# Del Mar Bluffs Stabilization Project 5
## (Milepost 244.1 to Milepost 245.7)

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## 30% Draft Drainage Study

**June 18, 2020**

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# 1. Introduction

## 1.1 Project Description

Stability of the rail corridor along the Del Mar Bluffs has been threatened by surficial landslides, erosion and global slope stability due to bluff retreat, wave runup and sea level rise. Del Mar Bluffs 5 is part of a phased approach to stabilize the bluffs until a permanent solution for stability of the railroad is completed. The Del Mar Bluffs 5 project includes construction of new slope stabilization and a comprehensive drainage system to control and convey concentrated runoff coming into the railroad right-of-way from the City of Del Mar (City). The railroad was constructed in the early 1900s before significant development in the City. Development in the City over the years has increased runoff exceeding the capacity of original systems. Several drainage improvement projects have been completed over the years to expand and replace older drainage systems, however many of the older drainage systems still remain. Some of the existing drainage systems are undersized and the earthen trackside ditches are unable to convey the increased flows. The Del Mar Bluffs 5 project will provide a comprehensive review of the existing drainage conditions and provide recommendations for new drainage improvements to mitigate erosion and protect against sudden slope failure due to concentrated storm flows.

## 1.2 Project Location

The proposed project is located in the City of Del Mar between Milepost (MP) 244.1 and MP 245.7 on the San Diego Subdivision of the LOSSAN Corridor. The right-of-way is owned by North County Transit District (NCTD).

## 1.3 Existing Drainage Pattern

The existing project site is developed with a combination of residential and commercial land uses. The total drainage area is 422 acres consisting of hydrologic soil type B and D with the drainage pattern from east to west. The project site topography is sloping (8% Average) from east to west. The proposed project will stabilize areas of the Del Mar Bluffs identified as needing improvements to support the track bed. Improvements include repair of existing facilities and construction of new facilities located within the railroad right-of-way and immediately adjacent to the railroad right-of-way. An overview of the project area relative to the City of Del Mar is shown in Figure 1 Project Vicinity Map.

**Figure 1. Vicinity Map**

# 2. Hydrology and Hydraulic Analysis

## 2.1 Purpose and Scope

The Del Mar Bluffs 5 drainage study is an extension of previous studies along the Del Mar Bluffs. Drainage studies were previously prepared for this area of the bluffs in 2001 (DMJM) and in 1993 (Frasier Engineering Inc) for NCTD. The purpose of these studies was to identify insufficiencies in the drainage systems and prioritize recommended drainage improvements. Several culverts and channels have been improved over the years, but many of the recommended drainage improvements have not been completed due to lack of funding and permitting challenges. Previous studies were based on the 1973 County of San Diego Drainage Design Manual. Several simplified assumptions were made while conducting these studies including constant runoff coefficients and rainfall intensities across all basins. The selected runoff coefficient of 0.55 generally represents residential development. These studies used 200 scale City/County topographic mapping to define drainage basins.

The purpose of this drainage study is to reassess drainage deficiencies within and adjacent to the railroad corridor and recommend improvements based on current regulations and standards. The hydrology analysis is based on the current County of San Diego Hydrology Manual (2003). This manual reflects a complete overhaul of the manuals used in previous studies with new intensity-duration curves, runoff coefficients, isopluvial maps and direction for hydrology analysis in the region. In general, the current hydrology manual provides higher rainfall intensities for small drainage basins such as the Del Mar Bluffs area.

The current study has reassessed development as it exists today. Commercial development along Camino Del Mar, higher density residential development and mixed-use development close to the beach are accounted for in the current study, resulting in higher coefficients of runoff. The flow patterns within this area are very difficult to assess accurately. Residential development on the hillside above Camino Del Mar are not characteristic of modern urban development. Even in the smaller residential lots, underground storm drains are limited, with many lots flowing to natural channels below street grade or flowing from lot to lot. The basic drainage basin configuration and overall time of concentration (Tc) for these areas is consistent with assumptions from earlier studies.

Damage to the rail corridor as a result of concentrated flow not being contained by existing drainage systems and flowing uncontrolled onto the railroad right-of-way has been significant in the last few years. This study, therefore, has focused on more detailed delineation of the flow patterns and points of concentration onto the rail corridor from City of Del Mar streets in order to assess better methods of point protection. Drainage basins west of Camino Del Mar have been adjusted from earlier studies to better assess street flow and obstructions that direct and concentrate runoff at entry points into the rail right-of-way. This study considers the shorter-term peak flows that occur at the ends of streets and alleys that will need to be controlled and recognizes the need to effectively mitigate against the effects of high velocities and concentrated runoff into the rail right-of-way. Based on the current hydrology manual, the peak flows to major storm drains are generally higher than predicted by the early studies, but the impact of this increase is not generally significant. The assessment of the shorter term, higher peak flows at the ends of the streets and alleys would reflect higher impacts with more recommended control structures in and adjacent to the public streets.

## 2.2 Existing Conditions

The City of Del Mar has added public storm drains over time to control the runoff at Camino Del Mar. Many of these storm drains are still undersized and do not convey all the tributary runoff to the downstream basins. Camino Del Mar generally flows northerly from the intersection of Del Mar Heights Road toward 15th Street. Major east-west roadways including Del Mar Heights Road, 4th Street, 8th Street, 9th Street, 10th Street, 11th Street, and 12th Street have storm drains intended to convey runoff across Camino Del Mar westerly to the beach through the railroad right-of-way. These storm drain systems are generally undersized, therefore all the runoff from upstream basins will not be conveyed to the west. During major storms, Camino Del Mar and the intersecting roadways will have significant flow in the streets. Roadway medians have been constructed which limit overtopping of the roadway to main intersections. Considering the rate of runoff from the hillside into Camino Del Mar, the relatively flat longitudinal slopes, and the momentum of flow coming down the steep intercepting streets, we have assumed the majority of flow would not be contained in the underground storm drains at major intersections resulting in significant street flow. Based on our assessment of the existing roadway capacity and field observations during rainfall events in March of this year, we have estimated the direction of bypass flows at flooded intersections as further detailed in the Methodology Section of this report. Previous studies assumed all bypass flows not contained in the underground systems would continue as sheet flow and stay in the existing basin to the west. Based on our assessment and field observations, we estimate that significant bypass of flow in Camino Del Mar is likely which results in greater flows to 15th Street and Camino Del Mar.

Proposed conditions are essentially the same as existing conditions. Most improvements are replacement or repair of existing facilities. All new or repaired systems will be designed to accommodate the existing peak flows tributary to the design points of concentration. A separate existing conditions hydrology study is not provided since no changes to the overall drainage patterns or peak rates of run off are anticipated.

## 2.4 Methodology and Calculations

The hydrology calculations were prepared in accordance with the County of San Diego Hydrology Manual dated June 2003. Base maps were prepared to define the basin areas using a combination of the City of Del Mar and the project topographic survey. The vertical datum for the project is NAVD88. The following is a listing of maps and sources.

Project Topographic Survey prepared by Aguirre and Associates, May 2020 and August 2018

City of Del Mar Storm Water System Map, November 2017

Topography-20-foot contours, SanGIS Regional Data Warehouse, 2012

City of Del Mar Zoning Map, November 2001

Camino Del Mar Streetscape plans (E-1800-01), March 2020

Base maps were prepared to define the basin area. The total drainage area is 422 acres. Peak flow rates for 25-year, 50-year and 100-year storms were calculated using the Rational Method, expressed by the equation Q=CIA, with 'C' being the runoff coefficient, 'I' being the rainfall intensity and 'A' being the drainage area in acres. The weighted average of the 'C' value were obtained for each basin considering the development and soil type. The rainfall intensities were calculated based on the County of San Diego Hydrology Manual which provides a graphical chart to determine the rainfall intensity based off of the equation $I = 7.44\ P_6 D^{-0.645}$, where $P_6$ is the 6-hour precipitation for the corresponding frequency return period rainfall storm in inches and D is the time of concentration of the storm in minutes. Drainage pipe and channel normal depths were determined using Bentley FlowMaster V8i software with the Mannings Formula friction method. Existing culvert capacities were evaluated based on the Bureau of Public Roads nomograph for pipe culverts with inlet control and the simplified County method for assessment of junction losses.

### 2.4.1 Runoff Coefficient

Assessment of runoff coefficients is based on a combination of zoning designation, impervious area and soil type. Most of the site is Type B Soil as shown on the soil hydrologic group map in Appendix F. For purposes of assessing the runoff coefficient, the entire site is assumed to be Type B. The Runoff Coefficient Map in Appendix D shows the City of Del Mar zoning designations and correlation with the County of San Diego zoning designations. Much of the development west of Camino Del Mar appears to be developed at a density and level of impervious surface greater than the zoning designations would indicate. Sample areas were assessed to determine percent of impervious surfaces within the basins to determine the average percent of impervious surfaces and correlating runoff coefficient. The Runoff Coefficient Map shows the final weighted averages for the runoff coefficients of each basin used in the hydrology calculations.

### 2.4.2 Basin Delineation and Flow Patterns

Drainage patterns within the basin area are very complex making it difficult to accurately determine the basin areas. Sheet flow between properties is common. Many properties are below street grade; however, many have sump pumps to direct flow back to the adjacent streets. Existing storm drains are limited and undersized. Initial basin delineation was completed based on flow patterns determined from SanGIS Regional Data Warehouse topographic mapping with 20-foot contours and confirmed as consistent with previous drainage studies. Due to the complexity of the drainage patterns and limited topography in the overall basin, field assessments were completed on March 19, April 10, and May 27, 2020 to further define direction of flow and limits of the sub-basins. Drainage patterns were observed under light to medium rainfall events on April 10, 2020. Drainage basins east of Camino Del Mar were mapped consistent with the previous drainage studies. The drainage basin boundaries west of Camino Del Mar were adjusted based on high points and conveyance systems visible in the field and the drainage patterns observed on March 19 and May 27, 2020.

The topography is relatively steep and slopes from east to west. The majority of Camino Del Mar has medians which interrupt the flow pattern and tend to direct flows northerly from Del Mar Heights Road toward 15th Street instead of allowing sheet flow across the roadways. There are some storm drain systems that convey runoff from the east side of Camino Del Mar to the west side of Camino Del Mar. Most of these storm drains are undersized and cannot convey all the runoff from the upstream basins to the downstream basins. Significant flows bypassing existing storm drains would be conveyed within the street. Recent streetscape improvements by the City of Del Mar include new storm drains, gutters, cross walks and other surface improvements. New inlets and modified inlets at 11th Street, 12th Street and 13th Street have provided better collection of runoff, but the overall pipe systems were not improved. New crosswalk improvements were constructed. The intersecting streets are steep and grades were flattened into Camino Del Mar to accommodate the new improvements.

Determining an accurate capacity of existing storm drains and overflow in Camino Del Mar is beyond the scope of this study, therefore some general guidelines are used to estimate the existing capacity and bypass flows. Based on field observations, flows from small to moderate storms resulted in flooding of the intersections. Flows from the upstream intersecting streets extended well into Camino Del Mar but were generally directed northerly and did not overtop the roadway, See Figure 2.

**Figure 2. Flow Patterns at 9th Street and Camino Del Mar**

Flows in the north bound lanes of Camino Del Mar were directed to the southbound lanes of Camino Del Mar and continued flowing northerly. No significant flows were visible overtopping the street centerline and flowing to the downstream basin. During increased intensity rain events we expect flooding would be more severe and would likely have bypass flows to the downstream basin. For purposes of this evaluation, we have assumed that flows at flooded intersections will be directed 50% to the northbound lanes, 25% to the south bound lanes and 25% to the downstream intersecting street as shown on the Drainage Hydrology Map in Appendix B The existing storm drains generally follow the street grades, but capacity is limited by the depth of the systems. The efficiency of collecting runoff in the existing inlets impacts the overall capacity of the existing systems. Many inlets are in steep passing grades and would have significant bypass flows, see Figures 3 and 4. Private storm drain connections not shown on City base maps likely exist, improving the ability to collect runoff. We have assumed that the existing inlets would be able to collect the flows or additional improvements could be made to improve the efficiency of the existing inlets. Assuming an available head of 2.5 feet, a velocity of 10 feet per second (FPS) flowing full was estimated for each of the storm drains crossing Camino Del Mar. The maximum capacity was estimated as function of pipe size and velocity.

**Figure 3. Inlet Bypass at the Intersection of 9th Street and Camino Del Mar**

**Figure 4. 9Th Street – Inlet Bypass**

## 2.4.3 Time of Concentration

An initial assessment of the Tc for each of the basins and sub-basins was completed consistent with the County of San Diego Hydrology manual with the initial Tc limited based on zoning/land use and assumed slope and the remaining travel time being estimated based on flow type i.e. gutter, pipe, or channel. Flow paths for these basins are very complex. Storm drain systems are limited and generally undersized resulting in bypass of flow from the intended system to the next downstream street or system. Additionally, many properties are below street grade with flow directed to open channels or sheet flow between lots. Many of the homes west of Camino Del Mar have sump pumps that redirect flow towards higher street levels. The basins to the east of Camino Del Mar are similar in elevation difference and overall length. The basins west of Camino Del Mar have similar elevation differences and total basin lengths. The westerly sub basins have shorter travel times compared to the easterly basins which would result in higher intensities for initial flows from those basins. Tc calculations were completed and the times for the basins east of Camino Del Mar varied from 11 minutes to 15 minutes and times for basins west of Camino Del Mar varied from 4 minutes to 11 minutes. Total travel time for junctions varied from 14 minutes to 16 minutes. Considering the complexity of flow patterns and the uncertainty of detailed travel times, an average Tc equal to 13 minutes was selected for the basins east of Camino Del Mar and Tc equal to 7 minutes for basins west of Camino Del Mar. A total average Tc equal to 15 minutes was selected for all junctions. While flows to junctions would reflect the same overall travel time, the shorter travel time was used to better define the higher peak flows for interim channels tributary to downstream junctions and for sizing of inlets.

### 2.4.4 Assumptions:

- The minimum Tc provided in Figure 3-2 “Intensity-Duration Design Chart” of the hydrology manual is equal to 5 minutes, therefore the Tc for small basins was assumed to be a minimum of 5 minutes.
- Travel times used to determine Tc through open ditches, i.e., track side ditches, is calculated as length divided by average velocity. Average velocities are defined for the following general conditions with supporting calculations in Appendix C:
  - Earthen channel velocity with a slope less than 0.5% is 2.5 fps
  - Earthen channel velocity with a slope greater than 0.5% and less than 5% is 5 fps
  - Earthen channel velocity with a slope greater than 5% is 8 fps
  - Concrete (gunite) channel velocity with a slope greater than 0.5% is 6 fps
  - Concrete (gunite) channel velocity with a slope less than 0.5% is 5 fps
- Junction points have been defined at the confluence of sub-basins. The junction travel time is typically defined as the longest travel time from the upstream basins. The junction travel time was used to adjust the intensities of the sub-basins at the junctions, therefore adjusting the peak flow rates tributary from each basing to the junctions. This adjustment at the junctions accounts for the sub-basins fully contributing (at which time the peak flow is assumed to occur) at different times due to the difference in Tc.

## 2.5 Conclusions & Recommendations

This hydrology analysis and assessment of existing drainage facilities is part of on-going effort to identify deficiencies in and adjacent to the rail corridor and provide solutions to help mitigate the impacts of concentrated runoff onto the rail corridor. Drainage studies were complete in 1993 and 2001 with similar goals. Where improvements were recommended in previous studies and have not been completed, those deficiencies are still included in the current assessment. Some of the previously repaired elements are now approaching their useful service life and are included in recommendations for additional repair or replacement.

