PRELIMINARY HYDROLOGY & HYDRAULICS REPORT

FOR

PARCEL 2 OF PARCEL MAP NO. 15762

W.O. 01-537

CITY OF AGOURA HILLS

PREPARED BY:

HMK ENGINEERING, INC.
24007 VENTURA BLVD., SUITE 102
CALABASAS, CA 91302

MARK D. HARDY RCE 36538 EXP. 6/30/2004 ***DATE:*** 08/28/02

HYDROLOGY SUMMARY

The site is located on the south side of Agoura Road between Reyes Adobe Road and Lindero Canyon Road at the foot of Ladyface Mountain.

The proposed development consists of buildings, driveways and parking for a Retirement Home. There are three watercourses running through the site and they drain to Lindero Canyon Channel through a debris basin and a bulked flow storm drain at Agoura Road (Lindero Canyon Channel is on the north side of Agoura Road). The three watercourses running through the site will remain in their natural state and the on-site and off-site runoff will drain into these watercourses. The most westerly watercourse will have a retention basin before draining into the 78" storm drain that goes underneath Agoura Road. As Agoura Road will be widened the existing debris basin and bulked flow storm drain will have to be modified.

The runoff rate (Q) was taken from "L.A.C.F.C.D. Design Division Hydrologic Analysis Units" which was generated for the design of Lindero Canyon Channel. The design took into consideration the future development of this project.

All storm drain and flood control facilities will be built to L.A.C.F.C.D standards and maintained by the L.A.C.F.C.D.

HYDROLOGY

RAINFALL ZONE K
SOIL #: 028
DPA-7 (Debris Production Area)
DPV = 1.564
q=2.67 cfs/acre

OFF-SITE HYDROLOGY TABLE

AREA NO.	AREA(Ac.)	Q(cfs)	Qbulked(cfs)
1	61	163	255
2	23	61	95
3	21	56	88

ON-SITE HYDROLOGY TABLE

AREA NO.	AREA(Ac.)	Q(cfs)	Qpm = 0.438 cfs
1	0.52	1.4	0.749
2	0.12	0.3	0.017
3	0.12	0.3	0.017
4	0.94	2.5	0.135
5	0.44	1.2	0.173
6	0.49	1.3	0.187
7	0.12	0.3	0.017
8	0.29	0.8	0.042
9	1.20	3.2	0.195

A.1 METHOD FOR CALCULATING STANDARD URBAN STORMWATER MITIGATION PLAN FLOW RATES AND VOLUMES BASED ON 0.75-INCHES OF RAINFALL: WORKSHEET

