Appendix J Hydrology Report

Appendix

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Preliminary Hydrology and Hydraulics

for

The Hub at Fullerton

Fullerton, CA

FEBUARY 2021 | PRELIMINARY

Prepared By:

Kimley»Horn

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INTRODUCTION

PROJECT DESCRIPTION AND PURPOSE

This project is proposing to develop an existing 3.55-acre commercial/retail development, to a mixed-use/residential development. The development consists of two multifamily residential buildings, parking garage and retail units. The existing property is located within the proposed College Town Specific plan and is located within commercial zoning and is designated as Office Professional (O-P). This project site is in Fullerton, CA. It is located at the Northeast Corner of E. Chapman Ave and N. Commonwealth Ave. In addition, the site is west of the 57 Freeway, and south of an existing residential development.

The purpose of this report is to provide information about the design of the Storm Water Management System for the proposed project. This investigation was conducted to evaluate the hydrologic and hydraulic conditions of the project described above. The purpose is also to determine the impact that the proposed development has on the local drainage system and to ensure that the post development peak flows, will not increase beyond the level at which the Orange County Drainage Area Master Plan (DAMP) designed the storm sewer lateral along E. Chapman Avenue for.

Figure 1: Project Site Location

PROJECT SITE CONDITIONS

EXISTING SITE (PRE-DEVELOPMENT) CONDITIONS

The existing site is an existing 3.55-acre commercial/retail development. The existing site is 88% impervious and 12% pervious. The existing topography drains from the northeast to the southwest corner of the site (elevations ranging from 227.50 to 224.85). Overland flows exit the site and flow west along an existing curb and gutter in E. Chapman Ave., entering an existing catch basin located on the North East Corner of the E. Chapman Avenue and N. Commonwealth Avenue intersection. Flows are then conveyed West, discharging into Fullerton Creek, a naturally lined river. This river discharges into the Coyote Creek, which discharges into the San Gabriel River Estuary, which ultimately discharges into the San Pedro Bay Near/OffShore Zones. Refer to the Existing Hydrology Exhibit in **Appendix D.**

PROPOSED SITE (POST-DEVELOPMENT) CONDITIONS

Storm water runoff from each DMA will be captured and conveyed to various on-site inlets throughout the site. These flows will be diverted to an onsite proprietary bioretention BMP specified as Modular Wetland Systems (MWS) prior to discharging into the local storm drain system. Refer to the Preliminary Water Quality Management Plan for water quality calculations and documentation. Runoff discharges from the MWS to the existing catch basin located in the southwest corner of the site. The modular wetlands were sized based on the proposed drainage area. Refer to the Proposed Hydrology Exhibit in **Appendix D.**

PRECIPITAITON

Precipitation values for the hydrologic analysis were determined from site specific precipitation frequency estimates published online in the NOAA Atlas 14. For this site (Fullerton, California) the 100 year, 1-hr storm precipitation depth of 1.32 inches was used in both the storm water flow and volume calculations. **Appendix A** contains the site-specific tabular output from NOAA Atlas 14.

WATERSHED DESCRIPTION

The project is relatively flat slopes and the regional topography slopes to the southwest. The project site is located with in the San Gabriel-Coyote Creek Watershed.

SOIL TYPES

The type of soil and its conditions are major factors affecting infiltration and resultant storm water runoff. The Natural Resources Conservation Service (NRCS) has classified soils into four general hydrologic groups for comparing infiltration and runoff rates. This Project Site has a hydrologic soil group classification of B. Group B soils typically have a moderate infiltration rate when thoroughly wetted and consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse textures. See **Appendix B** for soil type classifications.

LAND USE

The project site is located within a commercial planning zone and its land use is designated as Office Professional (O-P)

GROUNDWATER

Per the draft Geotechnical Investigation Report prepared by NTS Geotechnical, INC. dated 10/2/2020, the historical groundwater depth is deeper than 70 feet below the existing grade at the project site.

FEMA MAPPING

The project site is covered by Map Number 06059C0132J of the FEMA Flood Insurance Rate Map (FIRM) for Orange County County, California. The City of Fullerton, community number 060219, Is included in this FIRM. None of the project area is within a FEMA-mapped special flood hazard area. The site is classified as Zone X, which is an area of minimal flooding. The effective FEMA map is dated December 3rd, 2009 and is provided in **Appendix C.**

HYDROLOGIC ANALYSIS

METHODOLOGY

The design criteria for the hydrologic calculations for this project have been conducted per requirements as outlined in the Orange County Hydrology Manual (August 1986).

Runoff calculations were performed using the Modified Rational Method as utilized by the HydroWin Advanced Engineering Software, (AES). AES was used to estimate time of concentrations and 100-year peak flow rates generated from the pre-development and post-development conditions. These Rational Method calculations are included in this report as **Appendix E**. Runoff coefficients were established from D.5. of the Hydrology Manual. Intensity values were obtained from NOAA Atlas 14.

The site was delineated into 7 drainage management areas (DMAs), but only two main routes were modeled in AES for preliminary purposes. The other DMAs were modeled by adding the area to the main line at the main line time of concentration rather than modeling all connections as confluences. This approach is conservative and will generate a slightly higher flow rate.

This site does not fall within a hydromodification zone and therefore the 2-year storm was not analyzed.

RESULTS AND CONCLUSIONS

The Modified Rational Method calculations demonstrate that post-development peak flow is only 2% greater than the pre-development peak flow. Therefore, the impacts of the post-development peak flow do not need to be mitigated. Although the post-development peak flows do not need to be detained, the runoff water does need to be treated. To treat post-development runoff, modular wetland systems were designed

Table 1. Rational Method Analysis

Analysis	Storm	DMA (Ac)	Peak Flow (cfs)
Existing	100-yr 24-hr	3.55	13.46
Proposed	100-yr 24-hr	3.54	13.75

HYDRAULIC ANALYSIS

METHODOLOGY

A new on-site storm drain system, designed for the 100 -year storm, will be installed to collect surface runoff at designated storm inlet locations across the site and convey flows downstream. Each inlet has been sized to limit ponding depths to less than the 6-inch curb height.

