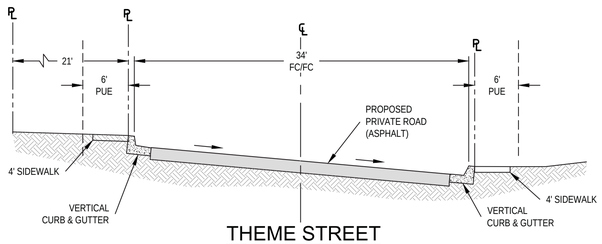
PRELIMINARY GRADING & DRAINAGE PLAN

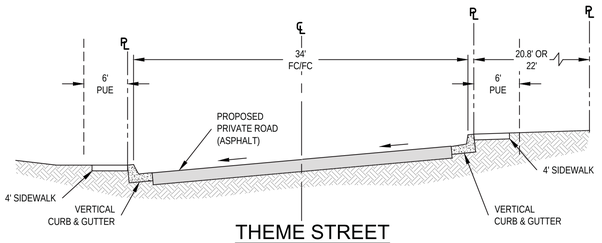
FOR

BELLA ENCANTA

A PORTION OF THE NORTHEAST QUARTER OF SECTION 34, TOWNSHIP 1 NORTH, RANGE 7 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA



THEME STREET
WEST SIDE OF AMENITY AREA (LOOKING NORTH)
N.T.S.



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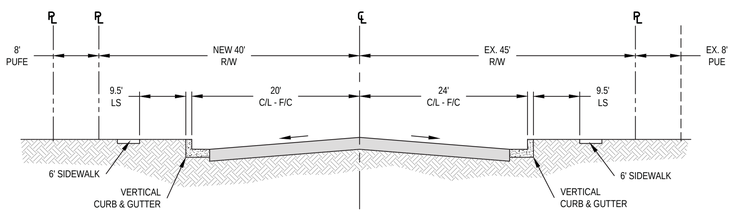
N.T.S.



HAMPTON AVE (LOOKING WEST)
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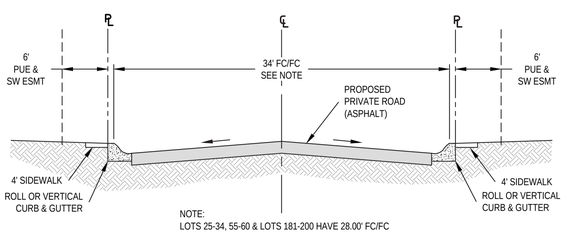

ALL OTHER ROADS (LOOKING NORTH OR EAST)
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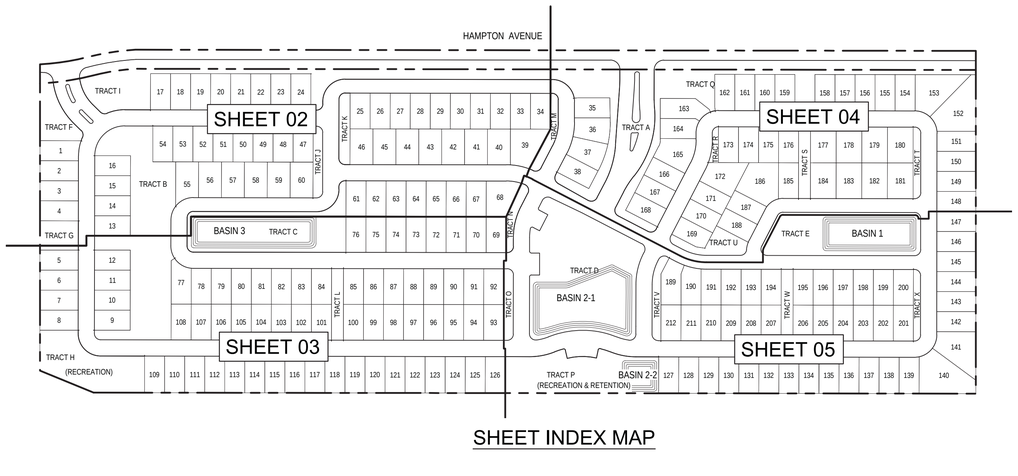


SHEET INDEX MAP

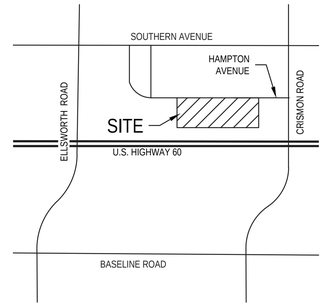
TRACT USE & AREA TABLE

TRACT	USE	AREA(SF)	AREA(AC)
A	PRIVATE ROADWAY, PARKING & P.U.E.	294,948.82	6.771
B	LANDSCAPE OPEN SPACE, RECREATION & DRAINAGE	43,975.31	1.010
C	LANDSCAPE OPEN SPACE, RECREATION & RETENTION	29,682.06	0.681
D	LANDSCAPE OPEN SPACE, RECREATION & RETENTION	54,068.25	1.241
E	LANDSCAPE OPEN SPACE, RECREATION & RETENTION	28,711.10	0.659
F	LANDSCAPE OPEN SPACE	6,771.05	0.155
G	LANDSCAPE OPEN SPACE, RECREATION & DRAINAGE	4,933.12	0.113
H	LANDSCAPE OPEN SPACE & DRAINAGE	19,043.61	0.437
I	LANDSCAPE OPEN SPACE & DRAINAGE	40,192.21	0.923
J	LANDSCAPE OPEN SPACE	2,927.46	0.067
K	LANDSCAPE OPEN SPACE	3,436.06	0.079
L	LANDSCAPE OPEN SPACE	3,750.00	0.086
M	LANDSCAPE OPEN SPACE	3,053.78	0.070
N	LANDSCAPE OPEN SPACE	2,587.36	0.059
O	LANDSCAPE OPEN SPACE	2,927.46	0.067
P	LANDSCAPE OPEN SPACE	25,585.94	0.587
Q	LANDSCAPE OPEN SPACE & RECREATION	22,585.00	0.518
R	LANDSCAPE OPEN SPACE	1,068.79	0.025
S	LANDSCAPE OPEN SPACE	3,750.00	0.086
T	LANDSCAPE OPEN SPACE	2,327.46	0.053
U	LANDSCAPE OPEN SPACE	5,106.62	0.117
V	LANDSCAPE OPEN SPACE	3,241.56	0.074
W	LANDSCAPE OPEN SPACE	3,750.00	0.086
X	LANDSCAPE OPEN SPACE	2,177.46	0.050
R/W	RIGHT OF WAY DEDICATED TO THE CITY OF MESA	78,557.64	1.80

LEGEND & ABBREVIATIONS

	OFFSITE FLOW DIRECTION
	FLOW DIRECTION
SS	EXISTING SEWER
S	EXISTING SEWER MANHOLE
W	EXISTING WATER
	EXISTING FIRE HYDRANT
	EXISTING/PROPOSED WATER VALVE
UGP	EXISTING UNDERGROUND GAS PIPE
1490	EXISTING CONTOURS
	CENTERLINE
	PROPOSED SEWER MANHOLE
SS	PROPOSED SEWER
	PROPOSED FIRE HYDRANT
W	PROPOSED WATER
	PROPERTY LINE
M.C.R.	MARICOPA COUNTY RECORDER

A.P.N.	ASSESSOR'S PARCEL NUMBER
BC	BACK OF CURB
DU	DWELLING UNITS
R/W	RIGHT OF WAY
S/W	SIDEWALK
SF	SQUARE FEET
LS	LANDSCAPE
AC	ACRES
W OR WTR	WATER
S OR SEW	SEWER
P.U.E.	PUBLIC UTILITY EASEMENT
P.U.F.E.	PUBLIC UTILITY FACILITIES EASEMENT
FF	FINISH FLOOR
GB	GRADE BREAK
LP/HP	LOW POINT HIGH POINT
VG	VALLEY GUTTER
P	PAVEMENT
EOG	END OF GARAGE



VICINITY MAP
N.T.S.

SHEET INDEX

OWNER/DEVELOPER

CRISMON BFC, LLC
C/O BELA FLOR COMMUNITIES
1635 N. GREENFIELD RD. #115
MESA, ARIZONA 85205
CONTACT: HUDD HASSELL
PHONE: (602) 525-0000

ENGINEER

VERTEX CIVIL ENGINEERING, LLC
2131 S. SABRINA
MESA, ARIZONA 85209
CONTACT: DANIEL GONZALEZ, P.E.
PHONE: (480) 577-4984

BENCHMARK

2012 CITY OF MESA BENCHMARK BRASS TAG TOP OF CURB SOUTHEAST CORNER OF SOUTH ELLSWORTH ROAD AND SOUTHERN AVENUE.

ELEVATION 1481.20 (NAVD88)

BASIS OF BEARING

MONUMENT LINE OF CRISMON ROAD, ALSO BEING THE EAST LINE OF THE NORTHEAST QUARTER OF SECTION 34, USING A BEARING OF NORTH 00 DEGREES 03 MINUTES 32 SECONDS WEST, AS PER THE RECORD OF SURVEY. BOOK 946 OF MAPS, PAGE 34, RECORDS OF MARICOPA COUNTY. ARIZONA.

FLOODZONE INFORMATION

PER F.E.M.A. THIS PROJECT LIES WITHIN PANEL 04013C2315L, DATED OCTOBER 16, 2013.
NO PRINTED PANEL PROVIDED IN THIS AREA.

SITE DATA

TAX ASSESSOR'S PARCEL NUMBER(S)
200-80-002X
220-80-009G
220-80-008C

EXISTING ZONING: NC & PEP

PROPOSED ZONING: RM-2 PAD (SINGLE-RESIDENCE ATTACHED)

TYPE OF UNITS:
SINGLE RESIDENCE ATTACHED: 212 UNITS

TOTAL NUMBER OF LOTS/UNITS: 212
PROJECTED POPULATION: (212 x 2.5) = 530 PERSONS

GROSS AREA: 1,404,000.06 SF ~ 32.23 AC
GROSS DENSITY (ALL UNITS/LOTS): 6.58 DU/AC

NET AREA: 1,325,442.93 SF ~ 30.43 AC
NET DENSITY (ALL UNITS/LOTS): 6.97 DU/AC

TOTAL OPEN SPACE: 315093.70 SF ~ 7.23 AC
% OPEN SPACE (GROSS): 22.43%
% OPEN SPACE (NET): 23.76%

VERTEX CIVIL ENGINEERING

VERTEX CIVIL ENGINEERING, LLC
2131 S. SABRINA
MESA, ARIZONA 85209
(480) 577-4984

BELLA ENCANTA
MESA, AZ

PRELIMINARY
GRADING AND DRAINAGE
PLAN

Registered Professional Engineer
CERTIFICATE NO.
41932
DANIEL S. GONZALEZ
Date Signed 5-10-19
ARIZONA U.S.A.
EXPIRES 3/31/20

No	Date	Revision Description

Proj No: 19.005
Date: 05/10/2019
Designed By: DG
Drawn By: HD
Scale: NONE
Sheet: PGD-001

