 segment begins at the downstream end of the Soledad Canyon Creek - Sorrento Valley Road 1 segment. The Roselle 2 segment is a concrete-lined trapezoidal channel with a 63-foot wide channel bottom and 1.5:1 (H:V) side slopes that convey flows in a northwesterly direction for approximately 2,314 feet where it discharges flows into the Roselle 1 transition zone. The Roselle 1 transition zone is an approximately 215-foot length section of the channel where the channel width reduces from 63 feet to approximately 15 feet. The Roselle 1 segment is an earthen trapezoidal channel that continues to drain in the northwesterly direction until it discharges into the Los Peñasquitos Creek – Sorrento Valley facility group. The Roselle 1 segment channel bottom varies from approximately 8 to 15 feet and the channel top width varies from approximately 10 to 45 feet.

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

Hydrology

The hydrologic peak flows presented in Table 2 are from the Federal Emergency Management Agency's (FEMA's) 2006 Flood Insurance Study (FIS) for San Diego County. The FIS provided the 10-, 50-, and 100-year flow rate information. The 2-, 5-, and 25-year flow rate information was calculated using log-probability paper to create a flow rate distribution, which was 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
Roselle 1	220	730	1,500	3,100	4,500	6,700
Roselle 2	220	730	1,500	3,100	4,500	6,700

Hydraulics

A one-dimensional steady flow model was developed for the 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 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 the site visits conducted by ESA in January 2016. The Roselle 2 segment was assigned Manning's coefficient values ranging from 0.018 to 0.06 to represent light to dense vegetation. The Roselle 1 segment was assigned Manning's coefficient values ranging from 0.045 to 0.07 to represent moderate to dense vegetation. The sediment/debris depth was estimated to be up to 18 inches deep in the Roselle 2 segment.

The assigned Manning's coefficient values for the recommended maintained condition for Roselle 2 was set at 0.016 to reflect the roughness of the originally constructed facility. The assigned Manning's coefficient value for the recommended maintained condition for Roselle 1 was set at 0.03 within the transition zone to represent the removal of sediment/debris and vegetation within the zone and 0.045 to reflect trimmed vegetation throughout the rest of the segment. 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 Roselle facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Roselle 2 (concrete)	3930.989-6245	Baseline: 0.018-0.06	
		Maintained: 0.016	
Roselle 1 (earthen)	2376.6995-3930.989	Baseline: 0.045-0.07	Transition Zone (Station 3716 to 3930.989)
		Maintained: 0.03 (transition zone) 0.045 (channel)	

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 acapacities and level of service for each segment are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition
In the baseline condition, the Roselle 2 segment can convey 1,500 cubic feet per second (cfs) (10-year level of service) before surrounding infrastructure is impacted. The Roselle 1 segment can convey 1,500 cfs (10-year level of service) before surrounding infrastructure is impacted.

Recommended Maintained Condition
Removing deposited sediment and vegetation/debris from the overall Roselle 2 segment increases the conveyance capacity to >10-year storm event (1,900 cfs). The portion of the Roselle 2 segment upstream of the Sorrento Valley Boulevard bridge increases to a 25-year level of service (3,100 cfs). Removing deposited sediment and vegetation/debris from the Roselle 1 transition zone, along with trimming vegetation from the Roselle 1 channel does not have an impact on the overall level of service in this segment. Roselle 1 remains at a 10-year level of service (1,500 cfs). Since the overall level of service is unchanged, trimming vegetation from the Roselle 1 channel is not recommended. The maintenance does have a slight improvement in the water surface elevation near the 10900 block of Roselle Street where the flooding is mostly contained within the roadway thereby reducing the flooding impacts and providing a benefit to the properties immediately adjacent to the facility group.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Roselle 2 segment 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*. The estimated velocities in the Roselle 1 segment are below the maximum permissible velocities for earthen channels (5 fps). 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 due the constriction of flows within Roselle 1 along with low bank heights in the vicinity of the transition zone. Restoration plans for the Los Peñasquitos Lagoon are currently in the planning phase and may improve the conveyance capacity in the Roselle 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 Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Roselle 2 (concrete)	3930.989-6245	1,500	1,900	10-year	>10-year
Roselle 1 (earthen)	2376.6995-3930.989	1,500	1,500	10-year	10-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 from the previous IHHA document are included in this fact sheet with the original photo numbers. A site visit was conducted by ESA in January 2016.

1. Roselle 2: Looking upstream of the I-5 overpass.

2. Roselle 2: Looking upstream from the northwest side of the I-5 overpass.

3. Roselle 2: Looking downstream at the transition area between Roselle 1 and 2.

4. Roselle 1: Looking downstream at the upstream end of Roselle 1.

Analysis Performed By: Rick Engineering, URS Corporation, ESA

Fact Sheet Prepared By: Dudek

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 Roselle facility group.

Soledad Canyon, Map Numbers 7, 11 & 12 - Hydraulic Workmap

Sheet 1 of 2

W:\15541-A\SoledadaCanyon\Exhibits\SoledadCanyon_HydraulicWorkmap_01.mxd

Exhibit Date: November 5, 2010

REC JN: 15541A

0 200 400 800 Feet

Data Sources:
SanGIS Topo 2' Contours: 1999
SanGIS Roads - March 2010
Eagle Aerial Photo: March 2009

RICK ENGINEERING COMPANY

Soledad Canyon, Map Numbers 7, 11 & 12 - Hydraulic Workmap

Sheet 2 of 2

W:\15541-A\SoledadaCanyon\Exhibits\SoledadCanyon_HydraulicWorkmap_02.mxd

Exhibit Date: November 5, 2010

REC JN: 15541A

0 200 400 800 Feet

Data Sources:
SanGIS Topo 2' Contours: 1999
SanGIS Roads - March 2010
Eagle Aerial Photo: March 2009

RICK ENGINEERING COMPANY

A.10 Soledad Canyon Creek – Sorrento (Sorrento Valley Road 1 & 2)

Summary of Recommended Maintenance

Sorrento Valley Road 1 (No. 2-03-004)

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.

Sorrento Valley Road 2 (No. 2-03-006)

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 to create the baseline condition modeling for this Fact Sheet. The modeling completed for Sorrento Valley Road 1 and 2 segments was a continuation of the previous modeling completed for the Soledad Creek facility groups.

Table 1. Completed Reports

Segment	Report	Reach
Downstream Domain of Analysis	URS Corporation, 2013. IHHA Report for Sorrento Creek-Flintkote-Soledad-Los Peñasquitos Channel.	Reach 3[1]
	ESA, 2016. Draft Memorandum - Sorrento Valley Channel Emergency Maintenance Analysis.	

1 Reach 3 is the label as it appears in the URS IHHA and ESA Draft Memorandum completed reports and references to most upstream channel reach modeled in these reports. Reach 3 coincides with the Downstream Domain of Analysis of the Soledad Canyon Creek – Sorrento Valley Road facility group, and it is not to be confused with the Sorrento Valley Road 1, Reach 3 as used in this Fact Sheet.

General Description

The Soledad Canyon Creek – Sorrento - Sorrento Valley Road (Sorrento Valley Road) facility group was classified as two Category 3 facility segments as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Sorrento Valley Road facility group is located in the Los Peñasquitos Watershed Management Area. The Sorrento Valley Road facility group consists of a small portion of Soledad Canyon Creek, which extends from just upstream of the concrete channel that starts around 1,500 feet east of the Sorrento Valley Boulevard bridge to approximately 280 feet west of Interstate (I-) 805 at its easterly end. The channel runs parallel to Sorrento Valley Road and is bordered by an industrial/commercial area to the north/northeast, and by Roselle Street, industrial/commercial development, and various parking lots to the south/southwest.

The facility group is split into two segments, where Sorrento Valley Road 1 is the downstream segment and Sorrento Valley Road 2 is the upstream segment. The facility group is an earthen trapezoidal channel with a bottom width that varies 10 feet to 40 feet; flow direction in the channel is from east to west. The bulk of the storm flow conveyed through this channel comes from the upstream portion of Soledad Canyon Creek, located to the east of the Sorrento Valley Road facility group. A tributary confluences with the main creek channel by a railroad bridge near Station 11143. The channel also receives smaller inflows from storm drains and surface flows along its length. All flows from the Sorrento Valley Road facility group discharge west through a concrete trapezoidal channel that begins at Station 8284 (Soledad Canyon Creek – Sorrento -Roselle 2 segment) and continues to convey flow 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 Sorrento Valley Road 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 April 5, 2016. The peak flows for the remaining recurrence intervals (2-, 5-, and

25-year) were extrapolated using a log-log plot as described in *Section 3.1.1.1 of the Hydrology and Hydraulics Technical Report.* The FEMA FIS reports different flow rates upstream and downstream of the railroad bridge located at Station 11123, as shown in the table below. Note that in the FEMA FIS, the subject reach of Soledad Canyon Creek is referred to as Carroll Canyon 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
Sorrento Valley Road	480	850	1,300	2,400	3,800	5,600
Downstream Domain of Analysis	550	1,000	1,500	2,800	4,500	6,700

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.

Maintenance responsibility varies along the Sorrento Valley Road facility group, so the facility group was broken into the following reaches for analysis purposes:

- Sorrento Valley Road 2, Reach 6 (earthen): Stations 15040 to 14760. This reach is privately owned with no recorded City of San Diego drainage easements.
- Sorrento Valley Road 2, Reach 5 (earthen): Stations 14760 to 14614
- Sorrento Valley Road 2, Reach 4 (earthen): Stations 14614 to 13567. This reach is privately owned with no recorded City of San Diego drainage easements.
- Sorrento Valley Road 1, Reach 3 (earthen): Stations 13567to 11900. This reach is privately owned with no recorded City of San Diego drainage easements.
- Sorrento Valley Road 1, Reach 2 (earthen): Stations 11900 to 11123
- Sorrento Valley Road 1, Reach 1 (earthen): Stations 11123 to 8284. This reach is privately owned with no recorded City of San Diego drainage easements.

The main focus of the hydraulic analysis is associated with the two reaches owned and maintained by the City of San Diego (City) which are Reach 2 and Reach 5. Private property owners or other public agencies are responsible for maintaining the other four reaches listed above. Note that a short (approximately 15-foot) portion of the earthen channel immediately upstream of the concrete channel has been identified as City maintenance responsibility. Maintenance of this area was completed as part of the Soledad Canyon Creek – Sorrento - Roselle (Roselle) facility group.

The upstream and downstream domains of analysis for the Sorrento Valley Road 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 natural channel above the facility group, from Station 16527 to Station 15040. The downstream domain of analysis begins at the concrete channel and extends down to the Sorrento Valley Boulevard bridge (Stations 8284 to 6794). Known water surface elevations provided by FEMA were used for the upstream boundary conditions. For the downstream boundary conditions known water surface elevations were extracted from the IHHA Report for Sorrento Creek-Flintkote-Soledad-Los Penasquitos Channel, prepared by URS Corporation, dated June 14, 2013.

The baseline condition for the Sorrento Valley Road facility group was based on observations during a July 2017 site visit. Consultation with the biological assessment team was performed to determine the current condition of the facility group is considered at its ultimate vegetated condition. The banks and bottom of the earthen channel portions, from Station 15040 to Station 8284, were assigned Manning's coefficient values ranging from 0.025 to 0.065, representative of the density of the vegetation observed and a few areas where riprap is present (Station 15321 to Station 14469). The concrete-lined channel portion in the downstream domain of analysis, from Station 8284 to Station 6794, was assigned Manning's coefficient values ranging from 0.016 to 0.030, based on observations of accumulated sediment/debris within the channel. Cross sections for the downstream domain of analysis (a portion of Roselle facility group) were based on the URS IHHA, the ESA Draft Memorandum for Sorrento Valley Channel Emergency Maintenance Analysis, dated June 2016, and the 2-foot contour interval topography provided by SanGIS. See the Representative Photos section below for examples of the condition of the facility as observed during the July 2017 site visit.

The maintained condition scenario is based on trimming vegetation in Reach 2 and Reach 5 only, and removing sediment/debris in the downstream domain of analysis. The assigned Manning's coefficients in the maintained condition for Reach 2, Reach 5, and the downstream domain of analysis were set at 0.030, 0.025, and 0.016, respectively. The assigned Manning's coefficients for Reach 2 and Reach 5 are reflective of slightly shorter and slightly less dense vegetation anticipated after trimming activities. The assigned Manning's coefficient for the downstream domain of analysis is reflective of the originally constructed concrete facility roughness. The Manning coefficients and sediment/debris depths in the rest of the reaches and upstream domain of analysis segments were kept the same as in the baseline condition scenario.

Model parameters and velocities for these scenarios are summarized in Table 3. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity for each analyzed segment.

Table 3. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Upstream Domain of Analysis (earthen)	16527-15040	Baseline: 0.025-0.045 Maintained: 0.025-0.045	Baseline: 5.0–15.8 Maintained: 5.0–15.8	-	Known Water Surface Elevation
Sorrento Valley Road 2, Reach 6 (earthen)	15040-14760	Baseline: 0.025–0.045 Maintained: 0.025–0.045	Baseline: 6.5–8.2 Maintained: 7.9–8.2	-	-
Sorrento Valley Road 2, Reach 5 (earthen)	14760-14614	Baseline: 0.025–0.040 Maintained: 0.025–0.040	Baseline: 4.4–8.2 Maintained: 4.4–8.2	-	-
Sorrento Valley Road 2, Reach 4 (earthen)	14614-13567	Baseline: 0.018-0.055 Maintained: 0.018-0.055	Baseline: 2.8-9.1 Maintained: 2.8-9.1	-	-
Sorrento Valley Road 1, Reach 3 (earthen)	13567-11900	Baseline: 0.018–0.055 Maintained: 0.018–0.055	Baseline: 2.8–9.1 Maintained: 2.8–9.1	-	-
Sorrento Valley Road 1, Reach 2 (earthen)	11900-11123	Baseline: 0.025–0.035 Maintained: 0.025–0.035	Baseline: 4.2–8.8 Maintained: 4.2–8.8	-	-
Sorrento Valley Road 1, Reach 1 (earthen)	11123-8284	Baseline: 0.018–0.065 Maintained: 0.018–0.065	Baseline: 3.7–8.0 Maintained: 3.7–8.0	Railroad Bridge (Station 11123-11083)	-
Downstream Domain of Analysis (concrete)	8284-6794	Baseline: 0.018–0.030 Maintained: 0.018–0.030	Baseline[1]: 3.6–6.8 Maintained: 3.6–6.8	-	Known Water Surface Elevation

[1] Velocities listed for the downstream domain of analysis (concrete channel) are based on the flow rate associated with the level of service in the Sorrento Valley Road facility group (upstream earthen channel). Velocities reported in Soledad Canyon Creek - Roselle facility group fact sheet correspond to the flow rates associated with the level of service for the concrete segment and therefore may differ from the velocities listed in this table.

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 maximum level of service of Reach 2, Reach 5 and Reach 6 in the baseline condition is the 100-year storm, or 5,600 cubic feet per second (cfs). The maximum level of service of Reach 3 and Reach 4 in the baseline condition is the 10-year storm and is capable of conveying 1,300 cfs before storm flows impact parking lots of industrial/commercial area. The maximum level of service of Reach 1 in the baseline condition is greater than the 10-year storm and is capable of conveying 1,700 cfs before storm flows impact industrial/commercial properties .

Recommended Maintained Condition

The hydraulic analysis results show that the level of service of Reach 2 and Reach 5 in the baseline condition is at the 100-year storm. Maintenance of Reaches 2 and 5 alone did not provide additional capacity benefits to the overall facility group. An additional scenario in which vegetation was trimmed in all reaches was also analyzed. The results from that scenario show that the benefits in conveyance capacity and freeboard would be marginal and that the additional maintenance could result in erosive velocities in several locations along the facility group. Therefore, no maintenance is recommended.

Post-Maintenance Erosion Control Measures

No maintenance is proposed. Therefore, no measures to reduce velocity or otherwise control erosion are recommended.

Potential Facility Capital Improvements

Since Reaches 2 and 5 provide a 100-year level of service in the baseline condition, no potential capital improvements are recommended for these segments.

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions, the levels of service for Reach 1, Reach 3, and Reach 4 were restricted by low bank heights. However, since these segments are outside the City's maintenance area, no potential capital improvements are recommended.

Summary Table

Table 4. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Sorrento Valley Road 2 Reach 6	15040 – 14760	5,600	5,600	100-year	100-year
Sorrento Valley Road 2 Reach 5	14760 – 14614	5,600	5,600	100-year	100-year
Sorrento Valley Road 2 Reach 4	14614 – 13567	1,300	1,300	10-year	10-year
Sorrento Valley Road 1 Reach 3	13567 – 11900	1,300	1,300	10-year	10-year
Sorrento Valley Road 1 Reach 2	11900 – 11123	5,600	5,600	100-year	100-year
Sorrento Valley Road 1 Reach 1	11123 – 8284	1,700	1,700	>10-year	>10-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, ">10-year" means greater than a 10-year event level of service but less than a 25-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 July 2017.

1. Upstream Domain of Analysis: Looking downstream (from the west side of I-8) at vegetation density and riprap located upstream from Reach 6.

2. Sorrento Valley 1: Looking downstream at vegetation density upstream from the Reach 2/Reach 3 transition.

3. Sorrento Valley 1 Reach 2: Looking downstream at channel bottom near the upstream side of railroad bridge.

4. Sorrento Valley 1, Reach 1: Looking downstream at channel bottom under the railroad bridge and vegetation density immediately downstream.

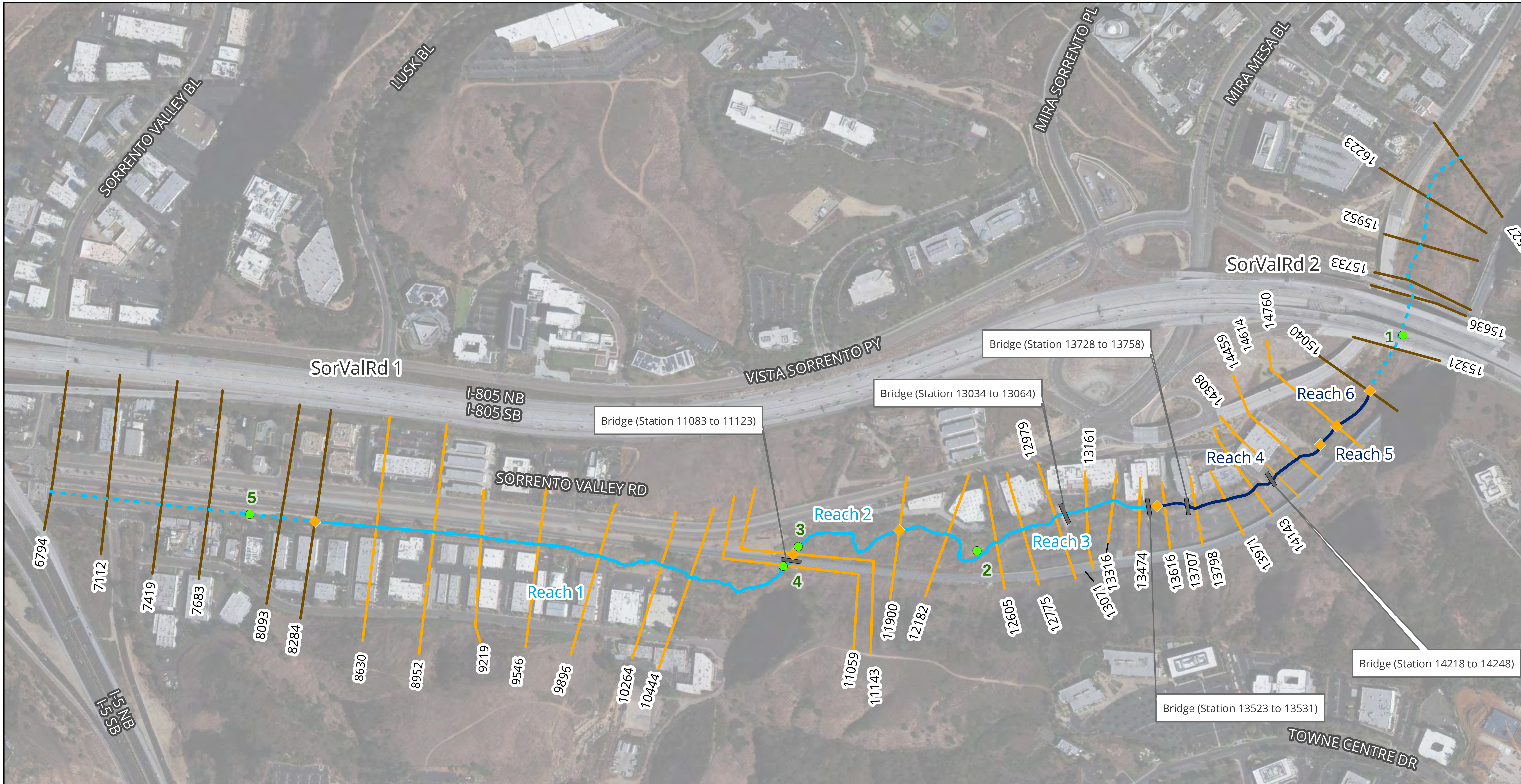
5. Downstream Domain of Analysis: Looking downstream near the upstream end of the concrete lined channel (Roselle 2).

Analysis Performed By: D-MAX Engineering Inc., URS Corporation, ESA

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.



Drainage Area: 11,392 acres

The City of SAN DIEGO

Facility Group Name: Soledad Canyon Creek - Sorrento
Segment Name: SorValRd 1 - 2
Facility Nos: 2-03-004, 2-03-006
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.11 Carroll Canyon Creek – Carroll (No. 2-03-012)

Summary of Recommended Maintenance

Facility Type	Bed: Concrete, Riprap, Earthen Banks: Concrete, Riprap, Earthen	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and overgrown vegetation from channel bottom and temporary diversion berm from Station 58[2] to Station 178 and from Station 497 to Station 561. • Removed sediment/debris in culvert from Station 178 to Station 497.	
Benefit	• Increases level of service from >2-year storm event (400 cfs) to >5-year storm event (900 cfs). • Reduces the risk of clogging the culvert from Station 497 to Station 178.	

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 Approximate station of right-of-way and the extent of the City's maintenance responsibility.

General Description

The Carroll Canyon Creek – Carroll (Carroll Canyon 1) facility group was classified as a Category 2 segment as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The facility group is located in the Los Peñasquitos Creek Watershed Management Area. The facility group consists of a small portion of Carroll Canyon Creek where it diagonally crosses Carroll Canyon Road. The facility group is an earthen channel that begins approximately 40 feet upstream of the Carroll Canyon Road box culvert and continues 110 feet downstream of the box culvert. The channel runs parallel to Carrol Canyon Road with El Camino Memorial Park located to the north of the facility group and a parking lot located to the south. The channel has a bottom width of approximately 14 to 28 feet and banks that are approximately 5 feet high.

As indicated on the as-built drawings no. 26930-14-D, no. 26930-15-D, no. 21569-3-D, no. 21569-14-D, and no. 21569-23-D, the Carroll Canyon facility group conveys flows from the natural upstream channel onto a diamond-shaped concrete apron inlet (approximately 40 feet long by 55 feet wide at the widest point) before entering a double 10-foot-wide by 5-foot-tall reinforced concrete box (RCB) culvert beneath Carroll Canyon Road. Per as-built drawing no. 26930-14-D and no. 26930-15-D Facing Class 1.4 feet thick riprap extends for approximately 400 feet immediately downstream of the culvert, after which 1/4 ton 2.7 feet thick riprap extends for approximately 100 feet further downstream. The natural channel continues southwest.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Carroll Canyon 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 Carroll Canyon Creek. 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
Carroll Canyon	363	655	1,000	1,846	3,000	4,500

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.

The baseline condition for the Carrol Canyon facility group was determined to be the current condition as observed during the site visit conducted by Geosyntec Consultants in May 2017. Emergency maintenance was previously performed at the upstream end of the Carroll Canyon facility group in 2015. The maintenance involved clearing the double box culvert and the adjacent upstream concrete apron. The facility group was assigned Manning's coefficient values ranging from 0.04–0.07 for the segment bottom width based on accumulated sediment and cobbles observed. The banks were assigned Manning's coefficient values ranging from 0.05–0.1, which represents the density of the vegetation observed within the facility. The average sediment/debris depth throughout the length of the facility group was estimated to be 2 feet, including within the culvert. Photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2017 site visit.

For the recommended maintained condition, the concrete portions of the facility group were assigned a Manning's coefficient value of 0.015, to reflect the roughness of the originally constructed facility, and the natural channel portions were assigned a Manning's value of 0.03 along the channel bottom.

Model parameters and velocities for the baseline and recommended maintained conditions for the Carroll Canyon 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
Carroll Canyon 1 (concrete, riprap)	577-17	Baseline: 0.04-0.1	Baseline: 1.9-6.5	Culvert (Station 497 to 178)	Normal Depth at Station 17
		Maintained: 0.015-0.03	Maintained: 3.5-7.16		

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

Carroll Canyon Creek facility group can convey 400 cubic feet per second (cfs), corresponding to a >2-year level of service, before the roadway and the culvert are impacted.

Recommended Maintained Condition

Due to the limited amount of City right-of-way downstream of the culvert, maintenance is limited to the culvert area. Recommended maintenance will remove deposited sediment/debris and vegetation from 29 feet upstream of the culvert inlet, within the culvert, and extending 120 feet downstream of the culvert outlet along the riprap lined bed and banks (i.e., Station 58 to Station 178). Removing sediment/debris and vegetation from the culvert improves the conveyance capacity to 900 cfs, with the level of service increasing to >5-year before roadway and the culvert are impacted.

Post-Maintenance Erosion Control Measures

The estimated velocities in the concrete and riprap portions of the facility group in the recommended maintained condition (Table 2) are below the maximum permissible velocities (35 feet per second (fps) and 12-14 fps, respectively) 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 Carroll Canyon Road culvert. It is also understood that large material (i.e., cobble) is being delivered from upstream and deposited at this location due to the constriction, as evidenced by the emergency sediment removal that was conducted in 2015. 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
Carroll Canyon 1	577-17	400	900	>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 May 2017.

1. Carroll Canyon 1: Natural channel upstream of double 10-foot-wide by 5-foot-tall RCB culvert.

2. Carroll Canyon 1: Sediment and cobbles accumulated on concrete inlet apron upstream of the culvert.

3. Carroll Canyon 1: Sediment and gravel accumulated at the culvert outlet.

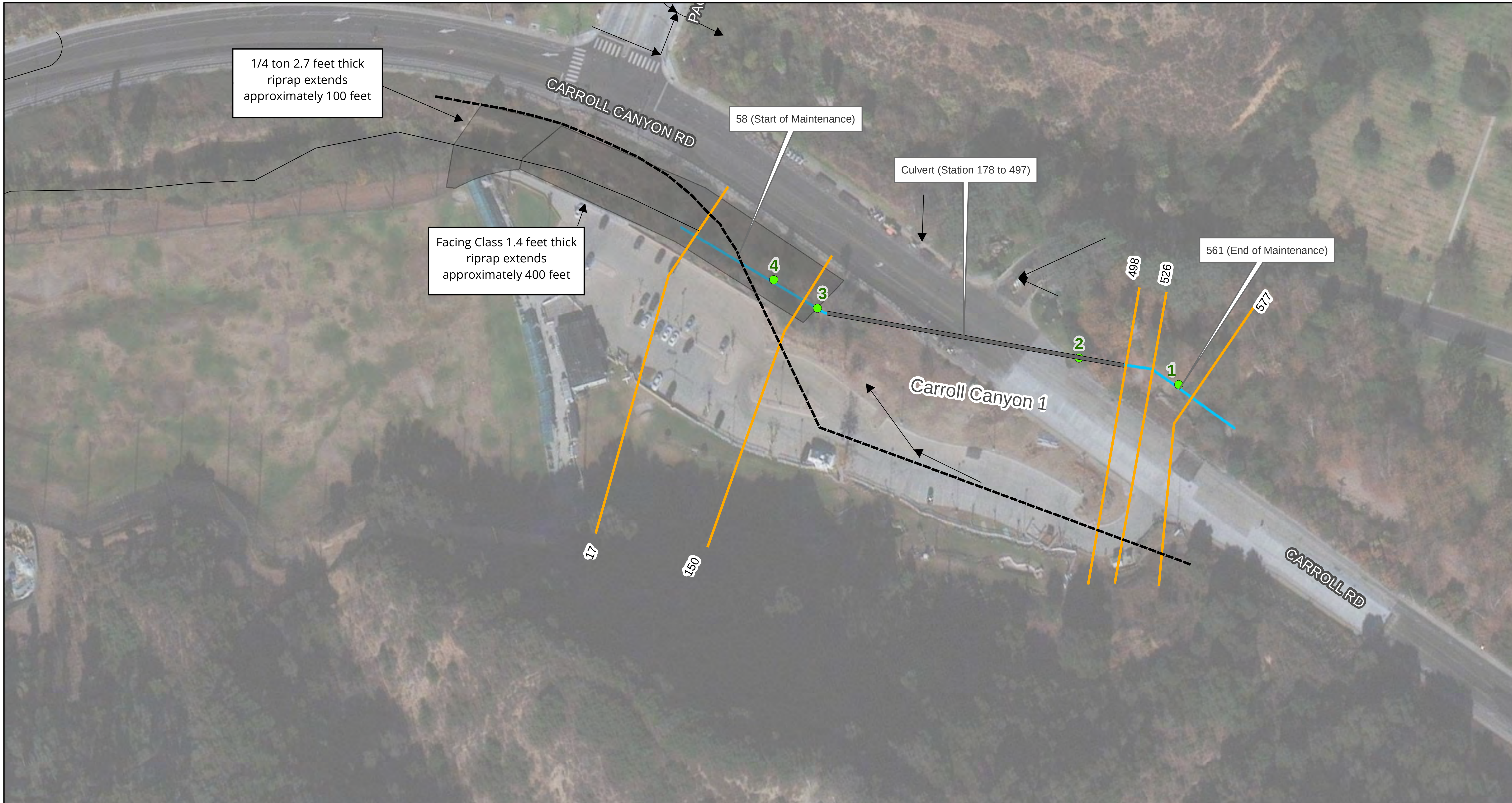
4. Carroll Canyon 1: Natural channel downstream of culvert.

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	MWMP Facility Cross Section
Right-of-Way	Domain of Analysis Cross Section
Storm Drain Conveyance	MWMP Facility Center Line
Culvert	Riprap

N

Drainage Area: 7,680 acres

0 25 50 100 Feet

The City of SAN DIEGO

Facility Group Name: Carroll Canyon Creek - Carroll
Segment Name: Carroll Canyon 1
Facility No: 2-03-012
Hydraulic Map - Municipal Waterways Maintenance

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.12 Soledad Canyon Creek - Flintkote (No. 2-03-100)

Summary of Recommended Maintenance

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from Station 49.81 to Station 1124.62. • Remove accumulated sediment/debris and vegetation from culvert from Station 300 to 383.	
Benefit	• Increase level of service from <1-year storm event (60 cfs) to >2-year storm event (80 cfs). • 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.

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
Flintkote 1	URS Corporation, 2013. IHHA Report for Sorrento Creek-Flintkote-Soledad-Los Peñasquitos Channel Map Numbers 7, 8, 9, 10, 11, & 12.	7

General Description

The Soledad Canyon Creek – Flintkote (Flintkote) 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 Flintkote facility group is located in the Los Peñasquitos Watershed Management Area. The facility group is bound by Flintkote Avenue to the south, commercial/industrial facilities to the east and west, and Soledad Canyon Creek to the north.

The Flintkote segment is an approximately 4-foot-deep concrete-lined trapezoidal ditch. The ditch bottom is 8 feet wide with 1:1 (H:V) side slopes. A 24-inch reinforced concrete pipe (RCP) and 30-inch RCP discharge into the upstream end of the segment. The segment conveys the flows in a northeasterly direction for approximately 400 feet where an existing wooden pedestrian bridge crosses the ditch. The ditch continues in the northeasterly direction approximately 340 feet to a 2-foot-high by 12-foot-wide reinforced concrete box culvert that conveys the flows under Roselle

Street. The box culvert discharges into a concrete ditch that conveys flows to a dual 36-inch RCP culvert that discharges into Soledad Canyon Creek.

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

Hydrology

The hydrologic peak flows presented in Table 2 were estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated April 1984*. The rational method computer program developed by Advanced Engineer Software (AES 2003) was used as the hydrologic model to determine the 2-, 5-, 10-, 25-, 50-, and 100-year peak flows.

Table 2. Hydrology Results

Segment	Reach	Peak Flow Rates by Storm Event Frequency (cfs)					
		2-year	5-year	10-year	25-year	50-year	100-year
Flintkote 1	1	69	87	101	120	131	140
	2	76	97	112	133	145	155

Hydraulics

A one-dimensional steady flow model was developed for the 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 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 the site visit conducted by URS Corporation in April 2013. The segment's bottom and banks were assigned Manning's coefficient values ranging from 0.016 for sections free of vegetation/debris and sediment to 0.04 for areas with dense vegetation and sediment/debris. The sediment/debris depth was estimated to be up to 1.25 feet. The assigned Manning's coefficient value for the recommended maintained condition was set at 0.016 to reflect the roughness of the originally constructed facility. 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 Flintkote facility group are summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Flintkote 1 (concrete)	Reach 1: 1124.62–383.12	Baseline: 0.04-0.016	Culvert (Station 383.12-299.56)
		Maintained: 0.016	
	Reach 2: 383.12–49.81	Baseline: 0.04-0.016	Culvert (Station 49.81)
		Maintained: 0.016	

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, Flintkote facility group can convey 60 cubic feet per second (cfs) (1-year level of service) before surrounding infrastructure is impacted.

Recommended Maintained Condition

Removing accumulated sediment/debris and vegetation from the facility group increases the conveyance capacity to 80 cfs (>2-year level of service) before impacting surrounding infrastructure.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Flintkote segment 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 conditions, the overall facility level of service was restricted by the culverts within the facility group.

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
Flintkote 1	49.81-1124.62	60	80	1-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 from the previous IHHA document are included in this fact sheet with the original photo numbers. A site visit was conducted by URS Corporation in April 2013.

IHHA 62. Flintkote 1: Looking upstream at the 24- and 30-inch RCP outlet.

IHHA 69. Flintkote 1: Looking west from approximately 400 feet east of Flintkote Avenue.

IHHA 79. Flintkote 1: Looking downstream at the double-barrel 36-inch RCP culvert entrance at downstream end of facility group.

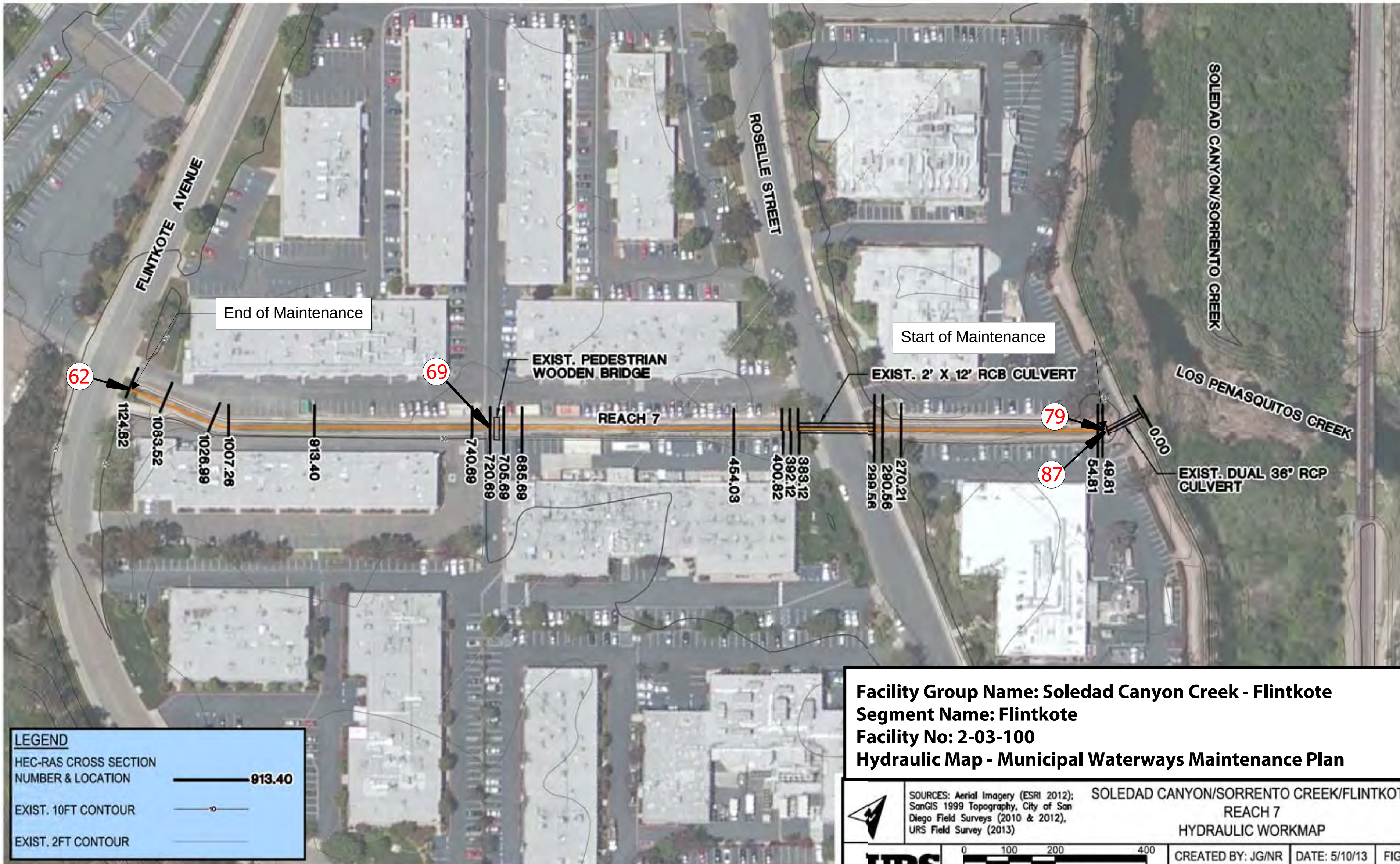
IHHA 87. Flintkote 1: Looking upstream direction from at the double-barrel 36-inch RCP culvert entrance at downstream end of facility group.

Analysis Performed By: URS Corporation

Fact Sheet Prepared By: Dudek

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 Flintkote facility group.



Facility Group Name: Soledad Canyon Creek - Flintkote
Segment Name: Flintkote
Facility No: 2-03-100
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES: Aerial Imagery (ESRI 2012); SanGIS 1999 Topography, City of San Diego Field Surveys (2010 & 2012), URS Field Survey (2013)

SOLEDAD CANYON/SORRENTO CREEK/FLINTKOTE
REACH 7
HYDRAULIC WORKMAP

URS

0 100 200 400
SCALE: 1"=200'
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: JG/NR	DATE: 5/10/13	FIG. NO:
PM: MM	PROJ. NO: 27679954.11400	10

A.13 Soledad Canyon Creek – Dunhill 1 (No. 2-03-150)

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 bottom of the facility from Station 329 to Station 759. • Bank repair from Station 715 to Station 759 on the north (street) side. • Maintain/repair existing debris fence as needed.	
Benefit	• The level of service remains <2-year storm event, but the conveyance capacity increases from 120 cfs to 125 cfs. • Reduce clogging potential of the downstream culvert. • Bank repair prevents damage to the roadway.	

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 Soledad Canyon Creek – Dunhill (Dunhill) 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 Soledad Creek – Dunhill facility group is located in the Peñasquitos Watershed Management Area. The facility is bordered by Dunhill Street to the north, Tower Road to the west, a commercial facility to the south, and Roselle Street to the east.

Runoff from commercial properties and slopes along Tower Road is conveyed to the Dunhill channel through an upstream underground storm drain pipe. The Dunhill channel begins at a 42-inch-diameter reinforced concrete pipe (RCP) storm drain outfall at the end of the upstream storm drain pipe, just east of the intersection of Tower Road and Dunhill Street. The earthen channel conveys runoff to the east towards Roselle Street. A debris fence is located at approximately Station 345, and the channel ends at a 54-inch-diameter RCP culvert that passes under Roselle Street. That culvert in turn discharges into Soledad 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 Soledad Creek – Dunhill 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.* 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
Dunhill 1	248	321	372	445	486	521

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 is the existing storm drain system that discharges into the Soledad Creek – Dunhill facility group. The downstream domain of analysis consists of an existing 54-inch-diameter, 330-foot-long RCP culvert that crosses Roselle Street and the commercial development to discharge flows into Soledad Creek. Based on the methodology presented in *Section 3.21..3 of the Hydrology and Hydraulics Technical Report,* the upstream domain of analysis has been excluded from the modeling.

The baseline condition for the Soledad Creek – Dunhill facility group was determined to be the current condition as observed during a site visit conducted by Dudek in May 2017. The banks and bottom of the Dunhill segment were assigned Manning's coefficient values ranging from 0.035 to 0.060, which represents the density of the vegetation and accumulated sediment/debris observed within the earthen channel. The sediment/debris deposition depth in the channel varied from approximately 6 inches at the upstream end to approximately 3 feet within the channel bottom at the downstream end. Evidence of sediment deposition in the roadway and along the top of bank, approximately 6 inches above the top of curb, was also noted at the downstream end of the channel during the site visit. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2017 site visit.

The assigned Manning's coefficient values in the recommended maintained condition were set at 0.027, reflecting the removal of sediment/debris and vegetation along the channel bottom.

Model parameters and velocities for the baseline and maintained conditions for Soledad Creek – Dunhill 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
Dunhill 1 (earthen)	329–759	Baseline: 0.035–0.06 Maintained: 0.027	Baseline: 2.2–6.0 Maintained: 1.4–6.0	—	Normal Depth at Station 759
Downstream Domain of Analysis	329–1	—	—	Culvert	Known water surface elevation

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 capacity 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 of the Dunhill channel provides a level of service of less than the 2-year storm and is capable of conveying up to 120 cubic feet per second (cfs) before flows impact the adjacent roadway. The capacity of the Dunhill channel is limited by the northern bank elevation and by the capacity of the culvert to Soledad Creek.

Recommended Maintained Condition

Removing accumulated sediment/debris (varies from 6 inches to 3 feet deep) and vegetation increases the conveyance capacity to 125 cfs. However, the level of service remains at less than the

2-year event before flows impact the adjacent roadway. Removal of the sediment/debris upstream of the debris fence located at Station 345 prevents a potential culvert obstruction. Repairing the bank is also recommended along the north side of the channel along Dunhill Street near the outlet at Station 759. At the time of the site visit, the back of the curb and gutter was beginning to be exposed. Bank repair will help prevent damage to the curb and gutter and undermining the road. A geotechnical evaluation may be required prior to maintenance activities to assess bank conditions. The existing debris fence should be maintained or repaired as needed based on the conditions at the time of maintenance.

Post-Maintenance Erosion Control Measures

Some of the estimated velocities in the Dunhill facility group are above the recommended permissible velocities for vegetated channels (less than 5 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. However, the hydraulic characteristics of this channel are complex in that during the field visit evidence of both erosion and sediment deposition was observed upstream of Station 592, where the model reports higher velocities in both the baseline and recommended maintained condition. Downstream of Station 592, the velocities decrease significantly to below 5 fps. It is recommended that velocity reduction measures consistent with the methodology described in *Section 6 of the Hydrology and Hydraulics Technical Report* be implemented upstream of Station 592 to prevent erosion.

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 capacity. Other potential improvements may be realized by evaluating the canyon upstream of the facility for opportunities to reduce sediment loading to the facility and an energy dissipation device at the outlet of the upstream culvert. 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
Dunhill 1 (earthen)	759-329	120	125	<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. The site visit was conducted by Dudek in May 2017.

1a. Dunhill 1: Looking upstream at 42-inch-diameter RCP outfall.

