INDIVIDUAL HYDROLOGIC & HYDRAULIC (IHHA) ASSESSMENT REPORT

Site Name/Facility:	Tijuana River Pilot and Smuggler's Gulch Channels
Master Program Map No.:	138a-138c & 138-139
Date:	December 21, 2012
Civil Engineer: (name, company, phone number):	Matt Moore URS Corporation 858-812-9292
Registered Civil Engineer Number & Expiration Date (place stamp here):	RCE No. 56780, Exp. 6/30/2013

***Instructions:** This form must be completed for each target facility following the completion of the Individual Maintenance Plan (IMP) report form and prior to any work being conducted in the facility. Attach additional sheets if needed.

EXISTING CONDITIONS

The City of San Diego (City) has developed the Master Storm Water System Maintenance Program (MMP) (City of San Diego 2011a) to govern channel operation and maintenance activities in an efficient, economic, environmentally and aesthetically acceptable manner to provide flood control for the protection of life and property. This document provides a summary of the Individual Hydrologic and Hydraulic Assessment (IHHA) activities conducted within the Tijuana River Pilot (Pilot) Channel and the Smuggler's Gulch (SG) Channel in order to comply with the MMP's Programmatic Environmental Impact Report (PEIR) (City of San Diego 2011b).

The purpose of this report is to assess if the maintenance described in the City's MMP is needed based on a hydrologic and hydraulic assessment. As-built data found on these channels provided information on the channel dimensions; however, little information was obtained on the hydrologic and hydraulic design of the channels. The hydrologic estimations for the channels were based on previous Tijuana River Valley reports that are further discussed in the Hydrologic information section. For the Pilot Channel, an additional analysis was performed to determine the amount of flow that enters the Pilot Channel after the Tijuana River splits into two water conveyance paths approximately 800 feet east of the Hollister Street bridge. The Pilot Channel is considered part of the Southern Channel as described later in this section. These estimates are refered to throughout this report as the estimated storm event flow rate. For the hydrualic design capacity of the channels, the Maintained Condition – Sediment removed section of this report best reflects the intended capacity of the channels as it is based on the MMP channel dimension data. This is refered to as the calculated design capacity throughout this report. To improve channel hydraulics, it was also assumed that the Pilot Channel

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would be maintained in a manner to create a positive slope of 0.04% from the Hollister Bridge to the end of the channel.

Based on this IHHA assessment, both the Pilot Channel and SG Channel do not currently have capacity to convey their original design flows. Maintenance of the Pilot Channel and SG Channel is needed to restore the channels' flood conveyance capacity to their original design condition. The current capacity of the Pilot Channel is at 5% of its calculated design capacity due to sedimentation. The SG Channel is at 73% of its calculated design capacity due to sedimentation. Tables ES-1 and ES-2 summarize the results for each channel. It is recommended that both channels be excavated to their original design depths and widths to reduce the flooding impacts created by the sedimentation within the channels. For the Pilot Channel maintenance would generally consist of trash and vegetation clearing and excavation of approximately 2 to 7 feet over its length. For the SG Channel maintenance would generally consist of trash and vegetation clearing and excavation of approximately 2 to 3 feet over its length.

Table ES-1. Pilot Channel Results Summary

Storm Event	Estimated Storm Event Flow Rate (cfs)	Calculated Design Capacity1 (cfs)	Current Capacity (cfs)
2-year	278	200	10

[1] Based upon MMP channel dimensions

Table ES-2. SG Channel Results Summary

Storm Event	Estimated Storm Event Flow Rate (cfs)	Calculated Design Capacity (cfs)1	Current Capacity (cfs)
2-year	653	900	653
5-year	1,479	900	800

[1] Based upon MMP channel dimensions

EXISTING CONDITIONS

Description of creek/channel (limits of reach, surrounding land use and area, creek/channel geometry and vegetative condition):

The channels associated with this assessment report are located in the Tijuana River Valley (Valley), within the jurisdiction of the City of San Diego (City). The Tijuana River watershed covers an area of approximately 1,725 square miles, of which 73 percent is located in Mexico and 27 percent in the United States. The main Tijuana River flows in a northwesterly direction from the international border into the Valley and City jurisdiction. Approximately 21.9 square miles of the watershed (~1% of the total watershed area) is within City jurisdiction.