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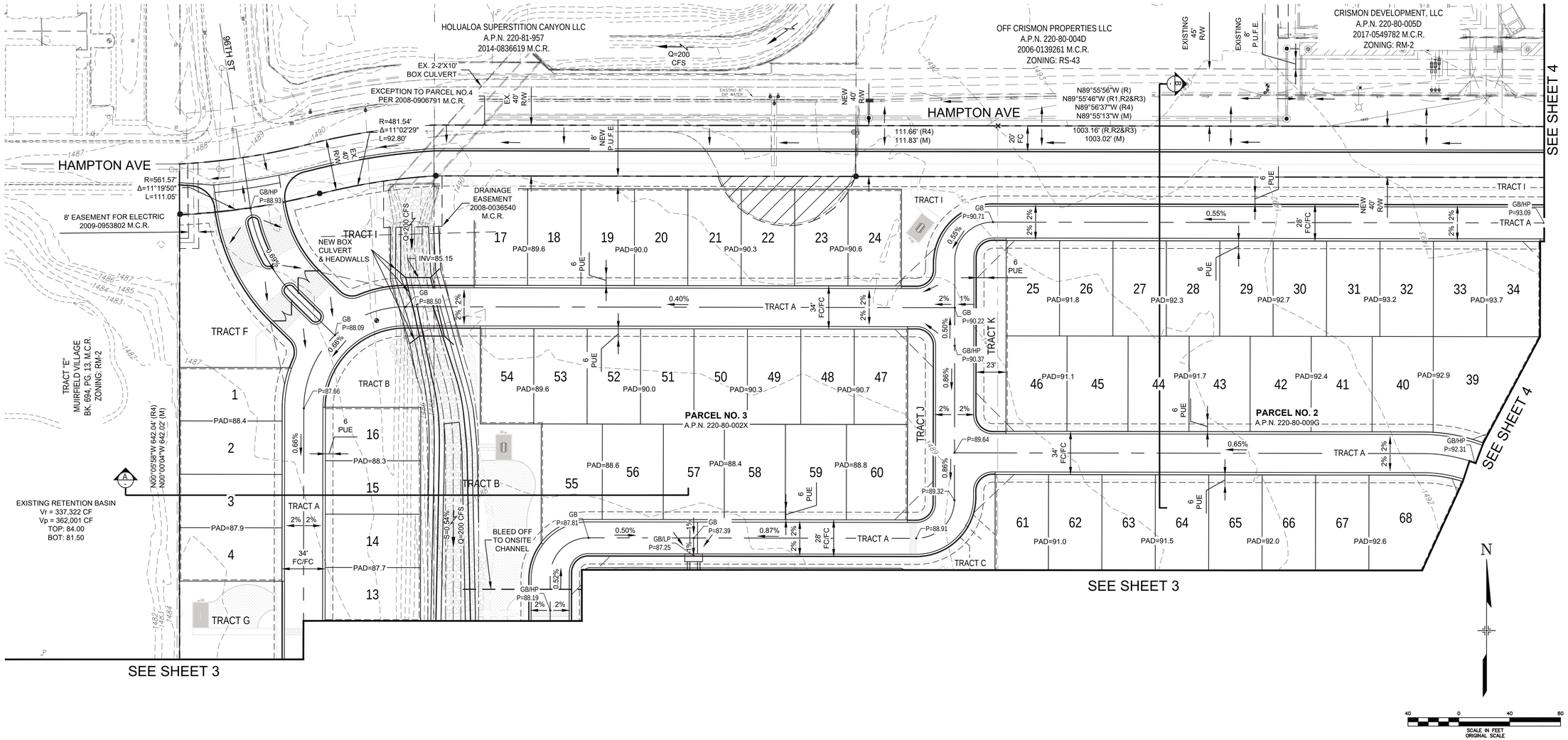
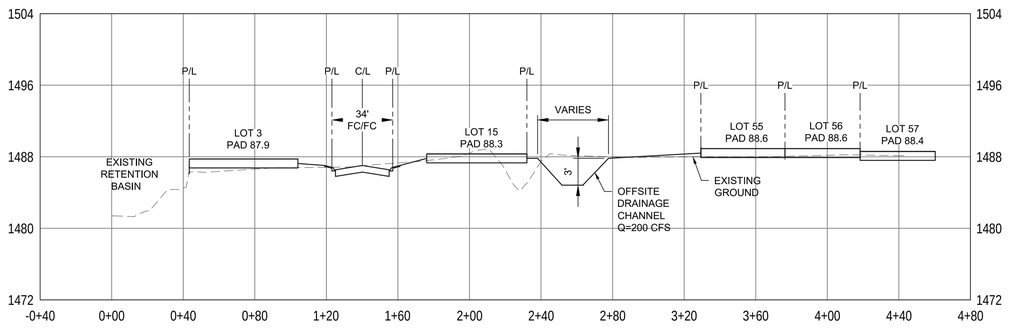
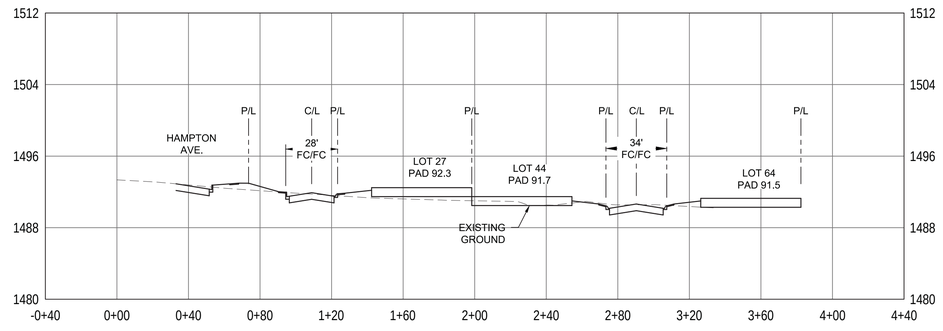




SECTION A - A

SCALE: 1"=40' HORIZ.
1"=8' VERT.



SECTION B - B

SCALE: 1"=40' HORIZ.
1"=8' VERT.

VERTEX CIVIL ENGINEERING

VERTEX CIVIL ENGINEERING, LLC
2131 S. SABRINA
MESA, ARIZONA 85209
(480) 577-4884

BELLA ENCANTA
MESA, AZ

PRELIMINARY
GRADING AND DRAINAGE
PLAN

Registered Professional Engineer
CERTIFICATE NO.
41932
DANIEL S. GONZALEZ
Date Signed 5/31/19
ARIZONA U.S.A.
EXPIRES 3/31/20

No	Date	Revision Description

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Date: 05/10/2019
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Drawn By: HD
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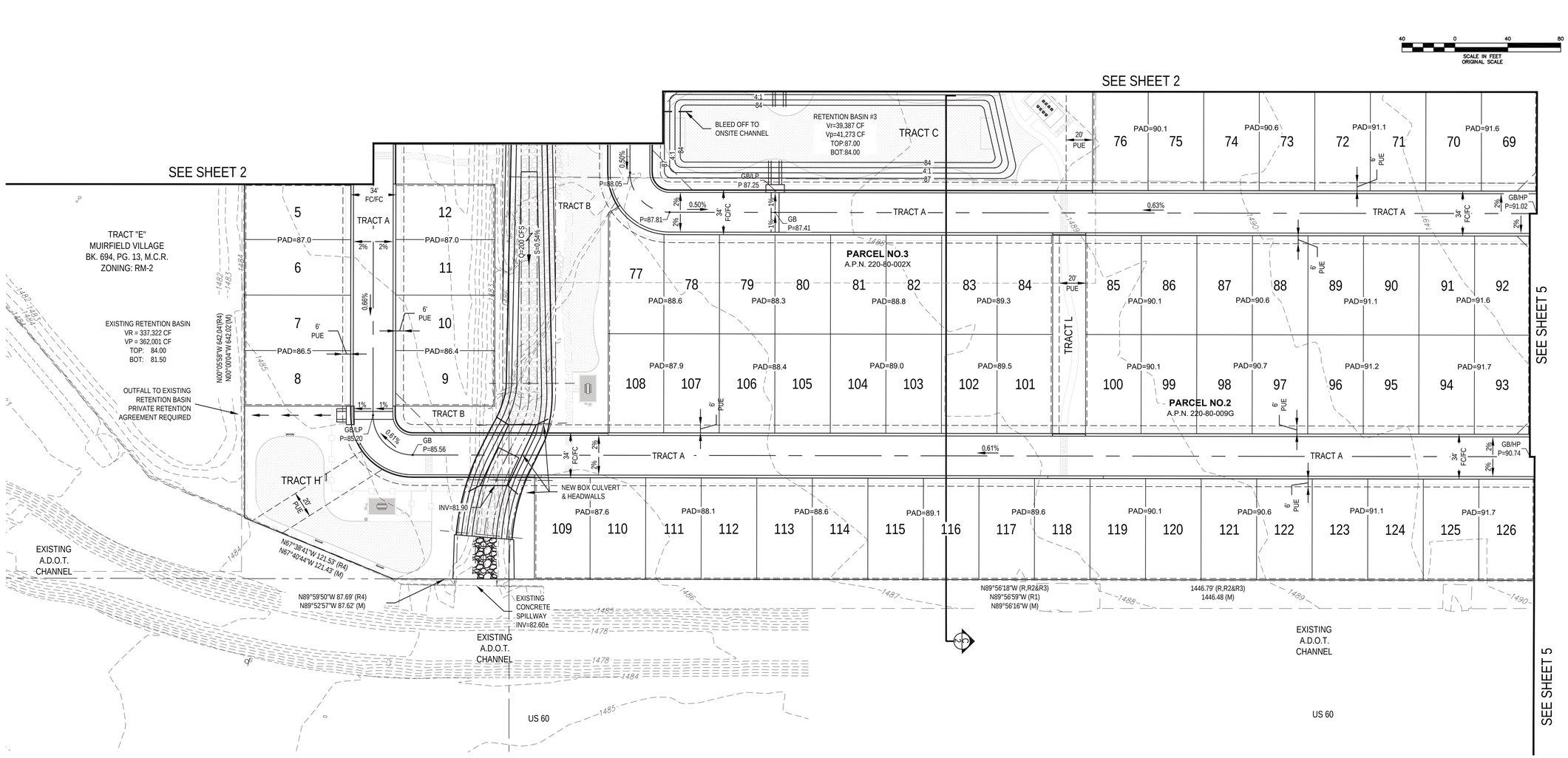

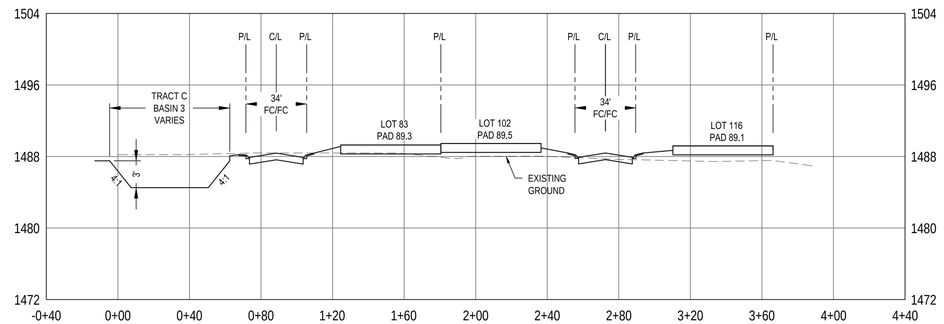

SECTION C - C

SCALE: 1"=40' HORIZ.
1"=8' VERT.

VERTEX CIVIL ENGINEERING
CIVIL ENGINEERING

VERTEX CIVIL ENGINEERING, LLC
2131 S. SABRINA
MESA, ARIZONA 85209
(480) 577-4884

BELLA ENCANTA
MESA, AZ

PRELIMINARY
GRADING AND DRAINAGE
PLAN

Registered Professional Engineer (Civil)
CERTIFICATE NO.
41932
DANIEL S. GONZALEZ
Date Signed
ARIZONA U.S.A.
EXPIRES 3/31/20

Revision		
No.	Date	Description

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Date: 05/10/2019
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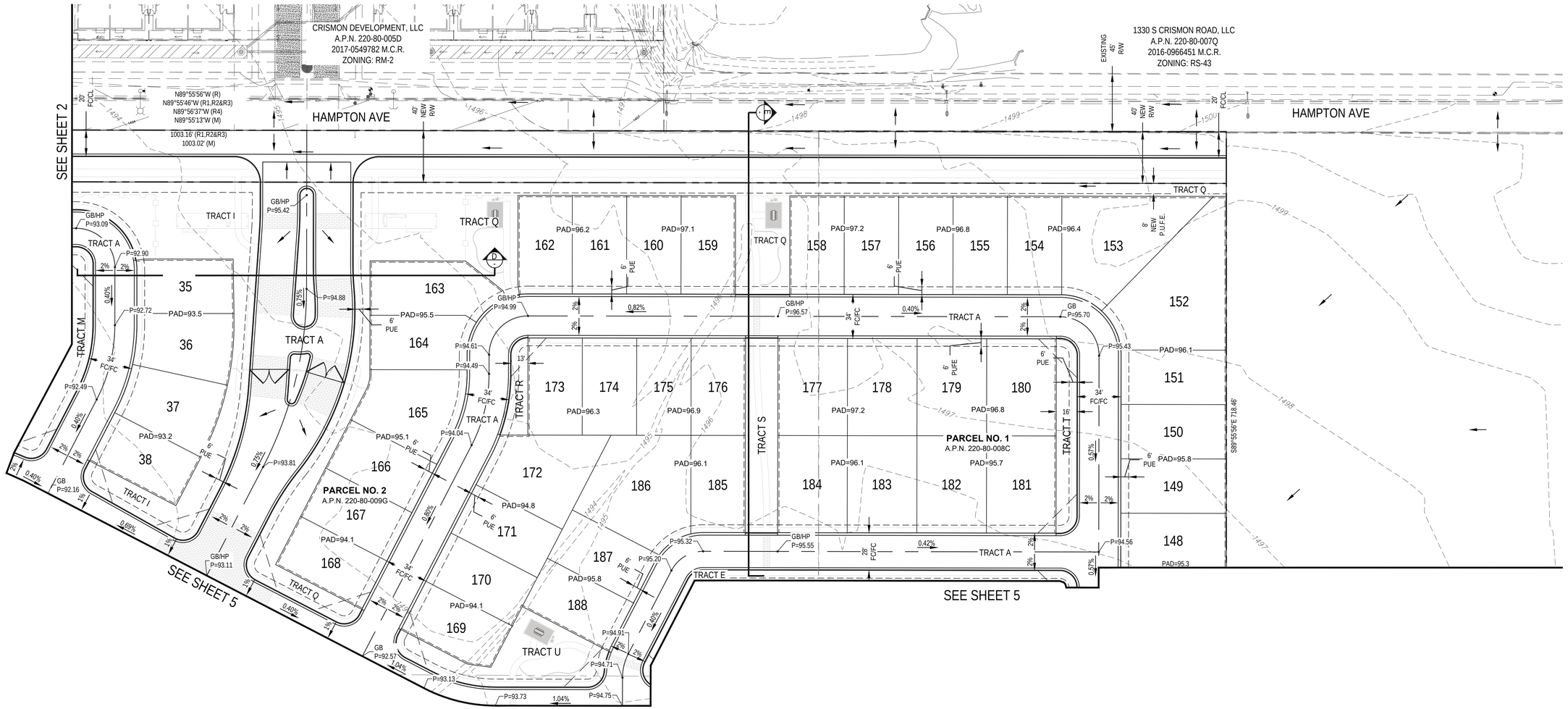