1b. Dunhill 1: Looking at bank erosion along Dunhill Street.

2. Dunhill 1: Looking downstream at vegetation and sediment in Dunhill segment.

3. Dunhill 1: Looking downstream at vegetation and sediment in Dunhill segment.

4. Dunhill 1: Looking downstream at vegetation and sediment/debris near downstream culvert inlet.

5. Dunhill 1: Looking upstream at debris fence, vegetation, and sediment/debris from downstream culvert inlet.

6. Dunhill 1: Looking downstream at entrance to 54-inch-diameter RCP culvert inlet.

Analysis Performed By: Dudek and Rick Engineering

Fact Sheet Prepared By: Dudek

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

N

Drainage Area: 253 acres

0 25 50 100 Feet

The City of SAN DIEGO

Facility Group Name: Soledad Canyon Creek - Dunhill
Segment Name: Dunhill 1
Facility No: 2-03-150
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.14 Chicarita Creek – Via San Marco (No. 2-05-140)

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 179 to Station 481 and Station 501 to Station 896. • Remove accumulated sediment/debris from the culverts at Station 179 and from Station 481 to Station 501. • Repair failed gunite ditch bottom lining from Station 209 to Station 451 and from Station 531 to Station 896.	
Benefit	• The level of service remains <2-year storm event, but conveyance capacity increases from 96 cfs to 112 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 Chicarita Creek – Via San Marco 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 located in the Los Peñasquitos San Diego Watershed Management Area. The facility is bordered by Carmel Mountain Road to the west, residential development to the north and south, and by Interstate 15 to the east. The facility is a gunite ditch with a trapezoidal cross-section as indicated on as-built drawing no. 11668-7-D. A portion of the ditch has a bottom width of 3-5.6 feet, banks that are 2-3 feet high with 1:1 (H:V) side slopes; and a longitudinal slope ranging from 0.01–0.09 (feet/feet) longitudinal. The segment begins on the south side of Carmel Mountain Road northeast of the intersection with Via San Marco where the 48-inch-diameter reinforced concrete pipe (RCP) culvert discharges flows into the ditch. The ditch continues southeast before making an approximate 90-degree turn, which is also where 36-inch-diameter double-barrel RCP culverts are located (Station 501 to 481). The ditch continues northeast until terminating north of the Caminito Quevedo cul-de-sac, where it enters a 48-inch-diameter RCP culvert (Station 179 to 99).

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Chicarita Creek – Via San Marco 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 3.1.1.3 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
Via San Marco 1	127	162	190	228	256	284

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 condition and the recommended maintained condition. 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.

The baseline condition was assumed to be the existing condition of the facility. In the baseline condition, the ditch bottom and banks were assigned Manning's coefficient value ranges of 0.025–0.04 and 0.02–0.05, respectively. These assignments were based on observations from the site visit conducted by Geosyntec Consultants in July 2017 where accumulated sediment/debris, leaf debris and light vegetation in the bottom of the ditch was observed. The sediment depth in the ditch was estimated to be 4 inches, and the sediment depth in one of the double pipe culverts (Station 501 to 481) was estimated to be 6 inches. A Manning's coefficient value for both the ditch bottom and banks for the recommended maintained condition was set at 0.016 to reflect the roughness of the originally constructed concrete facility.

Model parameters and velocities for the baseline and maintained conditions for the Chicarita Creek – Via San Marco 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 Coefficients	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Via San Marco 1 (gunite)	896–99	Baseline: 0.025–0.05	Baseline: 3.29–12.54	Culvert (Station 501 to 481), Culvert (Station 179 to 99)	Normal Depth at Station 896
		Maintained: 0.016	Maintained: 3.62–18.17		

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 facility flows rates, summarized in Table 1 in the Hydrology section, were used in determining of 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 conveyance capacities and levels of service for the segments are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained conditions.

Baseline Condition

The baseline condition is the current condition of the ditch. The Chicarita Creek – Via San Marco segment can convey 96 cubic feet per second (cfs) (<2-year level of service) before residential development is inundated at Station 481.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the ditch increases the conveyance capacity from 96 cfs to 112 cfs before residential development is inundated at Station 481. The level of service is unchanged from the <2-year storm event, but the recommended maintenance increases the conveyance capacity as well as reduces the risk of vegetation dislodging, flowing downstream, and clogging the culverts. Repair of the failed gunite ditch bottom lining from Station 531 to Station 896 is recommended. It is also recommended that the channel lining be repaired from Station 209 to Station 451 to prevent scour and further damage to the channel lining.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition (Table 2) 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 group level of service was restricted by the culvert at Station 501. In the maintained condition, the gunite ditch was estimated to provide a level of service greater than the 10-year storm event, but due to the restricted flow condition at the culvert at Station 501, the combined level of service is only the <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
Via San Marco 1	896-99	96	112	<2-year storm	<2-year storm

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. Via San Marco 1: Representative of segment with moderate vegetation, looking upstream.

2. Via San Marco 1: Representative of segment showing failure of gunite bottom, looking upstream.

3. Via San Marco 1: Upstream of double pipe culverts, looking downstream (Station 501).

4. Via San Marco 1: Pipe culvert at downstream end of segment, looking northeast (Station 179).

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: 188 acres

0 25 50 100 Feet

The City of SAN DIEGO

Facility Group Name: Chicarita Creek - Via San Marco
Segment Name: Via San Marco 1
Facility No: 2-05-140
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.15 Torrey Pines – Torrey Pines (No. 3-00-120)

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 upstream of each existing check dams from Station 1282 to Station 1334 • Remove accumulated sediment/debris and overgrown vegetation from Station 153 to Station 193. • Remove accumulated sediment/debris and overgrown vegetation at the drop inlet at Station 153. • Maintain/repair existing debris fences as needed.	
Benefit	• Increases level of service from <2-year storm event (60 cfs) to <5-year storm event (77 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 Torrey Pines – Torrey (Torrey Pines) 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 Torrey Pines facility group is an earthen segment located in the Mission Bay Watershed Management Area. The channel segment is located in an undeveloped canyon that drains in a westerly direction and discharges into a drop inlet adjacent to Torrey Pines Road at Pottery Park Drive. Along the channel segment, there are two check dams located at Station 1282 and Station 1312. Downstream of the two check dams, a 30" CMP culvert is located from Station 1259 to 1235. Between Stations 1073 and 1053, there is a double 12" PVC culvert. Further downstream is a foot bridge between Stations 973 and 958. Depth of the channel at the foot bridge is less than 3 feet. The facility bottom width varies from 1 to 14 feet. The facility length is approximately 1,185 feet long.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Torrey Pines 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 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
Torrey Pines	66	83	96	114	127	141

Hydraulics

A one-dimensional steady flow model was developed for the 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 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 prepared model is presented in the Hydraulic Reference Map.

The condition of the facility during the April 2017 field visit ranged from bare earth to heavy brush. The upstream domain of analysis extends approximately 220 feet upstream (greater than 20 channel widths). The downstream domain of analysis extends approximately 70 feet downstream (pipe culvert) of the defined channel segment to the west side of Torrey Pines Road. Given the measurements of the drop inlet at the downstream end of the channel and assuming a pipe slope of 10%, no backwater effects occur in the channel segment.

For the baseline condition, the channel bottom and sides were assigned Manning's coefficient values ranging from 0.02 to 0.06, which represents the density of the vegetation observed along the reach; the vegetation ranged from bare earth to heavy brush. The model accounted for up to 1 foot of sediment deposition between Station 254 and the downstream culvert at Station 153.

For the recommended maintained condition, the channel bottom and sides were assigned Manning's coefficient values ranging from 0.02 to 0.06. The sediment at the downstream end was removed to reflect the recommended maintenance.

Model parameters and outputs for the evaluated reaches are summarized in the Table 2.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Upstream Domain of Analysis	1557-1334	Baseline: 0.06 Maintained: 0.06	Baseline: 5.2-8.0 Maintained: 5.2-8.0	-	Normal Depth
Torrey Pines (earthen)	1334-153	Baseline: 0.02-0.06 Maintained: 0.02-0.06	Baseline: 0.6-11.8 Maintained: 0.6-11.8	Two check dams (Stations 1312 to 1282) Two culverts (Station 1259 to 1235 and Station 1073 to 1053) One foot bridge (Station 973 to 958) Drop inlet (Station 153)	-
Downstream Domain of Analysis	153-24	Baseline: 0.012 Maintained: 0.012	- -	Storm Drain System	Normal Depth at Station 24

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 in determining 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 conveyance capacity is limited by the physical characteristics of the channel (i.e., channel width, depth, etc.) between Station 153 and 290. The facility can convey 60 cubic feet per second (cfs) (< 2-year level of service) before the residential property is impacted (Station 158).

Recommended Maintained Condition

The recommended maintenance includes removing the deposited sediment/debris and vegetation upstream of the existing check dams from Station 1282 to Station 1334 and at the downstream end of the channel from Station 153 to Station 193. The recommended maintenance also includes removing overgrown vegetation at the drop inlet (Station 153). After performing the recommended maintenance, the conveyance capacity increases to 77 cfs (<5-year level of service). The existing debris fences should be maintained or repaired as needed based on the conditions at the time of maintenance. Removing the deposited sediment and vegetation for the remaining sections of the channel (Station 193 to 1282) was shown in the modeling to result in minimal improvements to the conveyance capacity and result in velocities that would be erosive to the channel (as defined in the *City of San Diego Drainage Design Manual, dated January 2017*). Therefore, maintenance is not recommended in these areas.

Post Maintenance Erosion Control Measures

The estimated velocity in the recommended maintenance area from Station 1282 to Station 1334 and from Station 153 to Station 193 are within the recommended permissible velocities for natural grass-lined channels (5 feet per second) 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 either facility.

Recommended Channel 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. 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.

Table 3. Summary Table

Segment Name/ Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintenance	Baseline	Recommended Maintenance
Torrey Pines	1334-153	60	77	<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. Site visit conducted by Geosyntec Consultants in April 2017.

1. Torrey Pines 1: Looking upstream at check dams.

2. Torrey Pines 1: Representative of light weeds in the channel segment.

3. Torrey Pines 1: Looking upstream, representative of thick brush in the channel segment.

4. Torrey Pines 1: The drop inlet at the downstream end of the channel.

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.

Check Dam	Domain of Analysis
Field Photo Location	WMP Channel Segment
Storm Drain Conveyane	Domain of Analysis Center Line
Culvert	WMP Facility Center Line

N

Drainage Area: 82 acres

0 20 40 80 Feet

The City of SAN DIEGO

Facility Group Name: Torrey Pines - Torrey
Segment Name: Torrey Pines 1
Facility No: 3-00-120
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 line is approximate.

November 2019

A.16 Alta La Jolla – Vickie (No. 3-00-150)

Summary of Recommended Maintenance

Facility Type	Detention Basin: Earthen	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from basin bottom, from around inlet structure at the far north end of the basin, and from outflow structure at the south end of the basin to restore the as-built condition. • Remove accumulated debris from storm drain outlet structures upstream of the basin.	
Benefit	• Reduces flood risk associated with outlet structure clogging and overtopping. • 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

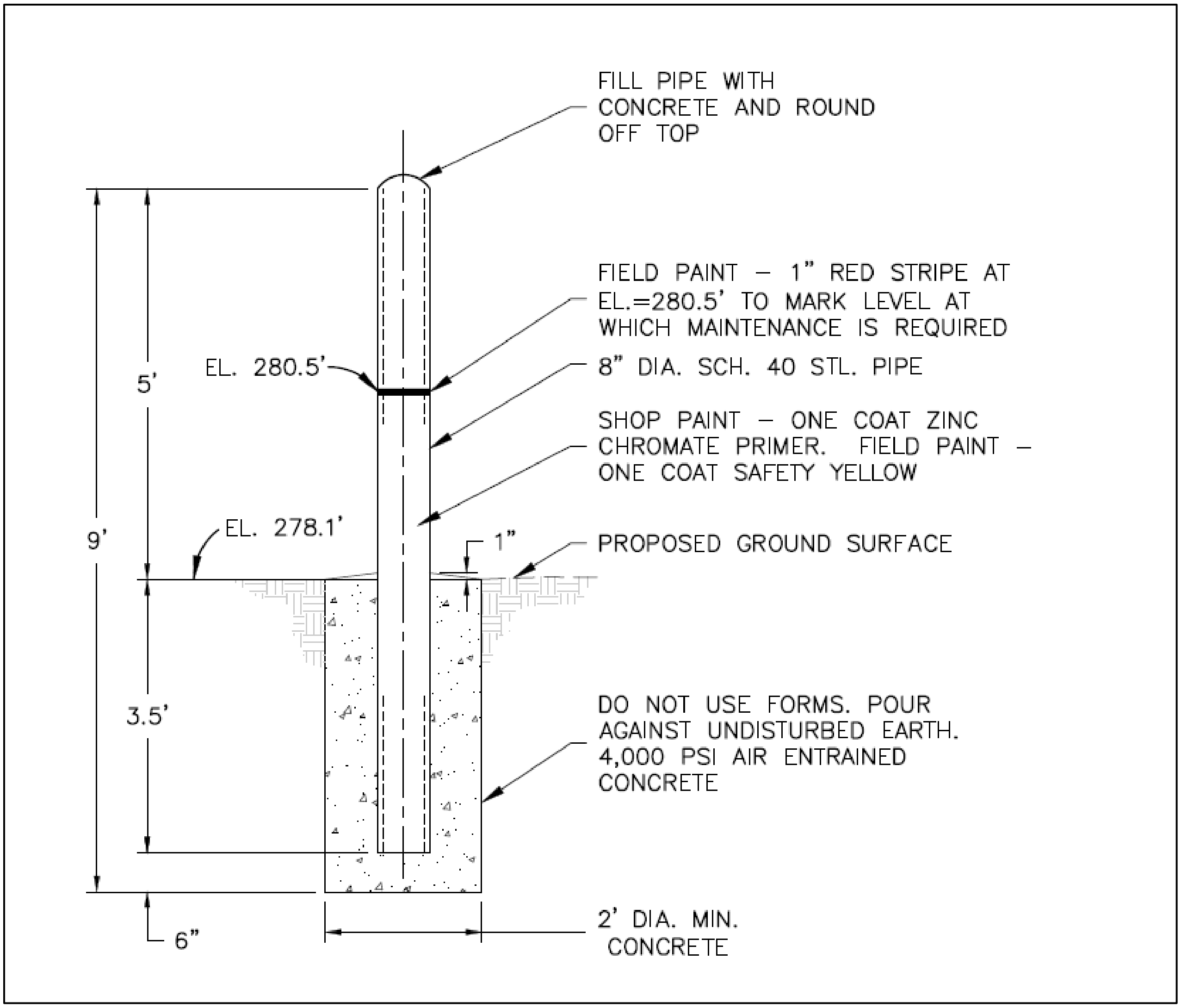
The Alta La Jolla – Vickie (Vickie) facility group was classified as a Category 2 detention basin as described in *Chapter 4, Section 4.3 of the Hydrology and Hydraulics Technical Report*. The facility is a 0.67-acre detention basin located in the Mission Bay Watershed Management Area and receives runoff from approximately 219 acres of upstream residential area. The detention basin is approximately 230 feet long and 95 feet wide with 2:1 slopes and a 2% internal slope. The facility is bordered on all sides by residential development.

The Alta La Jolla facility group drainage area includes runoff from an upstream ephemeral channel that flows from north to south within the canyon bottom, two storm drain tributaries flowing west to east, and one storm drain tributary flowing from east to west. The three storm drain tributaries convey storm water and non-storm water flows from urbanized areas surrounding the facility. The ephemeral channel conveys flows from urbanized and natural areas north of the facility via two storm drains under Alta La Jolla Drive. The two storm drains under Alta La Jolla Drive drain to an outlet structure that is then connected to a 42-inch Reinforced Concrete Pipe (RCP) that discharges to the toe of the buttress. At the toe of the buttress the RCP then discharges to another outlet structure that acts as flow splitter that diverts a portion of flows to the channel and the rest of the flows into a storm drain that discharges to the detention basin. The ephemeral channel and the basin drain to a 48-inch diameter culvert that is located at the southern site boundary of the facility at the northern terminus of Vickie Drive. The basin outlets to a storm drain which discharges into the Pacific Ocean at Tourmaline Beach, approximately 1.25 miles southwest of the facility.

The 4.64 acre-foot capacity basin has an earthen-lined bottom, a spillway height of approximately 11 feet (elevation 289 feet) from the basin invert (elevation 278 feet), and discharges to a 5-foot-tall outlet structure (as-built drawing no. 35418-D) enclosing one 48-inch-diameter reinforced concrete pipe. Based on the design documents the detention basin was designed to:

- attenuate the flood peak flows resulting from upstream development to reduce pressure flow in the downstream storm drain conduits; and
- treat as much of the volume of runoff from the 85^{th} percentile storm event as possible. Because the design balances water quality treatment with the long-term channel stability design; treatment of the entire 85^{th} percentile storm event could not be achieved. Flows for the 85^{th} percentile storm event that are not diverted to the detention basin are conveyed in the channel to support riparian vegetation similar to pre-development conditions.

To maintain the intended functions, the design documents recommend maintaining the basin once the sediment elevation within the basin reaches 280.5 feet. This is indicated by a red stripe on a bollard installed next to the outlet structure (see below). Sediment should be removed down to elevation 278.1 feet at the outlet and the basin bottom should be graded at a grade of 2 percent toward the basin inlet. The two storm drain outlet structure located upstream of the basin should be kept free of debris to maintain the function of the outlets and the flow splitter.



The following sections describe the maintenance criteria, and assessment used to develop conclusions and recommendations regarding maintenance specific to the Vickie facility group.

Baseline Condition

The baseline condition for the Alta La Jolla facility group was determined to be the current condition as observed during a site visit in May 2018. Dense vegetation, tree growth, and accumulated sediment/debris were observed in the detention basin. The sediment depth was estimated to be approximately 2.5 feet deep as observed at the bollard (see photos). All inlets and outlets were partially surrounded by vegetation. Ponded water was not observed in the basin bottom. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2018 site visit.

Recommended Maintained Condition

The recommended maintained condition for the Alta La Jolla facility group was determined to be the as-built condition as reflected in the as-built drawings no. 35418-D. If the deposited sediment/debris and vegetation within the basin bottom is removed, the total basin depth will be restored to 11 feet at the spillway embankment. Maintenance is recommend to reduce potential impacts to downstream residential properties.

Recommended Maintenance

This section presents the conclusions and recommendations based on the site visit and identifies whether maintenance is recommended for the facility group and the amount of maintenance recommended.

To maintain the intended functions, the design documents recommend maintaining the basin once the sediment elevation within the basin reaches 280.5 feet. The bollard monitoring pole in the basin bottom (see photos) indicate that the sediment accumulation has reached the "red stripe" (elevation 280.5) indicating sediment removal down to elevation 278.1 is necessary. The recommended maintenance includes removing accumulated sediment/debris and vegetation from basin bottom, from inlet culvert at the far north end of the basin, and from outflow structure at the south end of the basin to restore the as-built condition. In addition, the two storm drain outlet structures upstream of the basin are recommended to be maintained to remove any debris accumulation. The frequency will be established based on annual inspection of the basin and outlet works.

Representative Photos

Photos are from the site visit conducted in May 2018.

1. Alta La Jolla: Inlet observed to be mostly clear of sediment/debris.

2. Alta La Jolla: Vegetation observed in basin.

3. Alta La Jolla: Sediment/debris deposition depth is at “red stripe” elevation on monitoring bollard.

4. Alta La Jolla: Outlet structure observed to be partially blocked with sediment/debris.

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.

Field Photo Locations
Storm Drain Conveyance
Top Detention Basin Boundary

N

Drainage Area: 219 acres

Feet
0 135 270

The City of SAN DIEGO

Facility Group Name: Alta La Jolla - Vickie
Segment Name: Vickie 1
Facility No: 3-00-150
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.17 Mission Bay – Mission Bay High School

Summary of Recommended Maintenance

Mission Bay High School (MBHS) 1 (No. 3-02-103)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 8 to Station 17. • Removed accumulated sediment/debris and vegetation from the culvert at Station 17. • Maintain/repair existing debris fence as needed.	
Benefit	• Increase level of service from <1-year storm event (10 cfs) to 2-year storm event (43 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.

Pacific Beach - Olney (PBO) 1 (No. 3-02-101)

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 ditch from Station 1 to Station 8. • Removed accumulated sediment/debris and vegetation from the culvert at Station 1.	
Benefit	• The level of service remains 2-year storm event (59 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.

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

Table 1. Completed Reports

Segment	Report	Reach
MBHS 1	URS Corporation, 2014. IHHA Report for Mission Bay High School & Pacific Beach Drive/Olney Street Channels Map Numbers 36 & 37.	MBHS
PBO 1	URS Corporation, 2014. IHHA Report for Mission Bay High School & Pacific Beach Drive/Olney Street Channels Map Numbers 36 & 37.	PBO

General Description

The Mission Bay – Mission Bay High School (Mission Bay High School) 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 Mission Bay High School facility group is located in the Mission Bay/La Jolla Watershed Management Area and is in a relatively flat area in close proximity to Mission Bay. The facility group is bound by the Mission Bay High School bus loading zone to the north and Pacific Beach Drive to the south.

The Mission Bay High School (MBHS) segment (upstream segment) is a 2-foot-deep concrete trapezoidal ditch. The ditch bottom is 4 feet wide; the ditch top is 10 feet wide; and the longitudinal slope is 0.25%. The ditch begins at the outfall of a 27-inch-diameter reinforced concrete pipe (RCP) culvert located at the southwest corner of the Mission Bay High School bus loading\unloading zone and continues south to Pacific Beach Drive. The MBHS segment is bordered by Mission Bay High School to the east and residential development and Quincy Street to the west.

The Pacific Beach - Olney (PBO) segment (downstream segment) is an earthen segment that conveys runoff in a westerly direction along the north side of Pacific Beach Drive before entering a 42-inch-diameter RCP culvert underneath the intersection of Pacific Beach Drive and Olney Street. The segment is bound by residential development to the north. The RCP culvert conveys flows to the south side of Pacific Beach Drive and discharges into the Mission Bay Sewerage Interceptor System (MBSIS) box. This structure diverts dry weather flows into the sanitary sewer system where the storm water is treated. Overflow from the MBSIS box discharges into a bowl-shaped concrete basin that then discharges to a natural channel that conveys the runoff to Mission Bay.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Mission Bay High School facility.

Hydrology

The hydrologic peak flows presented in Table 1 were estimated using the modified rational method as described in the *City of San Diego Drainage Design Manual, dated April 1984* and the CivilCADD/CivilDesign Hydrology Program Package.

Table 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)						
	1-year	2-year	5-year	10-year	25-year	50-year	100-year
MBHS 1	33	43	58	70	80	95	104
PBO 1	46	59	80	96	110	130	143

Hydraulics

A one-dimensional steady flow model was developed for the 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 is presented in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition for both the MBHS and PBO segments were determined to be the ultimate vegetated condition as observed during the site visit conducted by URS Corporation in September 2013. Both facilities appeared to be very close to their vegetation growth capacity. The MBHS segment was assigned a Manning's coefficient value of 0.17 based on observations of dense vegetation and accumulated sediment throughout the concrete ditch. Sediment deposition in this segment was estimated to be between 3 to 4 inches. The PBO segment was assigned Manning's coefficient values ranging from 0.1 to 0.15 based on observations of dense vegetation and accumulated sediment throughout the earthen ditch, with a greater density of vegetation observed in the upstream section. Sediment deposition in this segment was estimated to be 6 inches, except at the entrance of the 42-inch-diameter RCP culvert where sediment deposition was estimated to be 8 inches. 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 MBHS segment in the recommended maintained condition was set at 0.015, to reflect the roughness of the originally constructed concrete facility. Manning's coefficient values ranging between 0.03 and 0.04 were assigned for the PBO segment to reflect the maintained condition in the earthen segment.

Model parameters for the baseline and maintained conditions for the Mission Bay High School facility group are summarized in Table 2.

Table 2. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
MBHS 1 (concrete)	17–8	Baseline: 0.17	Culvert (Station 8)
		Maintained: 0.015	
PBO 1 (earthen)	8–1	Baseline: 0.1–0.15	Culvert (Station 1)
		Maintained: 0.03–0.04	

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 in determining the level of service. The overall conveyance capacities and level of service for each segment are summarized in Table 3 for both the baseline and recommended maintained condition.

Baseline Condition

In the baseline condition, the capacity of the MBHS segment is limited by low bank heights between Stations 11 and 12, and can convey less than 10 cubic feet per second (cfs) (<1-year level of service). The PBO segment can convey 59 cfs (2-year level of service) in the baseline condition. During the 5-year storm, the PBO segment is overtopped along most of its length due to low bank heights throughout the reach.

Recommended Maintained Condition

Removing the deposited sediment and vegetation in the MBHS segment increases the conveyance capacity to 43 cfs (2-year level of service). The flooding limits of the segment are limited to between Stations 11 and 12.

Removing the deposited sediment and vegetation in the PBO segment preserves conveyance capacity at 59 cfs (2-year level of service). Removal of vegetation in this segment reduces the extent of the flooding conditions along the southerly portions of the MBHS segment and the southern areas of Mission Bay High School. The existing debris fence should be maintained or repaired as needed based on the conditions at the time of maintenance.

It was determined in the hydraulic analysis that the PBO segment hydraulics are governed by the capacity of the existing 42-inch-diamter RCP culvert at the downstream end of the segment, which in turn is impacted by the hydraulic conditions of the MBSIS box, located further downstream at the outfall of the RCP culvert. These hydraulic conditions contribute to the backwater effect experienced in the PBO and MBHS facility segments. The maintenance efforts in the PBO segment will have minimal impact for the segment itself, but provide benefits to the upstream MBHS segment flooding conditions.

Post-Maintenance Erosion Control Measures

The estimated velocities in the MBHS segment are below recommended permissible velocities for concrete lined (35 feet per second (fps)), and the estimated velocities in the PBO segment are not anticipated to exceed the recommended permissible velocities for earthen channels (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 MBHS and PBO segments were restricted by the 42-inch-diameter culvert at the downstream end of the PBO segment, which in turn is impacted by the MBSIS box. 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 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
MBHS 1 (concrete)	17–8	10	43	<1-year	2-year
PBO 1 (earthen)	8–1	59	59	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 in September 2013.

1. IHHA 24. MBHS 1: At upstream end of concrete segment, just downstream of 27-inch-diameter RCP and headwall.

2. IHHA 30. MBHS 1: North edge of southern parking lot looking south. Existing vegetation is 8–10 feet high within the concrete channel.

3. IHHA 31. PBO 1: High vegetation density and growth at the upstream end of the earthen channel were observed.

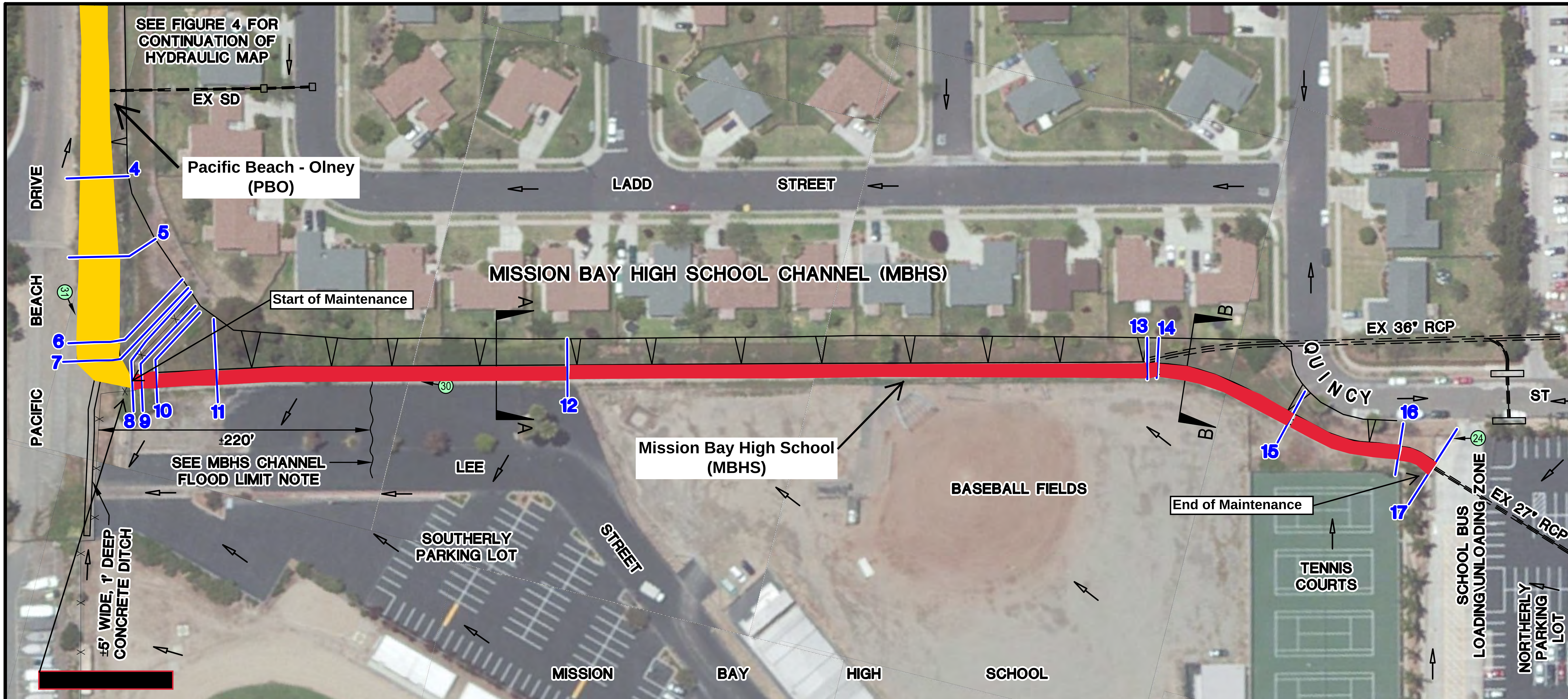
4. 7. IHHA 31. PBO 1: Downstream end looking east. High vegetation density and growth were observed

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 is included on the following page for the Mission Bay High School facility group.



LEGEND

HEC-RAS CROSS SECTION NO. AND LOCATION	4
APPROXIMATE CHANNEL TOP WIDTH	
EXIST. STORM DRAIN	
EXIST. 2:1 SLOPE	
EXIST. CHAINLINK FENCE	
FLOOD LIMIT	
PHOTOGRAPH LOCATION & ORIENTATION (PHOTOGRAPH DATE: SEPTEMBER 2013)	35
DIRECTION OF FLOW	

MBHS CHANNEL FLOOD LIMIT NOTE:
THE MBHS CHANNEL WILL FLOOD WITHIN THIS AREA DURING MOST EVENTS. FLOODING NORTH OF THIS POINT IS MINIMIZED WITH MAINTENANCE OF THE MBHS AND PBO CHANNELS.

SOURCES: AERIAL IMAGERY (ESRI, 2011), SAN-GIS, URS PHOTOS (AUG. 2012 & SEP. 2013).

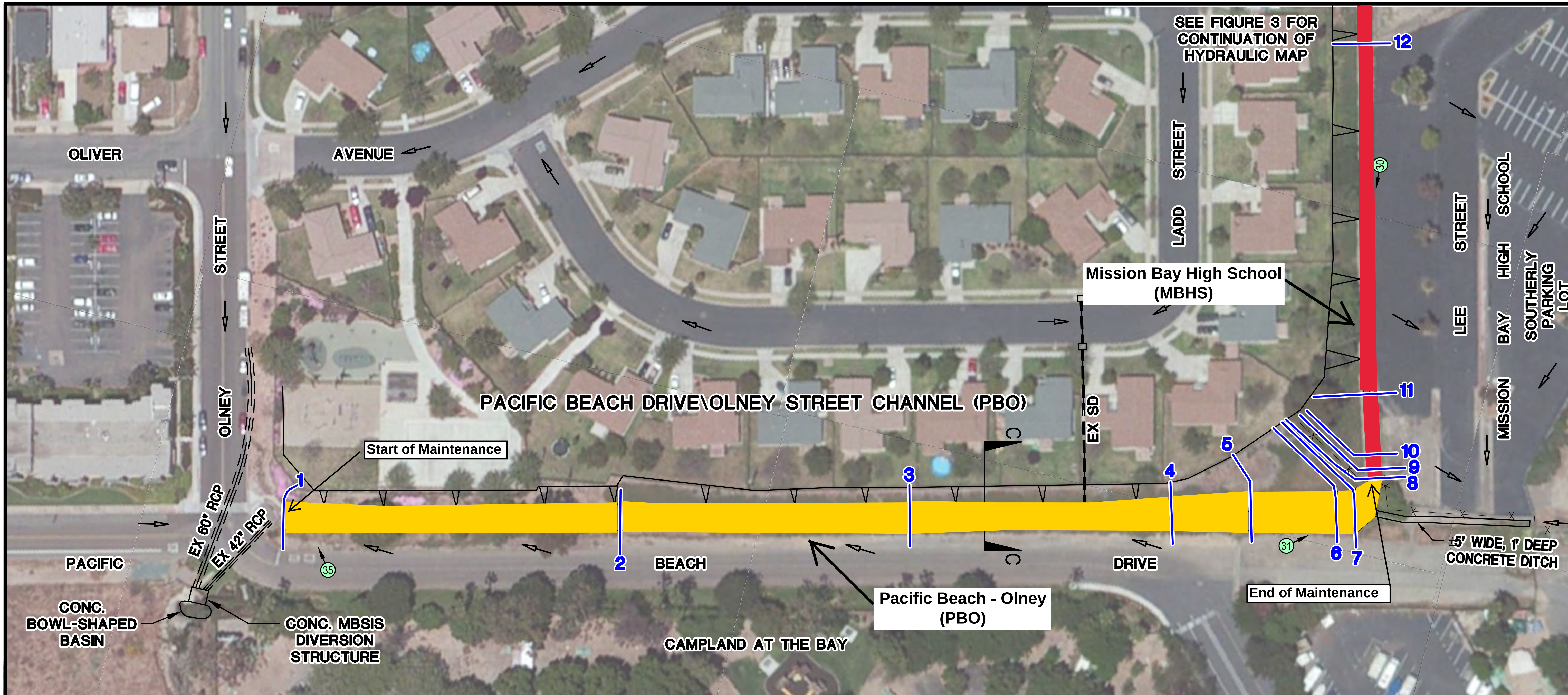
HYDRAULIC WORKMAP
MISSION BAY HIGH SCHOOL AND
PACIFIC BEACH/OLNEY STREET CHANNELS

URS

0 40 80 160
SCALE: 1" = 80'

CREATED BY: JG/NR	DATE: 10/4/2013	FIG. NO: 3
PM: BE	PROJ. NO: 27679067.05000	

Facility Group Name: Mission Bay - Mission Bay High School
Segment Names: Mission Bay High School (MBHS),
Pacific Beach - Olney (PBO)
Facility Nos: 3-02-103, 3-02-101
Hydraulic Map - Municipal Waterways Maintenance Plan



LEGEND

HEC-RAS CROSS SECTION NO. AND LOCATION 4

APPROXIMATE CHANNEL TOP WIDTH . . . .

EXIST. STORM DRAIN . . . .

EXIST. 2:1 SLOPE . . . .

EXIST. CHAINLINK FENCE . . . .

PHOTOGRAPH LOCATION & ORIENTATION (PHOTOGRAPH DATE: SEPTEMBER 2013) . . . 35

DIRECTION OF FLOW . . . .

SOURCES: AERIAL IMAGERY (ESRI, 2011), SAN-GIS, URS PHOTOS (AUG. 2012 & SEP. 2013).

HYDRAULIC WORKMAP
MISSION BAY HIGH SCHOOL AND
PACIFIC BEACH/OLNEY STREET CHANNELS

URS

0 40 80 160
SCALE: 1" = 80'

CREATED BY: JG/NR	DATE: 10/4/2013	FIG. NO: 4
PM: BE	PROJ. NO: 27679067.05000	

Facility Group Name: Mission Bay - Mission Bay High School
Segment Names: Mission Bay High School (MBHS),
Pacific Beach - Olney (PBO)
Facility Nos: 3-02-103, 3-02-101
Hydraulic Map - Municipal Waterways Maintenance Plan

A.18 Mission Bay – Mission Bay Drive (No. 3-02-130)

Summary of Recommended Maintenance

Facility type	Bed: Earthen Banks: Earthen	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and overgrown vegetation from the banks and bed of the earthen channel from Station 245 to Station 1330. • Maintain/repair existing trash rack as needed.	
Benefit	• The level of service remains >2-year storm event and conveyance capacity remains unchanged (208 cfs), but reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert. • The water surface elevation (WSE) at the upstream end of the channel (Station 1330) improves from the 5-year WSE in the baseline condition to the 100-year WSE in the recommended maintained condition. This provides benefits to properties immediately upstream with a history of flooding.	

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 Mission Bay – Mission Bay Drive (Mission Bay Drive) facility group was classified as a Category 2 channel segment as described in Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report. The facility group is an earthen segment located in the Mission Bay/La Jolla Watershed Management Area. The facility group is bordered by a golf course on the southwest and by Grand Avenue and Mission Bay Drive to the northeast.

The Mission Bay Drive facility group is an earthen channel with a trapezoidal cross-section, as indicated on as-built drawing no. 2319-D, that receives flow from a culvert underneath Grand Avenue from the northwest. The channel bottom is 20 feet wide; the banks are 6 feet high with 1.5:1 (H:V) earthen side slopes. Runoff is conveyed through the facility group in a southeasterly direction to a 60-inch-diameter reinforced concrete pipe (RCP) culvert located at Station 245. The culvert conveys flows into the storm drain system and ultimately to Mission Bay. 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 Mission Bay Drive 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
Mission Bay Drive 1	198	250	292	347	389	432

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.

The baseline condition was defined as the existing condition of the channel. For the analysis of the baseline condition, the channel bottom was assigned a Manning's coefficient value of 0.10, and side slopes were assigned 0.07 based on dense vegetation, including large trees, that was observed during the field visits conducted by Geosyntec Consultants in July 2017. The accumulated sediment depth in the channel was estimated to range from 2 feet deep at the upstream end (Station 1302) to 6 feet deep towards the downstream end. Sediment/debris from the last 15-20 feet of the segment (up to the culvert at Station 245) appears to have been removed at some unknown time prior to the field visit. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the July 2017 site visit. The culvert entrance at Station 245 is outfitted with a metal trash/debris rack with vertical bars. The hydraulic impact of the rack on the culvert is accounted for in the existing and recommended maintained condition models by increasing the entrance loss coefficient from 0.2 (HEC-RAS User's Manual, Table 6-3) to 0.4.

For the recommended maintained condition, the earthen channel bottom and side slopes were assigned a Manning's coefficient value of 0.03 to reflect sediment/debris and vegetation removal from the earthen bottom.

Model parameters and velocities for the baseline and recommended maintained conditions for the Mission Bay Drive 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
Mission Bay Drive 1 (earthen)	1330–245	Baseline: 0.10–0.07	Baseline: 0.83–2.15	Culvert (Station 245)	Critical Depth; Known Water Surface Elevation
		Maintained: 0.03	Maintained: 0.8–1.01		

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 channel segment can convey 208 cubic feet per second (cfs)(>2-year level of service), before the roadway and culvert are impacted at Station 245. In the baseline condition, the WSE at the upstream end (Station 1330) corresponds to the 5-year level of service prior to impacting Grand Avenue and upstream properties to the north.

Recommended Maintenance Condition

Removing deposited sediment/debris and vegetation from the channel bed and banks does not improve the conveyance capacity or level of service from the baseline condition (208 cfs, >2-year level of service, respectively) before the roadway and culvert are impacted at Station 245. However, the recommended maintenance reduces the risk of vegetation, sediment, or debris flowing downstream and clogging the culvert at Station 245. In addition, the recommended maintenance decreases the WSE at the upstream end of the segment where flooding has historically impacted Grand Avenue and properties in the vicinity. In the recommended maintained condition, the WSE decreases at the upstream end to correspond to the 100-year level of service. The existing trash rack should be maintained or repaired as needed based on the conditions at the time of maintenance.

Recommended Temporary Velocity Reduction Measures

The estimated velocities in the recommended maintained condition (Table 2) are below the maximum permissible velocities for an earthen channel (less than 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 this facility group.

Recommended 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 capacity of the downstream culvert at Station 245. 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
Mission Bay Drive 1	1330–245	208	208	>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. Photos are from the site visits conducted by Geosyntec Consultants in July 2017.

1. Mission Bay Drive 1: At upstream end of channel; culvert not visible.

2. Mission Bay Drive 1: Representative upstream channel segment with dense vegetation.

3. Mission Bay Drive 1: Representative downstream channel segment with dense vegetation.

4. Mission Bay Drive 1: Recently maintained culvert inlet at downstream end of segment.

Analysis Performed By: Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

A map illustrating the facility group 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: 266 acres

0 25 50 100 Feet

The City of SAN DIEGO

Facility Group Name: Mission Bay - Mission Bay Drive
Segment Name: Mission Bay Drive 1
Facility No: 3-02-130
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.19 Miramar – Engineer (No. 3-03-901)

Summary of Recommended Maintenance

Facility Type	Bed: Concrete, Asphalt Banks: Concrete, Asphalt	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from Station 12 to Station 1232. • Remove accumulated sediment/debris and vegetation from culverts at Station 12 and Station 1232.	
Benefit	• Increases conveyance capacity from 15 cfs to 45 cfs; level of service remains <2-year storm event in Reach 1. • Increases conveyance capacity from <10 cfs to 25 cfs; level of service remains <2-year storm event in Reach 2. • Increases conveyance capacity from <10 cfs to 40 cfs; level of service remains <2-year storm event in Reach 3. • Decreases water surface elevations, reducing the limits and frequency of flooding.	

[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
Engineer 1	Rick Engineering, 2017. IHHA Report for 7969–7971 Engineer Road Channel Map Number 47.	1, 2, 3

General Description

The Miramar – Engineer (Engineer) facility group was classified as a Category 1 facility segment as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The majority of the area tributary to the Engineer facility group is located in the Mission Bay Watershed Management Area; however, the downstream storm drain system drains north and eventually discharges to San Clemente Canyon near Convoy Street. Therefore, the facility group is located in the Los Peñasquitos Watershed Management Area. The Engineer facility group runs parallel to Engineer Road, bordered by commercial/industrial development and is bound by Mercury Road to the east and by Brinell Street to the west.

The Engineer facility group is a concrete- and asphalt-lined ditch. The upstream end of the Engineer facility group is defined as the outfall of a concrete swale that extends along a parking lot privately owned by the Extron Corporation. Runoff is conveyed by the facility in a northwesterly direction for approximately 1,220 feet before entering a 36-inch RCP crossing beneath Engineer Road and into a storm drain system. The facility group has been divided into three reaches for analysis purposes. See Hydraulic Reference Map located at the end of this fact sheet.

