

APPENDIX E
Hydrology and Hydraulics Study

*Hydrology & Hydraulic Study
TTM 82395”
Victoria Street
Carson California*

**HYDROLOGY & HYDRAULICS STUDY
TTM 82395
In the City of Carson, California**

Prepared For:

Brandywine Homes
16580 Aston
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Prepared By:

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Revised April 2019

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APPENDICIES

- A.** Supporting Hydrology Documents
- B.** Proposed and Existing Flows per Tc Calculator
- C.** LID Calculations
- D.** Soils Report

List of Exhibits:

- 1.** Preliminary Grading and Utility Plan
- 2.** Hydrology Map

**Hydrology Study and Hydraulic Analysis
For
TTM 82395
City of Carson**

ACKNOWLEDGEMENT AND SIGNATURE PAGE

This Hydrology Study prepared by KES Technologies, Inc. under the supervision of Ali Monshizadeh, P.E.



Ali Monshizadeh R.C.E 67674
KES Technologies, Inc.

4/12/2019
Date



Introduction:

The project site is currently (1) fee parcel and is proposed to be developed as one fee parcel for condominium purposes as TTM 82395

The proposed project will include several building sequences as 6-plex multi-family buildings. The subject site will include residential for sale units, vehicular drive aisles, open space and landscape throughout the development.

The existing site currently resides as an existing residential parcel. The exiting site surface flows to the west through the existing fence/wall into the western adjacent parcels as demonstrated by the existing contours. Currently the existing site is 100% pervious. The proposed development is proposed as 23%. The proposed development will mitigate the Q10 to 1 cfs per acre per LA County Flood Control standards.

The proposed site will capture and bio-filtrate the required LID flow by use of flow through filters. Any flow in addition to this flow will bypass the filters and flow to the public right of way through an under walk drain. Once in the public right of way the flow is gathered in County maintained storm drain that ultimately outlets into the San Gabriel River. No current water quality BMP are in place and utilized on the current site. The proposed main system will be sized for a 50-year storm event.

Prior to outletting into the public system, storm water flows will be encouraged to flow through landscape areas. These systems can be representative for a typical site treatment train.

Methodology:

The proposed drainage area was analyzed by utilizing the County of Los Angeles Hydrology Manual dated January 2006. Each drainage area was divided as demonstrated on the hydrology map (Exhibit 1&2). Each area was analyzed for acreage, impervious cover, and time of concentration according to the Rational Method. The flows, expressed in cubic feet per second (cfs), were totaled at outfall locations.

The proposed project only has one sub area as denoted on the proposed hydrology exhibit. The flows have been allocated to flow in the direction that closely matches the existing conditions.

Design Assumptions:

1. The onsite drainage area was analyzed for a 50-year storm event using Rational Method Analysis per County of Los Angeles Standards
2. No additional infiltration was utilized for reducing the storm water flows.
3. Perimeter street right of way is considered to be un treated for water quality.
4. The impervious area has been calculated to be 77% for the subject project.
5. All flows are based on the complete future development of land.
6. The Final Hydrology Map will be included within the final engineering documents.
7. Tc and other calculation were obtained by utilizing the Los Angeles County Tc calculator.
8. Existing impervious percentage is 5%
9. Project is not within a County adopted Floodway
10. Project is not within a FEMA Flood Zone A.+
11. Project is a Designated Project
12. Infiltration is not feasible due to existing infiltration rates.
13. Runoff Harvest is not feasible.

****Note: Additional Calculation Assumptions Have Been Noted Throughout Report****

Conclusion:

The results from this hydrology and hydraulic analysis demonstrate the following:

- The site is designed to manage runoff from a 10 and 25-year storm.
- The subject site safely transfers storm water into the existing right of way to maintain the existing drainage patterns.

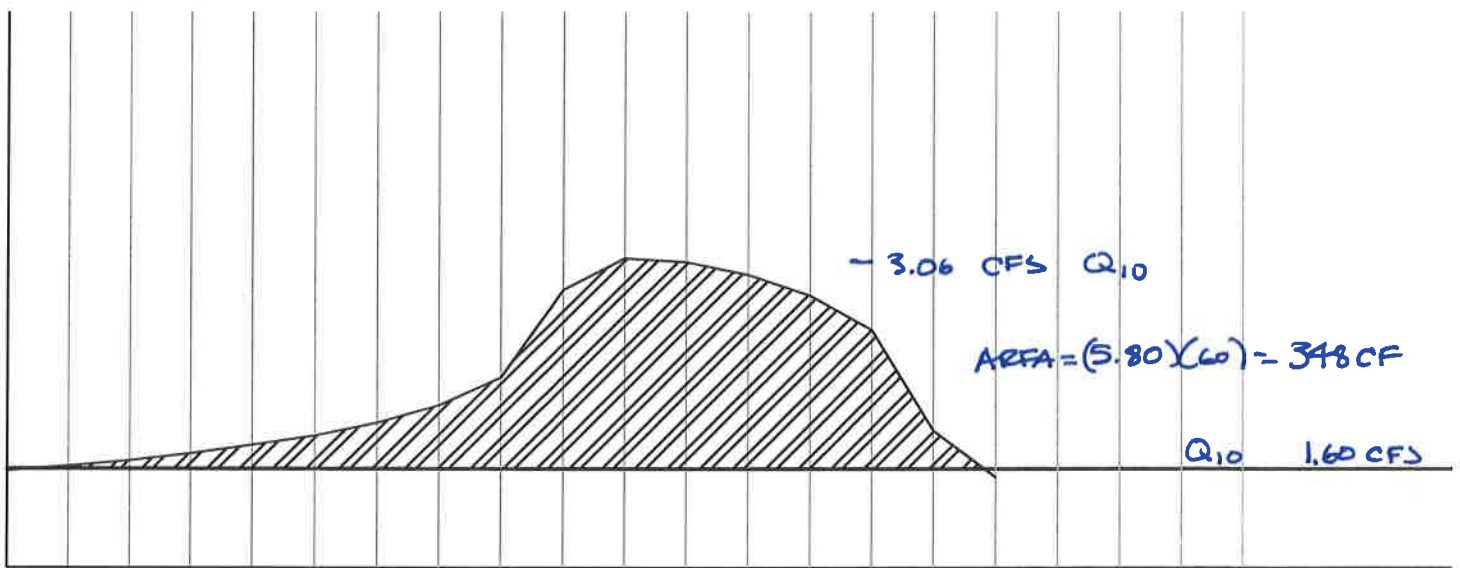
References

1. County of Los Angeles Hydrology Manual, dated January, 2006.
2. Water Surface and Pressure Gradient (WSPG) Hydraulic Analysis System Software, Los Angeles County Department of Public Works Program No. F0515P, April 1979.
3. Advanced Engineering Software, HELE1 Hydraulic Elements I for Street Flooding and Catch Basin Design, 1996 version.

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Supporting Hydrology Documents

