3. Hydrology Study

Hydrology Analysis

A storm drain master plan was last completed for the City of Manhattan Beach in 1996 by Kennedy/Jenks Consultants. This hydrology study was completed in accordance with the 1991 Los Angeles County Hydrology Manual. Since completion of this study, the Los Angeles County of Public Works released the 2002 Addendum to the 1991 Hydrology/Sedimentation Manual, which was then superseded by the 2006 Hydrology Manual .

The 10, 25, and 50-year return periods were analyzed for the hydrology study. The theoretical return period is the inverse of the probability that the event will be exceeded in any one year (or more accurately the inverse of the expected number of occurrences in a year). For example, a 10-year flood has a 0.10 or 10% chance of being exceeded in any one year and a 50-year flood has a 0.02 or 2% chance of being exceeded in any one year.

The precipitation depths from the hydrology manual were compared to historical rainfall data (2000-2020) for the National Oceanic and Atmospheric Administration (NOAA) Los Angeles International Airport Station (USW00023174). Based on the historical rainfall, only the December 28, 2004 rainfall event (4.53 inches) exceeded the 10-year, 24-hour rainfall isohyet within the City shown in the Hydrologic Maps[1].

AECOM used the Innovyze XP-SWMM (version 2018.2.2) Los Angeles County Modified Rational Method (MODRAT) module to complete the hydrologic modeling. AECOM obtained the digital topographic data of the City, County hydrology maps, prior hydrologic studies, and storm drain as-built information from both County and the City of Manhattan Beach in order to develop the hydrologic model. The 10, 25, 50-year storm events were modeled as part of the hydrologic analysis.

The peak flow results of the hydrology study were used to perform the hydraulic analysis for existing storm drain capacity analysis and CIP model.

Drainage Boundaries

The Los Angeles County MODRAT requires that subareas and outlets be numbered once the watershed and subareas are delineated. This hydrologic modeling numbering system indicates spatial relationships without the need for a hydrologic diagram. The MODRAT module within XP-SWMM can only have up to 26 branches in the system. The City's storm drain exceeded the upper limit for total branches, therefore, the City hydrologic model was broken up into three distinct watershed areas based on the topology and the storm drain network. The three models were named the West, Central and East. These three watershed areas were then further divided into 832 catchments. The median catchment size is 2.5 acres, with the smallest catchment being 0.01 acres and the largest catchment equaling 32.8 acres. The West watershed is a separate model that does not interface with the Central and East watersheds. The Central and East model interface at manhole MHLAC0188 along Manhattan Beach Blvd. Figure 3-1 displays the watersheds and sub-watersheds. This study is limited to areas within the City limits.

Catchments

The XP-SWMM hydrologic model performs a rainfall to run-off transformation for each catchment area. The calculated run-off is then loaded to catch basins. A hybrid approach was used to delineate the catchments where raw catchments boundaries were auto-delineated using the Arc Hydro tools and LiDAR data. These initial catchments were then used as a reference to manually

[1] Source for hydrologic maps is 2006 LACPW Hydrology Manual, Appendix B.

delineate the detailed catchments. Each of the catchments were routed to nearby catch basin. This delineation effort excluded the MBPS study area limits. The hydrology data within the existing MBPS H & H Model was not modified, except the basins that interfaced with the East Model extents.

Figure 3-2 displays the citywide catchments.

Hydrologic Parameters

The hydrology calculations were performed in accordance with the 2006 Los Angeles County Hydrology Manual. Hydrologic parameters for the project area were determined using digital files obtained from either the Los Angeles County Public Works website or Los Angeles Regional Imagery Acquisition Consortium (LARIAC). Precipitation depths of the project area were shown on the Venice and Redondo Beach hydrologic maps found in Appendix B of the Hydrology Manual. A copy of these hydrologic maps are included in Appendix A.

Soil types vary from type 003 soil along the coast, with the majority of the City consisting of soil type 010 for inland areas. The landuse for the project area is a mixture of single-family and multi-family residences, as well as commercial, schools, and open space. The LACPW 2005 landuse shapefile, City General Plan, and aerial images were used to estimate an average percent impervious was for each drainage basin. Drainage basin areas, flowpath lengths, and slopes were determined using the digital topography. The parameters were entered into XP-SWMM, which was used to calculate the time of concentration (Tc) for each drainage basin. Table 3-1 shows the GIS data used for hydrologic analysis.