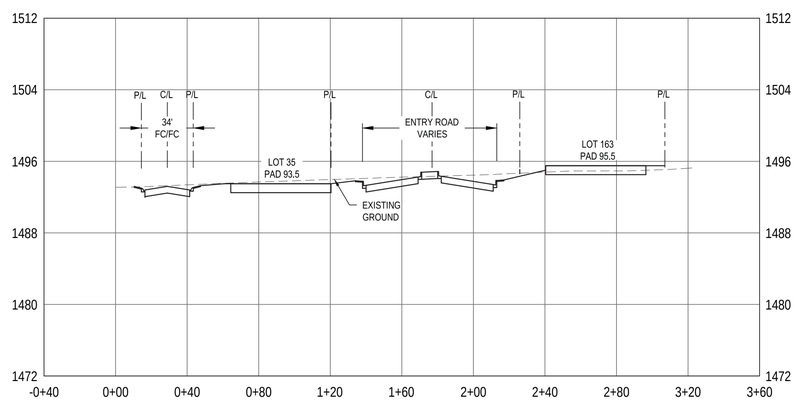

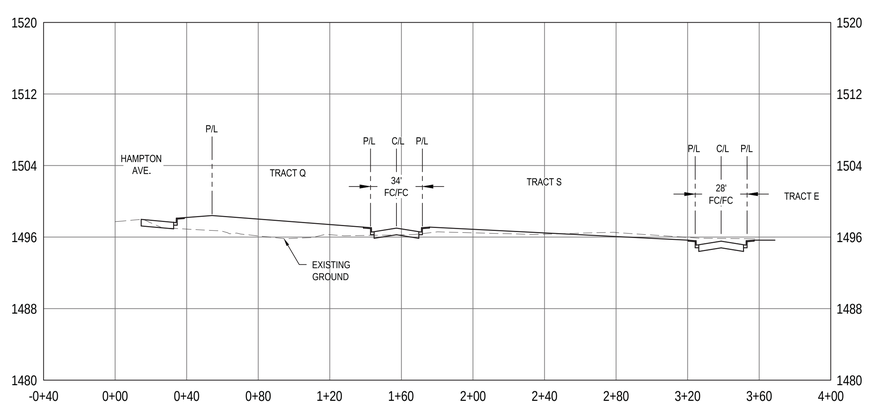

VERTEX CIVIL ENGINEERING

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BELLA ENCANTA
MESA, AZ

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DANIEL S. GONZALEZ
Date Signed 5/31/19
ARIZONA U.S.A.
EXPIRES 3/31/20

No	Revision	Date
	Description	

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Date:	05/10/2019
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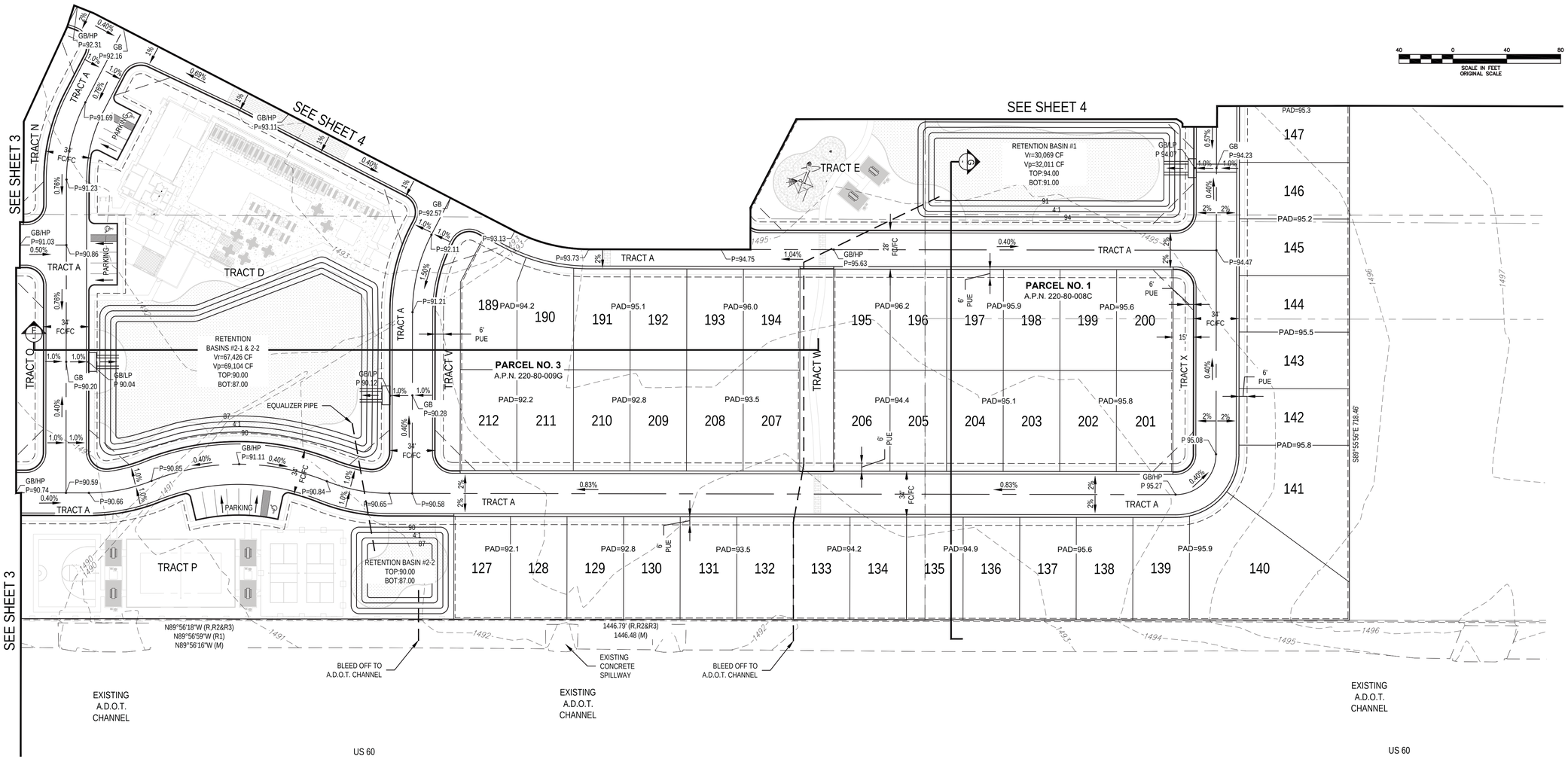

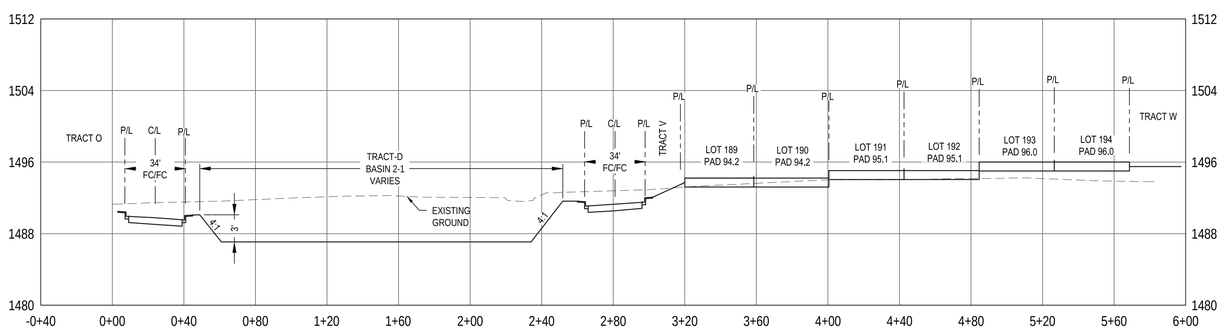

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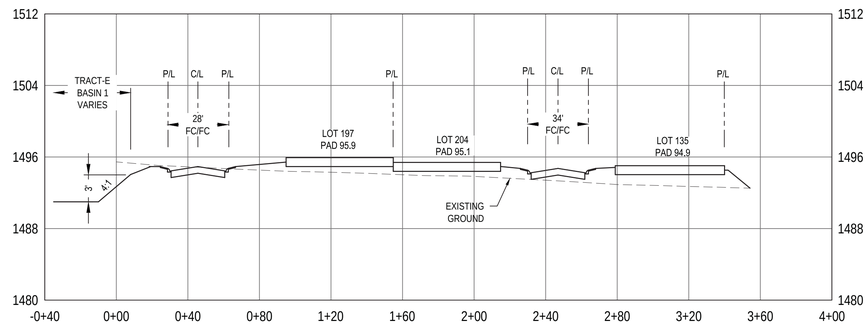

SECTION G - G

SCALE: 1"=40' HORIZ.
1"=8' VERT.

VERTEX CIVIL ENGINEERING

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2131 S. SABRINA
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(480) 577-4884

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MESA, AZ

PRELIMINARY
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DANIEL S. GONZALES
Date Signed 5/31/20
ARIZONA U.S.A.
EXPIRES 3/31/20

Revision	Description	Date
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Date: 05/10/2019
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BELLA ENCANTA
PRELIMINARY DRAINAGE REPORT

SE corner of Hampton Avenue & S 96th St, Mesa, AZ 85142

Prepared for:
Bela Flor Communities
1635 N Greenfield Road, Ste 115
Mesa, AZ 85205
Hudd Hassell
602-525-0000

Prepared by:
Vertex Civil Engineering
2131 S. Sabrina
Mesa, AZ 85209
Contact: Daniel Gonzalez P.E.
Email: daniel@vertexcivileng.com
TEL: 480-577-4984

Project #: 19.005

April 2019
Revised May 2019

Table of Contents

1 INTRODUCTION/PURPOSE

The purpose of this report is to investigate the existing drainage conditions at the proposed Bella Encanta Subdivision, and to present calculations regarding the project's drainage design. This report will verify that the submitted layout of the Bella Encanta Subdivision is feasible and meets the drainage requirements for the City of Mesa.

2 EXECUTIVE SUMMARY

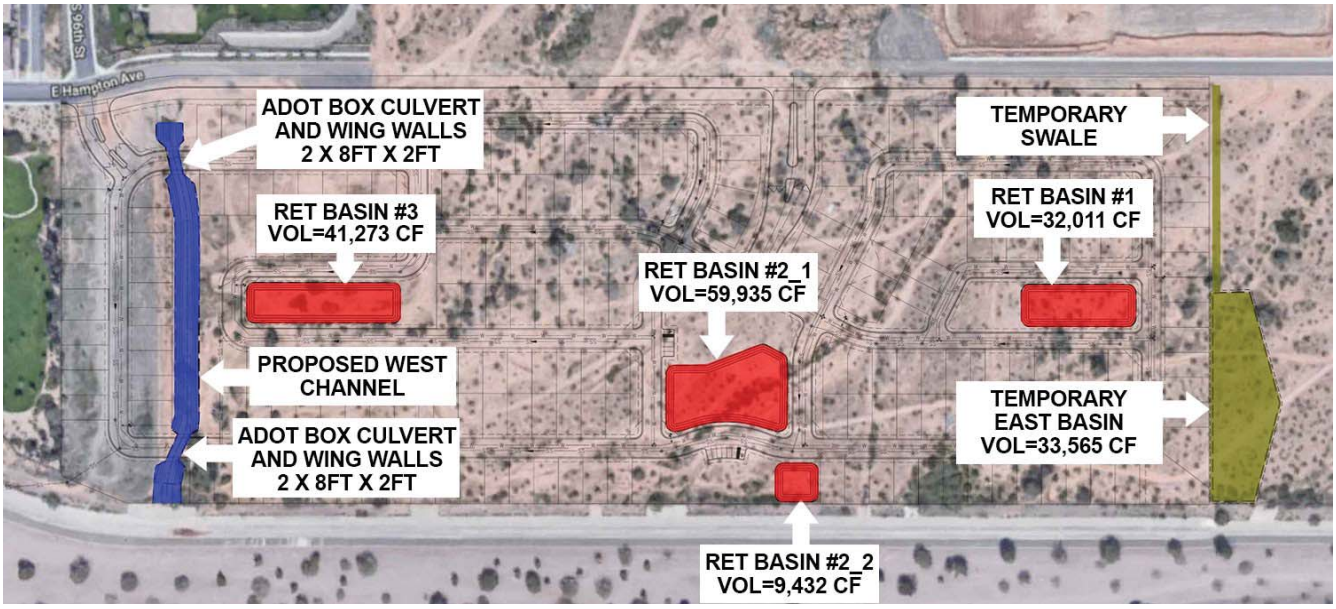


Figure 1: Proposed on-site and off-site drainage structures.

3 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The proposed subdivision is located within a portion of the northeast quarter of Section 34, Township 1 North, Range 7 East of the Gila and Salt River Meridian, Maricopa County, Arizona. The proposed Bella Encanta development consists of 212 single-residence attached homes covering approximately 32 gross acres. The parcel is currently undeveloped, vacant desert with minimal vegetation. The existing site slopes from the northeast corner to the southwest corner at approximately 1.0%.

4 FEMA FLOODPLAIN CLASSIFICATION

This site lies entirely within Zone X, according to FEMA Flood Insurance Rate Map - panel 04013C2315L, revised on October 16, 2013. Zone X denotes areas of 0.2% annual chance of flood; areas of 1% annual chance of flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; areas protected by levees from 1% annual flood chance.

5 OFF-SITE DRAINAGE DISCUSSION

The subject property, adjacent development and infrastructure are shown on Figure 2: Subject property and adjacent development

The existing Muirfield Village (3) is designed to contain runoff generated within its own property and does not convey any runoff onto this site (1). The Superstition Canyon Estates (4) contains its onsite as well, but also discharges flows into the West channel (12) within this site (1), which are ultimately delivered into the ADOT drainage channel (11) to the south. There's a provided berm at the Undeveloped land (5) to the north, which prevents offsite flows reaching this site (1). The Crismon Estates Apartments (6) site to the north is designed to contain its on-site runoff. The site is currently under development and construction will be complete by the time Bella Encanta starts construction. Therefore no runoff will be conveyed onto this site (1) by Crimson Estates Apartments (6). The Developed land (7) is also designed to contain its own flow and will not impact this site (1). The Undeveloped land (10) located to the east drains in a southwest direction, and therefore a portion of the land will affect this site (1), while the rest drains into the ADOT drainage channel (11) to the south. The existing Crismon Road (9) prevents any additional flows from impacting the subject site or the adjacent area.

