

APPENDIX 4.19-1

SEWER ANALYSIS



Technical Memorandum

October 18, 2023 (Updated November 16, 2023)

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From	Andy Leung, GHD; Ulysses Fandino, GHD	GHD Project No.	12589260
Project Name	City of Anaheim Festival Hills Development Sewer Analysis		
Subject	Sewer Analysis Model Results		

1. Introduction

The City of Anaheim (City) has retained GHD to perform a sewer analysis on the City's sewer collection system to determine the effects of an approved medium density residential development, herein referred to as Festival Hills Development. The Festival Hills Development project is located on Festival Drive between Santa Ana Canyon Road and Roosevelt Road within the East Anaheim Master Plan of Sanitary Sewer (EAMPSS) study area and the Anaheim Hills Festival Specific Plan (SP90-1) area.

2. Methodology

The sewer hydraulic analysis utilized the current iteration of the sewer hydraulic model prepared for the 2023 EAMPSS update. The EAMPSS sewer model includes all sewer improvements the City has constructed since the previous 2005 Combined East Anaheim Area Master Plan of Sanitary Sewers. Sewer pipe alignments, elevations, connections, and manholes for the project area were verified during the EAMPSS update.

The anticipated sewer generation changes are inputted into the hydraulic model for analysis. The following sections describe the study area for this sewer analysis, the proposed land use changes, the methodology for preparing the sewer hydraulic model, and the revised sewer loadings from the proposed Festival Hills Development.

2.1 Study Area

The Anaheim Hills Festival Specific Plan (Specific Plan) consists of four existing Development Areas, identified as Development Areas 1 through 4. Development Areas 1 and 2 (DA1 and DA2) are designated for "Retail Commercial" use (Anaheim Hills Festival shopping center), Development Area 3 (DA3) is designated for "Visitor Commercial" use, and Development Area 4 (DA4) is designated for "Senior Residential" use following an amendment in 1999. The Festival Hills Development is part of a proposed amendment to the Specific Plan (SP Amendment No. 6) to reassign three parcels (APNs 35445119, 35445131 and 35445132) from the southern portion of DA2 to form a new Development Area 5 (DA5). The General Plan will be updated to change the long-term land use designations of these three parcels from "Regional Commercial" to "Mixed-Use High" ahead of the Specific Plan amendment.

The Festival Hills Development (blue outline in **Figure 2.1**) will be constructed in the two western parcels of DA5 (APNs 35445119 and 35445132), which are currently used as a cinema and a paved parking lot. The development will consist of a 450-dwelling units (DU) medium density residential apartment complex and associated amenities. The total development area will be approximately 10.4 acres.

The proposed SP Amendment No. 6 stated that there will be a retention of approximately 48,360 square feet of existing non-residential uses within DA5, in reference to the remaining parcel of DA5 (APN 35445131). However, the City has directed GHD to treat this parcel as a Mixed Use-High parcel with a 60 DU/acre building density for the purpose of this sewer analysis. In the event that this parcel is redeveloped into residential units, which is allowable under its Mixed Use-High land use designation, the resulting loading to the sewer system will be much greater than if this parcel was to remain as a commercial use property. This approach provides the City with a more conservative analysis and increased flexibility to allow changes to the development plan to suit the community needs in the future. The Festival Hills Development and the potential redevelopment of this remaining DA5 parcel will be collectively referred to herein as DA5 Developments.

According to the City's records, the Specific Plan area is served by a network of 6-inch and 8-inch private sewer lines that run within the Anaheim Hills Festival shopping center and in Festival Drive. The private sewer lines outfall to the City's sewer network at Manhole SW207202 at the intersection of Santa Ana Canyon Road and Festival Drive. From there onwards, the City's sewer network consists of a 10-inch sewer main flowing west along Santa Ana Canyon Road until it outfalls to an 18-inch Orange County Sanitation District (OC San) trunk sewer at Manhole SW201405 east of Eucalyptus Drive. The existing parcels, proposed Festival Hills Development and the nearby City sewer network are presented in **Figure 2.1**. Excerpts from the SP Amendment No. 6 and the Festival Hills Development plans are included as **Figure 2.2** and **Figure 2.3** to illustrate the proposed land use changes.

