

APPENDIX D
Hydrology Study



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June 17, 2019

Kristen Bogue
Michael Baker International
14725 Alton Parkway
Irvine, CA 92618
Via email: kboque@mbakerintl.com

Subject: Chick-fil-A and In-N-Out Restaurants, Hydrology and WQMP Reports
Santa Ana area of Orange County

Dear Ms. Bogue,

Chick-fil-A, Inc. contracted with Truxaw and Associates in October of 2015 to complete a Conceptual Submittal package for the proposed project at the northeast corner of 17th Street and Tustin Avenue in the County of Orange. The submittal package included the preparation of a Hydrology Study and Conceptual Water Quality Management Plan (WQMP).

The Hydrology Study and WQMP have been revised based on changes to the site plan and the WQMP has been updated to use the current County of Orange WQMP template. The current Hydrology Study and WQMP are adequate for the current submittal package and are not affected by the extended time frame of the project.

Sincerely,

Randy Decker, PE
Project Engineer



Hydrology Study

Chick-fil-A Restaurant No. 3756 & In-N-Out Burger
NEC of 17th St. and Tustin Avenue
Santa Ana, California

Prepared for:

Chick-fil-A Inc.

15635 Alton Parkway, Suite 350
Irvine, CA 92618

and

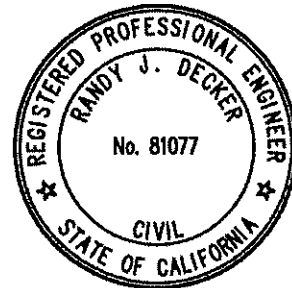
In-n-Out Burger.

13502 Hamburger Lane
Baldwin Park, CA

Prepared by:

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September 13, 2017

Project Narrative

This project is located at the NEC of 17th St. and Tustin Avenue in the City of Santa Ana, California. The project is bound to the north by undeveloped private property, to the east by Ponderosa Street, to the south by 17th Street, and to the west by Tustin Avenue. The soil type is "B" as determined from the soils maps in the Orange County Hydrology Manual. See Appendix.

The proposed site consists of multiple lots that will be adjusted to accommodate the Chick-fil-A and In-n-Out Burger developments, approximately 96,369 SF. The parcel is currently undeveloped vacant land. The site is currently located within the County of Orange.

The proposed improvements to the site include the construction of a new Chick-fil-A Restaurant (4,777 SF) with drive-thru and a new In-N-Out Burger Restaurant (3,867 SF) with drive-thru, storage area with trash enclosures, paving of traffic and parking areas, and landscape planters. Site runoff will be collected by a private storm drain system and conveyed to underground infiltration systems for treatment. The overflow will be conveyed to municipal curb and gutter in Tustin Avenue via parkway drains and then to the municipal curb opening catch basin in 17th Street.

The proposed landscape areas will be irrigated with efficient irrigation systems and will be planted with drought-tolerant plant materials as selected by the project landscape architect.

Hydrology Calculations

For the purposes of this study, all drainage quantities have been calculated based on a 2-Year, 10-Year and 25-Year for major street travel-ways and 100-year frequency for building protection. The following hydrology calculations are based on the Orange County Hydrology Manual dated October, 1986, where the peak flow is determined by the equation:

$$Q=0.9(I-F_m)A$$

Q = runoff in cubic feet per second (cfs)

I = rainfall intensity (inches per hour) – see Figure D-1 from County Hydrology Manual.

F_m = loss rate for watershed (F_p = 0.30 for soil group "B" per Hydrology Manual)

A = drainage area (in acres)

Pre Development Condition

The Rational Method Hydrology Computer Program was used to compute the discharges on the existing gutters. See Appendix, and Hydrology Map.

10-Year Frequency

Node 102	Q = 2.08 cfs	Tustin Avenue
Node 202	Q = 3.00 cfs	17 th Street
Total runoff	Q = 5.08 cfs	

25-Year Frequency

Node 102	Q = 2.59 cfs	Tustin Avenue
Node 202	Q = 3.77 cfs	17 th Street
Total runoff	Q = 6.36 cfs	

100-Year Frequency

Node 102	Q = 3.42 cfs	Tustin Avenue
Node 202	Q = 5.02 cfs	17 th Street
Total runoff	Q = 8.44 cfs	

Post Development Condition

The Rational Method Hydrology Computer Program was used to compute the discharges on the shown Nodes. See Appendix, and Hydrology Map.