Figure 2: Subject property and adjacent development

5.1 OFF-SITE FLOWS FROM THE EAST UNDEVELOPED LAND

The current development proposes a temporary swale and retention basin on the east property (10) to manage the 100-year, 2-hour storm during the pre-development phase. The surface retention basin is designed to be 1-foot deep with 4:1 side slopes and will drain by earth infiltration or evaporation. The outfall of this basin will overtop into the ADOT channel located south of the property during storm events above the 100-year event. An off-site temporary construction, drainage, and retention easement will be needed for this improvement.

5.1.1 RETENTION BASIN DESIGN

V,req=AxCxP/12

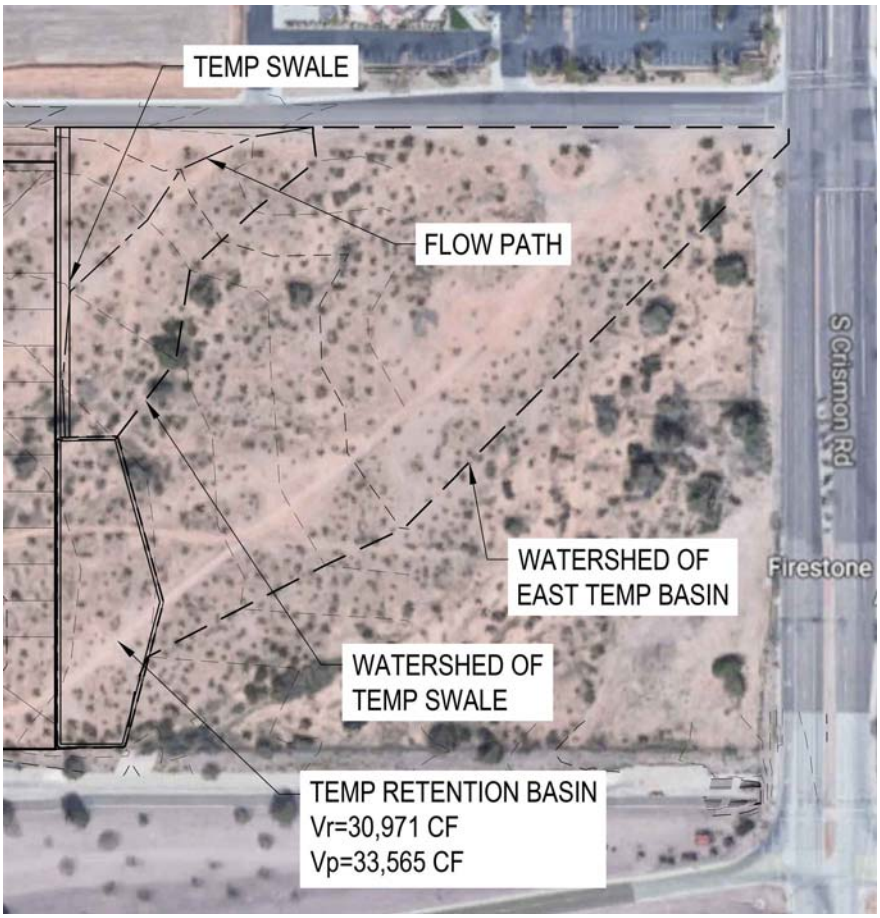
	A	C	V,req	P
	SQ FT	-	CU FT	inch
TEMP BAS	340547	0.5	30791.12	2.17

A: Runoff area;

C: Runoff coefficient (0.5 – Undeveloped desert);

V,req: Volume required;

P: 100-yr, 2-hr rainfall depth in inches per NOAA Atlas 14 (2.17)



5.1.2 TEMPORARY SWALE DESIGN

The 100-yr peak flow (Q=10.9 cfs) was calculated using Rational method (see APPENDIX A)
Normal depth calculations were performed using http://www.hawsedc.com/engcalcs/Manning-Trap.php, and it was determined that the temporary swale should have a minimum depth of 1 foot, side

slopes of 4:1 and slope of 0.5%.

Bella Encanta

Temporary swale, east

Set units: m | mm | ft | in

Bottom width	0	ft
Side slope 1 (horiz./vert.)	4	
Side slope 2 (horiz./vert.)	4	
Manning roughness, n ? (http://www.engineeringtoolbox.com/mannings-roughness-d_799.html)	0.03	
Channel slope	0.55	% rise/run
Flow depth	1.1	ft
Bend Angle? (/riprap-bend-angle.png) (for riprap sizing)		
Stone specific gravity (2.65)		

Results

Flow area	4.84	ft^2
Wetted perimeter	9.07	ft
Hydraulic radius	0.53	ft
Velocity, v	2.42	ft/sec
Flow, Q	11.70	cfs
Velocity head, h_v	0.09	ft
Top width, T	8.80	ft
Froude number, F	0.57	
Shear stress (tractive force), tau	0.18	psf
Implied design ? riprap size based on n	0.21	ft
Required bottom angular riprap size, D50, Maricopa County	-0.11	ft
Required side slope 1 angular riprap size, D50, Maricopa County	-0.11	ft
Required side slope 2 angular riprap size, D50, Maricopa County	-0.11	ft
Required angular riprap size, D50, per Maynord, Ruff, and Abt (1989)	NaN	ft
Required angular riprap size, D50, per Searcy (1967)	0.04	ft

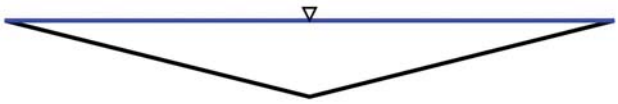


Figure 3: East temporary swale hydraulic design

5.2 OFF-SITE FLOWS FROM SUPERSTITION CANYON ESTATES

Flows are discharged into the subject site from Superstition Canyon Estates through a box culvert (2 barrels, 2ft x 10 ft).

5.2.1 FLOW DETERMINATION

According to a drainage report for Superstition Canyon Estates prepared by Rick Engineering Company in 2008 (see APPENDIX E), the 100-yr peak flow discharged into the box culvert under Hampton Road is Q=262 cfs. This flow was calculated using Rational Method combining areas of the developed areas north of Superstition Canyon Estates. Since there are no notable changes of the northern development, the 100-yr was revised using the same watershed/runoff characteristics but with current rainfall intensities per NOAA Atlas 2 Vol. 14. Additionally, onsite drainage area was also added as contributing to the overall 100-yr peak flow. The revised 100-yr peak flow was calculated to be Q= 200 cfs (see APPENDIX B)

5.2.2 CHANNEL DESIGN DISCUSSION

Due to site planning decisions, the existing channel at the west side of the subject property will be rerouted in order to accommodate the proposed site plan. The existing and proposed channels are shown on Figure 4: West channel - existing and proposed conditions below. The proposed drainage design also includes two concrete box culverts (2 barrels x 8 ft x 2 ft) located at the upstream and downstream ends of the proposed channel. All of the described drainage structures are designed for

Q_{100}=200cfs.

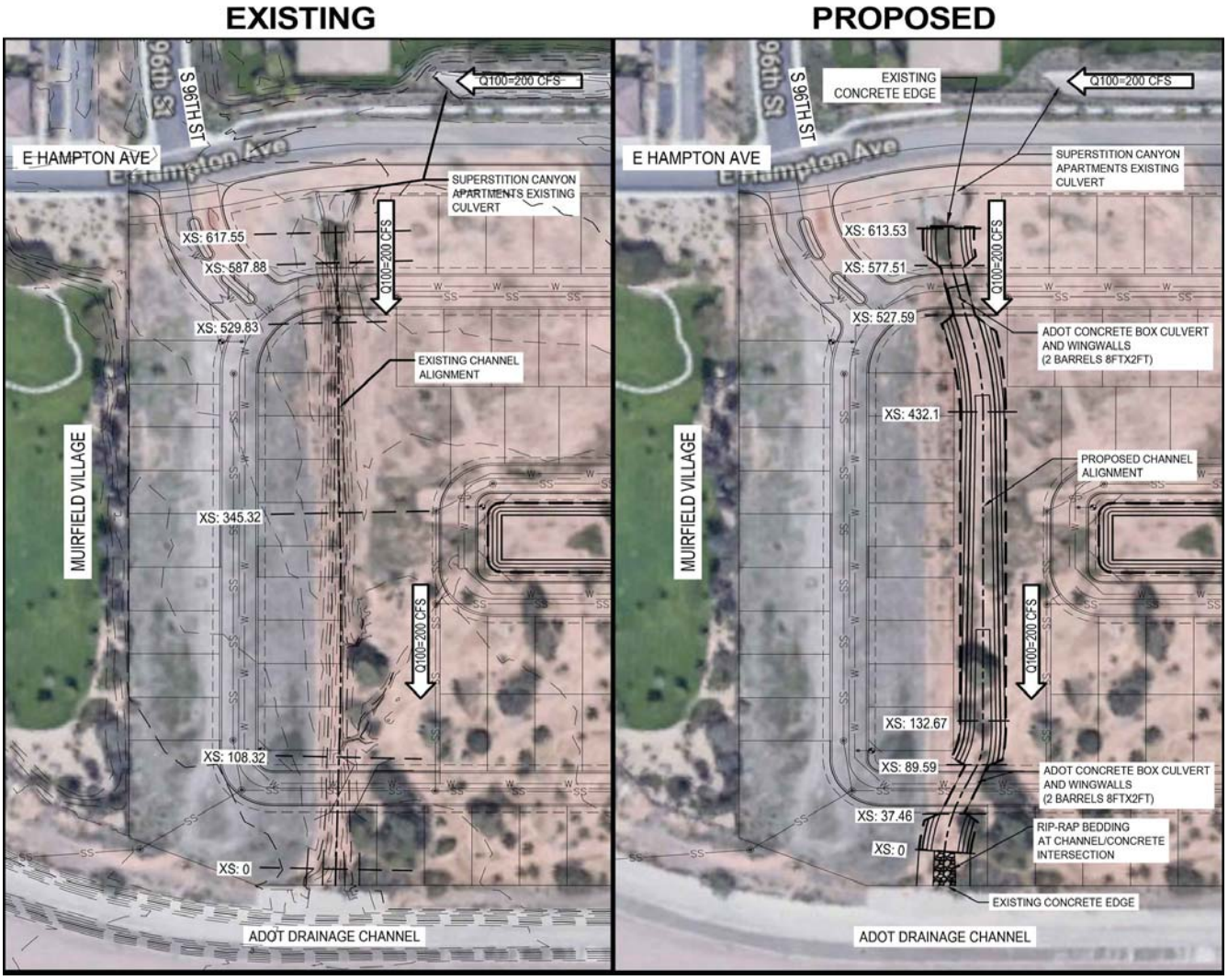


Figure 4: West channel - existing and proposed conditions

5.2.3 HYDRAULIC ANALYSIS USING HEC-RAS

Existing vs Proposed conditions were analyzed in HEC-RAS. The existing wash at the west side of the property was modeled using provided surveyed topography - 6 cross sections. Manning roughness of 0.035 was used for dirt material and subcritical flow regime was performed. The analysis was conducted to verify the channel capacity and to investigate the flow velocities.

HEC-RAS Plan: 1 River: WestChan_EG Reach: WestChan Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
WestChan	617.55	PF 1	200.00	1485.12	1488.60		1488.78	0.002628	3.46	57.76	45.21	0.42
WestChan	587.88	PF 1	200.00	1484.72	1488.46		1488.69	0.003457	3.83	52.16	27.04	0.48
WestChan	529.83	PF 1	200.00	1484.58	1488.05		1488.42	0.006106	4.85	41.27	22.25	0.63
WestChan	345.32	PF 1	200.00	1483.42	1487.11		1487.39	0.004817	4.26	46.92	29.74	0.56
WestChan	108.32	PF 1	200.00	1482.58	1485.71	1485.13	1486.08	0.006338	4.87	41.08	23.46	0.64
WestChan	0	PF 1	200.00	1481.77	1484.40	1484.40	1485.00	0.017381	6.20	32.25	27.03	1.00

See APPENDIX C for Existing channel HEC-RAS results (cross sections)

The proposed channel was modeled using 8 cross sections and two box culverts at the upstream and downstream sections. Manning's roughness of 0.05 was used, as the proposed channel will be built as an earth structure with vegetation and appreciable obstructions along the bed. The channel has side slopes of 4:1 and varying bottom width between 17 feet (at the culverts) and 12 feet (throughout the rest of its length).

HEC-RAS Plan: Bella_Prop_C River: FG Reach: Prop-Chan Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Prop-Chan	613.53	PF 1	200.00	1485.40	1488.24		1488.33	0.002819	2.49	80.20	39.66	0.31
Prop-Chan	577.51	PF 1	200.00	1485.14	1488.16	1486.58	1488.24	0.002127	2.24	89.21	41.92	0.27
Prop-Chan	575.51		Culvert									
Prop-Chan	527.59	PF 1	200.00	1484.77	1487.18		1487.32	0.004767	2.97	67.29	38.04	0.39
Prop-Chan	432.1	PF 1	200.00	1483.86	1486.77		1486.90	0.004038	2.91	68.79	35.29	0.37
Prop-Chan	132.67	PF 1	200.00	1482.64	1485.63		1485.75	0.003603	2.79	71.71	35.95	0.35
Prop-Chan	89.59	PF 1	200.00	1482.49	1485.55	1483.94	1485.62	0.002079	2.21	90.48	42.73	0.27
Prop-Chan	87.59		Culvert									
Prop-Chan	37.46	PF 1	200.00	1482.33	1484.56	1483.72	1484.73	0.006159	3.24	61.73	37.18	0.44
Prop-Chan	0	PF 1	200.00	1482.22	1483.65	1483.65	1484.22	0.035878	6.10	32.78	28.71	1.01

See APPENDIX D for Proposed channel HEC-RAS results (cross sections)

Existing gravel bedding/lining at the south end of the existing channel (earth channel/ADOT channel intersection) shall be preserved/restored during construction of the proposed channel.