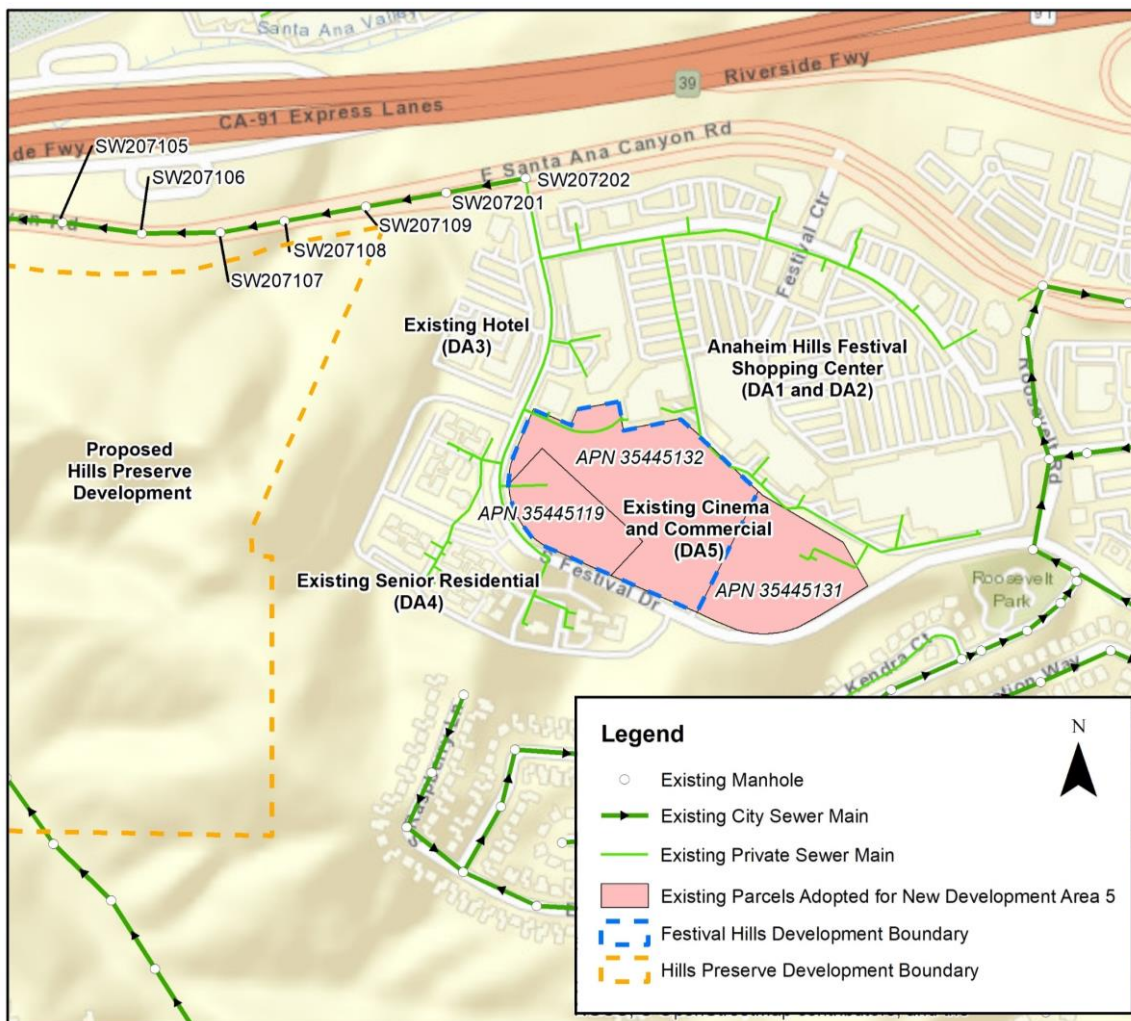


Figure 2.1 Study Area

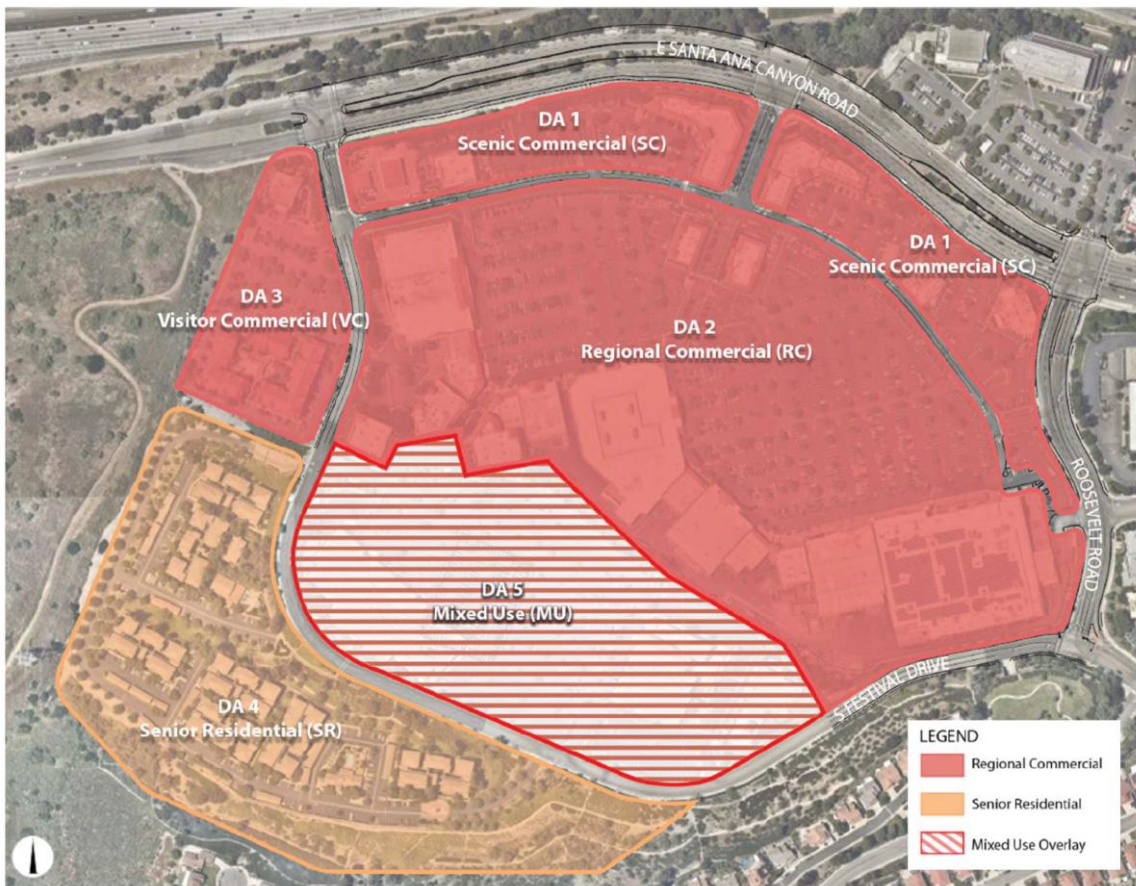


Figure 2.2 Proposed Anaheim Hills Festival Specific Plan Amendment No. 6

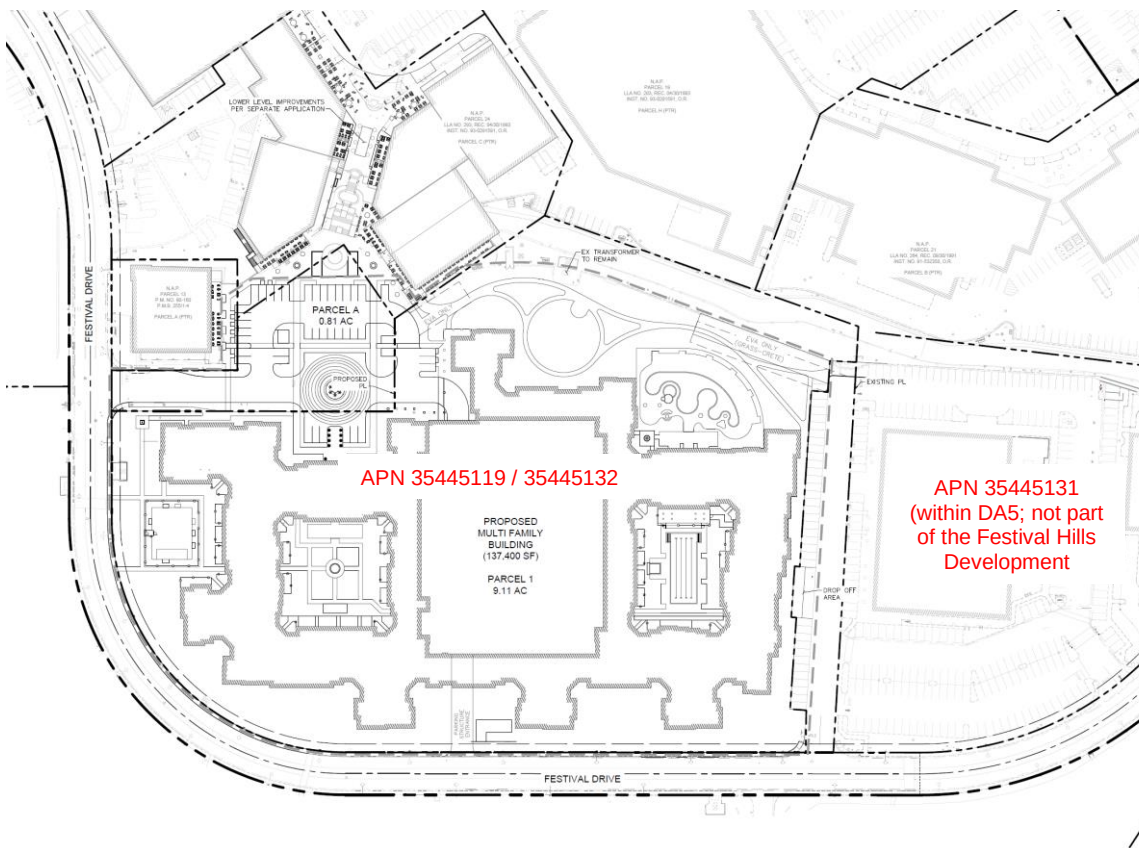


Figure 2.3 Proposed Festival Hills Development

2.2 Sewer Model Methodology

The sewer hydraulic model prepared for the EAMPSS was used as a basis for this sewer study. The model was developed using the Innovyze H₂OMAP Sewer hydraulic modeling software. Average sewage flows were calculated based on the land use and census data provided by the City, and unit flow factors were developed for the EAMPSS according to flow monitoring data and past sewer master plan studies. These flows were then allocated to the nearest manholes within the model. Peak flows were determined by applying diurnal curves according to land uses, as described in the next section.

The ratio of flow depth to pipe diameter at the actual peak flow is designated d/D . This d/D was calculated by the modeling program and was used to identify pipes needing improvement. The City's analysis criteria call for a maximum allowable $d/D = 0.67$ for pipes with diameters less than 12 inches, and $d/D = 0.75$ for pipes with diameters equal to or greater than 12 inches. Thus, pipes with d/D ratios equal to or greater than these values were identified as needing improvement.