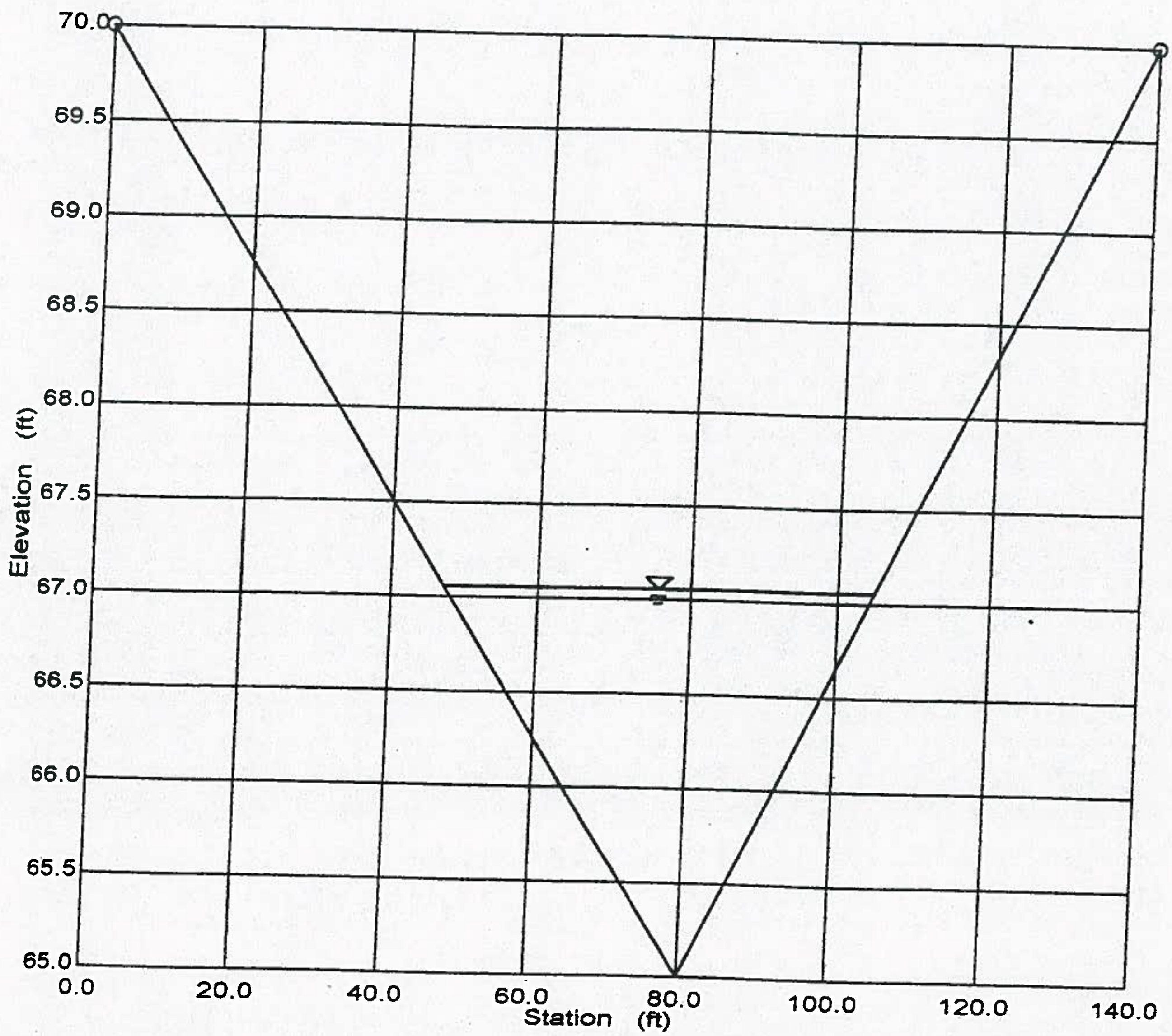
PROJECT NAME

PM 15762 PARCEL 2
W.O. 537

61 ACRES FLOW
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\470agour.fm2
Worksheet	AREA 1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.060	
Channel Slope	0.030000	ft/ft
Water Surface Elevation	67.05	ft
Discharge	255.00	cfs



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SOIL : 028
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5	0.44	1.2	0.173
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7	0.12	0.3	0.017
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A.1 METHOD FOR CALCULATING STANDARD URBAN STORMWATER MITIGATION PLAN FLOW RATES AND VOLUMES BASED ON 0.75-INCHES OF RAINFALL: WORKSHEET