6 ON-SITE DRAINAGE DISCUSSION

One portion of the onsite flows will be retained within the site using 4 retention basins, while other portion will be directed towards Muirfield Village Retention Basin (2) located west of the property (see Figure 2: Subject property and adjacent development). The watersheds of the respective basins are shown on Figure 5: On-site drainage areas and retention basins below.

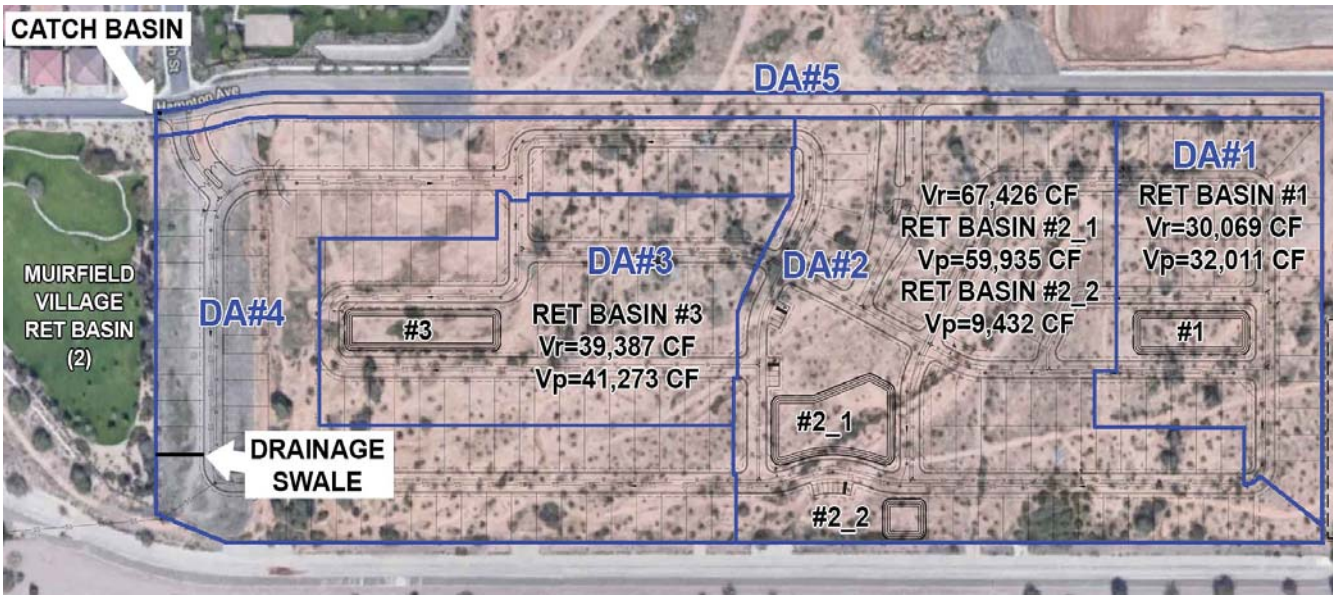


Figure 5: On-site drainage areas and retention basins

Using P=2.17 inches per NOAA Atlas 14, the following required volumes were calculated:

No	A,Pavement	A,Landscape	C,Pavement	C,Landscape	C,weight	V,req
-	SQ FT	SQ FT	-	-	-	CU FT
DA#1	159518	29478	0.95	0.5	0.88	30069.17
DA#2	317551	142374	0.95	0.5	0.81	67425.60
DA#3	211206	34324	0.95	0.5	0.89	39386.89
DA#4	389028.85	12816.15	0.95	0.5	0.94	67990.71
DA#5	62560	16037	0.95	0.5	0.86	12197.30
MUIRFIELD TOT						80188.01

Retention basin #1 will discharge in the ADOT Drainage Channel to the south with a bleed-off pipe.

Retention basins #2_1 and #2_2 will be connected with an equalizer pipe and will ultimately discharge in the ADOT Drainage Channel to the south with a bleed-off pipe.

Retention basin #3 will discharge in the proposed west channel through a bleed-off pipe.

The total volume (from DA#4 and DA#5) that will be conveyed towards the Muirfield Village Retention Basin (2) is ~80,188 CF. According to "Muirfield Village Final Drainage Report Revision 2" prepared by Brooks Engineers & Surveyors, Inc. in 2004, the excess volume of the existing retention basin is 223,751 CF (see APPENDIX F). Volume from DA#4 will be conveyed through a swale south of lot 8, and volumes from DA#5 will be discharged through a catch basin with a drain pipe on Hampton Avenue (NW corner of the site)

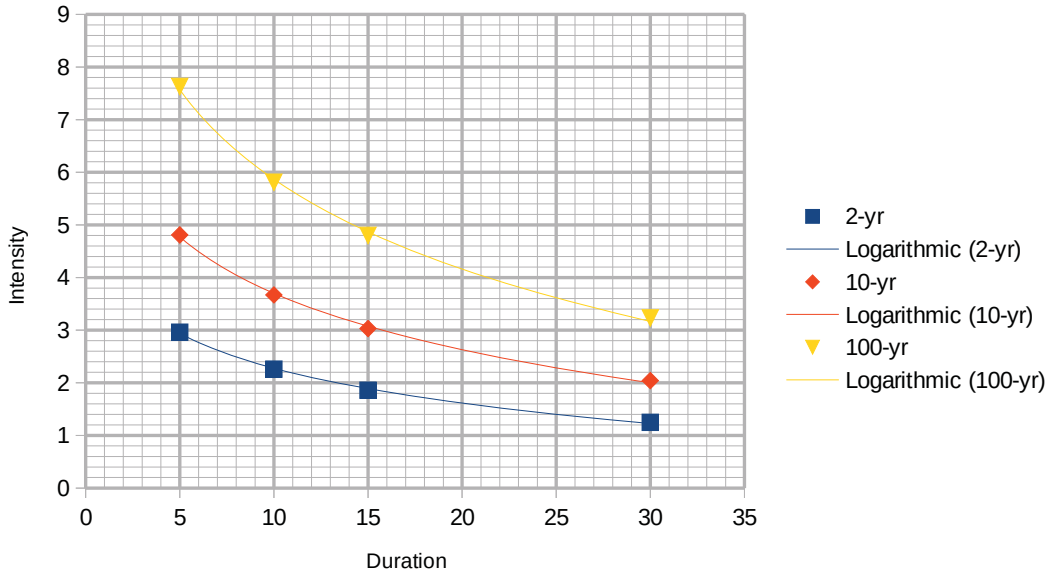
7 REFERENCES

1. Maricopa County Drainage Design Manual Volume 1, Hydrology;
2. Maricopa County Drainage Design Manual Volume 2, Hydraulics;
3. Superstition Canyon Estates Drainage Report;
4. Muirfield Village Final Drainage Report Revision 2

APPENDIX A

Bela Encantra - Rational Method East Channel

Area (should not exceed 160 acres)		3.51 acres		
Flow path length		527 feet		
		0.100 miles		
Upstream elevation		1502 feet		
Downstream elevation		1496 feet		
Flow path slope		60 feet/mile		
Land use category		VLDR		
		2-yr	10-yr	100-yr
10-yr runoff coefficient (from Table 2-1)		0.42	0.42	0.5
Watershed roughness type (from Table 2-2)		B		
Kb parameter m		-0.01375		
Kb parameter b		0.080		
Kb=m log(a) + b		0.07		
Time of concentration		0.19	0.16	0.13 hours
		11.5	9.4	7.8 minutes
Frequency-Intensity-Duration per NOAA Atlas 14 Point Precipitation Frequency Estimates				
Duration (minutes)		2-yr	10-yr	100-yr
	5	2.96	4.81	7.63
	10	2.26	3.67	5.81
	15	1.86	3.03	4.80
	30	1.25	2.04	3.23
Intensity		2.2	3.7	6.2 inches/hour
Peak flow (cfs)		**3.25**	**5.46**	**10.89**



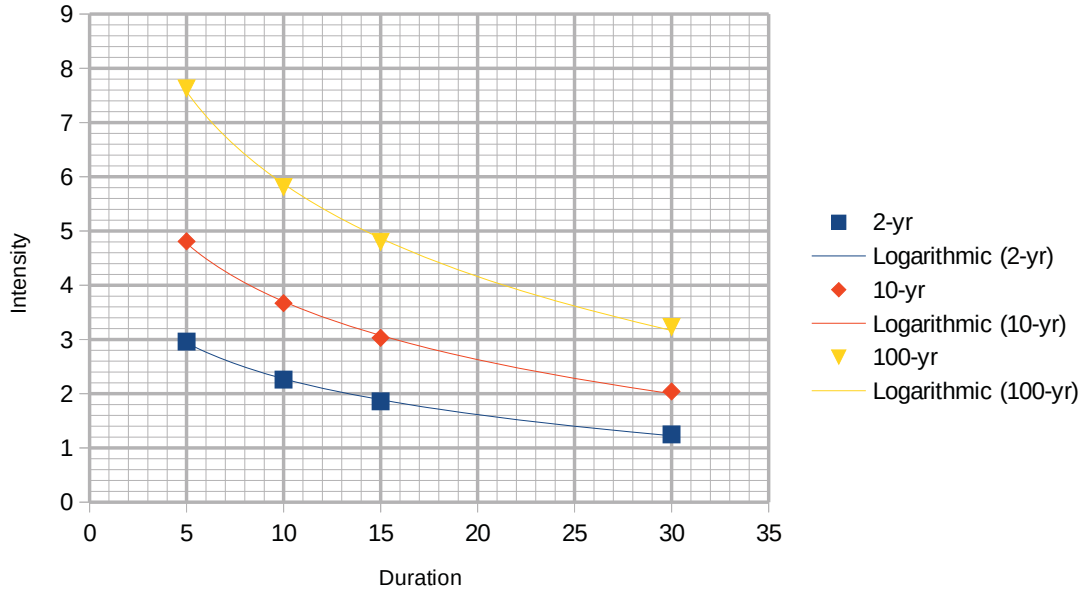
APPENDIX B
WEST CHANNEL RATIONAL METHOD

Bella Encanta - Rational Method West Channel

Area (should not exceed 160 acres)	80.2	acres		
Flow path length	8274	feet		
	1.567	miles		
Upstream elevation	1538	feet		
Downstream elevation	1482	feet		
Flow path slope	36	feet/mile		
Land use category	VLDR			
	2-yr		10-yr	100-yr
10-yr runoff coefficient (from Table 2-1)	0.42		0.42	0.69
Watershed roughness type (from Table 2-2)	B			
Kb parameter m	-0.00625			
Kb parameter b	0.040			
Kb=m log(a) + b	0.024			
Time of concentration	0.63		0.52	0.42 hours
	37.9		31.2	25.0 minutes

Frequency-Intensity-Duration per NOAA Atlas 14 Point Precipitation Frequency Estimates

Duration (minutes)	2-yr	10-yr	100-yr
5	2.96	4.81	7.63
10	2.26	3.67	5.81
15	1.86	3.03	4.80
30	1.25	2.04	3.23
Intensity	1.2	2	3.6 inches/hour
Peak flow (cfs)	**40.42**	**67.37**	**199.22**