ALLOWABLE HYDROGRAPH
CAESON
TR 82395



REQ MITIGATION VOL. = 348 CF = 50 LF 36 ϕ

TIME

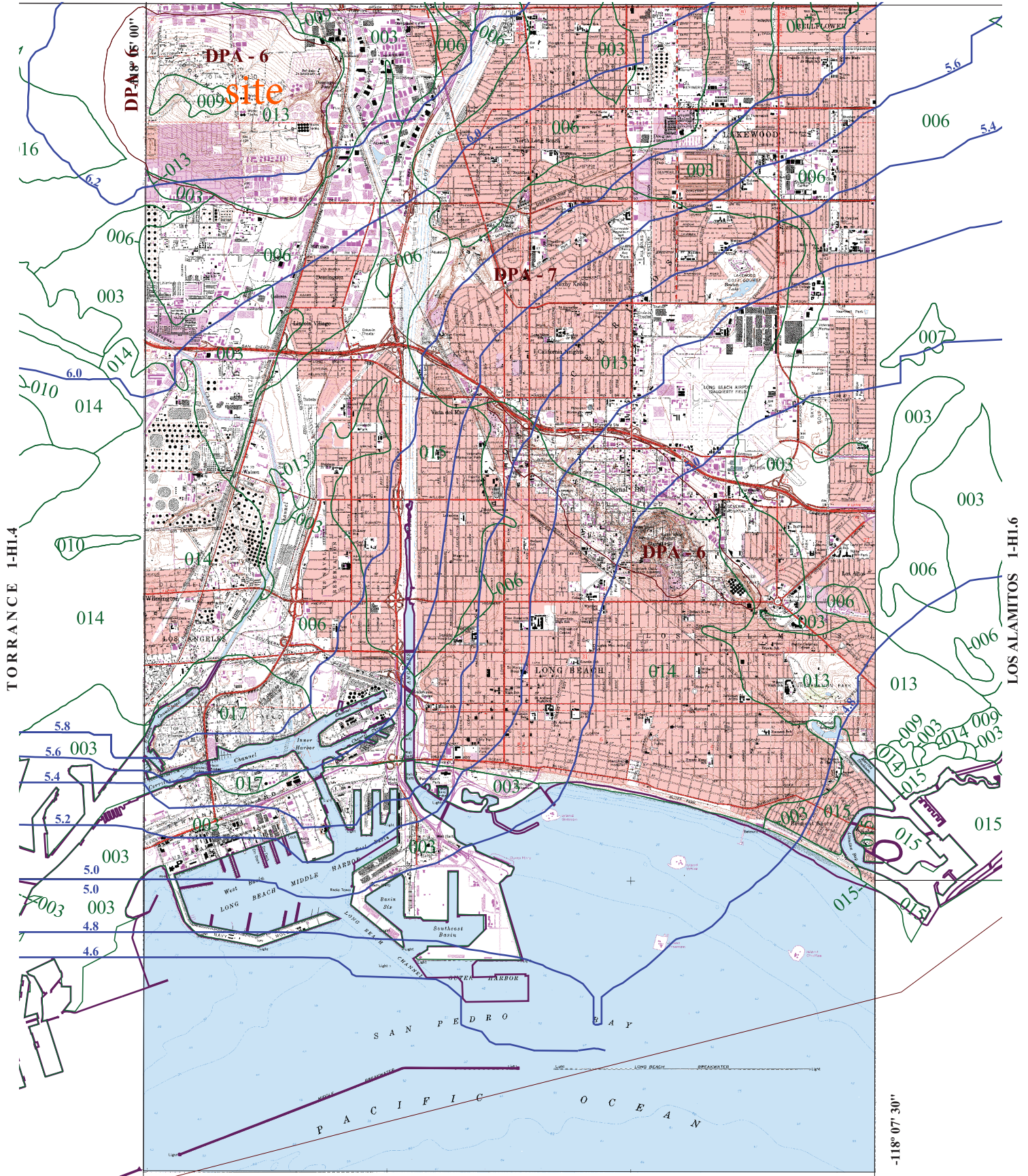
Flow

1149	0.76585	3.444945	1.141703	0.529372	0.814756	1.488335	17.69749	13931.48
1149.2	0.767076	3.450461	1.160871	0.538394	0.816831	1.517176	18.03307	13949.51
1149.4	0.768344	3.456165	1.181259	0.547989	0.819037	1.547993	18.39101	13967.9
1149.6	0.769659	3.462079	1.203025	0.558232	0.821393	1.58105	18.77426	13986.67
1149.8	0.771026	3.46823	1.226359	0.569215	0.823919	1.616674	19.18635	14005.86
1150	0.772454	3.47465	1.2515	0.581047	0.826641	1.655266	19.63164	14025.49
1150.2	0.77395	3.48138	1.278746	0.59387	0.82959	1.697336	20.11561	14045.61
1150.4	0.775526	3.488471	1.30848	0.607864	0.832809	1.743542	20.64527	14066.25
1150.6	0.777198	3.495993	1.341213	0.623269	0.836352	1.794762	21.22982	14087.48
1150.8	0.778987	3.50404	1.377643	0.640415	0.840295	1.852203	21.88179	14109.36
1151	0.780923	3.512746	1.418774	0.659772	0.844748	1.91761	22.61888	14131.98
1151.2	0.78305	3.522318	1.466144	0.682066	0.849875	1.993663	23.46763	14155.45
1151.4	0.785447	3.5331	1.522327	0.703683	0.854847	2.082171	24.455	14179.91
1151.6	0.788262	3.545758	1.592314	0.721495	0.858944	2.188333	25.62303	14205.53
1151.8	0.79187	3.561992	1.688834	0.746061	0.864594	2.336249	27.14749	14232.68
1152	0.8	3.59856	1.937572	0.809368	0.879155	2.725481	30.37038	14263.05
1152.2	0.804237	3.617621	2.054701	0.832439	0.884461	2.907685	33.799	14296.85
1152.4	0.806118	3.626082	2.092024	0.83734	0.885588	2.964275	35.23176	14332.08
1152.6	0.807585	3.63268	2.115045	0.840362	0.886283	2.999246	35.78113	14367.86
1152.8	0.808835	3.6383	2.130392	0.842377	0.886747	3.022589	36.13101	14403.99
1153	0.809944	3.643289	2.140656	0.843725	0.887057	3.038213	36.36481	14440.35
1153.2	0.810953	3.647827	2.147168	0.84458	0.887253	3.048131	36.51806	14476.87
1153.4	0.811885	3.652021	2.150719	0.845046	0.887361	3.053541	36.61003	14513.48
1153.6	0.812757	3.655942	2.151818	0.84519	0.887394	3.055216	36.65254	14550.14
1153.8	0.813578	3.659638	2.150816	0.845059	0.887364	3.053689	36.65343	14586.79
1154	0.814358	3.663146	2.14796	0.844684	0.887277	3.049338	36.61816	14623.41
1154.2	0.815102	3.666492	2.143434	0.84409	0.887141	3.042444	36.55069	14659.96
1154.4	0.815815	3.669698	2.137372	0.843294	0.886958	3.033213	36.45394	14696.41
1154.6	0.8165	3.672781	2.129875	0.842309	0.886731	3.021803	36.33009	14732.74
1154.8	0.817161	3.675754	2.121019	0.841146	0.886464	3.00833	36.18079	14768.92
1155	0.8178	3.678629	2.110857	0.839812	0.886157	2.99288	36.00726	14804.93
1155.2	0.81842	3.681415	2.099427	0.838312	0.885812	2.975515	35.81037	14840.74
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1155.8	0.820176	3.689316	2.057698	0.832833	0.884551	2.912223	35.08439	14946.76
1156	0.820732	3.691817	2.041304	0.83068	0.884056	2.887405	34.79777	14981.56
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1156.6	0.822326	3.698987	1.984336	0.82127	0.881892	2.799953	33.7919	15084
1156.8	0.822835	3.701278	1.96259	0.815736	0.880619	2.765271	33.39134	15117.39
1157	0.823335	3.703525	1.939349	0.809821	0.879259	2.728304	32.96145	15150.35
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1158	0.825702	3.714174	1.796428	0.773445	0.870892	2.503192	30.3454	15307.65
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1159	0.82789	3.724016	1.584529	0.719514	0.858488	2.176479	26.58449	15448.72
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1159.8	0.829537	3.731422	1.270727	0.590096	0.828722	1.684928	21.23431	15543.01
1160	0.829936	3.733217	1.009926	0.467353	0.800491	1.293499	17.87056	15560.88

33° 52' 30"

SOUTH GATE 1-H1.9



TORRANCE 1-H1.4

LOS ALAMITOS 1-H1.6

33° 43' 30"



- 016 SOIL CLASSIFICATION AREA
- 7.2 INCHES OF RAINFALL
- DPA - 6 DEBRIS POTENTIAL AREA



25-YEAR 24-HOUR ISOHYET REDUCTION FACTOR: 0.878
 10-YEAR 24-HOUR ISOHYET REDUCTION FACTOR: 0.714

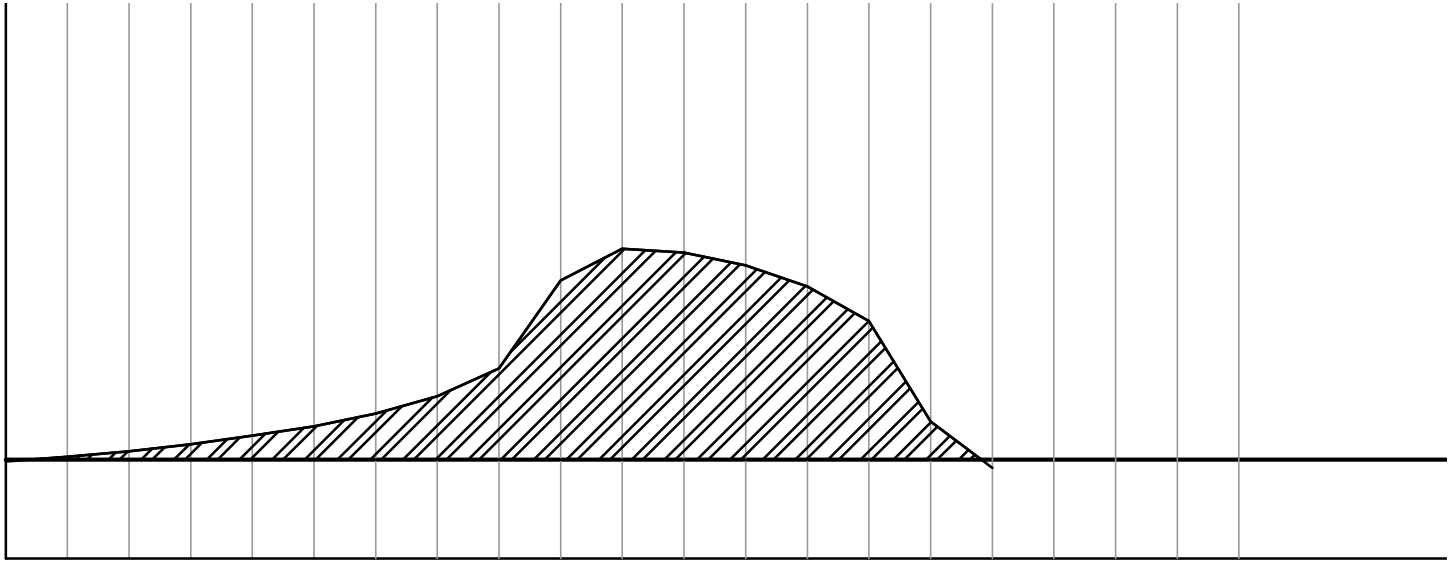
LONG BEACH 50-YEAR 24-HOUR ISOHYET

1-H1.5



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Proposed and Existing Flows



Peak Flow Hydrologic Analysis

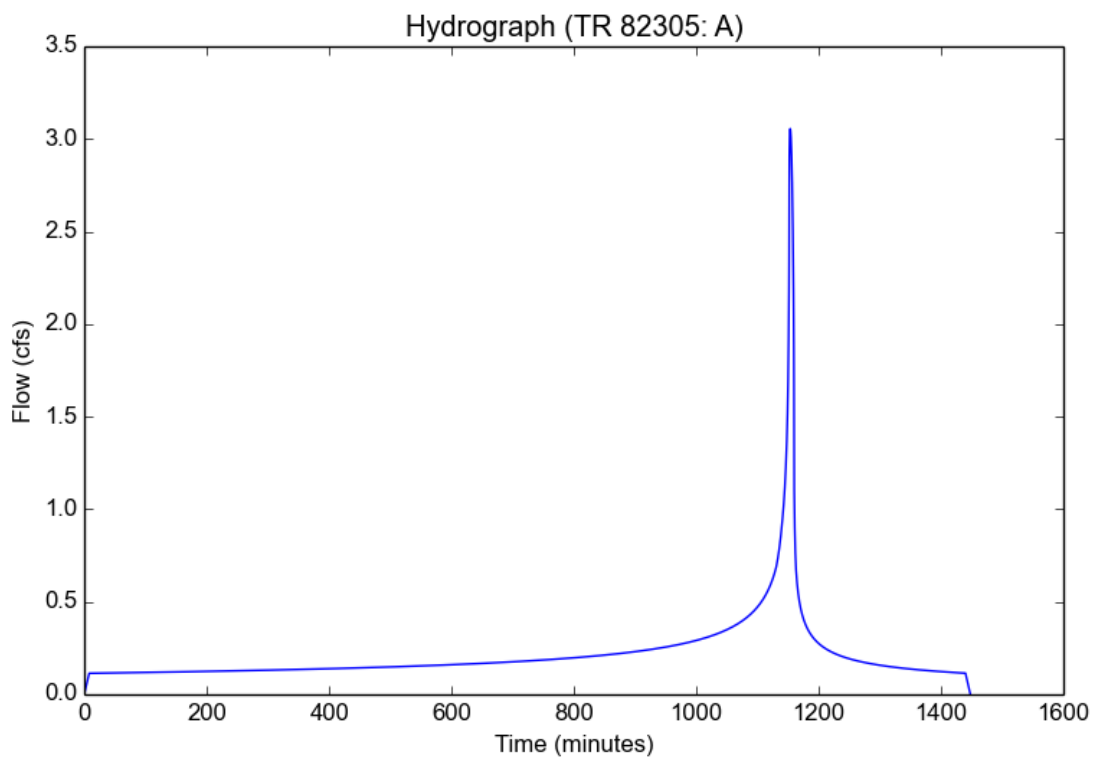
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Version: HydroCalc 1.0.2

Input Parameters

Project Name	TR 82305
Subarea ID	A
Area (ac)	1.6
Flow Path Length (ft)	451.0
Flow Path Slope (vft/hft)	0.0083
50-yr Rainfall Depth (in)	6.3
Percent Impervious	0.77
Soil Type	13
Design Storm Frequency	10-yr
Fire Factor	0
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	4.4982
Peak Intensity (in/hr)	2.1518
Undeveloped Runoff Coefficient (Cu)	0.8452
Developed Runoff Coefficient (Cd)	0.8874
Time of Concentration (min)	8.0
Clear Peak Flow Rate (cfs)	3.0552
Burned Peak Flow Rate (cfs)	3.0552
24-Hr Clear Runoff Volume (ac-ft)	0.4343
24-Hr Clear Runoff Volume (cu-ft)	18915.9401