PROJECT NAME

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Solve For	Water Elevation

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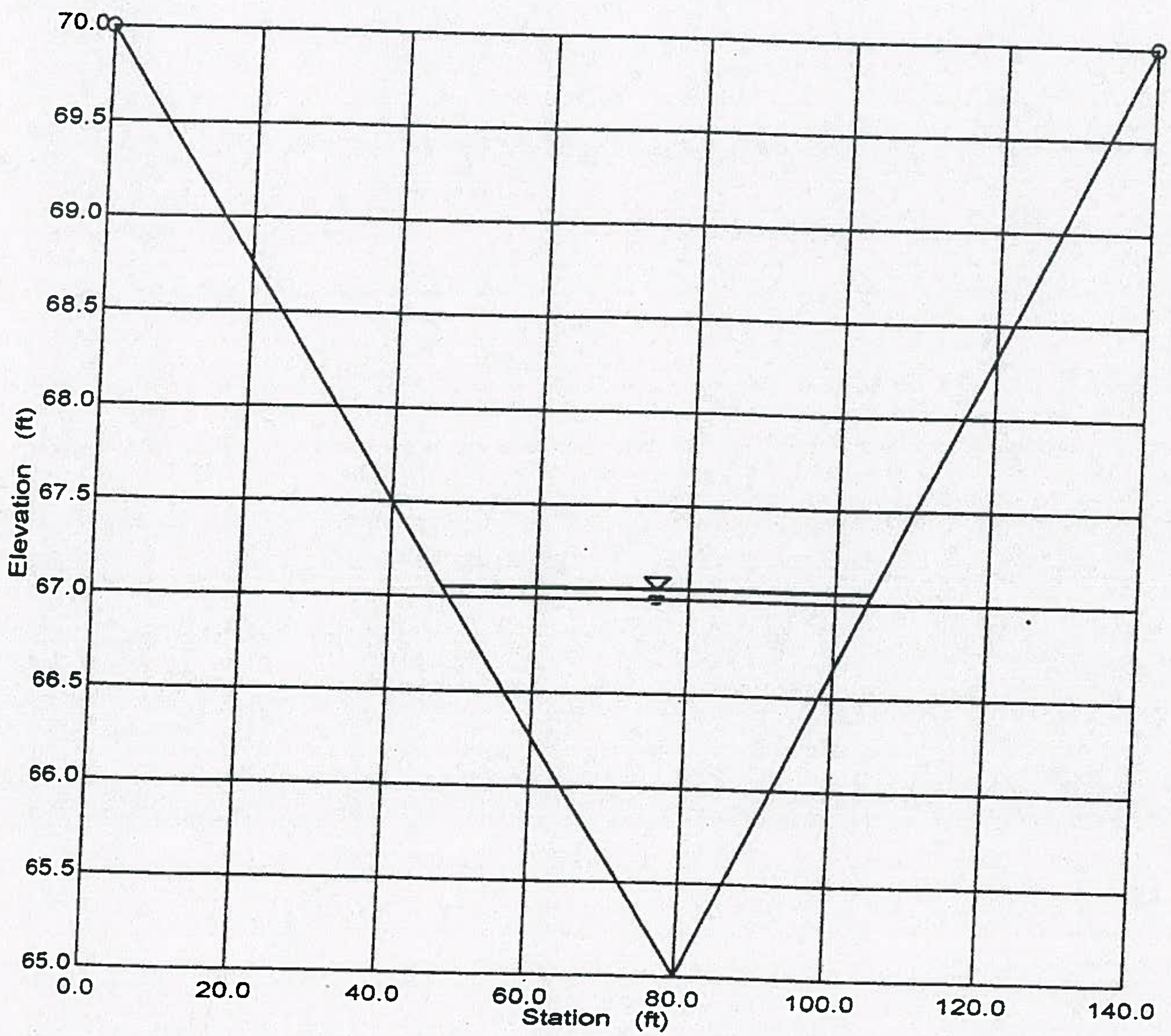
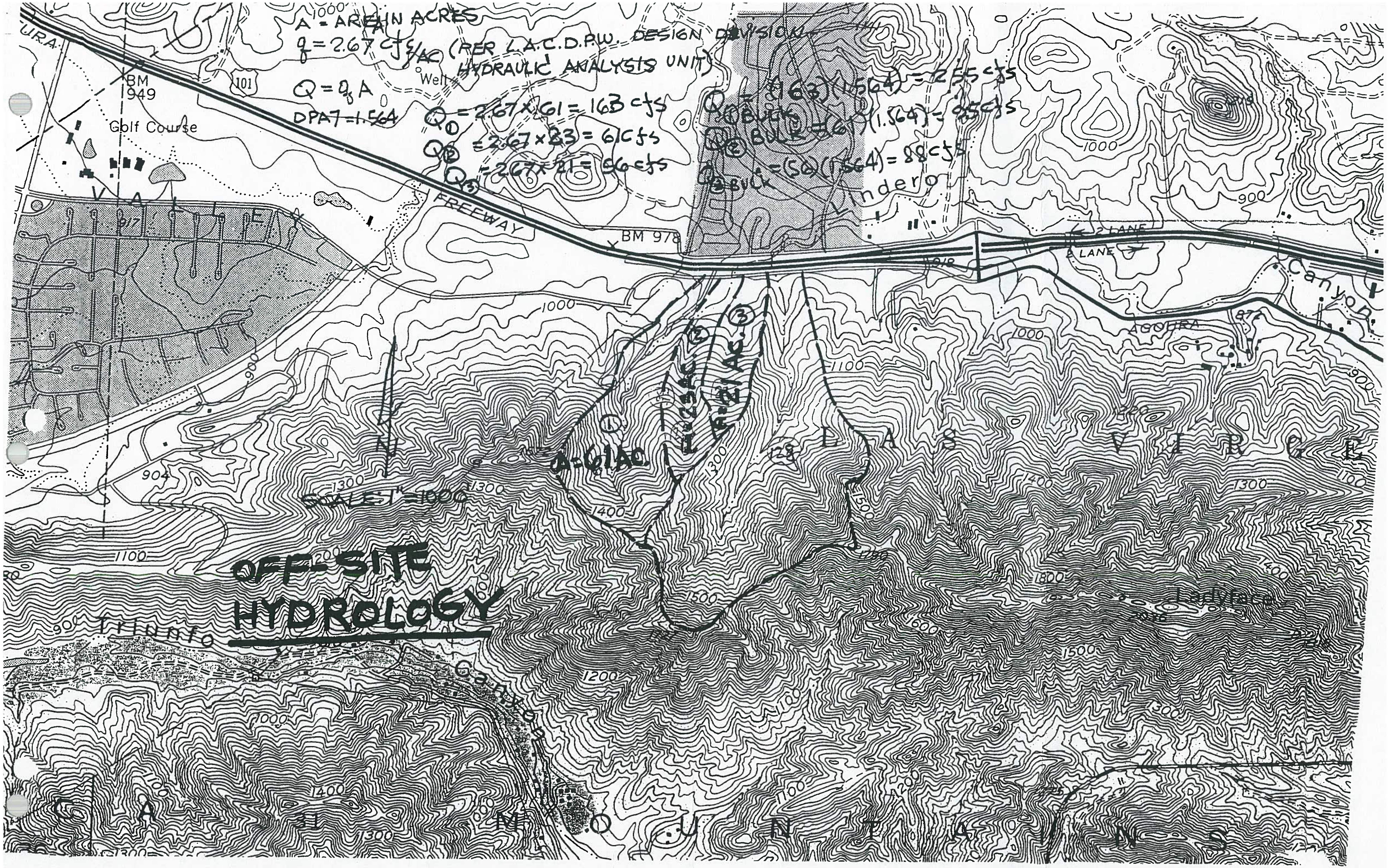
Water Surface Elevation	67.05	ft
Discharge	255.00	cfs