The Tijuana River National Estuarine Research Reserve (TRNERR) and a portion of the City of Imperial Beach are generally west of the project area located adjacent to the Tijuana River's discharge to the Pacific Ocean. The Otay-Nestor community and the United States Naval Outlying Landing Field Imperial Beach are located north of the project area; and the community of San Ysidro is located to the east.

The Pilot Channel is included on MMP Maps 138a through 138c and the SG Channel is included on MMP Maps 138 and 139 (City of San Diego 2011a). The Pilot and SG Channels are generally located in the Valley roughly bordered by Hollister Street to the east and Monument Road to the south. The Tijuana River low flow channel splits into what are commonly referred to as the Tijuana River's Northern and Southern Channels approximately 800 feet east of Hollister Street. The Pilot Channel follows the Southern Channel.

The Valley, including the project area, is within the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Areas Subject to Inundation by the 1-percent Annual Chance Flood (100-year floodplain). The project areas are zoned OF-1-1 (Open Space-Floodplain) and AR-1-1 (Agricultural/Residential); and are designated for Open Space and Agricultural land uses in the Tijuana River Valley Land Use Plan. In addition, the project area is within the boundaries of the County of San Diego's 2.7 square mile Tijuana River Valley Regional Park (Regional Park). The project area is also within the City's Multiple Species Conservation Program's Multi-Habitat Planning Area (MHPA).

The project consists of maintenance and dredging of the Pilot and SG Channels to remove anthropogenic-derived sediment and trash that accumulates as a result of development and other practices in the upstream watershed. The removal of sediment and trash is conducted to maintain flow conveyance capacities and reduce the risk of flooding to public and private infrastructure in the Valley.

<u>Pilot Channel</u>

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The Pilot Channel was originally excavated in 1993 within the Southern Channel. It is has been irregularly maintained since that time as an earthen trapezoidal channel that is approximately 5 feet deep, with a 23-foot top width, and a 15-foot streambed width. According to the MMP, the Pilot Channel was constructed to divert wet-weather flows from 2- to 5-year storm events into the Southern Channel (City of San Diego 2011b). The Pilot Channel stretches from 100 feet east to 5,300 feet west of Hollister Street for a total length of 5,400 feet and it flows roughly in an east-west direction. Figures 2 and 3 show the location of the Pilot Channel.

A site visit was conducted on September 13, 2012 to evalulate the current channel conditions from a hydrologic and hydraulic perspective. Due to high vegetation density, the current conditions of the Pilot Channel were not able to be thorougly assessed during the project site visit because of lack of access and visibility. Two locations did provide limited vantage view points to assess the channel's existing conditions. One location was the Hollister Street bridge. The view from the Hollister Street bridge was blocked by tall, dense vegetation beyond a distance of approximately 300 feet upstream and 100 feet downstream. From the bridge, it was observed that the width of the ponded water in the channel was approximately 38 feet with no vegetation in the ponded water areas. It was not reasonably feasible to measure the channel depth, ponded water depth, and sediment deposition depth. Significant trash and debris were not observed along this section of the channel (see Photo No. 1 through 6).

The second observation location was the confluence point of the Pilot and SG Channels (see Photo No. 7 through 14). Limited access to the Pilot Channel was possible at this location via an existing trail/access route from Saturn Boulevard; however, the areas of the Pilot Channel beyond this crossing, upstream or downstream,were not accessible due to the tall, dense vegetation. In addition, topography, land use and vegetation maps were evaluated to supplement the observations and data gathered during the site visit. These indirect methods were relied upon to make an assessment of the current extent and types of vegetation that exist along the Pilot Channel in the less accessible areas. The sources utilized included MMP documents, ESRI ArcGIS World Aerial imagery, and the URS biology staff familiar with the site to assist in the assessment. It was determined that the vegetation observed in the Pilot Channel was mostly families of Southern Willow Scrub and Mule Fat Scrub. Based on the observations of the amount of vegetation and the aerial imagery, it was assumed that channel sections with ponded water contain very little to no vegetation. It was also assumed that channel sections without visibly ponded water are heavily vegetated.