The previous studies were based on the 1973 County Hydrology Manual which is no longer used. The County Manual was replaced in 2003. The current manual typically provides for higher intensities and higher peak rates of runoff than the previous manual. Differences are most significant for smaller basins that exist in this project. Earlier studies predicted an average 100-year intensity of 3.0 inches per hour and an average 25-year intensity of 1.49 inches per hour. The updated 2020 study predicts average intensities at junctions for the 100-year condition at 3.1 inches per hour and for the 25-year condition at 2.46 inches per hour. The increase in 100-year peak flows as a result of changes in intensity are relatively small, but the increase in 25-year peak flows will be increased by approximately 65% based on changes in intensity.

Because of damage observed from overtopping of drainage channels, including both major points of confluence and trackside ditches, this update has provided additional detail and analysis for drainage basins directly tributary to the rail corridor. Flows from the basins west of Camino Del Mar have been analyzed considering the shorter times of concentration (Tc), higher intensities that are expected to occur ahead of peak flows from the entire upstream basins. The runoff coefficients have been assessed in more detail to reflect the actual development and increase in impervious surfaces that have changed over the years. The higher peak flows are used to assess the capacity of inlets and control of surface and ditch flows into the right-of-way. Storm flows from the east side of Camino Del Mar flow westerly. A limited number of existing storm drains collect runoff and convey flow across Camino Del Mar to the downstream basins. Del Mar Heights Road intersects Camino Del Mar near the high point in Camino Del Mar. Storm flows exceeding the capacity of existing storm drains continue as gutter flow in Camino Del Mar with flow splitting northerly and southerly at Del Mar Heights Road. Roadway medians have been constructed that further restrict gutter and street flow from reaching the downstream basin. Earlier studies assumed that all storm flows within the upstream basin would cross Camino Del Mar and flow to the downstream basin. The 2020 update has considered the bypass that occurs as a result of undersized storm drains and medians that block flow. In general, significant street flows are predicted for Camino Del Mar. Overtopping of the street centerline will occur during storm events including 25-year events with bypass to downstream basins occurring at breaks in the medians. Additional bypass flows are estimated at $11^{th}$ Street, $13^{th}$ Street and $15^{th}$ Street which show increased peak flow rates compared to previous studies.

By way of comparison, Table 2.1 shows a comparison between the assessment previously completed for the storm drain outfalls previously evaluated.

**Table 2.1: Comparison of existing pipe capacities and Q100 with previous studies**

| | | | | | 2020 Study | | 2001 Study | | 1993 Study |
|---|---|---|---|---|---|---|---|---|---|
| Design Points | Street Name | MP | Station | Culvert Existing Size (Inches) | Existing Pipe Capacity (CFS) | Existing Q100 (CFS) | Existing Pipe Capacity (CFS) | Existing Q100 (CFS) | Existing Pipe Capacity (CFS) |
| 1 | 15th Street | 244.12 | 1548+58 | 30 | 74 | 124 | 75.6 | 89 | 80 |
| 3 | 13th Street | 244.3 | 1540+38 | 24 | 38 | 66 | 27.6 | 23 | 140 |
| 4 | 12th Street | 244.4 | 1533+83 | 48 | 140 | 68 | 160 | 79 | 148 |
| 6 | Sea Orbit Lane | 244.45 | 1531+28 | 42 | 110 | 115 | 118.2 | 81 | NA |
| 12 | 8th Street | 244.7 | 1517+62 | 36<br>42 | 174 | 171 | 129.7 | 192 | NA |
| 14 | Anderson Canyon | 245.4 | 1482+92 | 72 | 735 | 195 | 881.9 | 110 | 730 |

In general, the peak flow rates predicted in accordance with current County manual are expected to be somewhat higher because of changes in intensity and runoff coefficient. Peak flow rates to the existing storm drain at 15th Street and 13th Street are significantly higher than previously predicted. The peak flow rates at 15th Street include bypass from upstream basins which increases the total flow rate. The drainage basin tributary to the storm drain at 13th Street is limited to the area west of Camino Del Mar. The current study considered this basin in more detail than previous studies to better predict the impact of increased runoff. Because of the basin configuration and lower Tc, the peak rate of flow is predicted much higher than the previous study predicted using the same average intensity and runoff coefficient for all basins. The peak flow rate predicted at 12th Street is lower than the previous study because of considering bypass flows in Camino Del Mar. There is a solid median at the Camino Del Mar – 12th Street intersection that prevents street flow from overtopping. Flows to the west side of 12th Street are restricted to flow capacity of the existing 30-inch storm drain crossing the intersection. The peak flow rate tributary to Sea Orbit Lane is significantly greater than previously predicted because of flow that is bypassed in Camino Del Mar to 10th Street and 11th Street. The peak flow rate tributary to the 8th Street storm drain is less than predicted previously because of bypass that occurs in Camino Del Mar at 9th Street.

The existing storm drain capacities calculated for 15th Street are the same. The current study assesses the capacity of the existing 24-inch storm drain at 13th Street considering improvements to the existing inlet structures reflecting a higher potential capacity than predicted by the previous study where inlets were defined as the limiting factor. The current study reflects higher capacity for the storm drain at 8th Street consistent with the addition of a secondary pipe outlet constructed as part of Del Mar Bluffs 1.

## 2.5.1 Existing Storm Drain Outfalls

Capacities of the existing storm drain outfalls to the beach as well as estimated peak flowrates have been calculated for the 25-year, 50-year and 100-year events. Table 2.2 below shows the peak rates of runoff and the capacity for each of the existing storm drain outfalls. The peak flow rates are detailed in Appendix A and the capacity calculations are in Appendix G.IV.

**Table 2.2: Culvert Capacities at Design Points**

| Design Points | Street Name | MP | Station | Culvert Existing Size (Inches) | Existing Pipe Capacity (CFS) | Existing Q100 (CFS) | Existing Q50 (CFS) | Existing Q25 (CFS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 15th Street | 244.12 | 1548+58 | 30 | 74 | 124 | 96 | 82 |
| 3 | 13th Street | 244.3 | 1540+38 | 24 | 38 | 66 | 55 | 48 |
| 4 | 12th Street | 244.4 | 1533+83 | 48 | 140 | 68 | 65 | 62 |
| 6 | Sea Orbit Lane | 244.45 | 1531+28 | 42 | 110 | 115 | 97 | 85 |
| 12 | 8th Street | 244.7 | 1517+62 | 36<br>42 | 174 | 171 | 157 | 148 |
| 14 | Anderson Canyon | 245.4 | 1482+92 | 72 | 735 | 195 | 176 | 163 |

Capacities of the existing storm drains have been assessed in accordance with the LOSSAN design criteria. The controlling criteria for these systems restricts the 100-year hydraulic grade line from being above the top of ballast. The existing storm drain outfalls at 15th Street and 13th Street do not have adequate capacity to convey existing peak flows. The capacities will be exceeded for all three storm events evaluated. The existing storm drain in 15th Street drains a large area of Del Mar. The existing 30-inch storm drain extends up 15th Street east of Camino Del Mar with numerous storm drain inlets. While many of the inlets are on passing grades and not likely performing efficiently, we have assumed that there are adequate number of inlets available for the system to function at its maximum capacity of approximately 80 CFS which is well below the demand of 124 CFS. Some of the excess flow will likely overflow from the existing inlets in 15th Street and flow down to the low point north of the project. Flows from Sea Grove Park and overflow from 15th Street through the park would back up in the railroad right of way, flooding the track before flowing northerly into 15th Street. The existing 24-inch storm drain at 13th Street has limited capacity due to existing inlet configuration. Even with improved inlets, the existing capacity would be exceeded. The existing rail alignment slopes to the north. Flows not captured by the system at 13th Street will continue flowing north to the storm drain at 15th Street. During high flow events, bypass flows from 13th Street will add to the flooding but will continue down 15th Street until the peak flow rates reduce to a level within the capacity of the existing storm drain, which also is deficient. Recommendations for improvements to this area include construction of a new storm drain outfall at MP 244.16 to relieve flows to the existing systems and construction of lined concrete trackside channels from 12th Street to 15th Street to convey flows more efficiently, provide a factor of safety against blockage by mudslides and debris and to facilitate bypass of runoff should any of the systems become blocked. The extent of proposed improvements is shown as Drainage Areas 1, 2 and 3 on the 30% Schematic Plans.

The existing storm drain outfall at 12$^{th}$ Street is more than 100 years old and is in need of replacement. The recommendation for 12$^{th}$ Street includes construction of a new storm drain outlet in 12$^{th}$ Street with upgraded inlets and a lined trackside ditch on the east side shown as Drainage Area 4 on the 30% Schematic Plans.

The existing storm drain outfall at Sea Orbit Lane is slightly over capacity as shown in Table G.II.2 above. The required capacity provides for a hydraulic grade line elevation below the bottom of ballast. While this criteria is ideal to protect the ballast, it is only the 100-flow that exceeds this criteria. Considering the hydraulic grade line to accommodate the 100-year flow would only exceed the bottom of ballast elevation for a short duration and the hydraulic grade line would not exceed the top of tie, no further improvements are recommended at this time.

### 2.5.2 Upper Bluff Channels

Between Sea Orbit Lane and the existing down drain structure at MP 245.15 south of 4$^{th}$ Street, flows from the City streets are intercepted by a series of concrete lined channels just inside the railroad right of way and conveyed to the various storm drain outfalls to the beach. Improvements and repairs were made to a number of these channels as part of Del Mar Bluffs 1 and replacement of a portion of the channel from 7$^{th}$ Street to 8$^{th}$ Street is planned as part of Del Mar Bluffs 4. A field assessment of the existing conditions was completed as part of this assessment and existing capacities were estimated and compared to the existing peak flow rates to assess inadequacies. The photo documentation of existing conditions and capacity assessment is in Appendix G.III.

### 2.5.3 Major Channel Upper Bluffs

Full replacement of the existing channel between 10$^{th}$ Street and Sea Orbit Lane due to deteriorated condition of the existing concrete. The existing section is irregular due to repairs and extensions completed on the channel over time. While the capacity is generally adequate for existing flows, freeboard requirements of the LOSSAN criteria are not consistently met. The channel replacement would be at a similar width with deeper sections to provide adequate freeboard. This is a relatively steep channel and will be subject to high velocities making the freeboard an important design consideration in providing a safety factor against obstructions that could cause a hydraulic jump and overflow from the channel.

Minor improvements to the existing channel between 9$^{th}$ Street and 8$^{th}$ Street are recommended to improve efficiency, fill in a missing gap at Sherrie Lane and replace a deteriorated section near 8$^{th}$ Street. A new channel entrance apron would be provided at 9$^{th}$ Street to improve efficiency and minimize the ponding that occurs in 9$^{th}$ Street.

Addition of splash walls is recommended at several locations as further detailed on the 30% Schematic Plans and outlined in the summary below.

#### 2.5.4 Trackside Channels

Between 12th Street and 15th Street and the down drain at MP 244.0 to Anderson Canyon and south of Anderson Canyon, significant flows from the City concentrate along the east side of the trackbed and are conveyed through the right-of-way to existing outfalls. A field assessment of the existing conditions was completed as part of this assessment and existing capacities were estimated and compared to the existing peak flow rates to assess inadequacies. The photo documentation of existing conditions and capacity assessment is in Appendix G.IV.

#### 2.5.5 Major Channel Trackside

Based on the assessment, the existing concrete lined channel north of Anderson Canyon is in good condition and provides adequate capacity to convey existing runoff. The remaining trackside channel is not concrete lined. They are adjacent to existing unprotected slopes and are subject to blockage from mud slides and debris from the upstream basins. The existing capacities are at or near zero considering the level of siltation that occurs on a regular basis. Cleaning the ditches will improve capacity in the short term, but the width between the existing track and toe of slope limits the width and corresponding capacity of graded trackside channels. Improvements for these areas include construction of concrete lined U-channels to improve efficiency and provide a factor of safety against blockage by mudslides and debris. Addition of retaining walls would be needed to maintain minimum ditch widths. Where the Del Mar formation is less than 20 feet below the surface grade, underdrains would be added to facilitate collection of subsurface flows. Details and extent of proposed trackside channels are shown on the 30% Schematic Plans and are described in the summary below.

**Figure 5. Existing Trackside Channel north of 13th Street**

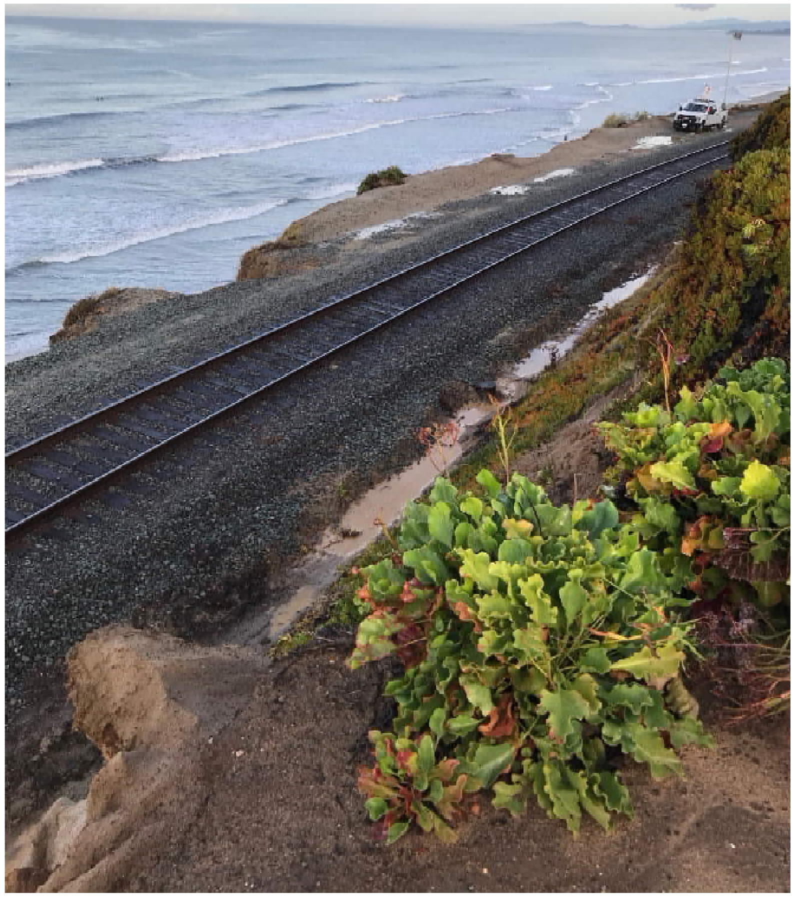

**Figure 6. Existing Trackside Channel South of Anderson Canyon**

## 2.5.6 Trackside Ditches and New Storm Drain Outfalls

The Del Mar Bluffs corridor is approximately 2 miles in length. The northerly and southerly ends of the rail alignment slope at grades of approximately 1% to the north and south respectively. The longitudinal slopes in the middle of the corridor are controlled by a flat tangent segment at a grade of 0.2% and long vertical curves transitioning to the steeper slopes at either end. Longitudinal slopes adjacent to the track between 8th Street and Anderson Canyon vary from 0.2% to 0.4%. Graded trackside ditches are very flat and subject to ponding as shown in the photo below. In the trench area surface runoff is trapped by slopes to the east and west. South of the trench to the down drain at MP 215.15, runoff is trapped between the toe of the slope and the track bed. Water ponds and impacts the ballast until it infiltrates through the pervious Terrace Deposits adding to the groundwater. The depth of the harder Del Mar formation is too deep to collect this water in an underdrain. Storm flows on the wider west side of the track south of 6th Street pond with some flows concentrating and creating new gullies down the face of the bluff. Proposed improvements for these areas include addition of concrete lined trackside ditches similar to previous recommendations. In addition to lined trackside ditches, new outfalls are recommended to provide controlled outlets at the termination of the new ditches. The extent of propose improvements is shown on the 30% Schematic Plans and are described in the summary below.