10-Year Frequency

Node 102	Q = 1.71 cfs	Tustin Avenue
Node 202	Q = 2.28 cfs	Tustin Avenue
Node 301	Q = 2.62 cfs	Tustin Avenue
Total runoff	Q = 6.61 cfs	
Pre-Development	Q = 5.08 cfs	
Post-Development	Q = 6.61 cfs	
	$\Delta Q = 1.53 \text{ cfs}$	

Volume to detain

It is required to detain a volume corresponding to **$\Delta Q = 1.53 \text{ cfs}$** . Due to the difference of the 3 drainage areas it will be calculated a hydrograph with the following information:

Sub-area Node 100-101	Sub-areas 200-201 and 300-301
CN = 69	CN = 56
Fm = 0.3	Fm = 0.03
A = 1.272 acres	A = 1.867 acres
Q = 1.71 ft ³ /s	Q = 4.90 ft ³ /s
Tc = 20.82 min.	Tc = 8.77 min.

The hydrograph will be proportional to the areas.

Hydrograph
CN = 61
Fm = 0.139
A = 3.139 acres

Q = 6.61 ft³/s
 Tc = 13.65 min.

See attached Hydrograph

The volume to detain will be:

$$V_1 = \frac{0.155 \times 1.53 \times 3,600}{2} = 425.90 \text{ ft}^3$$

$$V_2 = \frac{0.16 \times 1.53 \times 3,600}{2} = 440.64 \text{ ft}^3$$

Total volume = 866.54 ft³

This volume will be added to the Design Capture Volume in the WQMP.

25-Year Frequency

Node 102	Q = 2.13 cfs	Tustin Avenue
Node 202	Q = 2.73 cfs	Tustin Avenue
Node 301	Q = 3.13 cfs	Tustin Avenue
Total runoff	Q = 7.99 cfs	
Pre-Development	Q = 6.36 cfs	
Post-Development	Q = 7.99 cfs	
	ΔQ = 1.63 cfs	

Hydraulic Calculations

Node 201. Q₂₅ = 0.85 cfs

Analysis of the capacity of proposed 24" x 24" grate inlet

Grate Inlet operating as orifice:

$$Q = C_o A \sqrt{2gh}$$

Where:

- Q = Discharge (cfs) Q₂₅ = 0.85 cfs
- C_o = Orifice flow coefficient. Use C_o = 0.67
- A = Area of the grate. A = 4.00 sf.
- g = Acceleration of gravity
- h = Depth of water over the grate.

Assume 50% bars and 50% clogged.

$$0.85 = 0.67 \times \frac{4}{4} \sqrt{2 \times 32.2 \times h}$$

Solving for h:

h = 0.02 ft. h = 0.30 in.

Node 202. Q₂₅ = 2.73 – 0.85 = 1.88 cfs

Analysis of the capacity of proposed 24" x 24" grate inlet

Grate Inlet operating as orifice:

$$Q = C_o A \sqrt{2gh}$$

Where:

Q = Discharge (cfs) $Q_{25} = 1.88$ cfs
 C_o = Orifice flow coefficient. Use $C_o = 0.67$
 A = Area of the grate. $A = 4.00$ sf.
 g = Acceleration of gravity
 h = Depth of water over the grate.

Assume 50% bars and 50% clogged.

$$1.88 = 0.67 \times \frac{4}{4} \sqrt{2 \times 32.2 \times h}$$

Solving for h:

$$h = 0.12 \text{ ft.} \quad h = 1.47 \text{ in.}$$

Analysis of the capacity of proposed parkway drain.

Data

$Q = 2.73$ ft³/s
 $s = 0.020$
 $n = 0.015$

$D = 0.272$ ft. < 4 inch.
 $A = 0.544$ ft².
 $r = 0.214$ ft.
 $v = 5.02$ ft./s.
 $Q = 2.73$ ft³/s.

Node 301. $Q_{25} = 3.13$ cfs

Analysis of the capacity of proposed 24" x 24" grate inlet

Grate Inlet operating as orifice:

$$Q = C_o A \sqrt{2gh}$$

Where:

Q = Discharge (cfs) $Q_{25} = 3.13$ cfs
 C_o = Orifice flow coefficient. Use $C_o = 0.67$
 A = Area of the grate. $A = 6.00$ sf.
 g = Acceleration of gravity
 h = Depth of water over the grate.