Reach 3 (Stations 1136.944 to 1232) is a concrete lined ditch and Reach 2 (Stations 293 to 1136.944) is a concrete- and asphalt-lined trapezoidal ditch per as-built drawing no. 9603-D. The bottom widths are approximately 3 feet wide and approximately 1 foot deep with 1:1 (H:V) side slopes. Reach 3 conveys runoff from the concrete swale in the Extron Corporation parking lot and extends approximately 100 feet downstream. Reach 2 conveys flows from the downstream end of Reach 3 and extends approximately 840 feet downstream to the upstream end of Reach 1. Per as-built drawing no. 9606-6-D, Reach 1 (Stations 12 to 293) is a concrete-lined trapezoidal ditch. The bottom width is approximately 3 feet wide and ranges from approximately 1 to 4 feet deep with side slopes of 1:1 (H:V). At the upstream end, Reach 2 transitions into Reach 1 and extends approximately 280 feet downstream to the downstream end of the facility, where a 36-inch RCP outlet extends beneath Engineer Road and discharges into the 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 Engineer facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval presented in Table 2 were estimated based on the size of the watershed tributary to the channel and the peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation, as described 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
Engineer 1	125	157	182	205	239	256

Hydraulics

A one-dimensional steady flow model was developed for the Engineer 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 Engineer facility group is defined as the current condition as observed during site visits conducted by Rick Engineering in November 2015 and November 2016. In the baseline condition, Reach 3 was assigned a Manning's coefficient value of 0.06 to reflect medium vegetation within the ditch banks and along the ditch bottom. In Reach 2, the assigned Manning's coefficient values varied. A Manning's coefficient value of 0.018 was assigned for portions of the ditch where clean concrete was present. A value of 0.09 was used for a portion of the ditch where an estimated 1.5-foot depth of sediment with dense vegetation was present (Station 394.7933 to Station 503.2619). A Manning's coefficient value of 0.02 was used to reflect the standing water observed in the ditch (Station 253.5598 to Station 394.7933, and Station 503.2619 to Station 736.741). Values of 0.03 and 0.06 were used for the remaining portion of Reach 2 to reflect vegetation and standing water (Station 736.741 to Station 1136.944). Reach 1 was assigned a Manning's coefficient value of 0.018 where clean concrete was observed and a value of 0.075 to reflect the medium to dense vegetation observed during the site visits.

In the recommended maintained condition, the Manning's coefficient value for the entire facility group was set at 0.018 to reflect the roughness of the originally constructed facility.

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

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions
Engineer 1 (Concrete)	Reach 3: 1223.959–1136.944	Baseline: 0.06	Culvert (Station 1223.959)
		Maintained: 0.018	
	Reach 2: 1136.944–253.5598	Baseline: 0.018–0.09	–
		Maintained: 0.018	
	Reach 1: 253.5598–16.13424	Baseline: 0.018–0.075	Culvert (Station 16.13424)
		Maintained: 0.018	

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, Reach 3 and Reach 2 within the Engineer facility group each can convey <10 cubic feet per second (cfs) (<2-year level of service) before surrounding infrastructure is impacted. Reach 1 convey 15 cfs (<2-year level of service) before surrounding infrastructure is impacted.

Due to the inlet control and size constraint of the downstream 36-inch RCP that runs underneath Engineer Road, the tailwater condition causes an increase in water surface elevation at the downstream end of the channel, which limits the capacity of the already undersized channel. The downstream water surface elevation was based on inlet control hydraulic analysis.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the Engineer facility group increases the conveyance capacities from <10 cfs to 40 cfs in Reach 3, <10 cfs to 25 cfs in Reach 2, and 15 cfs to 45 cfs in Reach 1. The level of service is unchanged from the <2-year storm event for the facility group before surrounding infrastructure is impacted.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Engineer facility are below recommended permissible velocities for concrete-lined ditches (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 either facility.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the overall level of service for the Engineer facility was restricted due to the downstream 36-inch RCP that runs beneath Engineer Road, which causes tailwater to extend approximately 170 feet upstream of the existing 36-inch RCP for all storm events equal or greater than a 2-year storm event. 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 3. Summary Table

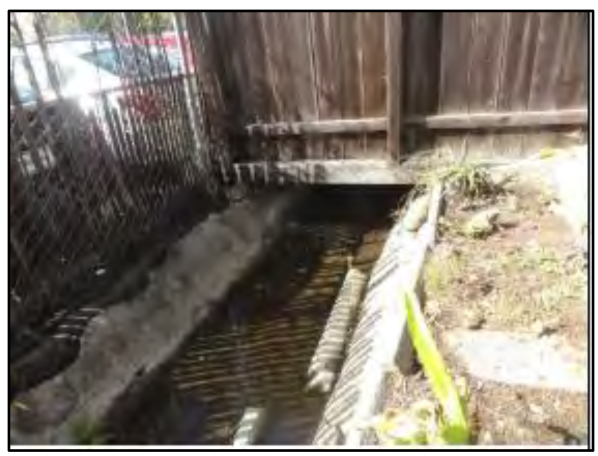
Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Engineer 1	Reach 3: 1223.959–1136.944	<10	40	<2-year	<2-year
	Reach 2: 1136.944–253.5598	<10	25	<2-year	<2-year
	Reach 1: 253.5598–16.13424	15	45	<2-year	<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 November 2015 and November 2016.

IHHA 1. Engineer 1 (Reach 1): Downstream end of facility group, facing east towards the 36-inch RCP (November 2015).



IHHA 6. Engineer 1 (Reach 2): Downstream portion of reach facing west (November 2015).

IHHA 8. Engineer 1 (Reach 2): Downstream portion of reach facing east at vegetation blocking the ditch (November 2015).

IHHA 15. Engineer 1 (Reach 2): Upstream portion of reach facing west, showing sediment and vegetation in ditch (November 2015).

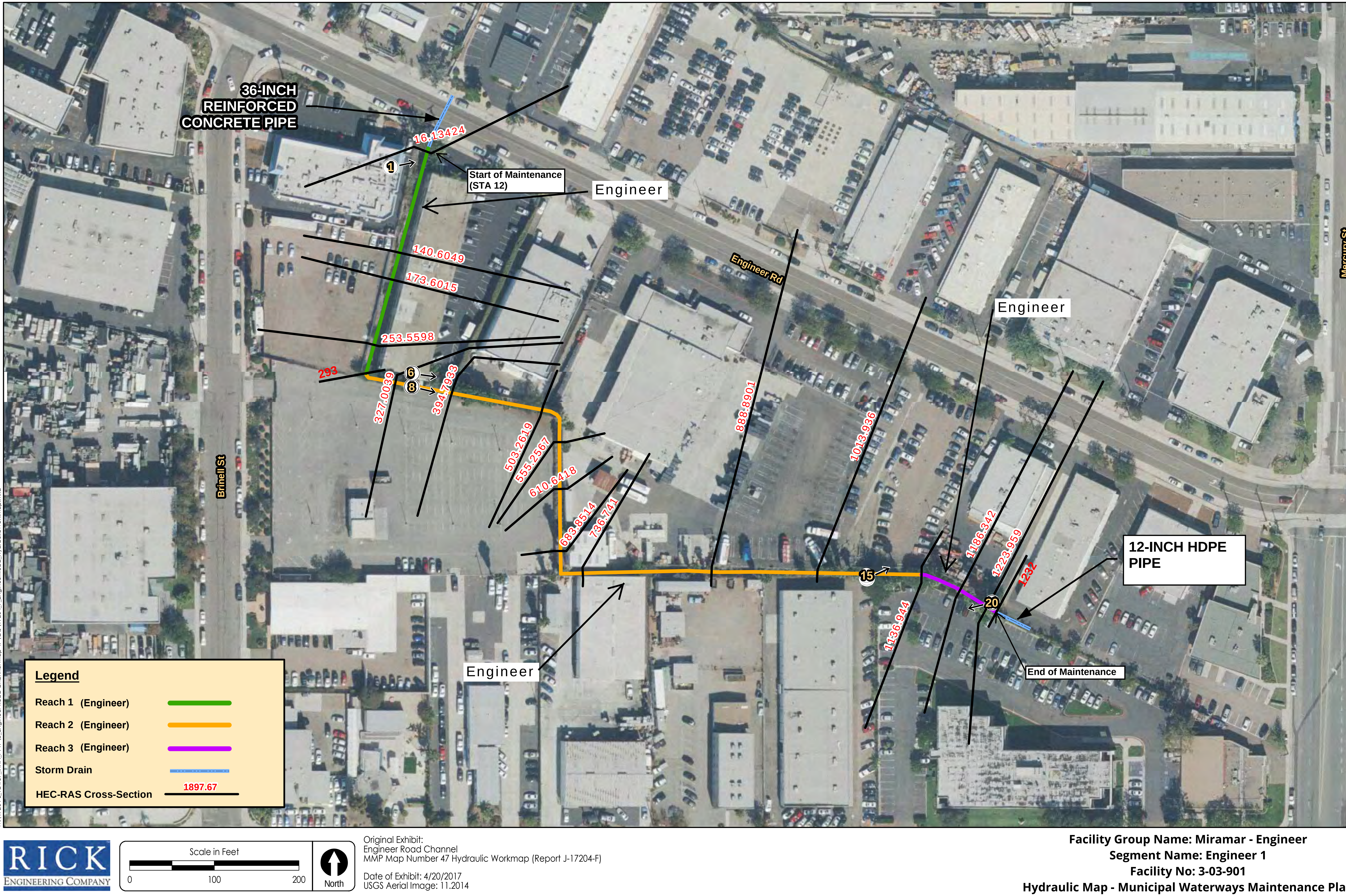
IHHA 20. Engineer 1 (Reach 3): Upstream end of facility group facing west.

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 Engineer facility group.



RICK ENGINEERING COMPANY

Original Exhibit:
Engineer Road Channel
MMP Map Number 47 Hydraulic Workmap (Report J-17204-F)

Date of Exhibit: 4/20/2017
USGS Aerial Image: 11.2014

Facility Group Name: Miramar - Engineer
Segment Name: Engineer 1
Facility No: 3-03-901
Hydraulic Map - Municipal Waterways Maintenance Plan

A.20 Tecolote Creek - Chateau

Summary of Recommended Maintenance

Chateau 1 (No. 3-04-055)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 959 to Station 3301, Station 3351 to Station 3970, and Station 4064 to Station 5607, Station 5851 to Station 6229. • Remove accumulated sediment/debris in culverts from Station 3301 to 3351, Station 3970 to Station 4064, and Station 5607 to Station 5851.	
Benefit	• The level of service remains at >2-year storm event (334 cfs). • 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.

Chateau 2 (No. 3-04-250)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 0 to Station 105 and Station 165 to Station 1117. • Remove accumulated sediment/debris in culverts from Station 105 to 165.	
Benefit	• Increase level of service from <2-year storm event (196 cfs) to <50-year storm event (435 cfs). • 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.

General Description

The Tecolote Creek - Chateau (Chateau) 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 Chateau facility group is a concrete ditch located in the Mission Bay/La Jolla Watershed Management Area. In general, the Chateau facility group runs parallel to Chateau Drive, is bordered by residential development, and is bound by Diane Avenue to the east and by Camber Drive to the west. At its downstream end, the segment discharges into a canyon west of Genesee Avenue.

The Chateau facility group is split into two segments (Chateau 1 and Chateau 2) that join southeast of the intersection of Boxwood Drive and Chateau Drive. Chateau 1 is defined from Station 6229 to Station 959, and Chateau 2 is defined from Station 1117 to Station 0. Chateau 1 joins Chateau 2 just upstream of Station 2100.

Chateau 1 is a concrete trapezoidal ditch as indicated on as-built drawing nos. 10208-6A-D and 10208-7A-D, 11473-2-D, and 10476-D. A portion of the ditch bottom width varies from 3 to 10.5 feet wide and the bank heights vary from 4.33 to 5.5 feet high with 1.5:1 (H:V) side slopes; and the ditches have longitudinal slopes ranging from 0.007 to 0.02 (feet/feet). Chateau 1 begins at the upstream end of the facility group and receives flows from a 66-inch-diameter reinforced concrete pipe (RCP) storm drain system outlet southwest of the Castelton Way cul-de-sac. Per as-built no. 11473-2-D, the segment continues southwest and enters a 72-inch-diameter CMP culvert beneath Chateau Drive, takes an approximately 90-degree turn, and continues northwest. The ditch enters a double 5-foot wide by 4-foot high reinforced concrete box (RCB) culvert beneath Derrick Drive, a 10-foot wide by 4-foot high RCB culvert beneath Verley Court, and continues northwest parallel to Chateau Drive. At Station 2100, the flows from Chateau 1 and Chateau 2 confluence and continue along the Chateau 1 ditch until the flows enters a double-barrel 84-inch-diameter CIPCP culvert that crosses beneath a residential complex and transitions into an 8-foot-wide by 8-foot-high RCB culvert beneath Genesee Avenue, per as-built nos. 19248-3-D and 4295-D, respectively. The culvert then discharges into a canyon west of Genesee Avenue.

Chateau 2 is a concrete trapezoidal ditch as indicated on as-built drawing no. 10476-10-D and 10476-11-D. A portion of the ditch bottom width is 4 feet and the banks are 4.5 feet high with 1.5:1 (H:V) side slopes. The segment is approximately 1,117 feet in total length, and at the downstream end, it enters a 10-foot-wide by 3-foot-high RCB culvert beneath Chateau Drive. The culvert discharges into Chateau 1 upstream of Station 2100. See 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 Chateau 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 Tecolote Creek. 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	Reference Stations	Peak Flow Rates by Storm Event Frequency (cfs)					
		2-year	5-year	10-year	25-year	50-year	100-year
Chateau 1	6229-959	324	467	640	883	1100	1500
Chateau 2	1117-0	236	295	354	387	442	491

Hydraulics

A one-dimensional steady flow model was developed for the 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. 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 segments evaluated in the model are presented in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition for both segments of the Chateau facility group was determined to be the current condition as observed during a site visit conducted by Geosyntec in May 2017. The bottom of the ditch was assigned Manning's coefficient values ranging from 0.015–0.04, which represent the concrete segment with minor sediment/debris and vegetation present. The banks of the facility were assigned Manning's coefficient values ranging from 0.015–0.07. The facility group was observed to be mostly clean during the site visit. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2017 site visit.

The assigned Manning's coefficient value for the bottom and side of the Chateau facility group in the recommended maintained condition was set at 0.015 to reflect the roughness of the originally constructed concrete facility. The banks of the facility were assigned Manning's coefficient values ranging from 0.03–0.07.

Model parameters and velocities for the baseline and maintained conditions for the Chateau 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
Chateau 1 (concrete)	6229-2100	Baseline: 0.015-0.07	Baseline: 1.8-20.2	Culverts (Stations 5851 to 5607, 4064 to 3970, 3351 to 3301), Confluence with Chateau 2 (Station 2100)	-
		Maintained: 0.015-0.07	Maintained: 1.9-20.2		
	2100-959	Baseline: 0.015-0.07	Baseline: 3.6-14.4	Confluence with Chateau 2 (Station 2100), Culvert (Station 959)	Normal Depth
		Maintained: 0.015-0.07	Maintained: 3.6-25.6		
Chateau 2 (concrete)	1117-0	Baseline: 0.02-0.07	Baseline: 6.4-11.3	Culvert (Station 165 to 105)	Normal Depth
		Maintained: 0.015-0.07	Maintained: 9.8-19.9		

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 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 facility flow rates, summarized in Table 1 in the Hydrology section, were used in determining 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 overall capacity of Chateau 1 is limited by low bank elevations immediately upstream of the culvert between Station 5851 to 5607, in addition to the culvert capacity. This portion of the segment can convey up to 334 cubic feet per second (cfs) (>2-year level of service) before the surrounding residential properties and the roadway are impacted. Downstream of the confluence with Chateau 2, Chateau 1 is limited by the culvert at Station 959 and can convey 856 cfs (<25-year level of service) before the surrounding residential properties and the roadway are impacted.

The capacity of Chateau 2 is limited by the culvert between Station 165 and 105, and can convey up to 196 cfs (<2-year level of service) before the surrounding residential properties and the roadway are impacted.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from Chateau 1 does not improve the overall conveyance capacity or level of service from the baseline condition (334 cfs, >2-year level of service, respectively). Water surface elevations further downstream do not decrease with maintenance by a substantial amount, and the capacities remain limited by the downstream culverts. Maintenance to remove the deposited sediment/debris and vegetation is still recommended to reduce the risk of vegetation flowing downstream and clogging the downstream culverts.

Removing deposited sediment/debris and vegetation from Chateau 1 and Chateau 2 improves the conveyance capacity of Chateau 2 to 435 cfs, with the level of service increasing to <50-year storm event.

Post-Maintenance Erosion Control Measures

The estimated velocities in both segments of the Chateau facility group are below maximum permissible velocities for concrete lined channels (35 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 facility group capacities were limited by the four culverts in Chateau 1 and the downstream culvert in Chateau 2. 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
Chateau 1	6229-2100	334	334	>2-year storm	>2-year storm
	2100-959	856	856	<25-year storm	<25-year storm
Chateau 2	1117-0	196	435	<2-year storm	<50-year storm

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 a site visit conducted by Geosyntec Consultants in May 2017.

1. Chateau 1: Downstream of 72-inch-diameter CMP culvert beneath Chateau Drive at Paola Way.

2. Chateau 1: Upstream of double 5-foot-wide by 4-foot-high RCB culvert beneath Derrick Drive.

3. Chateau 1: Looking upstream from 10-foot-wide by 4-foot-high RCB culvert at Verley Court.

4. Chateau 2: Downstream of 10-foot-wide by 3-foot-high RCB culvert beneath Chateau Drive.

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 pages for the Chateau facility group.

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

N

Drainage Area: 1,050 acres

Feet
0 100 200 400

The City of SAN DIEGO

Facility Group Name: Tecolote Creek - Chateau
Segment Name: Chateau 1 - 2
Facility No: 3-04-055, 3-04-250
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.21 Tecolote Creek - Morena (No. 3-04-101)

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	• 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.

General Description

The Tecolote Creek – Morena (Morena) 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 Morena facility group is located in the Mission Bay Watershed Management Area. The facility group is bordered by West Morena Boulevard to the east, the San Diego Metropolitan Transit system right-of-way to the west, Tecolote Creek to the north, and a commercial development to the south.

The Morena facility group begins at the outfall of a double barrel culvert northwest of the corner of West Morena Boulevard and Vega Street. The ditch continues in the northwest direction for 200 feet and then discharges into a 24-inch-diameter double barrel culvert that discharges into a paved portion of Tecolote Creek. The Morena facility group is an earthen ditch with a trapezoidal cross-section. The ditch dimensions estimated in the field have a bottom width ranging from 2 to 5 feet, a top of bank width ranging from 15 to 25 feet, and depth ranging from 4 to 5 feet. See 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 Tecolote Creek – Morena facility group.

Hydrology

The hydrologic peak flow for the 100-year recurrence interval presented in Table 1 below was estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated 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
Morena 1	35	44	50	56	66	72

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 *Chapter 3, 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 Morena facility group is the existing storm drain system that discharges into the ditch. The downstream domain of analysis consists of an existing double barrel 24-inch-diameter reinforced concrete pipe (RCP) culvert that discharges into a lined portion of Tecolote Creek and known water surface elevations provided by FEMA were used as the downstream boundary condition. Based on the methodology presented in *Chapter 3, 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 Morena facility group was determined to be the current condition as observed during a site visit conducted by Geosyntec Consultants in May 2017. The banks and bottom of the channel were assigned Manning's coefficient values ranging from 0.03 to 0.06, which represents the density of the vegetation observed within the facility. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2017 site visit.

For the recommended maintained condition, a Manning's coefficient value of 0.03 was assigned to the segment bottom and banks.

Model parameters and velocities for the baseline condition for the Morena facility group are summarized in Table 2. Velocities reported in Table 2 are associated with the maximum facility conveyance capacity.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Morena 1 (earthen)	350-151	Baseline: 0.03-0.06	Baseline: 0.3–2.4	Culvert (Station 151)	-
		Maintained: 0.03	Maintained: 0.16-1.41		
Downstream Domain of Analysis (concrete)	151-16	Baseline: 0.012	-	-	Known water surface elevation
		Maintained: 0.012	-		

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 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 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 each segment are summarized in the Summary Table (Table 3) for the baseline condition.

Baseline Condition

In the heavily vegetated condition observed during the May 2017 field visit, the facility can convey 72 cubic feet per second (cfs) (100-year level of service) before flows impact West Morena Boulevard to the east.

Recommended Maintained Condition

No maintenance is recommended for the facility. Maintaining the channel would not increase the capacity (72 cfs, 100-year level of service) as the overtopping of the ditch banks does not impact surrounding roadways and commercial development. The capacity of the facility is controlled by downstream water surface elevations in Tecolote Creek. Additionally, the Mid-Coast Corridor Transit Project will be removing the Morena segment for the construction of the trolley extension line and the future Tecolote Road Trolley Station.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Morena facility group are within the recommended permissible velocities for natural earthen channels (less than 5 feet per second) as defined in the *City of San Diego Drainage*

Design Manual, dated January 2017, and are not expected to cause erosion. 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 flows greater than the 10-year storm event (50 cfs) overtopped the culvert at the downstream end of the facility. Regardless of this overtopping, flows up to and including the 100-year storm event (72 cfs) are contained within the flood plain and do not inundate adjacent infrastructure. Additionally, the Mid-Coast Corridor Transit Project will be removing the Morena segment for the construction of the trolley extension line and the future Tecolote Road Trolley Station. For these reasons, additional analysis is not recommended to evaluate potential increases in the level of service that could be achieved by capital improvements.

Table 3. Summary Table

Segment	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Morena 1	151-350	72	-	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. Site visit conducted by Geosyntec Consultants in May 2017.

1. Morena 1: Looking upstream, culvert at upstream end of channel.

2. Morena 1: Looking downstream, representative of thick vegetation in the channel.

3. Morena 1: Looking downstream, culvert inlet at downstream end of channel covered in vegetation.

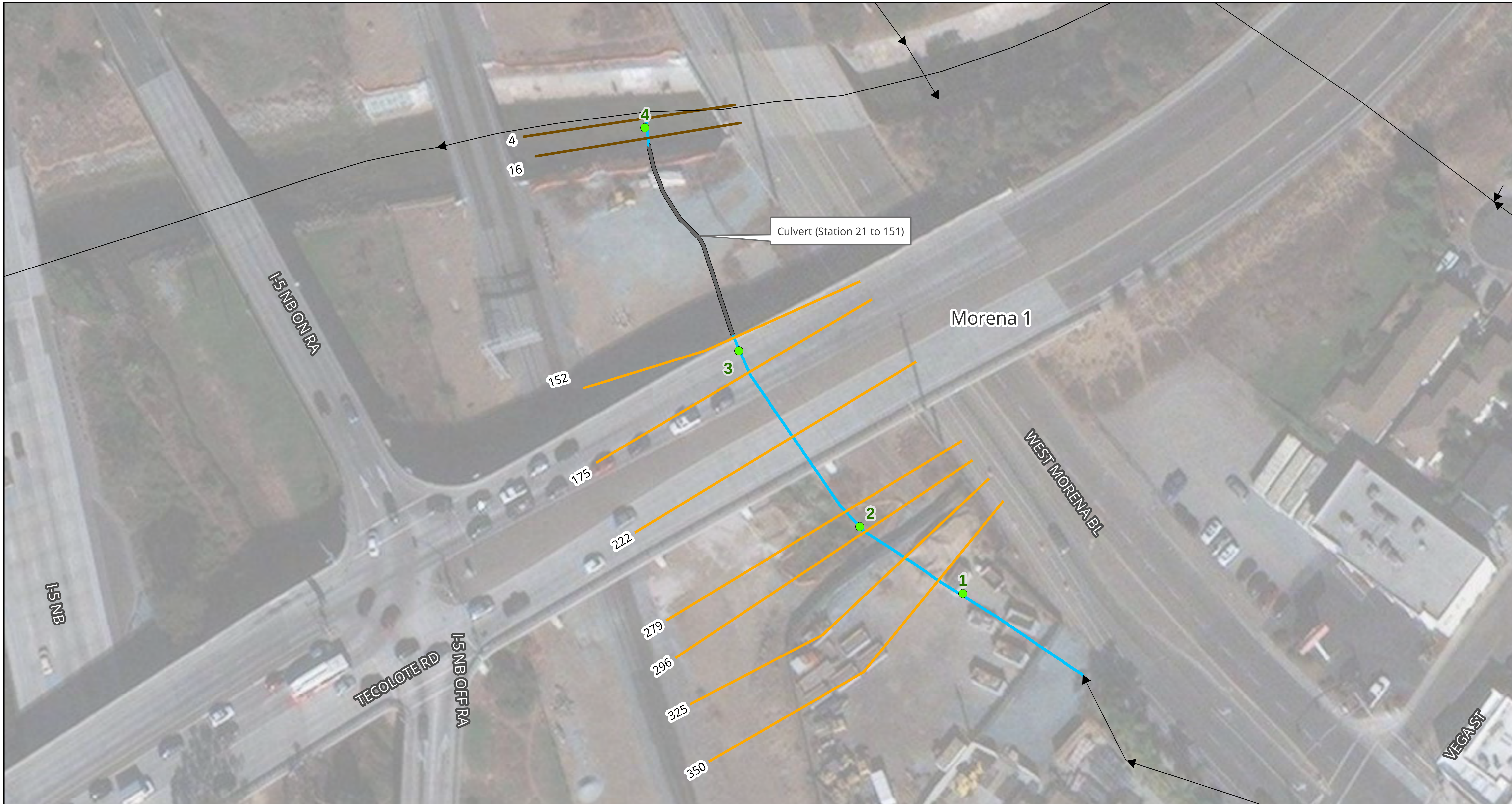
4. Morena 1: Downstream domain of analysis: Outfall into Tecolote Creek.

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
MWMP Facility Cross Section
Domain of Analysis Cross Section
MWMP Facility Center Line

N

Drainage Area: 43 acres

0 15 30 60 Feet

The City of SAN DIEGO

Facility Group Name: Tecolote Creek - Morena
Segment Name: Morena 1
Facility No: 3-04-101
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 line is approximate.

November 2019

A.22 Tecolote Creek – Genesee (No. 3-04-160)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen, Riprap Banks: Earthen, Riprap	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from bottom of the channel from Station 1592 to Station 2359. • Stabilize bank erosion on west bank at Station 1592.	
Benefit	• The level of service remains >10-year storm event, but the conveyance capacity increases from 1,050 cfs to 1,120 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 Tecolote Creek – Genesee (Genesee) 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 Tecolote Creek – Genesee facility group is located in the Mission Bay/La Jolla Watershed Management Area. The facility is bordered by an apartment complex to the north, Genesee Avenue to the west, and residential areas to the south and east.

The Genesee channel starts at the outlet of the dual pipe (84-inch-diameter and 54-inch-diameter) corrugated metal pipe (CMP) culvert near the apartment complex and conveys runoff in a southerly direction towards Marlesta Drive. At the upstream end, the earthen channel has riprap side slopes and a bottom width of approximately 35 feet per asbuilt drawing no. 20690-D. It gradually narrows to approximately 25 feet wide at Station 1992 and remains an approximately 25 foot width to the downstream culvert (Station 1592). The Genesee segment discharges into a dual pipe (84-inch-diameter and 72-inch-diameter) reinforced concrete pipe (RCP) culvert that conveys flows around a residential development. That culvert discharges into an earthen channel in a private parcel at Station 1236. The earthen channel then conveys flow to a culvert under Marlesta Drive (Station 1000), downstream of which the channel continues south parallel to Genesee Avenue. 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 Tecolote Creek – Genesee 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.* 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
Genesee 1	707	891	1,039	1,235	1,389	1,536

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 is the existing storm drain system that discharges into the Genesee facility group. The downstream domain of analysis consists of the existing dual pipe RCP culvert that conveys flows around a residential development and the earthen channel between the outlet of that culvert and the inlet of the culvert under Marlesta Drive. 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 Genesee facility group was determined to be the current condition as observed during a site visit in April 2017. The banks and bottom of Genesee were assigned Manning's coefficient values ranging from 0.04 to 0.08, which represents the density of the vegetation and accumulated sediment/debris observed within the earthen channel. The sediment/debris deposition in the channel varied from 1 to 3 feet throughout the length of the channel in addition to dead trees and vegetation creating obstructions to the flow path. 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 in the recommended maintained condition ranged from 0.035 to 0.07, reflecting the removal of sediment/debris and vegetation along the channel bottom and allowing the dense vegetation along the side slopes to remain.

Model parameters and velocities for the baseline and maintained conditions for Tecolote Creek – Genesee 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
Genesee 1 (earthen)	2369–1592	Baseline: 0.04–0.08 Maintained: 0.035–0.07	Baseline: 1.9–9.2 Maintained: 1.8–11.0	Culverts (Stations 2359 and 1592)	Normal Depth at Station 2359
Downstream Domain of Analysis	1592–1000	0.05–0.07	Baseline: 7.4–8.5 Maintained: 7.5–8.5	Culvert (Station 1000)	Normal Depth at Station 1000

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 Genesee channel has a level of service of >10-year storm event and is only capable of conveying up to 1,050 cubic feet per second (cfs) before flows impact the adjacent properties along the east bank. The capacity of the Genesee segment is limited by the capacity of the culvert at Station 1700.

Recommended Maintained Condition

Removing the deposited sediment/debris and the vegetation from the bottom of the Genesee segment increases the conveyance capacity to 1,120 cfs, and the level of service remains the same (>10-year storm event). On a site visit in December 2018, erosion along the west bank of the segment near Station 1592 was observed due to runoff overtopping the curb and gutter along

Genesee Avenue. The area of erosion is recommended to be stabilized until vegetation grows back along the bank.

Post-Maintenance Erosion Control Measures

Some of the estimated velocities in the Genesee segment are above the recommended permissible velocities for vegetated channels (5 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017* for both the baseline and recommended maintained condition. The erosive velocities are estimated based on the modeling to occur from the upstream culvert outlet for a length of approximately 200 feet in both the baseline and recommended maintenance condition (between Station 2731 to Station 2431). Therefore, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility. 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 culvert capacity. 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
Genesee 1 (earthen)	2359–1592	1,050	1,120	>10-year	>10-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. Genesee1: Looking upstream at dual 84-inch-diameter and 54-inch-diameter CMP culvert outlet.

2. Genesee 1: Looking downstream at vegetation and sediment/debris.

3. Genesee 1: Looking from the western bank (Genesee Avenue) at vegetation.

4. Genesee 1: Looking downstream at vegetation and sediment/debris.

5. Genesee 1: Looking downstream at dual 84-inch-diameter and 72-inch-diameter RCP culvert inlet.

6. Downstream Domain of Analysis: Looking from east bank towards the culvert outlet.

Analysis Performed By: Dudek

Fact Sheet Prepared By: Dudek

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

N

Drainage Area: 815 acres

Feet
0 25 50 100

The City of SAN DIEGO

Facility Group Name: Tecolote Creek - Genesee
Segment Name: Genesee 1
Facility No: 3-04-160
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.23 San Diego River – Nimitz

Summary of Recommended Maintenance

Nimitz 1 (No. 4-01-103)

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 earthen ditch near entrance of culvert from Station 118 to Station 234.	
Benefit	• Increases level of service from <2-year storm event (120 cfs) to 10-year storm event (339 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.

Nimitz 2 (No. 4-01-105)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 234 to Station 525.	
Benefit	• The level of service remains <2-year storm event, but the conveyance capacity increases from 15 cfs to 80 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.

Nimitz 3 (No. 4-01-107)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Trimming of vegetation from the bottom of the earthen ditch from Station 525 to Station 1001.	
Benefit	• Increases level of service from the 2-year storm (227 cfs) to the 5-year storm (290 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.

General Description

The San Diego River – Nimitz (Nimitz) 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 Nimitz facility group is located in the San Diego River Watershed Management Area. The facility is bordered by Nimitz Boulevard to the west, and by private developments to the north, east, and south.

The facility group is a linear ditch split into three segments (Nimitz 1, Nimitz 2, and Nimitz 3) flowing north for approximately 880 feet from the 78-inch reinforced concrete pipe (RCP) outfall north of Cleator Park at Station 1001 to the dual 54-inch RCP culvert entrance at Station 118. Nimitz 3 is an earthen ditch at the upstream end of the facility that flows from Station 1001 to Station 525, where the ditch transitions to Nimitz 2. Nimitz 2 is a concrete ditch that continues from Station 525 to Station 234, where the ditch transitions back to an earthen ditch at Nimitz 1. Nimitz 1 continues from Station 234 to Station 118, where flow enters the downstream 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 Nimitz 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*. The peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the six-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
Nimitz	227	290	339	407	456	505

Hydraulics

A one-dimensional steady flow model was developed for the 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 and downstream domains of analysis for the facility group are existing storm drain systems. The downstream domain of analysis consists of an existing dual 54-inch-diameter RCP culvert downstream of Nimitz 1. 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 Nimitz facility group was determined to be the pre-maintenance condition, as documented in the photos on record associated with the March 2016 maintenance of the facility group. The banks and bottom of Nimitz 3 were assigned Manning's coefficient values ranging from 0.04 to 0.07, which represents the density of the vegetation observed within the earthen ditch. Nimitz 2 was assigned a Manning's coefficient value of 0.015, representative for the concrete ditch for a majority of the ditch. The Manning's coefficient values from Station 294 to Station 234 ranged from 0.03 to 0.04, and sediment was added to the model to simulate a sediment/debris deposition area at the transition back to an earthen ditch to match the observations from the April 2017 site visit. The banks and bottom of Nimitz 1 were assigned Manning's coefficient values ranging from 0.045 to 0.08, consistent with the type of vegetation observed in photos on record associated with the March 2016 maintenance of the facility group. The photos included in the Representative Photos Section are of the facility as observed during the April 2017 site visit.

For the recommended maintained condition, the assigned Manning's coefficient value for the bottom of Nimitz 3 were reduced to a range of 0.035 to 0.045, reflecting the reduction in vegetation following maintenance. Nimitz 2 was modified to reflect the removal of sediment/debris and vegetation from Station 294 to Station 234, and the Manning's coefficient value is 0.015 throughout the length of the segment in the maintained condition. The Manning's coefficient value in Nimitz 1 was reduced to a range of 0.025 to 0.03 to represent the removal of vegetation and the removal of sediment/debris from Station 209 to Station 118.

Model parameters and velocities for the baseline and maintained conditions for the Nimitz 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
Nimitz 3 (earthen)	1001–525	Baseline: 0.04–0.07	Baseline: 0.7–4.1	–	Normal Depth at Station 1001
		Maintained: 0.035–0.045	Maintained: 0.8–6.6		
Nimitz 2 (concrete)	525–234	Baseline: 0.015–0.04	Baseline: 0.4–0.8	–	–
		Maintained: 0.015	Maintained: 2.0–4.3		
Nimitz 1 (earthen)	234–118	Baseline: 0.045–0.08	Baseline: 1.2–1.7	Culvert (Station 118)	–
		Maintained: 0.025–0.03	Maintained: 2.4–4.1		
Downstream Domain of Analysis	118–3	0.015	Baseline: 7.3–8.6	Storm Drain System	Normal Depth at Station 3
			Maintained: 9.6–11.3		

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 the channel where of 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 conditions.

Baseline Condition

The level of service in Nimitz 3 is the 2-year storm event with a capacity of 227 cubic feet per second (cfs). Flows in excess of 227 cfs would overflow the western bank at Station 580, impacting Nimitz Boulevard. Nimitz 2 provides a level of service less than the 2-year storm, only conveying 15 cfs before flow in the concrete ditch impacts the parking lot east of the facility. With the sediment/debris and vegetation modeled in Nimitz 1, the ditch provides a level of service less than the 2-year storm, conveying 120 cfs before impacting Nimitz Boulevard.

Recommended Maintained Condition

Trimming of vegetation in Nimitz 3 increases the level of service to the 5-year storm, allowing the ditch to convey 290 cfs. During the site visit, there was no evidence of erosion, deposited sediment/debris, or invasive vegetation that needed to be removed. Therefore, only trimming of vegetation was recommended. Removal of deposited sediment/debris and vegetation in Nimitz 2 does not increase the level of service, which is less than the 2-year storm; however, the capacity does increase to 80 cfs. Removal of deposited sediment/debris and vegetation in Nimitz 1 improves the level of service to the 10-year storm with a conveyance capacity of 339 cfs.

Post-Maintenance Erosion Control Measures

The estimated velocities in Nimitz 3 are all below 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*), except at Station 1001 where the estimated velocity is 6.6 fps. Station 1001 is the farthest upstream station in the model and represents the flow as it exits the 78-inch-diameter RCP outfall to a concrete apron. This computed velocity is below the recommended velocities from the above reference for concrete, and the velocities downstream of this point are within acceptable ranges for grass-lined conveyances. The velocities in Nimitz 2 and Nimitz 1 are well below the recommended velocities for their respective channel types, according to the above reference. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility group.

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 throughout the facility. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction. It is recommended that culvert improvements also be considered when evaluating potential 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
Nimitz 3 (earthen)	1001–525	227	290	2-year	5-year
Nimitz 2 (concrete)	525–234	15	80	<2-year	<2-year
Nimitz 1 (earthen)	234–118	120	339	<2-year	10-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. Nimitz 3: Looking downstream near upstream end of facility.

2. Nimitz 3: Looking downstream at vegetation, upstream of transition to Nimitz 2.

3. Nimitz 2: Looking downstream at debris/sediment at upstream end of concrete ditch.

4. Nimitz 2: Looking downstream at sediment/debris near end of concrete ditch.

5. Nimitz 1: Looking downstream at sediment/debris in segment and at entrance to dual 54-inch diameter RCP culvert inlet.

6. Nimitz 1: Looking downstream at dual 54-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	Domain of Analysis Cross Section
Storm Drain Conveyance	MWMP Facility Cross Section
Culvert	Nimitz 1
	Nimitz 2
	Nimitz 3

N

Drainage Area: 334 acres

Feet
0 25 50 100

The City of SAN DIEGO

Facility Group Name: San Diego River - Nimitz
Segment Name: Nimitz 1 - 3
Facility Nos: 4-01-103, 4-01-105, 4-01-107
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.24 San Diego River– Valeta (No. 4-01-120)

Summary of Recommended Maintenance

San Diego River – Valeta

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 254 to Station 415. • Maintain/repair existing debris fence as needed.	
Benefit	• Increases level of service from less than the 2-year storm event (55 cfs) to the 100-year storm event (215 cfs). • Reduces potential sediment transport to the downstream detention basins. • 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 San Diego River– Valeta (Valeta) facility group was classified as a Category 1 facility as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Valeta facility group is located in the San Diego River Watershed Management Area. The facility is bordered by Valeta Street to the south, multifamily residential to the east, a private parking lot to the west, and privately maintained detention basins to the north.

The facility group is a trapezoidal concrete ditch beginning northeast of the intersection of Valeta Street and Famosa Boulevard and flowing north to privately maintained detention basins upstream of Famosa Slough. The Valeta facility group receives flow from a 48-inch-diameter reinforced concrete pipe (RCP) and a 30-inch-diameter RCP at the facility inlet headwall at Station 415. Flow exits the facility at Station 254 at the end of the concrete ditch, where flows cross a raised pedestrian trail with a 24-inch-diameter polyvinylchloride (PVC) pipe culvert set at the invert of the facility. Flow then continues into the privately maintained detention basins. 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 Valeta 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*. 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
Valeta 1	96	123	144	173	194	215

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 Valeta facility group is existing storm drain systems that discharge into the facility group. The downstream domain of analysis consists of an existing 24-inch-diameter PVC culvert, a short ditch lined with an articulated concrete block revetment system to prevent erosion, and a detention basin located at the end of the short ditch. The water surface elevation in the detention basin was estimated based on the top of berm elevation surrounding the basin and was used as the downstream boundary condition. 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 Valeta facility group was determined to be the current condition as observed during a site visit in April 2017. Based on the observations made during the site visit, sediment levels in the facility were modeled at depths ranging from approximately 2 inches to 32 inches over the length of the facility. The lower levels of sediment/debris were observed immediately downstream of the culvert openings at the upstream end of the facility and between the downstream culvert and an approximately 2-foot-tall debris fence toward the downstream end of the facility. In the middle portion of the facility, between Stations 400 and 293, sediment/debris depth ranged from about 1.7 to 2.7 feet. The banks and bottom of the Valeta ditch were assigned a Manning's coefficient value of 0.15, which represents the density of the vegetation observed within the facility. 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 Valeta ditch in the recommended maintained condition were set at 0.015 to reflect the roughness of the originally constructed facility.

Model parameters and velocities for the baseline and maintained conditions for the Valeta 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
Valeta 1 (concrete)	415-254	Baseline: 0.15	Baseline: 0.7–1.8	-	Normal Depth at Station 415
		Maintained: 0.015	Maintained: 1.6–4		
Downstream Domain of Analysis	254-140	0.03-0.08	Baseline: 0.3–3.8	Culvert (Station 254)	Estimated Water Surface at Station 140
			Maintained: 0.6–8.4		

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 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 each segment are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained condition.

Baseline Condition

The level of service in the Valeta facility group in the baseline condition is less than the 2-year storm. The facility is only capable of conveying 55 cubic feet per second (cfs) in the current condition before flows overtop the west bank and impact the parking lot.

Recommended Maintained Condition

Removal of the deposited sediment/debris and vegetation in the facility improves the level of service in the facility to the 100-year storm event. The fully maintained facility can convey 215 cfs without overtopping the banks. It should be noted that the current condition of the concrete bottom and portions of the banks is unknown since they are concealed under the sediment/debris and vegetation, including several larger trees. The recommended maintenance and modeled capacity assumes that the concrete bottom and banks of the facility are in good condition. If removal of sediment/debris and vegetation reveal that some or all of the concrete lining is in disrepair or has broken loose, concrete repair or replacement is recommended. The existing debris fence should be maintained or repaired as needed based on the conditions at the time of maintenance.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Valeta facility group are within the recommended permissible velocities for concrete lined channels (30 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.

In reviewing the potential impacts of the recommended maintained condition within the domain of analysis, Station 228 was identified as an area where the velocity increased. However, the recommended maintained velocity at Station 228 is below the recommended permissible velocity for reinforced-turf-lined channels (10 fps), as defined in the above reference. 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 did not indicate any structural limitations on facility level of service that would benefit from capital improvements. At this time, no additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this facility.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Valeta 1 (concrete)	415-254	55	215	<2-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. Site visit conducted by Dmax Engineering in April 2017.

1. Valeta 1: Looking downstream over headwall and 48-inch-diameter and 30-inch-diameter diameter RCP culvert outlet.

2. Valeta 1: Looking downstream at vegetation in the ditch from the parking lot to the west of the facility.

3. Valeta 1: Looking downstream at vegetation in concrete ditch.

4. Valeta 1: Looking downstream at vegetation.

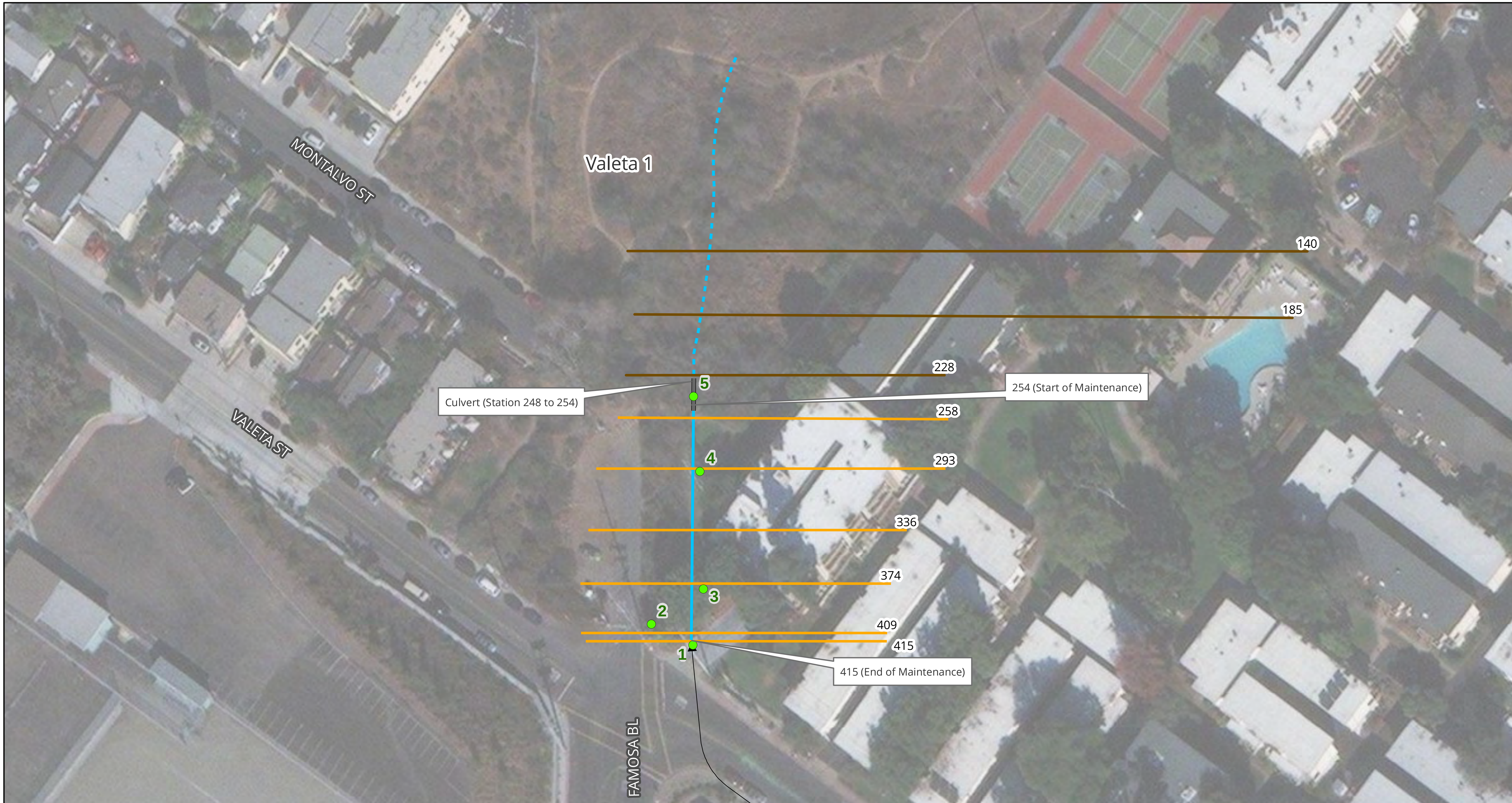
5. Downstream Domain of Analysis: Looking upstream at 24-inch-diameter PVC culvert through pedestrian trail.