The sediment deposition amount for the analsysis was estimated based on the site visit visual observations, aerial imagery and a number of previous hydrologic and hydraulic studies discussed in the next section. The hydrologic and hydraulic studies for the Tijuana River Valley, as well as knowledge of the past maintenance conditions, indicate that large

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amounts of sediment are deposited in this region. Based on this information, it was assumed that the sediment deposition is an average of approximately 3 feet throughout the area of study for the channel. In addition, the aerial imagery shows that in some areas, the entire cross-section of the channel was vegetated as the channel banks are not visible and there is no visibly ponded water. This suggests that the sediment deposition in these sections of the channel is very high relative to the original Pilot Channel depth of 5 feet. As a result, it has been assumed that sediment deposition for that condition is 4.5 feet.

Subsequent to the hydraulics analysis, limited survey spot elevation data was obtained for several key locations along the channel. Based on the survey data, approximately 0.5 foot of sediment accumulated in the channel near Hollister Bridge and over 5 feet of sediment was deposited in the area of the SG Channel confluence.

SG Channel

The SG Channel is an existing historical agricultural channel with manufactured berms. The contributing sub-watershed area is approximately 6.7 square miles, primarily located south of the international border within Canon de los Mataderos. The SG Channel, as originally constructed, is an earthen channel approximately 20 feet wide and 15 feet deep. The SG Channel is tributary to the South Channel and flows in a northerly direction, from the international border past Monument Road until it confluences with the Pilot Channel. The portion of the SG Channel maintained by the City extends for a distance of approximately 3,040 feet.

During the site visit on September 13, 2012, it was observed that the low flow crossing at Monument Road consists of a 52-inch diameter Corrugated Metal Pipe (CMP), and it was measured to be approxmiately 110 feet long. The SG Channel was measured to be 40 feet wide and 12 feet deep immediately north of Monument Road (see Photo No. 15 through 18). Disney Crossing is located approximately 1,490 feet downstream of Monument Road. The SG Channel dimensions on the upstream side of Disney Crossing was measured to be 17.5 feet wide and 15 feet deep and on the downstream side was measured to be 23.5 feet wide and 15 feet deep (see Photo No. 19 through 23). The SG Channel streambed near the junction with the Pilot Channel was measured to be 18.5 feet wide and 4 feet deep (see Photo No. 29 through 31). See the Photo Log Key Map, figures 5 and 6, for a plan view of the field measurement locations along the SG Channel.

The sediment deposition observed immediately north of Monument Road was estimated to be approximately 2 feet deep and it was observed to be consistent at this depth throughout most of the length of the channel. The sediment deposition depth was estimated by measuring the difference in elevation between the flow line at the end of the 52-inch CMP concrete apron and the adjacent accumulated sediment (see Photo No. 16). At the Disney Crossing, the culverts (three 72-inch CMPs) had sediment deposition of over 1-foot in the culverts and the middle pipe was nearly covered with trash, debris, and

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vegetation at its entrance and exit (see Photo No. 24 through 28). Channel side slopes were observed to be mostly vegetated with disturbed Southern Willow Scrub and disturbed Ruderal Habitat, and near the downstream end it was vegetated with Mule Fat Scrub and disturbed Southern Willow Scrub. The vegetation density along the side slopes is very high in most areas and the streambed was unvegetated and consisted mainly of the sediment deposition material (see Photo No. 15 through 31). Note: See attached pictures
Hydrologic information (source of hydrologic information, summary of flow rates and return frequencies):
There are numerous sources of hydrologic information for the Tijuana River Valley, as it has been studied extensively throughout the years. The references used in this study as sources of hydrologic information include the following: • "Hydraulic Floodplain Study for the Tijuana River, U.S. and Mexico Border, San Diego County, California", prepared by URS Group Inc., dated April 10, 2012. (Reference 1); • "FEMA Region IX Hydrologic Analysis, San Diego County, California", prepared by BakerAECOM, dated October 1, 2010. (Reference 2); • "Conceptual Feasibility BMP Study for Tijuana River Valley", Technical Memorandum, Document ID No. CSD-TM-09-URS08-01, prepared by URS Corp., dated October 5, 2009. (Reference 3); • "Area V – Smugglers's Gulch Sta. 73+31.94 to Sta. 180+40.14 Packages 1a, 1, 1 (Drainage), 2 & 3", prepared by HNTB, dated September 15, 2008. (Reference 4); • "San Diego Infrastructure Border Field Park and Smuggler's Gulch, San Diego, California", prepared by Michael Baker Jr., Inc., dated December 2007. (Reference 5); • "Smuggler's Gulch Sedimentation and Erosion Study", prepared by Michael Baker Jr., Inc., dated April 2005. (Reference 6); and • "Hydrologic and Hydraulic Report for the Replacement of the Hollister Street Bailey Bridge of the Tijuana River", prepared by Berryman & Henigar Consultants, Inc., dated August 1996. (Reference 7). References 1 and 2 were used to establish the necessary peak storm flows, in cubic feet per second (cfs), used in the hydraulic analyses of the Pilot and Southern Channels. Reference 6 developed and included all of the necessary storm flows required for the