APPENDIX C
HEC-RAS RESULTS: EXITING WEST CHANNEL

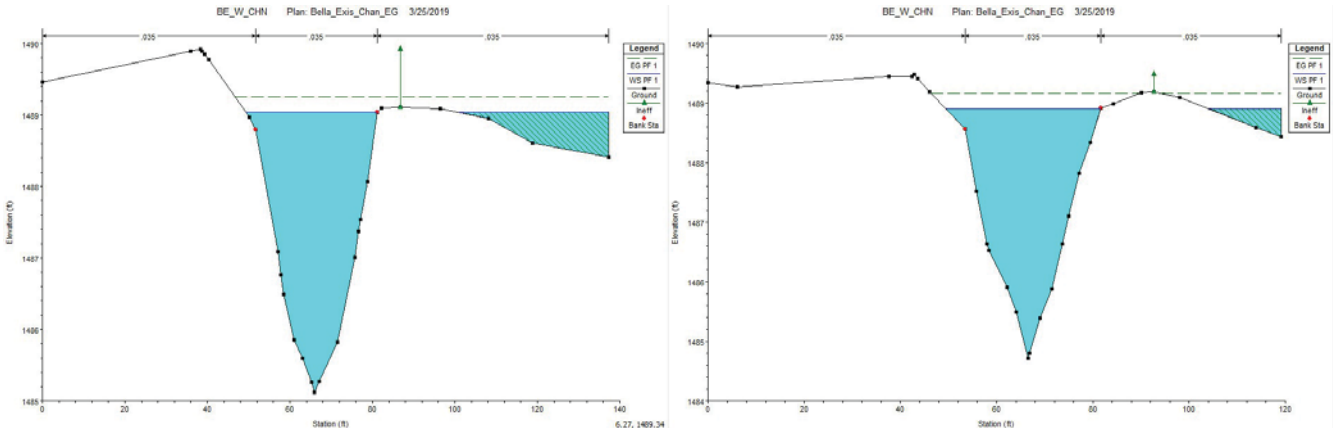


Figure 6: XS: 617.55, 587.88

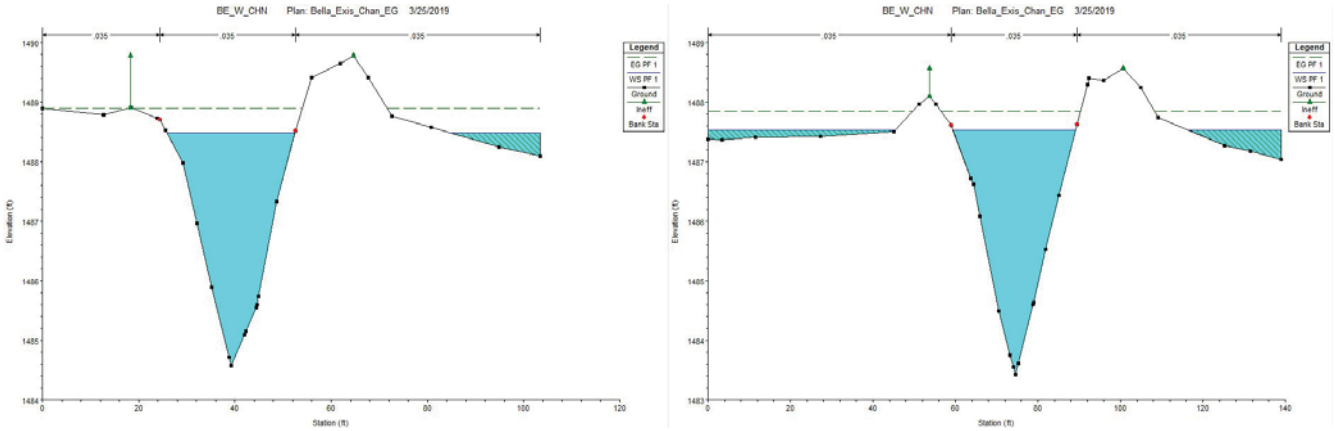


Figure 7: XS: 529.83, 345.32

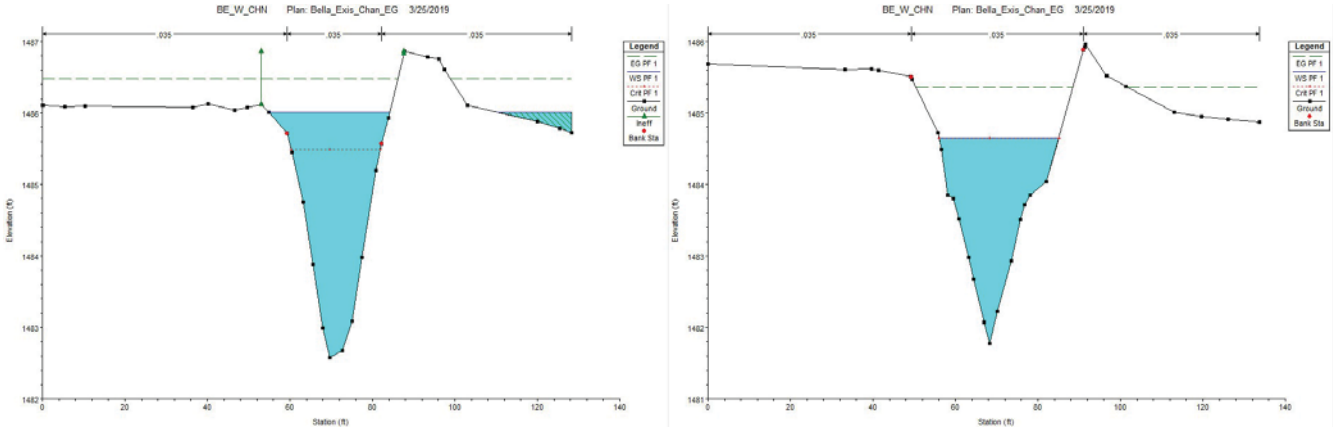


Figure 8: XS: 108.32, 0

APPENDIX D
HEC-RAS RESULTS: PROPOSED WEST CHANNEL

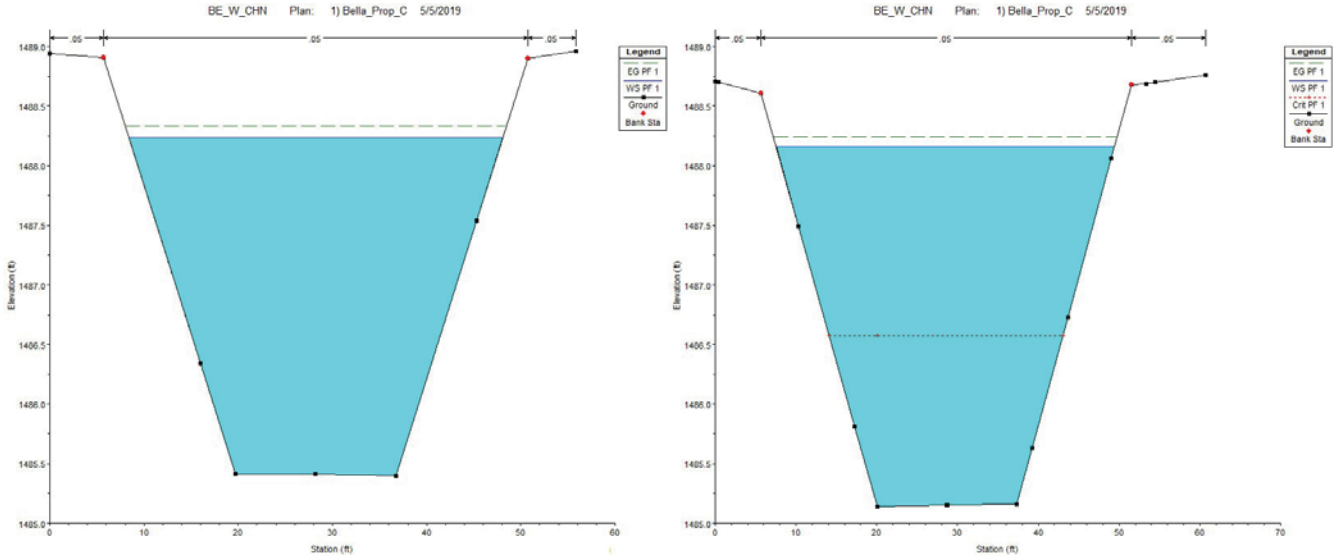


Figure 9: XS: 613.53, 577.51

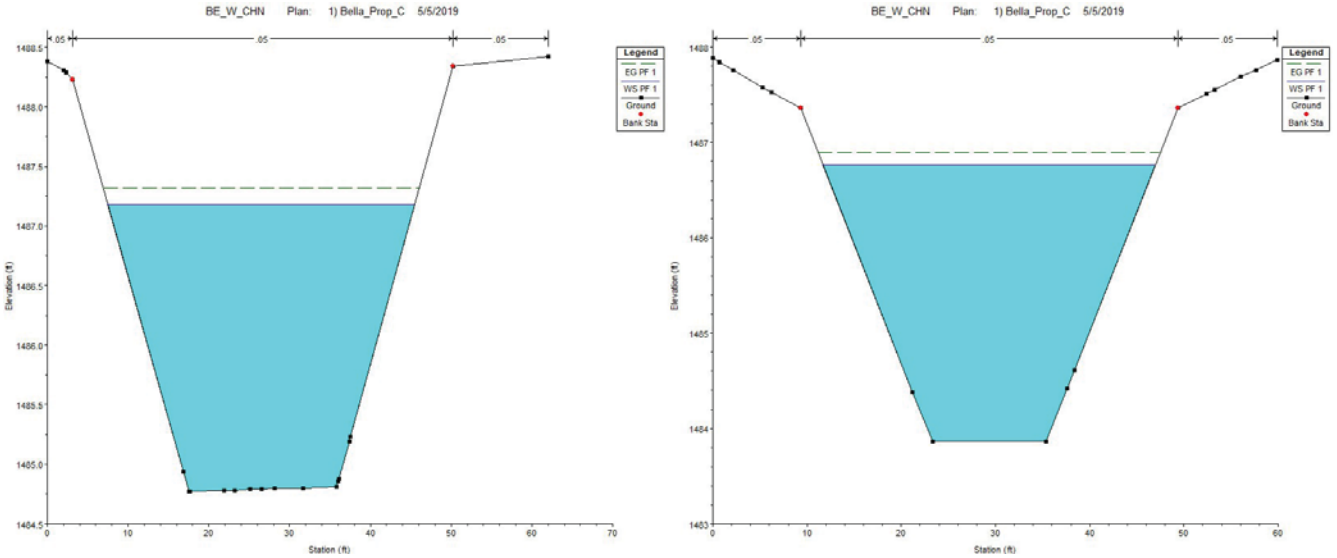


Figure 10: XS: 527.59, 432.1

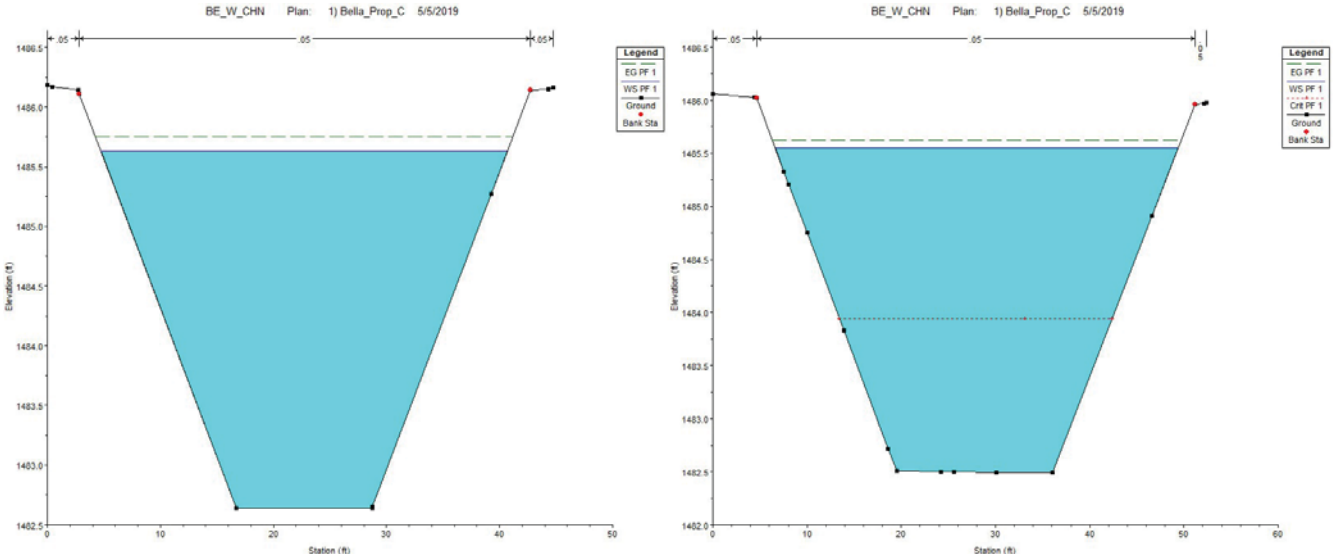


Figure 11: XS: 132.67, 89.59

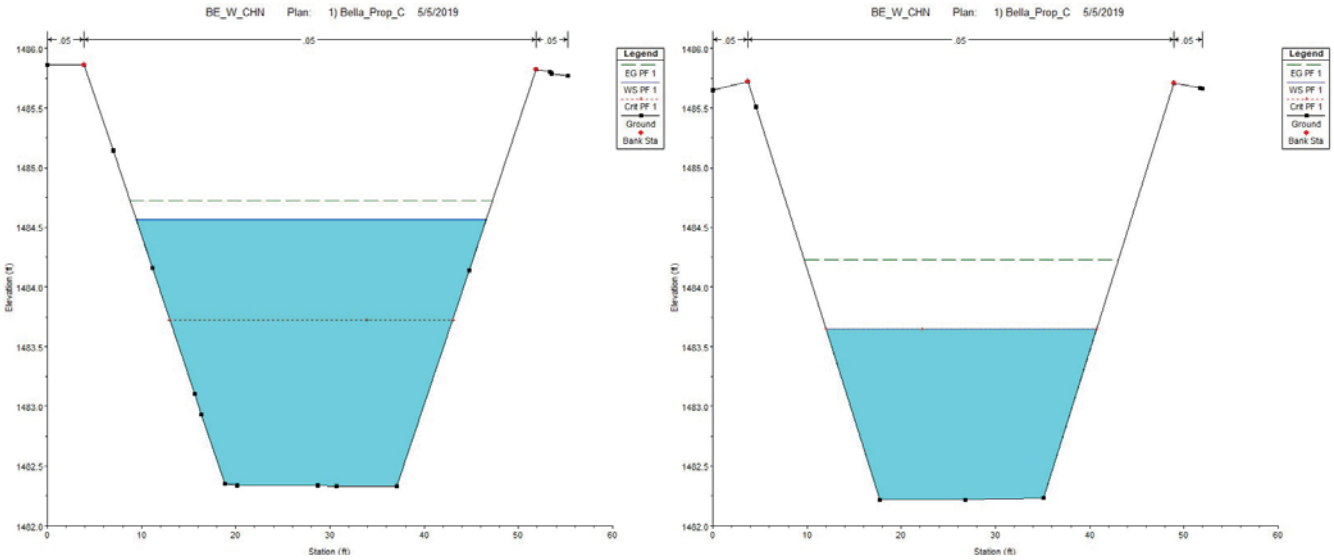


Figure 12: XS: 37.46, 0

OS - CP#1 - Rational Method Calculations

Conc. Point	1	
Drainage Length:	2,295	(ft)
Up Stream Elv:	1,520	
Down Stream Elv:	1,499	
Slope:	48.3	(ft/mile)
Kb value:	0.024	

10 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
0.33	3.10	0.21
0.25	3.80	0.20
0.17	4.50	0.18