Hydraulic calculations were performed for the main storm drainpipes utilizing Flowmaster, developed by Bentley. The software utilizes Manning's equation to determine acceptable friction slopes for design. An allowable friction slope of 0.46% was used to keep the hydraulic grades below ground surface.

RESULTS AND CONCLUSIONS

Pipes will be sized according to the table below based on the pipe hydraulic calculations. The flow rate tributary to a pipe size will not exceed the tabulated values listed below:

Table 2. Pipe Sizing Table

Pipe Sizing Table		
Pipe Size	Material	Capacity at 0.46% Friction Slope
6"	HDPE (n=0.015)	0.33 CFS
12"	HDPE (n=0.015)	2.09 CFS
18"	HDPE (n=0.015)	6.17 CFS
24"	HDPE (n=0.015)	13.30 CFS
30"	HDPE (n=0.015)	24.11 CFS

STREET FLOW

The City has requested that the finished floor elevations of the buildings be set 1-foot above the 100-yr water surface elevation in the adjacent street. The City Master Drainage Report was used to determine the 100-yr flow in the street adjacent to the site. The report contained a couple items that needed to be adjusted based on current existing conditions. For the SEC of the site, the report had the flow in Chapman running the wrong direction. The flow at this location was determined to consist of run-off from the area east and north of the site (32299). Flow at the middle driveway was estimated to consist of half the site flow (32294) and the flow coming from the east (32299). For the NWC of the site, the report included areas north of College Place. Since the report was prepared, a storm drain system with inlets on the four corners of the College/Commonwealth intersection has been installed. This system captures runoff from areas 32297 and 32291. Therefore, these flows were subtracted out of the flow for node 32285 in the report.

Flowmaster was then utilized to determine the water surface elevation based on the flow from the Master Drainage Report, the existing street cross-section and slope adjacent to the site (see below). Refer to the appendix for calculations and mark-ups of the Master Drainage Report.

Table 3. Street Flow Table

Location	100 yr Flow (cfs)	Depth (in)
Chapman - SEC	14.43	7.1
Chapman – Mid Driveway	29.41	9.0
Commonwealth - NWC	11.59	6.6