Assume 50% bars and 50% clogged.

$$3.13 = 0.67 \times \frac{6}{4} \sqrt{2 \times 32.2 \times h}$$

Solving for h:

$$h = 0.15 \text{ ft.} \quad h = 1.81 \text{ in.}$$

Analysis of the capacity of proposed parkway drain.

Data

Q = 3.13 ft³/s
 s = 0.020
 n = 0.015

D = 0.297 ft. < 4 inch.
 A = 0.594 ft².
 r = 0.229 ft.
 v = 5.26 ft./s.
 Q = 3.12 ft³/s.

100-Year Frequency

Node 102	Q = 2.81 cfs	Tustin Avenue
Node 202	Q = 3.49 cfs	Tustin Avenue
Node 301	Q = 4.01 cfs	Tustin Avenue
Total runoff	Q = 10.31 cfs	
Pre-Development	Q = 8.44 cfs	
Post-Development	Q = 10.31 cfs	
	ΔQ = 1.87 cfs	

Secondary Outlet (Overflow) pathway

Should all on-site storms drain systems fail, the overflow pathway of on-site drainage runoff would be the top at the parkway drains. Overflow runoff would flow to Tustin Avenue. However, even in a 100 year intensity storm event, the buildings would be protected from inundation. See analysis below.

Protection against flooding of new buildings

As per City recommendation, in regard to the new building finish floor elevations, elevation of habitable buildings should be 1 foot above the 100 year water elevation.

Node 202. Analysis of the capacity of proposed parkway drain

Data

Q = 3.49 ft³/s
 s = 0.020
 n = 0.015

D = 0.32 ft. < 4 inch.
 A = 0.640 ft².
 r = 0.242 ft.
 v = 5.46 ft./s.
 Q = 3.49 ft³/s.

Finished Floor elevation of Chick-fil-A Restaurant Building	= 177.70
Theoretical Water Surface elevation at parkway drain =	175.57 + 0.32 = 175.89
	Difference = 1.81'