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

N

Drainage Area: 129 acres

Feet
0 15 30 60

The City of SAN DIEGO

Facility Group Name: San Diego River - Valeta
Segment Name: Valeta 1
Facility No: 4-01-120
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.25 San Diego River – Camino del Rio

Summary of Recommended Maintenance

Camino del Rio 1 (No. 4-03-103)

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 1380 to Station 2399. • Remove accumulated sediment/debris in culvert from Station 1223 to Station 1380.	
Benefit	• Increase level of service from >10-year storm event (290 cfs) to >25-year storm event (330 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert at Station 1380.	

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.

Camino del Arroyo 1 (No. 4-03-101)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 581 to Station 1223.	
Benefit	• The level of service remains >10-year storm event, but conveyance capacity increases from 440 cfs to 445 cfs. • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert at Station 581.	

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 San Diego River – Camino del Rio (Camino del Rio) 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 River Watershed Management Area. The Camino del Rio segment (upstream segment) begins west of the Mission Center Road overpass and continues west. It is bounded by Camino del Rio North on the north side and westbound Interstate 8 on south side before entering a box culvert at the downstream end of the segment. The Camino del Arroyo segment (downstream segment) begins at the downstream end of the Camino del Rio box culvert, after which it continues north. It is bound by Camino del Arroyo to the west and a commercial development to the east.

Both segments are concrete ditches with trapezoidal cross-sections as indicated on as-built drawing no. 12289-2-D, 7340-D, and Caltrans as-built drawing no. 11-133204-34. The ditch bottoms are 4 feet wide; the banks are 7 feet high with 1.5:1 (H:V) side slope, and vary in longitudinal slope from 0.0018 (feet/feet) in Camino del Rio to 0.002 (feet/feet) in Camino del Arroyo. A 6.5-foot-wide by 6-foot-high rectangular concrete box (RCB) culvert discharges into the upstream end of the Camino del Rio segment which conveys flows to the east before discharging into a 9-foot 2-inch-wide by 6-foot-high RCB culvert that is located between Station 1223 and Station 1380. The flows exit the culvert into the Camino del Arroyo segment, which conveys the flows in a northerly direction to a double-barrel RCB culvert (5-foot-high by 7-foot-wide openings) at Station 581. The culvert then discharges into the San Diego River floodplain.

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

Hydrology

The hydrologic peak flow for the 100-year recurrence interval for the Camino del Rio segment 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 hydrologic peak flow for the 50-year recurrence interval for the Camino del Arroyo segment presented in Table 1 is derived from the design flow rate indicated for the culvert to which the ditch discharges (under Camino de la Reina) on as-built drawing no. 24613-D. The peak flows for the remaining recurrence intervals 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
Camino del Rio 1	184	235	276	328	368	409
Camino del Arroyo 1	284	355	425	473	520	591

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 condition and the recommended maintained condition. 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 reaches evaluated in the model are 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. In the baseline condition, the Camino del Rio ditch bottom was assigned a Manning's coefficient value range of 0.05–0.06 and the banks 0.04. These assignments were based on the site visit conducted by Geosyntec Consultants in July 2017 where dense vegetation in the bottom of the ditch was observed. The sediment depth was estimated to be 4 feet at the upstream end of the segment and 3 feet at the downstream end. The culvert at the downstream end (Station 1380) was estimated to have 2.5 feet of accumulated sediment. In a similar manner, the Camino del Arroyo ditch bottom was assigned a Manning's coefficient value range of 0.025–0.06 and the banks 0.04. Vegetation was observed in the ditch during the site visit for most of the segment reach, except for the downstream end where it was relatively clean. The sediment depth was estimated to be 2 feet at the upstream end of the segment, and the left box culvert at the downstream end (Station 581) was observed to have 0.5 feet of sediment. A Manning's coefficient value for both the bottom and banks of both segments for the recommended maintained condition was set at 0.015 to reflect the roughness of the originally constructed concrete facility.

Model parameters and velocities for the baseline and maintained conditions for the Camino del Rio facility are summarized in Table 2.

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Camino del Rio 1 (concrete)	2399–1223	Baseline: 0.05–0.06 Maintained: 0.015	Baseline: 1.71–2.59 Maintained: 2.77–5.26	Culvert (Station 1380 to 1223)	Critical Depth
Camino del Arroyo 1 (concrete)	1223–581	Baseline: 0.025–0.06 Maintained: 0.015	Baseline: 2.07–8.98 Maintained: 2.37–8.96	Culvert (Station 581 to 166)	Known Water Surface Elevation

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 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 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 conveyance capacities and levels of service for the segments are summarized in the Summary Table (Table 3) for both the baseline and recommended maintained conditions.

Baseline Condition

The Camino del Rio and Camino del Arroyo segments can convey 290 cubic feet per second (cfs) and 440 cfs (both <10-year level of service), respectively, before the roadway and culvert are inundated between Station 1223 and Station 581.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the Camino del Rio ditch increases the conveyance capacity from 290 cfs (>10-year level of service) to 330 cfs (>25-year level of service) before the roadway and culvert are inundated near Station 1380. Additionally, the conveyance capacity in the Camino del Arroyo ditch would increase from 440 cfs (>10-year level of service) to 445 cfs (>10-year level of service) before the roadway and culvert are inundated near Station 581.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition (Table 2) are below the maximum permissible velocities for a concrete ditch 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 low banks proximate to the culverts at the end of each segment. However, the modeling also indicates that culvert capacity may then become the limiting factor, particularly for the Camino del Arroyo segment that transitions to underground conveyance for approximately 400 feet before discharging to the San Diego River. 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
Camino del Rio 1	2399–1223	290	330	>10-year	>25-year
Camino del Arroyo 1	1223–581	440	445	>10-year	>10-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. Camino del Rio 1: Looking upstream towards the 6.5-foot-wide by 6-foot-high RCB inlet of the Camino del Rio segment.

2. Camino del Rio 1: Representative of Camino del Rio segment, looking downstream.

3. Camino del Arroyo 1: Looking upstream towards the 9-foot-wide by 6-foot-high RCB inlet of the Camino del Arroyo segment.

4. Camino del Arroyo 1: Representative of Camino del Arroyo segment, 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 Location	Domain of Analysis Cross Section
Storm Drain Conveyance	MWMP Facility Cross Section
Culvert	Camino del Arroyo 1
	Camino del Rio 1

N

Drainage Area: 364 acres

0 40 80 160 Feet

The City of SAN DIEGO

November 2019

Facility Group Name: San Diego River - Camino del Rio
Segment Name: Camino del Arroyo 1 and Camino del Rio 1
Facility Nos: 4-03-101, 4-03-103
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.26 Murphy Canyon Creek - Stadium

Summary of Recommended Maintenance

Murphy Canyon 1 (No. 4-04-006)

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	• 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.

Murphy Canyon 2 (No. 4-04-008)

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

Stadium 1 (No. 4-04-000)

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 119 to Station 1780.	
Benefit	• Increase level of service from <2-year storm event (<510 cfs) to 5-year storm event (1,050 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.

Stadium 2 (No. 4-04-002)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from Station 1780 to Station 1987.	
Benefit	• Increase level of service from <2-year storm event (<510 cfs) to 50-year storm event (2,700 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 Reports

Segment	Report	Reach
Murphy Canyon 2	URS Corporation, 2013. IHHA Report for Murphy Canyon Channels Map Numbers 58 & 58a.	4
Murphy Canyon 1	URS Corporation, 2013. IHHA Report for Murphy Canyon Channels Map Numbers 58 & 58a.	3
Stadium 2	URS Corporation, 2013. IHHA Report for Murphy Canyon Channels Map Numbers 58 & 58a.	2
Stadium 1	URS Corporation, 2013. IHHA Report for Murphy Canyon Channels Map Numbers 58 & 58a.	1

General Description

The Murphy Canyon Creek - Stadium 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 River Watershed Management Area. The facility group is separated into four segments (reaches), from upstream to downstream: Murphy Canyon 2 (Reach 4), Murphy Canyon 1 (Reach 3), Stadium 2 (Reach 2), and Stadium 1 (Reach 1).

Murphy Canyon 2 is an earthen segment located at the upstream end of the facility group that begins southwest of the intersection of Murphy Canyon Road and an Interstate-15 on-ramp, and is bound by golf facilities to the west and Murphy Canyon Road to the east. The segment continues south before transitioning to a trapezoidal concrete section that designates the beginning of the Murphy Canyon 1 segment.

Murphy Canyon 1 is a concrete segment that begins just north of a reinforced concrete box (RCB) culvert that crosses under an access road leading to the nearby Kinder-Morgan facility. The segment continues south until it transitions to underground conveyance at the entrance of a 14-foot-wide by 8-foot-high double barrel RCB culvert. The segment is bound by the Kinder-Morgan facility to the west and Murphy Canyon Road to the east.

The runoff from the Murphy Canyon segments discharges into the downstream Stadium 2 segment. This is a concrete segment that begins south of San Diego Mission Road and parallels Interstate-15 to the east and the San Diego County Credit Union Stadium and Mission Valley Terminal to the west. The segment continues south until transitioning to an earthen segment with riprap banks that designates the beginning of the Stadium 1 segment. The City of San Diego maintenance portion of Stadium 2 is from approximately Station 1780 to Station 1987. The California Department of Transportation (Caltrans) is responsible for the maintenance of the remainder of Stadium 2.

The Stadium 1 segment begins just south of San Diego Mission Road bridge and continues in a southerly direction parallel to Interstate-15 to the east and San Diego County Credit Union Stadium to the west. This segment ends approximately 40 feet south of the Stadium Road bridge at the property line, beyond which the facility group then discharges to the San Diego River.

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

Hydrology

The hydrologic peak flows presented in Table 2 for the Murphy Canyon and Stadium segments 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 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Murphy Canyon 2	300	680	1,100	1,700	2,400	3,000
Murphy Canyon 1	300	680	1,100	1,700	2,400	3,000
Stadium 2	510	1,050	1,500	2,000	2,700	3,500
Stadium 1	510	1,050	1,500	2,000	2,700	3,500

Hydraulics

Murphy Canyon and Stadium Segments

A one-dimensional steady flow model was previously developed for the Murphy Canyon and Stadium segments 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 extent of these reaches evaluated in this model are shown in Hydraulic Reference Map 1 located at the end of this fact sheet.

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 baseline condition for Murphy Canyon 1 and Murphy Canyon 2 segments was determined to be the ultimate vegetated condition. The bottom and banks of Murphy Canyon 1 were assigned Manning's coefficient values ranging from 0.15–0.17, which reflect a maximum vegetation carrying capacity. During the site visit conducted by URS Corporation in March 2013, Murphy Canyon 2 was observed to be at its ultimate vegetated state. The bottom and banks of Murphy Canyon 2 were assigned Manning's coefficient values ranging from 0.06–0.15, reflecting the observed conditions.

The baseline condition for the Stadium 1 and Stadium 2 segments was determined to be the current condition as observed during the site visit in March 2013. The bottom and banks of Stadium 1 were assigned Manning's coefficient values ranging from 0.08–0.17, and the bottom and banks of Stadium 2 were assigned Manning's coefficient values ranging from 0.08–0.17.

The assigned Manning's coefficient values for Murphy Canyon 2 in the recommended maintained condition ranged from 0.045–0.055 to reflect the trimming of vegetation in the earthen segment, and the assigned Manning's coefficient value for Murphy Canyon 1 was set at 0.015 to reflect the roughness of the originally constructed concrete segment. The assigned Manning's coefficient value for Stadium 2 in the recommended maintained condition was set at 0.016 to reflect the roughness of the originally constructed concrete segment. The assigned Manning's coefficient values for Stadium 1 ranged from 0.024–0.035 to reflect the removal of sediment/debris and vegetation in the earthen segment, including vegetation trimming along the side slopes and keeping mature trees along the edge of the channel bottom at 50-foot intervals.

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

Table 3. Model Parameters

Segment and Material	Reference Stations[1]	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Murphy Canyon 2 (earthen)	2132.098–572	Baseline: 0.06-0.15 Maintained: 0.045-0.055	-	Normal Depth at Station 2132.098
Murphy Canyon 1 (concrete)	572–40	Baseline: 0.15-0.17 Maintained: 0.016	Bridge (Station 572) Culvert (Station 40)	Known Water Surface Elevation
Stadium 2 (concrete)	3019.665– 1780	Baseline: 0.08-0.17 Maintained: 0.016	-	Normal Depth at Station 3019.665
Stadium 1 (earthen)	1780– 36.188	Baseline: 0.08-0.17 Maintained: 0.024-0.035	Bridge (Station >36.188)	Known Water Surface Elevation

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 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 Murphy Canyon 2 segment can convey up to 3,000 cubic feet per second (cfs) (100-year level of service) in the baseline condition. The Murphy Canyon 1 segment can convey up to 1,100 cfs (10-year level of service) and in the baseline condition before flows impact the adjacent property. The capacity of Murphy Canyon 1 is limited by low bank elevations.

The Stadium 1 and Stadium 2 segments both can convey less than 510 cfs (<2-year level of service) in the baseline condition before flows impact the adjacent property. The capacities of the Stadium 1 and Stadium 2 segments are each limited by the overtopping of a berm along the right bank.

Recommended Maintained Condition

The Murphy Canyon 2 segment has a 100-year storm event level of service in its ultimate vegetated condition, and the Murphy Canyon 1 segment has minimal vegetation or sediment in the baseline condition; therefore, maintenance is not currently recommended for either segment. Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance within Murphy Canyon 1 is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Removing the deposited sediment/debris and vegetation from Stadium 2, a concrete segment, increases the conveyance capacity to 2,700 cfs (50-year level of service). Removing the sediment/debris and vegetation from Stadium 1, an earthen segment, increases the conveyance capacity to 1,050 cfs (5-year level of service).

Post-Maintenance Erosion Control Measures

The estimated velocities in the Murphy Canyon Creek facility group segments are below recommended permissible velocities for concrete-lined (35 feet per second (fps)) and earthen channels (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.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the level of service for the Stadium 1, Stadium 2, and Murphy Canyon 1 segments were restricted by low bank heights. 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/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Murphy Canyon 2	2132.098–572	3,000	-	100-year	-
Murphy Canyon 1	572–40	1,100	-	10-year	-
Stadium 2	3019.665–1780	<510	2,700	<2-year	50-year
Stadium 1	1780–36.188	<510	1,050	<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 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 in March 2013.

IHHA 8. Stadium 2, Map 1: Looking upstream near area of recommended maintenance (March 2013).

IHHA 13. Stadium 1, Map 1: Heavily vegetated channel bottom near the downstream end of the facility group (March 2013).

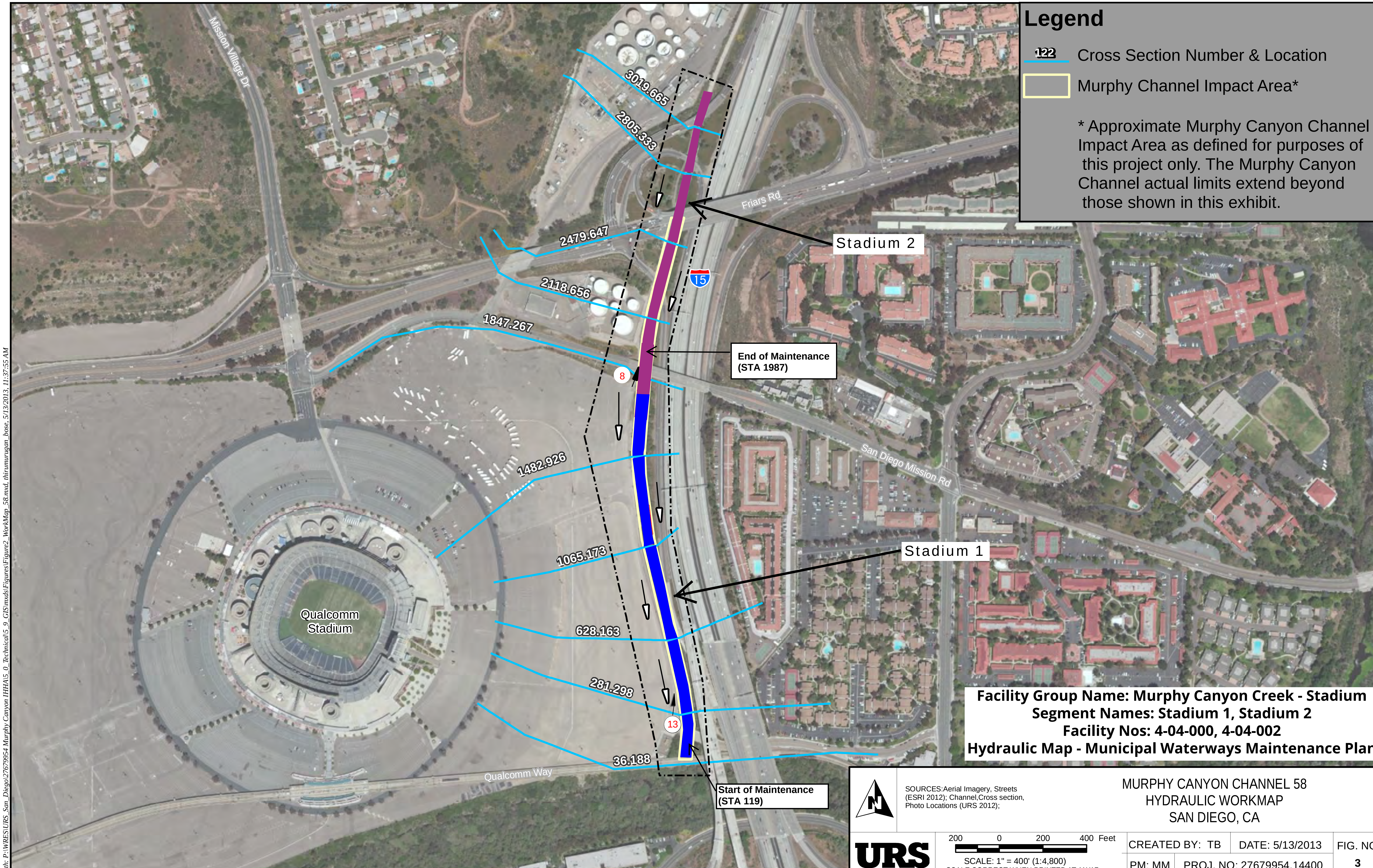
IHHA 20. Murphy Canyon 1, Map 1: Looking downstream towards access road bridge near the upstream limit of concrete channel lining (March 2013).

Analysis Performed By: URS Corporation

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 Stadium and Murphy Canyon segments.



Legend

122 Cross Section Number & Location

Murphy Channel Impact Area*

* Approximate Murphy Canyon Channel Impact Area as defined for purposes of this project only. The Murphy Canyon Channel actual limits extend beyond those shown in this exhibit.

Facility Group Name: Murphy Canyon Creek - Stadium
Segment Names: Stadium 1, Stadium 2
Facility Nos: 4-04-000, 4-04-002
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES: Aerial Imagery, Streets (ESRI 2012); Channel, Cross section, Photo Locations (URS 2012);

MURPHY CANYON CHANNEL 58
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: TB	DATE: 5/13/2013	FIG. NO:
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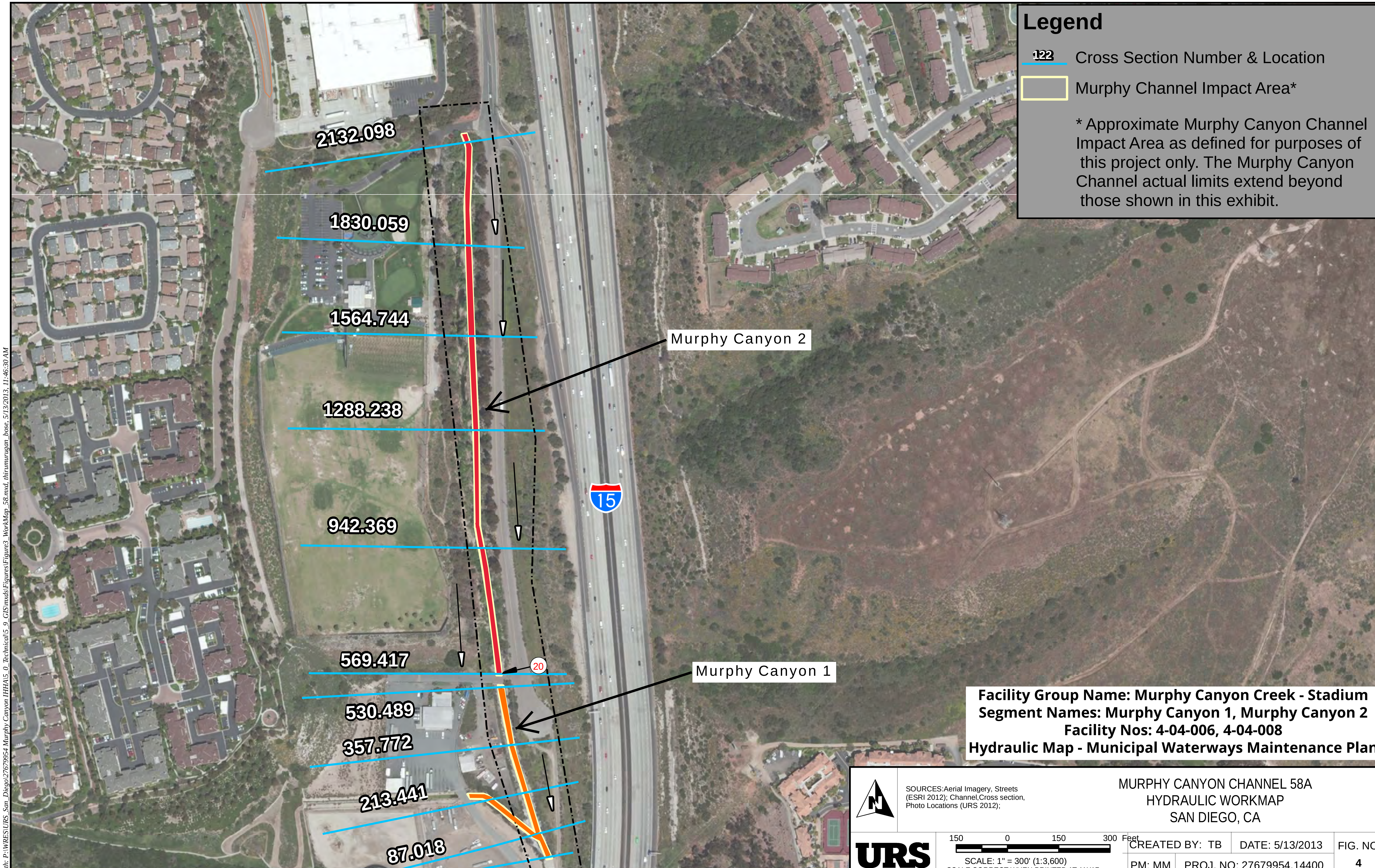


Facility Group Name: Murphy Canyon Creek - Stadium
Segment Names: Murphy Canyon 1, Murphy Canyon 2
Facility Nos: 4-04-006, 4-04-008
Hydraulic Map - Municipal Waterways Maintenance Plan

SOURCES:Aerial Imagery, Streets (ESRI 2012); Channel,Cross section, Photo Locations (URS 2012);

MURPHY CANYON CHANNEL 58A
HYDRAULIC WORKMAP
SAN DIEGO, CA

URS

150 0 150 300 Feet
SCALE: 1" = 300' (1:3,600)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: TB	DATE: 5/13/2013	FIG. NO:
PM: MM	PROJ. NO: 27679954.14400	4

Path: P:\WRES\URS_San_Diego\27679954 Murphy Canyon IHHA\5_0_Technical\5_9_GIS\mxds\Figures\Figure3_WorkMap_58.mxd, thirumurugan_bose, 5/13/2013, 11:46:30 AM

A.27 Alvarado Canyon Creek – Mission Gorge

Summary of Recommended Maintenance

Mission Gorge 1 (No.4-07-002)

Facility type	Bed: Concrete, Earthen Banks: Concrete, Riprap	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and overgrown vegetation from Station 819.1344 to Station 1155.562 and Station 1305.414 to Station 1686. • Remove accumulated sediment/debris in culvert from Station 1155.562 to Station 1305.414.	
Benefit	• Increases level of service from >2-year storm event (1,250 cfs) to <5-year storm event (1,800 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.

Mission Gorge 2 (No.4-07-004)

Facility type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and overgrown vegetation from Station 3006 to Station 3527.	
Benefit	• Increases level of service from <2-year storm event (950 cfs) to >2-year storm event (1,300 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.

Mission Gorge 3 (No.4-07-009)

Facility type	Bed: Concrete, Earthen Banks: Concrete	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and overgrown vegetation from Station 4160 to Station ~~4345~~4860 within the City owned portion of the segment. • ~~Trim overgrown vegetation from Station 4345 to Station 4860 within the City owned portion of the segment.~~ • The remainder of Mission Gorge 3 is recommended to be maintained by Caltrans to remove accumulated sediment/debris and overgrown vegetation, trim overgrown vegetation, and to remove accumulated sediment/debris in the culvert.	
Benefit	• The level of service increases from <5-year storm event to >~~5~~25-year storm event and capacity increases from 1,956 cfs to ~~2,165~~4,000 cfs. • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the downstream culverts. • Reduces the risk of further scour at bottom of channel at junction with tributary at approximately Station 4876.	

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.

Mission Gorge 4 (No.4-07-011)

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 6081 to Station 6596. • The remainder of Mission Gorge 4 is recommended to be maintained by the responsible parties and Caltrans to remove accumulated sediment/debris and overgrown vegetation from the channel and culverts.	
Benefit	• The level of service increases from <10-year storm event to >10-year storm event and capacity increases from 2,540 cfs to 2,837 cfs. • 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.

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

Table 1. Completed Reports

Segment	Report	Reach
Mission Gorge 4	–	–
Mission Gorge 3	–	–
Mission Gorge 2	Rick Engineering Company, 2015. IHHA Report for Alvarado Creek Channel Map Numbers 59 and 60.	4
–	Rick Engineering Company, 2015. IHHA Report for Alvarado Creek Channel Map Numbers 59 and 60.	3a, 3b
Mission Gorge 1	Rick Engineering Company, 2015. IHHA Report for Alvarado Creek Channel Map Numbers 59 and 60.	2a, 2b
–	Rick Engineering Company, 2015. IHHA Report for Alvarado Creek Channel Map Numbers 59 and 60.	1

General Description

The Alvarado Canyon Creek – Mission Gorge (Mission Gorge) facility group was classified as 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 River Watershed Management Area. The Mission Gorge facility group is bordered by commercial and residential development along the north side of Interstate 8 (I-8). The facility group starts just east of Waring Road along Zephyr Lane and extends west along the north side of I-8 to Mission Gorge Road. The facility group ultimately discharges to the San Diego River. The facility group is separated into four segments for City maintenance, from upstream to downstream: Mission Gorge 4, Mission Gorge 3, Mission Gorge 2, and Mission Gorge 1. Mission Gorge 3 and 4 are partially within Caltrans right-of-way and it is assumed the recommended maintenance will be coordinated between the City and Caltrans.

Mission Gorge 4 is the furthest upstream segment within the facility group and is bound by commercial and residential development to the north and by I-8 to the south. The channel begins within a current trapezoidal concrete lined channel east of Waring Road and continues west along the south side of Zephyr Lane and the north side of I-8. The channel enters a triple 9-foot-wide by 8-foot-high reinforced concrete box (RCB) culvert beneath the I-8 off-ramp to Waring Road, and then enters an additional triple 9-foot-wide by 8-foot-high RCB culvert beneath Waring Road. The maintenance responsibility varies along the length of the segment. From Station 5095 to Station 5485, Caltrans is responsible for maintenance. From Station 5485 to Station 6081, the segment is privately owned, with a flowage easement, meaning the City is not responsible for maintaining this section. The City is responsible for maintenance from Station 6081 to Station 6596.

Mission Gorge 3 is the subsequent downstream segment that is bound by commercial development to the north and I-8 to the south. The segment begins at the outlet of the triple 9-foot-wide by 8-foot-high RCB culvert beneath Waring Road and continues west and enters a triple 9-foot-wide by 8-foot-high RCB culvert beneath the I-8 on-ramp from Alvarado Canyon Road. The segment continues west before entering a triple 11-foot-wide by 8-foot-high RCB culvert beneath the Mission Gorge Place commercial area for an approximately a length of 1,300 feet. Per Caltrans as-built drawing no. 59-11VC112 and 11-169664, between the Waring Road and I-8 on-ramp culverts, the channel has a rectangular concrete section with a width of approximately 28 feet and depth of 8 feet, downstream of the I-8 on-ramp culvert the channel has a trapezoidal cross section with a bottom width of 44 feet, a depth of 8 feet, side slopes of 1:1 (H:V), and a channel lining as described here:

- Directly downstream of the I-8 on-ramp culvert until approximately Station ~~4912~~4904: Concrete lined bed and banks,
- Between approximately Station ~~4912~~ 4904 and Station ~~4345~~4349: Concrete lined banks, concrete lined bottom half-width (left 22 feet), and earthen bottom half width (right 22 feet),
- Downstream of approximately Station ~~4345~~4349: Concrete lined bed and banks .

Mission Gorge 3 is partially within the Caltrans right-of way. The City is responsible for maintenance for the full channel width from Station 4160 to Station 4404. From Station 4404 to Station 4860, the City's maintenance responsibility varies from the full channel width at Station 4404 decreasing in width to a point at Station 4860, with Caltrans responsible for the remaining portion. From Station 4860 to Station 5095, Caltrans is responsible for maintenance.

Mission Gorge 2 (Reach 4) is the subsequent downstream segment that is bound by commercial development to the north and south, Mission Gorge Place to the north, and Alvarado Canyon Road to the south. Mission Gorge 2 is a trapezoidal concrete lined segment and extends west for approximately 500 feet before transitioning to an earthen segment owned by the San Diego Metropolitan Transit Development Board.

The subsequent downstream segment from Mission Gorge 2 is referred to as Reach 3 (Reach 3a and Reach 3b) in the 2015 Individual Hydrology and Hydraulic Assessment (IHHA) completed by Rick Engineering. Reach 3 is an earthen segment owned by the San Diego Metropolitan Transit Development ~~Board, and~~Board and continues for approximately 1,300 feet. Reach 3 is bound by commercial development and a parking lot to the north and south.

Mission Gorge 1 (Reaches 2a and 2b) is the furthest downstream segment within the facility group and is bound by commercial development to the north and Alvarado Canyon Road and parking lots to the south. Mission Gorge 1 is a concrete lined segment and extends west for approximately 220 feet before entering a triple 8-foot-wide by 12-foot-tall RCB culvert beneath Fairmont Avenue. The concrete lined segment continues downstream of the culvert for approximately 300 feet, after which it transitions to 100 feet of earthen lined segment with rock lined slopes.

Reach 1 is the furthest downstream segment included in the limits of the study, per the 2015 IHHA completed by Rick Engineering. The segment is owned by Willis Enterprises Incorporated. The reach extends as earthen lined with rock lined slopes for approximately 180 feet, and transitions to a natural segment at its downstream end for approximately 250 feet. Reach 1 confluences with the San Diego River at its downstream end.

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

Hydrology

The hydrologic peak flows presented in Table 2 for the Mission Gorge facility group are based on the Federal Emergency Management Agency's (FEMA's) 2012 Flood Insurance Study (FIS) for San Diego County. The peak flows for the 2-, 5-, and 25-year recurrence intervals were interpolated by Rick Engineering and listed in the IHHA Report for Alvarado Creek Channel Map Numbers 59 and 60.

Table 2. Hydrology Results

Segment[1]	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Mission Gorge 4	1,180	2,050	2,700	3,800	4,500	5,100
Mission Gorge 3	1,180	2,050	2,700	3,800	4,500	5,100
Mission Gorge 2	1,180	2,050	2,700	3,800	4,500	5,100
Mission Gorge 1	1,180	2,050	2,700	3,800	4,500	5,100

Hydraulics

Mission Gorge 4 and Mission Gorge 3 Segments

A one-dimensional steady flow model was developed for the Mission Gorge 4 and Mission Gorge 3 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 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 are presented in the Hydraulic Reference Map 1 located at the end of this fact sheet.

The baseline condition is defined as the existing condition for Mission Gorge 4 and Mission Gorge 3, as observed during a site visit conducted by Geosyntec Consultants in May 2017 and March 2019. For the analysis of the baseline condition, the bottom of Mission Gorge 4 was assigned a range of Manning's coefficient values from 0.015–0.03, and side slopes were assigned 0.07 based on dense vegetation that was observed during the field visits in May 2017. The bottom of Mission Gorge 3 was assigned a range of Manning's coefficient values from 0.015–0.05, and side slopes were assigned 0.07. The accumulated sediment depth within the segments was estimated to be up to 2.5 feet deep. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the April 2017 and March 2019 site visit.

For the recommended maintained condition of the Mission Gorge 4 and Mission Gorge 3 segments, the concrete bottom and side slopes were assigned a Manning's coefficient value of 0.015, reflecting the originally constructed facility. For the recommended maintained condition of the Mission Gorge

3 segment, the earthen bottom was assigned a Manning's coefficient value of ~~0.043~~0.02 to reflect the recommended ~~trimming of~~ removal of accumulated sediment and overgrown vegetation.

Model parameters for the baseline and recommended maintained conditions for the Mission Gorge facility group are summarized in Table ~~2~~3.

Mission Gorge 2 (Reach 4) and Mission Gorge 1 (Reach 2a and 2b) Segments
A one-dimensional steady flow model was previously developed for the Mission Gorge 2 and Mission Gorge 1 segments using USACE 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 2 located at the end of this fact sheet.

The baseline condition is defined as the existing condition for Mission Gorge 2, Reach 3b, Reach 3a, Mission Gorge 1, and Reach 1, as observed during a site visit conducted by Rick Engineering in August 2014. For the analysis of the baseline condition, the bottom of Mission Gorge 2 was assigned Manning's coefficient values ranging from 0.06–0.1, and side slopes were assigned values ranging from 0.016–0.15. The field photos, located in the Representative Photos Section, show dense vegetation in the bottom of the segment and several trees. The accumulated sediment depth in the segment bottom was estimated to range from 0.5–1.1 feet deep. For the recommended maintained condition, the concrete bottom was assigned a Manning's coefficient value of 0.016, reflecting the originally constructed concrete facility.

For the analysis of the baseline condition, the bottom of Reach 3 was assigned Manning's coefficient values ranging from 0.025–0.1 and side slopes were assigned values ranging from 0.025–0.15, reflecting moderate to dense vegetation. The City of San Diego does not own the segment, and therefore no changes were made in the recommended maintained condition.

For the analysis of the baseline condition, the bottom of Mission Gorge 1 was assigned Manning's coefficient values ranging from 0.02–0.2, and side slopes were assigned values ranging from 0.016–0.07, reflecting moderate to dense vegetation. The accumulated sediment depth in the segment bottom was estimated to range from 0.2–0.9 feet deep. For the recommended maintained condition, the concrete bottom was assigned a Manning's coefficient value of 0.016, and the earthen bottom was assigned a Manning's coefficient value of 0.035, reflecting the originally constructed facility.

For the analysis of the baseline condition, Reach 1 was assigned a Manning's coefficient values of 0.15 for the bottom and side slopes of the segment, reflecting dense vegetation. The City of San Diego does not own the segment; therefore, no changes were made in the recommended maintained condition.

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

Table 3. Model Parameters and Velocities

Segment and Material	Reference Stations[1]	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Mission Gorge 4 (concrete)	6596-5095	Baseline: 0.015-0.07 Maintained: 0.015-0.07	Culverts (Stations 5446 to 5342, Stations 5231 to 5095)	Critical Depth
Mission Gorge 3 (concrete, earthen)	5095-4160[1]	Baseline: 0.015-0.07 Maintained: 0.015-0.07	Culverts (Stations 5021 to 4948, Station 4160)	Normal Depth
Mission Gorge 2 (concrete)	3519.105-3029.094	Baseline: 0.016-0.15 Maintained: 0.016-0.15	Lateral Structures (Stations 3506.967, 3029.094)	-
Reach 3a & 3b (earthen)	3029.094-1742.873	Baseline: 0.025-0.15 Maintained: 0.025-0.15	Lateral Structure (Station 2332.283)	-
Mission Gorge 1 (concrete, earthen/riprap)	1742.873-730	Baseline: 0.016-0.2 Maintained: 0.016-0.035	Culvert (Station 1230.5), Lateral Structures (Stations 1149.024, 1121.496)	-
Reach 1 (concrete, earthen/riprap)	730-415.4679	Baseline: 0.15 Maintained: 0.15	-	Normal Depth

1 The stationing for the Mission Gorge 4 and Mission Gorge 3 segments do not align with the stationing of the other segments due to being modeled separately.

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 flow rates, summarized in Table 1 in the Hydrology section, were used in determining the level of service. The overall channel conveyance capacities 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

Mission Gorge 4 can convey 2,540 cubic feet per second (cfs) (<10-year level of service), before the roadway is impacted.

Mission Gorge 3 can convey 1,956 cfs (<5-year level of service), before flows impact adjacent properties.

Mission Gorge 2 can convey 950 cfs (<2-year level of service).

The upstream portion of Mission Gorge 1, between Station 1742.873 and Station 1305.41, can convey 1,250 cfs (>2-year level of service). Further downstream, between Station 1305.41 and Station 730, the segment can convey 1,700 cfs (<5-year level of service).

Recommended Maintenance Condition

Removing deposited sediment/debris and vegetation from the entire Mission Gorge 4 segment improves the conveyance capacity to 2,837 cfs (>10-year level of service). If only the City portion of the segment is maintained (Station 6081 to Station 6596), the level of service remains <10-year (2,540 cfs).

Removing deposited sediment/debris and vegetation from the concrete and earthen bottom portions of Mission Gorge 3 from Stations 4160 to ~~Station 4345, Station 4912 to Station 4948 and Station 5021 to~~ Station 5095 ~~and trimming the vegetation in the earthen bottom portions of the segment (Station 4345 to Station 4912)~~ improves the conveyance capacity to ~~2,165~~ 4,000 cfs (>~~5~~25-year level of service). If only the City portions of the segment are maintained (Station 4160 to Station 4860), the level of service ~~remains at~~improves to <~~5~~10-year (~~1,956~~2,350 cfs). Repairing the scour hole at the channel bottom at the tributary junction at approximately Station 4876 (within the Caltrans portion) reduces the risk of further scour at the bottom of the channel and the potential for undermining of the concrete bank. ~~Removal of sediment and vegetation in the earthen bottom portion of the segment was not recommended due to the velocity in the baseline and recommended maintained condition however trimming is recommended to provide capacity~~

~~improvement and to reduce the risk of vegetation dislodging, flowing downstream, and clogging the downstream culverts.~~

Removing deposited sediment/debris and vegetation from Mission Gorge 2 improves the conveyance capacity to 1,300 cfs (>2-year level of service).

Removing deposited sediment/debris and vegetation from Mission Gorge 1 improves the conveyance capacity in the upstream portion of the segment to 1,800 cfs (<5-year level of service) from Station 1742.873 to Station 1305.41. Further downstream, the segment capacity improves to 4,000 cfs (>25-year level of service) from Station 1305.41 to Station 730.

The benefits to the Mission Gorge 1 and 2 segments as a result of the recommended maintenance are based on the assumption that the segments and culverts that are not within the City of San Diego jurisdiction have not been maintained. The benefits to the Mission Gorge 3 and 4 segments as a result of the recommended maintenance are based on the assumption that the segments and culverts that are not within the City of San Diego jurisdiction have been maintained.

Recommended Temporary Velocity Reduction Measures

The estimated velocities in the recommended maintained condition for Mission Gorge 1 and 2 are below the maximum permissible velocities for an earthen (5 fps) and concrete channel (35 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 these segments.

The estimated velocities in the recommended maintained condition for Mission Gorge 4 and the concrete bottom portion of the Mission Gorge 3 segment are below the maximum permissible velocities for a concrete channel (35 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 ~~these segments~~Mission Gorge 4 and the concrete bottom portion of Mission Gorge 3.

The estimated velocities in the baseline and recommended maintained condition for the earthen bottom portion of the Mission Gorge 3 segment exceed the maximum permissible velocities for vegetated channels (5 fps) 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 the earthen bottom following recommended maintenance.~~ Therefore, 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.

Recommended 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 either downstream culverts or low bank elevations. In addition, due to the presence of higher velocities in the baseline condition modeling in the Mission Gorge 3 segment, a capital improvement project to address potentially erosive velocities along the strip of earthen bottom and to maximize channel capacity needs to be further investigated. 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	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Mission Gorge 4	6596-5095	2,540	2,837	<10-year	>10-year
Mission Gorge 3	5095-4160	1,956	~~2,165~~4,000	<5-year	>~~5~~25-year
Mission Gorge 2	3519.105-3029.094	950	1,300	<2-year	>2-year
Mission Gorge 1	1742.873-730	1,250	1,800	>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 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 August 2014 (Mission Gorge 1 and 2) and by Geosyntec Consultants in May 2017 and March 2019 (Mission Gorge 3 and 4).

1. Mission Gorge 4, Map 1: Looking downstream from the upstream end.

2. Mission Gorge 4, Map 1: Looking downstream at the triple 9-foot-wide by 8-foot-high RCB culvert beneath the I-8 off-ramp to Waring Road.

3. Mission Gorge 3, Map 1: Looking at downstream end of segment, towards the triple 11-foot-wide by 8-foot-high RCB culvert beneath Mission Gorge Place.

4. Mission Gorge 3, Map 1 (March 2019), Looking north at scour hole at outlet of tributary channel.

5. Mission Gorge 3, Map 1 (March 2019), Looking downstream adjacent to the overpass. Sediment accumulation, palms, and vegetation evident on right half of channel, left half (lined) is mostly clear).

6. Mission Gorge 3, Map 1 (March 2019), Looking at channel bottom centerline where the concrete lining ends and the earthen bottom half width begins.

IHHA 3. Mission Gorge 1, Map 2: Looking upstream at the triple 8-foot-wide by 12-foot-tall RCB culvert beneath Fairmount Avenue.