**Figure 7. Existing Trackside Ditch North of Anderson Canyon**

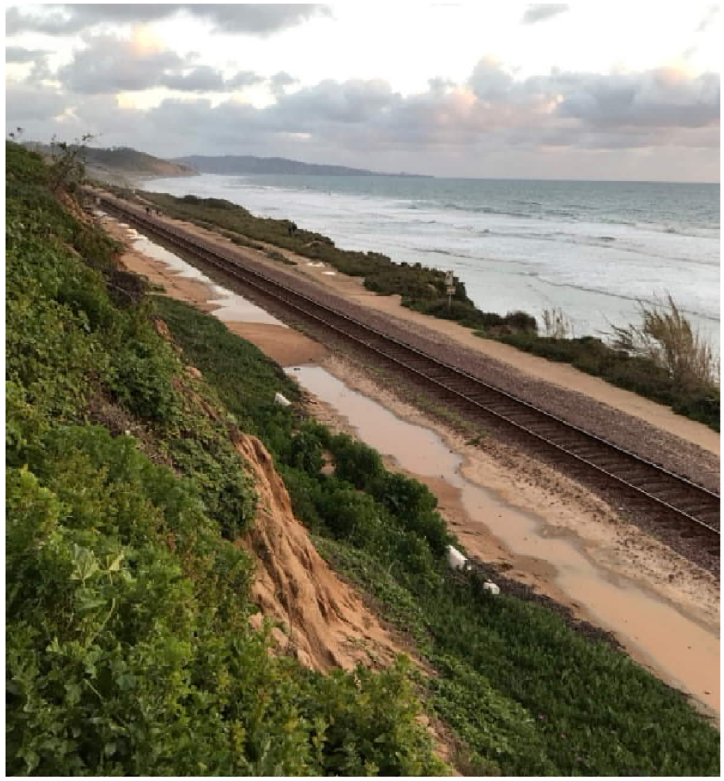

**Figure 8. Existing Trackside Ditch in Trench Area**

### 2.5.7 Existing Street End Condition – Curb Inlets and Drainage Channels

Between 13th Street and 4th Street, storm runoff from the City concentrates at the ends of intersecting streets and enters the railroad right-of-way as a combination of ditch flow, sheet flow and pipe flow. Significant erosion at the ends of the streets have been observed in recent rain events and significant amounts of mud and debris have filled trackside ditches. A field assessment of the existing conditions was completed as part of this assessment and existing capacities were estimated and compared to the existing peak flow rates to assess inadequacies. The photo documentation of existing conditions and capacity assessment is in Appendix G.I-Existing Street End Conditions. The existing curb inlets at the street ends are generally undersized for the anticipated peak flows. In many area grades adjacent to the streets have been lowered allowing storm flows to bypass the inlets or swales intended to control runoff. Proposed improvements include addition of inlets, modifications of swales, grading in the parkways to prevent overflow and addition of seat walls similar to the wall constructed at 9th Street as part of Del Mar Bluffs 1. The extent of propose improvements is shown on the 30% Schematic Plans and are described in the summary below.

### 2.5.8 Proposed Drainage Improvements by Drain Area

Proposed drainage areas for the Del Mar Bluffs corridor are shown on the 30% Schematic Plans. The proposed improvements area grouped by area with each area having a unique combination of the elements described above. A total of 15 distinct areas have been defined. The areas are defined to provide a stand-alone set of improvements that could be constructed independently of other areas to allow for simplicity in phasing. Table 2.3 below provides a summary of the elements included in each of the 15 Drainage Areas. The ranking of “High” is assigned to improvements needed to maintain bluff stability such as replacing undersized storm systems with high peak flows or control of groundwater. The “Medium” ranking is applied to improvements that would improve drainage and maintenance, but a delay in completion would not likely contribute to a catastrophic failure. The ranking of “Low” is applied to improvements that would be needed in the future, but the delay would not have a significant short-term effect.

### Table 2.3 Summary of Recommended Improvements

| Area Number | Location | Description | Ranking |
|---|---|---|---|
| 1 | MP 244.16<br>Coast Boulevard | New 48-inch storm drain and outlet to beach and 3-foot wide concrete trackside ditch west side of track.<br>New system will provide overflow relief to existing system in Coast Boulevard. | High |
| 2 | MP 244.16 TO 244.3 | New 5-foot wide concrete U-ditch, retaining wall and additional underdrain.<br>New ditch will convey surface flow to new outlet structure at MP 244.16. New 5-foot U-ditch and underdrain will continue beyond to the existing drainage system at MP 244.12 (15th Street). | High |
| 3 | MP 244.3 TO 244.4<br>13TH Street | Add new inlets to existing storm drain, new 1-foot deep x 4-foot wide channel over existing storm drain. New channel and Underdrain south of 13th Street will convey bypass runoff from existing 24-inch storm drain north of 13 street MP 244.3. Construct seat wall or barrier at 13th Street to direct storm flow to inlets. | High |
| 4 | MP 244.4 TO 244.43<br>12th Street | Abandon existing concrete chute, new 42-inch storm drain and outlet to beach, add inlets to existing storm drain in 12th Street. New outlet will be jack and bore or directional drilling. Remove two existing tiebacks to facilitate construction. Construct new grade beams and tiebacks after storm drain construction is complete.<br>Construct seat wall or barrier at 12th Street to direct storm flow to inlets. | High |
| 5 | MP 244.45 to 244.61<br>11th Street to Melanie Lane | Modify existing junction structure to provide debris control, reconstruct existing channel, add/modify inlets in 11th Street. New channel width to match existing channel width – 12 feet maximum. New channel connection to structure with 14-foot maximum opening. Provide slope stabilization to support existing channel between Melanie Way and 11th Street. | High |

| | | | |
|---|---|---|---|
| **6** | MP 244.48 to 244.7 | New 24-inch storm drain and outlet to beach, 200 feet of 24-inch storm drain south in trench, new 8-foot wide concrete gutter ditch west side and 5-foot wide concrete ditch east side. | High |
| **7** | MP 244.64 to 244.71<br>9th Street | New storm drain channel inlet apron and widened channel at 9th Street, new channel outfall from Shippey Lane and replace failing segment of channel at entrance to 8th Street storm drain outfall. | Medium |
| **8** | MP 244.7<br>8th Street | Modify existing drainage structure – raise outlet elevation above existing beach level, repair mid-bluff headwall, lower existing weir structure to reduce low flow, construct concrete trackside ditch 6 feet wide x 1-foot deep. | Medium |
| **9** | MP 244.9 | New 24-inch storm drain and outlet to beach, concrete trapezoidal track side ditch 10-foot wide x 2-foot deep east and west. | High |
| **10** | MP 244.83 to<br>245.02<br>Sherrie Lane to 4th Street | Add splash walls to existing channel and modify inlets/ add seat wall at 4th Street and Sherrie Lane to direct flow. | Medium |
| **11** | MP 244.9 | Reconstruct existing down drain structure due to age and condition. | Low |
| **12** | MP 244.1<br>4th Street | New 24-inch storm drain and outlet to beach, concrete trapezoidal track side ditch 10-foot wide x 2-foot deep east and west. | High |
| **13** | MP 245.15 | Reconstruct existing down drain structure due to age and condition. | Low |
| **14** | MP245.39 to 245.62 | New 5-foot wide U-Ditch with pervious bottom, retaining wall and underdrain. | Medium |
| **15** | MP 245.22 | New 24-inch storm drain and outlet to beach, concrete trapezoidal track side ditch 10-foot wide x 2-foot deep west. | High |

## Works Cited

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DMJM & Harris. Del Mar Drainage Study Report (September 2001)

Bentley Flow Master V 8I

# APPENDIX

# Appendix A

Hydrology Calculations

I. Basin Discharge Summary
II. Existing Q with Routing and Bypass

## A.I. Basin Discharge Summary

**Table A-1_Peak Discharge Summary at Design Points**

| Design Points | Location | Station | Existing Q100 | Existing Q50 | Existing Q25 | Contributing Basins |
|---|---|---|---|---|---|---|
| 1 | 15th Street | 1548+50 | *124 | 96 | 82 | Basin H |
| 3 | 13th Street | 1540+50 | 66 | 55 | 48 | Basin I, J, K |
| 4 | 12th Street | 1533+80 | 68 | 65 | 62 | Basin G |
| 6 | Sea Orbit Lane | 1531+30 | 115 | 97 | 85 | Basin E, F |
| 12 | 8th Street | 1517+60 | 171 | 157 | 148 | Basin D |
| 14 | Anderson Canyon | 1583 | 195 | 176 | 163 | Basin A, B, C |

* The existing pipe capacity at design point 3 is 38 cfs and inadequate for Q100, by pass from DP.3 is added to Q at Dp.1

**Table A-2-1_Basin 100-yr Discharge Summary**

| Basins | C | I | A | Existing Q100 |
|---|---|---|---|---|
| A.1 | 0.51 | 3.41 | 38.1 | 66.3 |
| A.2 | 0.42 | 5.09 | 11 | 23.5 |
| B.1 | 0.54 | 3.41 | 11.4 | 21.0 |
| B.2.2 | 0.32 | 5.09 | 4.4 | 7.2 |
| B.2.1.1 | 0.58 | 5.09 | 4.9 | 14.5 |
| B.2.1.2 | 0.42 | 5.09 | 6.2 | 13.3 |
| C.1 | 0.54 | 3.41 | 28 | 51.6 |
| C.2 | 0.58 | 5.09 | 9.9 | 29.2 |
| C.3 | 0.67 | 5.09 | 11 | 37.5 |
| D.1 | 0.54 | 3.41 | 52 | 95.8 |
| D.2 | 0.54 | 3.41 | 37.6 | 69.3 |
| D.3.1 | 0.7 | 5.09 | 17.1 | 60.9 |
| D.3.2 | 0.74 | 5.09 | 5.3 | 20.0 |
| D.3.3 | 0.74 | 5.09 | 10.6 | 39.9 |
| E.1 | 0.56 | 3.41 | 13.8 | 26.4 |
| E.2 | 0.66 | 5.09 | 7.2 | 24.2 |
| F.1 | 0.56 | 3.41 | 12.4 | 23.7 |
| F.2.1 | 0.66 | 5.09 | 10.3 | 34.6 |
| F.2.2 | 0.66 | 5.09 | 3.3 | 11.1 |
| G.1 | 0.56 | 3.41 | 40 | 76.5 |
| G.2 | 0.66 | 5.09 | 5 | 16.8 |
| H.1 | 0.56 | 3.41 | 12.9 | 24.7 |
| H.2 | 0.56 | 3.41 | 24.6 | 47.0 |
| H.3 | 0.8 | 5.09 | 7.7 | 31.4 |
| H.4 | 0.46 | 5.09 | 2.5 | 5.9 |
| I | 0.7 | 5.09 | 8.8 | 31.4 |
| J | 0.66 | 5.09 | 5.2 | 17.5 |
| K | 0.66 | 5.09 | 1.9 | 6.4 |
| L | 0.25 | 5.09 | 4.8 | 6.1 |

Table A-2-2_Basin 50-yr Discharge Summary

| Basins | C | I | A | Existing Q50 |
|---|---|---|---|---|
| A.1 | 0.51 | 2.99 | 38.1 | 58.1 |
| A.2 | 0.42 | 4.45 | 11 | 20.6 |
| B.1 | 0.54 | 2.99 | 11.4 | 18.4 |
| B.2.2 | 0.32 | 4.45 | 4.4 | 6.3 |
| B.2.1.1 | 0.58 | 4.45 | 4.9 | 12.6 |
| B.2.1.2 | 0.42 | 4.45 | 6.2 | 11.6 |
| C.1 | 0.54 | 2.99 | 28 | 45.2 |
| C.2 | 0.58 | 4.45 | 9.9 | 25.6 |
| C.3 | 0.67 | 4.45 | 11 | 32.8 |
| D.1 | 0.54 | 2.99 | 52 | 84.0 |
| D.2 | 0.54 | 2.99 | 37.6 | 60.7 |
| D.3.1 | 0.7 | 4.45 | 17.1 | 53.3 |
| D.3.2 | 0.74 | 4.45 | 5.3 | 17.5 |
| D.3.3 | 0.74 | 4.45 | 10.6 | 34.9 |
| E.1 | 0.56 | 2.99 | 13.8 | 23.1 |
| E.2 | 0.66 | 4.45 | 7.2 | 21.1 |
| F.1 | 0.56 | 2.99 | 12.4 | 20.8 |
| F.2.1 | 0.66 | 4.45 | 10.3 | 30.3 |
| F.2.2 | 0.66 | 4.45 | 3.3 | 9.7 |
| G.1 | 0.56 | 2.99 | 40 | 67.0 |
| G.2 | 0.66 | 4.45 | 5 | 14.7 |
| H.1 | 0.56 | 2.99 | 12.9 | 21.6 |
| H.2 | 0.56 | 2.99 | 24.6 | 41.2 |
| H.3 | 0.8 | 4.45 | 7.7 | 27.4 |
| H.4 | 0.46 | 4.45 | 2.5 | 5.1 |
| I | 0.7 | 4.45 | 8.8 | 27.4 |
| J | 0.66 | 4.45 | 5.2 | 15.3 |
| K | 0.66 | 4.45 | 1.9 | 5.6 |
| L | 0.25 | 4.45 | 4.8 | 5.3 |

Table A-2-3_Basin 25-yr Discharge Summary

| Basins | C | I | A | Existing Q25 |
|---|---|---|---|---|
| A.1 | 0.51 | 2.7 | 38.1 | 52.5 |
| A.2 | 0.42 | 4.03 | 11 | 18.6 |
| B.1 | 0.54 | 2.7 | 11.4 | 16.6 |
| B.2.2 | 0.32 | 4.03 | 4.4 | 5.7 |
| B.2.1.1 | 0.58 | 4.03 | 4.9 | 11.5 |
| B.2.1.2 | 0.42 | 4.03 | 6.2 | 10.5 |
| C.1 | 0.54 | 2.7 | 28 | 40.8 |
| C.2 | 0.58 | 4.03 | 9.9 | 23.1 |
| C.3 | 0.67 | 4.03 | 11 | 29.7 |
| D.1 | 0.54 | 2.7 | 52 | 75.8 |
| D.2 | 0.54 | 2.7 | 37.6 | 54.8 |
| D.3.1 | 0.7 | 4.03 | 17.1 | 48.2 |
| D.3.2 | 0.74 | 4.03 | 5.3 | 15.8 |
| D.3.3 | 0.74 | 4.03 | 10.6 | 31.6 |
| E.1 | 0.56 | 2.7 | 13.8 | 20.9 |
| E.2 | 0.66 | 4.03 | 7.2 | 19.2 |
| F.1 | 0.56 | 2.7 | 12.4 | 18.7 |
| F.2.1 | 0.66 | 4.03 | 10.3 | 27.4 |
| F.2.2 | 0.66 | 4.03 | 3.3 | 8.8 |
| G.1 | 0.56 | 2.7 | 40 | 60.5 |
| G.2 | 0.66 | 4.03 | 5 | 13.3 |
| H.1 | 0.56 | 2.7 | 12.9 | 19.5 |
| H.2 | 0.56 | 2.7 | 24.6 | 37.2 |
| H.3 | 0.8 | 4.03 | 7.7 | 24.8 |
| H.4 | 0.46 | 4.03 | 2.5 | 4.6 |
| I | 0.7 | 4.03 | 8.8 | 24.8 |
| J | 0.66 | 4.03 | 5.2 | 13.8 |
| K | 0.66 | 4.03 | 1.9 | 5.1 |
| L | 0.25 | 4.03 | 4.8 | 4.8 |