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hydraulic analysis of the SG Channel. Table 1 below summarizes the storm flows used in the hydraulic analysis of the channels.

Table 1. Hydrologic Data Summary

Channel	Watershed Area (mi^2)	Storm Event					
		2-Year (cfs)	5-Year (cfs)	10-Year (cfs)	25-Year (cfs)	50-Year (cfs)	100-Year (cfs)
Pilot	1,725	705	3,248	7,612	15,819	37,163	66,894
SG	5.52	653	1,479	1,668	2,520	3,081	3,626

Hydraulic analyses (description of hydraulic models created for project):

The United States Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) software was used for the hydraulic analysis of both channels. The HEC-RAS hydraulic model performs one-dimensional steady and unsteady flow river hydraulics calculations and is the model used by FEMA to establish water surface elevation profiles and floodplain limits within the Tijuana River. The results of the hydrologic analyses included in Table 1 above were used in the hydraulic analyses.

The Pilot and SG Channel hydraulic models for this report were based on topography used in the Reference 1 study, which was generated based on the most current LiDAR data obtained from the United States Department of Homeland Security (USDHS, 2007). The cross sections used in the Pilot Channel hydraulic model were based on the cross-sections in Reference 1, but the cross sections were adjusted based on the field measurements and data collected during the site visit. The LiDAR data does not reflect all of the Pilot Channel details since in the generation of the data, ponded water and tall, dense vegetation block the channel dimensions from being detected. The cross sections developed for the SG Channel hydraulic model were also based on the Reference 1 topography in conjunction with the field measurements and data gathered during the site visit. To improve the hydraulic conveyance of the Pilot Channel, the existing adverse slope 700 feet west of the Hollister Bridge was assumed to be removed with the maintainence activities. The channel slopes were estimated based on the LiDAR data to be a positive grade of 0.04% for the Pilot Channel and 0.5% for SG Channel.

The Manning's Roughness Coefficient values used within the Pilot and SG Channel hydraulic models were based on field observations, vegetation data provided by the City of San Diego, and the ESRI ArcGIS World Aerial imagery. However, the Manning's Roughness Coefficients for the areas beyond the Pilot Channel banks were adopted from the hydraulic model developed in Reference 1. The Manning's Roughness Coefficients range from 0.03 to 0.10.

The steady flow boundary conditions of the hydraulic models were based on normal depth computations, as there were no starting water surface elevations available that could be directly used to initialize the hydraulic models. For that reason, the hydraulic

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models were extended 1,050 feet and 2,350 feet upstream and downstream, respectively, beyond the Pilot Channel length limits. The topography used is based on the horizontal North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD88).

Pilot Channel

For purposes of analyses and discussion in this study, the Southern Channel is defined as the Pilot Channel area including the areas contained within the northerly berms of the agricultural fields to the south of the Pilot Channel and roughly by the east-west section of Saturn Boulevard to the north of the Pilot Channel (see Figure 2 & 3 for the approximate limits). It is important to note that the storm flows listed in Table 1 may not flow entirely through the Pilot and/or the Southern Channel, as the storm flows normally spread across the Tijuana River Valley, particularly during larger storm events. In the hydraulic models prepared, all of the storm flow was "forced" to flow through the Pilot Channel only to evaluate the channel capacity as the only drainage facility under the various conditions to provide a baseline for comparison purposes.