A = AREA IN ACRES
q = 2.67 cfs/AC (PER L.A.C.D.P.W. DESIGN DIVISION HYDRAULIC ANALYSIS UNIT)
Q = qA
DPA7 = 1.564
Q1 = 2.67 × 61 = 163 cfs
Q2 = 2.67 × 23 = 61 cfs
Q3 = 2.67 × 21 = 56 cfs
Q1 BULK = (163)(1.564) = 255 cfs
Q2 BULK = (61)(1.564) = 95 cfs
Q3 BULK = (56)(1.564) = 88 cfs
A = 61 AC.
A = 23 AC.
A = 21 AC.
SCALE 1" = 1000'
OFF-SITE HYDROLOGY
Golf Course
FREEWAY
Canyon
Triunfo
Ladyface

61 ACRES FLOW
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\470agour.fm2
Worksheet	AREA 1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.030000 ft/ft

Elevation range: 65.00 ft to 70.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	70.00	0.00	140.00	0.060
80.00	65.00			
140.00	70.00			

Discharge 255.00 cfs

Results

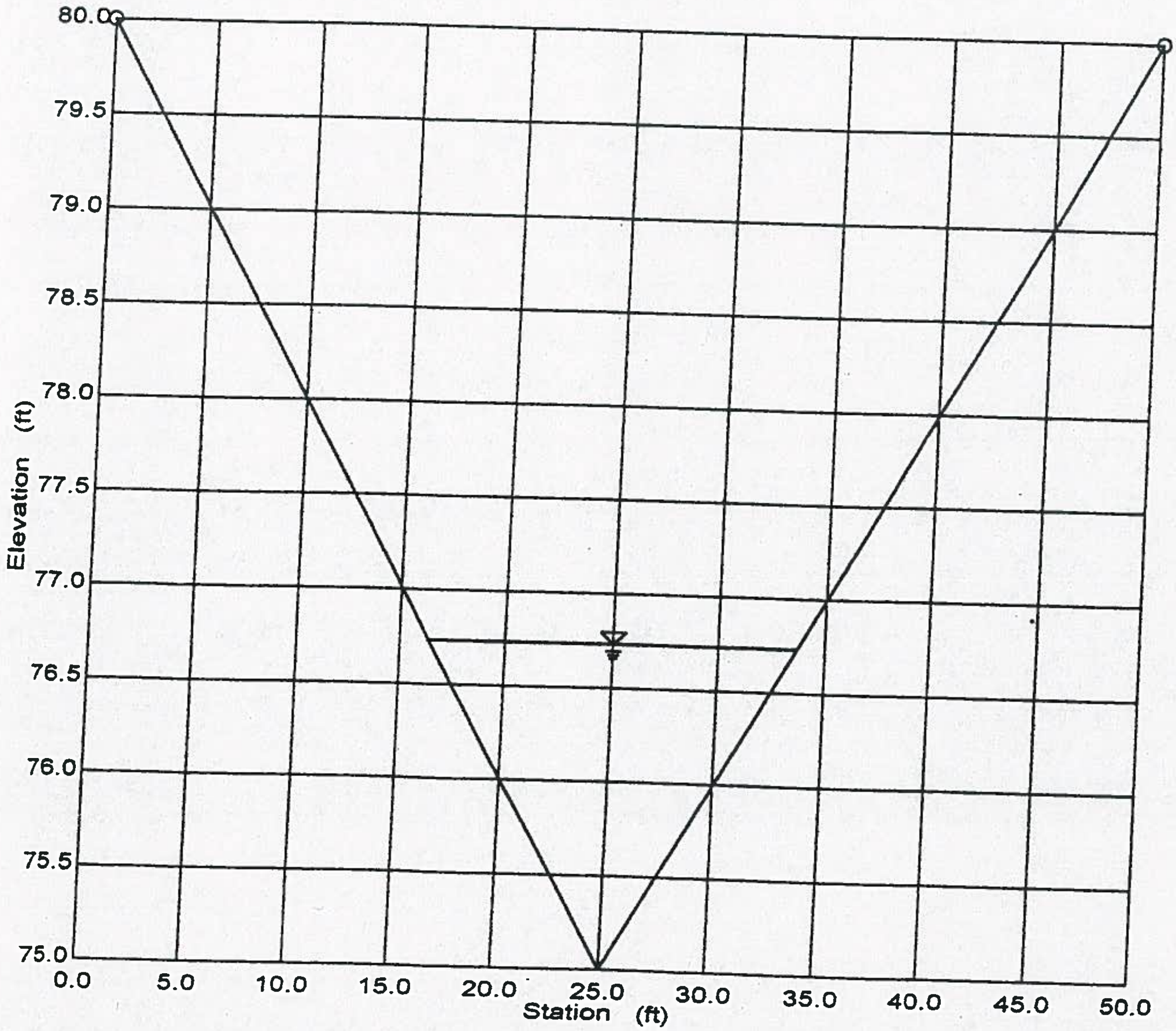
Wtd. Mannings Coefficient	0.060	
Water Surface Elevation	67.05	ft
Flow Area	58.64	ft²
Wetted Perimeter	57.46	ft
Top Width	57.31	ft
Height	2.05	ft
Critical Depth	66.83	ft
Critical Slope	0.054205	ft/ft
Velocity	4.35	ft/s
Velocity Head	0.29	ft
Specific Energy	67.34	ft
Froude Number	0.76	

Flow is subcritical.

21 ACRES FLOW
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\470agour.fm2
Worksheet	AREA 3
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.060	
Channel Slope	0.070000	ft/ft
Water Surface Elevation	76.73	ft
Discharge	88.00	cfs



21 ACRES FLOW
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\470agour.fm2
Worksheet	AREA 3
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.070000 ft/ft

Elevation range: 75.00 ft to 80.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	80.00	0.00	50.00	0.060
25.00	75.00			
50.00	80.00			

