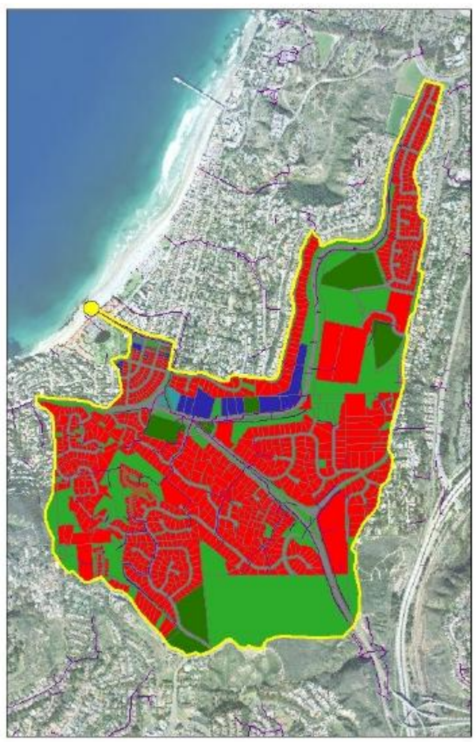
Avenida De La Playa Storm Drain

Hydraulic and Hydrological Analysis

La Jolla Sub-Watershed



Prepared for the City of San Diego

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TETRA TECH

Hydraulic and Hydrologic Analysis

A full hydrologic analysis was performed for the Avenida de la Playa watershed to determine peak runoff flows and to evaluate the role of the storm drain pipes on the localized flooding issues. Full flow storm drain capacity was calculated using the Manning's equation and compared to the peak flow from the 100-year storm event, as determined from the hydrologic analysis. Additional storm events were evaluated to match the storm drain capacity with the corresponding storm event. This analysis illustrates that the Avenida de la Playa storm drain pipes are undersized and unable to convey larger storm events, possibly contributing to the localized flooding issues.

Background

The Avenida de la Playa storm drain system and outfall structure drains approximately 820 acres (1.28 square miles) into a protected area of the Pacific Ocean in La Jolla, CA (Figure A-1). The watershed is located in a highly urbanized area of the coastal precipitation zone.

The drainage area for Avenida de la Playa was modified from a previous delineation based on 2' contours and storm drainage network data provided in GIS format. Hydrologic analysis for Avenida de la Playa is based on procedures established in the City of San Diego Drainage Design Manual (DDM), which specifies the evaluation of the 100-year storm and the use of Soil Conservation Service (SCS) methods for drainage areas greater than one square mile.