IHHA 5. Mission Gorge 1, Map 2: Looking at downstream end towards the triple 8-foot-wide by 12-foot-tall RCB culvert beneath Fairmount Avenue.

IHHA 6. Mission Gorge 1, Map 2: Looking downstream from upstream end of the segment.

IHHA 12. Mission Gorge 2, Map 2: Looking downstream from the south side.

IHHA 13. Mission Gorge 2, Map 2: Looking upstream from south side.

IHHA 14. Mission Gorge 2, Map 2: Looking downstream from the upstream end of the segment.

Analysis Performed By: Rick Engineering, Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Maps

Two maps illustrating the facility group location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following pages for both the Mission Gorge 3 and 4 segments (Map 1), and the Mission Gorge 1 and 2 segments (Map 2).

Field Photo Locations
Storm Drain Conveyance
Culvert
MWMP Facility Cross Section
Mission Gorge 3
Mission Gorge 4

N

Drainage Area: 16,302 acres

Feet
0 100 200 400

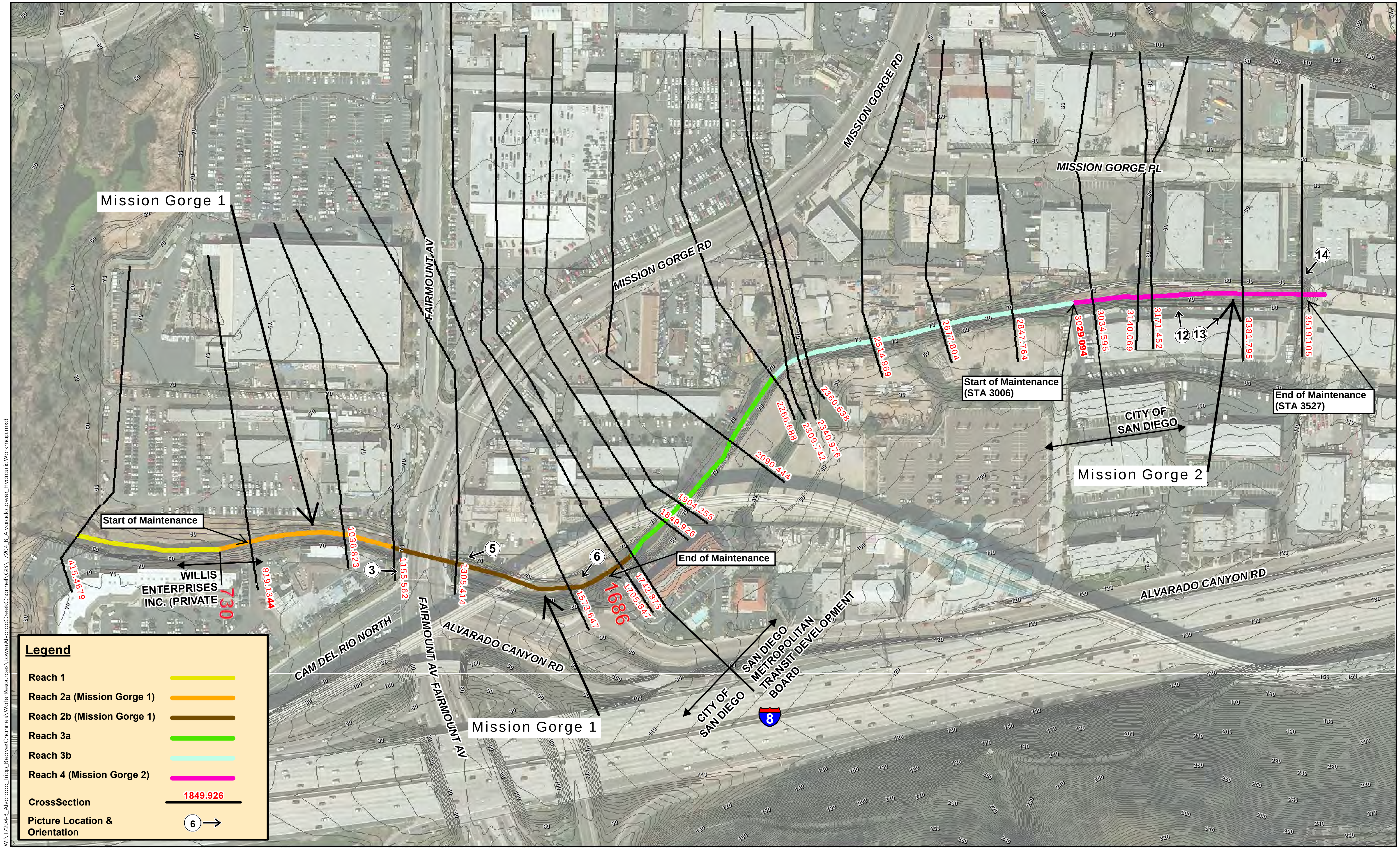
The City of SAN DIEGO

Facility Group Name: Alvarado Canyon - Mission Gorge
Segment Name: Mission Gorge 3 - 4
Facility Nos: 4-07-009, 4-07-011
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.

November 2019



RICK ENGINEERING COMPANY

Scale in Feet
0 200 400
North

Original Exhibit:
Alvarado Creek Channel - Lower Portion
MMP Map Numbers 59 & 60 Hydraulic Workmap (Report J-17204-B)

Date of Exhibit: 10.15.2014
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Alvarado Canyon Creek - Mission Gorge
Segment Names: Mission Gorge 1, Mission Gorge 2
Facility Nos: 4-07-002, 4-07-004
Hydraulic Map - Municipal Waterways Maintenance Plan

A.28 Alvarado Canyon Creek – Alvarado

Summary of Recommended Maintenance

Alvarado 1 (No.4-07-021)

Facility Type	Bed: Earthen Banks: Concrete, Earthen	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from channel bottom from Station 2317 to Station 3418.613. • Previously designed post maintenance erosion control measure at Station 2537 to be installed and maintained as necessary.	
Benefit	• Increases level of service from 5-year storm event (1,700 cfs) to <50-year storm event (<3,400 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.

Alvarado 2 (No.4-07-023)

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.

Alvarado 3 (No.4-07-250)

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.

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

Table 1. Completed Reports

Segment	Report	Reach
Alvarado 3	–	–
Alvarado 2	Rick Engineering Company, 2015. IHHA Report for Alvarado Channel (Upper Portion) Map Number 64.	3
Alvarado 1	Rick Engineering Company, 2015. IHHA Report for Alvarado Channel (Upper Portion) Map Number 64.	2
-	Rick Engineering Company, 2015. IHHA Report for Alvarado Channel (Upper Portion) Map Number 64.	1

General Description

The Alvarado Canyon Creek – Alvarado (Alvarado) facility group was classified as both Category 1 and 2 segments as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulic Technical Report*. The facility group is located in the San Diego River Watershed Management Area. The Alvarado facility group is bordered by Alvarado Hospital to the east and by commercial and residential development to the north and south. The facility group is located south of Alvarado Road, north of Cleo Street, west of Reservoir Drive, and east of Brockbank Place. The facility group is divided into three segments. Alvarado 2 and Alvarado 1, from upstream to downstream, are part of the main channel. Alvarado 3 is a tributary that discharges to the Alvarado 2 segment.

The Alvarado 2 segment (Reach 3) is the upstream segment of the facility group and is bound by residential development to the west and the south, and by Alvarado Hospital to the east. The Alvarado 3 segment discharges into Alvarado 2 between Station 4056.782 and Station 3913.392. The trapezoidal concrete segment begins south of Alvarado Road and continues south before making an approximately 90-degree turn to the west, and continuing for approximately 500 feet before it transitions to an earthen segment (Alvarado 1). The Alvarado 3 segment begins west of Reservoir Drive and south of Alvarado Road. The tributary is a fully concrete lined ditch with a 4-foot bottom width. The ditch extends west approximately 500 feet before discharging to the Alvarado 2 segment, just upstream of the 90-degree bend.

The Alvarado 1 segment (Reach 2) is the subsequent downstream segment and begins at the downstream end of Alvarado 2. The segment has an earthen bottom and left side slope with a concrete right side slope (facing downstream). The segment continues west approximately 980 feet before turning approximately 90 degrees to the north, and continuing for 120 feet before transitioning to a fully earthen segment, which is not under the jurisdiction of the City of San Diego. The earthen segment continues downstream of the facility group and is maintained by the State of California. The segment extends for approximately 1,700 feet and ends east of College Avenue.

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

Hydrology

The hydrologic peak flows presented in Table 2 for the Alvarado 1 and 2 segments 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 Alvarado Creek. 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*.

The hydrologic peak flow for the 100-year recurrence interval presented in Table 2 for the Alvarado 3 segment 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 3.1.1.3 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
Alvarado 3	239	305	358	433	488	544
Alvarado 2	1,000	1,700	2,100	2,558	3,400	3,900
Alvarado 1	1,000	1,700	2,100	2,558	3,400	3,900

Hydraulics

Alvarado 1 and 2 segments

A one-dimensional steady flow model was previously developed for the Alvarado 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 1 located at the end of this fact sheet.

The baseline condition is defined as the existing condition for the facility segments, as observed during the site visit conducted by Rick Engineering in August 2014. For the analysis of the baseline condition, the bottom and sides of Alvarado 2 were assigned Manning's coefficient values of 0.016 and 0.018, respectively. The earthen bottom of Alvarado 1 was assigned a range of Manning's coefficient values from 0.05–0.08, representing the light to moderate vegetation observed. The right concrete side slope of Alvarado 1 was assigned a value of 0.016, and the left earthen side slope was assigned values ranging from 0.03–0.05. The accumulated sediment depth within the Alvarado 1 segment was estimated to be up to 0.2–1.7 feet deep. The earthen bottom of Reach 1 was assigned a range of Manning's coefficient values from 0.08–0.1, and side slopes were assigned a range of Manning's coefficient values from 0.04–0.05. 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.

For the recommended maintained condition, the bottom and sides of Alvarado 2 were assigned Manning's coefficient values of 0.016 and 0.018, respectively. The bottom and sides of Alvarado 1 were assigned Manning's coefficient values ranging from 0.016–0.08 to reflect the roughness of the originally constructed facility.

Model parameters for the baseline and recommended maintained conditions for the Alvarado 1 and 2 segments are summarized in Table 3.

Alvarado 3 segment

An additional one-dimensional steady flow model was developed for Alvarado 3 using 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 the model is presented in the Hydraulic Reference Map 2 located at the end of this fact sheet.

The baseline condition is defined as the ultimate vegetated condition. Based on no recent history of maintenance in this segment, and little to no vegetation or sediment observed during the site visit conducted by Geosyntec Consultants in September 2017, the segment is considered to be at its ultimate vegetated state. For the analysis of the baseline condition, the bottom and sides of the

Alvarado 3 were assigned Manning's coefficient values ranging from 0.016–0.035. For the recommended maintained condition, the bottom and sides were assigned Manning's coefficient values ranging from 0.016–0.035.

Model parameters for the baseline and recommended maintained conditions for the Alvarado 3 segment is summarized in Table 3.

Table 3. Model Parameters

Segment and Material	Reference Stations[1,2]	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Alvarado 3 (concrete)	522-5	Baseline: 0.016-0.035 Maintained: 0.016-0.035	-	Normal Depth, Known Water Surface Elevation
Alvarado 2 (concrete)	4559.274-3418.613	Baseline: 0.016-0.018 Maintained: 0.016-0.018	Lateral Structure (Station 4543.777)	Critical
Alvarado 1 (concrete, earthen)	3418.613-2335.331	Baseline: 0.016-0.08 Maintained: 0.016-0.08	Temporary Check Dam (STA 2537)	-
Reach 1 (earthen)	2308.404-611.5112	Baseline: 0.04-0.1 Maintained: 0.04-0.1	-	Known Water Surface Elevation

1 The stationing for Alvarado 3 does not align with the stationing of the other facility group segments. Alvarado 3 was modeled separately.

2 Modeled reference stations may differ from proposed maintenance area stations.

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 2 in the Hydrology section, were used in determining the level of service. The overall channel conveyance capacities 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 Alvarado 3 segment can convey up to 426 cfs (<25-year level of service) in the baseline condition before the adjacent property is impacted.

The Alvarado 2 segment can convey up to 3,900 cubic feet per second (cfs) (100-year level of service) in the baseline condition before the adjacent property is impacted.

The Alvarado 1 segment can convey up to 1,700 cfs (5-year level of service) in the baseline condition before the adjacent property is impacted.

Recommended Maintained Condition

The Alvarado 3 segment has a level of service equal to <25-year storm in the baseline condition and because it is considered at its ultimate vegetated condition with little to no sediment present, the tributary is not recommended for maintenance.

The Alvarado 2 segment has a level of service equal to the 100-year storm in the baseline condition and is not recommended for maintenance. Due to the potential need for access and/or concrete repair, developing a plan for potential maintenance within Alvarado 2 and Alvarado 3 is recommended. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Removing deposited sediment/debris and vegetation from the Alvarado 1 segment will increase the conveyance capacity to <3,400 cfs (<50-year level of service). It is important to note that the benefits to the Alvarado facility group due to the recommended maintenance are dependent on the assumption that the downstream channel and culverts, which are not owned by the City of San Diego, have been maintained.

Post-Maintenance Erosion Control Measures

The estimated velocities in the concrete lined segments of Alvarado 2 and Alvarado 3 are below the recommended permissible velocities for concrete lined channels, as defined in the *City of San Diego Drainage Design Manual, dated January 2017* (35 feet per second (fps)), in both the baseline and recommended maintained conditions. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended.

The estimated velocities in the recommended maintained condition for the Alvarado 1 segment exceed the maximum permissible velocities for earthen channels (5 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are required for this facility.

Erosive velocities within the Alvarado 1 segment following the recommended maintenance require placement of a post-maintenance erosion control measure near the downstream limit of the segment (Station 2537). As part of the maintenance effort in 2016, a chain-link fence check dam was installed within the Alvarado 1 segment. The check dam decreases the capacity of the Alvarado 1 segment to <10-year storm event. After adequate vegetation has established, the check dam can be removed and the capacity will increase to <50-year storm event.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions, the facility group capacities were limited by an existing reinforced concrete arch under College Avenue at the downstream end of Reach 1 (owned by the State of California). 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	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Alvarado 3	522-5	426	-	<25–year storm	-
Alvarado 2	4559.274-3418.613	3,900	-	100–year storm	-
Alvarado 1	3418.613-2335.331	1,700	<3,400	5-year storm	<50–year storm

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. Photos are from site visits conducted by Rick Engineering in August 2014 (Alvarado 2 and 1) and by Geosyntec Consultants in September 2017 (Alvarado 3).

IHHA 1. Alvarado 1, Map 1: From south side of Reach 1 at the downstream end of the Alvarado Channel, upstream of College Avenue, looking upstream.

IHHA 3. Alvarado 1, Map 1: From northeast side of Reach 1, upstream of Alvarado Road near pedestrian crossing, looking slightly downstream.

IHHA 5. Alvarado 1, Map 1: From east side of Reach 2, directly upstream of State of California maintenance boundary, looking downstream.

IHHA 6. Alvarado 1, Map 1: From east side of Reach 2, directly upstream of photo 5, looking upstream.

IHHA 7. Alvarado 2, Map 1: From north side of Reach 2, looking downstream.

IHHA 11. Alvarado 2, Map 1: From north side of channel in Reach 2, looking upstream.

IHHA 12. Alvarado 2, Map 1: From north side of channel, at start of Reach 3, where channel becomes 100% concrete, looking downstream.

IHHA 13. Alvarado 2, Map 1: From north side of the channel in Reach 3, within 100% concrete portion of channel at 90-degree bend, looking downstream.

1. Alvarado 3, Map 2: Facing the upstream end of the segment, at the location of the recent concrete lining repair work.

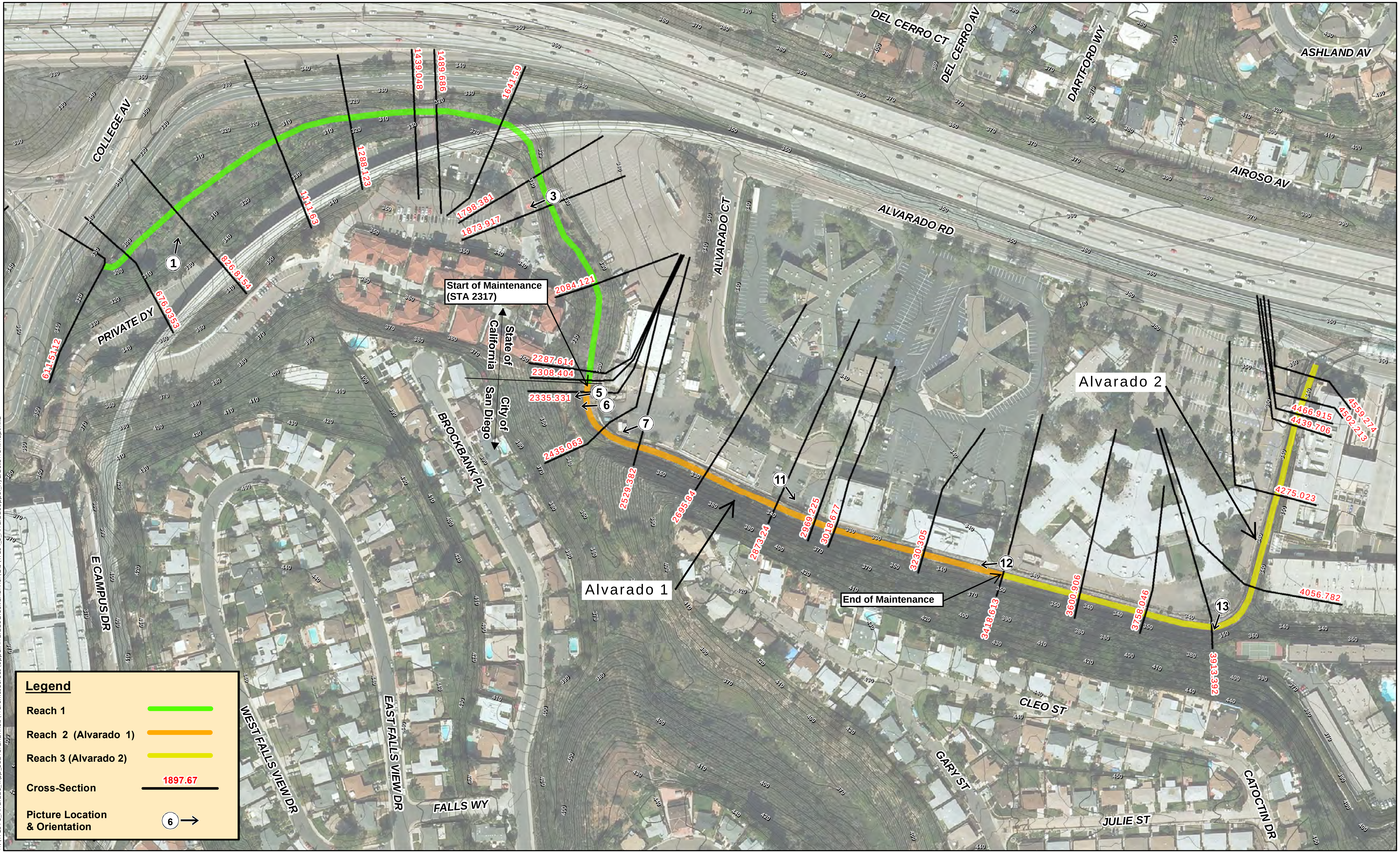
2. Alvarado 3, Map 2: Facing downstream at where the tributary discharges into the Alvarado 2 segment.

Analysis Performed By: Rick Engineering, Geosyntec Consultants

Fact Sheet Prepared By: Geosyntec Consultants

Hydraulic Reference Map

Two maps illustrating the facility location, domains of analysis (as applicable), and HEC-RAS model station locations are included on the following pages for both the Alvarado 1 and 2 segments (Map 1), and the Alvarado 3 segment (Map 2).



RICK ENGINEERING COMPANY

Scale in Feet

0 200 400

North

Original Exhibit:
Upper Alvarado Creek Channel
MMP Map Number 64 Hydraulic Workmap (Report J-17204-B)

Date of Exhibit: 09.15.2014
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Alvarado Canyon Creek - Alvarado
Segment Names: Alvarado 1, Alvarado 2
Facility Nos: 4-07-021, 4-07-023
Hydraulic Map - Municipal Waterways Maintenance Plan

Field Photo Location
Storm Drain Conveyance
MWMP Cross Section
MWMP Facility Center Line

N

Drainage Area: 300 acres

Feet
0 25 50 100

The City of SAN DIEGO

August 2019

Facility Group Name: Alvarado Canyon Creek - Alvarado
Segment Name: Alvarado 3
Facility No: 4-07-250
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.29 Murray Reservoir – Cowles Mountain

Summary of Recommended Maintenance

Cowles Mountain 1 (No. 4-07-901)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 709 to Station 1406. • Remove accumulated sediment/debris in culverts at Station 709 and Station 1406.	
Benefit	• Increases conveyance capacity from 317 cfs to 340 cfs. Level of service remains <2-year storm event. • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the 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.

Cowles Mountain 2 (No. 4-07-911)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from the ditch from Station 0 to Station 209, from Station 785 to Station 1735; and from Station 1855 to Station 2891. • Remove accumulated sediment/debris in culverts from Station 209 to Station 785 and from Station 1735 to Station 1855.	
Benefit	• Increases conveyance capacity from 142 cfs to 202 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 Murray Reservoir – Cowles Mountain (Cowles Mountain) facility group was classified as two Category 1 segments, as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulic Technical Report*. The Cowles Mountain facility group is located in the San Diego River Watershed Management Area. The two segments converge in a concrete lined channel in the San Carlos Golf Course. Cowles Mountain 1 is the northern branch, which follows Cowles Mountain Boulevard from Navajo Road to San Carlos Drive. Cowles Mountain 2 is the eastern branch, which begins at Boulder Lake Avenue and flows parallel to the southern side of Beaver Lake Road before crossing Cowles Mountain Boulevard and entering the golf course. Both segments are bordered by residential development.

Cowles Mountain 1 is a concrete lined ditch with a trapezoidal cross-section, as indicated on as-built drawing no. 10721-10-TD that receives flow from a 66-inch-diameter reinforced concrete pipe (RCP) culvert underneath Navajo Road from the north. Per the as-built drawings, the concrete ditch bottom is approximately 4 feet wide and the banks are 5-6 feet high with 1.5:1 (H:V) side slopes. Runoff is conveyed through the Cowles Mountain 1 segment in a southwesterly direction and enters a 66-inch-diameter RCP culvert behind residences at the intersection of Cowles Mountain Boulevard and San Carlos Drive. The culvert discharges into an earthen ditch and continues west of Cowles Mountain Boulevard towards the golf course. The earthen ditch transitions back to a concrete ditch at Station 179 before it confluences with the Cowles Mountain 2 segment at Station 0.

Cowles Mountain 2 is a ditch with a trapezoidal cross-section, as indicated on as-built drawing nos. 9741-9-D and 9741-10-D, that receives flow from a 66-inch-diameter RCP culvert underneath Boulder Lake Avenue from the east. Runoff is conveyed through the Cowles Mountain 2 segment in a westerly direction and enters a 66-inch-diameter RCP beneath Lake Badin Avenue. The segment continues west and enters a 60-inch-diameter RCP culvert beneath Cowles Mountain Boulevard and private property. The 60-inch RCP culvert then discharges into a trapezoidal concrete channel at Station 209 and continues in a northwest direction before joining the Cowles Mountain 1 segment at Station 0 in the San Carlos Golf Course. The ditch bottom is 5-7 feet wide; the banks are 3-6 feet high with side slopes that vary from1.5:1 (H:V) to 2:1 (H:V).

The following sections describe the hydrologic analysis, hydraulic assessment and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Cowles Mountain 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*. 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
Cowles Mountain 1	355	457	537	645	729	812
Cowles Mountain 2	284	365	429	517	583	649

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 in November 2014. For the analysis of the baseline condition, photos taken by the City of San Diego in October and November 2014 were used to assign Manning's coefficient values. The ditch bottom of Cowles Mountain 1 was assigned a Manning's coefficient values ranging from 0.018 to 0.07 and the ditch bottom of Cowles Mountain 2 was assigned values ranging from 0.02 and 0.05 based on the moderate to dense vegetation observed in the bottom of the ditch. The banks of Cowles Mountain 1 were assigned values ranging from 0.03 to 0.07 and the banks of Cowles Mountain 2 were assigned values ranging from 0.03 to 0.07 based on dense vegetation that was observed and many trees. The sediment/debris depth throughout the facility group was estimated to be 0.5 feet on the ditch bottom. The Cowles Mountain 1 culvert at Station 709 had an estimated sediment/debris depth of 0.5 feet, and the two culverts within Cowles Mountain 2 (Station 1855 and Station 785) were estimated to be blocked by 2.5 feet of sediment/debris. Photos in the Representative Photos section below provide examples of the condition of the facility as observed during the October and November 2014 site visit.

For the recommended maintained condition, the ditch bottoms were 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 ditch remain unchanged.

Model parameters and velocities for the baseline and recommended maintained conditions for the Cowles Mountain 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
Cowles Mountain 1	1406-709 (concrete)	Baseline: 0.04-0.05	Baseline: 2.88-5.29	Culvert (Station 709 to 460)	Normal Depth
		Maintained: 0.015-0.04	Maintained: 2.56-8.57		
	460-179 (earthen)	Baseline: 0.02-0.07	Baseline: 8.35-9.88		
		Maintained: 0.015-0.07	Maintained: 8.35-9.88		
	179-0 (concrete)	Baseline: 0.018-0.03	Baseline: 3.21-16.14		
		Maintained: 0.015-0.03	Maintained: 3.42-16.71		
Cowles Mountain 2 (concrete)	2891-785	Baseline: 0.02-0.06	Baseline: 1.20-8.26	Culverts (Station 1855 to 1735, Station 785 to 209)	Normal Depth
		Maintained: 0.015-0.06	Maintained: 1.21-8.28		
	209-0	Baseline: 0.03-0.07	Baseline: 2.64-6.77		
		Maintained: 0.015-0.07	Maintained: 5.89-7.37		

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 facility group. The Cowles Mountain 1 channel can convey 317 cubic feet per second (cfs) (<2-year level of service), before the roadway is impacted. The Cowles Mountain 2 channel can convey 148 cfs (<2-year level of service), before the roadway is impacted.

Recommended Maintenance Condition

Removing deposited sediment/debris and vegetation from the Station 709 to Station 1406 improves the conveyance capacity in Cowles Mountain 1 to 340 cfs (<2-year level or service). The conveyance capacity in Cowles Mountain 2 to 272 cfs, (<2-year level of service).

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 culvert from Station 709 to 460 within the Cowles Mountain 1 segment, and the culverts from Station 1855 to 1735 and from Station 785 to 209 within the Cowles Mountain 2 segment. 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
Cowles Mountain 1	1406-460	317	340	<2-year	<2-year
	460-179	340	340	<2-year	<2-year
	179-0	395	395	<5-year	<5-year
Cowles Mountain 2	2891-209	148	272	<2-year	<2-year
	209-0	142	202	<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 the City of San Diego in October and November 2014 and by Geosyntec Consultants in May 2017.

1. Cowles Mountain 1: Upstream of culvert near Station 780 (October 2018).

2. Cowles Mountain 2: Upstream of culvert at Station 785 (October 2014).

3. Cowles Mountain 2: Culvert under Lake Badin Avenue at Station 1855 (October 2014).

4. Cowles Mountain 2: Upstream of culvert at Lake Badin Avenue (October 2014).

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 Cowles Mountain facility group.

Field Photo Location
Storm Drain Conveyance
Culverts
MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Centerline
Cowles Mountain 1
Cowles Mountain 2

N

Drainage Area: 797 acres

0 75 150 300 Feet

The City of SAN DIEGO

Facility Group Name: Murray Reservoir - Cowles Mountain
Segment Name: Cowles Mountain 1 - 2
Facility Nos: 4-07-901, 4-07-911
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.30 Norfolk Canyon Creek – Fairmount (Fairmount 1 – 4 & Aldine)

Summary of Recommended Maintenance

Fairmount 1 (No. 4-08-008)

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..

Fairmount 2 (No. 4-08-011)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 1300 to Station 1875. • Remove accumulated sediment/debris in culvert from Station 655 to Station 1300.	
Benefit	• The level of service increases from <2-year storm event (50 cfs) to <10-year storm (563 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.

Fairmount 3 (No. 4-08-014)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Restore riprap from Station 4009 to Station 4038 at the culvert outlet.	
Benefit	• The level of service and capacity remains unchanged at <25-year storm event (670 cfs). • Prevents scour at the culvert outlet due to high velocity flow.	

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.

Fairmount 4 (No. 4-08-017)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Removal of sediment/debris and vegetation from Station 4637 to Station 5887. • Removed sediment/debris in culvert from Station 4038 to Station 4637.	
Benefit	• The level of service and capacity remains unchanged at <10-year storm event (120 cfs). • The WSE at the upstream end of the ditch improves to the 100-year WSE in the recommended maintained condition. • 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.

Aldine 1 (No. 4-08-150)

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 Norfolk Canyon Creek – Fairmount and Aldine (Fairmount) 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 Fairmount facility group is located in the San Diego River Watershed Management Area. The Fairmount 1 through 4 segments run parallel to the west side of Fairmount Avenue from approximately 900 feet north of the intersection of Meade Avenue and Fairmount Avenue to the southbound Montezuma Road-Fairmount Avenue interchange loop. The Aldine segment runs parallel to Aldine Drive, along the north side of the road, from Monroe Avenue to the northbound entrance ramp to Fairmount Avenue.

The facility group is y-shaped at the upstream end and is split into two segments (Aldine and Fairmount 4) that join within the culvert system under the Aldine Drive–Fairmount Avenue interchange. The Aldine segment receives flow from upstream storm drain system via a 24-inch-diameter reinforced concrete pipe (RCP). The flows in the Aldine segment run northwest within the earthen ditch to a 45-inch-diameter RCP culvert inlet which conveys flow under the Aldine Drive–Fairmount Avenue interchange. Fairmount 4 is a concrete ditch that receives flow from the upstream storm drain system via a 42-inch-diameter RCP and conveys the flow northeasterly to a 48-inch-diameter RCP culvert inlet south of the Aldine Drive–Fairmount Avenue interchange. The combined flows from Aldine and Fairmount 4 segments then discharge into Fairmount 3 via a 60-inch-diameter RCP culvert outlet.

Fairmount 3 is an earthen ditch that runs parallel to Fairmount Drive and conveys flows from the 60-inch-diameter RCP culvert outlet to the north for approximately 810 feet to a 72-inch-diameter RCP culvert inlet. Additional flows enter Fairmount 3 mid-segment from a tributary drainage area to the west of the facility. The culvert at the end of Fairmount 3 upsizes to an 84-inch-diameter RCP culvert before it outlets into Fairmount 2. Fairmount 2 is a concrete lined ditch that conveys the flows to the north to a dual 6-foot by 5-foot reinforced concrete box (RCB) culvert that crosses under the Montezuma–Fairmount interchange. This culvert then outlets into Fairmount 1, which is a concrete ditch located within the southbound Fairmount Avenue exit loop from Montezuma Road. Fairmount 1 conveys flow to a second dual 6-foot by 5-foot RCB culvert that conveys the flows under the remainder of the interchange. See Hydraulic Reference Map located at the end of this fact sheet.

Stationing for the Fairmount segments is independent from that of the Aldine segment. The stationing for Fairmount begins at Station 0 in the downstream domain and continues upstream to the upper end of Fairmount 4 at Station 5887. Stationing for Aldine begins at the confluence with the Fairmount segments at Station 0 (equivalent to Station 4286 of the Fairmount segments) and continues upstream to Station 1640.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Fairmount 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 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.* Aldine, Fairmount 3, and Fairmount 4 have distinct drainage areas; therefore, hydrologic peak flows were estimated separately for these segments. The combined peak flows downstream of the junction of Aldine and Fairmount 4 and the junction with Fairmount 3 tributary drainage was calculated using the modified rational method as described in the *City of San Diego Drainage Design Manual, dated January 2017*. The peak flow rates calculated for Fairmount 3 were also used for Fairmount 1 and Fairmount 2.

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
Aldine 1	280	359	419	503	563	624
Fairmount 4	83	106	124	148	166	184
Fairmount 1-3	390	499	583	699	784	868

Hydraulics

A one-dimensional steady flow model was developed for the 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 domains of analysis for the facility group are the existing storm drain systems. The downstream domain of analysis consists of an existing dual 6-foot by 5-foot culvert and downstream channel from Station 407 to Station 0. 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 Fairmount facility group was determined to be the existing condition. Modeling parameters for sediment/debris deposition and Manning's coefficient values were assigned based on observations made by D-MAX Engineering during the April 2017 site visit. Refer to the photos in the Representative Photos Section for examples of the facility as observed during the site visit.

The Aldine segment was assigned Manning's coefficient values ranging from 0.03 to 0.05 to represent the varying density of the vegetation within the facility, as well as the roughness of the rocky cobble sections.

The Fairmount 4 segment was modeled with sediment/debris accumulation depth of 2 feet from Station 5548 to Station 5328. Manning's coefficient values assigned ranged from 0.018 to 0.05 to reflect the observed density of vegetation throughout the segment.

The Fairmount 3 segment was assigned Manning's coefficient values ranging from 0.02 to 0.06 to represent the density of the vegetation within the earthen ditch. This segment was also modeled with a scour pool at the culvert outlet from Station 4038 to Station 4009.

The Fairmount 2 segment was modeled with sediment/debris accumulated ranging from 6 inches to 4 feet deep from Station 1782 to Station 1378. Manning's coefficient values were assigned based on the observed vegetation in the facility, ranging from 0.018 to 0.045.

Fairmount 1 was assigned a Manning's coefficient value of 0.018 to represent the concrete channel with a film of algae/moss lining the bottom of the facility.

For the recommended maintained condition, maintenance was not recommended for the Fairmount 1 and Aldine segments. Maintenance was not recommended for Fairmount 1 because there was no significant vegetation growth or obstruction observed in the channel that was causing a reduction in capacity. A maintenance area should be identified for Fairmount 1 for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs. Aldine was not recommended for maintenance due to the erosive velocities computed in the baseline condition along with the evidence of erosion in the segment observed during the site visit.

In the recommended maintained condition for Fairmount 4, the Manning's coefficient values were reduced to 0.015 for the entire length of the segment to represent the roughness of the originally constructed facility.

In the recommended maintained condition, the maintenance in Fairmount 3 was limited to replacement of riprap from Station 4038 to Station 4009 to repair the scour pool at the culvert outlet. Riprap is shown in this location on as-built drawing no. 6930-D and is part of the originally designed facility. Manning's coefficient values were only changed to 0.044 at the cross sections where riprap is recommended.

In the recommended maintained condition for Fairmount 2, the Manning's coefficient values were reduced to 0.015 for the entire length of the facility representative of the roughness of the originally constructed facility.

Model parameters and velocities for the baseline and maintained conditions for the Fairmount 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
Aldine 1 (earthen)	1640–400	Baseline: 0.03–0.05	Baseline: 1.7–17.9	Culvert (Station 400-0)	Normal Depth at Station 1640
		Maintained: Not Applicable	Maintained: Not Applicable		
Fairmount 4 (concrete)	5887-4637	Baseline: 0.018–0.05	Baseline: 2.0–17.0	Culvert (Station 4637-4038)	—
		Maintained: 0.015	Maintained: 2.0–19.3		
Fairmount 3 (earthen)	4038–3218	Baseline: 0.02–0.078	Baseline: 0.7–12.7	Culvert (Station 3218-1875)	—
		Maintained: 0.02–0.06	Maintained: 0.7–11.9		
Fairmount 2 (concrete)	1875-1300	Baseline: 0.018–0.045	Baseline: 1.5–12.5	Culvert (Station 1300-655)	—
		Maintained: 0.015	Maintained: 3.3–20.7		
Fairmount 1 (concrete)	655–407	Baseline: 0.018	Baseline: 3.8-17.2	Culvert	—

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Condition s
		Maintained: 0.018	Maintained: 3.8 – 17.2	(Station 407-32)	
Downstream Domain of Analysis	407–0	0.015–0.08	Baseline: 3.9–5.0		Normal Depth at Station 0
			Maintained: 3.9–5.0		

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 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 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 conditions.

Baseline Condition

The level of service for Aldine is less than the 2-year storm event and a capacity of 105 cubic feet per second (cfs) before the roadway is impacted. Fairmount 4 provides a level of service of less than the 10-year storm event and conveys 120 cfs before the water surface elevation (WSE) rises above the concrete banks of the facility; however, no adjacent properties are impacted. Fairmount 3 provides a level of service of less than the 25-year storm and can convey 670 cfs before the roadway is impacted. The level of service in Fairmount 2 is less than the 2-year storm and conveys 50 cfs before the roadway is impacted. Fairmount 1 provides a level of service of greater than 10-year storm event and conveys 600 cfs before the roadway is impacted.

Recommended Maintained Condition

Maintenance is not recommended for the Aldine and Fairmount 1 segments. The Aldine segment modeling indicated erosive velocities in the baseline condition, and there was evidence of erosion in the segment observed during the site visit. Additionally, maintenance did not improve the conveyance capacity of the segment. Therefore, maintenance activities that could exacerbate the erosive condition were not recommended. The Fairmount 1 segment had no significant vegetation growth or obstruction observed in the channel. A maintenance area should be identified for Fairmount 1 for access and/or potential concrete repair. Accumulated sediment/debris and vegetation may need to be removed for access or repairs.

Removal of sediment/debris and vegetation in Fairmount 4 does not increase the level of service or capacity of the segment; however, it does decrease the WSE in the concrete ditch by 2 feet, and the 100-year WSE is contained within the concrete portion of the ditch at the upstream end of the segment. Also, the removal of sediment/debris and vegetation provides a benefit by reducing the potential for clogging the downstream culvert.

In Fairmount 3, the recommended maintenance is to replace the riprap from Station 4038 to Station 4009 as shown on as-built drawing no. 6930-D. This eliminates the scour pool at the culvert outlet and protects this section of the earthen channel from the erosive velocities. The proposed maintenance does not increase the level of service or conveyance capacity of the Fairmount 3 segment. Maintenance of the remainder of the Fairmount 3 segment was evaluated and was found to not improve the conveyance capacity and it increased velocities within the segment above permissible levels therefore additional maintenance was not recommended.

Removal of sediment/debris and vegetation in Fairmount 2 improves the level of service to less than the 10-year storm event and improves the conveyance capacity to 563 cfs.

Post-Maintenance Erosion Control Measures

The estimated velocities in the concrete lined segments of Fairmount 1, Fairmount 2, and Fairmount 4 are below the recommended permissible velocities for concrete lined channels, as defined in the *City of San Diego Drainage Design Manual, dated January 2017* (35 feet per second (fps)), in both the baseline and recommended maintained conditions. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended.

No maintenance is proposed in the Aldine segment. The baseline condition velocities were noted to be above the recommended permissible velocities for earthen lined channels (5 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017* in the segment. However, since no maintenance is proposed, no post-maintenance measures are proposed.

Limited maintenance to replace the riprap at the culvert outlet is recommended in the Fairmount 3 segment. In the riprap lined portion of the segment, the estimated velocities are below the recommended permissible velocities for riprap lined channels (18 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. There are some portions of the segment that have estimated velocities in the baseline condition above the recommended permissible velocities for natural grass-lined channels, as defined in the *City of San Diego Drainage Design Manual, dated January 2017* (less than 5 fps) in the baseline condition. However, since no maintenance is proposed in the downstream portion of the segment, 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 level of service was restricted culvert inlet capacities for each segment of the facility. Due to the presence of scour and higher velocities in the baseline condition modeling in the Aldine and Fairmount 3 segments, 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
Aldine 1 (earthen)	1640–400	105	-	<2-year	-
Fairmount 4 (concrete)	5887–4637	120	120	<10-year	<10-year
Fairmount 3 (earthen)	4038–3218	670	670	<25-year	<25-year
Fairmount 2 (concrete)	1875–1300	50	563	<2-year	<10-year
Fairmount 1 (concrete)	655–407	600	-	>10-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. Aldine 1: Looking downstream at vegetation, erosion in facility.

2. Fairmount 4: Looking downstream at sediment/debris and vegetation in concrete ditch.

3. Fairmount 3: Looking downstream at scour pool at channel outfall.

4. Fairmount 3: Looking downstream at vegetation in channel.

5. Fairmount 2: Looking downstream at sediment/debris and vegetation in concrete ditch.

6. Fairmount 2: Looking downstream at vegetation concrete ditch.

7. Fairmount 1: Looking downstream at concrete channel.

Analysis Performed By: D-MAX Engineering Inc.

Fact Sheet Prepared By: D-MAX Engineering Inc.

Hydraulic Reference Map

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

Storm Drain Conveyance
MWMP Facility Cross Section
Domain of Analysis Cross Section
MWMP Facility Center Line

N

Drainage Area: 567 acres

Feet
0 255 510 1,020

The City of SAN DIEGO

Facility Group Name: Norfolk Canyon Creek - Fairmount
Segment Name: Fairmount 1 - 4; Aldine 1
Facility Nos: 4-08-008, 4-08-011, 4-08-014, 4-08-017, 4-08-105
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
Bridge/Culvert
MWMP Facility Cross Section
Domain of Analysis Cross Section
Fairmount 1
Fairmount 2

N

Drainage Area: 567 acres

Feet
0 75 150 300

The City of SAN DIEGO

Facility Group Name: Norfolk Canyon Creek - Fairmount
Segment Name: Fairmount 1 - 2
Facility Nos: 4-08-008, 4-08-011
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. Storm drain conveyance line is approximate.

November 2019

Field Photo Location
Storm Drain Conveyance
Culvert

MWMP Facility Cross Section
Aldine 1
Fairmount 3
Fairmount 4

N

Drainage Area: 567 acres

Feet
0 50 100 200

The City of SAN DIEGO

Facility Group Name: Norfolk Canyon Creek - Fairmount
Segment Name: Fairmount 3 - 4
Facility Nos: 4-08-014, 4-08-017
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
- MWMP Facility Cross Section
- Domain of Analysis Cross Section
- Aldine 1
- Fairmount 4

N

Drainage Area: 567 acres

Feet
0 50 100 200

The City of SAN DIEGO

Facility Group Name: Norfolk Canyon Creek - Fairmount
Segment Name: Aldine 1
Facility No: 4-08-150
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

A.31 Norfolk Canyon Creek - Fairmount (Baja 1; No. 4-08-105)

Summary of Recommended Maintenance

Facility Type	Bed: Concrete, Earthen Banks: Concrete, Earthen	Category 1 & 2
Is Maintenance Recommended?	Yes[1,2]	
Extent of Maintenance[3]	• From Station 281.1765 to Station 588.9762: Partially remove vegetation; cut down existing palm trees, leaving 2-foot-tall stumps with root balls intact in the ground. Stumps should be left in place to help mitigate velocities. Remove all fallen palm tree trunks and debris. Leave all other existing vegetation and sediment in place. • From Station 588.9762 to Station 646: Remove palm tree growing out of a crack in the concrete lining and repair/replace the broken and missing concrete lining to match the existing flow line. • Previously designed post maintenance erosion control measures at Station 281.1765 and 488.3933 to be installed and maintained as necessary. • Repair/replacement of broken concrete lining in Reach 2 (Station 281.1765 to Station 646).	
Benefit	• The level of service remains at the <2-year storm event for Reaches 1 and 3 (250 cfs and 325 cfs, respectively) and at the 100-year storm event (1,232 cfs) for Reach 2. • 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.