Table A-3-1_Railroad Basin 100-yr Discharge Summary

| Basins | C | I | A | Existing Q100 |
|---|---|---|---|---|
| Railroad 1 | 0.25 | 5.09 | 0.7 | 0.9 |
| Railroad 2 | 0.25 | 5.09 | 0.4 | 0.5 |
| Railroad 3 | 0.25 | 5.09 | 1.1 | 1.4 |
| Railroad 4 | 0.25 | 5.09 | 0.6 | 0.8 |
| Railroad 5 | 0.25 | 5.09 | 1.2 | 1.5 |
| Railroad 6 | 0.25 | 5.09 | 3.8 | 4.8 |
| Railroad 7 | 0.25 | 5.09 | 1.2 | 1.5 |
| Railroad 8 | 0.25 | 5.09 | 0.8 | 1.0 |
| Railroad 9 | 0.25 | 5.09 | 0.4 | 0.5 |
| Railroad 10 | 0.25 | 5.09 | 0.9 | 1.1 |
| Railroad 11 | 0.25 | 5.09 | 0.6 | 0.8 |
| Railroad 12 | 0.25 | 5.09 | 1.9 | 2.4 |
| Railroad 13 | 0.25 | 5.09 | 0.7 | 0.9 |

Table A-3-2_Railroad Basin 50-yr Discharge Summary

| Basins | C | I | A | Existing Q50 |
|---|---|---|---|---|
| Railroad 1 | 0.25 | 4.45 | 0.7 | 0.8 |
| Railroad 2 | 0.25 | 4.45 | 0.4 | 0.4 |
| Railroad 3 | 0.25 | 4.45 | 1.1 | 1.2 |
| Railroad 4 | 0.25 | 4.45 | 0.6 | 0.7 |
| Railroad 5 | 0.25 | 4.45 | 1.2 | 1.3 |
| Railroad 6 | 0.25 | 4.45 | 3.8 | 4.2 |
| Railroad 7 | 0.25 | 4.45 | 1.2 | 1.3 |
| Railroad 8 | 0.25 | 4.45 | 0.8 | 0.9 |
| Railroad 9 | 0.25 | 4.45 | 0.4 | 0.4 |
| Railroad 10 | 0.25 | 4.45 | 0.9 | 1.0 |
| Railroad 11 | 0.25 | 4.45 | 0.6 | 0.7 |
| Railroad 12 | 0.25 | 4.45 | 1.9 | 2.1 |
| Railroad 13 | 0.25 | 4.45 | 0.7 | 0.8 |

Table A-3-3_Railroad Basin 25-yr Discharge Summary

| Basins | C | I | A | Existing Q25 |
|---|---|---|---|---|
| Railroad 1 | 0.25 | 4.03 | 0.7 | 0.7 |
| Railroad 2 | 0.25 | 4.03 | 0.4 | 0.4 |
| Railroad 3 | 0.25 | 4.03 | 1.1 | 1.1 |
| Railroad 4 | 0.25 | 4.03 | 0.6 | 0.6 |
| Railroad 5 | 0.25 | 4.03 | 1.2 | 1.2 |
| Railroad 6 | 0.25 | 4.03 | 3.8 | 3.8 |
| Railroad 7 | 0.25 | 4.03 | 1.2 | 1.2 |
| Railroad 8 | 0.25 | 4.03 | 0.8 | 0.8 |
| Railroad 9 | 0.25 | 4.03 | 0.4 | 0.4 |
| Railroad 10 | 0.25 | 4.03 | 0.9 | 0.9 |
| Railroad 11 | 0.25 | 4.03 | 0.6 | 0.6 |
| Railroad 12 | 0.25 | 4.03 | 1.9 | 1.9 |
| Railroad 13 | 0.25 | 4.03 | 0.7 | 0.7 |

## A.II. Existing Q with Routing and Bypass

| | |
|---|---|
| APPENDIX | A |
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

**DEL MAR BLUFF 5**

**HYDROLOGY CALCULATIONS - WITH ROUTING (IN COUNTY OF SAN DIEGO)**

**EXISTING CONDITIONS**

| BASIN CHARACTERISTICS | | | | | CONDITIONS AT BASIN POINT OF CONCENTRATION | | | CONDITIONS AT JUNCTION (NOTE 1) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Basin | Downstream Junction | Area (Acres) | C | P6 (Inches) | Tc Basin (Min.) | I Basin (Inches/Hour) | Q Basin (CFS) | Tc Junction (Min.) | I Junction (Inches/Hour) | Intensity Adjustment Factor | Q Junction (CFS) | Flow Restricted by Pipe/Inlet capacity, max Q (CFS) | Q By Pass (CFS) | Q = Q Junction _ Q By Pass (CFS) |

## EXISTING CONDITIONS - 100 year

| Basin | Downstream Junction | Area (Acres) | C | P6 (Inches) | Tc Basin (Min.) | I Basin (Inches/Hour) | Q Basin (CFS) | Tc Junction (Min.) | I Junction (Inches/Hour) | Intensity Adjustment Factor | Q Junction (CFS) | Flow Restricted by Pipe/Inlet capacity, max Q (CFS) | Q By Pass (CFS) | Q = Q Junction _ Q By Pass (CFS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **100-YEAR STORM - BASIN A** | | | | | | | | | | | | | | |
| A.1 | A | 38.1 | 0.51 | 2.4 | 13.0 | 3.41 | 66.3 | 15.0 | 3.11 | 0.91 | 60.5 | 49.0 | 11.5 | |
| A.2 | A | 11.0 | 0.42 | 2.4 | 7.0 | 5.09 | 23.5 | 15.0 | 3.11 | 0.61 | 14.4 | | | |
| | **SUM** | 49.1 | | | | | | | | **TOTAL $Q_{100}$ =** | **74.9** | **49.0** | **** 11.5** | **63.4** |
| **100-YEAR STORM - BASIN B** | | | | | | | | | | | | | | |
| B.1 | B | 11.4 | 0.54 | 2.4 | 13.0 | 3.41 | 21.0 | 15.0 | 3.1 | 0.9 | 19.2 | 31.0 | 0.0 | |
| B.2.1.1 | B | 4.9 | 0.58 | 2.4 | 7.0 | 5.09 | 14.5 | 15.0 | 3.1 | 0.6 | 8.8 | 0.0 | | |
| B.2.1.2 | B | 6.2 | 0.42 | 2.4 | 7.0 | 5.09 | 13.3 | 15.0 | 3.1 | 0.6 | 8.1 | | | |
| | **SUM** | 22.5 | | | | | | | | **TOTAL $Q_{100}$ =** | **36.1** | **31.0** | **0.0** | **36.1** |
| **100-YEAR STORM - BASIN C** | | | | | | | | | | | | | | |
| C.1 | C | 28.0 | 0.54 | 2.4 | 13.0 | 3.41 | 51.6 | 15.0 | 3.11 | 0.91 | 47.1 | 48.0 | 0.0 | |
| C.2 | C | 9.9 | 0.58 | 2.4 | 7.0 | 5.09 | 29.2 | 15.0 | 3.11 | 0.61 | 17.9 | | | |
| C.3 | C | 11.0 | 0.67 | 2.4 | 7.0 | 5.09 | 37.5 | 15.0 | 3.11 | 0.61 | 22.9 | | | |
| | **SUM** | 48.9 | | | | | | | | **TOTAL $Q_{100}$ =** | **87.9** | **48.0** | **0.0** | **87.9** |
| **100-YEAR STORM - BASIN D** | | | | | | | | | | | | | | |
| D.1 | D | 52.0 | 0.54 | 2.4 | 13.0 | 3.41 | 95.8 | 15.0 | 3.11 | 0.91 | 87.3 | 48.00 | 39.3 | |
| D.2 | D | 37.6 | 0.54 | 2.4 | 13.0 | 3.41 | 69.3 | 15.0 | 3.11 | 0.91 | 63.2 | 31.00 | 32.2 | |
| D.3.1 | D | 17.1 | 0.70 | 2.4 | 7.0 | 5.09 | 60.9 | 15.0 | 3.11 | 0.61 | 37.3 | | | |
| D.3.2 | D | 5.3 | 0.74 | 2.4 | 7.0 | 5.09 | 20.0 | 15.0 | 3.11 | 0.61 | 12.2 | | | |
| D.3.3 | D | 10.6 | 0.74 | 2.4 | 7.0 | 5.09 | 39.9 | 15.0 | 3.11 | 0.61 | 24.4 | | | |
| 9th Street | 1/4 Q By pass of Basin D | | | | | | | 15.0 | | | 17.9 | | | |
| | **SUM** | 122.5 | | | | | | | | **TOTAL $Q_{100}$ =** | **242.3** | **79.0** | *** 71.5** | **170.8** |
| **100-YEAR STORM - BASIN E** | | | | | | | | | | | | | | |
| E.1 | E | 13.8 | 0.56 | 2.4 | 13.0 | 3.41 | 26.4 | 15.0 | 3.11 | 0.91 | 24.1 | 31.0 | 0.0 | |
| E.2 | E | 7.2 | 0.66 | 2.4 | 7.0 | 5.09 | 24.2 | 15.0 | 3.11 | 0.61 | 14.8 | | | |
| 10th Street | 1/4 Q By pass of Basin D | | | 2.4 | 15.0 | 3.11 | 17.9 | 15.0 | 3.11 | 1.00 | 17.9 | | | |
| | **SUM** | 21.0 | | | | | | | | **TOTAL $Q_{100}$ =** | **56.8** | **31.0** | **0.0** | **56.8** |
| **100-YEAR STORM - BASIN F** | | | | | | | | | | | | | | |
| F.1 | F | 12.4 | 0.56 | 2.4 | 13.0 | 3.41 | 23.7 | 15.0 | 3.11 | 0.91 | 21.6 | 31.00 | 0.0 | |
| F.2.1 | F | 10.3 | 0.66 | 2.4 | 7.0 | 5.09 | 34.6 | 15.0 | 3.11 | 0.61 | 21.2 | | 0.0 | |
| F.2.2 | F | 3.3 | 0.66 | 2.4 | 7.0 | 5.09 | 11.1 | 15.0 | 3.11 | 0.61 | 6.8 | | | |
| 11th Street | 1/4 of 1/2 Q By pass of Basin D | | | | 15.0 | | 8.9 | 15.0 | TcF/TcD | 1.00 | 8.9 | | | |
| | **SUM** | 26.0 | | | | | | | | **TOTAL $Q_{100}$ =** | **58.4** | **31.0** | **0.0** | **58.4** |
| **100-YEAR STORM - BASIN G** | | | | | | | | | | | | | | |
| G.1 | G | 40.0 | 0.56 | 2.4 | 13.0 | 3.41 | 76.5 | 15.0 | 3.11 | 0.91 | 69.7 | 49.0 | 20.7 | |
| G.2 | G | 5.0 | 0.66 | 2.4 | 7.0 | 5.09 | 16.8 | 15.0 | 3.11 | 0.61 | 10.3 | | | |
| 12th street | 1/4 of 1/2 Q By pass of Basin D | | | | 15.0 | | 8.9 | 15.0 | TcF/TcD | 1.00 | 8.9 | | | |
| 12th street | 1/2 of 1/2 Q By pass of Basin D | | | | 15.0 | | 17.9 | 15.0 | TcF/TcD | 1.00 | 17.9 | | 17.9 | |
| | **SUM** | 45.0 | | | | | | | | **TOTAL $Q_{100}$ =** | **106.8** | **49.0** | *** 38.6** | **68.2** |
| **100-YEAR STORM - BASIN I** | | | | | | | | | | | | | | |
| I | | 8.8 | 0.70 | 2.4 | 7.0 | 5.09 | 31.4 | 15.0 | 3.11 | 0.61 | 19.2 | | | |
| J | | 5.2 | 0.66 | 2.4 | 7.0 | 5.09 | 17.5 | 15.0 | 3.11 | 0.61 | 10.7 | | | |
| 13th Street | 1/4 Q By pass of Basin G | | | | 15.0 | | 9.7 | 15.0 | | 1.00 | 9.7 | | | |
| K | | 1.9 | 0.66 | 2.4 | 7.0 | 5.09 | 6.4 | 15.0 | 3.11 | 0.61 | 3.9 | | | |
| Railroad Basin 13 | | 0.7 | 0.25 | 2.4 | 7.0 | 5.09 | 0.9 | 15.0 | 3.11 | 0.61 | 0.5 | | | |
| | **SUM** | 16.6 | | | | **SUM** | **65.7** | | | **TOTAL $Q_{100}$ =** | **43.9** | **0.0** | **0.0** | **43.9** |
| **100-YEAR STORM - BASIN H** | | | | | | | | | | | | | | |
| H.1 | H | 12.9 | 0.56 | 2.4 | 13.0 | 3.41 | 24.7 | 15.0 | 3.11 | 0.91 | 22.5 | 21.7 | 0.8 | |
| H.2 | H | 24.6 | 0.56 | 2.4 | 13.0 | 3.41 | 47.0 | 15.0 | 3.11 | 0.91 | 42.9 | 49.0 | 0.0 | |
| H.3 | H | 7.7 | 0.80 | 2.4 | 7.0 | 5.09 | 31.4 | 15.0 | 3.11 | 0.61 | 19.2 | | | |
| H.4 | | 2.5 | 0.46 | 2.4 | 7.0 | 5.09 | 5.9 | 15.0 | 3.11 | 0.61 | 3.6 | | | |
| 15th Street | 1/2 Q By pass of Basin G | | | | | | 19.3 | 15.0 | 3.11 | 1.00 | 19.3 | | | |
| 15th Street | 1/4 Q By pass of Basin G | | | | | | 9.7 | 15.0 | 3.11 | 1.00 | 9.7 | | | |
| 15th Street | Q By pass of basin H.1 | | | | | | 0.8 | 15.0 | 3.11 | 1.00 | 0.8 | | | |
| | **SUM** | 45.2 | | | | | | | | **TOTAL $Q_{100}$ =** | **117.9** | **70.7** | **0.8** | |

| APPENDIX | A |
|---|---|
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

# DEL MAR BLUFF 5
## HYDROLOGY CALCULATIONS - WITH ROUTING (IN COUNTY OF SAN DIEGO)
## EXISTING CONDITIONS

| BASIN CHARACTERISTICS | | | | | CONDITIONS AT BASIN POINT OF CONCENTRATION | | | CONDITIONS AT JUNCTION (NOTE 1) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Basin | Downstream Junction | Area (Acres) | C | P6 (Inches) | Tc Basin (Min.) | I Basin (Inches/Hour) | Q Basin (CFS) | Tc Junction (Min.) | I Junction (Inches/Hour) | Intensity Adjustment Factor | Q Junction (CFS) | Flow Restricted by Pipe/Inlet capacity, max Q (CFS) | Q By Pass (CFS) | Q = Q Junction _ Q By Pass (CFS) |
| **100-YEAR STORM - BASIN B.2.2** | | | | | | | | | | | | | | |
| B.2.2 | | 4.4 | 0.32 | 2.4 | 7.0 | 5.09 | 7.2 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - BASIN L** | | | | | | | | | | | | | | |
| L | | 4.8 | 0.25 | 2.4 | 7.0 | 5.09 | 6.1 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 1** | | | | | | | | | | | | | | |
| RailRoad 1 | | 0.7 | 0.25 | 2.4 | 7.0 | 5.090 | 0.9 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 2** | | | | | | | | | | | | | | |
| RailRoad 2 | | 0.4 | 0.25 | 2.4 | 7.0 | 5.09 | 0.5 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 3** | | | | | | | | | | | | | | |
| RailRoad 3 | | 1.1 | 0.25 | 2.4 | 7.0 | 5.09 | 1.4 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 4** | | | | | | | | | | | | | | |
| RailRoad 4 | | 0.6 | 0.25 | 2.4 | 7.0 | 5.09 | 0.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 5** | | | | | | | | | | | | | | |
| RailRoad 5 | | 1.2 | 0.25 | 2.4 | 7.0 | 5.09 | 1.5 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 6** | | | | | | | | | | | | | | |
| RailRoad 6 | | 3.8 | 0.25 | 2.4 | 7.0 | 5.09 | 4.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 7** | | | | | | | | | | | | | | |
| RailRoad 7 | | 1.2 | 0.25 | 2.4 | 7.0 | 5.09 | 1.5 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 8** | | | | | | | | | | | | | | |
| RailRoad 8 | | 0.8 | 0.25 | 2.4 | 7.0 | 5.09 | 1.0 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 9** | | | | | | | | | | | | | | |
| RailRoad 9 | | 0.4 | 0.25 | 2.4 | 7.0 | 5.09 | 0.5 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 10** | | | | | | | | | | | | | | |
| RailRoad 10 | | 0.9 | 0.25 | 2.4 | 7.0 | 5.09 | 1.1 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 11** | | | | | | | | | | | | | | |
| RailRoad 11 | | 0.6 | 0.25 | 2.4 | 7.0 | 5.09 | 0.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 12** | | | | | | | | | | | | | | |
| RailRoad12 | | 1.9 | 0.25 | 2.4 | 7.0 | 5.09 | 2.4 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |
| **100-YEAR STORM - RailRoad 13** | | | | | | | | | | | | | | |
| RailRoad 13 | | 0.7 | 0.25 | 2.4 | 7.0 | 5.09 | 0.9 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{100}$ =** | | | | |