Peak Flow Hydrologic Analysis

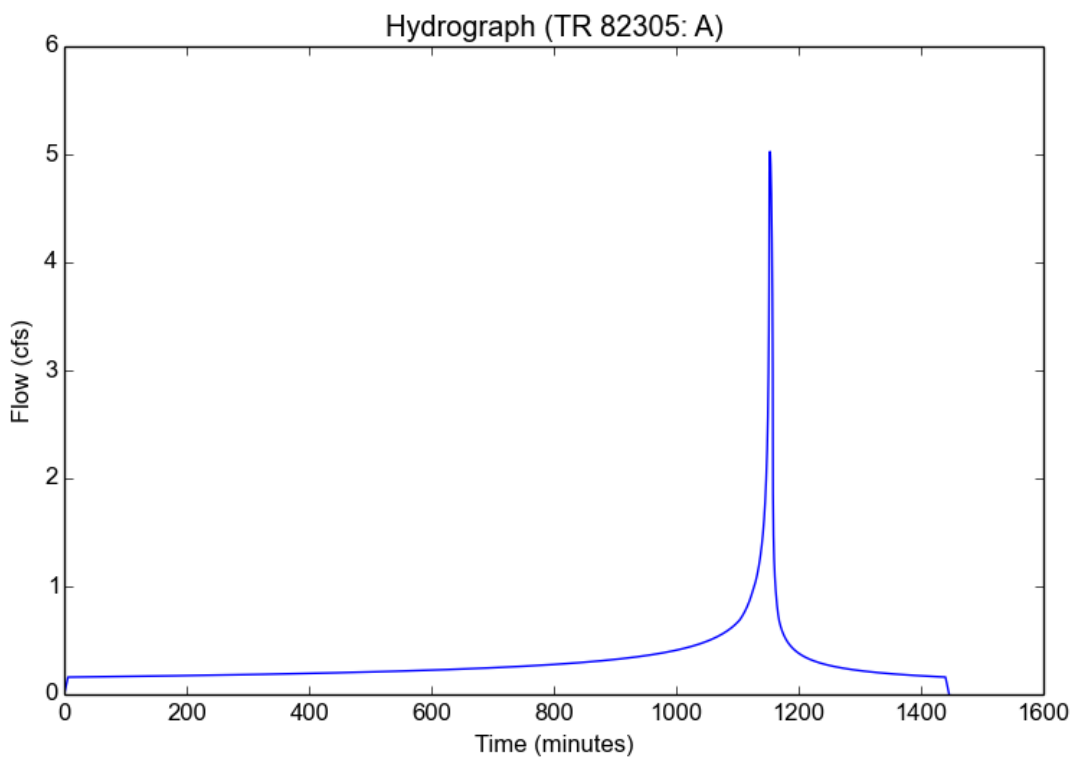
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Version: HydroCalc 1.0.2

Input Parameters

Project Name	TR 82305
Subarea ID	A
Area (ac)	1.6
Flow Path Length (ft)	451.0
Flow Path Slope (vft/hft)	0.0083
50-yr Rainfall Depth (in)	6.3
Percent Impervious	0.77
Soil Type	13
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	6.3
Peak Intensity (in/hr)	3.4501
Undeveloped Runoff Coefficient (Cu)	0.9457
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	6.0
Clear Peak Flow Rate (cfs)	4.9681
Burned Peak Flow Rate (cfs)	4.9681
24-Hr Clear Runoff Volume (ac-ft)	0.6137
24-Hr Clear Runoff Volume (cu-ft)	26731.4438



1149	0.76585	3.444945	1.141703	0.529372	0.814756	1.488335	17.69749	13931.48
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1153.4	0.811885	3.652021	2.150719	0.845046	0.887361	3.053541	36.61003	14513.48
1153.6	0.812757	3.655942	2.151818	0.84519	0.887394	3.055216	36.65254	14550.14
1153.8	0.813578	3.659638	2.150816	0.845059	0.887364	3.053689	36.65343	14586.79
1154	0.814358	3.663146	2.14796	0.844684	0.887277	3.049338	36.61816	14623.41
1154.2	0.815102	3.666492	2.143434	0.84409	0.887141	3.042444	36.55069	14659.96
1154.4	0.815815	3.669698	2.137372	0.843294	0.886958	3.033213	36.45394	14696.41
1154.6	0.8165	3.672781	2.129875	0.842309	0.886731	3.021803	36.33009	14732.74
1154.8	0.817161	3.675754	2.121019	0.841146	0.886464	3.00833	36.18079	14768.92
1155	0.8178	3.678629	2.110857	0.839812	0.886157	2.99288	36.00726	14804.93
1155.2	0.81842	3.681415	2.099427	0.838312	0.885812	2.975515	35.81037	14840.74
1155.4	0.819021	3.684121	2.086752	0.836647	0.885429	2.956273	35.59073	14876.33
1155.6	0.819606	3.686752	2.072843	0.834821	0.885009	2.935175	35.34869	14911.68
1155.8	0.820176	3.689316	2.057698	0.832833	0.884551	2.912223	35.08439	14946.76
1156	0.820732	3.691817	2.041304	0.83068	0.884056	2.887405	34.79777	14981.56
1156.2	0.821275	3.69426	2.023638	0.828361	0.883523	2.860689	34.48856	15016.05
1156.4	0.821806	3.696649	2.004665	0.825869	0.88295	2.83203	34.15632	15050.21
1156.6	0.822326	3.698987	1.984336	0.82127	0.881892	2.799953	33.7919	15084
1156.8	0.822835	3.701278	1.96259	0.815736	0.880619	2.765271	33.39134	15117.39
1157	0.823335	3.703525	1.939349	0.809821	0.879259	2.728304	32.96145	15150.35
1157.2	0.823825	3.70573	1.914518	0.803501	0.877805	2.688917	32.50333	15182.85
1157.4	0.824306	3.707895	1.887976	0.796745	0.876251	2.646946	32.01518	15214.87
1157.6	0.824779	3.710023	1.859576	0.789517	0.874589	2.602184	31.49478	15246.36
1157.8	0.825245	3.712115	1.829137	0.78177	0.872807	2.554374	30.93935	15277.3
1158	0.825702	3.714174	1.796428	0.773445	0.870892	2.503192	30.3454	15307.65
1158.2	0.826153	3.716201	1.761156	0.764468	0.868828	2.448226	29.70851	15337.36

1158.4	0.826597	3.718197	1.722944	0.754742	0.866591	2.388939	29.02299	15366.38
1158.6	0.827034	3.720164	1.681283	0.744139	0.864152	2.324615	28.28133	15394.66
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1159.4	0.828724	3.727766	1.46	0.679175	0.84921	1.983756	24.43696	15498.75
1159.6	0.829133	3.729605	1.378856	0.640986	0.840427	1.854124	23.02728	15521.78
1159.8	0.829537	3.731422	1.270727	0.590096	0.828722	1.684928	21.23431	15543.01
1160	0.829936	3.733217	1.009926	0.467353	0.800491	1.293499	17.87056	15560.88

Peak Flow Hydrologic Analysis

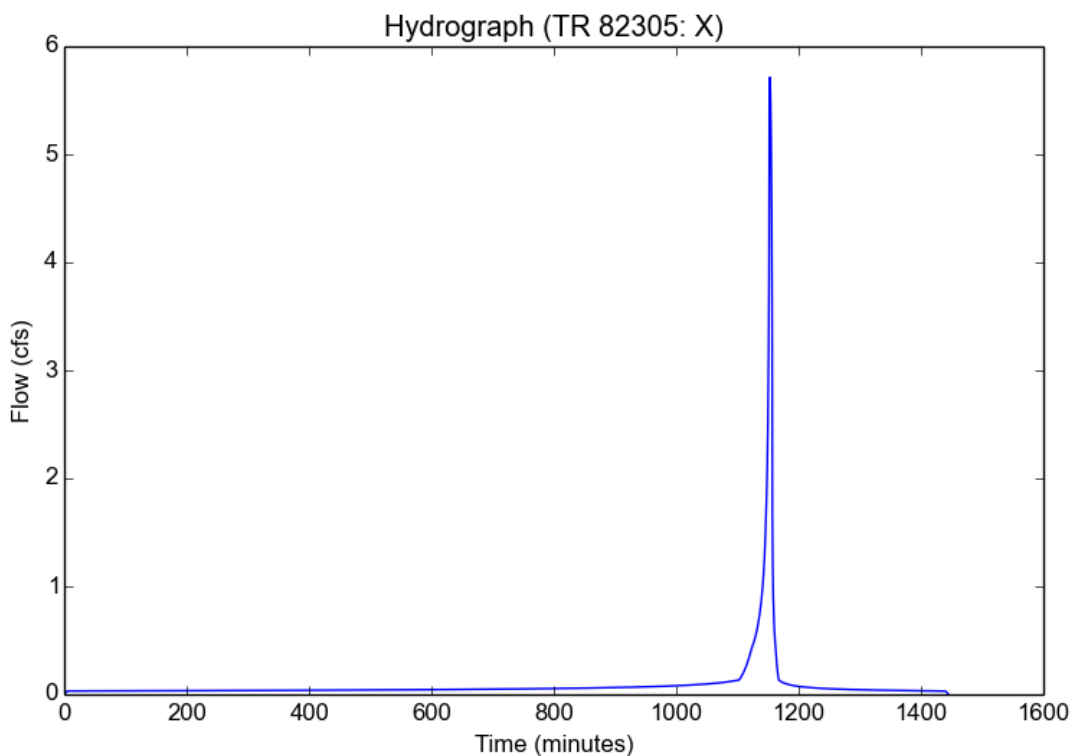
File location: C:/Users/dkessler/Desktop/TR 82305 - X.pdf
Version: HydroCalc 1.0.2

Input Parameters

Project Name	TR 82305
Subarea ID	X
Area (ac)	1.6
Flow Path Length (ft)	276.0
Flow Path Slope (vft/hft)	0.0362
50-yr Rainfall Depth (in)	6.3
Percent Impervious	0.05
Soil Type	13
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	6.3
Peak Intensity (in/hr)	3.7588
Undeveloped Runoff Coefficient (Cu)	0.9525
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	5.0
Clear Peak Flow Rate (cfs)	5.4126
Burned Peak Flow Rate (cfs)	5.4126
24-Hr Clear Runoff Volume (ac-ft)	0.1875
24-Hr Clear Runoff Volume (cu-ft)	8166.6944