2 Due to the potential need for concrete repair, developing a plan for potential maintenance is recommended.

3 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	Reports	Reach
Baja 1	Rick Engineering Company, 2017. IHHA Report for Montezuma Channel Map Numbers 66.	1, 2, 3

General Description

The Norfolk Canyon Creek - Fairmount – Baja (Baja) facility group was classified as a Category 1 and Category 2 facility segment, as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Baja facility group is located in the San Diego River Watershed Management Area and is fully bordered by residential development. The facility group parallels Baja Drive and Maisel Way to the east and the Collwood Villa Apartments to the west. The facility group is bound at the upstream end by a natural channel, and at the downstream end by the storm drain system. The facility group is a 1,500-foot segment that is predominantly a concrete trapezoidal channel, with approximately 250 feet of the total length being earthen lined. The facility group is divided into three reaches for the purpose of this assessment.

Reach 3 is the furthest upstream segment within the facility group and is a trapezoidal concrete lined ditch with a bottom width of 4 feet, a depth of 4 feet, and side slopes of 1.5:1(H:V), per as-built drawing no. 10657-5-D. The segment begins at the transition from the upstream natural segment south of Baja Drive and northeast of the Maisel Way cul-de-sac, and continues west for approximately 900 feet until it reaches a 60-inch-diameter reinforced concrete pipe (RCP) culvert beneath 54th Street.

Reach 2 is the subsequent downstream segment that begins at the outfall of the 60-inch-diameter RCP culvert beneath 54th Street and is approximately 340 feet in length. The upstream 50 feet of Reach 2 consists of a concrete lined trapezoidal channel with a bottom width of 20 feet, a depth of 4-feet, and side slopes of 1.5:1 (H:V), per as-built drawing no. 10657-5-D. The rest of the segment is earthen bottomed that varies in bottom width from 10 to 15 feet. A 3.5-foot-high 1.5:1 (H:V) concrete side slope extends along the right bank (looking downstream) of the channel, and the left bank is formed by the graded slopes of adjacent subdivision and ranges from 1:1 (H:V) to 2:1 (H:V). The segment extends west until it meets a transition from earthen lining to concrete lining (Reach 1).

Reach 1 is a trapezoidal concrete lined segment that begins downstream of the earthen-lined Reach 2. Per as-built drawing no. 13391-2-L, the segment has a 6-foot-wide bottom with 3.5-foot-high side slopes of 1.5:1 (H:V). On the left side of the segment (viewing downstream), earthen vegetated slopes extend approximately 10 vertical feet above the concrete lining. On the right side, vegetated earthen slopes extend to approximately 50 feet vertically above the concrete lining. The segment extends 275 feet before entering the storm drain system via a 60-inch-diameter RCP culvert beneath the Collwood Villa Apartments and enters the 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 Baja facility group.

Hydrology

The hydrologic peak flows for the 100-year recurrence interval presented in Table 2 were estimated based on the size of the watershed tributary to the channel and the peak flows for the remaining recurrence intervals (2-, 5-, 10-, 25-, and 50-year) were scaled using the 6-hour approximation as described 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
Baja 1	593	730	867	958	1049	1232

Hydraulics

A one-dimensional steady flow model was developed for the 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.

For Reach 3 of the Baja segment, the baseline condition was determined to be the ultimate vegetated condition. A Manning's coefficient value of 0.018 was used for the segment bottom and side slopes to reflect concrete with no vegetation or sediment/debris. No sediment deposition was observed in the current condition, and no sediment deposition or vegetation establishment is expected in this reach due to high flow velocities of up to 17 feet per second (fps) in the current condition. Therefore, an increased Manning's coefficient value representing ultimate vegetative growth was not applied to the segment bottom for Reach 3.

For Reach 2 of the Baja segment, the baseline condition was determined to be the current condition as observed during a site visit conducted by Rick Engineering in November 2016. A Manning's coefficient value of 0.018, reflecting concrete with no vegetation or deposited sediment, was applied to the right concrete side slope that extends the length of the reach as well as the short section of concrete lined channel immediately downstream of the 60-inch-diameter RCP beneath 54th Street. Areas of dense palm trees and wetland marsh vegetation within sections of earthen channel were modeled using a Manning's coefficient value of 0.14. Areas of moderately dense vegetation on both banks were modeled using a Manning's coefficient value of 0.035. The short section of rock and gravel lined channel where sections of the concrete lining are broken and missing was modeled using a Manning's coefficient value of 0.04. The single palm tree growing out of a crack in the concrete lined channel approximately 50 feet downstream of the 60-inch-diameter RCP beneath 54th Street was modeled as a 2-foot-wide obstruction. During high flows it was assumed that palm fronds would bend or break off, leaving the approximately 2-foot-wide palm tree trunk.

For Reach 1 of the Baja segment, the baseline condition was determined to be the ultimate vegetated condition. A Manning's coefficient value of 0.018 was used for the segment bottom and side slopes to reflect concrete with no vegetation growth. No sediment deposition was observed during the November 2016 site visit, and no sediment deposition or vegetation establishment is expected in this reach due to high flow velocities of up to 12 fps in the current condition. Therefore, an increased Manning's coefficient value representing ultimate vegetative growth was not applied to the segment bottom for Reach 1.

The assigned Manning's coefficient value for Reach 3 in the recommended maintained condition was 0.018, reflecting concrete with no vegetation or deposited sediment.

The assigned Manning's coefficient value for Reach 2 in the recommended maintained condition was 0.11, used to represent the proposed 2-foot-tall palm tree stumps and retained freshwater marsh vegetation (Stations 281.1765 to 588.9762). A Manning's coefficient value of 0.018 was used to reflect concrete along the right side (looking downstream) of Reach 2 as well as the concrete lined channel immediately downstream of the existing 60-inch-diameter RCP underneath 54th Street (Stations 588.9762 to 618.9795). The proposed fence posts at Station 281.1765 were modeled under two preferred maintenance conditions: unobstructed, where the fence posts were modeled as 3-inch-wide obstructions, and obstructed, where the fence posts were modeled completely obstructed with trash and debris creating a 2.5-foot-high barrier spanning the width of the channel.

The assigned Manning's coefficient value for Reach 1 in the recommended maintained condition was 0.018, reflecting concrete with no vegetation or deposited sediment.

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

Table 3. Model Parameters

Segment and Material	Reference Stations[1]	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Baja 1	Reach 3: 1507.444–618.9795 (concrete)	Baseline: 0.018	Culvert (Station 708.1308)	-
		Maintained: 0.018		
	Reach 2: 618.9795–281.1765 (earthen/concrete)	Baseline: 0.018–0.14	Earthen lined (Stations 588.9762 - 281.1765)	-
		Maintained: 0.018–0.11		
	Reach 1: 281.1765–6.136 (concrete)	Baseline: 0.018	-	Rating Curve
		Maintained: 0.018		

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 the Summary Table (Table 4) for both the baseline and recommended maintained condition.

Baseline Condition

In the baseline condition, Reach 3 can convey 325 cubic feet per second (cfs) (<2-year level of service); Reach 2 can convey 1,232 cfs (100-year level of service); Reach 1 can convey 250 cfs (<2-year level of service).

Recommended Maintained Condition

Following the partial removal of vegetation and the repair/replacement of broken concrete lining in Reach 2, the level of service for Reach 2 remains equal to the 100-year storm event, and can convey 1,232 cfs. The risk of clogging the 60-inch-diameter RCP culvert beneath Collwood Villa Apartments is reduced due to partial maintenance of the existing palm trees. Potential erosive velocities in the segment will require the placement of a post maintenance erosion control measure near the middle of the mapped segment, at Station 488.3933. Downstream of the post maintenance erosion control measure, fixed fence posts are proposed at Station 281.1765 to be installed to capture large debris and reduce further clogging of the downstream culvert.

Reaches 1 and 3 are not recommended for maintenance as the capacities and levels of service remain equal to those in the baseline condition since it is not expected that the hydraulic conditions will change to allow sediment deposition or vegetation growth. Due to the potential need for concrete repair, developing a plan for potential maintenance within all reaches is recommended.

Post-Maintenance Erosion Control Measures

The estimated velocities in Reaches 1 and 3 are below recommended permissible velocities for concrete lined (35 fps) channels 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 in these reaches.

Reach 2 is stable in the baseline condition for the velocities that it experiences. During the November 2016 site visit, no erosion was noted along the unlined portion of the channel, and a comparison of the 2014 LIDAR data to the as-built segment slopes indicates that sediment deposition is occurring in this portion of the channel. However, the recommended maintenance will increase velocities above the permissible velocities for unlined channels. To mitigate this, the recommended maintained condition was modified. The existing palm trees should be cut down, leaving 2-foot-tall stumps with root balls attached, in the ground. All fallen palm tree trunks and debris should be removed. All other existing vegetation, including freshwater marsh species, should be left in place. Vegetation maintenance performed in this manner will increase velocities for earthen bottomed portions of the channel (Stations 281.1765 to 588.967).

In addition, to mitigate the increases in velocity caused by maintaining the palm trees in Reach 2, post maintenance erosion control measures are proposed at Station 281.1765 and Station 488.3933. The post maintenance erosion control measures will reduce the risk of palm trees and other debris from being carried into the existing 60-inch RCP underneath the Collwood Villas Apartment Complex and Collwood Boulevard and promote a reduction in the velocities.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that in both the baseline and recommended maintained conditions the level of service for the Baja facility group was restricted by the 60-inch-diameter RCP culvert beneath 54th Street and the 60-inch-diameter RCP culvert beneath the Collwood Villa Apartments and Collwood Boulevard. 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/ Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Baja 1	Reach 3: 1507.444–618.9795 (concrete)	325	–	<2-year	–
	Reach 2: 618.9795–281.1765 (earthen/ concrete)	1,232	1,232	100-year	100-year
	Reach 1: 281.1765–6.136 (concrete)	250	–	<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. A site visit was conducted by Rick Engineering in November 2016.

IHHA 1. Baja 1 (Reach 1): Facing downstream end of facility group; towards 60-inch-diameter RCP culvert beneath the Collwood Villas Apartments and Collwood Boulevard.

IHHA 7. Baja 1 (Reach 2): Facing downstream towards tulles and downstream palm tree stand.

IHHA 9. Baja 1 (Reach 2): Facing the upstream end of Reach 2 towards transition from earthen bottomed to concrete lined immediately downstream of 60-inch-diameter RCP culvert beneath 54th Street.

IHHA 13. Baja 1 (Reach 3): Facing the upstream end of the facility group.

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 Baja facility group.

W:\17204-L_TO#39_IHHA_FY17\4_Montezuma Map 66\GIS\17204-L_Montezuma_HydraulicWorkmap.mxd

RICK ENGINEERING COMPANY

Feet
0 250 500

Original Exhibit:
Montezuma Channel
MMP Map Number 66 - Hydraulic Workmap (Report J-17204-L)

Date of Exhibit: 1/31/2017
DigitalGlobe Aerial Image: 04.2013

Facility Group Name: Norfolk Canyon Creek - Fairmount
Segment Name: Baja 1
Facility No: 4-08-105
Hydraulic Map - Municipal Waterways Maintenance Plan

A.32 Maple Canyon Creek – Maple (No. 5-02-140)

Summary of Recommended Maintenance

Facility Type	Desilting Basin: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from the desilting basin.	
Benefit	• Reduces the amount of sediment that discharges from the canyon.	

[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 Maple Canyon Creek – Maple (Maple) facility group was classified as a Category 3 desilting basin as described in *Chapter 4, Section 4.3 of the Hydrology and Hydraulics Technical Report*. The facility is an approximately 0.10-acre desilting basin located in the San Diego Bay Watershed Management Area and receives runoff from approximately 90 acres of upstream urban area flowing through Maple Canyon Open Space canyon. The open space area collects runoff from the surrounding developed mesa tops and conveys it in an earthen channel through the undeveloped canyon to the Maple facility group. The Maple facility group discharges into the street at the end of West Maple Street where flows drain west along West Maple Street until eventually being captured by a curb inlet at the intersection of West Maple and State Streets.

The desilting basin is earthen and unlined, with a rip-rap weir/embankment on the downstream side (west end of the basin). The operational volume of Maple Canyon is approximately 24,750 cubic-foot (average of 5-feet deep by 55-foot top width and 90-foot length).

The following sections describe the maintenance criteria, and assessment used to develop conclusions and recommendations regarding maintenance specific to the Maple Canyon facility group.

Baseline Condition

The baseline condition for the Maple Canyon facility group was determined to be the current condition as observed during a site visit in May 2018. The desilting basin is largely unvegetated and the sediment depth was estimated to be approximately 5 feet deep at the west end against the riprap embankment to less than 0.5 feet deep at the east (upstream) end of the basin. Ponded water was not observed within the basin area. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2018 site visit.

Recommended Maintained Condition

The recommended maintained condition for the Maple Canyon facility group was determined to be the fully-restored volume of the approximate dimensions of the basin (5 foot depth) until capital improvements are made. The basin also provides some flood control benefit before it fills in with sediment from the canyon. Maintenance is recommended to reduce potential impacts to downstream residential 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 50% maintenance threshold described in *Section 4.3 of the Hydrology and Hydraulics Technical Report*, maintenance is necessary. Sediment deposition is approximately 5 feet deep in the baseline condition at the west end. The sediment height is the same height as the overflow rip-rap weir/embankment height; therefore 100% of the storage volume is occupied by sediment, which exceeds the desilting basin maintenance threshold. Therefore, vegetation and sediment/debris removal from the basin is recommended to restore the capacity of the desilting basin. The frequency will be established based on annual inspection of the basin and outlet works.

Potential Facility Capital Improvements

To address the sediment issues, several plans have been developed by stakeholders to restore the degraded stream and reduce sediment export, these plans include:

Maple Canyon Restoration-Phase 1: This plan, referred to as "Phase 1," would extend the existing storm drain outfalls from their current locations along the mesa tops and canyon sidewalls to the bottom of the canyon, just outside of the boundary of the jurisdictional waters. Phase 1 includes extension of 14 outfalls and is intended to halt further erosion of the current tributaries and is detailed in the 90% plan set developed in December 2017 by AECOM (AECOM, 2017).

Maple Canyon Restoration-Phase 2: The second phase of the canyon restoration is referred to as "Phase 2" and would include design and implementation of stream rehabilitation projects for the degraded stream channel. One plan proposes the use of concrete block drop structures across the channel of the main stream. The intent of the structures is to reduce the effective slope of the stream and to concentrate the energy losses to armored sections downstream of each structure. This Phase 2 plan is outlined in the draft Maple Canyon Stream Rehabilitation Plan & Design Toolkit Specifications (Phase 2 Toolkit) developed in April 2017 by San Diego Canyonlands (Canyonlands, 2017). If the Phase 2 construction is completed, Maple Canyon is assumed to be stabilized and the basin would be removed.

Representative Photos

Photos are from the site visit conducted in May 2018.

1. Maple Canyon: Sediment deposition observed in basin and minimal vegetation growth within basin.

2. Maple Canyon: Looking south onto basin, completely filled with sediment.

3. Maple Canyon: Basin completely filled with sediment.

4. Maple Canyon: Uncontrolled drainage channel observed; no outlet control structure observed.

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.

Field Photo Locations

Flow Line

Storm Drain Conveyance

Top Desilting Basin Boundary

N

Drainage Area: 90 acres

Feet

0 40 80

The City of SAN DIEGO

November 2019

Facility Group Name: Maple Canyon Creek - Maple
Facilityl Nos: 5-02-140
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.33 Washington Canyon Creek – Washington

Summary of Recommended Maintenance

Washington 1 (No. 5-02-151)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 89 to Station 306. • Maintain/repair existing debris fence as needed.	
Benefit	• Level of service remains <50-year storm event (162 cfs). • Improves conveyance capacity of Washington 2. • 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.

Washington 2 (No. 5-02-153)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation in concrete ditch from Station 306 to Station 2516.	
Benefit	• Increases level of service from <2-year storm (70 cfs) to the 100-year storm (183 cfs). • Remove potential source of sediment to Washington 1. • 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 Washington Canyon Creek – Washington (Washington) 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 Washington facility group is located in the Pueblo San

Diego Watershed Management Area. The facility is bordered by West Washington Street to the southeast and by residential developments to the northwest.

The facility group flows from northeast to southwest along West Washington Street. Washington 2, a trapezoidal concrete ditch, begins at the 30-inch-diameter reinforced concrete pipe outlet and extends from Station 2516 to Station 306. At Station 306, it transitions into Washington 1 and continues as a vegetated trapezoidal channel to Station 115. Flows from Washington 1 then enter a concrete drop structure from Station 115 to Station 89 that conveys flows into a 2.5-foot by 6.5-foot reinforced concrete box (RCB) culvert entering the City 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 Washington Canyon Creek – Washington 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*. 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
Washington	82	105	123	147	165	183

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 Washington facility group is the existing storm drain system. The downstream domain of analysis consists of the concrete drop structure and 2.5-foot by 6.5-foot RCB culvert and subsequent storm drain modeled from Station 89 to Station 0. 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 Washington facility group was determined to be the pre-maintained condition. The pre-maintained modeling parameters were based on documentation of the January 2016 emergency maintenance conducted in the facility group. Manning's coefficient values for Washington 2 were set at 0.015 for portions of the concrete ditch that were free of obstruction. The January 2016 emergency maintenance documentation identified an area from Station 1452 to Station 1279 where sediment/debris had accumulated and dense (palm) vegetation was growing. This area was represented in the model by adding up to a foot of sediment and using a Manning's coefficient value of 0.15 to represent the density of the vegetation. Washington 1 was modeled to match the pre-maintenance condition of deposited sediment/debris and vegetation by adding up to four feet of sediment and using a Manning's coefficient of 0.15. The photos in the Representative Photos section below provide examples of the condition of the facility as observed in site visits conducted in November 2015 (pre-maintenance), January 2016 (during maintenance activities), and April 2017 (post-maintenance) by DMax Engineering and Dudek.

In the recommended maintained condition, the sediment/debris and vegetation are removed from both segments, and the Manning's coefficient values were set to match the recommended condition: 0.015 to reflect the roughness of the originally constructed facility in Washington 2 and 0.04 to reflect sediment/debris and vegetation removal from Washington 1.

Model parameters and velocities for the baseline and maintained conditions for the Washington 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
Washington 2 (concrete)	2516–306	Baseline: 0.015–0.15	Baseline: 1.5–20	–	Normal Depth at Station 2516
		Maintained: 0.015	Maintained: 8.8–25		
Washington 1 (earthen)	306–89	Baseline: 0.15	Baseline: 1.4–2.1	–	–
		Maintained: 0.04	Maintained: 0.8–8.6		
Downstream Domain of Analysis	89–0	0.015	2.2–16.6	Storm Drain System	Normal Depth at Station 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 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, Washington 2 provides a level of service of < 2-year storm event and only conveying 70 cubic feet per second (cfs) before flows impact the adjacent property. The maximum level of service in Washington 1 is the less than the 50-year storm or 162 cfs before flows impact the roadway and the parking lot immediately downstream of the culvert.

Recommended Maintained Condition

Removal of deposited sediment/debris and vegetation in Washington 2 increases the level of service to the 100-year storm event, allowing the ditch to convey 183 cfs. Removal of deposited sediment/debris and vegetation in Washington 1 does not affect the level of service or the capacity; however, it does contribute to improving the level of service in Washington 1. The existing debris fence should be maintained or repaired as needed based on the conditions at the time of maintenance.

Post-Maintenance Erosion Control Measures

The estimated velocities in Washington 2 are within the 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*, for both the baseline and recommended maintained condition. In the recommended maintained condition, the velocity in Washington 1, at Station 306, is above the recommended threshold for vegetated channels (5 fps). At Station 306, where the transition from concrete ditch to vegetated channel occurs, the velocities quickly drop from a maximum of 8.6 fps to approximately 1 fps within an approximately 35-foot length, and the velocities in the remainder of Washington 1 remain well below the permissible level. It is recommended that velocity reduction measures consistent with the methodology described in *Section 6 of the Hydrology and Hydraulics Technical Report* be implemented at Station 306 to prevent erosion.

Potential Facility Capital Improvements

The HEC-RAS modeling indicated that the overall facility level of service was restricted by the culvert inlet capacity. 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
Washington 2 (concrete)	2516–306	70	183	<2-year	100-year
Washington 1 (earthen)	306–89	162	162	<50-year	<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. A selection of photos representative of both the baseline and recommended maintained condition are included below. The photos were taken during site visits and maintenance activities conducted in November 2015, January 2016, and April 2017.

1. Washington 2: Looking downstream at vegetation in concrete ditch in baseline condition (November 2015).

2. Washington 2: Looking downstream at transition to Washington 1 (April 2017).

3. Washington 1: Looking upstream at transition from Washington 2 (April 2017).

4. Washington 1: Looking downstream at vegetation during January 2016 maintenance.

5. Washington 1: Looking northwest, across the facility at debris fence and elevated drop structure shown (April 2017).

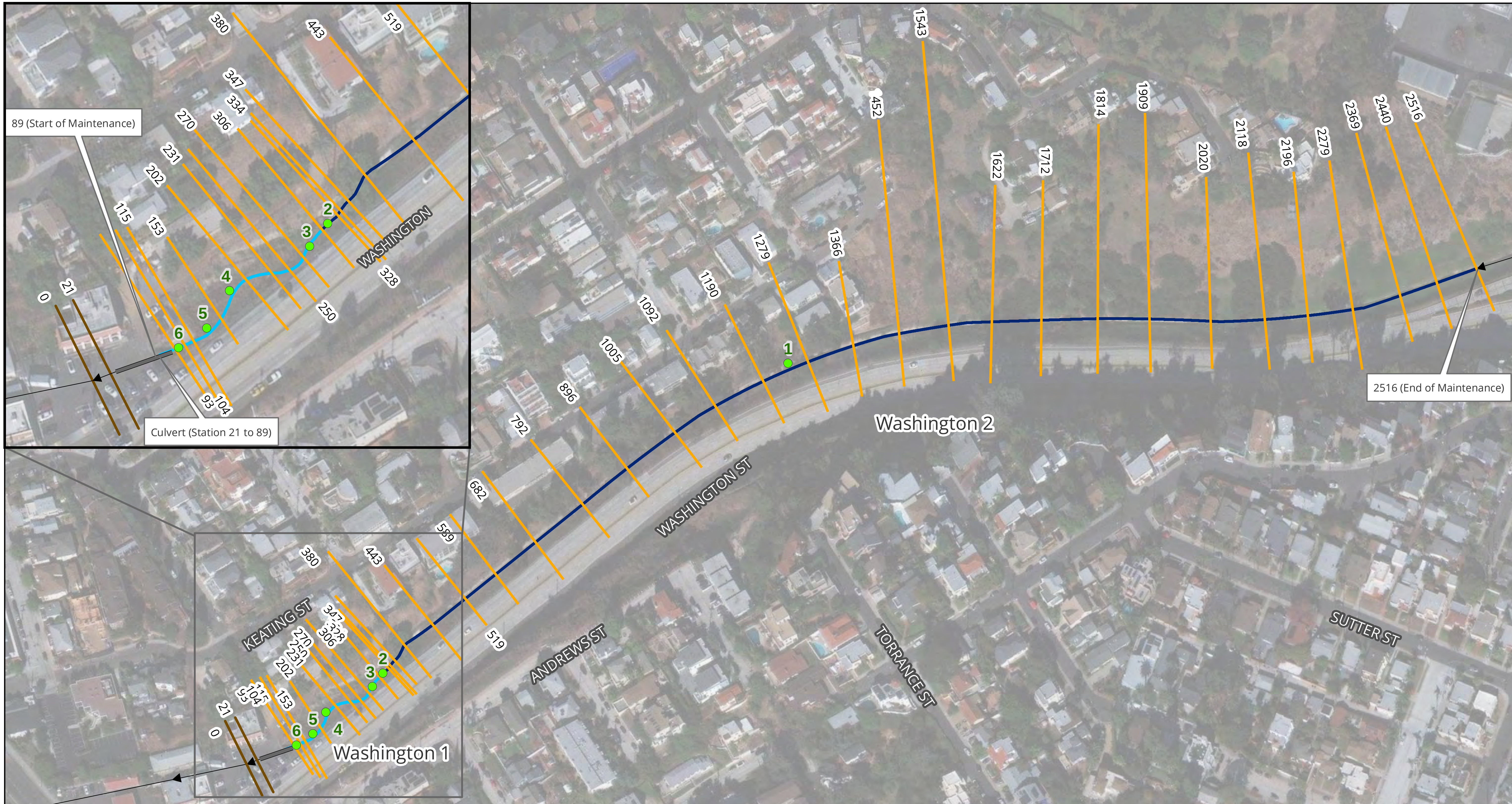
6. Downstream Domain of Analysis: Looking downstream at entrance to 2.5-foot by 6.5-foot RCB culvert inlet (April 2017).

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	MWMP Facility Cross Section
Storm Drain Conveyance	Domain of Analysis Cross Section
Culvert	Washington 1
	Washington 2

N

Drainage Area: 107 acres

0 50 100 200 Feet

The City of SAN DIEGO

Facility Group Name: Washington Canyon Creek - Washington
Segment Name: Washington 1 - 2
Facility Nos: 5-02-151, 5-02-153
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

A.34 Mission Hills Canyon Creek – Titus (No. 5-02-162)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris from Station 110 to Station 149. • Maintain/repair existing debris fence as needed.	
Benefit	• Increases level of service from <2-year storm event (17 cfs) to <25-year storm event (88 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 Mission Hills Canyon Creek – Titus (Titus) 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 Mission Hills Canyon Creek – Titus facility group is located in the Pueblo San Diego Watershed Management Area. The facility is located at the downstream end of a canyon area. The upstream end of the canyon begins near the intersection of Washington Place and Randolph Street, generally flowing from northeast to southwest between Pringle Street (to the southeast) and Henry Street (to the northwest) to the end of the canyon at Titus Street.

Flow enters the canyon via both surface flows and storm drain outfalls at various locations throughout the length of the canyon. The Titus facility group is identified as the earthen channel extending approximately 200 feet upstream (from Station 110 to Station 317) of the 42-inch-diameter reinforced concrete pipe (RCP) culvert located at the downstream end of the canyon and crosses Titus Street. The Hydraulic Reference Map, located at the end of this fact sheet, shows the canyon area and the identified facility group.

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Titus 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*. 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
Titus 1	52	66	77	92	104	115

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 Titus facility group is the natural channel above the facility group, extending greater than 20 channel widths above the facility from Station 317 to Station 2666. The downstream domain of analysis consists of an existing 42-inch-diameter RCP culvert at the end of the facility, from Station 0 to Station 110, which serves as the entrance to the City storm drain system. The extents of the domains of analysis were determined based on the methodology presented in *Section 3.2.1.3 of the Hydrology and Hydraulics Technical Report.*

The baseline condition for the Titus facility group was established based on a combination of the current conditions, as observed during an April 2017 site visit conducted by D-Max, as well as the historical conditions observed in association with previous maintenance activities conducted in the facility group. The banks and bottom of Titus were assigned Manning's coefficient values ranging from 0.03 to 0.045, which represents the density of the vegetation and channel substrate observed within the facility. Modeling for the baseline condition also includes sediment accumulation characteristic of the sediment/debris observed 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.

The assigned Manning's coefficient values for the Titus facility group in the recommended maintained condition were generally unchanged. Recommended maintenance is focused on removal of the sediment/debris, which is not expected to alter the roughness of the channel substrate, so the Manning's coefficients were not changed.

Model parameters and velocities for the baseline and maintained conditions for the Titus 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
Upstream Domain of Analysis	2666–317	Baseline: 0.03–0.045	Baseline: 3.1–9.3	-	Normal Depth at Station 2666
		Maintained: 0.03–0.045	Maintained: 3.1–12		
Titus 1	317–110	Baseline: 0.03–0.045	Baseline: 0.4–5.4	-	-
		Maintained: 0.03–0.045	Maintained: 1.3–10.6		
Downstream Domain of Analysis	110–0	0.015	Baseline: 4.5–6.4	Culvert (Station 110)	Normal Depth at Station 0
			Maintained: 4.5–9.7		

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, 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 Titus segment can convey up to 17 cubic feet per second (cfs) (<2-year level of service) in the baseline condition. As modeled, the accumulated sediment/debris restricts inflow to the 42-inch-diameter RCP culvert causing the water surface elevation to rise and impact the private residences immediately downstream of the culvert and Titus Street.

Recommended Maintained Condition

Removal of the deposited sediment/debris at the debris fence located at Station 115 alleviates the culvert obstruction and improves the facility level of service to less than the 25-year storm, improving the capacity to 88 cfs. Flows in excess of 88 cfs exceed the inlet capacity of the 42-inch-diameter RCP culvert resulting in flooding impacting the private residences immediately downstream of the culvert and Titus Street. The existing debris fence should be maintained or repaired as needed based on the conditions at the time of maintenance.

Post-Maintenance Erosion Control Measures

Some of the estimated velocities in Titus facility group are above the recommended permissible velocities as defined in the *City of San Diego Drainage Design Manual, dated January 2017,* based on the observed baseline channel bottom. The velocities estimated in the recommended maintained condition show an increase in the overall maximum flow velocity; however, that higher velocity is associated with a larger storm. When comparing storm event flow rates in both modeled conditions, the velocity remained consistent, meaning that velocity is mostly governed by the flow rate in the channel and not the changes due to the maintenance activities. However, the existing debris fence at Station 115 also functions as an erosion control measure, turning the facility into an area of deposition rather than erosion. Therefore, no additional measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility group.

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 42-inch-diameter RCP culvert inlet. Other potential improvements may be realized by evaluating the canyon upstream of the facility for opportunities to reduce sediment loading to the facility. Additional analysis is recommended to evaluate potential 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
Titus 1 (earthen)	380-110	17	88	<2-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. Site visit conducted in April 2017.

1. Titus 1: Upstream domain of analysis, Looking downstream at vegetation in canyon.

2. Titus 1: Looking downstream at vegetation

3. Titus 1: Looking downstream at vegetation and rock channel bottom.

4. Titus 1: Looking downstream at sediment/debris accumulated at debris fence.

5. Titus 1: Looking downstream at 42-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
MWMP Facility Cross Section
Domain of Analysis Cross Section
Domain of Analysis Center Line
MWMP Facility Center Line

N

Drainage Area: 90 acres

Feet
0 50 100 200

The City of SAN DIEGO

Facility Group Name: Mission Hills Canyon Creek - Titus
Segment Name: Titus 1
Facility No: 5-02-162
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

A.35 Powerhouse Canyon Creek – Pershing

Summary of Recommended Maintenance

Pershing 1 (5-03-011)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 332 to Station 1930.	
Benefit	• Increases conveyance capacity from 630 cfs to 633 cfs; level of service remains <10-year storm event. • 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.

Pershing 2 (5-03-100)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 0 to Station 437.	
Benefit	• Level of service remains 100-year storm event (1,350 cfs). • 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.

General Description

The Powerhouse Canyon Creek – Pershing (Pershing) 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 group is located in the Pueblo San Diego Watershed Management Area. In general, the Pershing facility group runs parallel to Pershing Drive and flows from northeast to southwest bordered by Pershing Drive to the north and a City Operations yard to the south. At its downstream end, the facility group discharges into the storm drain system east of Interstate 5 (I-5).

The Pershing facility group is split into two segments, Pershing 1 and Pershing 2, that join together approximately 425 feet west of Florida Drive/54th Street. Both Pershing 1 and Pershing 2 are concrete trapezoidal channels as indicated on as-built drawing no. 9890-1-D. The segment has a bottom width which varies from 7 to 14 feet wide and bank heights which vary from 5.5 to 10 feet high with 1.5:1 (H:V) side slopes; the channels' longitudinal slopes range from 0.0062 to 0.0068 (feet/feet).

The Pershing facility group receives flows from the upstream reinforced concrete pipe (RCP) storm drain systems via Pershing 2 (to the west) and Pershing 1 (to the east). Pershing 1 receives flow from a 24-inch-diameter storm drain outlet beneath 26th Street. Pershing 1 continues approximately 425 feet, where Pershing 2 confluences with Pershing 1 just upstream of Station 1441. Pershing 1 continues southwest and enters a 120-inch-diameter RCP storm drain system inlet beneath Pershing Drive, just east of I-5. Pershing 2 receives flows from a 120-inch-diameter RCP storm drain system outlet beneath Florida Drive. The Pershing 2 segment continues to the southwest and crosses beneath the Pershing Drive bridge, which has a clear height of 10 feet and maximum width of approximately 30 feet, before it confluences with Pershing 1. See the Hydraulic Reference Map located at the end of this fact sheet.

For the purposes of this fact sheet, Pershing 1 is defined from Station 1930 to Station 332. Pershing 2 has stationing independent from Pershing 1 and flows from Station 437 to Station 0 where it joins Pershing 1 (at Station 1441).

The following sections describe the hydrologic analysis, hydraulic assessment, and modeling results used to develop conclusions and recommendations regarding maintenance specific to the Pershing 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 10-, 50-, and 100-year flow rate information for the Pershing 1 and 2 segments. Data from the following FIS locations were used: Switzer Creek at Florida Drive (Pershing 1, Stations 1930 – 1441), Switzer Creek at Russ Boulevard (Pershing 1, Stations 1441 – 332), and Florida Drive Branch, upstream of confluence with Switzer Creek (Pershing 2). 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	Stations	Peak Flow Rates by Storm Event Frequency (cfs)					
		2-year	5-year	10-year	25-year	50-year	100-year
Pershing 1	1930-1441	106	152	185	287	420	510
	1441-332	386	554	675	1048	1540	1870
Pershing 2	437-0	280	402	490	761	1120	1350

Hydraulics

A one-dimensional steady flow model was developed for the Pershing 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 3.2.1.2 of the Hydrology and Hydraulics Technical Report* for the methodology used to develop the HEC-RAS model. The extent 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 current condition of the facility group as observed during the site visit conducted by Geosyntec Consultants in May 2017. The Pershing facility group was assigned Manning's coefficient values ranging from 0.015–0.05 for the segment bottom; the bottom was primarily bare concrete other than the upstream portion of the Pershing 2 where accumulated sediment and heavy vegetation was observed. The banks were assigned Manning's coefficient values ranging from 0.03–0.05, based on dense vegetation observed. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the May 2017 site visit.

For the recommended maintained condition, both segments of the concrete channel facility group were assigned a Manning's coefficient value of 0.015 to reflect the roughness of the originally constructed concrete facility.

Model parameters and velocities for the baseline and recommended maintained conditions for the Pershing 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
Pershing 1 (concrete)	1930-332	Baseline: 0.015-0.05	Baseline: 2.27-16.71	Culvert (Station 332)	Normal Depth
		Maintained: 0.015-0.05	Maintained: 2.28-18.93		
Pershing 2 (concrete)	437-0[1]	Baseline: 0.015-0.05	Baseline: 5.24-13.47	Bridge (Station 207 to 107)	Normal Depth
		Maintained: 0.015-0.05	Maintained: 5.26-17.54		

1 The stationing for Pershing 2 is independent from the stationing for Pershing 1. Pershing 2 Station 0 is equal to Pershing 1 Station 1441. 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 in determining 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 the Pershing 1 segment is limited by the capacity of the 120-inch-diameter RCP storm drain system inlet at Station 332. The segment can convey up to 630 cubic feet per second (cfs) (<10-year level of service) before the roadway is impacted. The upstream portion of the Pershing 1 segment, from Station 1441 to 1930, conveys 510 cfs (100-year level of service). The Pershing 2 segment conveys up to 1,350 cubic feet per second (cfs) (100-year level of service).

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the Pershing 1 segment increases the conveyance capacity to 633 cfs, but does not improve the level of service from the baseline condition (<10-year level of service) before the roadway is impacted. The recommended maintenance reduces the risk of vegetation flowing downstream and clogging the downstream culverts. In the recommended maintained condition, Pershing 1 from Station 1441 to Station 1930 and Pershing 2 remains at a level of service of the 100-year event (510 cfs and 1,350 cfs, respectively) however, maintenance is recommended to reduce the risk of vegetation flowing downstream and clogging the downstream culverts.

Post-Maintenance Erosion Control Measures

The estimated velocities in the Pershing facility group are below the 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 facility group capacity is limited by the 120-inch-diameter RCP storm drain system inlet beneath Pershing Drive. 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
Pershing 1	1930-1441	510	510	100-year	100-year
	1441-332	630	633	<10-year	<10-year
Pershing 2	437-0	1,350	1,350	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.

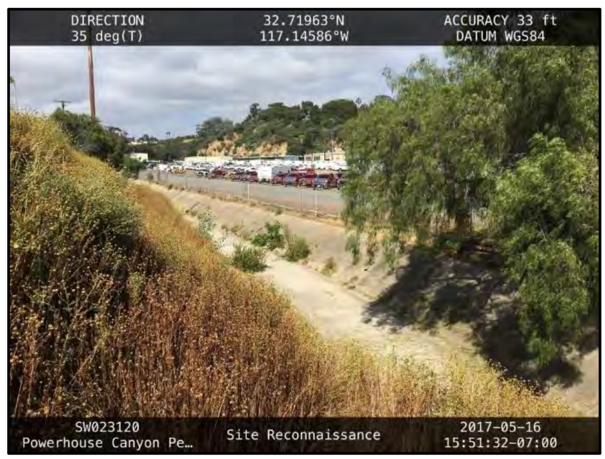
Representative Photos

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

1. Pershing 1: Looking downstream from the upstream end of the segment at 26th Street.

2. Pershing 2: Looking upstream from the Pershing Drive bridge.

3. Pershing 2: Looking downstream at the confluence with Pershing 1 shown to the upper left.



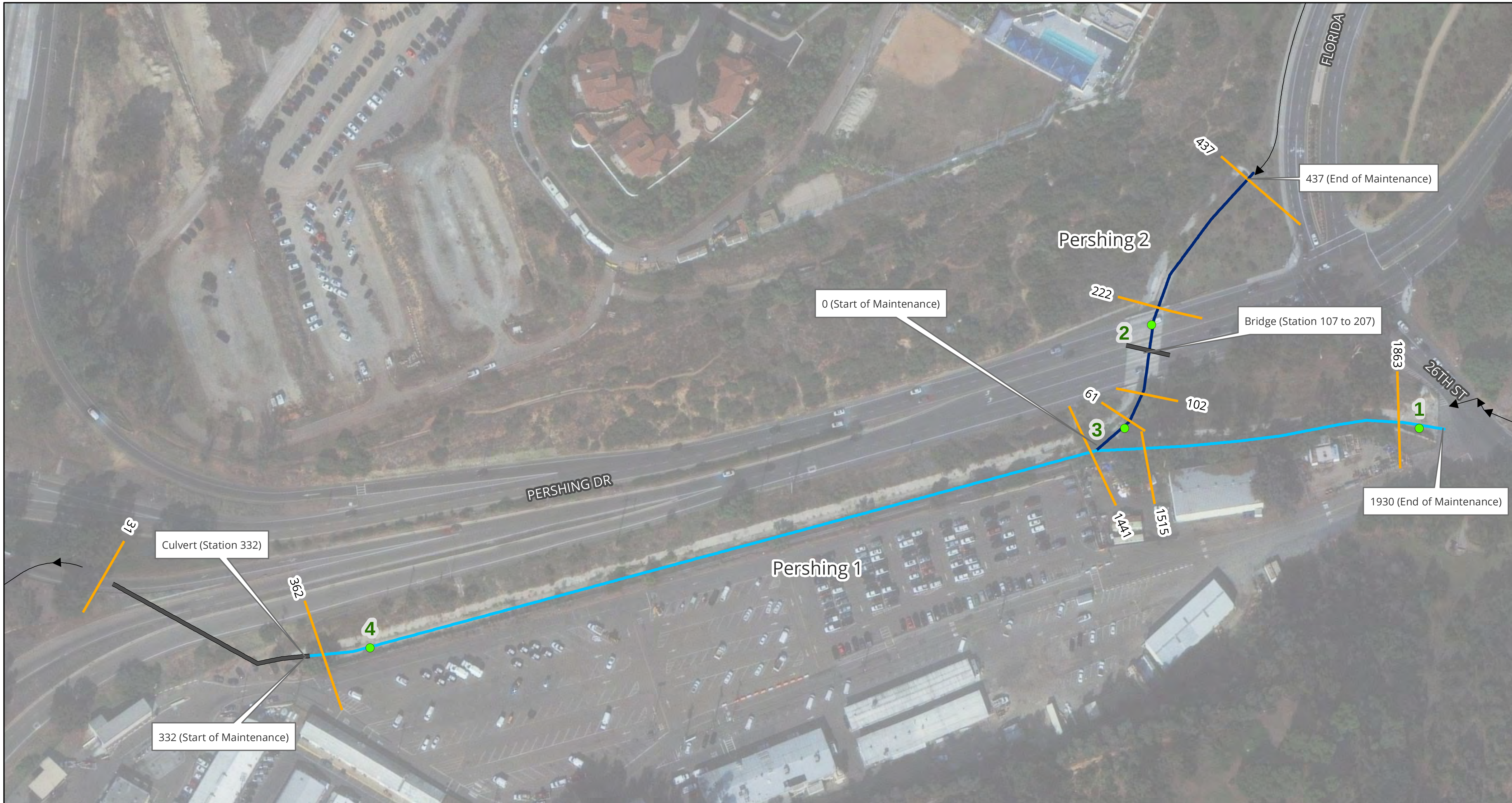
4. Pershing 1: Looking upstream near the downstream end of the segment.

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 Pershing facility group.



Field Photo Location
Storm Drain Conveyance
Bridge/Culvert
MWMP Facility Cross Section
Pershing 1
Pershing 2

N

Drainage Area: 1,934 acres

Feet
0 50 100 200

The City of SAN DIEGO

Facility Group Name: Powerhouse Canyon Creek - Pershing
Segment Name: Pershing 1 - 2
Facility Nos: 5-03-011, 5-03-100
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.36 San Diego Bay – 28th St (No. 5-03-901)

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 bottom of earthen segment from Station 72 to Station 139. • Perform bank repair on the eroded eastern sidewall over a length of approximately 50 feet (Station 81 to Station 131).	
Benefit	• The level of service remains <5-year storm event and conveyance capacity remains unchanged (50 cfs). • Minimizes further erosion of the eastern sidewall (Station 94 to Station 108). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert at Station 72. • Reduces the risk of further erosion of the eastern sidewall (	

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 San Diego Bay – 28th Street (28th Street) facility group was classified as a Category 3 channel segment as described in Chapter 3, Section 3.3 of the *Hydrology and Hydraulics Technical Report*. The facility group is in the Pueblo San Diego Watershed Management Area and is bordered by 28th Street to the east, G Street to the north, and residential development to the south and east.

The 28th Street facility group is an earthen segment that receives runoff from a reinforced concrete pipe (RCP) outlet south of G Street and conveys flows in a southerly direction before entering a 30 inch-diameter RCP inlet which in turn discharges to 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 28th Street 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 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 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
28th St 1	43	55	64	77	86	96

Hydraulics

A one-dimensional steady flow model was developed for the 28th Street 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. 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 located at the end of this fact sheet.

The upstream domain of analysis for 28th Street is the existing 30-inch-diameter RCP storm drain outlet. 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 28th Street was determined to be the existing condition, as observed during the site visit conducted by Geosyntec Consultants in July 2017. The bottom of the facility was assigned a Manning's coefficient value of 0.045, which represents the density of the vegetation observed within the earthen segment. The banks were assigned a Manning's coefficient value of 0.04. The photos in the Representative Photos section provide examples of the condition of the facility as observed during the July 2017 site visit.

The 28th Street facility group was assigned a Manning's coefficient value of 0.03 in the recommended maintained condition to reflect sediment/debris and vegetation removal from the earthen bottom. The geometry of the facility was revised in the recommended maintained condition to represent the repair of the eroded bank resulting from the recommended bank stabilization activities.

Model parameters for the baseline and maintained conditions for the 28th Street facility group are summarized in Table 2.