The City also has separate criteria for new sewer design. This is more stringent than the analysis criteria specified above. These criteria call for a maximum allowable $d/D = 0.50$ for pipes with diameters less than 12 inches, and a $d/D = 0.60$ for pipes with diameters equal to or greater than 12 inches.

2.3 Peak Flow Methodology

The methodology for peak sewer flow modeling within the Study Area is based on diurnal curves, which uses a 24-hour flow generation curve to represent the pattern of sewage flows generated by type of land use. The residential and non-residential diurnal curves from the EAMPSS update were applied to the model. The diurnal curves are shown in **Figure 2.4** and **Figure 2.5**. The x-axis represents a 24-hour period starting and ending at midnight, while the y-axis represents the peaking factor applied to the normal flow factor at each hour of the day.

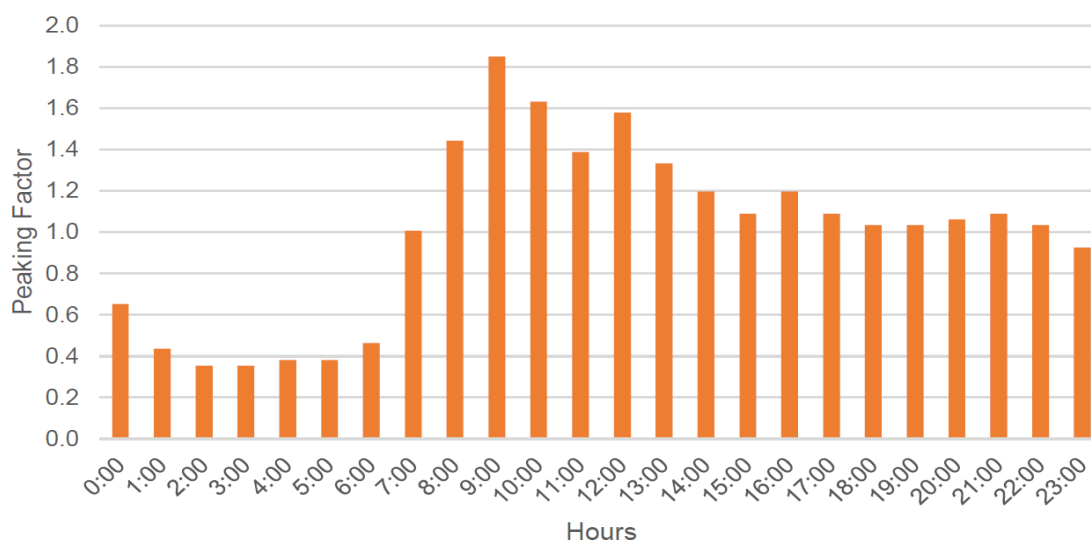


Figure 2.4 Typical Residential Diurnal Curve for the EAMPSS Study Area

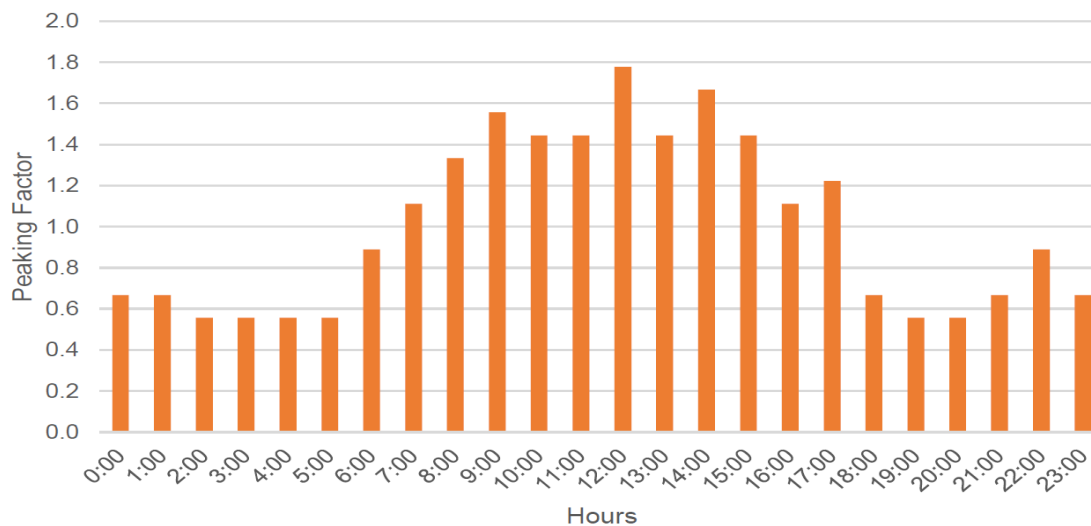


Figure 2.5 Typical Non-Residential Diurnal Curve for the EAMPSS Study Area

2.4 Sewer Loadings for Study Area

The proposed land uses and the associated EAMPSS sewage generation factor, along with the quantity of each land use in terms of parcel area or dwelling units, determined the sewage flows generated within the Study Area.