To gain a basic understanding of how the stormwater flows split between the Northern and Southern Channels, a HEC-RAS flow distribution analysis was performed for the various storm events. HEC-RAS divides the cross sections in a predetermined number of slices and then calculates the flow conveyed by each slice. By manually determining which slices are part of each channel, an estimate of the flow for each channel was calculated. The purpose of this exercise was to establish a relationship between the Pilot Channel's capacity and the estimated flows that enter the Pilot/Southern Channel during a given storm event. Table 2 summarizes the flow distribution analysis for the 2-, 5-, and 10-year storm events.

Table 2. Flow Distribution Analysis Results Summary

Storm Event	Estimated Pilot/Southern ChannelFlow (cfs)
2-year	278
5-year	669
10-year	1,364

Current Vegetated Condition:

Pilot Channel

The HEC-RAS models developed for the current vegetated condition reflect the field conditions based on the site visit and the additional available data that is discussed in the existing conditions section. For the current condition, it was assumed that an approximate 1,500-foot section, from HEC-RAS cross section 108 to cross section 93, (see the

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Hydraulic Workmap for the HEC-RAS cross section locations) of the Pilot Channel contained up to 4.5 feet of sediment deposition, while the rest of the channel contained 3 feet of sediment deposition. A Manning's Roughness Coefficient of 0.03 was assigned to the sections of the Pilot Channel that contained ponded water. The sections of the Pilot Channel that were determined to have a high vegetation density were assigned a Manning´s Roughness Coefficient of 0.08. For consistency, the Manning´s Roughness Coefficients for the areas beyond the Pilot Channel were adopted from the Reference 1 (URS Group Inc., April 10, 2012) hydraulic model, which varies from 0.05 to 0.08. SG Channel Because the SG Channel was readily accessible and visible, the selection of the Manning's Roughness Coefficient for the SG Channel was based on the field observations. A Manning's Roughness Coefficient of 0.03 was assigned to the SG Channel streambed as it was fully covered in sediment deposition. A Manning's Roughness Coefficient of 0.08 was assigned to the heavily vegetated side slopes. The sediment deposition was assumed to be 2 feet throughout the length of the channel. Note: See attached model output & workmap
Ultimate Vegetated Condition:
The Pilot and SG Channel hydraulic models developed for the "Ultimate Vegetated Condition" are similar to the "Current Vegetated Condition", except that the Manning´s Roughness Coefficients were increased to 0.10 and 0.08 within the Pilot and SG Channels, respectively, to reflect a maximum vegetation carrying capacity. The geometry and sediment deposition levels were maintained from the Current Vegetated Condition. Note: See attached model output & workmap
Maintained Condition – No sediment removed:
Pilot Channel The Pilot Channel hydraulic models were adjusted assuming that the vegetation that currently exists in the channel bed is trimmed down to the base, just above the sediment deposition levels. A Manning´s Roughness Coefficient of 0.04 was assigned to the Pilot Channel streambed sections that are currently vegetated. The sections that have ponded water were unchanged with a Manning´s Roughness Coefficient of 0.03. SG Channel The SG Channel hydraulic model remained unchanged from the Current Vegetated Condition. A Manning´s Roughness Coefficient of 0.03 was assigned for the streambed and 0.08 for the sides slopes. Note: See attached model output & workmap

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Maintained Condition – Sediment removed (if applicable):

This condition used the Maintained Condition – No Sediment Removed models as the base for both channels. The sediment deposition along the channel bed was removed to restore both channels to their original design conditions. The Manning´s Roughness Coefficients along the channel beds were set to 0.025. Also for the SG Channel, the set of triple 72-inch CMPs at Disney Crossing were assumed to be completely cleared of vegetation, trash and debris at the entrances and exits.

Note: See attached model output & workmap

MAINTENANCE IMPACTS

Hydraulics Results (Describe capacity of channel for each condition):

Current Vegetated Condition:

Pilot Channel

In the Current Vegetated Condition, the Pilot Channel's capacity was calculated at less than 10 cfs with zero freeboard due to the high levels of sediment deposition. The results show that the Pilot Channel alone is not capable of conveying storm water flows of a 2-year storm event. Table 3 below summarizes the Pilot Channel hydraulic analyses results under the Current Vegetated Condition.