*Hydrology & Hydraulic Study
TTM 82395”
Victoria Street
Carson California*

LID Calculations

Peak Flow Hydrologic Analysis

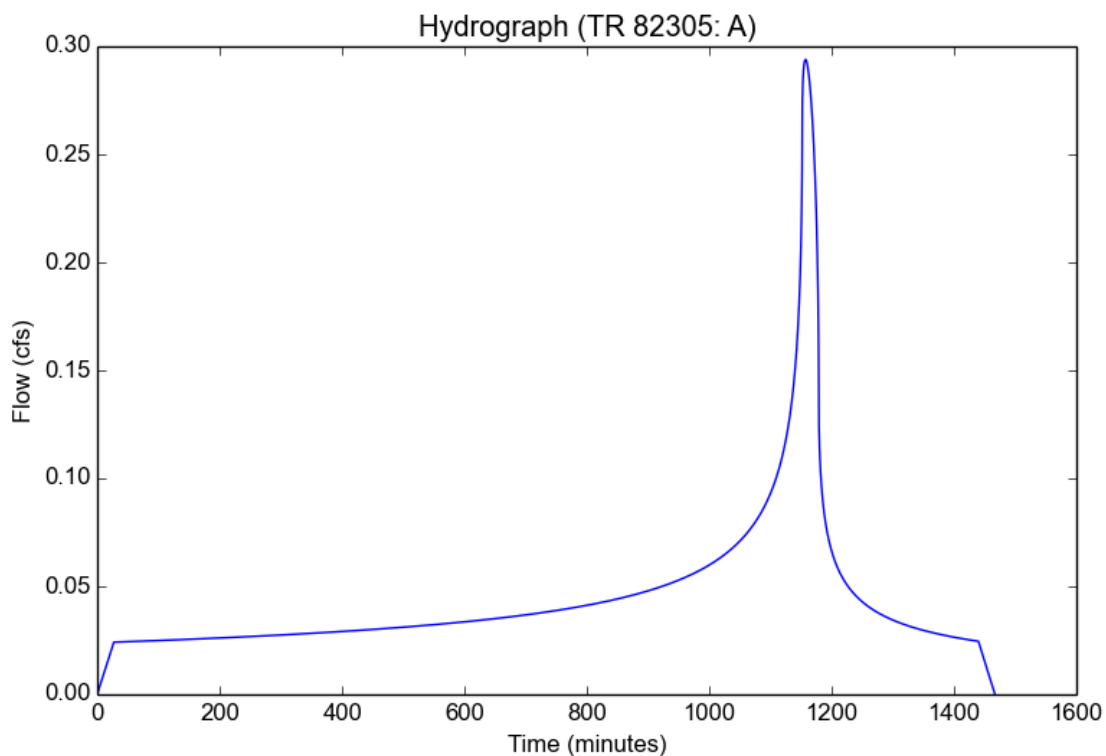
File location: C:/Users/dkessler/Desktop/TR 82305 - A-LID.pdf
Version: HydroCalc 1.0.2

Input Parameters

Project Name	TR 82305
Subarea ID	A
Area (ac)	1.6
Flow Path Length (ft)	451.0
Flow Path Slope (vft/hft)	0.0083
85th Percentile Rainfall Depth (in)	0.95
Percent Impervious	0.77
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

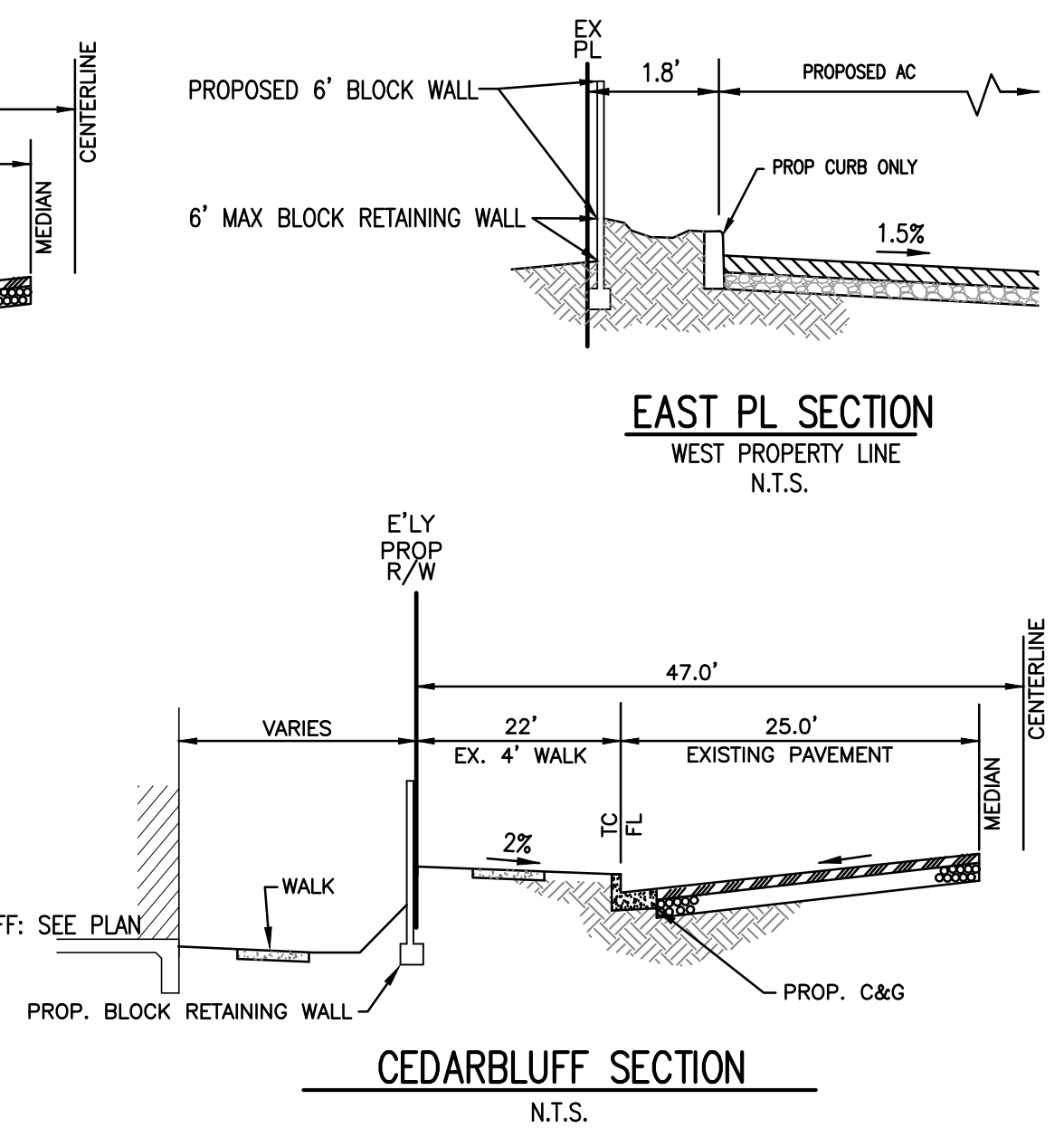
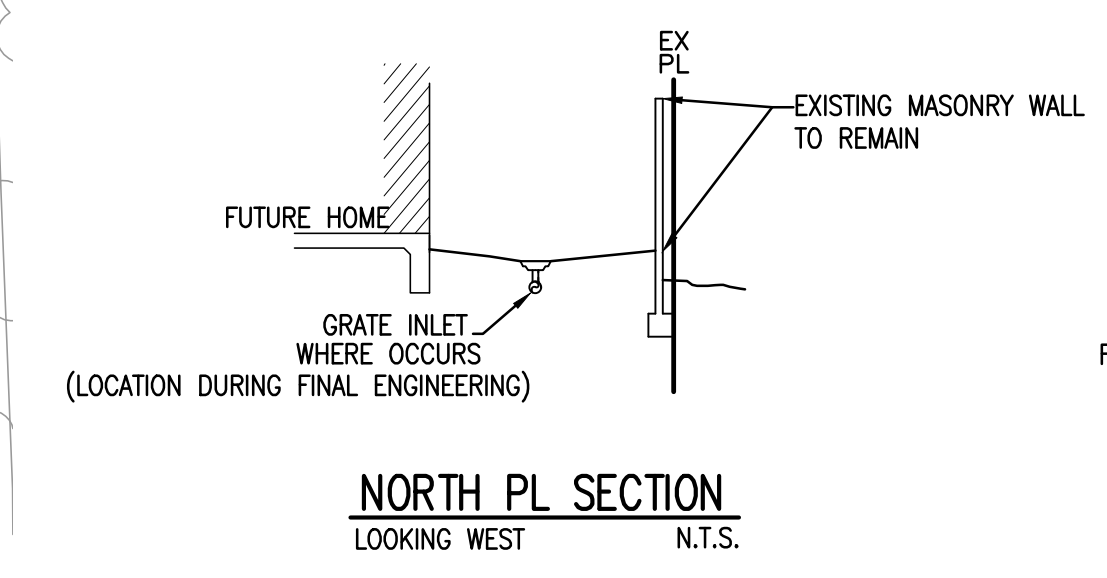
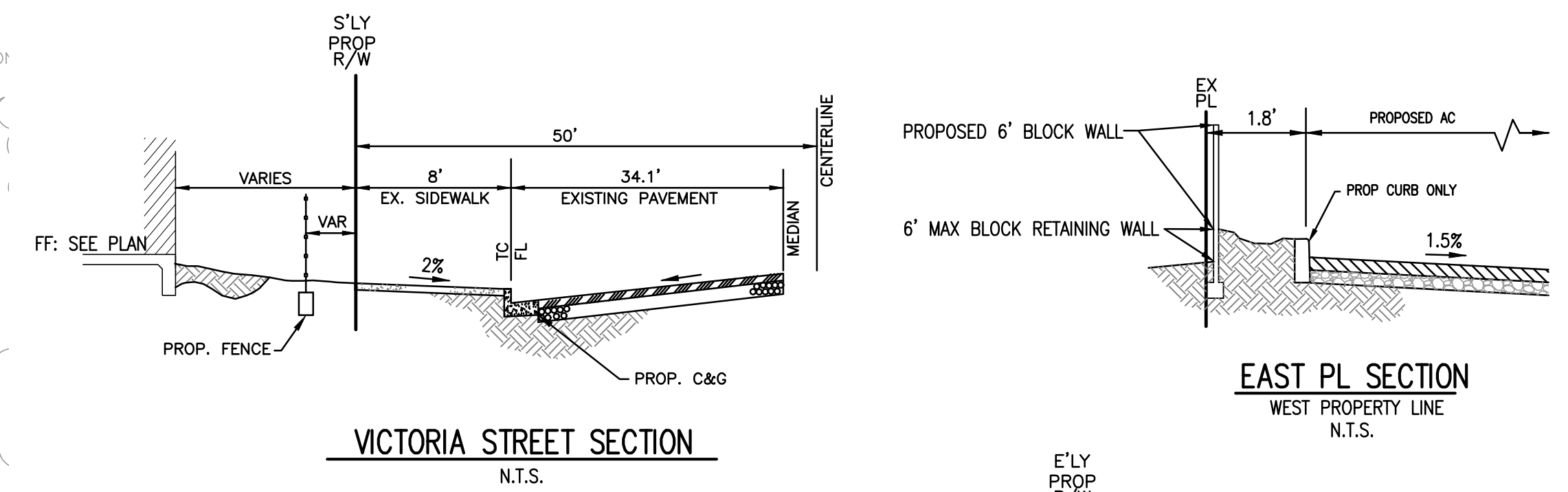
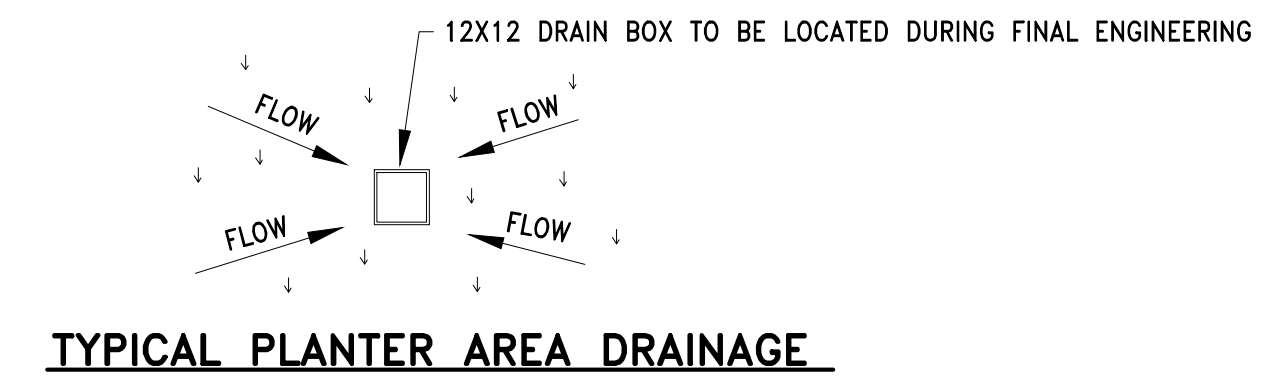
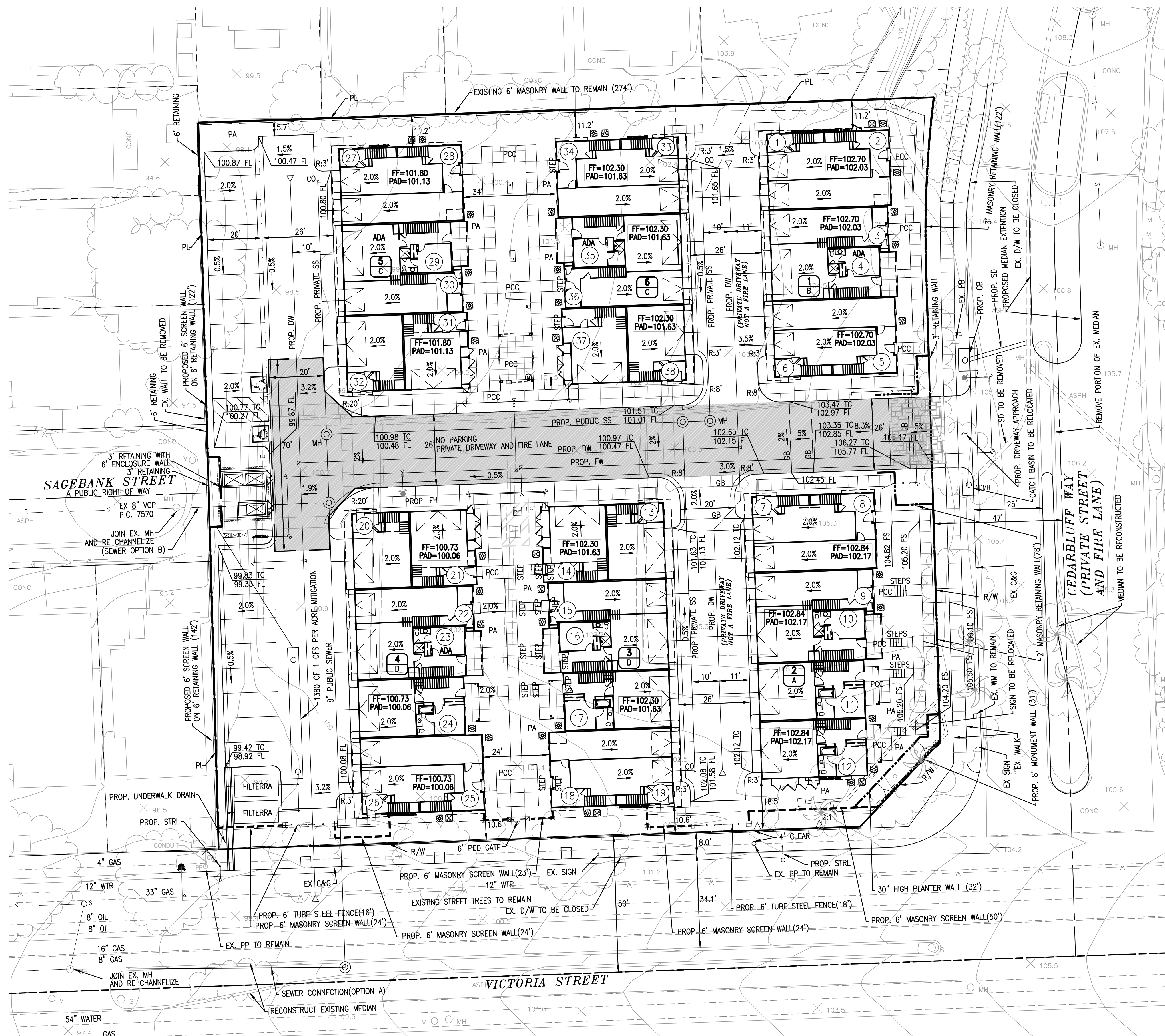
Modeled (85th percentile storm) Rainfall Depth (in)	0.95
Peak Intensity (in/hr)	0.2566
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.716
Time of Concentration (min)	27.0
Clear Peak Flow Rate (cfs)	0.2939
Burned Peak Flow Rate (cfs)	0.2939
24-Hr Clear Runoff Volume (ac-ft)	0.0899
24-Hr Clear Runoff Volume (cu-ft)	3917.9884