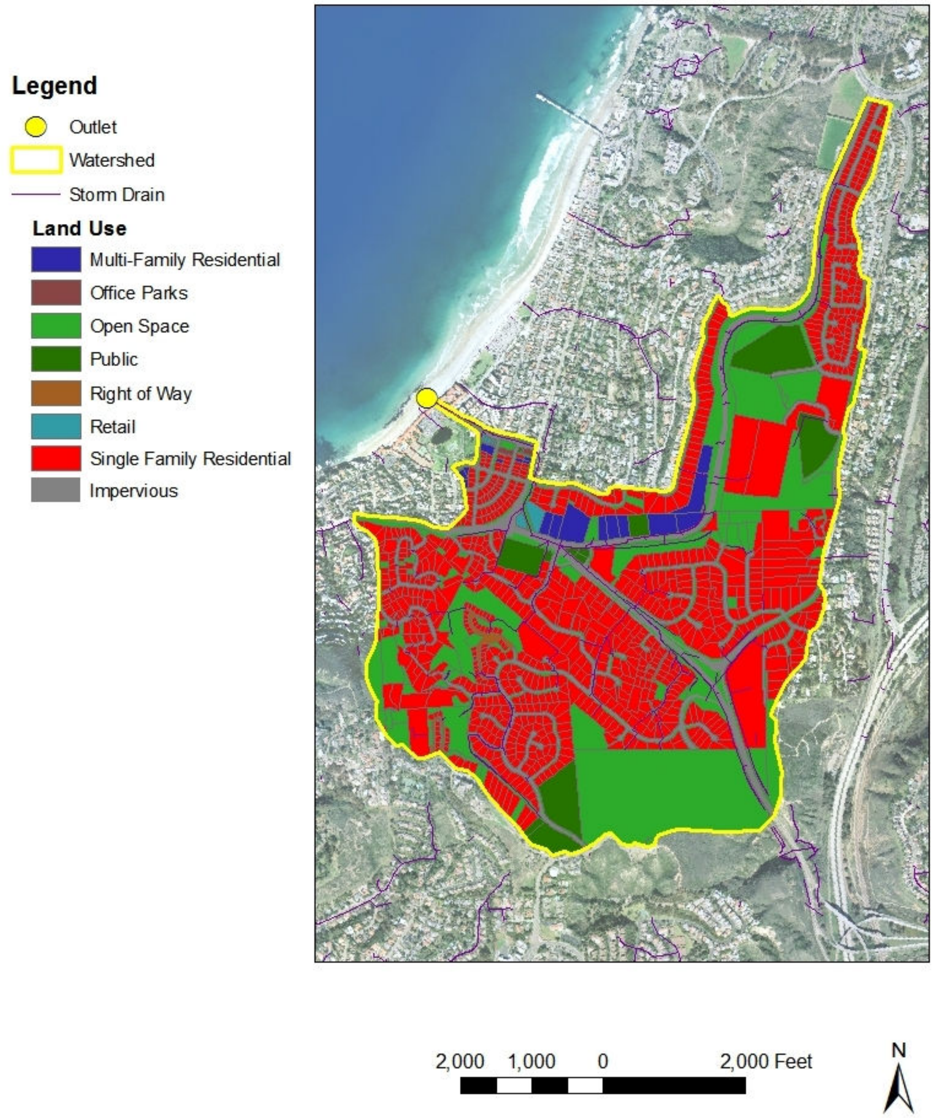

Figure A - 1. Avenida de la Playa Watershed

Land Use

Runoff curve numbers were obtained from the San Diego County Hydrology Manual (HM), which includes more detail on the urban environment and better represents the land use data available in the Avenida de la Playa watershed. Hydrologic Soil Group D soils were assumed throughout the entire watershed according to Section 1-102.2(4) of the DDM. Land use in Avenida de la Playa consists of primarily single family residential and open space as shown in Table A - 1 below. The curve numbers for each land use type as well as the watershed area-weighted curve number of 85.8 are also shown in Table A - 1. An average watershed imperviousness of 35% was determined from the land use characteristics.

Land Use	**Area (ac)**	**Curve Number**
Single Family Residential	407.0	85
Open Space	237.7	80
Impervious	98.4	98
Public	45.7	93
Multi-Family Residential	20.5	92
Right of Way	5.4	83
Retail	3.1	95
Office Parks	0.9	95
TOTAL	**818.8**	**85.8**

Table A - 1. Avenida de la Playa Land Use

Lag Time and Time to Peak

Lag time was calculated using the equation below, as specified in the DDM. The equation involves the length of the longest watercourse (L), the length of the longest watercourse measured upstream to a point opposite the center of area (L_C), the average Manning's roughness coefficient ($\overline{n}$) and the overall slope (S). The longest watercourse is taken along the path in the watershed that is hydraulically the farthest from the outlet. This path consists of overland flow, concentrated flow and pipe flow, all of which are accounted for in order to develop the average roughness coefficient.

$$T_{LAG} = 24\overline{n}\left(\frac{LxL_C}{\sqrt{S}}\right)^{0.38}$$

$$T_{LAG} = 24(0.022)\left(\frac{(2.41mi)(0.85mi)}{\sqrt{(168\,ft/mi)}}\right)^{0.38}$$

$$T_{LAG} = 0.26 \;\; hours$$

The Avenida de la Playa watershed is highly urbanized with a significant amount of impervious area directly connected to a well-developed storm drainage system. This results in an extremely short lag time for a watershed of this size. The time to peak was developed from the synthetic unit hydrograph as 0.862(T_{LAG}) or 0.22 hours. Since the time to peak was outside of the 0.4 to 4.0 hour range covered by the peak flow charts[6], HEC-HMS was used to determine the peak flow using the SCS methodology for a Type B storm with the parameters discussed above as required by the DDM.

[6] As discussed in the "Procedure for Using Peak Flow Charts to Compute Peak Flow" on p. 102 of the DDM

Rainfall

Rainfall depths for both the 6-hour, 100-year storm event and the 24-hour, 100-year storm event (2 inches and 4 inches, respectively) were determined from the precipitation maps included in the DDM. Rainfall hyetographs, using the Type B distribution modified by the rainfall depth, are included in Appendix B.