Table 3. Pilot Channel Results Summary

Storm Event	Storm Event Flow Rate (cfs)	Calculated Design Capacity (cfs)[1]	Current Condition Capacity (cfs)
2-year	278	200	10

[1]Based upon MMP channel dimensions.

SG Channel

The results of the Current Vegetated Condition model for the SG Channel showed that the channel only has capacity to convey the 2-year storm event flows, while maintaining 1 foot of freeboard in the channel. Without considering freeboard, the SG Channel has a maximum capacity of approximately 800 cfs before the stormwater flows will overtop the manufactured berm on the east side at HEC-RAS cross section number 2623.27 (approximately 90 feet upstream of the Disney Crossing). The results also showed that at the 2-year storm event flow level, Monument Road will be overtopped by the storm flows. As the storm water that weir flows over Monument Road expands due to the roadway profile, it is partially redirected towards the southerly end of the manufactured berm on the west side; thus creating a risk potential for that berm to be undermined.

MAINTENANCE IMPACTS

Table 4 below summarizes the SG Channel hydraulic analyses results under the Current Vegetated Condition.

Table 4. SG Channel Results Summary

Storm Event	Storm Event Flow Rate (cfs)	Calculated Design Capacity (cfs)[1]	Current Condition Capacity (cfs)
2-year	653	900	653
5-year	1,479	900	800

[1] Based upon MMP channel dimensions

Note: See attached HEC-RAS model profile

Ultimate Vegetated Condition:

Pilot Channel

As in the previous condition, the Pilot Channel's capacity was calculated at less than 10 cfs. The Pilot Channel alone provides very little conveyance capacity in this condition. Table 5 below summarizes the Pilot Channel hydraulic analyses results under the Ultimate Vegetated Condition.

Table 5. Pilot Channel Results Summary

Storm Event	Storm Event Flow Rate (cfs)	Calculated Design Capacity (cfs) [1]	Ultimate Vegetated Condition Capacity (cfs)
2-year	278	200	<10

[1] Based upon MMP channel dimensions

SG Channel

The results of the Ultimate Vegetated Condition model for the SG Channel shows that the channel's capacity is just under the 2-year storm event at 600 cfs and no freeboard. The results show that a flow of 600 cfs would overtop the channel at HEC-RAS cross section number 2623.27. Table 6 below summarizes the SG Channel hydraulic analyses results under the Ultimate Vegetated Condition.

Table 6. SG Channel Results Summary

Storm Event	Storm Event Flow Rate (cfs)	Calculated Design Capacity (cfs) [1]	Ultimate Vegetated Condition Capacity (cfs)
2-year	653	900	600
5-year	1,479	900	600

[1] Based upon MMP channel dimensions

Note: See attached HEC-RAS model profile

MAINTENANCE IMPACTS

Maintained Condition – No Sediment removed:

Pilot Channel

The Pilot Channel's capacity was insignificantly improved with the removal of the vegetation to approximately 10 cfs. Table 7 below summarizes the Pilot Channel hydraulic analyis results summary under the Maintained Condition – No Sediment removed.

Table 7. Pilot Channel Results Summary

Storm Event	Storm Event Flow Rate (cfs)	Calculated Design Capacity (cfs) [1]	No Sediment Removed Capacity (cfs)
2-year	278	200	10

[1] Based upon MMP channel dimensions

SG Channel

The results for the Maintained Condition – No Sediment removed of the SG Channel are the same as the Current Vegetated Condition because the channel bed is currently unvegetated. See Table 4 for the hydraulic analysis results summary.

Note: See attached HEC-RAS model profile

Maintained Condition – Sediment removed:

Pilot Channel

The removal of the sediment in the Pilot Channel increases capacity to approximately 200 cfs. See Table 8 for the Pilot Channel results summary under the Maintained Condition – Sediment removed.