## EXISTING CONDITIONS - 50 year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50-YEAR STORM - BASIN A** | | | | | | | | | | | | | | |
| A.1 | A | 38.1 | 0.51 | 2.1 | 13.0 | 2.99 | 58.0 | 15.0 | 2.72 | 0.91 | 52.9 | 49.0 | 3.9 | |
| A.2 | A | 11.0 | 0.42 | 2.1 | 7.0 | 4.45 | 20.6 | 15.0 | 2.72 | 0.61 | 12.6 | | | |
| | **SUM** | 49.1 | | | | | | | | **TOTAL $Q_{50}$ =** | **65.5** | **49.0** | ****3.9** | **61.6** |
| **50-YEAR STORM - BASIN B** | | | | | | | | | | | | | | |
| B.1 | B | 11.4 | 0.54 | 2.1 | 13.0 | 2.99 | 18.4 | 15.0 | 2.7 | 0.9 | 16.8 | 31.0 | 0.0 | |
| B.2.1.1 | B | 4.9 | 0.58 | 2.1 | 7.0 | 4.45 | 12.7 | 15.0 | 2.7 | 0.6 | 7.7 | 0.0 | | |
| B.2.1.2 | B | 6.2 | 0.42 | 2.1 | 7.0 | 4.45 | 11.6 | 15.0 | 2.7 | 0.6 | 7.1 | | | |
| | **SUM** | 22.5 | | | | | | | | **TOTAL $Q_{50}$ =** | **31.6** | **31.0** | **0.0** | **31.6** |

| APPENDIX | A |
|---|---|
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

**DEL MAR BLUFF 5**

**HYDROLOGY CALCULATIONS - WITH ROUTING (IN COUNTY OF SAN DIEGO)**

**EXISTING CONDITIONS**

| BASIN CHARACTERISTICS | | | | | CONDITIONS AT BASIN POINT OF CONCENTRATION | | | CONDITIONS AT JUNCTION (NOTE 1) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| **Basin** | **Downstream Junction** | **Area (Acres)** | **C** | **P6 (Inches)** | **Tc Basin (Min.)** | **I Basin (Inches/Hour)** | **Q Basin (CFS)** | **Tc Junction (Min.)** | **I Junction (Inches/Hour)** | **Intensity Adjustment Factor** | **Q Junction (CFS)** | **Flow Restricted by Pipe/Inlet capacity, max Q (CFS)** | **Q By Pass (CFS)** | **Q = Q Junction _ Q By Pass (CFS)** |
| **50-YEAR STORM - BASIN C** | | | | | | | | | | | | | | |
| C.1 | C | 28.0 | 0.54 | 2.1 | 13.0 | 2.99 | 45.2 | 15.0 | 2.72 | 0.91 | 41.2 | 48.0 | 0.0 | |
| C.2 | C | 9.9 | 0.58 | 2.1 | 7.0 | 4.45 | 25.6 | 15.0 | 2.72 | 0.61 | 15.6 | | | |
| C.3 | C | 11.0 | 0.67 | 2.1 | 7.0 | 4.45 | 32.8 | 15.0 | 2.72 | 0.61 | 20.1 | | | |
| | **SUM** | 48.9 | | | | | | | | **TOTAL $Q_{50}$ =** | **76.9** | **48.0** | **0.0** | **76.9** |
| **50-YEAR STORM - BASIN D** | | | | | | | | | | | | | | |
| D.1 | D | 52.0 | 0.54 | 2.1 | 13.0 | 2.99 | 83.8 | 15.0 | 2.72 | 0.91 | 76.4 | 48.00 | 28.4 | |
| D.2 | D | 37.6 | 0.54 | 2.1 | 13.0 | 2.99 | 60.6 | 15.0 | 2.72 | 0.91 | 55.3 | 31.00 | 24.3 | |
| D.3.1 | D | 17.1 | 0.70 | 2.1 | 7.0 | 4.45 | 53.3 | 15.0 | 2.72 | 0.61 | 32.6 | | | |
| D.3.2 | D | 5.3 | 0.74 | 2.1 | 7.0 | 4.45 | 17.5 | 15.0 | 2.72 | 0.61 | 10.7 | | | |
| D.3.3 | D | 10.6 | 0.74 | 2.1 | 7.0 | 4.45 | 34.9 | 15.0 | 2.72 | 0.61 | 21.4 | | | |
| 9th Street | 1/4 Q By pass of Basin D | | | | | | | 15.0 | | | 13.2 | | | |
| | **SUM** | 122.5 | | | | | | | | **TOTAL $Q_{50}$ =** | **209.5** | **79.0** | *** 52.7** | **156.8** |
| **50-YEAR STORM - BASIN E** | | | | | | | | | | | | | | |
| E.1 | E | 13.8 | 0.56 | 2.1 | 13.0 | 2.99 | 23.1 | 15.0 | 2.72 | 0.91 | 21.1 | 31.0 | 0.0 | |
| E.2 | E | 7.2 | 0.66 | 2.1 | 7.0 | 4.45 | 21.2 | 15.0 | 2.72 | 0.61 | 12.9 | | | |
| 10th Street | 1/4 Q By pass of Basin D | | | | 15.0 | | 13.2 | | | 1.00 | 13.2 | | | |
| | **SUM** | 21.0 | | | | | | | | **TOTAL $Q_{50}$ =** | **47.2** | **31.0** | **0.0** | **47.2** |
| **50-YEAR STORM - BASIN F** | | | | | | | | | | | | | | |
| F.1 | F | 12.4 | 0.56 | 2.1 | 13.0 | 2.99 | 20.7 | 15.0 | 2.72 | 0.91 | 18.9 | 31.00 | 0.0 | |
| F.2.1 | F | 10.3 | 0.66 | 2.1 | 7.0 | 4.45 | 30.3 | 15.0 | 2.72 | 0.61 | 18.5 | | | |
| F.2.2 | F | 3.3 | 0.66 | 2.1 | 7.0 | 4.45 | 9.7 | 15.0 | 2.72 | 0.61 | 5.9 | | | |
| 11th Street | 1/4 of 1/2 Q By pass of Basin D | | | | 15.0 | | 6.6 | 15.0 | TcF/TcD | 1.00 | 6.6 | | | |
| | **SUM** | 26.0 | | | | | | | | **TOTAL $Q_{50}$ =** | **49.9** | **31.0** | **0.0** | **49.9** |
| **50-YEAR STORM - BASIN G** | | | | | | | | | | | | | | |
| G.1 | G | 40.0 | 0.56 | 2.1 | 13.0 | 2.99 | 66.9 | 15.0 | 2.72 | 0.91 | 61.0 | 49.0 | 12.0 | |
| G.2 | G | 5.0 | 0.66 | 2.1 | 7.0 | 4.45 | 14.7 | 15.0 | 2.72 | 0.61 | 9.0 | | | |
| 12th street | 1/4 of 1/2 Q By pass of Basin D | | | | 15.0 | | 6.6 | 15.0 | TcF/TcD | 1.00 | 6.6 | | | |
| 12th street | 1/2 of 1/2 Q By pass of Basin D | | | | 15.0 | | 13.2 | 15.0 | TcF/TcD | 1.00 | 13.2 | | 13.2 | |
| | **SUM** | 45.0 | | | | | | | | **TOTAL $Q_{50}$ =** | **89.8** | **49.0** | *** 25.2** | **64.6** |
| **50-YEAR STORM - BASIN I** | | | | | | | | | | | | | | |
| I | | 8.8 | 0.70 | 2.1 | 7.0 | 4.45 | 27.4 | 15.0 | 2.72 | 0.61 | 16.8 | | | |
| J | | 5.2 | 0.66 | 2.1 | 7.0 | 4.45 | 15.3 | 15.0 | 2.72 | 0.61 | 9.3 | | | |
| 13th Street | 1/4 Q By pass of Basin G | | | | 15.0 | | 6.3 | 15.0 | | 1.00 | 6.3 | | | |
| K | | 1.9 | 0.66 | 2.1 | 7.0 | 4.45 | 5.6 | 15.0 | 2.72 | 0.61 | 3.4 | | | |
| RailRoad Basin 13 | | 0.7 | 0.3 | 2.1 | 7.0 | 4.45 | 0.8 | 15.0 | 2.72 | 0.61 | 0.5 | | | |
| | **SUM** | 16.6 | | | | **SUM** | **55.4** | | | **TOTAL $Q_{50}$ =** | **36.3** | **0.0** | **0.0** | **36.3** |
| **50-YEAR STORM - BASIN H** | | | | | | | | | | | | | **77.9** | |
| H.1 | H | 12.9 | 0.56 | 2.1 | 13.0 | 2.99 | 21.6 | 15.0 | 2.72 | 0.91 | 19.7 | 21.7 | 0.0 | |
| H.2 | H | 24.6 | 0.56 | 2.1 | 13.0 | 2.99 | 41.2 | 15.0 | 2.72 | 0.91 | 37.5 | 49.0 | 0.0 | |
| H.3 | H | 7.7 | 0.80 | 2.1 | 7.0 | 4.45 | 27.4 | 15.0 | 2.72 | 0.61 | 16.8 | | | |
| H.4 | | 2.5 | 0.46 | 2.1 | 7.0 | 4.45 | 5.1 | 15.0 | 2.72 | 0.61 | 3.1 | | | |
| 15th Street | 1/2 Q By pass of Basin G | | | | | | 12.6 | 15.0 | 2.72 | 1.00 | 12.6 | | | |
| 15th Street | 1/4 Q By pass of Basin G | | | | | | 6.3 | 15.0 | 2.72 | 1.00 | 6.3 | | | |
| | **SUM** | 45.2 | | | | | . | | | **TOTAL $Q_{50}$ =** | **96.0** | **70.7** | **0.0** | **96.0** |
| **50-YEAR STORM - BASIN B.2.2** | | | | | | | | | | | | | | |
| B.2.2 | | 4.4 | 0.32 | 2.1 | 7.0 | 4.45 | 6.3 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - BASIN L** | | | | | | | | | | | | | | |
| L | | 4.8 | 0.25 | 2.1 | 7.0 | 4.45 | 5.3 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 1** | | | | | | | | | | | | | | |
| RailRoad 1 | | 0.7 | 0.25 | 2.1 | 7.0 | 4.45 | 0.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |

| | |
|---|---|
| APPENDIX | A |
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

## DEL MAR BLUFF 5
## HYDROLOGY CALCULATIONS - WITH ROUTING (IN COUNTY OF SAN DIEGO)
## EXISTING CONDITIONS

| BASIN CHARACTERISTICS | | | | | CONDITIONS AT BASIN POINT OF CONCENTRATION | | | CONDITIONS AT JUNCTION (NOTE 1) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Basin | Downstream Junction | Area (Acres) | C | P6 (Inches) | Tc Basin (Min.) | I Basin (Inches/Hour) | Q Basin (CFS) | Tc Junction (Min.) | I Junction (Inches/Hour) | Intensity Adjustment Factor | Q Junction (CFS) | Flow Restricted by Pipe/Inlet capacity, max Q (CFS) | Q By Pass (CFS) | Q = Q Junction _ Q By Pass (CFS) |
| **50-YEAR STORM - RailRoad 2** | | | | | | | | | | | | | | |
| RailRoad 2 | | 0.4 | 0.25 | 2.1 | 7.0 | 4.45 | 0.4 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 3** | | | | | | | | | | | | | | |
| RailRoad 3 | | 1.1 | 0.25 | 2.1 | 7.0 | 4.45 | 1.2 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 4** | | | | | | | | | | | | | | |
| RailRoad 4 | | 0.6 | 0.25 | 2.1 | 7.0 | 4.45 | 0.7 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 5** | | | | | | | | | | | | | | |
| RailRoad 5 | | 1.2 | 0.25 | 2.1 | 7.0 | 4.45 | 1.3 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 6** | | | | | | | | | | | | | | |
| RailRoad 6 | | 3.8 | 0.25 | 2.1 | 7.0 | 4.45 | 4.2 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 7** | | | | | | | | | | | | | | |
| RailRoad 7 | | 1.2 | 0.25 | 2.1 | 7.0 | 4.45 | 1.3 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad8** | | | | | | | | | | | | | | |
| RailRoad 8 | | 0.8 | 0.25 | 2.1 | 7.0 | 4.45 | 0.9 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 9** | | | | | | | | | | | | | | |
| RailRoad 9 | | 0.4 | 0.25 | 2.1 | 7.0 | 4.45 | 0.4 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 10** | | | | | | | | | | | | | | |
| RailRoad10 | | 0.9 | 0.25 | 2.1 | 7.0 | 4.45 | 1.0 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 11** | | | | | | | | | | | | | | |
| RailRoad 11 | | 0.6 | 0.25 | 2.1 | 7.0 | 4.45 | 0.7 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 12** | | | | | | | | | | | | | | |
| RailRoad 12 | | 1.9 | 0.25 | 2.1 | 7.0 | 4.45 | 2.1 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |
| **50-YEAR STORM - RailRoad 13** | | | | | | | | | | | | | | |
| RailRoad 13 | | 0.7 | 0.25 | 2.1 | 7.0 | 4.45 | 0.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{50}$ =** | | | | |