Node 301. Analysis of the capacity of proposed parkway drain

Data

$$Q = 4.01 \text{ ft}^3/\text{s}$$

$$s = 0.020$$

$$n = 0.015$$

$$D = 0.35 \text{ ft.} > 4 \text{ inch.}$$

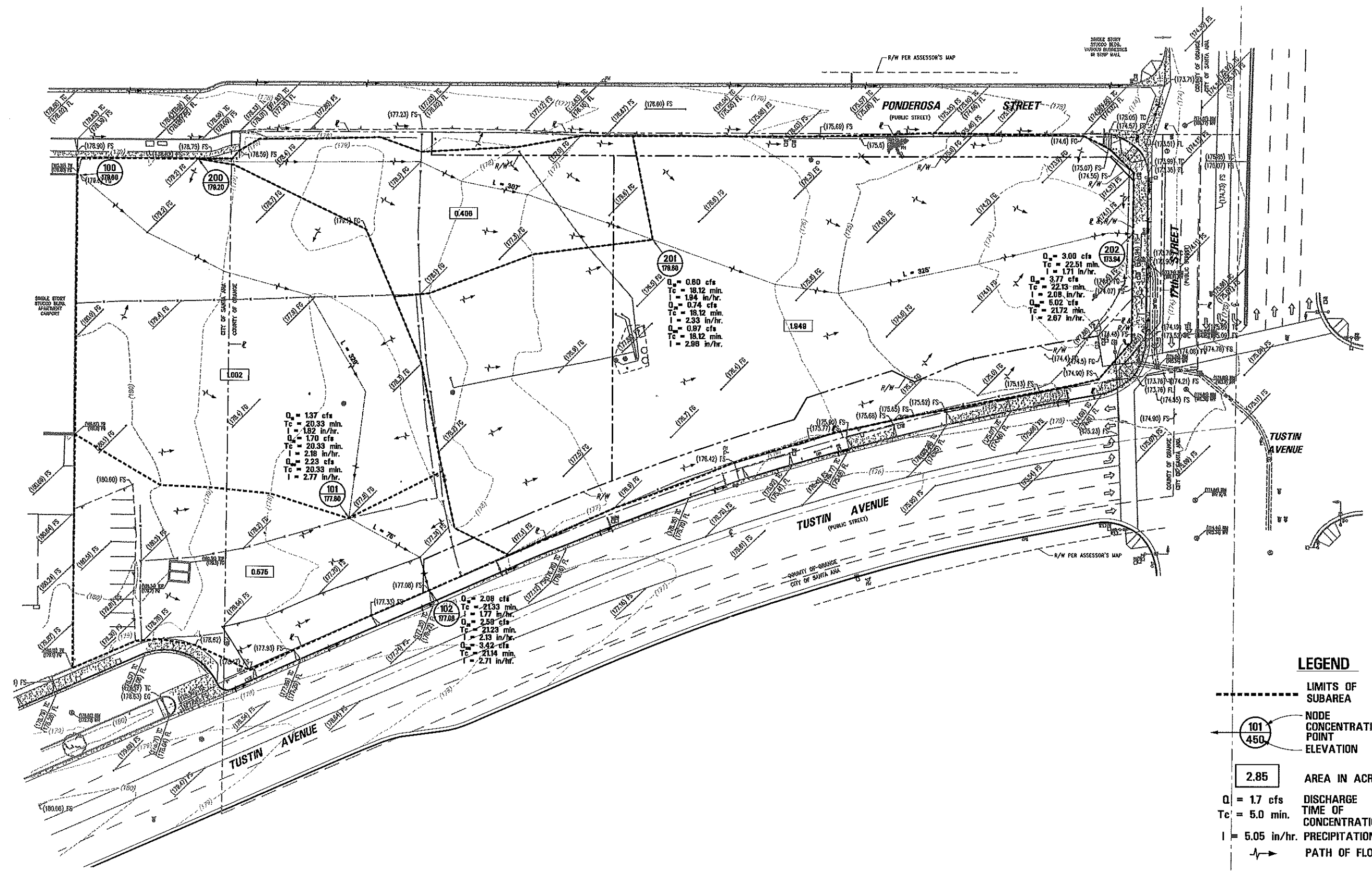
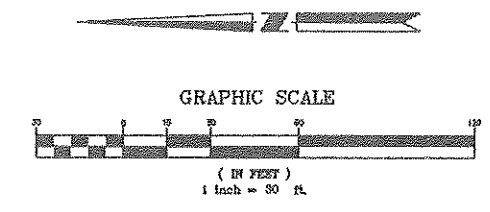
Finished Floor elevation of In-n-Out Restaurant Building = 179.30

Theoretical Water Surface elevation at parkway drain = $176.14 + 0.35 = 176.49$

Difference = 2.81'

The finish floors of the buildings are above 100 year water surfaces.

Appendix

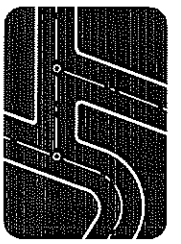


LEGEND

- LIMITS OF SUBAREA
- 101
450 NODE CONCENTRATION POINT ELEVATION
- 2.85 AREA IN ACRES
- Q = 1.7 cfs DISCHARGE
- Tc = 5.0 min. TIME OF CONCENTRATION
- I = 5.05 in/hr. PRECIPITATION
- PATH OF FLOW