*Hydrology & Hydraulic Study
TTM 82395”
Victoria Street
Carson California*

Exhibit

Grading and Utility Plan



BUILDING INFORMATION:

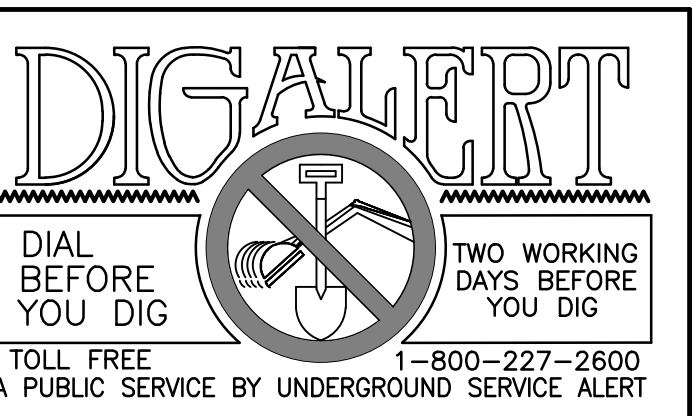
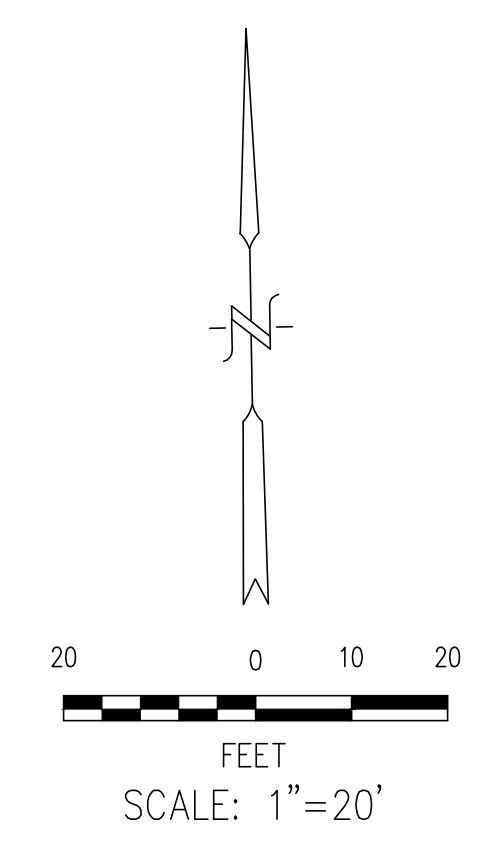
CONSTRUCTION TYPE: TYPE 5B
 OCCUPANCY: R-2
 SPRINKLER TYPE: NFPA 13R

BUILDING AREA	BUILDING NUMBER	BUILDING TYPE	GROSS AREA
	1	B	12,393 SF
	2	A	13,562 SF
	3	D	14,859 SF
	4	D	14,859 SF
	5	C	12,315 SF
	6	C	12,315 SF

NO PARKING PRIVATE DRIVEWAY AND FIRE LANE

SEWER NOTE:
 PROPOSED SEWER/ALLEY MAIN: 8" MAIN LATERAL PVC
 PROPOSED HOUSE LATERALS: 4" PVC
 ALL PROPOSED MAIN LINE SEWER TO BE PUBLIC
 ALL PROPOSED ALLEY SEWER LATERAL TO BE PRIVATE

PROPOSED EASEMENT
 AN EASEMENT IS PROPOSED OVER ALL VEHICULAR PAVEMENT AREA FOR INGRESS/EGRESS AND UTILITY PURPOSES.