As mentioned in **Section 2.1**, the City has requested GHD to treat APN 354451131 as a Mixed-Use High parcel for the purpose of this sewer analysis. Using a maximum allowable density of 60 DU/acre per the City General Plan, the sewer loadings for 264 residential DU were assigned to this parcel.

The DA5 Developments are planned to connect to the private sewer network mentioned in **Section 2.1**. Since the EAMPSS hydraulic model only encompasses the City's sewer network, the loadings from the DA5 Development are loaded to the nearest City manhole (Manhole SW207202) for the purpose of this hydraulic analysis.

The estimated sewer loading contributions for the Existing Condition and Build-Out Condition are presented in **Table 2.1** below.

Table 2.1 Estimated Sewer Loading Contribution

APN No.	Proposed Land Use	Proposed Units/Floor Area	Generation Factor	Proposed Sewer Loading	Loading Manhole
35445119/ 35445132	Residential - Medium	450 DU	170 gpd/DU	76,500 gpd	SW207202
35445131	Mixed Use - High	264 DU	170 gpd/DU	44,880 gpd	SW207202

3. Hydraulic Model Analysis

The City has recently received another application for a mixed-use development near the DA5 Developments, herein referred to as the Hills Preserve Development. The Hills Preserve Development consists of developing six vacant parcels on the north side of Deer Canyon Park into medium density residential units, estate-style low density residences and a commercial retail area. In particular, the commercial retail area would connect to the same 10-inch City sewer main at approximately 900 feet downstream of the connection point for the DA5 Developments. Due to the proximity of these developments and their influences on the same reaches of City sewer mains, the City has requested

additional scenarios to be performed to analyze the effects on its sewer network with the DA5 Developments only, and the effects with the DA5 Developments and Hills Preserve Development completed. For the purpose of this sewer analysis, it is assumed the Hills Preserve Development commercial area will have a floor area of 80,000 SF under the Existing Condition, and a floor area of 257,000 SF under Build-Out Condition based on information available to the City. The following model scenarios were analyzed:

- Scenario 1 – EAMPSS Existing Condition plus DA5 Developments
- Scenario 2 – EAMPSS Existing Condition plus DA5 Developments and Hills Preserve Development (with 80,000 SF Commercial Floor Area)
- Scenario 3 – EAMPSS Build-Out Condition plus DA5 Developments
- Scenario 4 – EAMPSS Build-Out Condition plus DA5 Developments and Hills Preserve Development (with 257,000 SF Commercial Floor Area)

The model results focus on the pipe segments downstream of the Festival Hills Development to the OC San trunk sewer outfall. The model results are reported by Pipe ID, which is comprised of each pipe's upstream and downstream manhole identification number.

Scenario 1 builds on the Existing Condition of the EAMPSS model, with the addition of sewage flows from the DA5 Developments. The DA5 Developments introduce a steady state loading of 121,380 gallons per day (gpd) of residential flows to the sewer system, while removing 25,208 gpd of non-residential flows from the sewer system, for a net increase of 96,172 gpd to the sewer system compared to the Existing Condition.

Scenario 2 builds onto Scenario 1 to depict the near-term condition once the DA5 Developments and Hills Preserve Development have been completed. In addition to the flow increases from the DA5 Developments, the 10-inch City sewer main in Santa Ana Canyon Road will convey an additional 8,000 gpd of non-residential flows from the commercial retail area of the Hills Preserve Development.

Scenario 3 builds on the EAMPSS Build-Out Condition, with the addition of sewage flows from the DA5 Developments. The additional residential steady state loadings from the DA5 Developments is the same as Scenario 1 at 121,380 gpd, while 31,510 gpd of non-residential flows based on the City General Plan land uses of the DA5 parcels were removed from the model. The net sewer loading increase to the sewer system due to the DA5 Developments is 89,870 gpd.

Scenario 4 builds onto Scenario 3 to depict the long-term condition when the DA5 Developments and Hills Preserve Development are in place and other parcels are at Build-Out Condition. The Hills Preserve Development commercial area is estimated to contribute 25,700 gpd of non-residential flows to the City sewer system at Build-Out Condition.

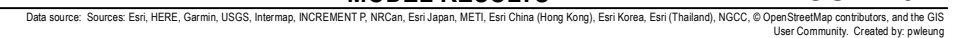
The analysis revealed the additional sewer loadings from the developments will not create any hydraulic deficiencies in the downstream pipelines. The peak flows in these pipelines were within the allowable d/D ratios, with a maximum d/D ratio of 0.48, 0.49, 0.56 and 0.57 for Scenarios 1 through 4, respectively. The hydraulic model results are presented in **Table 3.1** and **Table 3.2** from upstream to downstream. The Existing Condition and Build-Out Condition model results are also depicted in **Figure 3.1** through **Figure 3.4**, respectively.