Calculated Tc: 11.0

10 yr storm Rational Method Calc

Area:	26.4	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{10} :	4.5	(in/hr)
Discharge, Q_{10} :	82.0	(cfs)

100 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
0.33	5.00	0.18
0.25	5.80	0.17
0.17	6.90	0.16

Calculated Tc: 9.4

100 yr storm Rational Method Calc

Area:	26.4	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{100} :	6.9	(in/hr)
Discharge, Q_{100}:	126	(cfs)

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OS - CP#2 - Rational Method Calculations

Conc. Point	2	
Drainage Length:	5,986	(ft)
Up Stream Elv:	1,538	
Down Stream Elv:	1,498	
Slope:	35.3	(ft/mile)
Kb value:	0.024	

10 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
1.00	1.40	0.51
0.50	2.50	0.41
0.40	2.90	0.39

Calculated Tc: 23

10 yr storm Rational Method Calc

Area:	32*	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{10} :	2.9	(in/hr)
Discharge, Q_{10} :	64	(cfs)

100 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
1.00	2.60	0.40
0.50	4.00	0.34
0.33	5.00	0.31

Calculated Tc: 19

100 yr storm Rational Method Calc

Area:	32*	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{100} :	5.1	(in/hr)
Discharge, Q_{100}:	112.5	(cfs)

* HALF OF THE TOTAL AREA ACREAGE WAS USED, DUE TO SPLIT FLOW AT 96TH ST AND SOUTHERN AVE

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OS - CP#3 - Rational Method Calculations

Conc. Point	3	
Drainage Length:	6,280	(ft)
Up Stream Elv:	1,538	
Down Stream Elv:	1,496	
Slope:	35.1	(ft/mile)
Kb value:	0.024	

10 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
1.00	1.40	0.52
0.50	2.50	0.42
0.40	2.90	0.40

Calculated Tc: 24

10 yr storm Rational Method Calc

Area:	58.4*	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{10} :	2.9	(in/hr)
Discharge, Q_{10} :	117	(cfs)

100 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
1.00	2.60	0.41
0.50	4.00	0.35
0.33	5.00	0.32

Calculated Tc: 19

100 yr storm Rational Method Calc

Area:	58.4*	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{100} :	5.1	(in/hr)
Discharge, Q_{100}:	206	(cfs)

* COMBINE AREA OF OFFSITE SUB-AREAS 1 AND 2

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OS - CP#4 - Rational Method Calculations

Conc. Point	4	
Drainage Length:	6,681	(ft)
Up Stream Elv:	1,538	
Down Stream Elv:	1,494	
Slope:	34.8	(ft/mile)
Kb value:	0.024	

10 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
1.00	1.40	0.54
0.50	2.50	0.43
0.42	2.90	0.41

Calculated Tc: 25

10 yr storm Rational Method Calc

Area:	79.2 *	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{10} :	2.9	(in/hr)
Discharge, Q_{10} :	158	(cfs)

100 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
1.00	2.60	0.43
0.50	4.00	0.36
0.33	5.00	0.33

Calculated Tc: 20.0

100 yr storm Rational Method Calc

Area:	79.2 *	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{100} :	5.0	(in/hr)
Discharge, Q_{100}:	273	(cfs)

* COMBINE AREA OF OFFSITE SUB-AREAS 1, 2 AND 4

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OS - CP#5 - Rational Method Calculations

Conc. Point	5	
Drainage Length:	7,614	(ft)
Up Stream Elv:	1,538	
Down Stream Elv:	1,487	
Slope:	35.4	(ft/mile)
Kb value:	0.024	

10 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
1.00	1.40	0.57
0.50	2.50	0.46
0.42	2.90	0.43

Calculated Tc: 26

10 yr storm Rational Method Calc

Area:	79.2*	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{10} :	2.9	(in/hr)
Discharge, Q_{10} :	158	(cfs)

100 yr storm Tc Iteration table

Assume Tc (hr)	i (in/hr)	Calculated Tc (hr)
0.50	4.00	0.38
0.42	4.50	0.37
0.37	4.80	0.36

Calculated Tc: 22

100 yr storm Rational Method Calc

Area:	79.2*	(acres)
Runoff Coeff. C:	0.69	
Rainfall intensity, i_{100} :	4.8	(in/hr)
Discharge, Q_{100}:	262	(cfs)

* COMBINE AREA OF OFFSITE SUB-AREAS 1, 2 AND 4

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RICK ENGINEERING COMPANY
6150 North 16th Street
Phoenix, AZ 85016-1705
Tel: (602) 957-3350
Fax: (602) 285-2396

Date 6-6-08
Job No. 3179A
Page 1 OF 2
Done By SG
Checked By

RATIONAL METHOD CALCULATION EXAMPLE

1. XAMPLE: OS-CP#1

AREA = 26.4 AC
C = 0.69 (RUNOFF COEFF.)
DRAINAGE LENGTH = 2295 ft or 0.435 mile
UP STREAM ELV = 1520
DWN STREAM ELV = 1499
K_b VALUE = 0.024

2. CALCULATION TIME CONCENTRATION, T_c

$$T_c = 11.4 L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38}$$

T_c = TIME OF CONC (HR)
L = DRAINAGE LENGTH (M
K_b = RUNOFF FACTOR
S = SLOPE (ft/mile)

$$= \frac{1520 - 1499}{0.435}$$

$$= 48.3 \text{ ft/mile}$$

=> ASSUME T_c = 15 min (0.25 HR), i_{100} = 5.8 in/hr

$$T_c = 11.4(0.435)^{0.5}(0.024^{0.52})(48.3^{-0.31})(5.8^{-0.38})$$

= 0.167 HR ≠ 0.25 HR ASSUMED

NO Good.

=> ASSUME T_c = 10 min (0.17 HR), i_{100} = 6.90 in/hr

$$T_c = 11.4(0.435)^{0.5}(0.024^{0.52})(48.3^{-0.31})(6.9^{-0.38})$$

= 0.16 ≅ 0.17 ASSUMED

→ USE T_c = 10 min

RICK ENGINEERING COMPANY
6150 North 16th Street
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Date 6-6-08
Job No. 3179A
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RATIONAL METHOD CALCULATION EXAMPLE

1. XAMPLE: OS-CP#1

AREA = 26.4 AC
C = 0.69 (RUNOFF COEFF.)
DRAINAGE LENGTH = 2295 ft or 0.435 mile
UP STREAM ELV = 1520
DWN STREAM ELV = 1499
K_b VALUE = 0.024

2. CALCULATION TIME CONCENTRATION, T_c

$$T_c = 11.4 L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38}$$

T_c = TIME OF CONC (HR)
L = DRAINAGE LENGTH (M
K_b = RUNOFF FACTOR
S = SLOPE (ft/mile)

$$= \frac{1520 - 1499}{0.435}$$

$$= 48.3 \text{ ft/mile}$$

=> ASSUME T_c = 15 min (0.25 hr), i_{100} = 5.8 in/hr

$$T_c = 11.4(0.435)^{0.5}(0.024^{0.52})(48.3^{-0.31})(5.8^{-0.38})$$

= 0.167 hr ≠ 0.25 hr ASSUMED

NO Good.

=> ASSUME T_c = 10 min (0.17 hr), i_{100} = 6.90 in/hr

$$T_c = 11.4(0.435)^{0.5}(0.024^{0.52})(48.3^{-0.31})(6.9^{-0.38})$$

= 0.16 ≅ 0.17 ASSUMED

→ USE T_c = 10 min

RICK ENGINEERING COMPANY™
6150 North 16th Street
Phoenix, AZ 85016-1705
Tel: (602) 957-3350
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Date 6-6-08
Job No. 2117.01
Page 2 OF 2
Done By [illegible]
Checked By

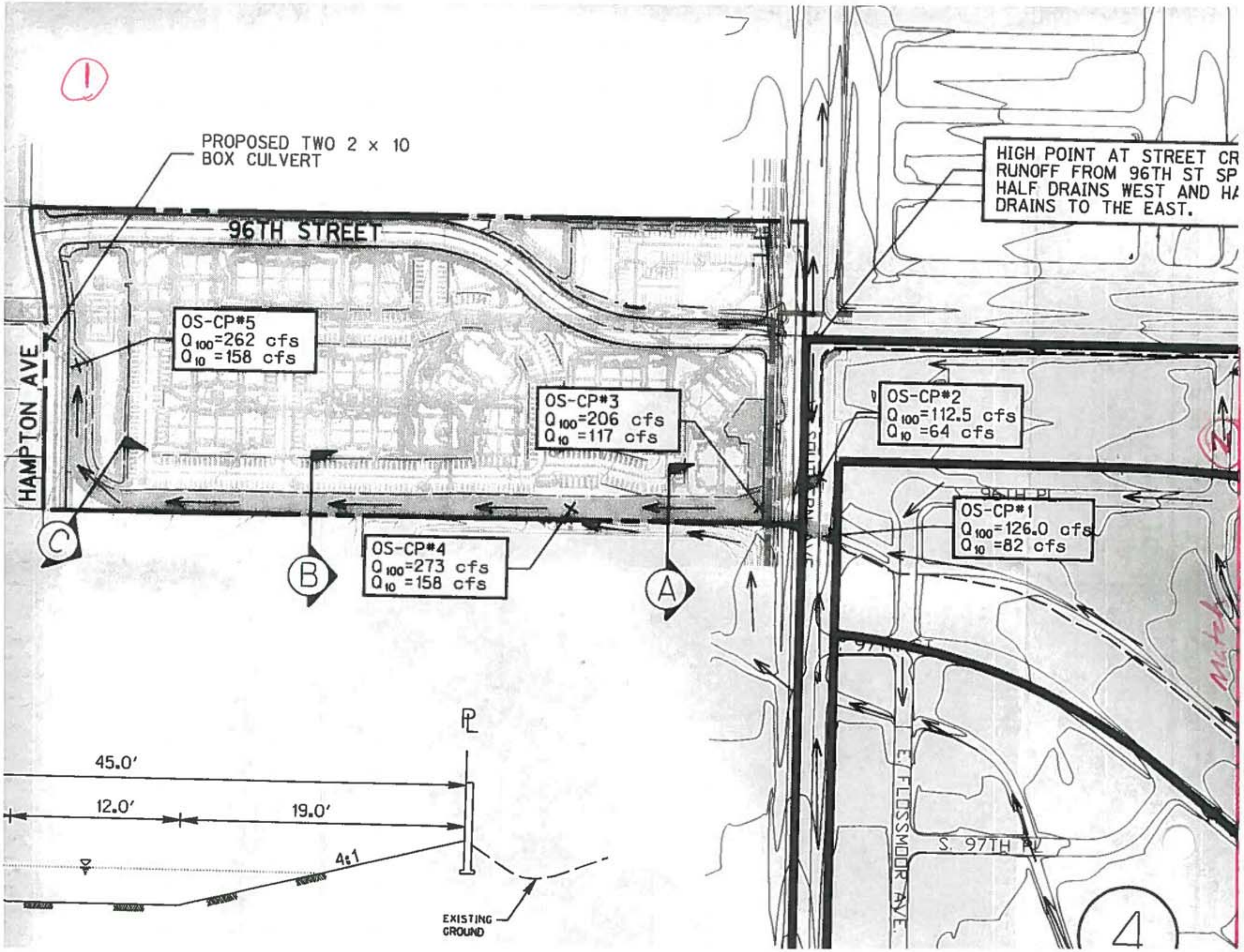
3. CALCULATE Q_{100}

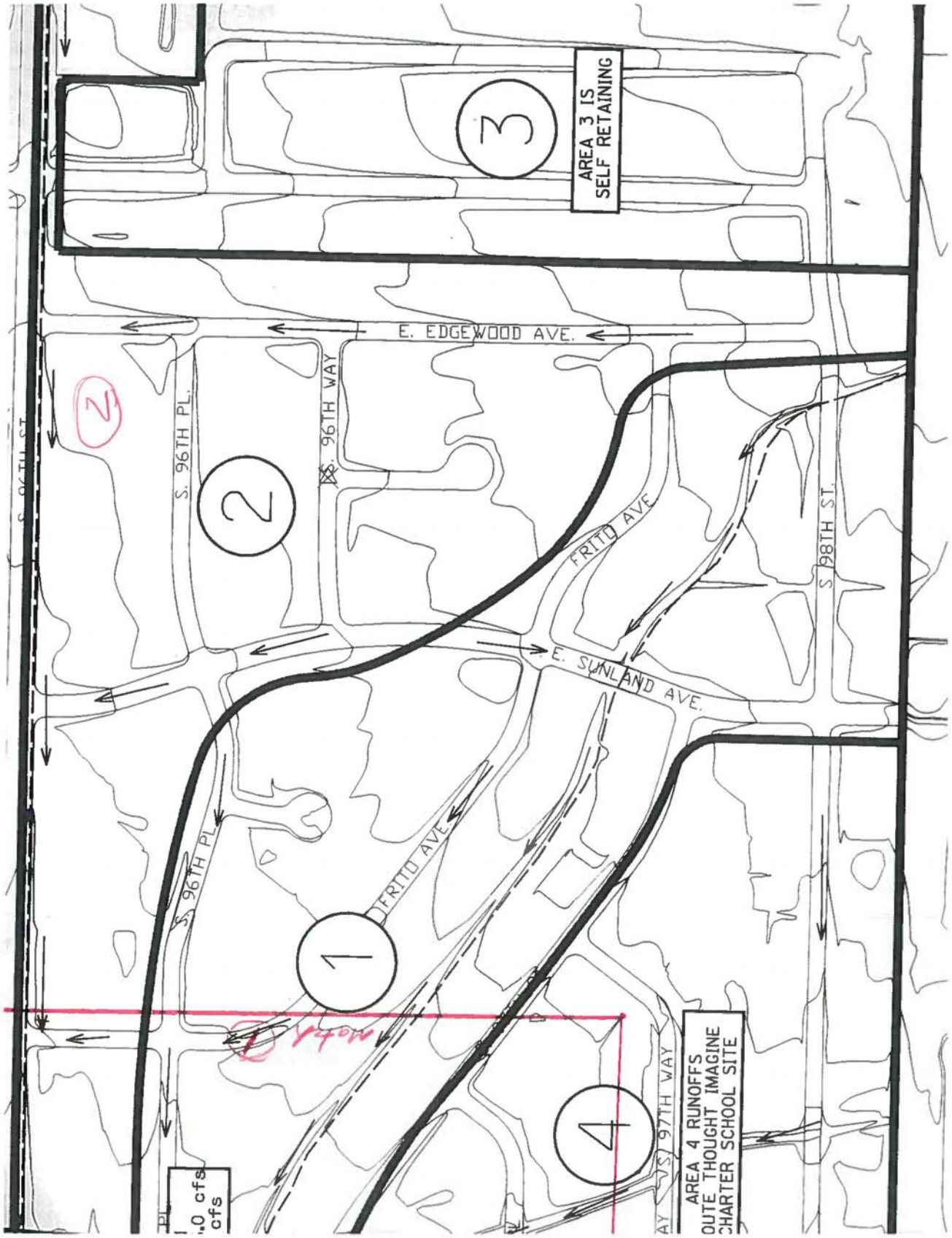
$Q_{100} = C\, i_{100}\, A$

$C = 0.69$ (Runoff Coeff.)
$A = 26.4$ AC
$i_{100} = 6.9$ IN/HR (RAINFALL INTENS. BY ADV $T_C = 10$ MIN.