Table 2. Model Parameters

Segment Name	Reference Stations	Manning's Coefficients	Velocities (fps)	Structures/ Transitions	Boundary Conditions
28th St 1	139–72	Baseline: 0.04–0.045	Baseline: 0.86–2.10	Culvert (Station 72)	Critical Depth at Station 139
		Maintained: 0.03	Maintained: 0.87-2.10		
Downstream Domain of Analysis	72–3	Baseline: 0.024	Baseline: 11.66	Storm Drainage System	Normal Depth at Station 3
		Maintained: 0.024	Maintained: 11.66		

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 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 28th Street facility can convey up to 50 cubic feet per second (cfs) (<5-year level of service) in the baseline condition. The capacity of the 28th Street facility is limited by the downstream culvert at Station 72.

Recommended Maintained Condition

The 28th Street facility can convey up to 50 cubic feet per second (cfs) (<5-year level of service) in the recommended maintained condition. Removing the deposited sediment/debris and vegetation along the 28th Street facility does not improve the level of service per the modeling, but it is recommended to return the ditch flow path to the originally designed condition where the flow path connected the upstream culvert to the downstream culvert in a straight line. Eliminating the slight flow line curve towards the current area of bank erosion will minimize the potential for future scour that will eventually impact the roadway. The recommended maintenance will also preserve the performance of the downstream culvert by preventing potential obstruction of the culvert opening.

Repair of the eroded banks is also recommended. Erosion of the eastern sidewall of the segment was observed over a length of approximately 50 feet, between Station 81 and Station 131. From the toe of the eroded slope to the deepest cut into the sidewall was measured to be a horizontal distance of 11 feet. Performing bank repair would reduce the risk of further erosion along the eastern sidewall. A geotechnical evaluation may be required prior to maintenance activities to assess bank conditions.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition (Table 2) are below the maximum permissible velocities for an earthen channel (less than 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 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 capacity of the downstream culvert at Station 72. 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
28th St 1	139-72	50	50	<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 July 2017.

1. 28th St 1: RCP culvert outlet at upstream end of segment.

2. 28th St 1: Eroded eastern sidewall.

3. 28th St 1: Looking upstream towards the eroded eastern sidewall.

4. 28th St 1: 30-inch-diameter RCP culvert at downstream end of segment.

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 28th Street facility group.

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: 188 acres

Feet
0 5 10 20

The City of SAN DIEGO

Facility Group Name: San Diego Bay Unnamed Tributary - 28th St
Segment Name: 28th St 1
Facility No: 5-03-901
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.37 Chollas Creek – National

Summary of Recommended Maintenance

National 1 (No. 5-04-004)

Facility Type	Bed: Earthen Banks: Concrete, Earthen	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove sediment/debris and vegetation from the channel bottom only from Station 1250.226 to Station 1745.911. • Remove vegetation from the earthen channel bottom only from Station 1745.9117 to Station 2065.8479.	
Benefit	• The level of service remains >10-year storm event (3,095 cfs). • Removes invasive vegetation from the channel. • Contributes to the increase in level of service in the National 2 segment.	

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.

National 2 (No. 5-04-006)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove vegetation and sediment/debris throughout the channel from Station 2065.8479 to Station 4774.1509.	
Benefit	• Increase level of service from 5-year storm event (2,000 cfs) to >19-year storm event (4,350 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.

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

Table 1. Completed Report

Segment	Report	Reach
–	Rick Engineering Company, 2010. IHHA Report for Chollas Creek Channel Lower Portion Map Numbers 91 & 93.	3
National 2	Rick Engineering Company, 2010. IHHA Report for Chollas Creek Channel Lower Portion Map Numbers 91 & 93.	2
National 1	Rick Engineering Company, 2010. IHHA Report for Chollas Creek Channel Lower Portion Map Numbers 91 & 93.	1

General Description

The Chollas Creek – National facility group was classified as having a Category 1 segment (National 2) and a Category 2 segment (National 1) as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The National facility group is located in the Pueblo San Diego Watershed Management Area. The facility group extends south from Webster Avenue and flows parallel to Interstate 15 (I-15) along its western side, before the channel is conveyed underneath Interstate 5 (I-5) and ends just upstream of where Chollas Creek confluences with South Las Chollas Creek.

Reach 3, as referred to in the 2010 Individual Hydrologic and Hydraulic Assessment (IHHA) completed by Rick Engineering, is located at the upstream end of the analysis. Reach 3 is a concrete lined trapezoidal segment that borders I-15 to the east and Imperial Avenue to the north. The segment extends approximately 800 feet south to the Access/Maintenance Ramp near Webster Avenue.

National 2 (Reach 2) is the subsequent downstream segment and is a fully concrete lined trapezoidal segment from Station 4774.1509 to Station 2065.8479. The segment begins at the Access/Maintenance Ramp near Webster Avenue along the west side of I-15 and continues south to approximately Logan Avenue. A 2-foot-high berm runs along the right bank.

The National 1 segment is the most downstream reach (Reach 1) and the downstream portion of Reach 2 (Station 2065.8479 to Station 1745.9117) and has an earthen bottom and a mix of concrete and earthen banks. The segment begins at the downstream end of the National 2 segment, at approximately Logan Avenue, and continues south to end just upstream of where Chollas Creek confluences with South Las Chollas Creek, south of I-5.

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 – National 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. 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-, 19-year) were interpolated using a power regression analysis as described in *Section 3.1.1.1 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	19-year	50-year	100-year
National 2	900	2,000	3,000	4,000	6,000	7,900
National 1	900	2,000	3,000	4,000	6,000	7,900

Hydraulics

A one-dimensional steady flow model was developed for the National 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.

To model the upstream boundary condition, Reach 3 is included in the modeling and extends approximately 790 feet upstream of the National 1 segment to the Imperial Avenue bridge. The baseline condition for Reach 3, the National 2 segment, and the National 1 segment were defined as the current condition, as observed during the site visit conducted by Rick Engineering in October 2009. Reach 3 was assigned Manning's coefficient values ranging from 0.016 to 0.02 to represent the low amount of vegetation observed throughout the segment. The National 2 segment was assigned a Manning's coefficient value ranging from 0.06 to 0.13, representing moderate to dense vegetation throughout the channel. The sediment depth throughout the National 2 segment was estimated to range from 0.3 to 1 foot. The National 1 segment was assigned Manning's coefficient values ranging from 0.016 to 0.02, representing low vegetation throughout the channel. The sediment/debris depth throughout the National 1 segment was estimated to range from 0.5 to 3 feet.

The assigned Manning's coefficient values for Reach 3 and National 2 in the recommended maintained condition range from 0.016 for the segment bottom and banks, reflecting the roughness of the originally constructed concrete facility. The assigned Manning's coefficient values for National 1 in the recommended maintained condition (Station 2065.8479-1250.226) range from 0.016-0.02 for the segment bottom and up to 0.025 for the banks. The National 1 segment downstream cross sections (Station 972.5853-89.74629) remain the same as in the baseline condition, where maintenance is not recommended, and the Manning's coefficient values range from 0.016-0.035 in the segment bottom, and from 0.02 to 0.08 for the banks.

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

Table 3. Model Parameters

Segment and Material	Reference Stations	Manning's Coefficient	Structures/ Transitions	Boundary Conditions
Reach 3 (concrete)	5564.4243-4774.1509	Baseline: 0.016-0.02 Maintained: 0.016	-	-
National 2 (concrete)	4774.1509-2065.8479	Baseline: 0.06-0.13 Maintained: 0.016	-	-
National 1 (earthen)	2065.8479-89.7463	Baseline: 0.016-0.02 Maintained: 0.016-0.035, 0.02-0.08	Earthen-lined bottom & concrete sides; Fully concrete lined upstream	Normal Depth, Known Water Surface Elevation at Station 89.7463

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 each segment are summarized in the Summary Table (Table 4) for both the baseline and recommended maintained condition.

Baseline Condition

The capacity of the National 2 segment is limited by the low right bank height between Station 2307.5293 and Station 3238.8015, even though a berm has been built up to prevent further flooding. The National 2 segment can convey up to 2,000 cubic feet per second (cfs) (5-year level of service) in the baseline condition.

The capacity of the National 1 segment is limited by low bank heights on either side of the segment between Station 1250.2268 and Station 1745.9117. The National 1 segment can convey up to 3,095 cfs (>10-year level of service) in the baseline condition.

Recommended Maintained Condition

For the downstream portion of Reach 2 (Station 2065.8479 to Station 1745.9117), there was not a significant increase in conveyance capacity between the vegetation removed condition and the vegetation and sediment removed condition. However, in National 2, the conveyance capacity increased significantly when sediment was removed in addition to vegetation. When only vegetation was removed, the capacity of the upstream portion was between 4,600 to 6,000 cfs, and when sediment was also removed, the capacity increased to a range of 6,000 to 7,900 cfs.

Removing both deposited sediment and vegetation from National 2 with only vegetation removal in National 1 from Station 2065.8479 to Station 1745.9117, will increase the overall conveyance capacity to 4,350 cfs (>19-year level of service). .

When deposited sediment and vegetation are removed from Station 1745.911 to Station 1250.226 in the National 1 segment, the capacity remains the same at 3,095 cfs (>10-year storm).Maintenance removes invasive vegetation in the National 1 segment and it contributes to the improvement in level of service of the National 2 segment. Improvements to the capacity of the National 1 segment are limited by the downstream tidal influence.

Post-Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained portion of the facility group are below recommended permissible velocities for concrete lined (35 feet per second) channels as defined in the *City of San Diego Drainage Design Manual, dated April 1984*. 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 both the National 2 and National 1 segments were restricted by the low right bank height. Therefore, 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	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
National 2	4774.1509-2065.8479	2,000	4,350	5-year	>19-year
National 1	2065.8479-89.7463	3,095	3,095	>10-year	>10-year

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. Photos are from a site visit conducted by Rick Engineering in October 2009.

1. IHHA 2. National 1: Looking upstream where the channel crosses under National Avenue, representative of low vegetation.

2. IHHA 4. National 1: Looking downstream, representative of low vegetation.


3. IHHA 5. National 2: Looking downstream, representative of dense vegetation.

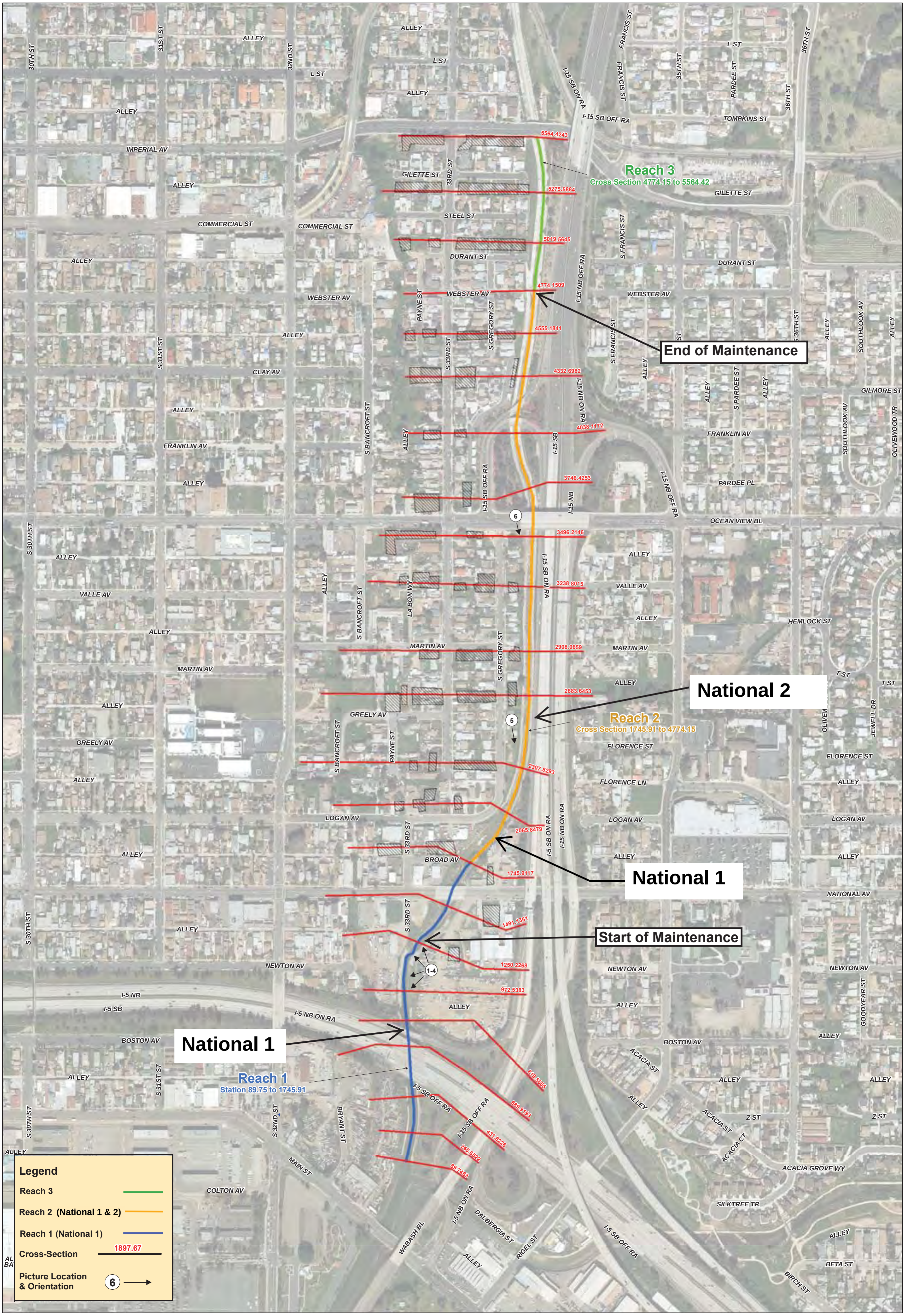

4. IHHA 6. National 2: Looking downstream, representative of medium to dense vegetation.

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 National facility group (Reaches 1 and 2).



RICK ENGINEERING COMPANY

0 200 400 800 Feet

Original Exhibit:
Chollas Creek Channel MMP Map Numbers 91 & 93
Hydraulic Workmap
REC JN: 15541A
Exhibit Date: August 25, 2010

Data Sources:
SanGIS Topo 2' Contours: 1999
SanGIS Roads - March 2010
Eagle Aerial Photo: March 2009

Facility Group Name: Chollas Creek - National & Oceanview
Segment Names: National 1, Oceanview 1
Facility Nos: 5-04-004, 5-04-006
Hydraulic Map - Municipal Waterways Maintenance Plan

A.38 Chollas Creek – Rolando

Summary of Recommended Maintenance

Rolando 1 (No. 5-04-046)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from Station 6272 to Station 6646. • Remove accumulated sediment/debris in culvert from Station 6222 to Station 6272.	
Benefit	• The level of service remains >10-year storm event (829 cfs). • 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.

Rolando 2 (No. 5-04-048)

Facility Type	Bed: Earthen & Riprap Banks: Earthen, Riprap, & Gunite	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from segment bottom from Station 6697 to Station 7517. • Remove accumulated sediment/debris in culvert from Station 6646 to Station 6697. • Perform bank repair on the eroded northern bank over a length of approximately 160 feet (Station 6917 to Station 7077). • Perform concrete bank repair on the side slopes over a length of approximately 55 feet (Station 7462 to Station 7517).	
Benefit	• The level of service remains <2-year storm event (235 cfs). • Reduces the risk of vegetation dislodging, flowing downstream, and clogging the downstream culverts. • Reduces the risk of further erosion and failure of the side slopes (Station 6917 to Station 7077 and Station 7462 to Station 7517).	

[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.

Cartagena 1 (No. 5-04-044)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from segment bottom from Station 4997 to Station 6222.	
Benefit	• Increases level of service from <2-year (1,132 cfs) to >5-year (1,826 cfs). • 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.

General Description

The Chollas Creek – Rolando (Rolando) facility group was classified as having two Category 1 segments and a Category 2 segment as described in *Chapter 3, Section 3.3 of the Hydrology and Hydraulics Technical Report*. The Rolando facility group is located in the Pueblo San Diego Watershed Management Area. The facility is located south of University Avenue and is bordered by Aragon Drive to the east, by commercial development to the north, by residential development to the south, and by College Avenue to the west. The Rolando facility group is separated into three segments, in order of upstream to downstream: Rolando 2, Rolando 1, and Cartagena.

Rolando 2 is a trapezoidal channel with a 15-foot bottom width and 1.5:1(H:V) side slopes, per as-built drawing no. 12701-L and 12378-L. The channel is located at the upstream end of the facility group and begins at the outlet of a double 8-foot wide by 5-foot tall RCB culvert southwest of the intersection of University Avenue and Aragon Drive. The Rolando 2 segment continues southwest, parallel to University Avenue before entering a double 8-foot-wide by 5-foot, 2-inch tall reinforced concrete box (RCB) culvert beneath Rolando Boulevard. The channel substrate caries throughout the segment. The channel bed and banks are rip-rap lined between Station 6917 to Station 6697 and are earthen between Station 7462 to Station 6917. From Station 7507 to Station 7462, Rolando 2 has an earthen bed with gunite lined banks. From Station 7517 to Station 7507 at the culvert outlet, the bottom of the channel is a concrete apron with a 16.5-foot bottom width and gunite lined side slopes.

Rolando 1 is the subsequent downstream reach, and is a trapezoidal concrete segment with an 8-foot wide bottom width, depth of 6.5 feet and 1:1 (H:V) side slopes, per as-built drawing no. 11287-3-D. The channel begins at the outlet of the double 8-foot wide by 5-foot, 2-inch tall RCB culvert underneath Rolando Boulevard, and continues southwest before entering a 10-foot wide by 6-foot tall RCB culvert beneath Bonillo Drive.

Cartagena is a concrete lined segment located at the downstream end of the facility. The segment begins at the outlet of the 10-foot wide by 6-foot tall RCB culvert underneath Bonillo Drive and continues southwest before entering a double 8-foot wide by 6-foot tall RCB culvert to the east of College Avenue. The segment has a trapezoidal geometry for approximately the first 450 feet, with an 8-foot wide bottom width, depth of 6.5 feet and 1:1 (H:V) side slopes, per as-built drawing no. 20597-4-D. The segment geometry transitions to a rectangular channel, which remains consistent for the rest of the segment. The rectangular portion of the segment has a bottom width of 20 feet and a height of 7.33 feet, per as-built drawing no. 20597-1-D and 20597-2-D.

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

Hydrology

The hydrologic peak flow for the 100-year recurrence interval for the Rolando 1 and 2 segments is presented in Table 1 and was determined using the peak discharge for the 100-year storm event identified on as-built drawing no. 30265-4-D for the existing culvert immediately upstream of Aragon Drive and the Rolando segment. 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 hydrologic peak flow for the 100-year recurrence interval for the Cartagena segment presented in Table 1 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 1. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Rolando 2	577	707	793	943	986	1,157
Rolando 1	577	707	793	943	986	1,157
Cartagena 1	1,306	1,738	1,928	2,328	2,434	2,739

Hydraulics

A one-dimensional steady flow model was developed for the Rolando 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 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 these reaches evaluated in this model are shown in the Hydraulic Reference Map located at the end of this fact sheet.

The baseline condition for the Rolando 2 segment was determined to be the pre-maintenance condition as observed during a site visit conducted by Rick Engineering in May 2015. Maintenance was completed for the channel segment in June 2016. The bottom of Rolando 2 between Station 7507 and Station 6697 was assigned a Manning's coefficient value of 0.11, which represents the pre-maintained condition of the channel bottom having medium to dense brush and trees in the channel. The bottom of Rolando 2 between Station 7517 and Station 7507 was assigned a Manning's coefficient value of 0.013, which represents the concrete apron at the outlet of the culvert. The channel banks were assigned a Manning's coefficient value of 0.03 to reflect the vegetation observed. The sediment depth was estimated to be 0.7 feet throughout the segment.

The baseline condition for the Rolando 1 segment was determined to be the current condition as observed during a site visit conducted by Geosyntec Consultants in July 2017. The bottom of Rolando 1 was assigned a Manning's coefficient value of 0.025, which represents the relatively clean concrete channel, with minor vegetation present. The channel banks were assigned a Manning's coefficient value of 0.03 to reflect the vegetation observed.

The baseline condition for the Cartagena segment was determined to be the current condition as observed during a site visit conducted by Geosyntec Consultants in July 2017. The bottom of Cartagena was assigned a Manning's coefficient value of 0.025, which represents the relatively clean concrete channel, with minor vegetation present. The channel banks were assigned Manning's coefficient values ranging from 0.03-0.06 to reflect the light to heavy vegetation observed.

The assigned Manning's coefficient value for the Rolando 2 channel bottom in the recommended maintained condition was set at 0.04 to reflect removal of sediment/debris and vegetation from the rip-rap lined channel bottom, 0.035 to reflect removal of sediment/debris and vegetation from the earthen channel bottom, and 0.013 to reflect removal of sediment/debris and vegetation from the concrete apron. The geometry of the facility was revised in the recommended maintained condition to represent the repair of the eroded bank resulting from the recommended bank stabilization activities.

The assigned Manning's coefficient value for Rolando 1 in the recommended maintained condition was set at 0.015 to reflect the roughness of the originally constructed concrete facility. The assigned Manning's coefficient value for Cartagena in the recommended maintained condition was set at 0.015 to reflect the roughness of the originally constructed concrete facility.

Model parameters and velocities for the baseline and maintained conditions for the Rolando & Cartagena 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
Rolando 2 (earthen & rip-rap)	7517-6646	Baseline: 0.013-0.11	Baseline: 0.89-3.52	Culvert (Station 7517) Culvert (Station 6697 to 6646)	Normal Depth at Station 7879
		Maintained: 0.013-0.04	Maintained: 1.09-13.02		
Rolando 1 (concrete)	6646-6222	Baseline: 0.025-0.03	Baseline: 3.60 – 9.25	Culvert (Station 6272 to 6222)	-
		Maintained: 0.015	Maintained: 3.64 – 9.97		
Cartagena 1 (concrete)	6222 - 4997	Baseline: 0.025-0.06	Baseline: 6.24 – 14.63	Trapezoidal to Rectangular transition (Approx. Station 5860), Culvert (Station 4997)	Normal Depth at Station 4997
		Maintained: 0.015	Maintained: 13.26 – 31.03		

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 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 of 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 Rolando 2 segment can convey 235 cubic feet per second (cfs) (<2-year level of service) in the baseline condition before flows impact the adjacent property. The capacity of Rolando 2 is limited by both the downstream culvert beneath Rolando Boulevard (Station 6646 to 6697) and low bank elevations in the vicinity.

The Rolando 1 segment can convey 829 cfs (>10-year level of service) in the baseline condition before flows impact the adjacent property. The capacity of Rolando 1 is limited by both the downstream culvert beneath Bonillo Drive (Station 6222 to 6272) and low bank elevations in the vicinity.

The Cartagena segment can convey 1,132 cfs (<2-year level of service) in the baseline condition before flows impact the adjacent property. The capacity of Cartagena is limited by the downstream culvert beneath College Avenue (Station 4997) and low bank elevations in the vicinity.

Recommended Maintained Condition

Removing deposited sediment/debris and vegetation from the Rolando 1 and 2 segments and performing bank repair activities along the Rolando 2 segment will not affect the levels of service, which remain <2-year storm for Rolando 2, and >10-year storm for Rolando 1. The recommended maintenance will reduce the risk of vegetation dislodging, flowing downstream, and clogging the downstream culverts and will repair the eroded bank and failed concrete side slopes. Removing deposited sediment/debris and vegetation from the Cartagena segment will increase the level of service to >5-year, and the segment can convey up to 1,826 cfs.

Erosion of the side slopes of the Rolando 2 segment was observed over a length of approximately 160 feet, between Station 7077 and Station 6917. Performing bank repair would reduce the risk of further erosion along the side slopes. Concrete failure of the side slopes of the Rolando 2 segment was observed over a length of approximately 55 feet, between Station 7517 and Station 7462. Performing concrete bank repair would reduce the risk of further failure along the side slopes. A geotechnical evaluation may be required prior to maintenance activities to assess bank conditions.

Post-Maintenance Erosion Control Measures

Following maintenance, the estimated velocities in the Rolando 2 segment exceed the recommended permissible velocities for unlined channels (5 feet per second) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Velocity reduction measures are recommended for this segment.

The estimated velocities in the Rolando 1 and Cartagena segments are below recommended permissible velocities for concrete lined channels (35 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. No measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended within these segments.

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 culverts beneath Rolando Boulevard (Station 6646 to 6697), Bonillo Drive (Station 6222 to 6272), and College Avenue (Station 4997), and additionally 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 these restrictions.

Table 3. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Rolando 2	7517-6646	235	235	<2 - year storm	<2 - year storm
Rolando 1	6646-6220	829	829	>10 - year storm	>10 - year storm
Cartagena 1	6220 - 4997	1,132	1,826	<2 - year storm	>5 – year storm

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 in May 2015 (Rolando 2) and by Geosyntec Consultants in July 2017 (Rolando 1 and Cartagena 1).

1. Rolando 2: Pre-maintenance; looking upstream from downstream end of segment.

2. Rolando 2: Pre-maintenance; looking towards the double 8-foot wide by 5-foot, 2-inch tall RCB culvert at downstream end of segment.


3. Rolando 1: Looking upstream from downstream end segment.


4. Cartagena 1: Looking upstream; missing sidewall and eroded bank at center.

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 Rolando facility group.

- Field Photo Locations
- Storm Drain Conveyance
- Culvert
- MWMP Facility Cross Section
- Cartagena 1
- Rolando 1
- Rolando 2

N

Drainage Area: 2,658 acres

Feet
0 100 200

The City of SAN DIEGO

Facility Group Name: Chollas Creek - Rolando
Segment Name: Cartagena 1, Rolando 1-2
Facility Nos: 5-04-044, 5-04-046, 5-04-048
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.39 Chollas Creek – Martin (No. 5-04-101)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen and Concrete	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Repair and restabilize scoured channel bed between Station 496 to Station 616.	
Benefit	• Prevents further scour of the channel bed. • Reduces the potential for downstream sediment deposition and clogging of the downstream culvert. • The level of service remains at <50-year storm event (228 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.

General Description

The Chollas Creek Unnamed Tributary – Martin (Martin) 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 Martin facility group is located in the San Diego Bay Watershed Management Area. The facility is bordered by 36th Street to the east, Interstate 15 (I-15) to the west, single-family residential developments to the north, and multifamily residential developments to the south.

The Martin facility group flows from east to west and begins at the existing culvert outlet, consisting of a 36-inch-diameter reinforced concrete pipe (RCP) and a 24-inch-diameter RCP, near the corner of Hemlock Street and 36th Street. The culvert outlets to an earthen trapezoidal ditch with a 6-foot-wide bottom. A portion of the ditch from Station 1035 to Station 825 features a retaining wall and concrete walkway on the south side of the channel. The ditch enters a 60-inch-diameter RCP culvert beneath 35th Street and the culvert outlets to a trapezoidal earthen ditch with a 6-foot bottom width, which continues to flow to the west for approximately 500 feet. The Martin facility group discharges into a second 60-inch-diameter RCP culvert that crosses into the California Department of Transportation's (Caltrans) right-of-way for I-15 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 Martin facility group.

Hydrology

The hydrologic peak flow for the 100-year recurrence interval presented in Table 1 below was estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated 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
Martin 1	118	151	176	211	237	262

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 *Chapter 3, 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 storm drain pipes to the east of the channel. The downstream domain of analysis is the 60-inch-diameter RCP culvert that discharges into Chollas Creek, and known water surface elevations provided by the Federal Emergency Management Agency (FEMA) were used as the downstream boundary condition. Based on the methodology presented in *Chapter 3, 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 Martin facility group was determined to be the current condition as observed during a site visit in July 2017. The banks and bottom of the facility from Station 1428 to Station 825 were assigned Manning's coefficient values ranging from 0.016 to 0.060, representative of the concrete block retaining wall/walkway, riprap present in the facility, and the density of the vegetation observed. The banks and bottom of the facility from Station 721 to Station 235 were assigned Manning's coefficient values ranging from 0.020 to 0.037, representative of the observed vegetation density and the scoured area identified during the July 2017 site visit between Station 616 and Station 496. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the July 2017 site visit.

The recommended maintained condition for the Martin facility group is limited to repairing a scoured area between Station 616 and Station 496 within the downstream reach of the facility.

Because minimal maintenance is recommended, the same Manning's coefficients used in the baseline condition were also used in the maintained condition modeling.

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

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Martin 1 (earthen)	1428–233	Baseline: 0.016–0.060	Baseline: 1.1–12.5	60-inch RCP Station 825	Normal Depth at Station 1428
		Maintained: 0.016–0.060	Maintained: 1.1–12.5		
Downstream Domain of Analysis	233–2	0.013–0.015	0.2–3.0	60-inch RCP Station 233	Known Water Surface Elevation

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 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

In the baseline condition, the level of service is broken up into the upstream reach of the segment, from 36th Street to 35th Street, and the downstream reach from 35th Street to the Caltrans I-15 right-of-way. In the upstream reach, the ditch has a level of service of the 100-year storm and conveys 262 cubic feet per second (cfs). In the downstream reach, the maximum level of service in the baseline condition is less than the 50-year storm and is capable of conveying up to 228 cfs before the storm water surface elevation impacts properties on the north side. The hydraulic analysis results show that the level of service is limited by the conveyance capacity of the existing 60-inch-diameter RCP culvert, the facility's discharge point. While both the upstream and downstream reaches drain into the same size culvert with the same flow rate, the difference in level of service is a function of the adjacent infrastructure's proximity to the respective portions of the channel rather than a conveyance capacity difference between the two 60-inch diameter culverts. For the entire Martin facility group, the level of service is listed as the 50-year storm, and the ditch is capable of conveying 228 cfs to match the most restricted reach.

Recommended Maintained Condition

Because the baseline condition modeling showed velocities outside the permissible range for a vegetated channel and the evidence of scour in the downstream reach in the current condition, maintenance was scaled back. In addition, several hydraulic modeling scenarios were analyzed which showed maintenance activities such as vegetation removal, trimming, or grubbing/mowing do not improve the facility capacity.

The recommended maintenance consists of filling and compacting of the scoured area and contouring the filled area of the channel bed with a constant slope from Station 616 to Station 496. The level of service after these maintenance activities will remain unchanged at less than the 50-year storm, or 228 cfs, due to the limited capacity of the culvert at Station 233.

Post-Maintenance Erosion Control Measures

The baseline and recommended maintained velocities in the channel are potentially erosive based on the recommended permissible velocities for vegetation lined channels (5 feet per second) according to the *City of San Diego Drainage Design Manual, dated January 2017*. The range of velocities in the recommended maintained condition remains unchanged from the baseline condition. The majority of the facility group showed no evidence in erosion in the baseline condition; however, some portions of the facility group, such as the existing scour area to be repaired in the recommended maintained condition, did show evidence of erosion. Therefore, measures to reduce velocity or otherwise control erosion are recommended for this facility at the existing scour area, 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.

Potential Facility Capital Improvements

The HEC-RAS modeling results show that the conveyance capacity of the facility is restricted by the 60-inch-diameter RCP culvert under I-15, and the floodplain extends well within various private properties' open space areas. Therefore, additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address restrictions at the two 60-inch-diameter RCP culverts.

Due to the presence of scour in the channel, a capital improvement to address potentially erosive velocities may be the most effective measure for preventing continuing erosion in the ditch. Additional analysis is recommended to determine the extent and type of improvement that would most effectively address erosion in the ditch.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Martin 1	1428-233	228	228	<50-year	<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 in July 2017.

1. Martin 1: Looking upstream at vegetation density in upstream reach.

2. Martin 1: Looking upstream at retaining wall/walkway and vegetation in upstream reach.

3. Martin 1: Looking downstream at 60-inch-diameter RCP culvert entrance under 35th Street.

4. Martin 1: Looking downstream at scoured channel bed.

5. Martin 1: Looking downstream at 60-inch-diameter RCP culvert entrance (below concrete block wall).

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

Creek

N

Drainage Area: 133 acres

0 50 100 200 Feet

The City of SAN DIEGO

Facility Group Name: Chollas Creek Unnamed Tributary - Martin
Segment Name: Martin 1
Facility No: 5-04-101
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.40 Chollas Creek – J Street (No. 5-04-163)

Summary of Recommended Maintenance

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Trim vegetation and remove invasive vegetation between Station 10 and Station 25. • The remainder of J Street is recommended to be maintained by private property owners from Station 25 to Station 193 to trim vegetation and remove invasive vegetation. • Remove sediment/debris in culvert at Station 10.	
Benefit	• The level of service remains at <5-year storm event (17 cfs), but reduces the risk of vegetation dislodging, flowing downstream, and clogging the culvert. • The water surface elevation (WSE) upstream of Station 193 improves from the <5-year WSE in the baseline condition to the 5-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 Chollas Creek Unnamed Tributary – J Street (J Street) 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 J Street facility group is located in the San Diego Bay Watershed Management Area. The facility is bordered by single-family residential developments along its entire length, except for the upstream end, which is bordered by a community garden along Market Street, and the downstream end, which is bordered by Toyne Street to the west.

The J Street facility group was broken down into Reaches 1 and 2 for analysis purposes as follows:

- J Street, Reach 2: Stations 414 to 100.
- J Street, Reach 1: Stations 100 to 10.

The J Street facility group initially flows from north to south in Reach 2 and begins at a 42-inch reinforced concrete pipe (RCP) at its northern end. After about 300 feet, the facility makes an approximately 90-degree bend to the west. Runoff from a 24-inch-diameter RCP outlet from the east joins the main ditch at the 90-degree bend and the combined flows are conveyed to the west toward Toyne Street in Reach 1. The bottom width ranges from 4 to 6 feet in both reaches of the ditch. The ditch discharges into a 30-inch-diameter RCP culvert at the east side of Toyne Street, about 100 feet north of J Street. A 30-inch-diameter RCP storm drain system conveys flow to the west. The majority of the facility group is within privately owned properties. The city maintained portion of the segment is within the 15' drainage easement located upstream of the culvert at Station 10. 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 J Street facility group.

Hydrology

The hydrologic peak flow for the 100-year recurrence interval presented in Table 1 below was estimated using the rational method as described in the *City of San Diego Drainage Design Manual, dated 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.* The combined peak flows downstream of the junction (Station 108), where the flows from the main ditch to the north and the 24-inch-diameter RCP culvert to the east 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
J St 1, Reach 2	16	20	23	28	31	35
J St 1, Reach 1	29	37	43	51	57	64

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 *Chapter 3, 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 storm drain pipes to the northwest of the ditch. The downstream domain of analysis is the 30-inch-diameter RCP culvert and subsequent storm drain to which the facility discharges. Based on the methodology presented in *Chapter 3, Section 3.2.1.3, of the*

Hydrology and Hydraulics Technical Report, the upstream and downstream domains of analysis have been excluded from the modeling.

The baseline condition for the J Street facility group was determined to be the current condition as observed during site visits conducted by D-Max Engineering in July 2017. Manning's coefficient values from 0.035 to 0.040 were assigned to portions of the ditch at Station 279 and between Station 193 and Station 45 to represent dense growths of invasive vegetation observed in these areas. The rest of the ditch banks and bottom were assigned Manning's coefficient values from 0.018 to 0.030, representative of the earthen ditch and the density of the vegetation observed in those areas. The photos in the Representative Photos section below provide examples of the condition of the facility as observed during the July 2017 site visit.

The recommended maintained condition for the J Street facility group includes trimming vegetation and removal of invasive vegetation between Station 193 and Station 10. The Manning's coefficients in the recommended maintained condition vary from 0.018 for the concrete pad at the culvert entrance to 0.030 for the trimming/removal of invasive vegetation within the channel bottom. The Manning's coefficient values for Reach 2 upstream of Station 193 remained unchanged since no maintenance is proposed. Station 193 is the approximate end of the invasive vegetation that is recommended to be removed and the reach conveys the 100-year storm event in the current condition upstream of Station 220.

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

Table 2. Model Parameters and Velocities

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
J St 1, Reach 2 (earthen)	414-100	Baseline: 0.018-0.04	Baseline: 0.21-10.57	-	Normal Depth
		Maintained: 0.018-0.04	Maintained: 0.31-10.57		
J St 1, Reach 1 (earthen)	100-10	Baseline: 0.020-0.04	Baseline: 0.49-4.17	-	Culvert Inlet Analysis
		Maintained: 0.018-0.03	Maintained: 0.53-4.47		

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 ditch 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 level of service in both Reach 2 and Reach 1 portions of the facility group is less than the 5-year storm event. Reach 1 and Reach 2 are capable of conveying 17 cubic feet per second (cfs) before storm flow impacts adjacent residential properties to the north of Reach 1 and to the west of Reach 2 at Stations 10 and 166, respectively. The portion of Reach 2 that is upstream of Station 193 has a level of service of the 100-year storm event and is capable of conveying up to 35 cfs in the baseline condition. The hydraulic analysis results show that the level of service of the portion of Reach 2, downstream of Station 193, and Reach 1 are limited by the conveyance capacity of the existing 30-inch-diameter storm drain system.

Recommended Maintained Condition

Vegetation trimming is recommended from Station 10 to Station 25 within the City drainage easement and vegetation trimming and removal of invasive vegetation is recommended from Station 25 to Station 193 in the privately owned properties. Vegetation trimming and removal of invasive vegetation between Station 193 and Station 31 does not improve the conveyance capacity (17 cfs) or level of service (<5-year) from the baseline condition before the storm flows impact adjacent residential properties. However, the recommended maintenance reduces the risk of vegetation, sediment, or debris flowing downstream and clogging the culvert at Station 10. In addition, the recommended maintenance decreases the WSE at the upstream end of the maintenance area. In the recommended maintained condition, the WSE decreases at Station 193 to correspond to the 5-year level of service. Upstream of Station 220, Reach 2 has a level of service equal to the 100-year event in the existing condition and is not being recommended for maintenance.

It is important to note that the benefits to the J Street facility group due to the recommended maintenance are dependent on the assumption the portions of the J Street segment which are not owned or maintained by the City of San Diego have been maintained.

Post-Maintenance Erosion Control Measures

The baseline and recommended maintained velocities between Station 244 and Station 220 and Station 414 and Station 393 in Reach 2 are potentially erosive based on the recommended permissible velocities for vegetation-lined channels (5 feet per second [fps]) according to the *City of*

San Diego Drainage Design Manual, dated January 2017. The range of velocities in these segments in the recommended maintained condition remains unchanged from the baseline condition. If the private property portions of the segment are maintained, it is recommended that velocity reduction methods consistent with those described in *Section 6 of the Hydrology and Hydraulics Technical Report* be reviewed and implemented as needed.

The velocities in Reach 1 from Station 25 to Station 10, do not exceed 5 fps in the baseline or recommended maintained conditions. 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 results show that the conveyance capacity of the facility is restricted by the 30-inch-diameter storm drain system that receives runoff from the J Street facility group. Therefore, additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address restrictions in the downstream storm drain system.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
J St 1	414-10	17	17	<5-year	<5-year

Representative Photos

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

1. J St 1 (Reach 2): Looking downstream at vegetation in upstream reach

2. J St 1 (Reach 2): Looking upstream at invasive vegetation

3. J St 1 (Reach 1): looking upstream at 24-inch-diameter culvert outlet

4. J St 1 (Reach 1): Looking upstream at invasive vegetation

5. J St 1 (Reach 1): Looking downstream at 30-inch-diameter RCP culvert inlet on east side of Toyne Street

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
MWMP Facility Cross Section
MWMP Facility Center Line

N

Drainage Area: 25 acres

Feet
0 25 50 100

The City of SAN DIEGO

Facility Group Name: Chollas Creek Unnamed Tributary - J St
Segment Name: J St 1
Facility No: 5-04-163
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.41 Auburn Creek – Home

Summary of Recommended Maintenance

Home 1 (No. 5-04-220)

Facility Type	Bed: Earthen Banks: Earthen, Riprap	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from the in-line weir at Station 641 and from the bottom of the segment from Station 295 to Station 710. • Remove accumulated sediment/debris in culvert from Stations 221 to Station 295.	
Benefit	• The level of service remains >50-year storm event, but the conveyance capacity increases from 957 cfs to 1,028 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.

Home 2 (No. 5-04-224)

Facility Type	Bed: Earthen Banks: Earthen, Grouted Riprap	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from the bed and banks of the segment from Station 4.590 to Station 165. • Remove accumulated sediment/debris in culvert at Station 4.590.	
Benefit	• Increase level of service from 25-year storm event (630 cfs) to 100-year storm event (1,200 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.

Home 3 (No. 5-04-227)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Concrete repair/replacement from Station 1793 to Station 2161.775. • Remove accumulated sediment/debris and vegetation from Station 1793 to Station 2161.775. • Maintenance of the culvert from Station 925.442 to Station 1793 is recommended to be maintained by Caltrans.	
Benefit	• Level of service remains 50-year storm event (950 cfs). • Prevent dislodging of the gunite and concrete pieces and potential clogging of downstream culverts or side slope failure.	

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.

Home 4 (No. 5-04-229)

Facility Type	Bed: Earthen Banks: Earthen, Concrete	Category 2
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.

Home 5 (No. 5-04-231)

Facility Type	Bed: Earthen Banks: Earthen, Concrete	Category 2
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance[2]	• Remove accumulated sediment/debris and vegetation from bottom of segment from Station 3018 to Station 3293. • Remove accumulated sediment/debris from culvert from Station 2916.303 to Station 3018.	
Benefit	• The level of service remains a 25-year storm event (630 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.

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
Home 5	Rick Engineering Company, 2017. IHHA Report for Auburn Creek Channel Map Numbers 70 & 76. Job Number 17204-L.	5
Home 4	Rick Engineering Company, 2017. IHHA Report for Auburn Creek Channel Map Numbers 70 & 76. Job Number 17204-L.	4
Home 3	Rick Engineering Company, 2017. IHHA Report for Auburn Creek Channel Map Numbers 70 & 76. Job Number 17204-L.	3
Home 2	Rick Engineering Company, 2017. IHHA Report for Auburn Creek Channel Map Numbers 70 & 76. Job Number 17204-L.	1, 2
Home 1	Rick Engineering Company, 2016. IHHA Report for Emergency Maintenance Home Avenue Channel Map Numbers 77. Job Number 17204-F.	2a, 2b

General Description

The Auburn Creek – Home Avenue (Home Avenue) facility group was classified as having Category 1, Category 2, and Category 3 segments, as described in *Chapter 3, Section 3.3, of the Hydrology and Hydraulics Technical Report*. The Home Avenue facility group has a highly urbanized tributary watershed and is located in the San Diego River Watershed Management Area. The facility group flows in a southwesterly direction along the southern side of Home Avenue, and eventually confluences with Chollas Creek at State Route 94, and ultimately discharges into San Diego Bay. The Home Avenue facility group is separated into five segments, in order of upstream to downstream: Home 5, Home 4, Home 3, Home 2, and Home 1.

Home 5 is a trapezoidal segment with an earthen bottom and is located at the upstream end of the facility. The segment begins at the outlet of a double-barrel 74-inch-diameter reinforced concrete pipe (RCP) culvert, located approximately 275 feet upstream of Fairmount Avenue, and continues to the southwest before entering a double 6-foot by 6-foot reinforced concrete box (RCB) culvert underneath Fairmount Avenue. The upstream 130 feet of the segment consists of a right (looking downstream) concrete side slope, and a left vegetated side slope. The remaining downstream 145 feet of the segment consists of a right concrete side slope and a left shotcrete side slope. Pursuant to as-built drawing no. 12728-2-L, the channel geometry consists of a bottom width of 12 feet, depth of 6 feet, and side slopes of 1.5:1 (H:V).

Home 4 is the subsequent downstream reach and is a trapezoidal segment that begins at the outlet of the double 6-foot by 6-foot RCB culvert underneath Fairmount Avenue. The segment continues for approximately 755 feet to the southwest before transitioning to concrete lining. The segment is an earthen channel on the bottom and on the left side slopes (looking downstream), with concrete right side slopes. Pursuant to as-built drawing no. 12728-2-L, the channel geometry consists of a bottom width of 12 feet, depth of 6 feet, and side slopes of 1.5:1 (H:V).