Table 8. Pilot Channel Results Summary

Storm Event	Storm Event Flow (cfs)	Calculated Design Capacity (cfs) [1]	Sediment Removed Capacity (cfs)
2-year	278	200	200

[1] Based upon MMP channel dimensions

SG Channel

The results for the Maintained Condition – Sediment removed for the SG Channel show that the maximum capacity is approximately 900 cfs, which is 250 cfs above the 2-year storm event flow rate. The conveyance capacity of the channel is limited by the elevation discontinuities (HEC-RAS cross section 3863.17 and 2623.27) of the manufactured berm

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profiles.

One assumption of the analysis is that all of the storm flow that crosses Monument Road stays in the channel. The calculated water surface elevation of the maximum capacity flow at Monument Road is higher than the highest elevations of the channel/roadway profile in the area. This indicates that some of the runoff may find other paths around the SG Channel to the Tijuana River and could result in a decrease in flow downstream of Monument Road. See Table 9 for the SG Channel hydraulic analysis results summary under the Maintained Condition – Sediment removed.

Table 9. SG Channel Results Summary

Storm Event	Storm Event Flow (cfs)	Calculated Design Capacity (cfs) [1]	Sediment Removed Capacity (cfs)
2-year	653	900	900
5-year	1,479	900	900

[1] Based upon MMP channel dimensions

Note: See attached HEC-RAS model profile

Areas within channel that can be avoided (this section can be completed upon completion of Individual Biological Assessment Form):

Subsequent to the hydraulic analysis, limited suvey data was obtained to help understand the sediment deposition in a few key areas. Based on this limited survey spot elevation data, the sediment deposition east of Hollister Bridge is approximately 0.5 feet. Comparing the small amount of sediment deposition to the biological impacts necessary to maintain this area, it was determined that the 100-foot channel section east of Hollister Bridge will not require maintainence at this time.

Would the velocity of storm water during a "bank-full" storm event exceed the velocities identified for unlined channels per Table 1-104.108 of the City's Design Manual? If so, describe the appropriate form of erosion control (e.g., check dam or comparable mechanism). ~~Is a downstream check dam or comparably mechanism required?~~

The velocities within the Pilot and SG Channel during a bank-full event approximately meet the maximum velocities identified in Table 1-104.10A of the City's Design Manual. However, the current conditions and maintenance history show that the streambeds of both channels experience aggradation as opposed to degradation. Additional erosion control measures, such as check dams, are not necessary for these channels since channel erosion does not appear to be an issue at these locations and MMP Protocols WQ-9 and WQ-10 would not be applicable.

MITIGATION
Conclusion/Recommendations (Describe the limits of recommended maintenance, degree to which native vegetation within the facility can be retained, and capacity of maintained channel):
Pilot Channel The results of the various scenarios and conditions analyzed indicate that the Pilot Channel alone conveys approximately 70-percent of the 2-year storm flow under the Maintained Condition – Sediment removed. It is recommended that the Maintained Condition – Sediment removed option be implemented to increase the channel's conveyance capacity from 10 cfs to 200 cfs. This study is largely based on available data and information from previous studies and information databases. To further understand the complexities of this channel, a detailed study with ground cross-sectional survey data and updated topography would be needed, as well as a detailed Northern and Southern Channel split flow analysis. Another important factor to be further investigated is the amount and types of sediment and debris that are deposited in this channel as these play a large role in the bulking of the storm water runoff. The long history of flooding in this area and the past maintenance record indicate a need for continued full vegetation and sediment removal in the channel. SG Channel The results show that the SG Channel current condition capacity is approximately the 2-year storm flow. Flows larger than the 2-year storm flow puts the west berm, immediately to the north of Monument Road, at risk for erosion. Under the Maintained Condition – Sediment removed option, the maximum capacity of the SG Channel is increased to 900 cfs. The past maintenance record and flooding history indicate a need for continued full vegetation and sediment removal in the channel until other future measures upstream of the channel decrease the need for this maintenance. Therefore, it is recommended that the accumulated sediment deposition in the SG Channel be removed. When clearing the channel, it is recommended that the vegetation on the side slopes be protected in place where possible, as the vegetation protects the side slopes from erosion. A further recommendation is for the concrete grout near the outlet of the 52-inch CMP be reconstructed, as this area may experience high velocities, and would help prevent failures around the outlet of the culvert. Additionally, the maximum flow that the SG Channel can convey may be increased to 1,000 cfs if the discontinuities in the berm profiles at HEC-RAS cross sections 2623.27 and 3863.17 are reconstructed to match the adjacent elevations.