## EXISTING CONDITIONS - 25 year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **25-YEAR STORM - BASIN A** | | | | | | | | | | | | | | |
| A.1 | A | 38.1 | 0.51 | 1.9 | 13.0 | 2.70 | 52.5 | 15.0 | 2.46 | 0.91 | 47.9 | 49.0 | 0.0 | |
| A.2 | A | 11.0 | 0.42 | 1.9 | 7.0 | 4.03 | 18.6 | 15.0 | 2.46 | 0.61 | 11.4 | | | |
| | **SUM** | 49.1 | | | | | | | | **TOTAL $Q_{25}$ =** | **59.3** | **49.0** | **0.0** | **59.3** |
| **25-YEAR STORM - BASIN B** | | | | | | | | | | | | | | |
| B.1 | B | 11.4 | 0.54 | 1.9 | 13.0 | 2.70 | 16.6 | 15.0 | 2.5 | 0.9 | 15.2 | 31.0 | 0.0 | |
| B.2.1.1 | B | 4.9 | 0.58 | 1.9 | 7.0 | 4.03 | 11.5 | 15.0 | 2.5 | 0.6 | 7.0 | | | |
| B.2.1.2 | B | 6.2 | 0.42 | 1.9 | 7.0 | 4.03 | 10.5 | 15.0 | 2.5 | 0.6 | 6.4 | | | |
| | **SUM** | 22.5 | | | | | | | | **TOTAL $Q_{25}$ =** | **28.6** | **31.0** | **0.0** | **28.6** |
| **25-YEAR STORM - BASIN C** | | | | | | | | | | | | | | |
| C.1 | C | 28.0 | 0.54 | 1.9 | 13.0 | 2.70 | 40.9 | 15.0 | 2.46 | 0.91 | 37.3 | 48.0 | 0.0 | |
| C.2 | C | 9.9 | 0.58 | 1.9 | 7.0 | 4.03 | 23.1 | 15.0 | 2.46 | 0.61 | 14.2 | | | |
| C.3 | C | 11.0 | 0.67 | 1.9 | 7.0 | 4.03 | 29.7 | 15.0 | 2.46 | 0.61 | 18.2 | | | |
| | **SUM** | 48.9 | | | | | | | | **TOTAL $Q_{25}$ =** | **69.6** | **48.0** | **0.0** | **69.6** |
| **25-YEAR STORM - BASIN D** | | | | | | | | | | | | | | |
| D.1 | D | 52.0 | 0.54 | 1.9 | 13.0 | 2.70 | 75.8 | 15.0 | 2.46 | 0.91 | 69.1 | 48.00 | 21.1 | |
| D.2 | D | 37.6 | 0.54 | 1.9 | 13.0 | 2.70 | 54.9 | 15.0 | 2.46 | 0.91 | 50.0 | 31.00 | 19.0 | |
| D.3.1 | D | 17.1 | 0.70 | 1.9 | 7.0 | 4.03 | 48.2 | 15.0 | 2.46 | 0.61 | 29.5 | | | |
| D.3.2 | D | 5.3 | 0.74 | 1.9 | 7.0 | 4.03 | 15.8 | 15.0 | 2.46 | 0.61 | 9.7 | | | |
| D.3.3 | D | 10.6 | 0.74 | 1.9 | 7.0 | 4.03 | 31.6 | 15.0 | 2.46 | 0.61 | 19.3 | | | |
| 9th Street | 1/4 Q By pass of Basin D | | | | | | | 15.0 | | | 10.0 | | | |
| | **SUM** | 122.5 | | | | | | | | **TOTAL $Q_{25}$ =** | **187.7** | **79.0** | *** 40.2** | **147.5** |

| | |
|---|---|
| APPENDIX | A |
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

**DEL MAR BLUFF 5**
**HYDROLOGY CALCULATIONS - WITH ROUTING (IN COUNTY OF SAN DIEGO)**
**EXISTING CONDITIONS**

| BASIN CHARACTERISTICS | | | | | CONDITIONS AT BASIN POINT OF CONCENTRATION | | | CONDITIONS AT JUNCTION (NOTE 1) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Basin | Downstream Junction | Area (Acres) | C | P6 (Inches) | Tc Basin (Min.) | I Basin (Inches/Hour) | Q Basin (CFS) | Tc Junction (Min.) | I Junction (Inches/Hour) | Intensity Adjustment Factor | Q Junction (CFS) | Flow Restricted by Pipe/Inlet capacity, max Q (CFS) | Q By Pass (CFS) | Q = Q Junction _ Q By Pass (CFS) |
| **25-YEAR STORM - BASIN E** | | | | | | | | | | | | | | |
| E.1 | E | 13.8 | 0.56 | 1.9 | 13.0 | 2.70 | 20.9 | 15.0 | 2.46 | 0.91 | 19.1 | 31.0 | 0.0 | |
| E.2 | E | 7.2 | 0.66 | 1.9 | 7.0 | 4.03 | 19.1 | 15.0 | 2.46 | 0.61 | 11.7 | | | |
| 10th Street | 1/4 Q By pass of Basin D | | | | 15.0 | | 10.0 | | | 1.00 | 10.0 | | | |
| | **SUM** | 21.0 | | | | | | | | **TOTAL $Q_{25}$ =** | **40.8** | **31.0** | **0.0** | **40.8** |
| **25-YEAR STORM - BASIN F** | | | | | | | | | | | | | | |
| F.1 | F | 12.4 | 0.56 | 1.9 | 13.0 | 2.70 | 18.7 | 15.0 | 2.46 | 0.91 | 17.1 | 31.00 | 0.0 | |
| F.2.1 | F | 10.3 | 0.66 | 1.9 | 7.0 | 4.03 | 27.4 | 15.0 | 2.46 | 0.61 | 16.8 | | | |
| F.2.2 | F | 3.3 | 0.66 | 1.9 | 7.0 | 4.03 | 8.8 | 15.0 | 2.46 | 0.61 | 5.4 | | | |
| 11th Street | 1/4 of 1/2 Q By pass of Basin D | | | | 15.0 | | 5.0 | 15.0 | TcF/TcD | 1.00 | 5.0 | | | |
| | **SUM** | 26.0 | | | | | | | | **TOTAL $Q_{25}$ =** | **44.2** | **31.0** | **0.0** | **44.2** |
| **25-YEAR STORM - BASIN G** | | | | | | | | | | | | | | |
| G.1 | G | 40.0 | 0.56 | 1.9 | 13.0 | 2.70 | 60.5 | 15.0 | 2.46 | 0.91 | 55.2 | 49.0 | 6.2 | |
| G.2 | G | 5.0 | 0.66 | 1.9 | 7.0 | 4.03 | 13.3 | 15.0 | 2.46 | 0.61 | 8.1 | | | |
| 12th street | 1/4 of 1/2 Q By pass of Basin D | | | | 15.0 | | 5.0 | 15.0 | TcF/TcD | 1.00 | 5.0 | | | |
| 12th street | 1/2 of 1/2 Q By pass of Basin D | | | | 15.0 | | 10.0 | 15.0 | TcF/TcD | 1.00 | 10.0 | | 10.0 | |
| | **SUM** | 45.0 | | | | | | | | **TOTAL $Q_{25}$ =** | **78.4** | **49.0** | *** 16.2** | **62.2** |
| **25-YEAR STORM - BASIN I** | | | | | | | | | | | | | | |
| I | | 8.8 | 0.70 | 1.9 | 7.0 | 4.03 | 24.8 | 15.0 | 2.46 | 0.61 | 15.2 | | | |
| J | | 5.2 | 0.7 | 1.9 | 7.0 | 4.03 | 13.8 | 15.0 | 2.46 | 0.61 | 8.5 | | | |
| 13th Street | 1/4 Q By pass of Basin G | | | | 15.0 | | 4.1 | 15.0 | | 1.00 | 4.1 | | | |
| K | | 1.9 | 0.7 | 1.9 | 7.0 | 4.03 | 5.1 | 15.0 | 2.46 | 0.61 | 3.1 | | | |
| RailRoad Basin 13 | | 0.7 | 0.3 | 1.9 | 7.0 | 4.03 | 0.7 | 15.0 | 2.46 | 0.61 | 0.4 | | | |
| | **SUM** | 16.6 | | | | **SUM** | **48.4** | | | **TOTAL $Q_{25}$ =** | **31.2** | **0.0** | **0.0** | **31.2** |
| **25-YEAR STORM - BASIN H** | | | | | | | | | | | | | **56.4** | |
| H.1 | H | 12.9 | 0.56 | 1.9 | 13.0 | 2.70 | 19.5 | 15.0 | 2.46 | 0.91 | 17.8 | 21.7 | 0.0 | |
| H.2 | H | 24.6 | 0.56 | 1.9 | 13.0 | 2.70 | 37.2 | 15.0 | 2.46 | 0.91 | 34.0 | 49.0 | 0.0 | |
| H.3 | H | 7.7 | 0.80 | 1.9 | 7.0 | 4.03 | 24.8 | 15.0 | 2.46 | 0.61 | 15.2 | | | |
| H.4 | | 2.5 | 0.5 | 1.9 | 7.0 | 4.03 | 4.6 | 15.0 | 2.46 | 0.61 | 2.8 | | | |
| 15th Street | 1/2 Q By pass of Basin G | | | | | | 8.1 | 15.0 | 2.46 | 1.00 | 8.1 | | | |
| 15th Street | 1/4 Q By pass of Basin G | | | | | | 4.1 | 15.0 | 2.46 | 1.00 | 4.1 | | | |
| | **SUM** | 45.2 | | | | | | | | **TOTAL $Q_{25}$ =** | **82.0** | **70.7** | **0.0** | **82.0** |
| **25-YEAR STORM - BASIN B.2.2** | | | | | | | | | | | | | | |
| B.2.2 | | 4.4 | 0.32 | 1.9 | 7.0 | 4.03 | 5.7 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - BASIN L** | | | | | | | | | | | | | | |
| L | | 4.8 | 0.25 | 1.9 | 7.0 | 4.03 | 4.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 1** | | | | | | | | | | | | | | |
| RailRoad 1 | | 0.7 | 0.25 | 1.9 | 7.0 | 4.03 | 0.7 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 2** | | | | | | | | | | | | | | |
| RailRoad 2 | | 0.4 | 0.25 | 1.9 | 7.0 | 4.03 | 0.4 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM -RailRoad 3** | | | | | | | | | | | | | | |
| RailRoad 3 | | 1.1 | 0.25 | 1.9 | 7.0 | 4.03 | 1.1 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 4** | | | | | | | | | | | | | | |
| RailRoad 4 | | 0.6 | 0.25 | 1.9 | 7.0 | 4.03 | 0.6 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 5** | | | | | | | | | | | | | | |
| RailRoad 5 | | 1.2 | 0.25 | 1.9 | 7.0 | 4.03 | 1.2 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |

| APPENDIX | A |
|---|---|
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

**DEL MAR BLUFF 5**

**HYDROLOGY CALCULATIONS - WITH ROUTING (IN COUNTY OF SAN DIEGO)**

**EXISTING CONDITIONS**

| BASIN CHARACTERISTICS | | | | | CONDITIONS AT BASIN POINT OF CONCENTRATION | | | CONDITIONS AT JUNCTION (NOTE 1) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| **Basin** | **Downstream Junction** | **Area (Acres)** | **C** | **P6 (Inches)** | **Tc Basin (Min.)** | **I Basin (Inches/Hour)** | **Q Basin (CFS)** | **Tc Junction (Min.)** | **I Junction (Inches/Hour)** | **Intensity Adjustment Factor** | **Q Junction (CFS)** | **Flow Restricted by Pipe/Inlet capacity, max Q (CFS)** | **Q By Pass (CFS)** | **Q = Q Junction _ Q By Pass (CFS)** |
| **25-YEAR STORM - RailRoad 6** | | | | | | | | | | | | | | |
| RailRoad 6 | | 3.8 | 0.25 | 1.9 | 7.0 | 4.03 | 3.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 7** | | | | | | | | | | | | | | |
| RailRoad 7 | | 1.2 | 0.25 | 1.9 | 7.0 | 4.03 | 1.2 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 8** | | | | | | | | | | | | | | |
| RailRoad 8 | | 0.8 | 0.25 | 1.9 | 7.0 | 4.03 | 0.8 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM -RailRoad 9** | | | | | | | | | | | | | | |
| RailRoad 9 | | 0.4 | 0.25 | 1.9 | 7.0 | 4.03 | 0.4 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 10** | | | | | | | | | | | | | | |
| RailRoad 10 | | 0.9 | 0.25 | 1.9 | 7.0 | 4.03 | 0.9 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 11** | | | | | | | | | | | | | | |
| RailRoad 11 | | 0.6 | 0.25 | 1.9 | 7.0 | 4.03 | 0.6 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 12** | | | | | | | | | | | | | | |
| RailRoad 12 | | 1.9 | 0.25 | 1.9 | 7.0 | 4.03 | 1.9 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |
| **25-YEAR STORM - RailRoad 13** | | | | | | | | | | | | | | |
| RailRoad 13 | | 0.7 | 0.25 | 1.9 | 7.0 | 4.03 | 0.7 | | | | | | | |
| | | | | | | | | | | **TOTAL $Q_{25}$ =** | | | | |

**AUTOMATIC CALCULATIONS IN THIS TABLE ARE BASED ON THE COUNTY OF SAN DIEGO HYDROLOGY MANUAL, 2003 EDITION, AND THE FOLLOWING:**

Column 4: Coefficient of Runoff for the basin. "C" Values determined from Table V of the "Evaluation of Rational Method "C" Values" (Hill, 1998,2002) study for the County of San Diego.
Column 5: Precipitation in inches for a six hour storm per County of San Diego Hydrology Manual Rainfall Isopluvial Maps
Column 6: Time of Concentration calculated for the Basin reflecting travel time from the top of the basin to the point of concentration at the basin outlet. See the "Tc Calculations_Prop" tab and Basin Maps for travel paths.
Column 7: Intensity (I) for the Basin calculated from the Intensity- Duration Design Chart - Figure 3.2 -- I = 7.44 (P6) (Tc**-.645)
Column 8: The peak rate of runoff at the point of concentration for the Basin
Column 9: Time of Concentration at the Junction = Travel time in minutes from the most remote part of all the tributary basins to the junction.
Column 10: Intensity (I) in inches per hour at the Junction point calculated from the Intensity- Duration Design Chart - Figure 3.2 -- I = 7.44 (P6) (Tc**-.645)
Column 11: Intensity Adjustment factor = Junction Intensity / Basin Intensity. Applied to the Basin Q to calculate the Q tributary from the basin to the Junction point.
Column 12: The Q tributary from the basin to the Junction point. The sum of the Q from the tributary basins = the total Q at the Junction point.

**NOTE:**

* This Q will by pass/split at further intersections.

**Q bypass flow to south and out of the system.

# Appendix B

<u>Hydrology Map</u>


NOTE
1. INTERSECTION LOCATIONS SUBJECT TO FLOODING WITH BYPASS FLOWS. FLOWS ASSUMED TO SPLIT AS SHOWN BELOW:
50% IN CDM EAST LANE
25% IN CDM WEST LANE
25% IN DOWNSTREAM BASIN

SEE 30% PLANS FOR ADDITIONAL DETAIL ON EXISTING AND PROPOSED FACILITIES

LEGEND
- DRAINAGE BASINS
- EXISTING STORM DRAIN
- EXISTING CONCRETE SWALE
- DESIGN POINT EXISTING STORM DRAIN OUTFALLS — DPXX
- DESIGN POINT POTENTIAL NEW STORM DRAIN OUTFALLS — DPXX

200 0 200 600
SCALE: 1"=200'

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

DATE: 06-17-2020 TIME: 4:07:18 PM

FILENAME: J:\62499 SANDAG ON-CALL\TO 02 DEL MAR BLUFFS 4\08_TECHPROD\03 SHEETS\EXHIBITS\DMB 5\OVERALL DRAINAGE EXH-01.DWG

| NO. | DATE | REVISIONS | BY | CHK | APRV |
|---|---|---|---|---|---|

HNTB
401 B Street
Suite 301
San Diego, CA 92101

| | DATE |
|---|---|
| DESIGNED BY A. EDNEY | 06/20 |
| DRAWN BY G. FARAJI | 06/20 |
| CHECKED BY P. MCCOLL | 06/20 |
| SANDAG PM A. DEVAUX | 06/20 |

SANDAG
NORTH COUNTY TRANSIT DISTRICT

DEL MAR BLUFFS STABILIZATION PROJECT 5

DRAINAGE BASIN MAP

SCALE: AS SHOWN
SANDAG CONTRACT NO. CIP1146100
DRAWING NO. SHEET NO.