APPENDIX A

NOAA Atlas 14, Volume 6, Version 2
Location name: Fullerton, California, USA*
Latitude: 33.8745°, Longitude: -117.8826°
Elevation: 226.24 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.132** (0.111-0.159)	**0.168** (0.141-0.203)	**0.216** (0.180-0.262)	**0.256** (0.211-0.313)	**0.310** (0.247-0.392)	**0.352** (0.275-0.456)	**0.395** (0.300-0.525)	**0.440** (0.324-0.602)	**0.501** (0.354-0.716)	**0.548** (0.373-0.814)
10-min	**0.189** (0.158-0.228)	**0.241** (0.202-0.291)	**0.310** (0.259-0.376)	**0.367** (0.303-0.448)	**0.444** (0.354-0.563)	**0.505** (0.394-0.653)	**0.566** (0.430-0.752)	**0.630** (0.465-0.863)	**0.718** (0.507-1.03)	**0.786** (0.535-1.17)
15-min	**0.229** (0.192-0.276)	**0.292** (0.244-0.352)	**0.375** (0.313-0.454)	**0.443** (0.367-0.542)	**0.537** (0.429-0.680)	**0.610** (0.476-0.790)	**0.685** (0.521-0.910)	**0.762** (0.562-1.04)	**0.868** (0.613-1.24)	**0.951** (0.647-1.41)
30-min	**0.313** (0.262-0.378)	**0.399** (0.334-0.482)	**0.513** (0.428-0.622)	**0.607** (0.502-0.742)	**0.736** (0.587-0.932)	**0.836** (0.652-1.08)	**0.938** (0.713-1.25)	**1.04** (0.770-1.43)	**1.19** (0.839-1.70)	**1.30** (0.886-1.93)
60-min	**0.441** (0.370-0.532)	**0.563** (0.471-0.680)	**0.724** (0.603-0.876)	**0.856** (0.707-1.05)	**1.04** (0.827-1.31)	**1.18** (0.919-1.52)	**1.32** (1.00-1.76)	**1.47** (1.09-2.01)	**1.68** (1.18-2.40)	**1.83** (1.25-2.72)
2-hr	**0.639** (0.535-0.771)	**0.815** (0.682-0.985)	**1.05** (0.872-1.27)	**1.23** (1.02-1.51)	**1.49** (1.19-1.89)	**1.69** (1.32-2.18)	**1.88** (1.43-2.50)	**2.09** (1.54-2.86)	**2.37** (1.67-3.38)	**2.58** (1.76-3.83)
3-hr	**0.803** (0.672-0.968)	**1.02** (0.856-1.24)	**1.31** (1.09-1.59)	**1.54** (1.28-1.89)	**1.86** (1.48-2.36)	**2.10** (1.64-2.72)	**2.35** (1.78-3.12)	**2.60** (1.92-3.56)	**2.94** (2.07-4.20)	**3.20** (2.18-4.75)
6-hr	**1.14** (0.951-1.37)	**1.45** (1.21-1.75)	**1.85** (1.55-2.25)	**2.18** (1.81-2.67)	**2.63** (2.10-3.33)	**2.97** (2.32-3.85)	**3.31** (2.52-4.40)	**3.67** (2.71-5.02)	**4.14** (2.93-5.93)	**4.51** (3.07-6.69)
12-hr	**1.47** (1.24-1.78)	**1.89** (1.58-2.28)	**2.43** (2.03-2.94)	**2.87** (2.38-3.51)	**3.48** (2.78-4.40)	**3.95** (3.08-5.11)	**4.42** (3.36-5.88)	**4.91** (3.63-6.73)	**5.58** (3.94-7.98)	**6.10** (4.16-9.05)
24-hr	**2.03** (1.79-2.34)	**2.62** (2.31-3.02)	**3.40** (3.00-3.94)	**4.04** (3.53-4.72)	**4.93** (4.17-5.94)	**5.61** (4.65-6.91)	**6.32** (5.12-7.96)	**7.05** (5.55-9.13)	**8.05** (6.09-10.9)	**8.84** (6.47-12.3)
2-day	**2.43** (2.15-2.80)	**3.19** (2.82-3.69)	**4.20** (3.70-4.86)	**5.01** (4.38-5.85)	**6.12** (5.18-7.39)	**6.98** (5.79-8.59)	**7.85** (6.35-9.89)	**8.74** (6.89-11.3)	**9.95** (7.53-13.4)	**10.9** (7.97-15.2)
3-day	**2.71** (2.40-3.13)	**3.62** (3.19-4.18)	**4.79** (4.22-5.55)	**5.75** (5.02-6.71)	**7.03** (5.95-8.48)	**8.01** (6.64-9.86)	**9.01** (7.29-11.4)	**10.0** (7.90-13.0)	**11.4** (8.62-15.4)	**12.4** (9.11-17.4)
4-day	**2.90** (2.57-3.35)	**3.89** (3.44-4.49)	**5.18** (4.56-6.00)	**6.22** (5.44-7.26)	**7.63** (6.46-9.20)	**8.70** (7.21-10.7)	**9.79** (7.92-12.3)	**10.9** (8.58-14.1)	**12.4** (9.37-16.7)	**13.5** (9.90-18.9)
7-day	**3.31** (2.93-3.82)	**4.44** (3.92-5.13)	**5.92** (5.21-6.85)	**7.12** (6.22-8.31)	**8.76** (7.41-10.6)	**10.0** (8.31-12.3)	**11.3** (9.15-14.2)	**12.6** (9.95-16.4)	**14.4** (10.9-19.4)	**15.8** (11.6-22.0)
10-day	**3.57** (3.16-4.12)	**4.78** (4.23-5.53)	**6.39** (5.63-7.40)	**7.70** (6.73-8.99)	**9.51** (8.05-11.5)	**10.9** (9.04-13.4)	**12.3** (9.99-15.6)	**13.8** (10.9-17.9)	**15.9** (12.0-21.4)	**17.4** (12.8-24.3)
20-day	**4.23** (3.74-4.88)	**5.70** (5.04-6.59)	**7.68** (6.77-8.90)	**9.33** (8.15-10.9)	**11.6** (9.84-14.0)	**13.4** (11.1-16.5)	**15.3** (12.4-19.3)	**17.3** (13.6-22.4)	**20.0** (15.2-27.0)	**22.2** (16.2-31.0)
30-day	**4.96** (4.39-5.73)	**6.72** (5.93-7.76)	**9.10** (8.02-10.5)	**11.1** (9.71-13.0)	**13.9** (11.8-16.8)	**16.2** (13.4-19.9)	**18.5** (15.0-23.3)	**21.0** (16.5-27.2)	**24.5** (18.5-33.0)	**27.3** (20.0-38.0)
45-day	**5.82** (5.15-6.71)	**7.88** (6.96-9.11)	**10.7** (9.44-12.4)	**13.1** (11.5-15.3)	**16.5** (14.0-19.9)	**19.3** (16.0-23.7)	**22.2** (17.9-27.9)	**25.3** (19.9-32.7)	**29.6** (22.4-40.0)	**33.2** (24.3-46.2)
60-day	**6.71** (5.93-7.74)	**9.06** (8.00-10.5)	**12.3** (10.8-14.3)	**15.1** (13.2-17.6)	**19.1** (16.1-23.0)	**22.3** (18.5-27.4)	**25.7** (20.8-32.3)	**29.3** (23.1-38.0)	**34.5** (26.1-46.5)	**38.7** (28.3-54.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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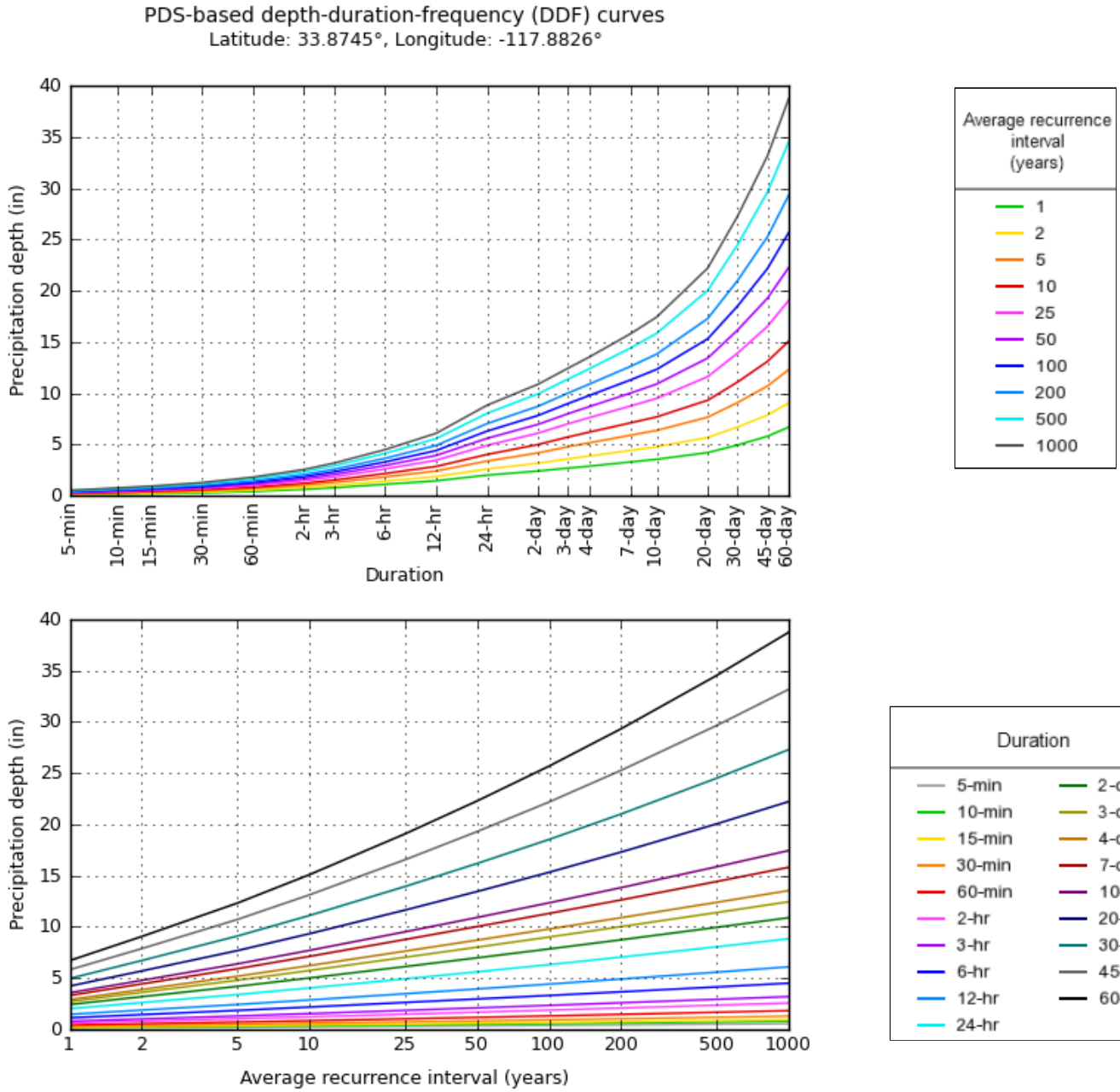
PF graphical