ADDITIONAL COMMENTS OR RECOMMENDATIONS

The Recirculated Program Environmental Impact Report (PEIR) for the Master Storm Water System Maintenance Program lists four alternatives that would reduce the need for regular maintenance of the storm water facilities. The list of those alternatives is summarized below followed by a brief discussion as to how they apply to the Pilot and SG Channels.

- Raising the channel banks by constructing walls or berms along the top of the channels – the hydraulic analyses show that increasing the capacity of the Pilot Channel with construction of walls or berms would be beneficial to increase the channel's capacity. However since the Pilot Channel works in conjunction with the Southern Channel to provide flood protection to the surrounding properties, this alternative is not recommended as the walls would disrupt the synergy between the channels. Based on the visual inspection of the manufactured berms along the SG Channel, and the available topography for the area, it was determined that there are a number of discontinuities and depressions along the profiles of the berms. It is recommended that the berms be reconstructed along the depressions to maintain a continuous profile.
- Diverting storm water in pipes around constrained segments – the watershed size and channel flow rates make this alternative impractical. An underground storm drain system would be very large to convey the flows of the Pilot and SG Channels. The permitting, environmental, and monetary costs associated with such a system would render it prohibitive.
- Widening channels to accommodate vegetation – these channels were constructed in larger drainages to reduce flooding impacts of the smaller storm events on properties in the Tijuana River Valley. The construction of larger channels to maintain the vegetation would be at odds with limiting the disturbance of the existing vegetation in the area. The studies of this area also indicate that without a plan to reduce the continuous and unpredictable sediment loads carried by the Tijuana River, widening would only provide a temporary solution and would have significant biological and potentially cultural resource impacts.
- Off-site runoff reduction – 73-percent of the watershed tributary to the Tijuana River is in Mexico. Efforts are under way by the Tijuana River Valley Recovery Team to coordinate with the Mexican authorities to create a program that reduces the amount of runoff, sediment, trash and pollutants carried by the Tijuana River. Additionally, the costs of reducing impermeable areas, redirecting runoff into previous areas, etc. only within the 27 percent of the watershed area that is within the U.S. would be very high, rendering this type of project cost prohibitive.

Further analysis is recommended at Monument Road to investigate the requirements to mitigate or reduce flooding at this crossing and to establish a benefit-cost ratio criteria.

ADDITIONAL COMMENTS OR RECOMMENDATIONS
Based on the topographic information, flows larger than the 2-year storm flows have a tendency to flood the properties adjacent to either side of the channel. The benefit-cost ratio criteria should also consider that the 5-year storm flows would overtop the SG Channel at Disney Crossing.

LIST OF ATTACHMENTS

- ☐ Attachment 1 - Site Photos
- ☐ Attachment 2 – Figures
    - Figure 1. Vicinity Map
    - Figure 2. Tijuana River Pilot Channel Hydraulic Workmap
    - Figure 3. Tijuana River Pilot Channel Hydraulic Workmap
    - Figure 4. Smuggler's Gulch Channel Hydraulic Workmap
    - Figure 5. Tijuana River Pilot Channel Photo Log Key Map
    - Figure 6. Smuggler's Gulch Channel Photo Log Key Map
- ☐ Attachment 3 – Hydraulic Profiles and Detailed Results
    - Hydraulic Profiles for Current Vegetated Condition Model
    - Hydraulic Profiles for Ultimate Vegetated Condition Model
    - Hydraulic Profiles for Maintained Condition Model (No Sediment Removed)
    - Hydraulic Profiles for Maintained Condition Model (Sediment Removed)
    - Detailed Hydraulic Results for Current Vegetated Condition Model
    - Detailed Hydraulic Results for Ultimate Vegetated Condition Model
    - Detailed Hydraulic Results for Maintained Condition Model (No Sediment Removed)
    - Detailed Hydraulic Results for Maintained Condition Model (Sediment Removed)