Peak Flow

The peak flow rate was determined by evaluating both the 6-hour and 24-hour storm events and selecting the larger of the two, as specified in the DDM. This resulted in a peak discharge of 514 cfs for the 24-hour, 100-year storm event and 703 cfs for the 6-hour, 100-year storm event. ***The peak flow of 703 cfs will be used for the capacity analysis at the Avenida de la Playa outfall.*** Hydrographs for the 6-hour and 24-hour, 100-year storm events are included in Appendix B.

Capacity

In the capacity analysis it was assumed that the pipe was flowing full, free of obstructions and in good condition. This is an "idealized" capacity, which indicates whether the system is undersized for the current hydrology in the watershed regardless of any possible environmental conditions that would reduce the capacity. The capacity of the final conduit running full (twin 51-inch RCPs, slope S=0.002 and Manning's n=0.015) is 130cfs, meaning the pipes are under-designed for the 100-year storm. The capacity of the 72-inch RCP (S=0.005, n=0.015) is 260 cfs, also under-designed for the 100-year storm. (Idealized capacity equations are included below.) To determine the return period that corresponds with the capacity of the twin 51-inch RCPs, peak flows were calculated for the 2-, 5-, 10-, 25- and 50-year frequency storms using the same DDM procedures described above. (Hydrographs for the 2-, 5-, 10-, 25- and 50-year frequency, 6-hour Type B storm events are also included below.) A power curve was fit to these peak flows in order to assess the return period for the twin 51-inch RCPs (Figure A - 2). Based on this analysis, the Avenida de la Playa storm drain pipes reach capacity during the 0.7 year storm event. Statistically, the storm drain pipes that serve Avenida de la Playa would be expected to exceed capacity approximately 1.5 times per year even without the added complications associated with sedimentation at the outfall, trash buildup at the outlet and tidal influences.

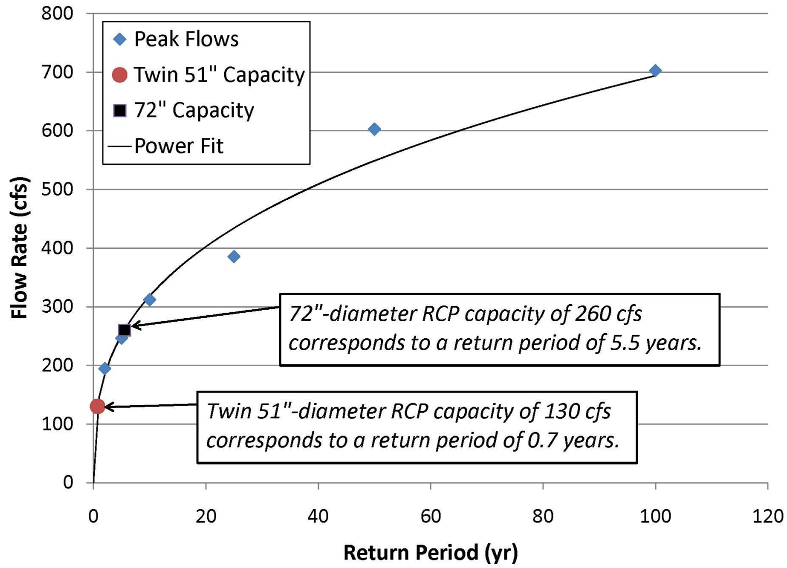

Figure A - 2. Return Period Analysis

To achieve capacity for the 100-year storm event peak flow of 703 cfs, nine additional – 51-inch RCPs would be needed at the same slope. Alternatively, it would require two (2) additional 51-inch RCPs or the conversion of the existing twin 51-inch RCPs or twin 5-foot by 5-foot Reinforced Concrete Boxes (RCBs) to meet or exceed the capacity of the 72-inch RCP located immediately upstream. This capacity corresponds to the 5.5 year event, as shown in Figure A - 2.

Conclusion

The Avenida de la Playa storm drain pipes are undersized and unable to convey the peak flow from the 100-year storm event. The existing twin 51-inch RCPs immediately upstream of the outlet structure are only capable of conveying the 0.7-year storm event although the 72-inch RCP located immediately upstream is capable of conveying the 5.5-year storm event. To adequately convey the 100-year storm event would require the addition of nine – 51-inch RCPs.