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Created (GMT): Wed Oct 28 02:58:57 2020

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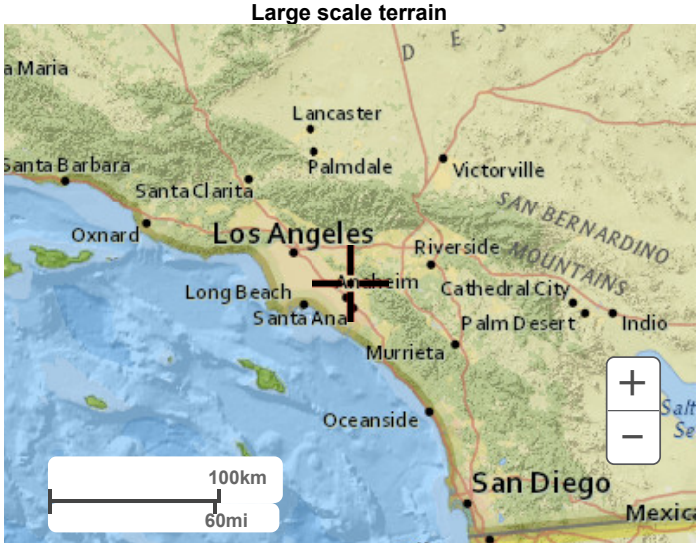
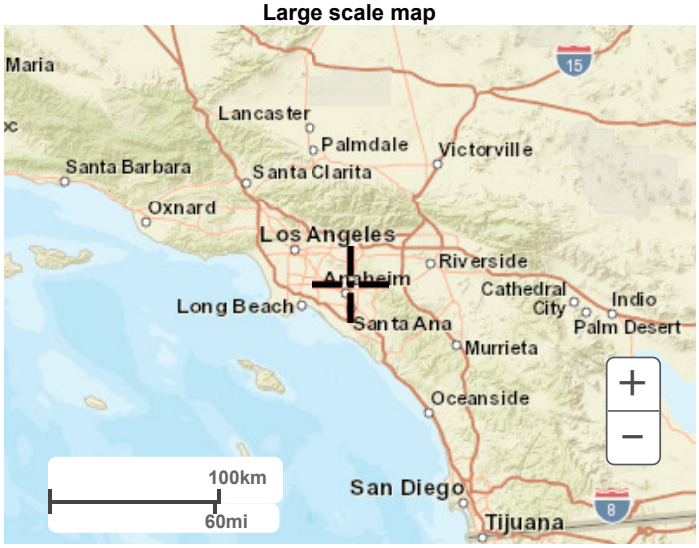
Maps & aerials

Small scale terrain

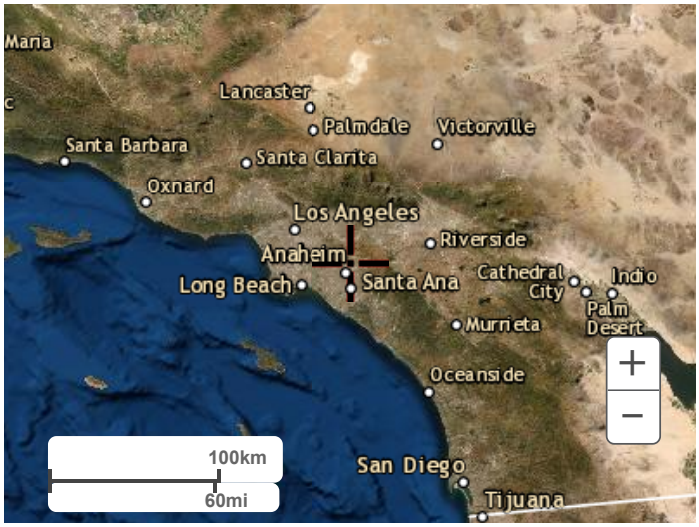
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

APPENDIX B

Map Scale: 1:1,560 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Orange County and Part of Riverside County, California
Survey Area Data: Version 14, May 27, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 27, 2020—Mar 30, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
166	Mocho loam, 0 to 2 percent slopes, warm MAAT, MLRA 19	B	4.8	100.0%
Totals for Area of Interest			**4.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX C

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 11. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from the National Agriculture Imagery Program, dated 2005.