# Appendix C

Time of Concentration Calculations

| | |
|---|---|
| APPENDIX | C |
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

## DEL MAR BLUFF 5
## EXISTING TIME OF CONCENTRATION CALCULATIONS

| BASIN | | | INITIAL OVERLAND FLOW - URBAN AREAS (Initial Tc) | | | OVERLAND FLOW - NATURAL WATERSHEDS | | | GUTTER FLOW / PIPE FLOW | | | | | GRADED SWALE/ CHANNEL FLOW (NOTE 1) | | | | | Time of Conc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| BASIN | TRIBUTARY AREA (ACRE) | RUNOFF COEF. C | HEIGHT (FT) | LENGTH (FT) | Tc-Initial (MIN) | HEIGHT OF AVG. SLOPE LINE (FT) | LENGTH (FT) | Tc (MIN) | HEIGHT (FT) | LENGTH (FT) | GUTTER / PIPE SLOPE (%) | VELOCITY (FPS) | Tc (MIN) | TYPE | APPROX. SLOPE | LENGTH (FT) | VELOC. (FT/SEC) | Tc (MIN) | Tc | Sum of Segments Tc | Average Tc |
| **EXISTING CONDITIONS** | | | | | | | | | | | | | | | | | | | | | |
| For basin Tc less than 5 minutes, use 5 minutes | | | | | | | | | | | | | | | | | | | | | |
| **BASIN A** | | | | | | | | | | | | | | | | | | | | | |
| A.1 | 38.1 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 164.0 | 1692.0 | 9.7% | 6.2 | 4.5 | | | | | | 12.1 | **12.1** | **13.0** |
| A.2 | 11.0 | 0.42 | 1.6 | 80.0 | 8.7 | | | | | | | | | Ditch | | 1206.0 | 12.0 | 1.7 | 10.4 | **10.4** | **7.0** |
| A | 49.1 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 164.0 | 1692.0 | 9.7% | 6.2 | 4.5 | | | | | | 12.1 | **12.8** | **15.0** |
| | | | | | | | | | | | 0.0% | 0.0 | 0.0 | Ditch | | 500.0 | 12.0 | 0.7 | 0.7 | | |
| **BASIN B** | | | | | | | | | | | | | | | | | | | | | |
| B.1 | 11.4 | 0.54 | 1.6 | 80.0 | 7.2 | | | | 140.0 | 1456.0 | 9.6% | 6.2 | 3.9 | | | | | | 11.1 | **11.1** | **13.0** |
| B.2.1.1 | 4.9 | 0.58 | 30.0 | 424.0 | 10.0 | | | | | | | | | | | | | | 10.0 | **10.0** | **7.0** |
| B.2.1.2 | 6.2 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 88.0 | 859.0 | 10.2% | 6.4 | 2.2 | | | | | | 9.8 | **9.8** | **7.0** |
| B | 22.5 | 0.54 | 1.6 | 80.0 | 7.2 | | | | 140.0 | 1456.0 | 9.6% | 6.2 | 3.9 | | | | | | 11.1 | **13.9** | **15.0** |
| | | | | | | | | | 65.0 | 900.0 | 7.2% | 5.4 | 2.8 | | | | | | 2.8 | | |
| **BASIN C** | | | | | | | | | | | | | | | | | | | | | |
| C.1 | 28.0 | 0.54 | 1.6 | 80.0 | 7.2 | | | | 168.0 | 2383.0 | 7.0% | 5.3 | 7.5 | | | | | | 14.6 | **14.6** | **13.0** |
| C.2 | 9.9 | 0.58 | 1.5 | 75.0 | 6.4 | | | | 82.0 | 1288.0 | 6.4% | 5.0 | 4.3 | | | | | | 10.7 | **10.7** | **7.0** |
| C.3 | 11.0 | 0.67 | 1.6 | 80.0 | 5.5 | | | | 62.0 | 1037.0 | 6.0% | 4.9 | 3.5 | | | | | | 9.0 | **9.0** | **7.0** |
| C | 48.9 | 0.54 | 1.6 | 80.0 | 7.2 | | | | 168.0 | 2383.0 | 7.0% | 5.3 | 7.5 | | | | | | 14.6 | **17.4** | **15.0** |
| | | | | | | | | | 65.0 | 900.0 | 7.2% | 5.4 | 2.8 | | | | | | 2.8 | | |
| **BASIN D** | | | | | | | | | | | | | | | | | | | | | |
| D.1 | 52.0 | 0.54 | 1.6 | 80.0 | 7.2 | | | | 190.0 | 2244.3 | 8.5% | 5.8 | 6.4 | | | | | | 13.6 | **13.6** | **13.0** |
| D.2 | 37.6 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 29.0 | 374.0 | 7.8% | 5.6 | 1.1 | Ditch | | 120.0 | 12.0 | 0.2 | 8.8 | **12.6** | **13.0** |
| | | | | | | | | | 4.0 | 137.0 | 2.9% | 3.4 | 0.7 | Conc Swale | | 932.0 | 15.0 | 1.0 | 1.7 | | |
| | | | | | | | | | 62.0 | 730.0 | 8.5% | 5.8 | 2.1 | | | | | | 2.1 | | |
| D.3.1 | 17.1 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 4.0 | 718.0 | 0.6% | 1.5 | 8.0 | Ditch | | 438.0 | 12.0 | 0.6 | 12.3 | **12.8** | **7.0** |
| | | | | | | | | | | | 0.0% | 0.0 | 0.0 | Conc Swale | | 390.0 | 15.0 | 0.4 | 0.4 | | |
| D.3.2 | 5.3 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 56.0 | 487.0 | 11.5% | 6.8 | 1.2 | Ditch | | 664.0 | 12.0 | 0.9 | 5.8 | **5.8** | **7.0** |
| D.3.3 | 10.6 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 95.0 | 1376.0 | 6.9% | 5.3 | 4.4 | | | | | | 8.1 | **8.1** | **7.0** |
| D | 122.5 | 0.54 | 1.6 | 80.0 | 7.2 | | | | 190.0 | 2244.3 | 8.5% | 5.8 | 6.4 | | | | | | 13.6 | **16.4** | **15.0** |
| | | | | | | | | | 65.0 | 900.0 | 7.2% | 5.4 | 2.8 | | | | | | 2.8 | | |
| **BASIN E** | | | | | | | | | | | | | | | | | | | | | |
| E.1 | 13.8 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 202.0 | 2111.0 | 9.6% | 6.2 | 5.7 | | | | | | 13.2 | **13.2** | **13.0** |
| E.2 | 7.2 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 69.0 | 1131.7 | 6.1% | 4.9 | 3.8 | | | | | | 7.5 | **7.5** | **7.0** |
| E | 21.0 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 202.0 | 2111.0 | 9.6% | 6.2 | 5.7 | | | | | | 13.2 | **16.0** | **15.0** |
| | | | | | | | | | 65.0 | 900.0 | 7.2% | 5.4 | 2.8 | | | | | | 2.8 | | |
| **BASIN F** | | | | | | | | | | | | | | | | | | | | | |
| F.1 | 12.4 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 42.0 | 574.0 | 7.3% | 5.4 | 1.8 | Ditch | | 360.0 | 12.0 | 0.5 | 9.8 | **10.5** | **13.0** |
| | | | | | | | | | | | 0.0% | 0.0 | 0.0 | Conc Swale | | 604.0 | 15.0 | 0.7 | 0.7 | | |
| F.2.1 | 10.3 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 78.0 | 1191.0 | 6.5% | 5.1 | 3.9 | | | | | | 7.6 | **7.6** | **7.0** |
| F.2.2 | 3.3 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 65.0 | 881.0 | 7.4% | 5.4 | 2.7 | | | | | | 6.4 | **6.4** | **7.0** |
| F | 26.0 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 42.0 | 574.0 | 7.3% | 5.4 | 1.8 | Ditch | | 360.0 | 12.0 | 0.5 | 9.8 | **13.3** | **15.0** |
| | | | | | | | | | | | 0.0% | 0.0 | 0.0 | Conc Swale | | 604.0 | 15.0 | 0.7 | 0.7 | | |
| | | | | | | | | | 65.0 | 900.0 | 7.2% | 5.4 | 2.8 | | | | | | 2.8 | | |
| **BASIN G** | | | | | | | | | | | | | | | | | | | | | |
| G.1 | 40.0 | 0.51 | 0.4 | 20.0 | 3.8 | | | | 96.0 | 1096.0 | 8.8% | 5.9 | 3.1 | Conc Swale | | 481.0 | 15.0 | 0.5 | 7.4 | **12.0** | **13.0** |
| | | | | | | | | | 80.0 | 1343.0 | 6.0% | 4.9 | 4.6 | | | | | | 4.6 | | |
| G.2 | 5.0 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 68.0 | 1033.0 | 6.6% | 5.1 | 3.4 | | | | | | 7.1 | **7.1** | **7.0** |
| G | 45.0 | 0.51 | 0.4 | 20.0 | 3.8 | | | | 96.0 | 1096.0 | 8.8% | 5.9 | 3.1 | Conc Swale | | 481.0 | 15.0 | 0.5 | 7.4 | **14.8** | **15.0** |
| | | | | | | | | | 80.0 | 1343.0 | 6.0% | 4.9 | 4.6 | | | | | | 4.6 | | |
| | | | | | | | | | 65.0 | 900.0 | 7.2% | 5.4 | 2.8 | | | | | | 2.8 | | |
| **BASIN H** | | | | | | | | | | | | | | | | | | | | | |
| H.1 | 12.9 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 19.0 | 347.0 | 5.5% | 4.7 | 1.2 | Conc Swale | | 123.0 | 15.0 | 0.1 | 8.9 | **13.1** | **13.0** |
| | | | | | | | | | 74.0 | 630.0 | 11.7% | 6.9 | 1.5 | Conc Swale | | 572.0 | 15.0 | 0.6 | 2.2 | | |
| | | | | | | | | | 46.0 | 646.0 | 7.1% | 5.3 | 2.0 | | | | | | 2.0 | | |
| H.2 | 24.6 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 30.0 | 276.0 | 10.9% | 6.6 | 0.7 | Ditch | | 337.0 | 12.0 | 0.5 | 8.7 | **13.1** | **13.0** |
| | | | | | | | | | 99.0 | 1269.0 | 7.8% | 5.6 | 3.8 | Ditch | | 438.0 | 12.0 | 0.6 | 4.4 | | |
| H.3 | 7.7 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 78.0 | 1570.0 | 5.0% | 4.5 | 5.9 | | | | | | 9.6 | **9.6** | **7.0** |
| H | 45.2 | 0.51 | 1.6 | 80.0 | 7.5 | | | | 19.0 | 347.0 | 5.5% | 4.7 | 1.2 | Conc Swale | | 123.0 | 15.0 | 0.1 | 8.9 | **15.9** | **15.0** |
| | | | | | | | | | 74.0 | 630.0 | 11.7% | 6.9 | 1.5 | Conc Swale | | 572.0 | 15.0 | 0.6 | 2.2 | | |
| | | | | | | | | | 46.0 | 646.0 | 7.1% | 5.3 | 2.0 | | | | | | 2.0 | | |
| | | | | | | | | | 65.0 | 900.0 | 7.2% | 5.4 | 2.8 | | | | | | 2.8 | | |

**CHANNEL VELOCITIES**
**Earthen - >0.5%<2% is 5 fps, <0.5% is 2.5 fps, >2% is 10 fps**
**Concrete (gunite) - <0.5% is 5 fps, >0.5% is 6 fps**

| | |
|---|---|
| APPENDIX | C |
| W.O. #: | |
| CALC'D BY: | GELAREH FARAJI |
| CHECKED BY: | MATTHEW ENRIQUEZ |

**DEL MAR BLUFF 5**
**EXISTING TIME OF CONCENTRATION CALCULATIONS**

| BASIN | | | INITIAL OVERLAND FLOW - URBAN AREAS (Initial Tc) | | | OVERLAND FLOW - NATURAL WATERSHEDS | | | GUTTER FLOW / PIPE FLOW | | | | | GRADED SWALE/ CHANNEL FLOW (NOTE 1) | | | | | Time of Conc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| BASIN | TRIBUTARY AREA (ACRE) | RUNOFF COEF. C | HEIGHT (FT) | LENGTH (FT) | Tc-Initial (MIN) | HEIGHT OF AVG. SLOPE LINE (FT) | LENGTH (FT) | Tc (MIN) | HEIGHT (FT) | LENGTH (FT) | GUTTER / PIPE SLOPE (%) | VELOCITY (FPS) | Tc (MIN) | TYPE | APPROX. SLOPE | LENGTH (FT) | VELOC. (FT/SEC) | Tc (MIN) | Tc | Sum of Segments Tc | Average Tc |
| **EXISTING CONDITIONS** | | | | | | | | | | | | | | | | | | | | | |
| **BASIN I** | | | | | | | | | | | | | | | | | | | | | |
| I | 8.8 | 0.67 | 37.0 | 650.0 | 11.1 | | | | 4.0 | 265.0 | 1.5% | 2.5 | 1.8 | | | | | | 12.9 | **12.9** | **7.0** |
| **BASIN J** | | | | | | | | | | | | | | | | | | | | | |
| J.1 | 5.2 | 0.80 | 1.5 | 75.0 | 3.7 | | | | 67.0 | 1139.0 | 5.9% | 4.9 | 3.9 | | | | | | 7.6 | **7.6** | **7.0** |
| **BASIN K** | | | | | | | | | | | | | | | | | | | | | |
| K | 1.9 | 0.67 | 1.5 | 75.0 | 5.3 | | | | 37.0 | 553.0 | 6.7% | 5.2 | 1.8 | | | | | | 7.1 | **7.1** | **7.0** |
| **BASIN B.2.2** | | | | | | | | | | | | | | | | | | | | | |
| B.2.2 | 4.4 | 0.32 | 102.0 | 545.0 | 12.4 | | | | | | | | | | | | | | 12.4 | **12.4** | **7.0** |
| **BASIN H.4** | | | | | | | | | | | | | | | | | | | | | |
| H.4 | 2.5 | 0.46 | 15.0 | 193.0 | 8.1 | | | | | | | | | | | | | | 8.1 | **8.1** | **7.0** |
| **BASIN L** | | | | | | | | | | | | | | | | | | | | | |
| L | 4.8 | 0.25 | | | | | | | | | | | | | | | | | | | **7.0** |
| **Railroad Areas** | | | Undisturbed Natural Terrain, used the minimum of TC for these areas. | | | | | | | | | | | | | | | | | | |
| Railroad Areas | | 0.25 | | | | | | | | | | | | | | | | | | | **7.0** |

**NOTE**

Due to Uncertainty of drainage basins and preliminary analysis, we have decided to use average Tc=13 min for east basins, average Tc=7 min for west basins, and average Tc=15 min for junctions.