The following list provides a summary of the hydrologic parameters required to perform the hydraulic analysis:

Catchment area: Catchment area in acres was estimated in ArcGIS.

Flow path length: Longest flow paths were manually delineated. The longest flow path length was drawn in GIS. These flow paths were used to calculated the slope of the catchment

Slope: The slope of the catchment is the average gradient at which the catchment drains to the outlet. The average gradient in the catchment was calculated using the flow paths generated during the delineation process and from the DEM dataset. The slope along each flow path was calculated, and averaged for all flow paths in the catchment.

Soil class: Figure 3-3 shows the soil map covering the city service area. Soil class 010 (Oakley Fine Sand) covers 82 percent of the city area whereas soil class 003 (Chino Silt Loam) and 014 (Ramona Sandy Loam) each covers 9 percent of the city area. Each catchment was assigned with predominant soil class using model builder routine.

Time of concentration (Tc): The time of concentration is the time required for runoff from the most hydrologically remote point in the catchment to reach the catchment drainage node. The built-in calculator in XP-SWMM was used to determine the time of concentration for each catchment as required by MODRAT method. A minimum Tc of 5 minutes was used.

Impervious area**: The percent of directly connected impervious area of the catchment is dependent upon the land use type. The land use types with assigned percent impervious area are listed in Appendix D of the hydrology manual. Figure 3-4 shows the existing land use classifications within the City.**

Table 3-2 shows the land use classification and assigned percent imperviousness within the city service area. Each catchment was assigned with weighted average percent impervious value using model builder tool. For the purposes of this study, AECOM assumes that the City is built-out and current landuse will not be affected in the future.

Table 3-1: Hydrologic Parameter Source Data

GIS Data	File Name
Digital Elevation Model (DEM)	Acres
LA County Soil shapefile	Soils_2004.shp
LA County landuse shapefile	adpw_landuse_2005.shp
LA County rainfall grid	lac50year24hr.asc; lac25year24hr.asc; lac10year24hr.asc

Table 3-2: Land Use Classification

Land Use	% Impervious
Attended Pay Public Parking Facilities	91
Base Government Offices	91
Beach Parks	10
Developed Local Parks and Recreation	10
Elementary Schools	82
Fire Stations	91
Golf Courses	3
Government Offices	91
High-Density Single Family Residential	42
High-Rise Major Office Use	91
Hotels and Motels	96
Junior or Intermediate High Schools	82
Low- and Medium-Rise Major Office Use	91
Low-Rise Apartments, Condominiums, and Townhomes	86
Maintenance Yards	91
Medium-Rise Apartments and Condominiums	86
Mixed Multi-Family Residential	74
Mixed Residential	59
Modern Strip Development	96
Motion Picture and Television Studio Lots	82
Non-Attended Public Parking Facilities	91
Older Strip Development	97
Other Open Space and Recreation	10
Police and Sheriff Stations	91
Regional Shopping Center	95
Religious Facilities	82
Research and Development	91
Retail Centers (Non-Strip With Contiguous Int	96
Senior High Schools	82
Vacant Undifferentiated	1
Water Storage Facilities	91

Rain depth - The hydrologic map shows that the City watershed area is bounded by the 4.9-inch (50-year, 24-hour isohyet) to the west, and the 5.2-inch isohyet to the east. The scope of the study includes hydrologic analysis of the 10-year, 25-year, and 50-year storm events. The rainfall depths for 10-year and 25-year storm event were estimated using the rainfall frequency factors defined in the hydrology manual. Table 3-3 summarizes the relationship between the required frequencies as factors of the 50-year frequency depths as presented in Table 5.3.1 of the County Hydrology Manual. The factors are normalized to the 50-year event because this event is defined as the County Capital Flood level of protection. Per County's methodology, this rainfall depth is assumed to occur on the fourth day of a four-day storm. Precipitation depths on the preceding three days are assumed to be 10 percent, 40 percent, and 35 percent of the depth on the maximum day, i.e. the fourth day.

Table 3-3: Rainfall Frequency Multiplication Factors

Frequency	Multiplication Factor
10-year	0.714
25-year	0.878
50-year	1.000