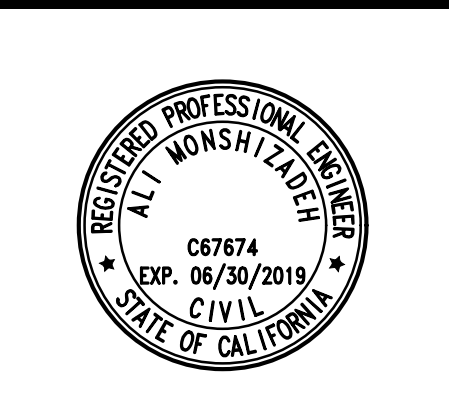


REVISIONS

NO	DATE	INITIAL	DESCRIPTION	APP	DATE

OWNER/DEVELOPER:
BRANDYWINE HOMES, INC.
 16580 ASTON
 IRVINE, CA 92606
 (949) 296-2400

PREPARED BY:
KES TECHNOLOGIES INC
 CIVIL ENGINEERING
 LAND PLANNING AND SURVEYING
 1 VENTURE STE 130
 IRVINE, CALIFORNIA 92608
 PHONE (949) 339-5331
 FAX (866) 426-2201



I hereby certify that:
 1. These plans have been prepared under my supervision;
 2. The grading shown hereon will not divert drainage from its natural downstream course or obstruct the drainage of adjacent properties;
 3. All specimen trees located on this property are shown;
 4. Existing ground contours and elevations were obtained by field survey on/aerial topography flown on MAY, 2018

ENGINEER: *[Signature]* DATE: 4/12/19
 RCE 67674 EXP. DATE: 6-31-19

MAJOR LAND DIVISION
 VESTING TENTATIVE TRACT NO. 82395
 EXHIBIT MAP
 (FOR CONDOMINIUM PURPOSES)
 LOCATED IN THE CITY OF CARSON
 THE COUNTY OF LOS ANGELES, STATE OF CA

SCALE: AS SHOWN DRAWN BY: DSK CHECKED BY: AM
CITY OF CARSON

SHEET 3 OF 4

*Hydrology & Hydraulic Study
TTM 82395”
Victoria Street
Carson California*

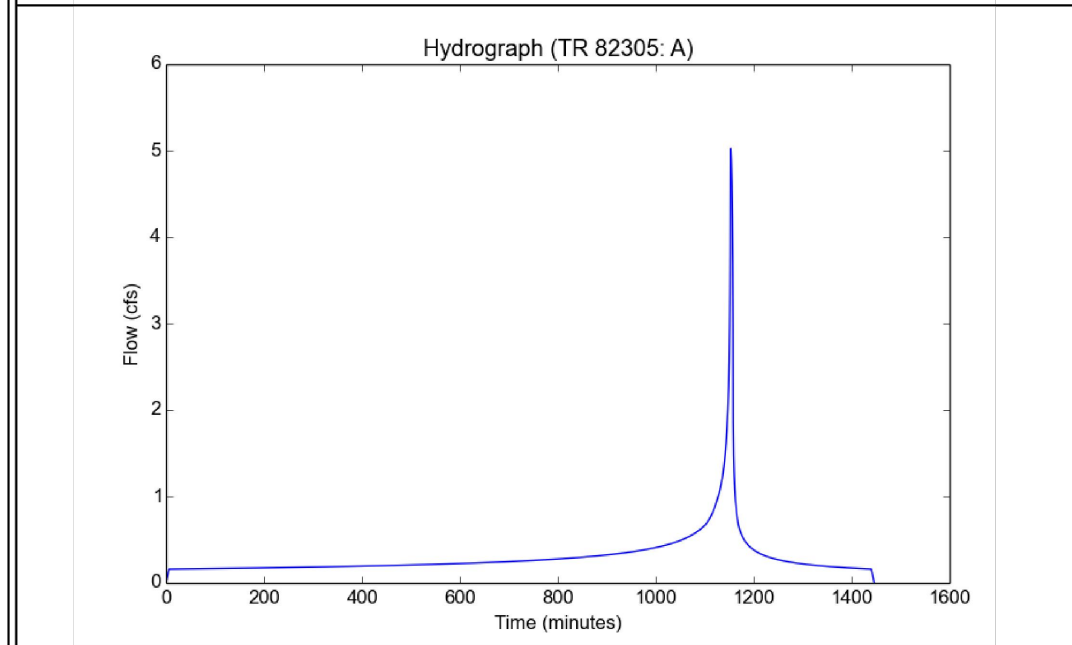
Exhibit

Hydrology Map

Peak Flow Hydrologic Analysis
File location: C:\Users\skessler\Desktop\TR 82305 - A.pdf
Version: HydroCalc 1.0.2

Input Parameters	
Project Name	TR 82305
Subarea ID	A
Area (ac)	1.6
Flow Path Length (ft)	451.0
Flow Path Slope (ft/ft)	0.0083
50-yr Rainfall Depth (in)	6.3
Percent Impervious	0.77
Soil Type	13
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results	
Modeled (50-yr) Rainfall Depth (in)	6.3
Peak Intensity (in/hr)	3.4501
Undeveloped Runoff Coefficient (Cu)	0.9457
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	6.0
Clear Peak Flow Rate (cfs)	4.9681
Burned Peak Flow Rate (cfs)	4.9681
24-Hr Clear Runoff Volume (ac-ft)	0.6137
24-Hr Clear Runoff Volume (cu-ft)	26731.4438

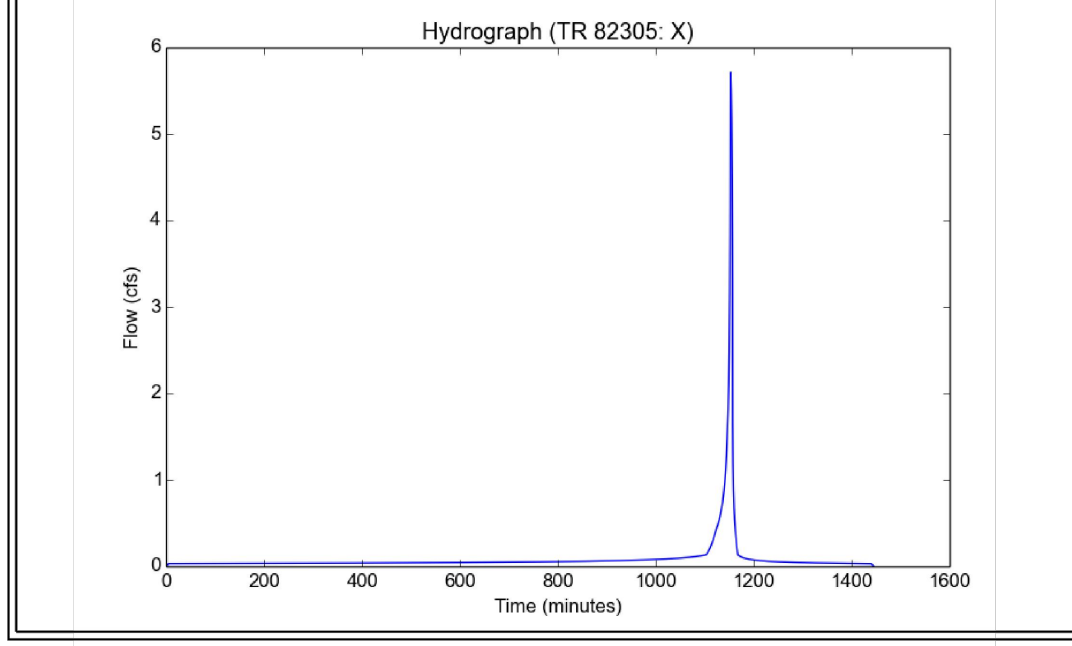


PROPOSED HYDROLOGY INPUTS

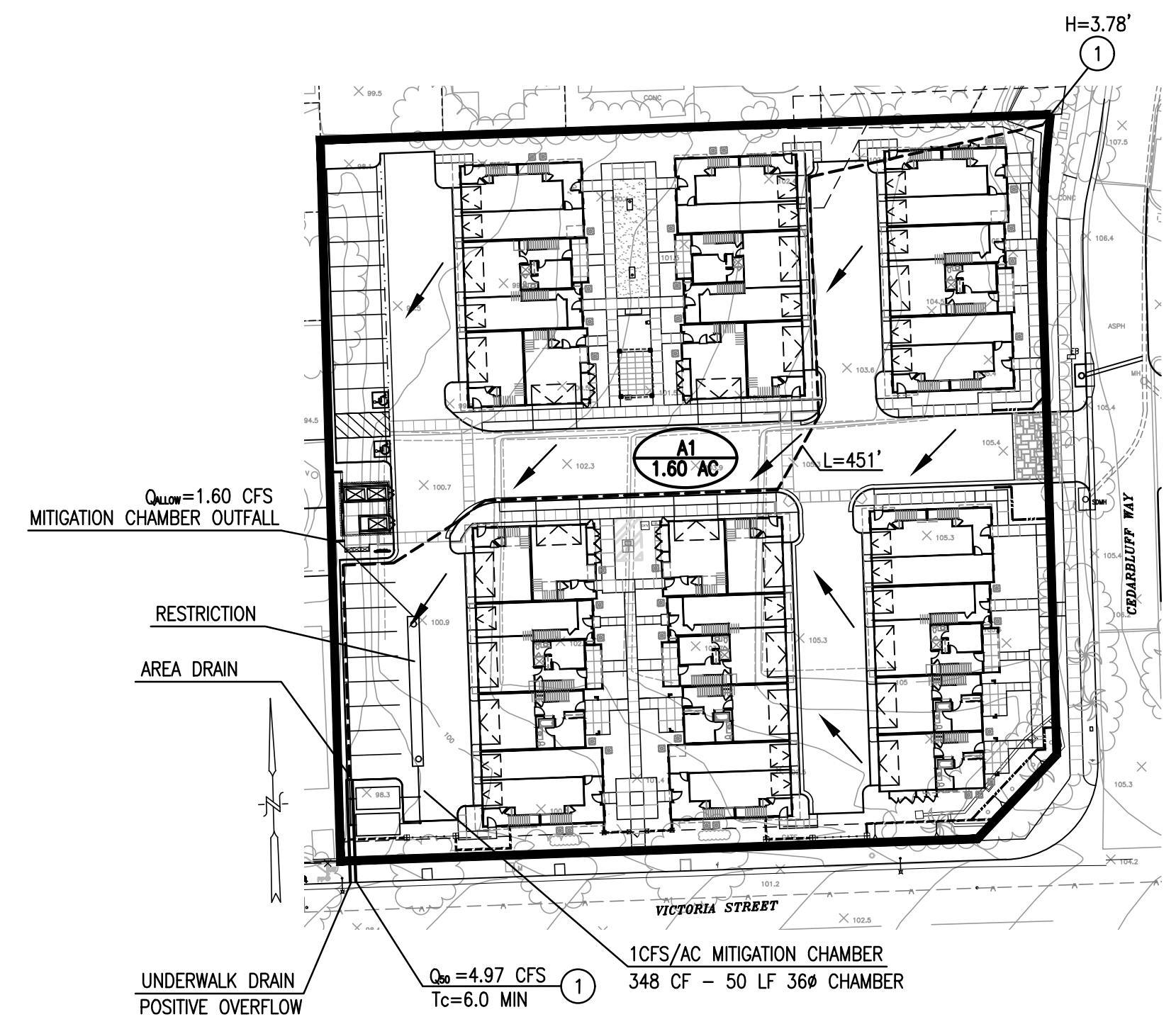
Peak Flow Hydrologic Analysis
File location: C:\Users\skessler\Desktop\TR 82305 - X.pdf
Version: HydroCalc 1.0.2

Input Parameters	
Project Name	TR 82305
Subarea ID	X
Area (ac)	1.6
Flow Path Length (ft)	276.0
Flow Path Slope (ft/ft)	0.0362
50-yr Rainfall Depth (in)	6.3
Percent Impervious	0.05
Soil Type	13
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