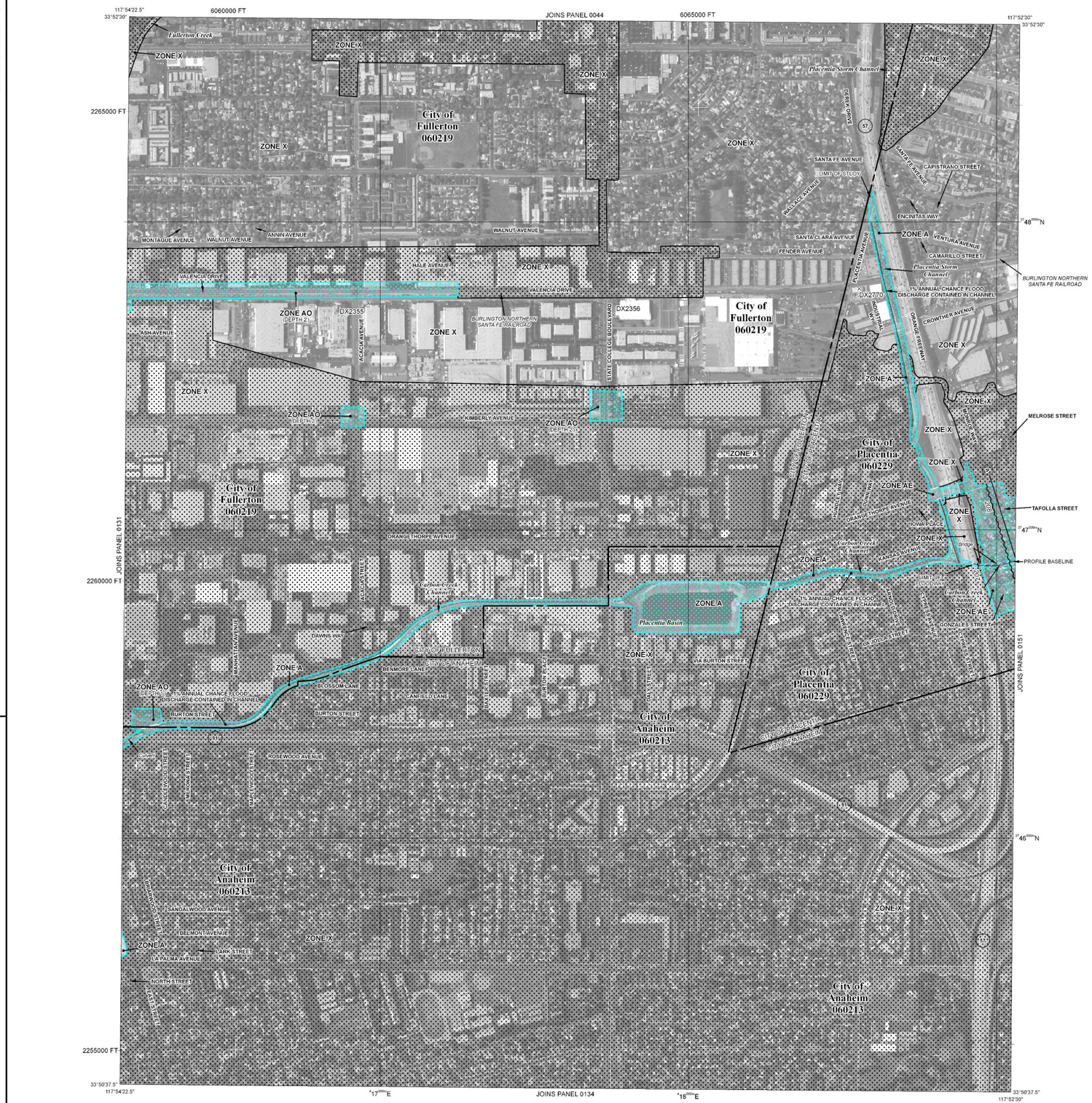
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 (EL 987) — Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- Cross section line
- Transect line
- 87°07'45", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
- 3776000mN — 1000-meter Universal Transverse Mercator grid values, zone NAD 1983 UTM Zone 11N
- 600000 FT — 5000-foot grid ticks: California State Plane coordinate system, zone VI (FIPSZONE 0406), Lambert Conformal Conic projection
- DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- ●M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
September 15, 1989

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 5, 1992 - November 3, 1993 - January 3, 1997 - February 18, 2004 - December 3, 2009 : for description of revisions, see Notice to Users page in the Flood Insurance Study report.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0132J

FIRM

FLOOD INSURANCE RATE MAP

ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS

PANEL 132 OF 539

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ANAHEIM, CITY OF	060213	0132	J
FULLERTON, CITY OF	060219	0132	J
PLACENTIA, CITY OF	060229	0132	J

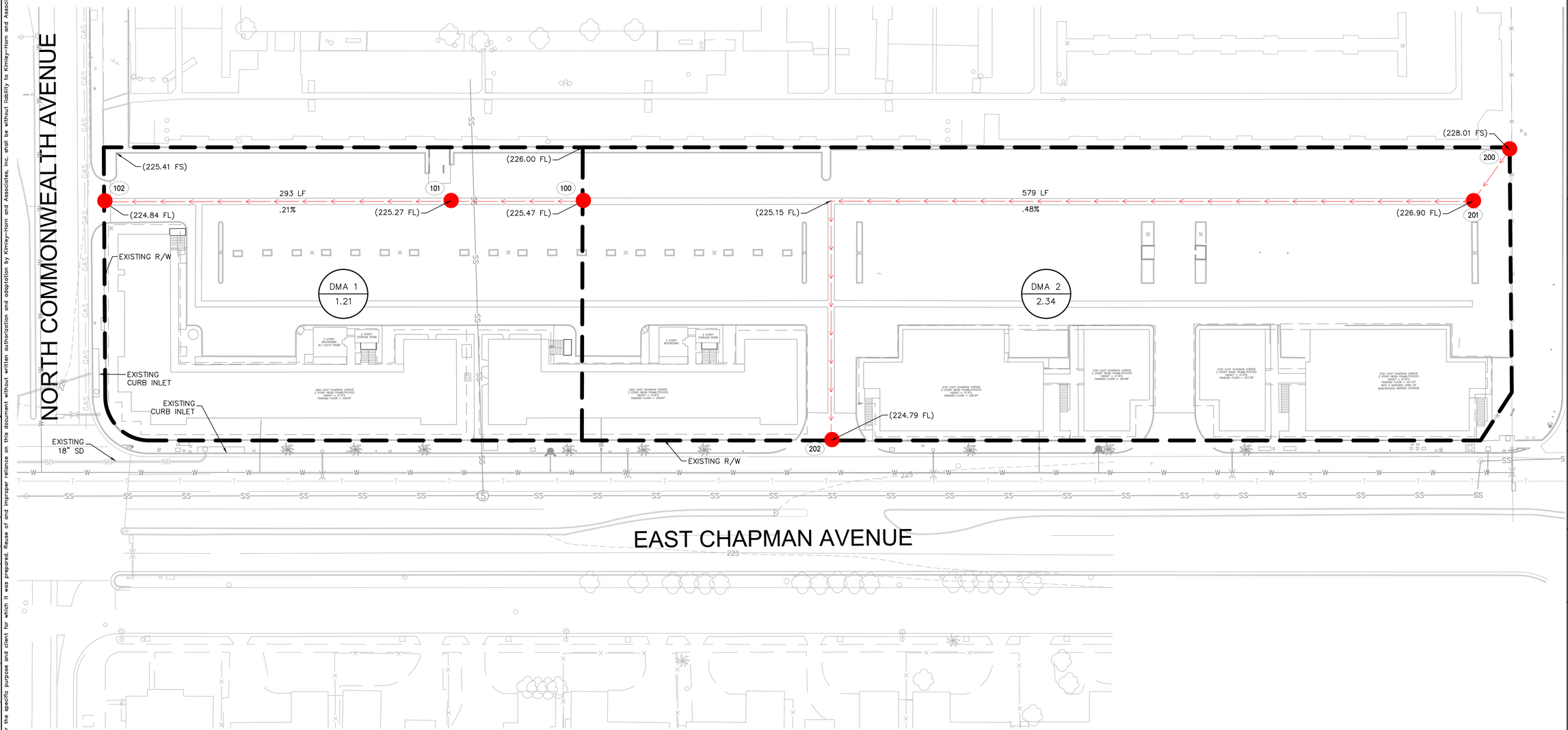
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06059C0132J