Home 3 is the subsequent downstream reach and is a concrete trapezoidal segment which begins at the transition from the earthen upstream segment. The segment continues southwest before entering a double 7-foot by 6-foot RCB culvert which extends beneath Interstate 805 (I-805). Pursuant to as-built drawing no. 12728-2-L, the channel is entirely concrete lined and consists of a bottom width of 12 feet, depth of 6 feet, and side slopes of 1.5:1 (H:V).

Home 2 is the subsequent downstream reach and is an earthen trapezoidal segment that begins at the downstream end of the double 7-foot by 6-foot RCB culvert which extend underneath I-805. The segment continues to the southwest before entering a triple 6-foot by 6-foot RCB culvert under Spillman Drive. As-built drawings were not available at the time the IHHA was prepared.

Home 1 is an earthen trapezoidal segment located at the downstream end of the facility. The segment begins at the outlet of a 12-foot by 6-foot RCB culvert underneath the existing Terrace View Villas. The segment continues southwest before entering a triple 6-foot by 6-foot RCB culvert beneath Federal Boulevard. At Station 641, there is a 4-foot-deep and 12-foot-wide in-line weir present. Per as-built drawing 57-11VC1P, the channel geometry consists of a bottom width of 10 to 25 feet, a depth of 7 to 10.5 feet, and side slopes of 2:1 (H:V).

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

Hydrology

The hydrologic peak flows presented in Table 2 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 the Home Avenue facility group. 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 2. Hydrology Results

Segment	Peak Flow Rates by Storm Event Frequency (cfs)					
	2-year	5-year	10-year	25-year	50-year	100-year
Home 5	120	290	430	630	950	1,200
Home 4	120	290	430	630	950	1,200
Home 3	120	290	430	630	950	1,200
Home 2	120	290	430	630	950	1,200
Home 1	120	290	430	630	950	1,200

Hydraulics

Auburn Creek - Home 2 through 5

A one-dimensional steady flow model was developed for Home 2 through 5 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 recommended maintained conditions. The extent of the reaches evaluated in the model are presented in Hydraulic Reference Map 1 located at the end of this fact sheet.

To establish the downstream boundary conditions for the modeled facility segments, the headwater depth for the downstream culvert under Spillman Drive was analyzed utilizing the Federal Highway Administration – Hydraulic Design Series (FHWA HDS)-Method through the Culvert Master program for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events.

The baseline condition for the Home 5 segment was determined to be the existing condition as observed during the site visit conducted by Rick Engineering in February 2017. The bottom and banks of the Home 5 segment were assigned Manning's coefficient values ranging from 0.018–0.045, which represent the varying density of vegetation observed within the earthen segment. The baseline condition for the Home 4 segment was determined to be the ultimate vegetated condition. The bottom and banks of Home 4 were assigned Manning's coefficient values ranging from 0.018–0.15, which represent the vegetative carrying capacity of the earthen segment. The baseline condition for the Home 3 segment was determined to be the existing condition as observed during the site visit in February 2017. The bottom and banks of Home 3 were assigned Manning's coefficient values ranging from 0.018–0.04, which represent the relatively clean concrete segment. The baseline condition for the Home 2 segment was determined to be the existing condition as observed during the site visit in February 2017. The bottom and banks of Home 2 were assigned Manning's coefficient values ranging from 0.025–0.1, which represent the varying density of vegetation observed within the earthen segment.

The assigned Manning's coefficient values for Home 5 in the recommended maintained condition ranged from 0.018–0.049 to reflect the removal of sediment and vegetation in the earthen segment; 0.049 reflects the riprap side slopes. The assigned Manning's coefficient values for Home 4 in the recommended maintained condition ranged from 0.018–0.049 to reflect removal of sediment and vegetation in the earthen segment. The assigned Manning's coefficient values for Home 3 in the recommended maintained condition ranged from 0.018 to reflect removal of sediment and vegetation in the concrete segment. The assigned Manning's coefficient values for Home 2 in the recommended maintained condition ranged from 0.03–0.049 to reflect the removal of sediment and vegetation in the earthen segment including vegetation removal on the banks; 0.049 reflects the riprap area.

Model parameters for the baseline and maintained conditions for the Home 2, Home 3, Home 4, and Home 5 segments are summarized in Table 3.

Auburn Creek - Home 1

A one-dimensional steady flow model was developed under a separate effort for the Home 1 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. 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 2 located at the end of this fact sheet.

The upstream domain of analysis for the Home 1 segment is the existing storm drain system that discharges into 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 downstream domain of analysis is a 6-foot by 6-foot RCB culvert underneath Federal Boulevard, which outlets to the south as a concrete channel.

The baseline condition for the Home 1 segment was determined to be the pre-maintenance condition as observed during a site visit conducted by Rick Engineering in March 2016. Emergency maintenance was performed on the segment during March 2016. The bottom and overbanks of Home 1 were assigned Manning's coefficient values ranging from 0.015–0.06, which represent the density of the vegetation and sediment/debris observed, as well as the concrete headwalls and concrete slope protection along the west slope on the downstream end of the segment. The assigned Manning's coefficient values for Home 1 in the recommended maintained condition ranged from 0.015–0.045 to reflect the removal of sediment/debris and vegetation from the channel bottom.

Model parameters and velocities for the baseline and maintained conditions for the Home 1 facility segment are summarized in Table 3. Velocities reported below are the output velocities for the flow associated with the maximum facility conveyance capacity for the analyzed segment.

Table 3. Model Parameters

Segment and Material	Reference Stations[1]	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Home 5 (earthen, concrete)	3293–2916.303	Baseline: 0.018–0.045	–	Culvert (Station 3018)	Normal Depth
		Maintained: 0.018–0.049	–		
Home 4 (earthen, concrete)	2916.303–2161.775	Baseline: 0.018–0.15	–	–	–
		Maintained: 0.018–0.049	–		
Home 3 (concrete)	2161.775–925.442	Baseline: 0.018–0.04	–	Culvert (Station 1793)	–
		Maintained: 0.018	–		
Home 2 (earthen)	925.442–4.590	Baseline: 0.025–0.1	–	Culvert (Station 4.590)	Calculated Water Surface Elevation
		Maintained: 0.03–0.049	–		
Home 1 (earthen)	710–221	Baseline: 0.015–0.06	Baseline: 3.22–8.53	In-line weir (Station 641); Culvert (Station 295 to 221)	Normal Depth
		Maintained: 0.015–0.06	Maintained: 2.91–6.93		
Downstream Domain of Analysis	221–63	Baseline: 0.015–0.03	Baseline: 8.64–12.64	Concrete channel	Known Water Surface Elevation
		Maintained: 0.015–0.03	Maintained: 8.89–12.82		

1 The stationing for the Home 1 segment and the downstream domain of analysis does not align with the stationing of the other facility group segments. Home 1 and the downstream domain of analysis were modeled separately from the other facility group segments.

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 velocities, summarized Table 3 in the Hydraulics section, were utilized in the post-maintenance erosion control assessment. The overall conveyance capacity and level of service for the segments are summarized in Table 4 for both the baseline and recommended maintained condition.

Baseline Condition

The capacity of Home 5 is limited by the culvert at Station 3018. The segment can convey up to 630 cubic feet per second (cfs) (25-year level of service) in the baseline condition. The Home 4 segment convey up to 1,200 cfs (100-year level of service) in the baseline condition. The capacity of Home 3 is limited by the culvert at Station 1793. The segment convey up to 950 cfs (50-year level of service) in the baseline condition. The capacity of Home 2 is limited by the culvert at Station 4.590. The segment convey up to 630 cfs (25-year level of service) in the baseline condition. The capacity of Home 1 is limited by the culvert at Station 263. The segment can convey up to 957 cfs (>50-year level of service) in the baseline condition.

Recommended Maintained Condition

Removing the deposited sediment and vegetation throughout Home 5, an earthen channel, preserves the conveyance capacity of 630 cfs (25-year level of service). Although the level of service does not change from the current condition, Home 5 will need maintenance in the future and will lose significant capacity if left unmaintained.

Home 4 has a level of service equal to the 100-year event in the existing condition and is not being recommended for maintenance. Home 3 was observed to contain various sections of broken and undermined gunite riprap and concrete side slopes, as observed during the site visit in February 2017. It is recommended that these portions be repaired to prevent dislodging of the concrete and gunite pieces and potential clogging of downstream culverts or side slope failure. These sections of broken concrete have the potential to cause an emergency; however, they are currently at low risk for causing an emergency. Removal of deposited sediment and vegetation is not recommended for the Home 3 segment. The culvert from Station 925.442 to Station 1793 is located within the Caltrans right-of-way and is recommended to be maintained by Caltrans.

Removing the deposited sediment and vegetation throughout Reach 1 (Station 4.590 to Station 165) of the Home 2 segment and from the downstream culvert beneath Spillman Drive, increases the conveyance capacity to 1,200 cfs (100-year level of service). Removing the deposited sediment and vegetation throughout the segment bottom, in-line weir, and culvert within Home 1 increases the conveyance capacity to 1,028 cfs (50-year level of service).

Post-Maintenance Erosion Control Measures

In the recommended maintained condition, the estimated velocities for Home 5 and Home 2 are below the maximum permissible velocities for an unlined channel with cobbles (5 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*.

The estimated velocities for Home 3 in the recommended maintained condition are below the maximum permissible velocities for a concrete channel (35 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*.

The estimated velocities for Home 1 in the recommended maintained condition are generally below the maximum permissible velocities for unlined earthen channels (5 fps); however, velocities at Station 706 were noted to be above the permissible thresholds for erosive velocities. The high velocities at Station 706 are only during large storms (greater than the 25-year event) and occur in both the baseline and maintained condition modeling results. Therefore, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility. 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 facility group capacities were limited by the capacity of the downstream culverts. Additional analysis is recommended to evaluate potential increases in the level of service that could be achieved by capital improvements to address this restriction.

In addition, it was noted in Home 4, where no maintenance is proposed, that the estimated velocities in the baseline condition exceed the maximum permissible velocities for an unlined channel with cobbles (5 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. The velocities between Station 2709.054 and Station 2916.303 range from 5.2 fps to 11 fps. It is recommended this area be monitored for erosion and permanent erosion control measure be implemented as needed.

Table 4. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Home 5	3293– 2916.303	630	630	25-year	25-year
Home 4	2916.303– 2161.775	1,200	-	100-year	-
Home 3	2161.775– 925.442	950	950	50-year	50-year
Home 2	925.442–4.590	630	1,200	25-year	100-year
Home 1	710–221	957	1,028	>50-year	>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 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 March 2016 (Home 2 through 5) and by Geosyntec Consultants in February 2017 (Home 1).

IHHA 1. Home 2, Map 1: Looking downstream at the triple 6-foot wide by 6-foot tall RCB culvert under Spillman Drive. Photo shows 50% clogging of culvert.

IHHA 4. Home 2, Map 1: Looking upstream at the vegetation and displaced riprap downstream of the double 7-foot wide by 6-foot tall RCB culvert.

IHHA 6. Home 3, Map 1: Looking downstream towards 7-foot wide by 6-foot tall double RCB culvert. Note clean channel.

IHHA 10. Home 4, Map 1: Looking upstream at the double 6-foot wide by 6-foot tall RCB culvert. Note the standing water and erosion at culvert outlet.

IHHA 13. Home 5, Map 1: Looking upstream at the double-barrel 74-inch-diameter RCP culvert.

1. Home 1, Map 2: Looking the upstream end of the segment towards the 12-foot wide by 6-foot tall RCB culvert under Terrace View Villas.

2. Home 1, Map 2: Standing at the upstream end the segment, looking west where erosion occurs along Home Avenue.

3. Home 1, Map 2: Standing along east bank of segment, looking southwest at erosion behind east wing wall at downstream end.

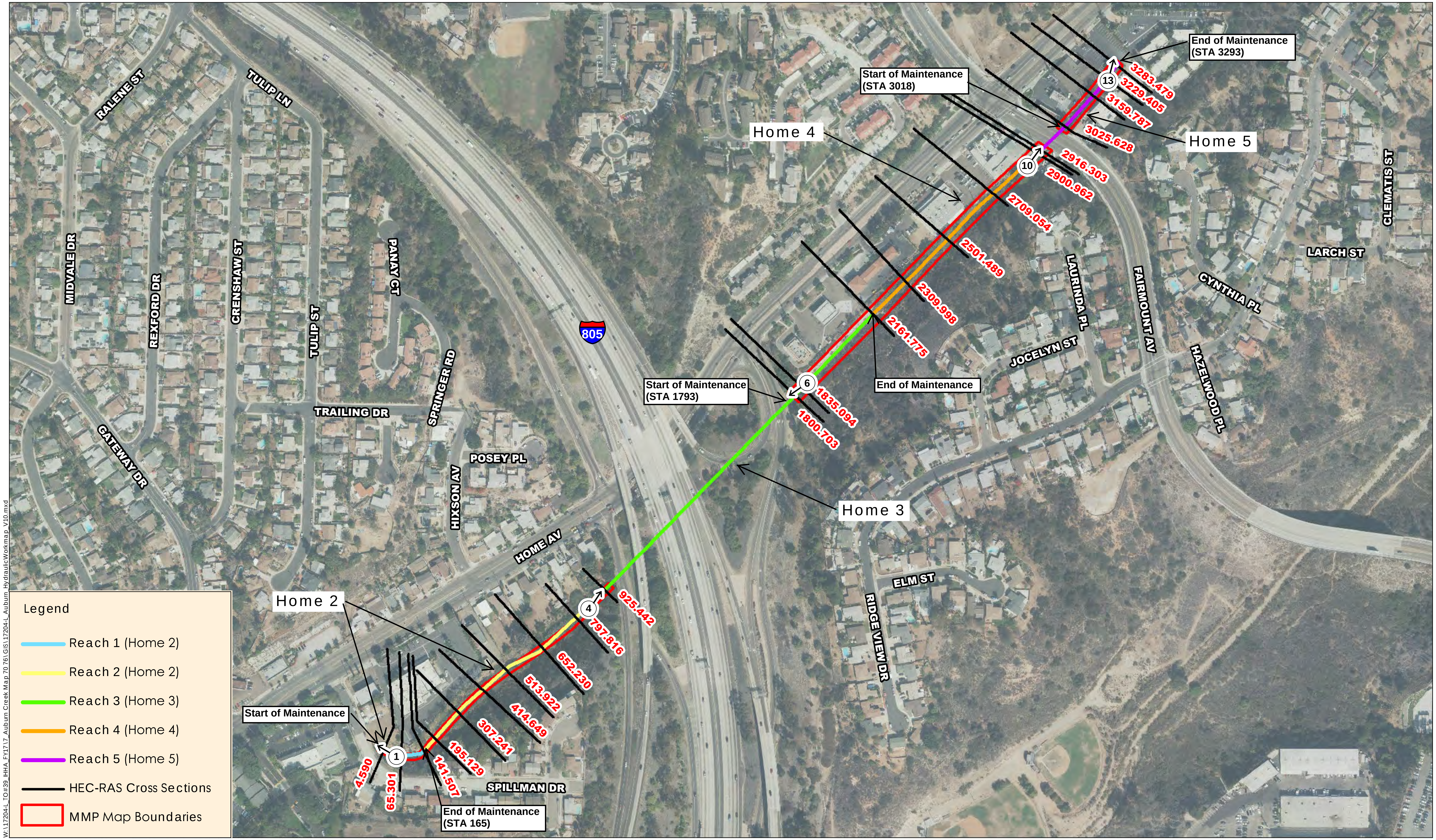
4. Home 1, Map 2: Standing at downstream end of segment, looking northeast at erosion along the east bank of the channel.

Analysis Performed By: Rick Engineering, 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 Home 2, 3, 4, and 5 segments (Map 1), and the Home 1 segment (Map 2).



RICK ENGINEERING COMPANY

Feet

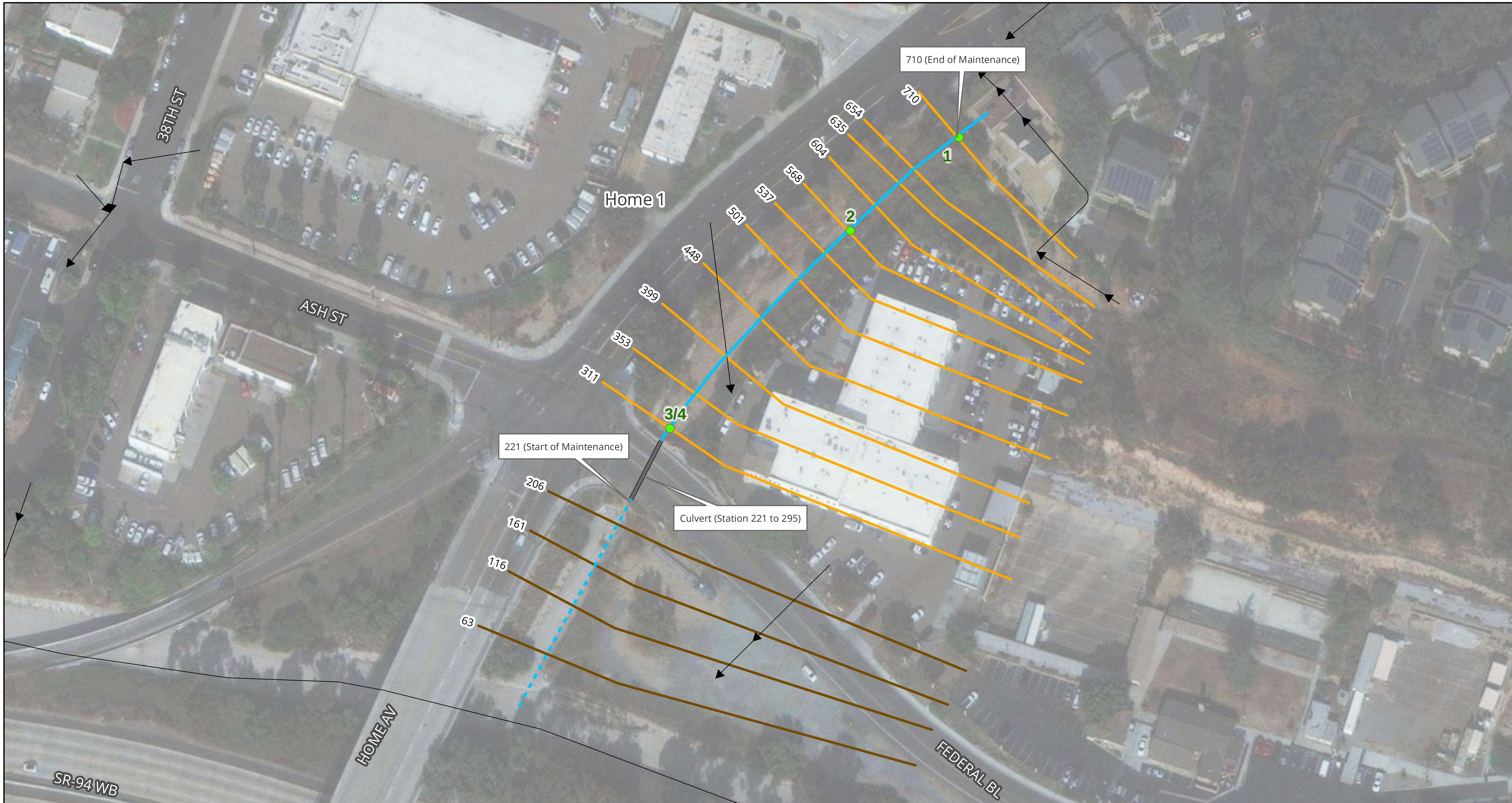
0 300 600

North

Original Exhibit:
Auburn Creek Channel
Attachment 3 - MMP Map Numbers 70 & 76 Hydraulic Workmap (Report J-17204-L)

Date of Exhibit: 4/3/2017
ESRI World Topographic Basemap: November 2014

Facility Group Name: Auburn Creek - Home
Segment Names: Home 2, Home 3, Home 4, Home 5
Facility Nos: 5-04-224, 5-04-227, 5-04-229, 5-04-231
Hydraulic Map - Municipal Waterways Maintenance Plan



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: 1,340 acres

0 25 50 100 Feet

The City of SAN DIEGO

Facility Group Name: Auburn Creek - Home
Segment Name: Home 1
Facility No: 5-04-220
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.42 Auburn Creek - Oakcrest and Wightman

Summary of Recommended Maintenance

Oakcrest 1 (No. 5-04-245)

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.

Wightman 1 (No. 5-04-239)

Facility Type	Bed: Concrete, Earthen Banks: Concrete, Earthen	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from bottom of segment from Station 5830 to Station 6127. • Remove accumulated sediment/debris in culvert from Station 5795 to Station 5830.	
Benefit	• Level of service remains >10 year storm event (248 cfs). • 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.

Wightman 2 (No. 5-04-241)

Facility Type	Bed: Earthen, Concrete Banks: Earthen, Concrete	Category 3
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove accumulated sediment/debris and vegetation from bottom of segment from Station 6166 to Station 6542 and Station 6659 to Station 6928. • Remove accumulated sediment/debris in culvert from Station 6127 to Station 6166 and Station 6542 to Station 6659. • Perform bank repair between Station 6780 to Station 6850. • Perform concrete repair/replacement between Station 6659 to Station 6710 and Station 6353 to Station 6403	
Benefit	• Level of service remains 10 year level of service (160 cfs). • 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.

General Description

The Auburn Creek – Oakcrest and Auburn Creek - Wightman (Oakcrest and Wightman) facility groups were classified as having three 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 Pueblo San Diego Watershed Management Area and extends from north to south between Euclid Avenue and 54th Street, crossing beneath University Avenue. The Oakcrest and Wightman facility group is bordered by residential development, parks, and commercial development. The facility group is separated into three segments from upstream to downstream: Oakcrest, Wightman 2, and Wightman 1.

Oakcrest is an earthen segment that begins at the outlet of a culvert west of the Canyon Creek Village Apartments on Altadena Avenue and continues south, making an approximately 45-degree turn south, before entering a 72-inch-diameter reinforced concrete pipe (RCP) culvert north of University Avenue. Downstream of the culvert headwall, the right overbank area continues to slope down towards the Pacific Cove Apartments along 51st Street.

Wightman 2 is an earthen and concrete segment that begins at the outlet of the 72-inch-diameter RCP culvert, and continues south before making a gradual bend west and entering a concrete double-barrel 42-inch-diameter RCP culvert between two apartment complexes. At the culvert, a concrete weir along the left bank diverts high flows around the culvert into a concrete swale, resulting in a split flow, where water either discharges back into the channel downstream of the culvert, or ponds in the northwestern corner of the southern apartment complex before flowing in the curb and gutter through the parking lot and discharging, through a curb inlet, back into the main channel downstream of the 7.5-foot-wide by 4.5-foot-tall reinforced concrete box (RCB) culvert at Wightman Street (Station 6095). The 233-foot-long split flow segment was also modeled as part of the analysis. The main channel curves gradually south, bordering a City Park before reaching the RCB culvert beneath Wightman Street.

The Wightman 1 segment begins at the outlet of the RCB culvert beneath Wightman Street and is concrete lined for approximately 250 feet before transitioning to earthen for approximately 40 feet, and then back to concrete for the remaining 40 feet of the segment; the segment flows southwest before entering a double-barrel 60-inch-diameter RCP culvert at the southern terminus of 50th street.

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

Hydrology

The hydrologic peak flows presented in Table 1 are based on the Federal Emergency Management Agency's (FEMA's) 2016 Flood Insurance Study (FIS) for San Diego County. The FIS provided the 10-, 50-, and 100-year flow rate information for Auburn Creek above the Auburn Drive culvert. The peak flows for the remaining recurrence intervals (2-, 5-, and 25-year) were interpolated using the method described in *Section 3.1.2.3, 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
Oakcrest 1	86	127	160	248	360	450
Wightman 2	86	127	160	248	360	450
Wightman 1	116	172	220	343	500	630

Hydraulics

A one-dimensional steady flow model was developed for the Oakcrest and Wightman 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. 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 are presented in the Hydraulic Reference Map located at the end of this fact sheet.

The upstream domain of analysis for Oakcrest is the existing RCP storm drain system. 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 downstream domain of analysis for Oakcrest is the 788-foot-long, 72-inch-diameter RCP, which extends south beneath University Avenue. The downstream domain of analysis for the overall facility group, located downstream of Wightman 1, is the Auburn Creek model previously prepared by Rick Engineering, which continues downstream from Station 5811 to Station 22.

The baseline condition for the Oakcrest and Wightman facility group was based on observations during the August 2017 site visit conducted by Geosyntec Consultants and consultation with the biological assessment team to determine that the facility group is considered at its ultimate vegetated condition. The baseline condition for Wightman 1 and Wightman 2 was determined to be the existing condition, as observed during the site visits. Maintenance was performed on the Wightman 1 and 2 segments during 2015–2016, and the premaintained condition was determined to be comparable to the current condition.

The Oakcrest segment was assigned Manning's coefficient values for the bottom and banks ranging from 0.03–0.08 in the baseline condition to reflect the dense vegetation in the channel and overbank area observed at the time of the site visit. Standing water of unknown depth was observed at the culvert outlet at the upstream end of the channel segment. The Wightman 2 segment was assigned Manning's coefficient values for the bottom and banks ranging from 0.015–0.04 in the baseline condition to reflect varying degrees of vegetation within the segment, as well as portions of clean concrete. Overgrown vegetation, earthen bank/erosion failure (Station 6850 to Station 6780), and concrete bank failure (Station 6710 to Station 6649) were observed within the segment. The Wightman 1 segment was assigned Manning's coefficient values for the bottom and banks ranging from 0.015–0.035 in the baseline condition to reflect varying degrees of vegetation within the segment, as well as portions of clean concrete.

The Wightman 2 segment was assigned Manning's coefficient values for the earthen bottom ranging from 0.035–0.04 in the recommended maintenance condition to reflect sediment/debris and vegetation removal from the segment bottom. The geometry of Wightman 2 was also revised in the recommended maintained condition to represent the repair of the eroded bank resulting from the recommended bank repair activities between Station 6850 and Station 6780. The Wightman 1 segment was assigned Manning's coefficient values for the bottom ranging from 0.015–0.035 in the recommended maintenance condition to reflect sediment/debris and vegetation removal from the concrete and earthen lined bottom.

Model parameters and velocities for the baseline and maintained conditions for the Oakcrest and Wightman 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

Segment and Material	Reference Stations	Manning's Coefficient	Velocities (fps)	Structures/ Transitions	Boundary Conditions
Oakcrest 1 (earthen)	8049-6928	Baseline: 0.03-0.08	Baseline: 2.01-5.93	Culvert (Station 7716 to 6928)	Critical Depth at Station 8049
Wightman 2 (earthen bottom, concrete banks)	6928-6127	Baseline: 0.015-0.04 Maintained: 0.015-0.04	Baseline: 1.97-8.57 Maintained: 1.97-9.12	Culvert (Station 6659 to 6542), Flow-Split Weir (Station 6648), Culvert (Station 6166 to 6127)	-
Split Flow (concrete)	488-241	Baseline: 0.015 Maintained: 0.015	Baseline: 0.03-5.05 Maintained: 0.03-5.05	-	Critical Depth at Station 488
Wightman 1 (concrete, earthen)	6127-5795	Baseline: 0.015-0.035 Maintained: 0.015-0.035	Baseline: 2.02-47.85 Maintained: 2.02-47.85	Concrete to Earthen Transition (Station 5884), Culvert (Station 5830 to 5795)	-
Downstream Domain of Analysis	5795-22	Baseline: 0.015-0.04 Maintained: 0.015-0.04	-	-	Rating Curve at Station 22

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 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 Oakcrest segment has a level of service equal to the 100-year storm and can convey up to 450 cubic feet per second (cfs) in the baseline condition.

The Wightman 2 segment has a level of service equal to the 10-year storm and can convey up to 160 cfs in the baseline condition before flooding impacts the parking lot within the Split Flow Reach.

The Wightman 1 segment has a level of service equal to the 25-year storm and can convey up to 248 cfs in the baseline condition before overbank flooding impacts surrounding properties.

Recommended Maintained Condition

The Oakcrest segment has a level of service equal to the 100-year storm and can convey up to 450 cfs in the baseline condition, therefore maintenance is not currently recommended for the segment.

Removing the deposited sediment/debris and vegetation along Wightman 2 does not improve the level of service per the modeling, but it is recommended to preserve the performance of the downstream culverts by preventing potential obstruction of the culvert opening. Performing bank repair between Station 6850 and Station 6780 is also recommended to reduce the risk of further erosion. A geotechnical evaluation may be required prior to maintenance activities to assess bank conditions. If repair is beyond the feasibility of maintenance, project should be evaluated as a capital improvement project.

Removing the deposited sediment/debris and vegetation from Wightman 1 does not improve the level of service per the modeling, but it is recommended to preserve the performance of the downstream culverts by preventing potential obstruction of the culvert opening.

Post Maintenance Erosion Control Measures

The estimated velocities in the recommended maintained condition (Table 2) for Wightman 1 and Wightman 2 exceed the maximum permissible velocities for an earthen channel (less than 5 feet per second (fps)) and a concrete channel (less than 35 fps) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. Therefore, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility. 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 culverts at the downstream ends of each segment. In the maintained condition, Wightman 2 was estimated to provide a level of service equivalent to the 100-year storm event, but due to restricted flow conditions at the low overbanks, the combined level of service is only the 10-year storm event. In the maintained condition, Wightman 1 was estimated to provide a level of service equivalent to the 100-year storm event, but due to restricted flow conditions at the low overbanks, the combined level of service is only the 25-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. In addition, if it is not feasible to be performed as part of the maintenance activities, bank repair is recommended to be performed on the eroded bank between Station 6850 and Station 6780 as part of any capital improvements performed on this facility group.

Table 4. Summary Table

Segment Name	Reference Stations	Conveyance Capacity (cfs)		Level of Service	
		Baseline	Recommended Maintenance	Baseline	Recommended Maintenance
Oakcrest 1	8049-6928	450	-	100-year storm	-
Wightman 2	6928-6127	160	160	10-year storm	10-year storm
Wightman 1	6127-5795	248	248	25-year storm	25-year storm

Representative Photos

Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Site visits were conducted by Geosyntec Consultants in July and August 2017.

1. Oakcrest 1: Looking upstream at RCP storm drain system outlet.

2. Wightman 2: Looking downstream toward channel bank failure/erosion.

3. Wightman 2: Looking upstream at double 42-inch-diameter RCP; split flow into parking lot seen to the left.

4. Wightman 1: Looking upstream just after transition from concrete to earthen lining; deep sediment observed.

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 Oakcrest and Wightman facility group.

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

N

Drainage Area: 1,216 acres

0 50 100 200 Feet

The City of SAN DIEGO

November 2019

Facility Group Name: Auburn Creek - Wightman, Auburn Creek - Oakcrest
Segment Name: Wightman 1 - 2, Oakcrest 1
Facility Nos: 5-04-239, 5-04-241, 5-04-245
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.43 Chollas Creek– Megan

Summary of Recommended Maintenance

Megan 1 (No. 5-04-260)

Facility Type	Bed: Concrete Banks: Concrete	Category 1
Is Maintenance Recommended?	Yes[1]	
Extent of Maintenance	• Remove deposited sediment/debris and vegetation from Station 2 to Station 851. • Concrete repair/replacement between Stations 2 and 851. • Perform bank repair behind right (north/northeast) bank of concrete ditch from Station 846 to 851. • Perform bank repair and riprap replacement at Station 2.	
Benefits	• The level of service is increased from the 25-year storm (602 cfs) to the 100-year storm event (747 cfs). • Concrete repair and replacing eroded soil and riprap 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.

Megan 2 (5-04-262)

Facility Type	Bed: Earthen Banks: Earthen	Category 3
Is Maintenance Recommended?	Yes[1, 2]	
Extent of Maintenance	• Remove deposited sediment and vegetation from the south side (left bank) of the ditch between Stations 851 and 913 to return the ditch flow path to originally designed condition.	
Benefit	• Level of service remains 100 year level of service (355 cfs). • Minimizes further scour of the north side corner property near Station 851. • Reduces the potential for downstream sediment deposition. • Reduces the potential for failure of the concrete ditch right (north/northeast) bank at its upstream end.	

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, developing a plan for potential maintenance throughout the entire segment is recommended. Accumulated sediment/debris and vegetation may need to be removed for access.

General Description

The Chollas Creek – Megan (Megan) facility group was classified as having both Category 1 and Category 3 facility segments as described in *Chapter 2, Section 2.3, of the Hydrology and Hydraulics Technical Report*. The Megan facility group is located in the San Diego Bay Watershed Management Area. The facility is bordered by Euclid Avenue to the east, Chollas Creek to the west, and single-family residential developments to the north and south.

At its upstream end, the Megan facility group receives flow from an existing 36-inch reinforced concrete pipe (RCP) culvert that crosses under Euclid Avenue. The Megan 2 segment is an earthen trapezoidal ditch that extends from Station 1315 to Station 851 and flows from east to west. At Station 851, the facility turns 90 degrees to the north where it transitions to a concrete ditch (Megan 1) that flows from south to north. This reach (Megan 1, Reach 2) extends to Station 450, where it makes a 90-degree bend to the west. A 66-inch diameter RCP outfall discharges into the ditch between Station 450 and 376. Downstream of this outfall, transitioning to Megan 1, Reach 1, the ditch remains concrete but has a larger cross section and flows from east to west. At Megan 1's downstream end, just downstream of a pedestrian bridge, the ditch discharges to Chollas Creek at Station 2. 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 Megan 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 major storm drain conveyances that drain into the facility has a distinct drainage area; therefore, hydrologic peak flows were estimated separately for the 36-inch-diameter and 66-inch-diameter RCPs. 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.* The combined peak flows downstream of the junction (Station 376) where the flows from the 36-inch-diameter and 66-inch-diameter RCP culverts 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
Megan 2	106	204	239	286	321	355
Megan 1, Reach 2	106	204	239	286	321	355
Megan 1, Reach 1	295	430	502	602	675	747

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 3.2.2.3 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.

Due to differences in facility material and dimensions, the Megan facility group was broken into the following three reaches for hydraulic analysis purposes:

- Megan 2: Stations 1315 to 851. This reach is a trapezoidal earthen ditch, shown in as-built drawing no. 11812-D. The ditch has a bottom width of approximately 5 feet, has 1.5:1 (H:V) side slopes, and is approximately 6 feet deep.
- Megan 1, Reach 2: Stations 851 to 450. This reach is a concrete trapezoidal ditch, shown in as-built drawing no. 11812-D. The ditch has a bottom width of 3 feet, has 1.5:1 (H:V) side slopes, and is 4 feet deep.
- Megan 1, Reach 1: Stations 450 to 2. This reach is a concrete trapezoidal ditch, shown in as-built drawing no. 16653-D. The ditch has a bottom width of 6 feet, has 1.5:1 (H:V) side slopes,

and is 6 feet deep from Station 450 to Station 38. Between Station 38 and Station 2, where the facility discharges to Chollas Creek, the bottom width increases linearly from 6 feet at Station 38 to about 30 feet at Station 2.

The upstream domain of analysis for the facility is the existing 36-inch-diameter RCP culvert that discharges to the upstream end of the earthen ditch. The downstream domain of analysis is Chollas Creek. Known water surface elevations provided by the Federal Emergency Management Agency (FEMA) were used as the downstream boundary condition. Based on the methodology presented in *Section 3.2.3 of the Hydrology and Hydraulics Technical Report,* both the upstream and downstream domains of analysis have been excluded from the modeling.

A pedestrian bridge is located between Stations 41 and 38. It is high enough above the channel that it does not impact channel capacity and therefore was not incorporated into the HEC-RAS model.

The baseline condition for the Chollas Creek facility group was determined to be the current condition as observed during a site visit in July 2017. The banks and bottom of Megan 2 were assigned Manning's coefficient values ranging from 0.030 to 0.040, representative of the density of the vegetation observed. Megan 1, Reaches 1 and 2 were assigned Manning's coefficient values ranging from 0.018 to 0.035 based on observations of vegetation and accumulated sediment/debris. The 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 Megan 2 in the recommended maintained condition are the same as those in the baseline condition. Maintenance is not recommended for most of Megan 2, and recommended maintenance is not expected to change the Manning's coefficient values where maintenance is recommended. The assigned Manning's coefficient value for Megan 1, Reaches 1 and 2 in the recommended maintained condition were set to 0.018 to reflect the roughness of the originally constructed facility.

A model scenario was completed in the event access from Euclid Avenue through Megan 2 is required. The assigned Manning's coefficient values for Megan 2 if used for access were set to 0.025 to represent a vegetation trimming for access along the channel bed. See the Post-Maintenance Erosion Control Measures section for the channel velocities in this condition.

Model parameters and velocities for the baseline and maintained conditions for the 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
Megan 2 (earthen)	1315-851	Baseline: 0.03-0.04	Baseline: 3.4 – 12.1	-	Normal Depth at Station 1315
		Maintained: 0.03-0.04	Maintained: 3.1 – 11.3		
Megan 1, Reach 2 (concrete)	851-450	Baseline: 0.018–0.035	Baseline: 8.8 – 13.5	-	
		Maintained: 0.018	Maintained: 10.9 – 13.3		
Megan 1, Reach 1 (concrete)	450-2	Baseline: 0.018–0.035	Baseline: 2.6 – 15.8	-	Known Water Surface Elevation
		Maintained: 0.018	Maintained: 2.6 – 15.7		

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, 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 ditch 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

Megan 2 has a level of service of the 100-year storm event and is capable of conveying up to 355 cubic feet per second (cfs) in the baseline condition. The maximum level of service for Megan 1, Reach 2 is the 100-year storm event and is capable of conveying 355 cfs before flows impact residential properties on the south side of the ditch. The maximum level of service for Megan 1, Reach 1 is the 25-year storm event and is capable of conveying up to 602 cfs.

Recommended Maintained Condition

The recommended maintenance for Megan 2 is to return the current flowline to the originally designed condition Megan 2 conveys the 100-year storm event flows (355 cfs) in both the baseline and recommended maintained condition. In the baseline condition, the Megan 2 centerline veers to the north just upstream of Station 851. Removing the deposited sediment/debris and vegetation from the south side (left bank) of the ditch between Station 851 and Station 913 is recommended. This will return the ditch flow path to the originally designed condition where the flow path connecting Megan 2 segment into the downstream Megan 1 segment is a straight line. Eliminating the curved flow path upstream of the earthen-concrete transition will minimize the potential for further scour that has been impacting the property on the north/northeast side of the ditch near Station 851 (Photo 2). It also will minimize scour that has eroded some of the earthen material behind upstream end of the right (north/northeast) concrete bank in Section 851 at the earthen to concrete transition. Through reducing scour and erosion, this maintenance will also reduce the potential for downstream sediment deposition in the Megan facility group and to Chollas Creek.

Removing accumulated sediment/debris and vegetation in Megan 1 (Reaches 1 and 2) improves the level of service in Reach 1 to the 100-year storm event and increases the conveyance capacity to 747 cfs. The level of service in Reach 2 remains the 100-year storm event (355 cfs) as in the baseline condition. Maintenance is recommended in Reach 2 to maintain the 100-year level of service and to reduce the risk of sediment/ debris and vegetation flowing downstream and clogging the downstream conveyance. In addition, bank repair activities are recommended from Station 846 to Station 851, behind the right (north/northeast) concrete bank. A geotechnical evaluation may be required prior to maintenance activities to assess bank conditions.

Other maintenance recommendations for Megan 1 include concrete repair/replacement and riprap replacement activities. Broken and cracked concrete was observed at several points in Megan 1 and is recommended for repair. Replacement of riprap at the outlet of the ditch to Chollas Creek is recommended at Station 2 to return the ditch to the originally designed condition. Riprap is shown in this location in as-built drawing nos. 11812-D and 16653-D. As shown in Photo 7, riprap and soil under the downstream end of the ditch has been eroded. Riprap installation and soil backfill and compaction behind the riprap, as needed, is proposed across the entire width of the downstream end of the ditch, which is about 50 feet. Riprap installation is anticipated to vary from about 3 to 4 feet vertically; the estimated quantity of riprap needed is about 15 to 20 cubic yards. As-build drawing no. 16653-13-D states that the anticipated maximum velocity associated with the 100-year storm event peak flow in the Chollas Creek at Station 2 is 13.6 feet per second (fps). Per Table 7-3 in the *City of San Diego Drainage Design Manual, dated 2017*, 0.5-ton riprap is the standard size for this velocity. A geotechnical evaluation may be required prior to maintenance activities to assess bank conditions.

Post-Maintenance Erosion Control Measures

In the Megan 2 segment, some of the estimated velocities in the baseline and recommended maintained condition (Table 2) are above the maximum permissible velocities for vegetated channels (5 feet per second (fps)) as defined in the *City of San Diego Drainage Design Manual, dated January 2017*. The velocities in the Megan 2 segment remain unchanged as a result of the recommended maintenance, and no evidence of erosion was observed during the site assessment. In addition, restoring the original flow path is expected to mitigate scour between Stations 851 and 913 at the downstream end of Megan 2. Therefore, no measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this segment.

If access from Euclid Avenue, through the portion of Megan 2 that is not currently proposed for maintenance is required, measures to reduce velocity or otherwise control erosion in the post-maintenance condition are recommended for this facility. The velocities range from 3.7 fps to 13.1 fps for the 100-year storm event if vegetation trimming occurs to allow a 12-foot wide access path along the length of the segment. Refer to *Chapter 6 of the Hydrology and Hydraulics Technical Report* for additional details on appropriate velocity reduction and erosion control measures.

The estimated velocities in the Megan 1 segment in the recommended maintained condition (Table 2) are below the maximum permissible velocities for concrete channel (35 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 this segment.

Potential Facility Capital Improvements

No potential capital improvements to improve facility level of service were identified for the Megan facility group. Repair of the eroded slope in the Megan 2 segment is recommended from approximately Station 851 and 913. Additional analysis is recommended to determine the extent of capital improvements needed to repair the slope.

Summary Table

Table 3. Summary Table

Segment Name/Number	Reference Stations	Conveyance Capacity (cfs)		Level of Service[1]	
		Baseline	Recommended Maintained	Baseline	Recommended Maintained
Megan 2 (earthen)	1315-851	355	355	100-year	100-year
Megan 1, Reach 2 (concrete)	851-450	355	355	100-year	100-year
Megan 1, Reach 1 (concrete)	450-2	602	747	25-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

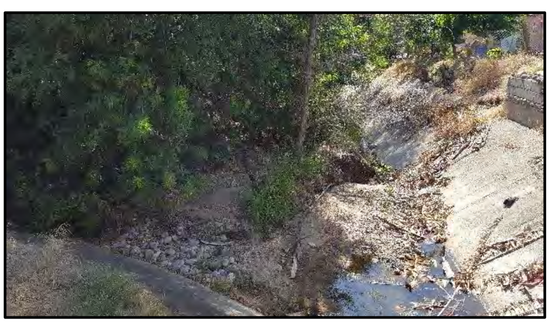
Photo numbers and segment/locations correspond to the photo points shown on the Hydraulic Reference Map. Site visit conducted in July 2017.

1. Megan 2: looking upstream near upstream end at vegetation.

2. Transition between Megan 1 and 2: Looking downstream at eroded area behind right concrete bank.

3. Megan 1, Reach 2: Looking downstream at damaged concrete.

4. Megan 1, Reach 1: looking upstream at concrete ditch.



5. Megan 1, Reach 1: Looking downstream from 90-degree bend.

6. Megan 1, Reach 1: Looking upstream at concrete bank and vegetation.

7. Megan 1, Reach 1: Looking upstream at erosion under concrete bottom at ditch outfall to Chollas Creek.

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	Domain of Analysis Cross Section
End of Reach	MWMP Facility Cross Section
Storm Drain Conveyance	Megan 1
	Megan 2

N

Drainage Area: 695 acres

Feet: 0, 50, 100, 200

The City of SAN DIEGO

Facility Group: Chollas Creek Unnamed Tributary - Megan
Segment Name: Megan 1 - 2
Facility Nos: 5-04-260, 5-04-262
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