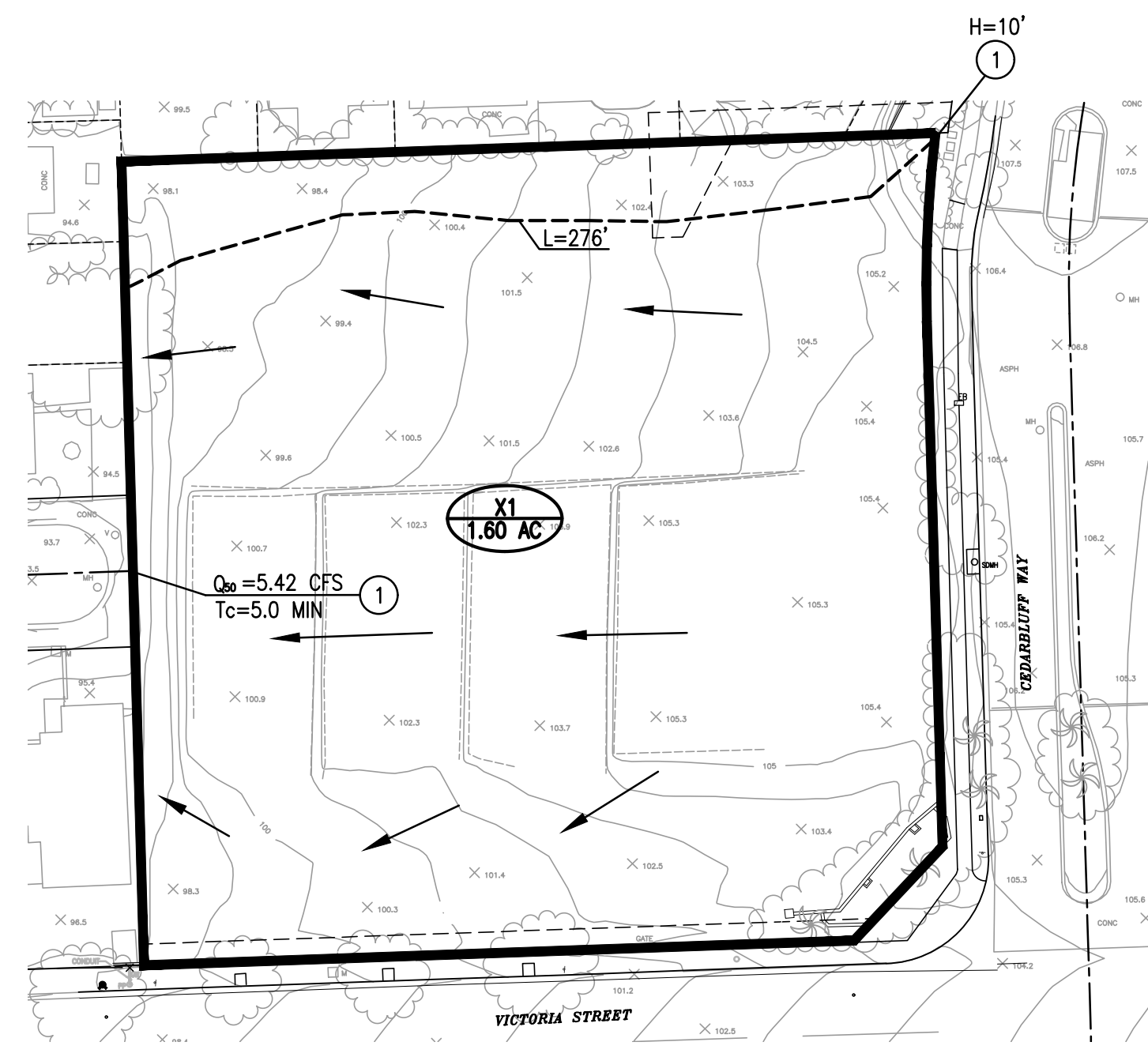
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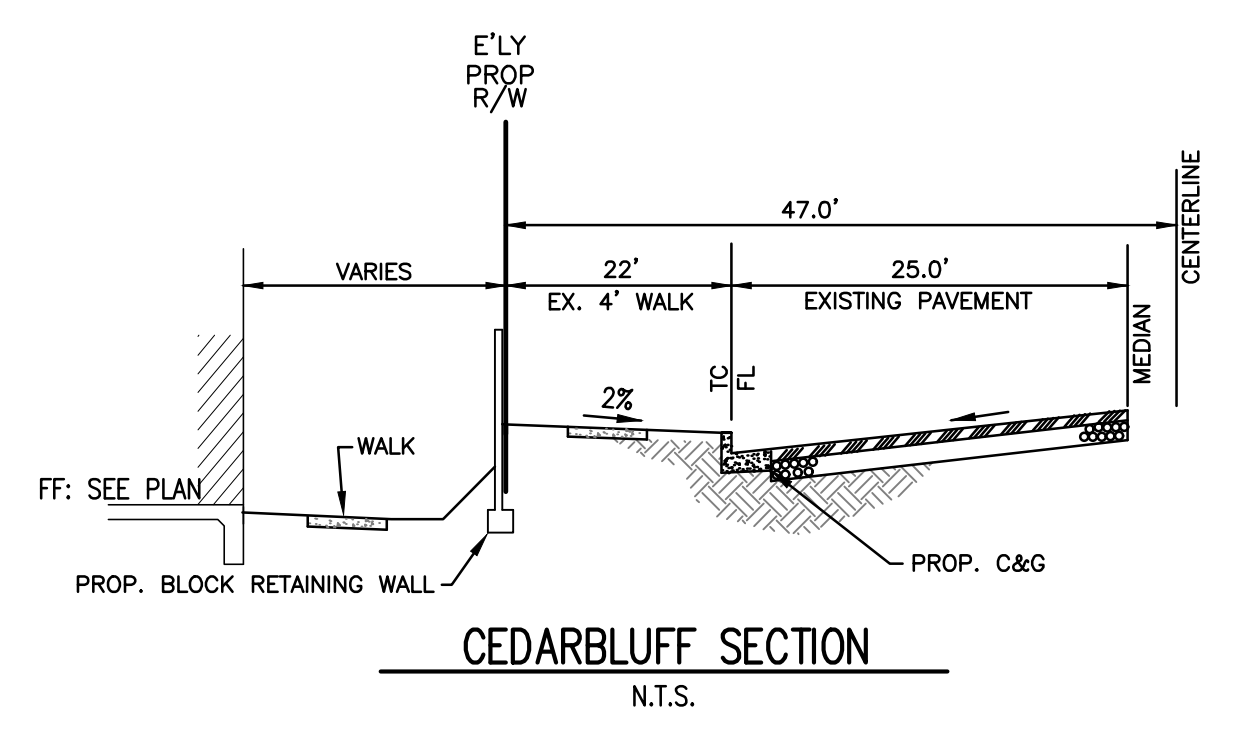
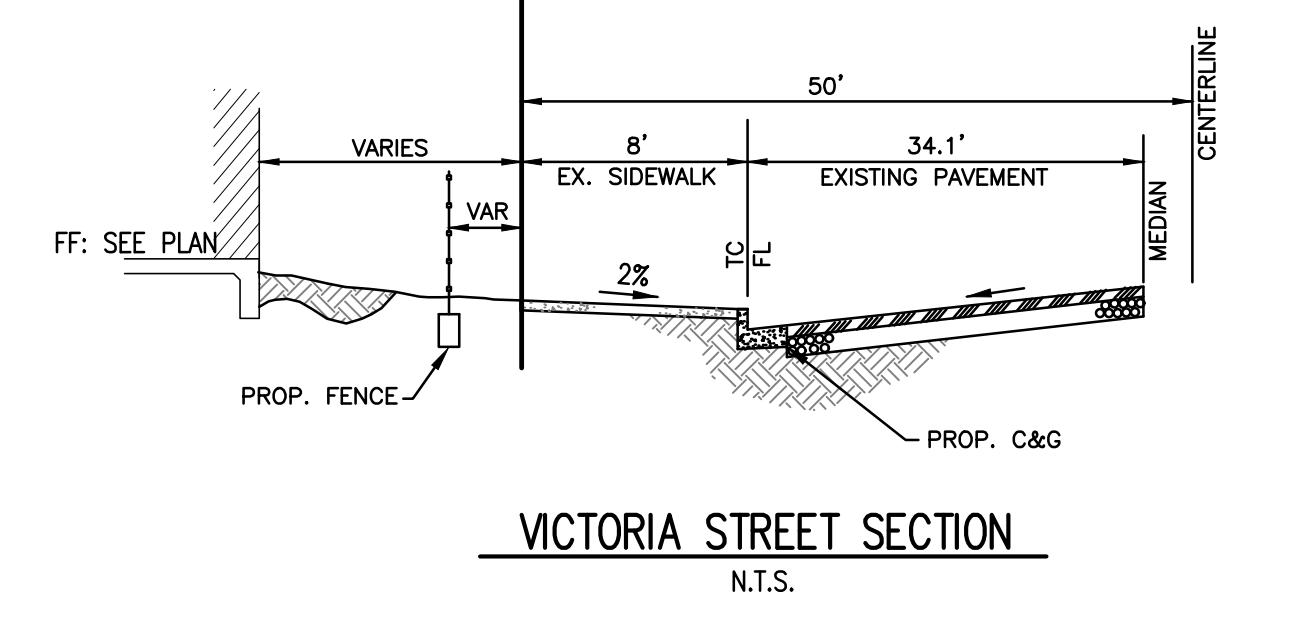
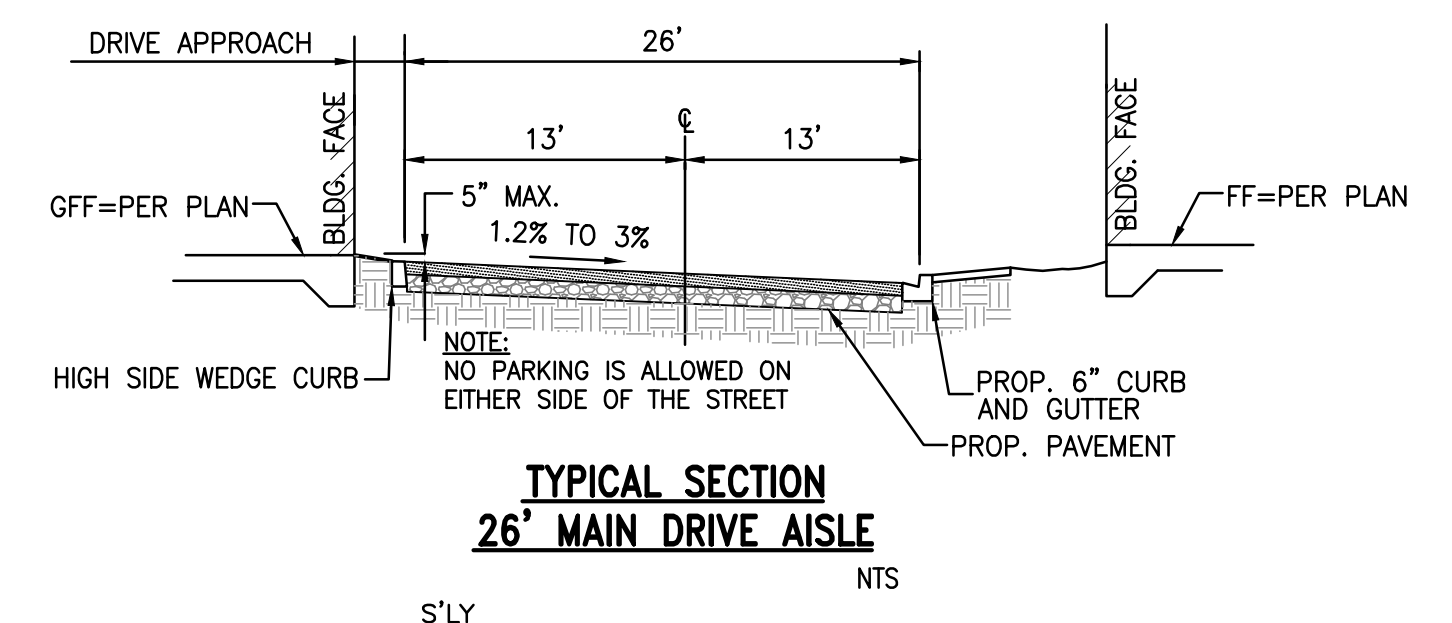
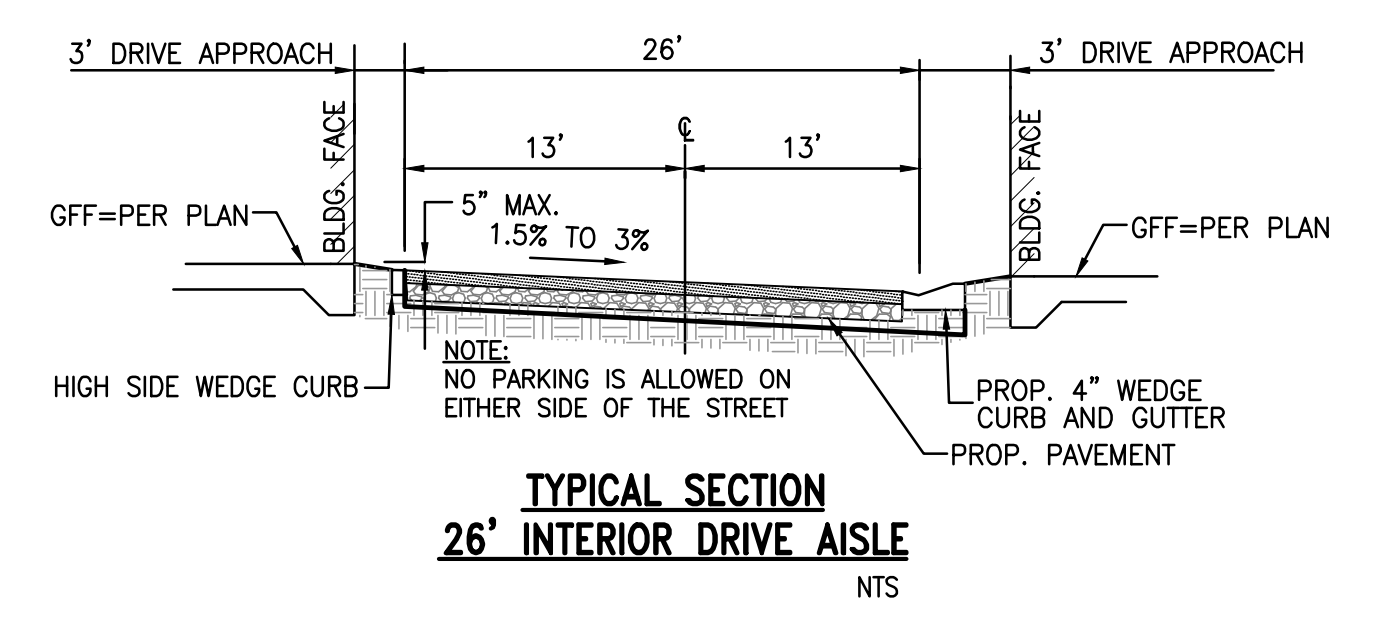
EXISTING HYDROLOGY INPUTS