**AUTOMATIC CALCULATIONS IN THIS TABLE ARE BASED ON THE COUNTY OF SAN DIEGO HYDROLOGY MANUAL, 2003 EDITION, AND THE FOLLOWING:**

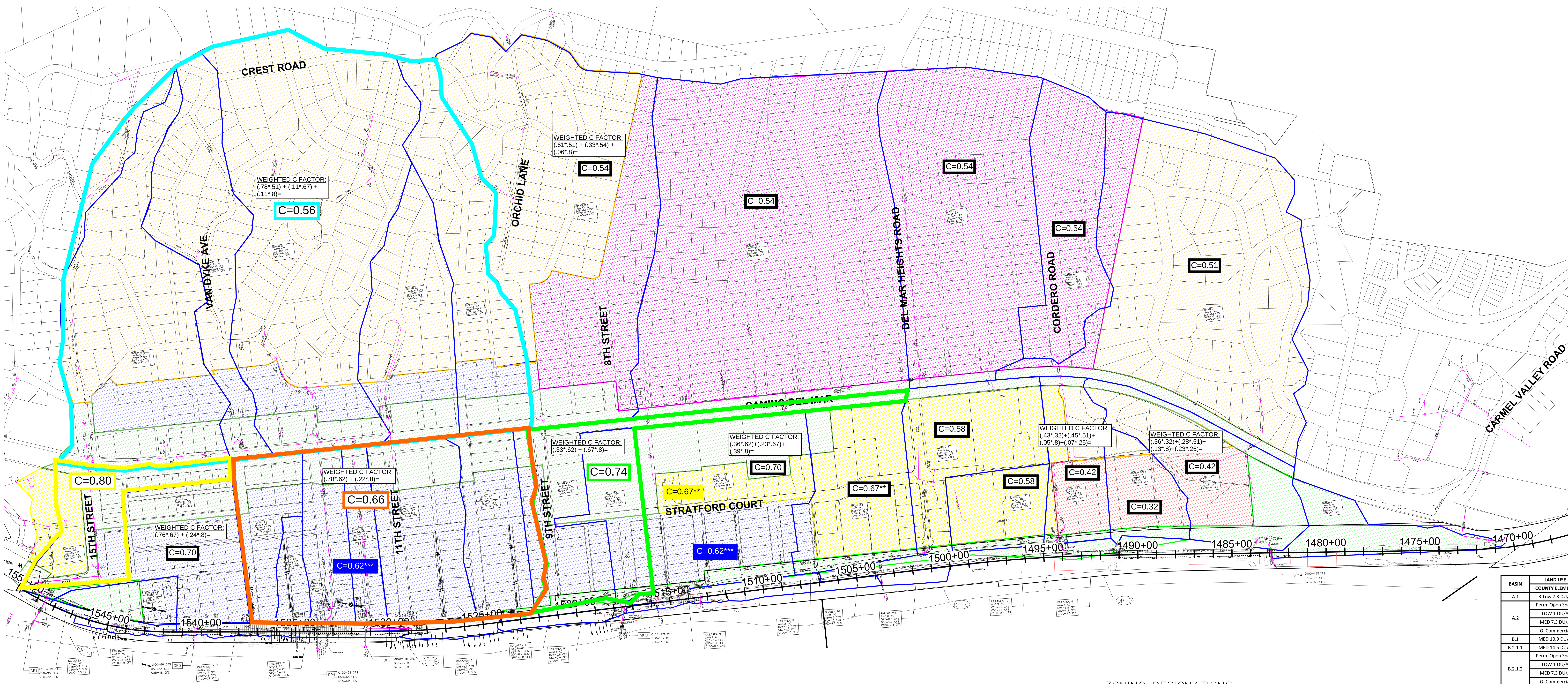
Column 6: Time of Concentration (Tc) for Urban Areas Overland Flow (Initial Tc) is based on the formula in the *Hydrology Manual,* Figure 3-3. Tc =(1.8*(1.1-C)*(D**.5)/(S**.333)) and maximum overland flow length table 3-2, page 3-12
Column 9: Time of Concentration (Tc) for Overland flow - Natural is based on the Kirpich Formula in the *Hydrology Manual* page 3-16, Figures 3-4 & 3-5: Tc =((11.9 (L**3))/H)**0.385 , where H is not the max. elevation difference, but the elevation of the effective slope line.
Column 12: The average Gutter Slope, S(gutter)= H / L.
Column 13: Gutter flow Velocity is estimated as V(gutter) = 2 * (S(gutter)**0.5), conservatively approximating velocities indicated in the *Hydrology Manual*, page 3-18, Figure 3-6.
Column 14: Gutter flow Time of Concentration is Tc= Travel-Length/Velocity.
Column 19: Ditch/Channel flow Time of Concentration Tc= Travel-Length / Velocity.



**CHANNEL VELOCITIES**
**Earthen - >0.5%<2% is 5 fps, <0.5% is 2.5 fps, >2% is 10 fps**
**Concrete (gunite) - <0.5% is 5 fps, >0.5% is 6 fps**

# Appendix D

Runoff Coefficient Reference Material




LEGEND

DRAINAGE BASIN BOUNDARY

BASIN DESIGNATION

WEIGHTED C FACTOR — C= XX

WEIGHTED C FACTOR FOR MULTIPLE BASINS — C= XX

ADJUSTED C FACTOR FOR LAND USES — C=XX

## ZONING DESIGNATIONS

| CITY OF DEL MAR | COUNTY OF SAN DIEGO | C FACTOR* |
|---|---|---|
| PUBLIC PARKLAND/RR ROW | PERM. OPENSPACE LAND USE | 0.25 |
| VERY LOW DENSITY | R–LOW 1 DU/A LAND USE | 0.32 |
| LOW DENSITY | R–MED 7.3 DU/A LAND USE | 0.51 |
| MEDIUM DENSITY SF | R–MED 10.9 DU/A LAND USE | 0.54 |
| MEDIUM DENSITY MIXED | R–MED 14.5 DU/A LAND USE | 0.58 |
| HIGH DENSITY | R–HIGH 24 DU/A LAND USE | 0.67 |
| COMMERCIAL/PUBLIC FACILITY | COMMERCIAL LAND USE | 0.80 |

NOTE

1. C FACTOR IS BASED ON ZONING DENSITY PER COUNTY OF SAN DIEGO DRAINAGE DESIGN MANUAL AND THE CITY OF DEL MAR ZONING MAP. PERCENT IMPERVIOUS HAS BEEN ADJUSTED FOR AREAS WITH GREATER OR LESSER DENSITY.

* ADJUSTED C FACTORS ARE SHOWN ON THE PLAN.
** INCREASED C FACTOR BASED ON OBSERVED DENSITY.
*** DECREASED C FACTOR BASED ON CALCULATED PERCENT IMPERVIOUS.

200' 0 200' 400'
SCALE: 1"=200'

| BASIN | LAND USE / COUNTY ELEMENT | WEIGHTED AVE C FACTOR |
|---|---|---|
| A.1 | R-Low 7.3 DU/A | 0.51 |
| A.2 | Perm. Open Space | 0.42 |
| | LOW 1 DU/A | |
| | MED 7.3 DU/A | |
| | G. Commercial | |
| B.1 | MED 10.9 DU/A | 0.54 |
| B.2.1.1 | MED 14.5 DU/A | 0.58 |
| B.2.1.2 | Perm. Open Space | 0.42 |
| | LOW 1 DU/A | |
| | MED 7.3 DU/A | |
| | G. Commercial | |
| B.2.2 | LOW 1 DU/A | 0.32 |
| C.1 | MED 10.9 DU/A | 0.54 |
| C.2 | MED 14.5 DU/A | 0.58 |
| C.3 | HIGH 24 DU/A | 0.67 |
| D.1 | MED 10.9 DU/A | 0.54 |
| D.2 | MED 7.3 DU/A | 0.54 |
| | MED 10.9 DU/A | |
| | G. Commercial | |
| D.3.1 | | 0.7 |
| | HIGH 24 DU/A | |
| | G. Commercial | |
| D.3.2 | | 0.74 |
| D.3.3 | G. Commercial | |
| E.1-F.1-G.1-H.1-H.2 | MED 7.3 DU/A | 0.56 |
| | HIGH 24 DU/A | |
| | G. Commercial | |
| E.2-F.2.1-F.2.2-G.2-J-K | | 0.66 |
| | G. Commercial | |
| H.3 | G. Commercial | 0.80 |
| H.4 | | 0.46 |
| I | HIGH 24 DU/A | 0.70 |
| | G. Commercial | |
| L, Railroad 1-13 | Perm. Open Space | 0.25 |

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

DATE: 06-17-2020 TIME: 4:20:50 PM

FILENAME: J:\62499 SANDAG ON-CALL\TO 02 DEL MAR BLUFFS 4\08_TECHPROD\03 SHEETS\EXHIBITS\DMB 5\OVERALL DRAINAGE EXH-C FACTOR MAP.DWG

| NO. | DATE | REVISIONS | BY | CHK | APRV |
|---|---|---|---|---|---|

HNTB
401 B Street
Suite 301
San Diego, CA 92101

| | DATE |
|---|---|
| DESIGNED BY A. EDNEY | 06/20 |
| DRAWN BY G. FARAJI | 06/20 |
| CHECKED BY P. MCCOLL | 06/20 |
| SANDAG PM A. DEVAUX | 06/20 |

SANDAG
NORTH COUNTY TRANSIT DISTRICT

DEL MAR BLUFFS STABILIZATION PROJECT 5

RUNOFF COEFFICIENTS MAP

SCALE AS SHOWN

SANDAG CONTRACT NO. CIP1146100

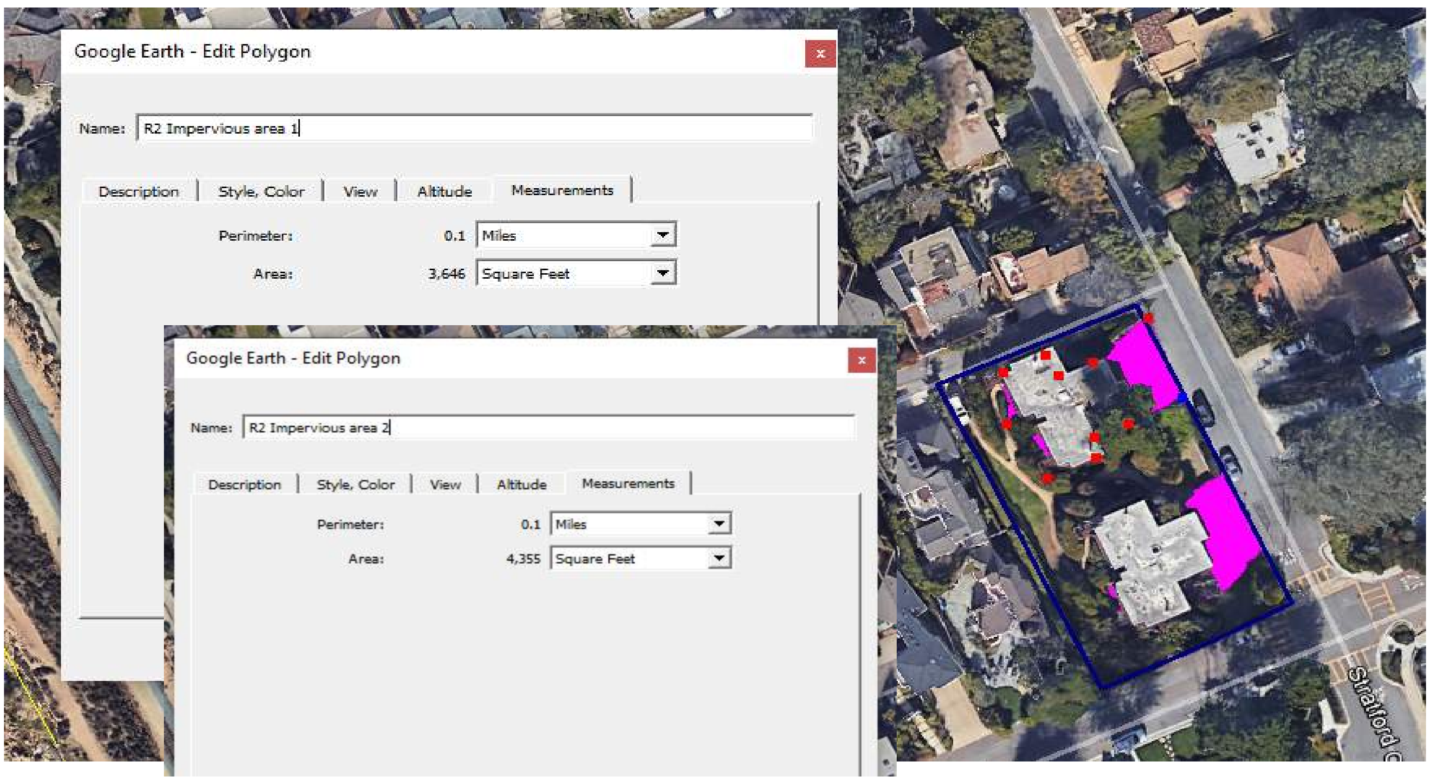
DRAWING NO. SHEET NO.

# Appendix D

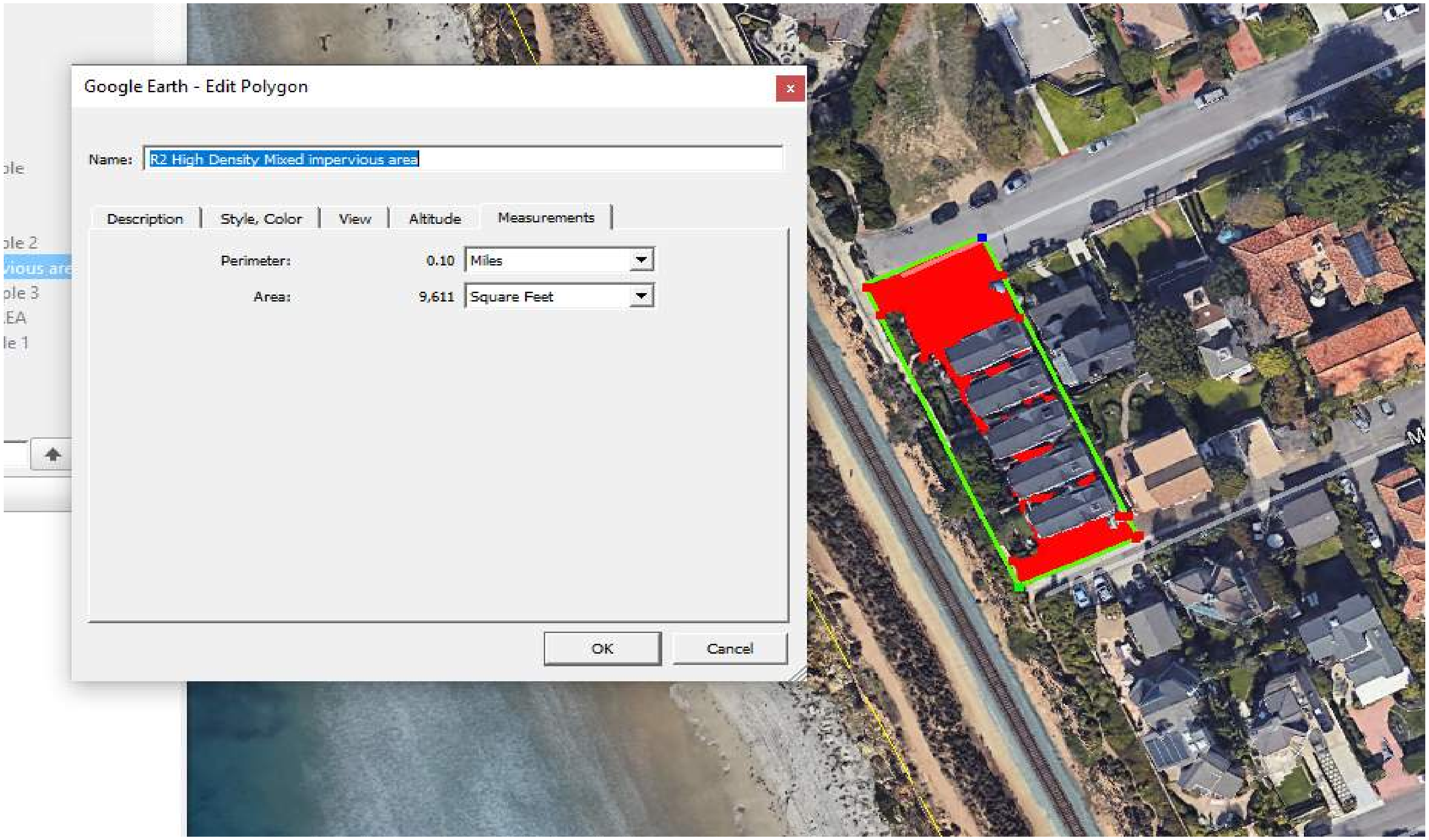
## II. Adjused C Factor Based on Measured Impervious Area

| Del Mar Zone R2 Sample Lots | | | |
|---|---|---|---|
| Site | LOT SIZE | IMP AREA | % IMP |
| 910 & 922 Stratford Ct. | 17000 | 8000 | 47% |
| 939 Ocean Ave (End of 10th Street) | 13000 | 9600 | 74% |
| 151 8th & Street | 8500 | 5600 | 66% |
| | | | |
| **Average % Impervious** | | | **62%** |

**922 & 910 Stratford Ct.**



**939 Ocean Ave (western terminus of 10th Street)**



**151 8th Street**