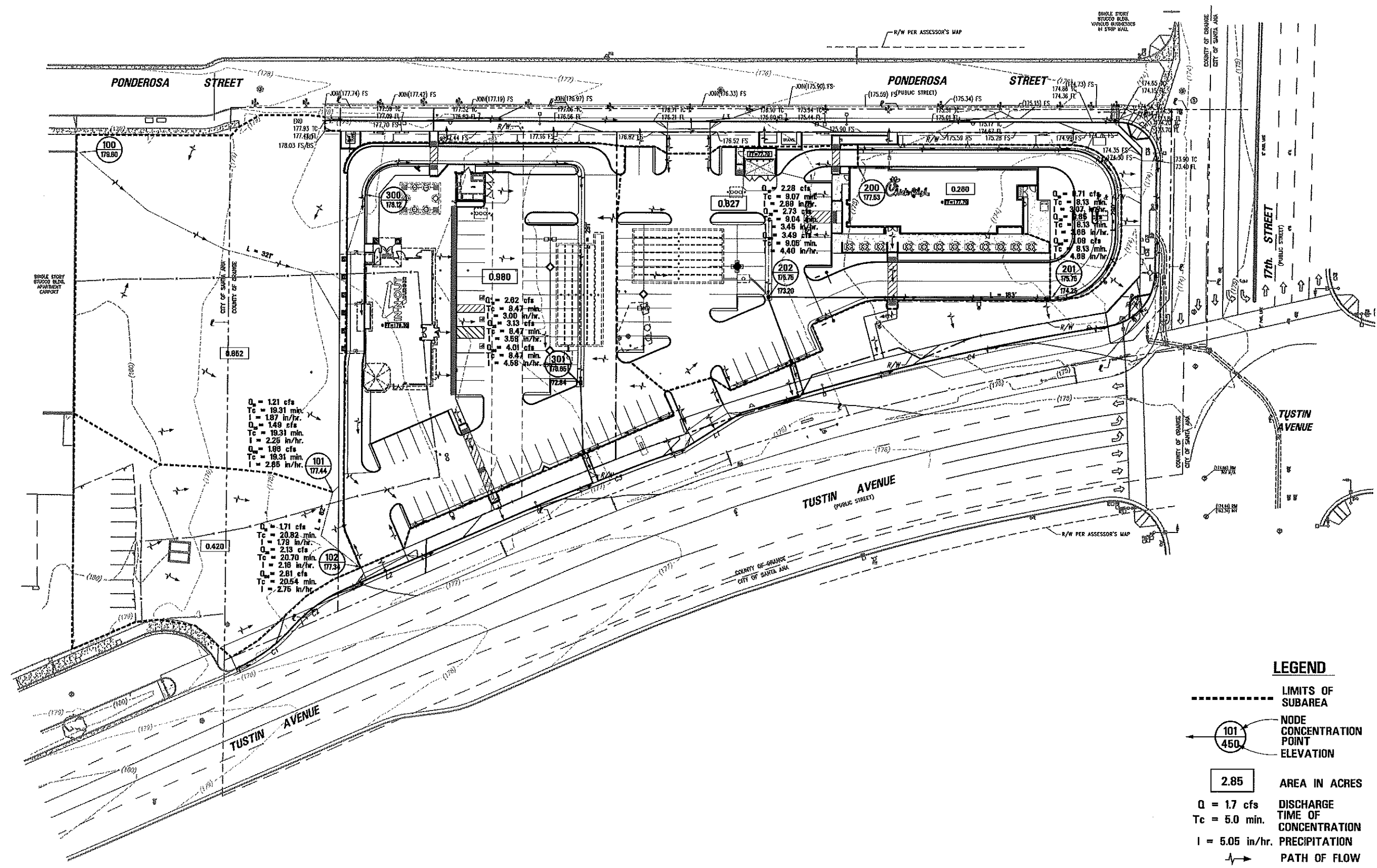
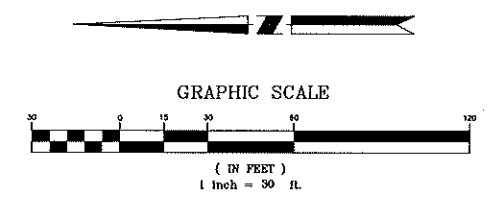
NO.	REVISIONS	DATE

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HYDROLOGY MAP
PRE-DEVELOPMENT CONDITION
 CHICK-FIL-A RESTAURANT No. 3756
 NEC OF 17TH ST. AND TUSTIN AVE.
 IN THE CITY OF SANTA ANA, COUNTY OF ORANGE,
 STATE OF CALIFORNIA

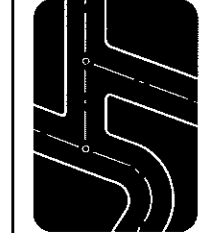
DATE	05-10-16
DRAWN BY	HV
CHECKED BY	SMH
JOB NO.	CFA98055
SHEET NO.	1
OF 2 SHEETS	



- LEGEND**
- LIMITS OF SUBAREA
 - 101
450 NODE CONCENTRATION POINT ELEVATION
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HYDROLOGY MAP
POST-DEVELOPMENT CONDITION
 CHICK-FIL-A RESTAURANT No. 3756
 NEC. OF 17TH ST. AND TUSTIN AVE.
 IN THE CITY OF SANTA ANA, COUNTY OF ORANGE,
 STATE OF CALIFORNIA

DATE	05-11-16
DRAWN BY	HV
CHECKED BY	SMH
JOB NO.	CFA98055
SHEET NO.	2

OF 2 SHEETS

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