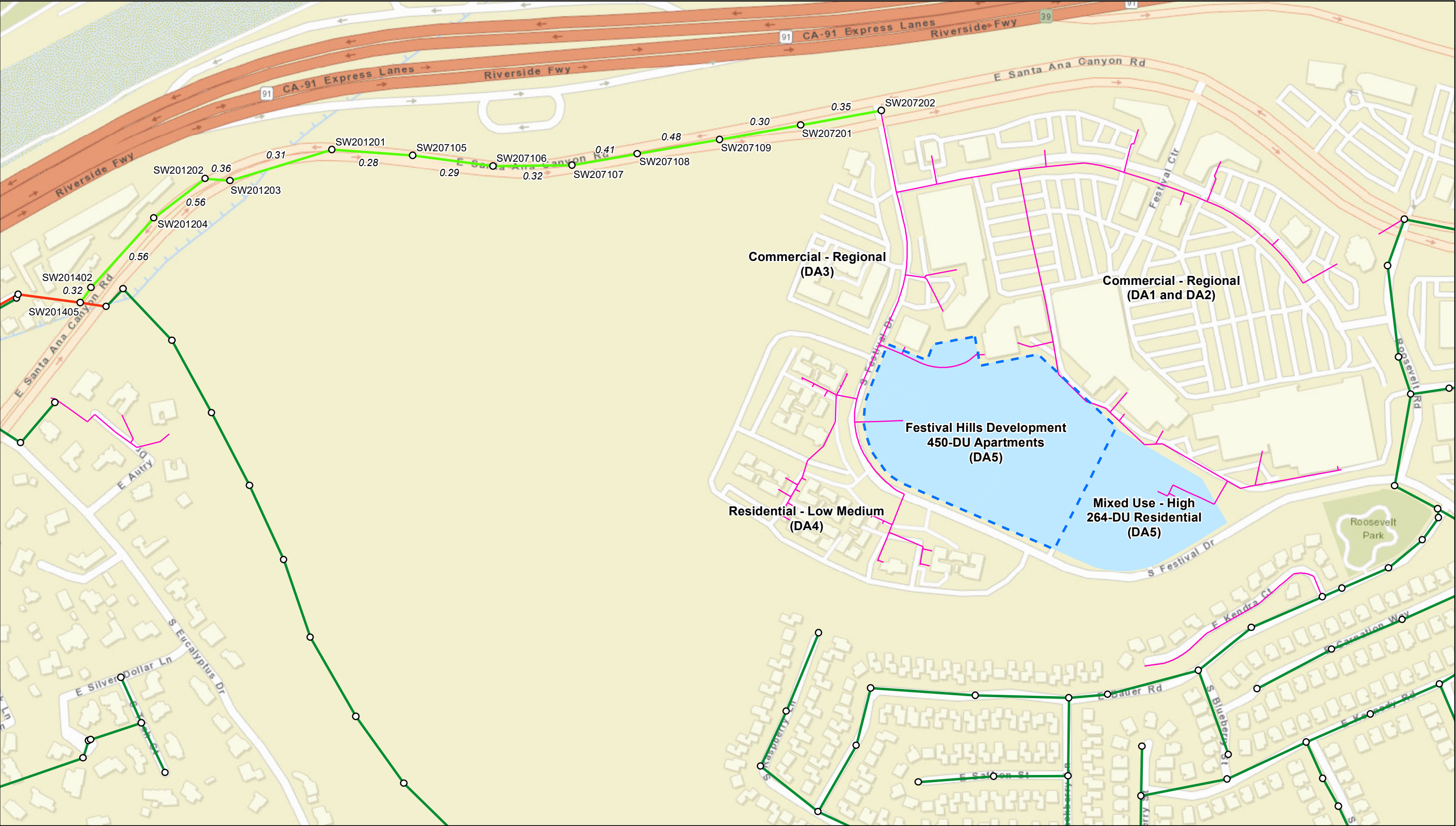
Table 3.1 - Existing Conditions Model Results (Scenarios 1 and 2)

Pipe ID	Pipe Diameter (inch)	Pipe Length (feet)	Pipe Slope	EAMPSS Model Results			Scenario 1 - Model Results with DA5 Developments			Scenario 2 - Model Results with Hills Preserve and DA5 Developments			Comment
				Maximum Flow (MGD)	Maximum Velocity (ft/s)	Maximum d/D	Maximum Flow (MGD)	Maximum Velocity (ft/s)	Maximum d/D	Maximum Flow (MGD)	Maximum Velocity (ft/s)	Maximum d/D	
10" Sewer Main - Santa Ana Canyon Road													
SW207202-SW207201	10	296	0.0230	0.29	4.3	0.25	0.47	4.9	0.32	0.47	4.9	0.32	DA5 loadings assigned to MH SW207202.
SW207201-SW207109	10	296	0.0449	0.29	5.4	0.21	0.47	6.2	0.27	0.47	6.2	0.27	
SW207109-SW207108	10	296	0.0078	0.29	2.9	0.33	0.47	3.3	0.43	0.47	3.3	0.43	
SW207108-SW207107	10	244	0.0144	0.29	3.6	0.28	0.47	4.1	0.36	0.49	4.2	0.37	Hills Preserve loading assigned to MH SW207108.
SW207107-SW207106	10	320	0.0338	0.29	4.9	0.23	0.47	5.6	0.29	0.49	5.7	0.29	
SW207106-SW207105	10	296	0.0534	0.29	5.8	0.20	0.47	6.6	0.26	0.49	6.7	0.26	
SW207105-SW201201	10	296	0.0564	0.29	5.9	0.20	0.47	6.7	0.25	0.48	6.8	0.26	
SW201201-SW201203	10	296	0.0421	0.29	5.3	0.21	0.47	6.1	0.27	0.48	6.1	0.28	
SW201203-SW201202	10	118	0.0227	0.29	4.3	0.25	0.47	4.9	0.32	0.48	4.9	0.32	
SW201202-SW201204	10	255	0.0050	0.29	2.5	0.37	0.47	2.8	0.48	0.48	2.8	0.49	
SW201204-SW201402	10	317	0.0050	0.30	2.5	0.37	0.47	2.8	0.48	0.49	2.8	0.49	
SW201402-SW201405	10	68	0.0398	0.29	5.2	0.22	0.47	6.0	0.28	0.49	6.0	0.28	