MAP REVISED
DECEMBER 3, 2009

Federal Emergency Management Agency

APPENDIX D



LEGEND

- RIGHT OF WAY/ PROPERTY LINE
- CENTERLINE
- DRAINAGE BOUNDARY
- 147 EXISTING CONTOURS
- 147 PROPOSED CONTOURS
- FLOW LINE
- SD EXISTING STORM DRAIN
- (XX.XX TC) / (XX.XX FS) EXISTING SPOT GRADE
- XX.XX TC / XX.XX FS PROPOSED SPOT GRADE
- EXISTING CATCH BASIN
- PROPOSED CATCH BASIN

LEGEND

- EXISTING STORM DRAIN MANHOLE
- DIRECTION OF WATER FLOW
- PROPOSED MODULAR WETLAND
- CONFLUENCE POINT
- XXX NODE
- DA ID / ACRES DRAINGAGE AREA LABEL

FLOOD ZONE

FLOOD ZONE X : AREA OF MINIMAL FLOOD HAZARD

NORTH

GRAPHIC SCALE IN FEET
0 15 30 60

Know what's below. Call 811 before you dig.

No.	REVISIONS	DATE	BY

Kimley»Horn
© 2021 KIMLEY-HORN AND ASSOCIATES, INC.
1100 TOWN AND COUNTRY ROAD, SUITE 700, ORANGE, CA 92868
PHONE: 714-939-1030 FAX: 714-938-9488
WWW.KIMLEY-HORN.COM

LICENSED PROFESSIONAL
BRIAN GILLIS
CA LICENSE NUMBER 63021
DATE: 6/30/22

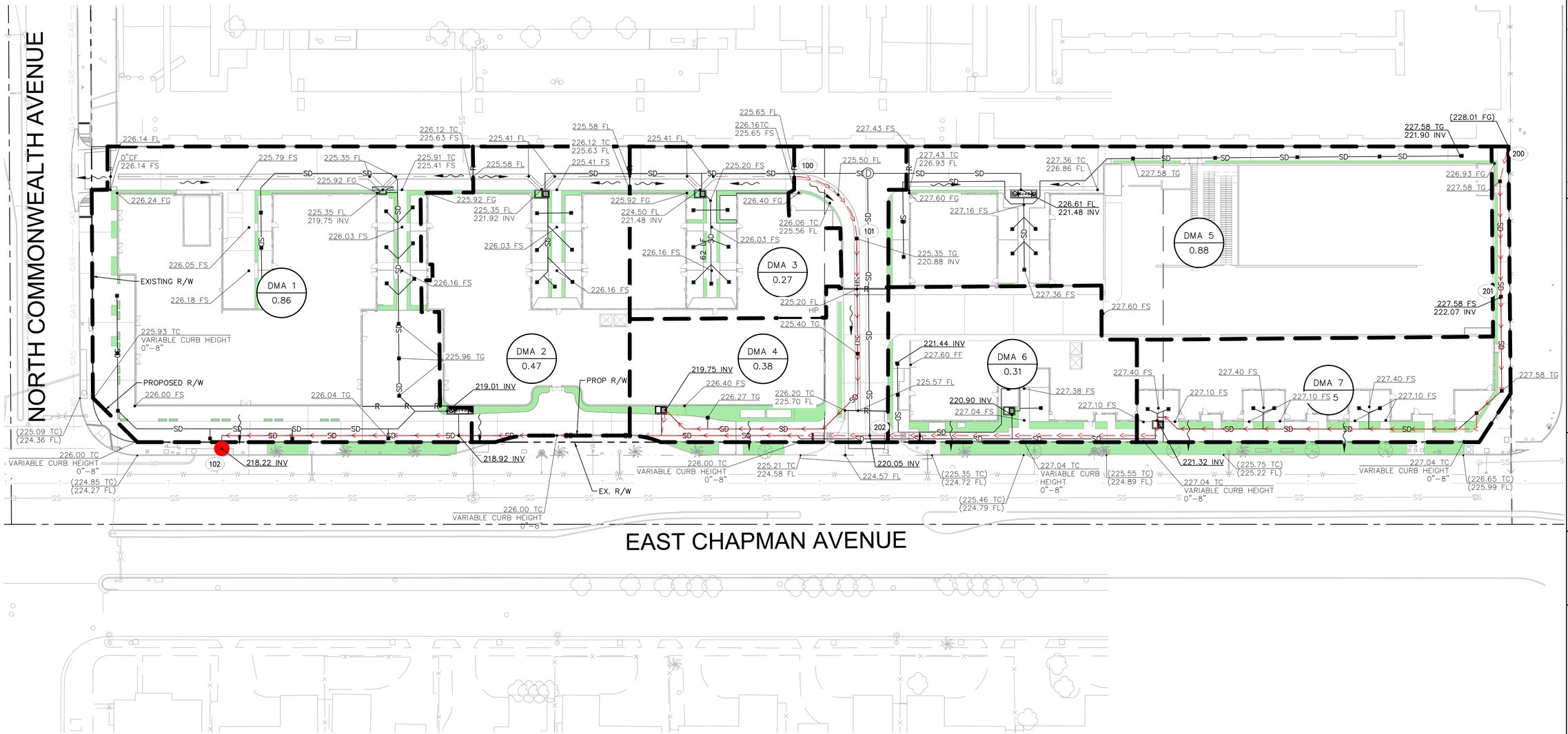
KHA PROJECT	194224001
DATE	10/22/20
SCALE	AS SHOWN
DESIGNED BY	BG
DRAWN BY	KH
CHECKED BY	BG