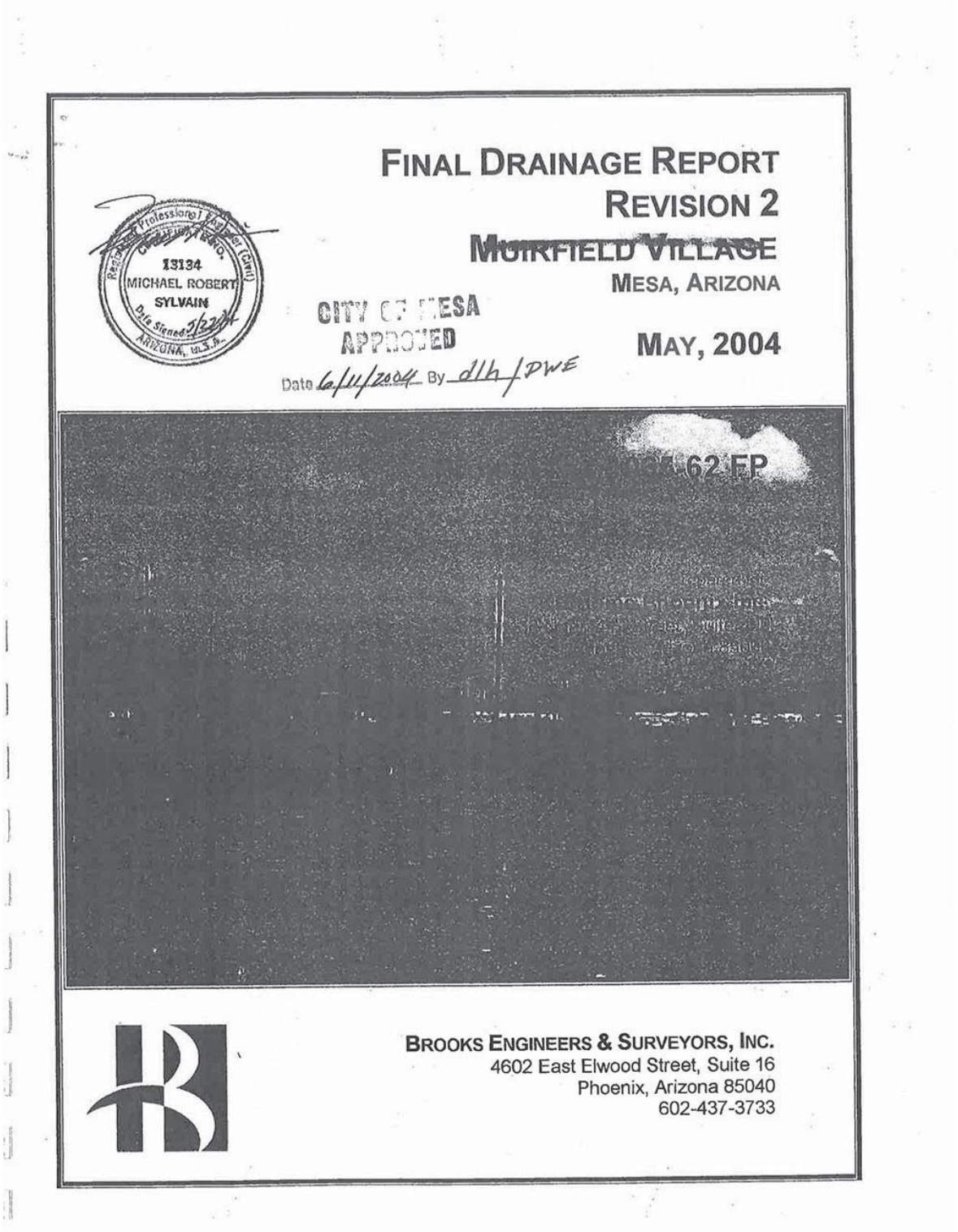
$= (0.69)(6.9)(26.4)$

$= 125.7$ cfs ←


PROPOSED TWO 2 x 10
BOX CULVERT
96TH STREET
HAMPTON AVE
OS-CP#5
Q100=262 cfs
Q10 =158 cfs
OS-CP#3
Q100=206 cfs
Q10 =117 cfs
OS-CP#4
Q100=273 cfs
Q10 =158 cfs
OS-CP#2
Q100=112.5 cfs
Q10 =64 cfs
OS-CP#1
Q100=126.0 cfs
Q10 =82 cfs
HIGH POINT AT STREET CR
RUNOFF FROM 96TH ST SP
HALF DRAINS WEST AND HA
DRAINS TO THE EAST.
A
B
C
E. FLOSSMOOR AVE.
S. 97TH PL
4
PL
45.0'
12.0'
19.0'
4:1
EXISTING GROUND


AREA 3 IS SELF RETAINING
E. EDGEWOOD AVE.
S. 96TH PL.
S. 96TH WAY
FRITO AVE
S. 98TH ST.
E. SUNLAND AVE.
S. 96TH PL.
FRITO AVE
S. 97TH WAY
AREA 4 RUNOFFS OUTE THOUGHT IMAGINE CHARTER SCHOOL SITE
1
2
3
4

APPENDIX F
MUIRFIELD VILLAGE DRAINAGE REPORT EXCERPTS



FINAL DRAINAGE REPORT
REVISION 2
MUIRFIELD VILLAGE
MESA, ARIZONA
MAY, 2004

13134
MICHAEL ROBERT
SYLVAIN
ARIZONA, U.S.A.

CITY OF MESA
APPROVED
Date 6/11/2004 By dlh/PWE

62 FP

BROOKS ENGINEERS & SURVEYORS, INC.
4602 East Elwood Street, Suite 16
Phoenix, Arizona 85040
602-437-3733

MUIRFIELD VILLAGE
Final Drainage Report Revision 2

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Appendix

Composite Runoff Factors

These calculations are based on areas for the entire subdivision

Type	Area (ft^2)	C Factor	C*A
Building	335500	0.95	318,725
Streets	668630	0.95	635,199
Sidewalk	93234	0.95	88,572
Basin	170897	0.30	51,269
Landscaped	194122	0.45	87,355
Total Area:	1462383	Total:	1,181,120

Entire Composite "C" Factor: 0.81

These calculations are based on areas for the interior-area drainage

Type	Area (ft^2)	C Factor	C*A
Building	335500	0.95	318,725
Streets	668630	0.95	635,199
Sidewalk	93234	0.95	88,572
Landscaped	220566	0.45	99,255
Total Area:	1317930	Total:	1,141,751

Interior Composite "C" Factor: 0.87

Drainage Area No	Area (Acres)	Area ft^2
1	2.11	92007
2	0.90	39393
3	1.27	55271
4	1.01	44022
5	3.27	142448
6	1.73	75379
7	0.92	40104
8	1.31	57171
9	0.79	34334
10	0.67	29249
11	0.67	29244
12	0.54	23364
13	2.29	99900
14	0.83	36046
15	2.41	104775
16	1.34	58429
17	1.59	69139
18	1.35	58972
19	1.59	69225
20	1.31	57043
21	1.00	43681
22	0.34	14809
23	0.40	17481
∑	**29.65**	1291486

Runoff Volumes

	ft
100YR-2HR Precipitation=2.6"=	0.22

Total C*A	Volume
1,181,120	255,909

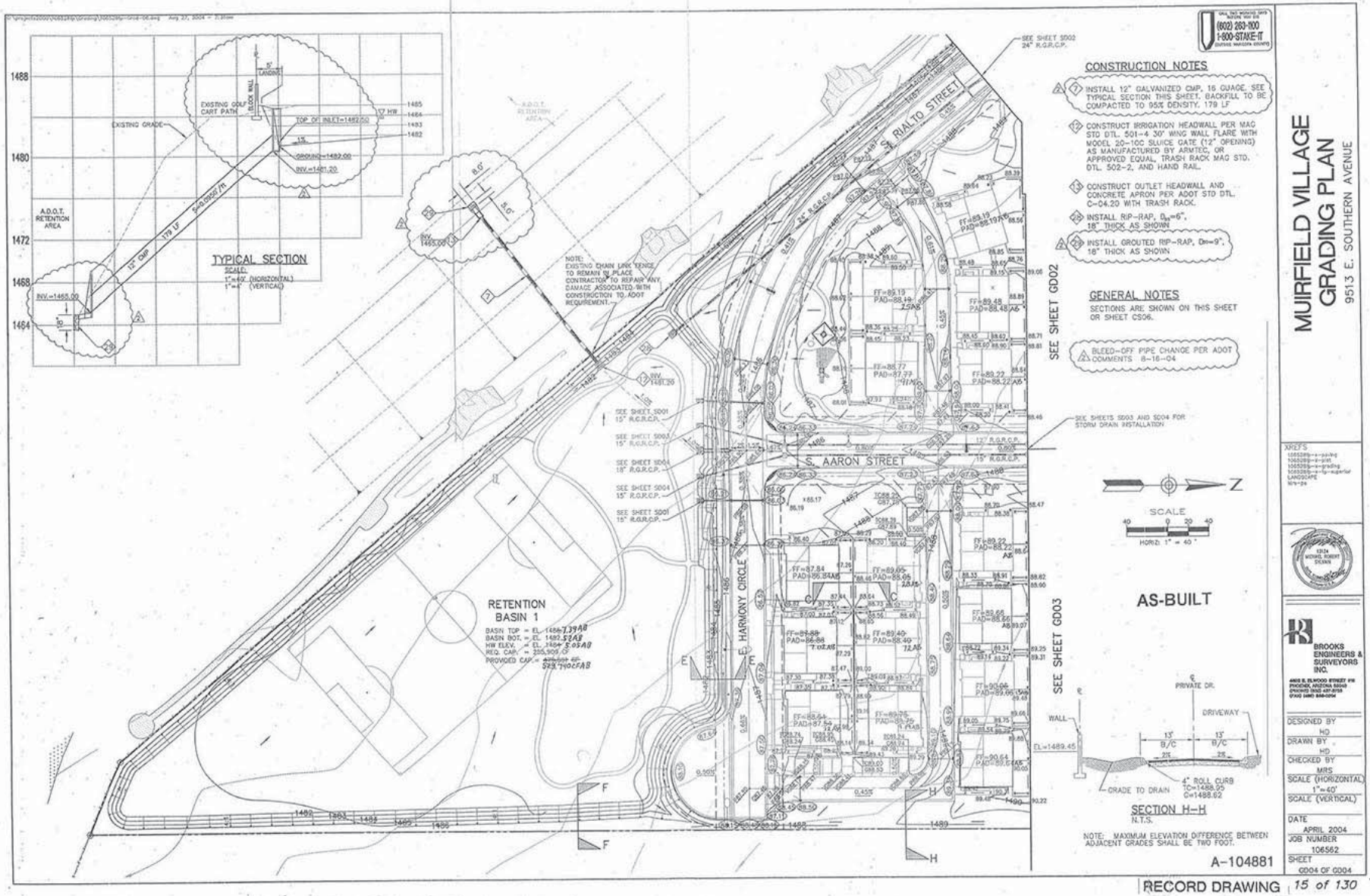
Retention Volume Calculations

Allowable depth of ponding= (ft) 3.0

	(ft^2) A1	(ft^2) A2	(ft^3) Volume
Basin 1	149124	170897	479,661

Volume Provided	Volume Required	Excess Volume
479,661	**255,909**	**223,751**

Retention Volume Calculations
Project NO. 1065-62FP
Final Drainage Report Revision 2



MUIRFIELD VILLAGE GRADING PLAN

9513 E. SOUTHERN AVENUE

XREFS

BROOKS ENGINEERS & SURVEYORS INC.

DESIGNED BY	HD
DRAWN BY	HD
CHECKED BY	MRS
SCALE (HORIZONTAL)	1"=40'
SCALE (VERTICAL)	
DATE	APRIL 2004
JOB NUMBER	106562
SHEET	GD04 OF GD04

RECORD DRAWING