Table 3.2 - Build-Out Conditions Model Results (Scenarios 3 and 4)

Pipe ID	Pipe Diameter (inch)	Pipe Length (feet)	Pipe Slope	EAMPSS Model Results			Scenario 3 - Model Results with DA5 Developments			Scenario 4 - Model Results with Hills Preserve and DA5 Developments			Comment
				Maximum Flow (MGD)	Maximum Velocity (ft/s)	Maximum d/D	Maximum Flow (MGD)	Maximum Velocity (ft/s)	Maximum d/D	Maximum Flow (MGD)	Maximum Velocity (ft/s)	Maximum d/D	
10" Sewer Main - Santa Ana Canyon Road													
SW207202-SW207201	10	296	0.0230	0.41	4.7	0.30	0.58	5.2	0.35	0.58	5.2	0.35	DA5 loadings assigned to MH SW207202.
SW207201-SW207109	10	296	0.0449	0.41	6.0	0.25	0.58	6.6	0.30	0.58	6.6	0.30	
SW207109-SW207108	10	296	0.0078	0.41	3.2	0.39	0.58	3.5	0.48	0.58	3.5	0.48	
SW207108-SW207107	10	244	0.0144	0.42	4.0	0.34	0.59	4.4	0.41	0.62	4.4	0.42	Hills Preserve loading assigned to MH SW207108.
SW207107-SW207106	10	320	0.0338	0.43	5.5	0.27	0.60	6.0	0.32	0.62	6.1	0.33	
SW207106-SW207105	10	296	0.0534	0.43	6.4	0.24	0.60	7.1	0.29	0.62	7.1	0.29	
SW207105-SW201201	10	296	0.0564	0.42	6.5	0.24	0.60	7.2	0.28	0.62	7.3	0.29	
SW201201-SW201203	10	296	0.0421	0.42	5.9	0.26	0.60	6.5	0.31	0.62	6.6	0.31	
SW201203-SW201202	10	118	0.0227	0.43	4.8	0.31	0.60	5.2	0.36	0.62	5.3	0.37	
SW201202-SW201204	10	255	0.0050	0.43	2.7	0.46	0.60	3.0	0.56	0.62	3.0	0.57	
SW201204-SW201402	10	317	0.0050	0.44	2.8	0.47	0.61	3.0	0.56	0.63	3.0	0.57	
SW201402-SW201405	10	68	0.0398	0.44	5.9	0.27	0.61	6.4	0.32	0.63	6.5	0.32	





Legend

- Existing Non-Deficient City Sewer Mains
- Non-Deficient City Sewer Mains Downstream of Development
- Existing OC San Trunk Sewers
- Existing Private Sewer Mains
- Existing Manhole
- Proposed Development Area 5
- 0.28 Maximum d/D Ratio
- Festival Hills Development Boundary

Paper Size ANSI B

0 125 250 500 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD83 California zone 6 ftUS