EXISTING HYDROLOGY EXHIBIT

THE HUB
PREPARED FOR
CORE CAMPUS MANAGER

CA
FULLERTON

SHEET NUMBER
1



LEGEND

- RIGHT OF WAY/ PROPERTY LINE
- CENTERLINE
- DRAINAGE BOUNDARY
- 147 EXISTING CONTOURS
- FLOW LINE
- SD EXISTING STORM DRAIN
- SD PROPOSED STORM DRAIN
- (XX.XX TC) (XX.XX FS) EXISTING SPOT GRADE
- XX.XX TC XX.XX FS PROPOSED SPOT GRADE
- EXISTING CATCH BASIN
- PROPOSED CATCH BASIN

LEGEND

- EXISTING STORM DRAIN MANHOLE
- PROPOSED STORM DRAIN MANHOLE
- DIRECTION OF WATER FLOW
- PROPOSED MODULAR WETLAND
- CONFLUENCE POINT
- XXX NODE
- DA ID / ACRES DRAINGAGE AREA LABEL
- PERVIOUS AREA

FLOOD ZONE

FLOOD ZONE X : AREA OF MINIMAL FLOOD HAZARD

Know what's below. Call 811 before you dig.

NORTH

GRAPHIC SCALE IN FEET
0 15 30 60

No.	REVISIONS	DATE	BY

Kimley»Horn

1100 TOWN AND COUNTRY ROAD, SUITE 700, ORANGE, CA 92868
PHONE: 714-939-1030 FAX: 714-938-9488
WWW.KIMLEY-HORN.COM

LICENSED PROFESSIONAL
BRIAN GILLIS
CA LICENSE NUMBER 63021
DATE: 6/30/22

KHA PROJECT 194224001	DATE 10/22/20	SCALE AS SHOWN	DESIGNED BY BG	DRAWN BY KH	CHECKED BY BG

FINAL HYDROLOGY EXHIBIT

THE HUB
PREPARED FOR
CORE CAMPUS MANAGER

FULLERTON CA

SHEET NUMBER 1

APPENDIX E

```
**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
           (Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
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             Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                          Analysis prepared by:




 ************************* DESCRIPTION OF STUDY *************************
* EXISTING CONDITIONS                                                   *
* 100 YEAR 24 HR STORM                                                  *
* THE HUB AT FULLERTON                                                  *
 *************************************************************************

  FILE NAME: HUBEX100.DAT
  TIME/DATE OF STUDY: 17:14 02/15/2021
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

**************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
```

```
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    82.80
  ELEVATION DATA: UPSTREAM(FEET) =    226.00  DOWNSTREAM(FEET) =    225.28

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.000
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  6.187
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 B        0.12      0.30     0.100    76    5.00
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      0.66
  TOTAL AREA(ACRES) =      0.12   PEAK FLOW RATE(CFS) =      0.66

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    225.28  DOWNSTREAM(FEET) =    224.84
  CHANNEL LENGTH THRU SUBAREA(FEET) =   214.84   CHANNEL SLOPE =  0.0020
  CHANNEL BASE(FEET) =    0.00   "Z" FACTOR =  99.000
  MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   0.50
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.412
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  COMMERCIAL                 B        1.09      0.30     0.100    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.86
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   0.89
  AVERAGE FLOW DEPTH(FEET) =   0.18   TRAVEL TIME(MIN.) =   4.02
  Tc(MIN.) =    9.02
  SUBAREA AREA(ACRES) =     1.09       SUBAREA RUNOFF(CFS) =    4.30
  EFFECTIVE AREA(ACRES) =      1.21     AREA-AVERAGED Fm(INCH/HR) =   0.03
  AREA-AVERAGED Fp(INCH/HR) =   0.30  AREA-AVERAGED Ap =   0.10
  TOTAL AREA(ACRES) =        1.2         PEAK FLOW RATE(CFS) =       4.77

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.22   FLOW VELOCITY(FEET/SEC.) =   1.03
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =     297.64 FEET.

****************************************************************************
```

```
 FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    40.35
 ELEVATION DATA: UPSTREAM(FEET) =    228.01  DOWNSTREAM(FEET) =    226.90

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.000
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  6.187
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                 B        0.03      0.30     0.100    76    5.00
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      0.17
 TOTAL AREA(ACRES) =      0.03   PEAK FLOW RATE(CFS) =      0.17

****************************************************************************
 FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  51
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =    226.90  DOWNSTREAM(FEET) =    224.79
 CHANNEL LENGTH THRU SUBAREA(FEET) =   536.24   CHANNEL SLOPE =  0.0039
 CHANNEL BASE(FEET) =    0.00   "Z" FACTOR =  99.000
 MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   0.50
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.764
 SUBAREA LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 COMMERCIAL                 B        2.31      0.30     0.100    76
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.16
 TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.29
 AVERAGE FLOW DEPTH(FEET) =   0.18   TRAVEL TIME(MIN.) =   6.90
 Tc(MIN.) =   11.90
 SUBAREA AREA(ACRES) =     2.31       SUBAREA RUNOFF(CFS) =    7.76
 EFFECTIVE AREA(ACRES) =      2.34     AREA-AVERAGED Fm(INCH/HR) =   0.03
 AREA-AVERAGED Fp(INCH/HR) =   0.30  AREA-AVERAGED Ap =   0.10
 TOTAL AREA(ACRES) =        2.3         PEAK FLOW RATE(CFS) =       7.86

 END OF SUBAREA CHANNEL FLOW HYDRAULICS:
 DEPTH(FEET) =  0.23   FLOW VELOCITY(FEET/SEC.) =   1.48
 LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     576.59 FEET.
============================================================================
```

```
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        2.3  TC(MIN.) =     11.90
  EFFECTIVE AREA(ACRES) =      2.34  AREA-AVERAGED Fm(INCH/HR)=  0.03
  AREA-AVERAGED Fp(INCH/HR) =  0.30  AREA-AVERAGED Ap = 0.100
  PEAK FLOW RATE(CFS)   =       7.86
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