PROPOSED HYDROLOGY CONDITIONS
SEE PROJECT GRADING PLAN FOR DETAILED ELEVATIONS

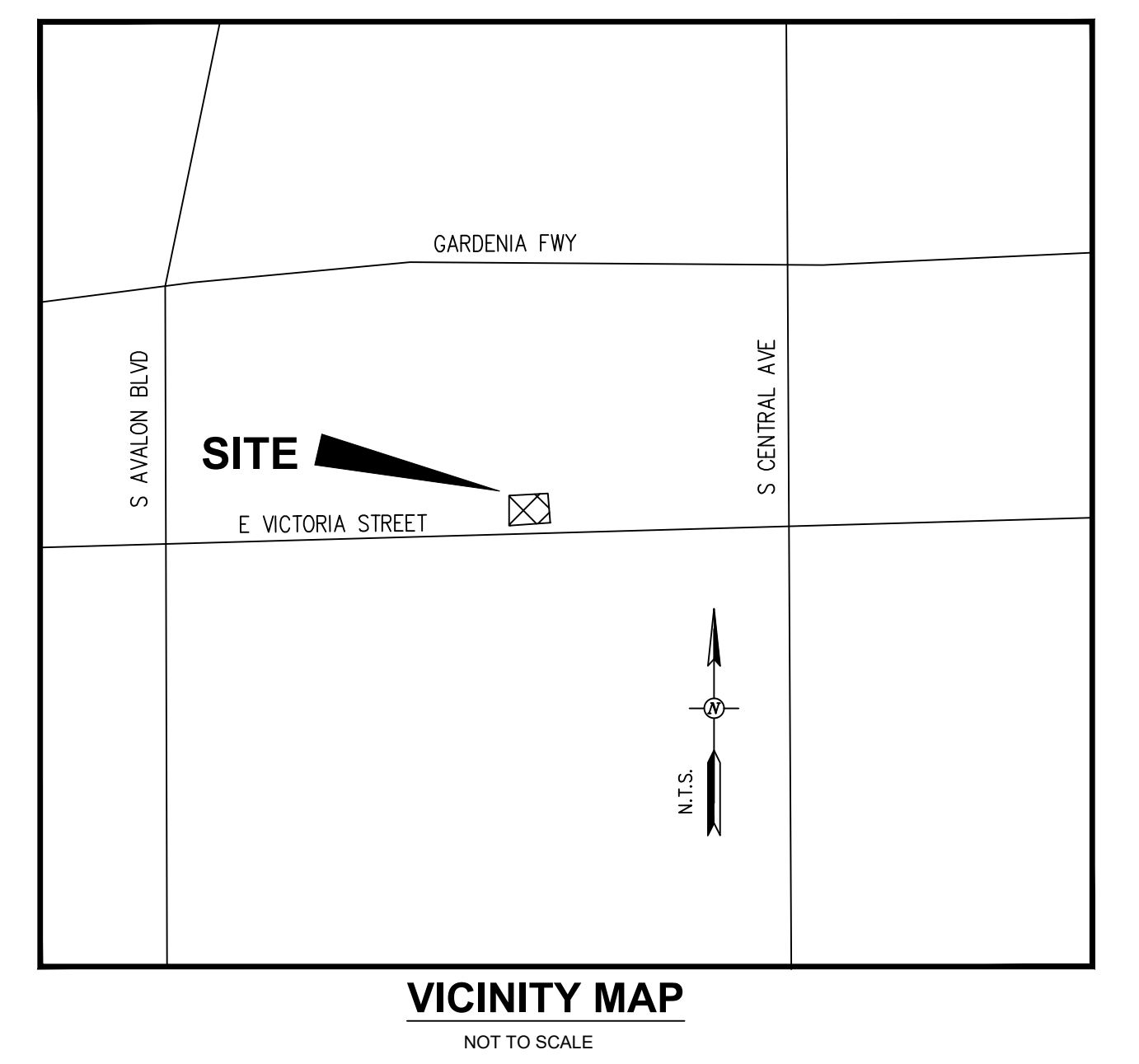


EXISTING HYDROLOGY CONDITIONS



LEGEND

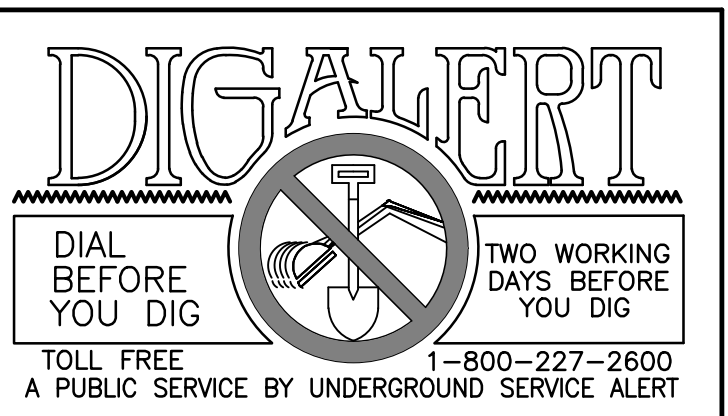
- DRAINAGE AREA BOUNDARY
- FLOW DIRECTION
- X1 - 1.60 AC DRAINAGE AREA NUMBER
- 1.60 AC DRAINAGE AREA IN ACRES



LID TABLE

85TH PERCENTILE STORM SIZE: 0.95"
HYDROMODIFICATION - N/A
COUNTY Q-ALLOWABLE MITIGATION - 1 CFS/AC
BMP VOLUME - 3918 CF (INFILTRATION) 5877 CF (BIO-FILTRATION)
BMP FLOW - 0.29 CFS (INFILTRATION) 0.44 CFS (BIO-FILTRATION)
PERCENT TREATED OFF SITE - 0%

MAINTENANCE NOTE: ALL PROPOSED STORM DRAIN FACILITIES SHOWN ARE PRIVATE/MAINTAINED BY HOA



REVISIONS					
NO	DATE	INITIAL	DESCRIPTION	APP	DATE

OWNER/DEVELOPER:
BRANDYWINE HOMES, INC.
16580 ASTON
IRVINE, CA 92606
(949) 296-2400

PREPARED BY:
KES TECHNOLOGIES INC
CIVIL ENGINEERING
LAND PLANNING AND SURVEYING
1 VENTURE STE 130
IRVINE, CALIFORNIA 92618
PHONE (949) 339-5331
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3. All specimen trees located on this property are shown;
4. Existing ground contours and elevations were obtained by field survey on/aerial topography flown on MAY, 2018.

ENGINEER: *[Signature]* DATE: 4/12/19
RCE 67674 EXP. DATE: 6-31-19

MAJOR LAND DIVISION
VESTING TENTATIVE TRACT NO. 82395
DRAINAGE CONCEPT/HYDROLOGY
STUDY FOR TR 82395
LOCATED IN THE CITY OF CARSON

SCALE: AS SHOWN DRAWN BY: DSK CHECKED BY: AM

CITY OF CARSON

SHEET 1 OF 1