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CITY OF ANAHEIM
FESTIVAL HILLS DEVELOPMENT
SEWER ANALYSIS

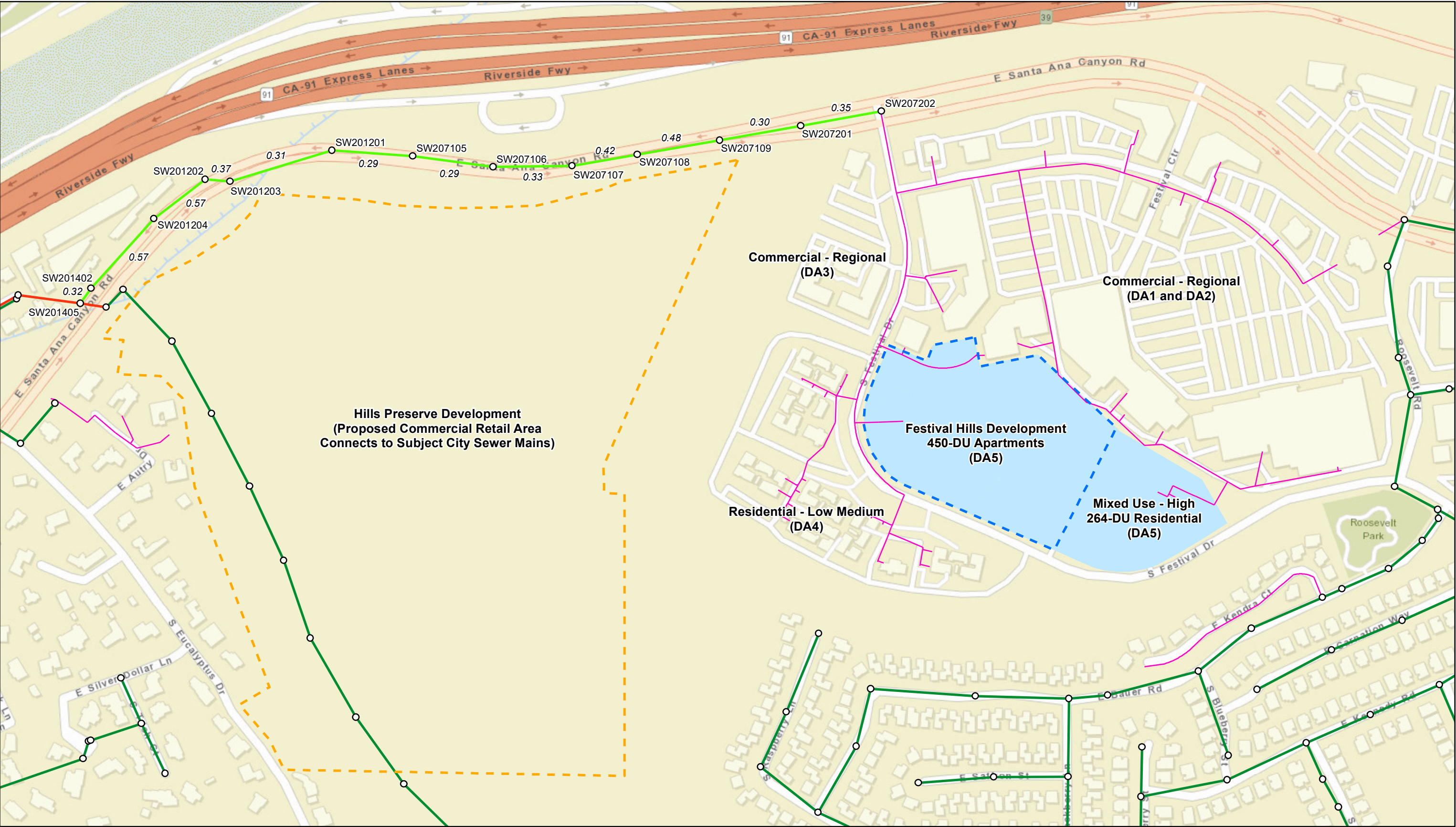
**SCENARIO 3 - BUILD-OUT CONDITION
PLUS DA5 DEVELOPMENTS
MODEL RESULTS**

Project No. 12589260
Revision No. 1
Date 11/15/2023

FIGURE 3.3

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Scenario 3 Model Results.mxd
Print date: 15 Nov 2023 - 17:35

Data source: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community. Created by: pwleung



Legend

- Existing Non-Deficient City Sewer Mains
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- Maximum d/D Ratio
- Festival Hills Development Boundary
- Hills Preserve Development Boundary

Paper Size ANSI B

0 125 250 500 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD83 California zone 6 ftUS

CITY OF ANAHEIM
FESTIVAL HILLS DEVELOPMENT
SEWER ANALYSIS

**SCENARIO 4 - BUILD-OUT CONDITION +
DA5 AND HILLS PRESERVE
DEVELOPMENTS MODEL RESULTS**

Project No. 12589260
Revision No. 1
Date 11/15/2023

FIGURE 3.4

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Scenario 4 Model Results.mxd
Print date: 15 Nov 2023 - 17:39

Data source: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community. Created by: pwleung

4. Conclusion

The Festival Hills Development is an approved medium density residential project located on two of the three parcels within the new DA5 proposed in Amendment No. 6 of the Anaheim Hills Specific Plan. The Festival Hills Development will consist of a 450-DU apartment complex and associated amenities. The remaining parcel of DA5 was treated as a 264-DU Mixed Use-High development for the purpose of this sewer analysis per the City's request. Collectively, these land use changes to DA5 are referred to as DA5 Developments in this memorandum.

Scenario 1 (EAMPSS Existing Condition + DA5 Developments) is projected to contribute an additional steady state sewage flow of 96,172 gpd to the sewer system compared to the EAMPSS Existing Condition. Scenario 3 (EAMPSS Build-Out Condition + DA5 Developments) represents a 89,870 gpd increase in steady state loading when compared to the EAMPSS Build-Out Condition, in which loadings were assigned based on General Plan land uses. Scenarios 2 and 4 were included at the request of the City to analyze the effects when the nearby Hills Preserve Development is also completed. The commercial retail area of the Hills Preserve Development contributes a steady state flow of approximately 8,000 gpd under Existing Condition and 25,700 gpd under Build-Out Condition to the same 10-inch City sewer main approximately 900 feet downstream of the connection point for the DA5 Developments.

The sewer analysis revealed no hydraulic deficiencies in the pipelines downstream of the developments in the modeled scenarios. The maximum d/D ratios for all four scenarios are below 0.57, which are within the City's maximum allowable $d/D = 0.67$ for pipes with diameters less than 12 inches, and $d/D = 0.75$ for pipes with diameters equal to or greater than 12 inches.