```
**************************************************************************
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            Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                          Analysis prepared by:




 ************************* DESCRIPTION OF STUDY *************************
* THE HUB AT FLLERTON                                                   *
* PROPOSED CONDITION                                                    *
* FINAL HYDROLOGY ANALYSIS 100 YEAR 24 HOUR                             *
 ************************************************************************

  FILE NAME: HUBPR100.DAT
  TIME/DATE OF STUDY: 12:52 02/15/2021
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   26.0     21.0    0.018/0.018/0.020   0.50    2.00 0.0312 0.125 0.0150
  2   41.0     36.0    0.018/0.017/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.67 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  1.3 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

**************************************************************************
```

```
 FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    59.00
 ELEVATION DATA: UPSTREAM(FEET) =    225.65  DOWNSTREAM(FEET) =    225.35

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.000
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  6.187
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 APARTMENTS                 B        0.10      0.30     0.200    76    5.00
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
 SUBAREA RUNOFF(CFS) =      0.55
 TOTAL AREA(ACRES) =      0.10   PEAK FLOW RATE(CFS) =      0.55

****************************************************************************
 FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   220.88  DOWNSTREAM(FEET) =   218.22
 FLOW LENGTH(FEET) =   516.00   MANNING'S N =  0.015
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   4.1 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   2.29
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       0.55
 PIPE TRAVEL TIME(MIN.) =   3.75    Tc(MIN.) =    8.75
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =     575.00 FEET.

+--------------------------------------------------------------------------+
| ADDITION OF SUB AREA = DMA 1 + DMA 4                                     |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
 FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =    8.75
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.490
 SUBAREA LOSS RATE DATA(AMC III):
```

```
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  APARTMENTS                  B        1.14      0.30     0.200    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA AREA(ACRES) =    1.14      SUBAREA RUNOFF(CFS) =    4.55
  EFFECTIVE AREA(ACRES) =      1.24   AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.30  AREA-AVERAGED Ap =  0.20
  TOTAL AREA(ACRES) =        1.2       PEAK FLOW RATE(CFS) =       4.94

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.75
  RAINFALL INTENSITY(INCH/HR) =   4.49
  AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.30
  AREA-AVERAGED Ap =  0.20
  EFFECTIVE STREAM AREA(ACRES) =       1.24
  TOTAL STREAM AREA(ACRES) =       1.24
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       4.94

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    22.00
  ELEVATION DATA: UPSTREAM(FEET) =    228.01  DOWNSTREAM(FEET) =    227.58

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.000
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  6.187
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  APARTMENTS                  B        0.11      0.30     0.200    76    5.00
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA RUNOFF(CFS) =      0.61
  TOTAL AREA(ACRES) =      0.11   PEAK FLOW RATE(CFS) =      0.61

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  31
----------------------------------------------------------------------------
```

```
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
================================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   222.07  DOWNSTREAM(FEET) =   220.05
  FLOW LENGTH(FEET) =   470.00   MANNING'S N =  0.015
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   4.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   2.22
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       0.61
  PIPE TRAVEL TIME(MIN.) =   3.53    Tc(MIN.) =    8.53
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     492.00 FEET.

+------------------------------------------------------------------------------+
| ADDITION OF SUB-AREA= DMA 2 + DAM 3 + DMA 5 + DMA 6 + DMA 7                  |
|                                                                              |
|                                                                              |
+------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    202.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =    8.53
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.557
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  APARTMENTS                 B        2.16      0.30     0.200    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.30
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA AREA(ACRES) =    2.16      SUBAREA RUNOFF(CFS) =    8.74
  EFFECTIVE AREA(ACRES) =      2.27   AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.30  AREA-AVERAGED Ap =  0.20
  TOTAL AREA(ACRES) =        2.3       PEAK FLOW RATE(CFS) =       9.19

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    102.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   220.05  DOWNSTREAM(FEET) =   218.22
  FLOW LENGTH(FEET) =   402.00   MANNING'S N =  0.015
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  15.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.46
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       9.19
  PIPE TRAVEL TIME(MIN.) =   1.50    Tc(MIN.) =   10.03
```

```
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    102.00 =     894.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   10.03
  RAINFALL INTENSITY(INCH/HR) =   4.15
  AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.30
  AREA-AVERAGED Ap =  0.20
  EFFECTIVE STREAM AREA(ACRES) =       2.27
  TOTAL STREAM AREA(ACRES) =       2.27
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       9.19

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        4.94    8.75    4.490  0.30( 0.06) 0.20       1.2     100.00
      2        9.19   10.03    4.152  0.30( 0.06) 0.20       2.3     200.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       13.62    8.75    4.490  0.30( 0.06) 0.20       3.2     100.00
      2       13.75   10.03    4.152  0.30( 0.06) 0.20       3.5     200.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      13.75    Tc(MIN.) =    10.03
  EFFECTIVE AREA(ACRES) =       3.51   AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.30  AREA-AVERAGED Ap =  0.20
  TOTAL AREA(ACRES) =        3.5
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    102.00 =     894.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        3.5  TC(MIN.) =     10.03
  EFFECTIVE AREA(ACRES) =      3.51  AREA-AVERAGED Fm(INCH/HR)=  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.30  AREA-AVERAGED Ap = 0.200
  PEAK FLOW RATE(CFS)   =      13.75

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
```

```
      1       13.62    8.75    4.490  0.30( 0.06) 0.20       3.2     100.00
      2       13.75   10.03    4.152  0.30( 0.06) 0.20       3.5     200.00
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```