Discharge 88.00 cfs

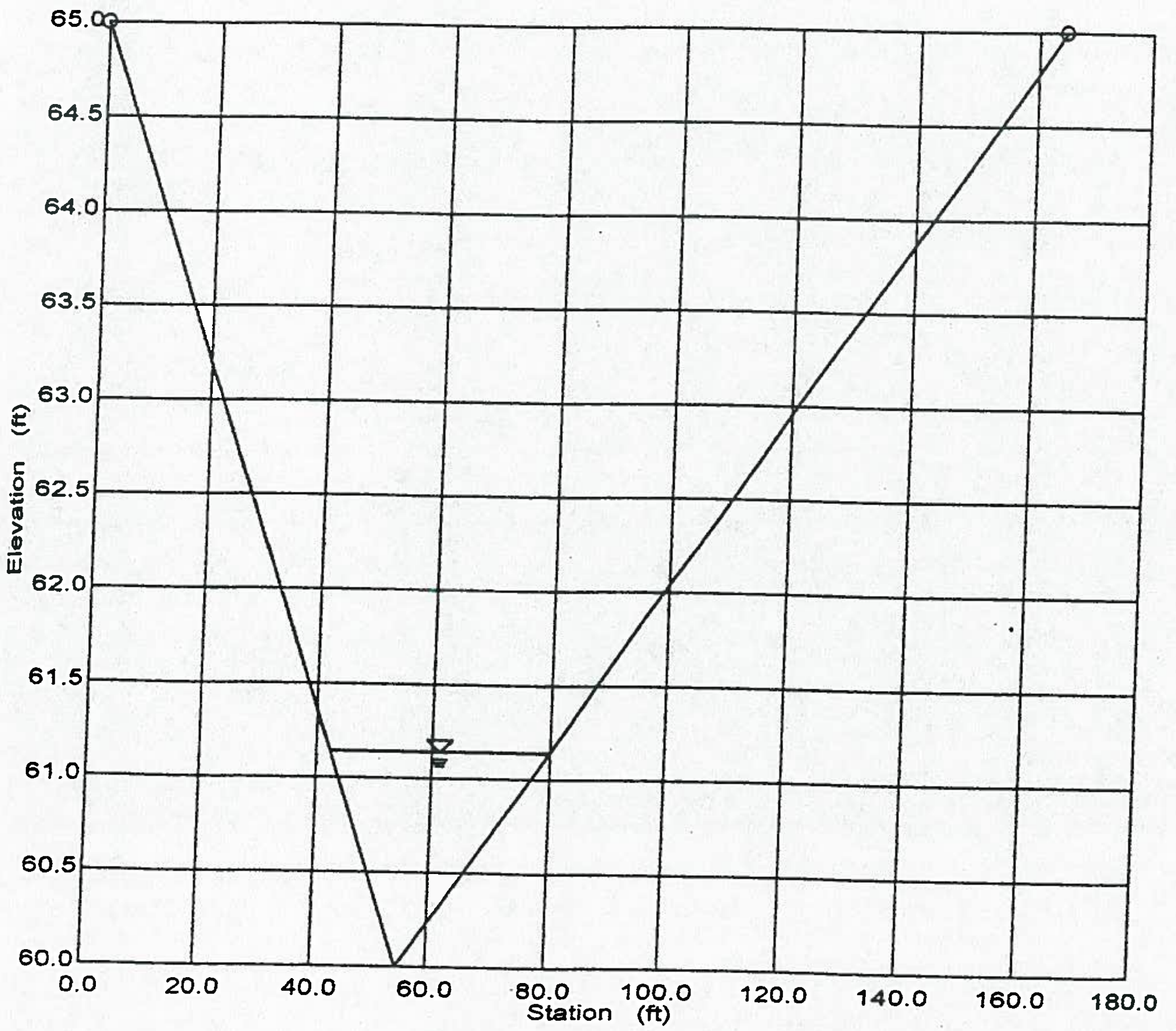
Results		
Wtd. Mannings Coefficient	0.060	
Water Surface Elevation	76.73	ft
Flow Area	14.98	ft²
Wetted Perimeter	17.65	ft
Top Width	17.31	ft
Height	1.73	ft
Critical Depth	76.81	ft
Critical Slope	0.055703	ft/ft
Velocity	5.87	ft/s
Velocity Head	0.54	ft
Specific Energy	77.27	ft
Froude Number	1.11	

Flow is supercritical.

23 ACRES FLOW
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\470agour.fm2
Worksheet	AREA 2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.060	
Channel Slope	0.070000	ft/ft
Water Surface Elevation	61.13	ft
Discharge	95.00	cfs



23 ACRES FLOW
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\470agour.fm2
Worksheet	AREA 2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.070000 ft/ft

Elevation range: 60.00 ft to 65.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	65.00	0.00	165.00	0.060
55.00	60.00			
165.00	65.00			

Discharge 95.00 cfs

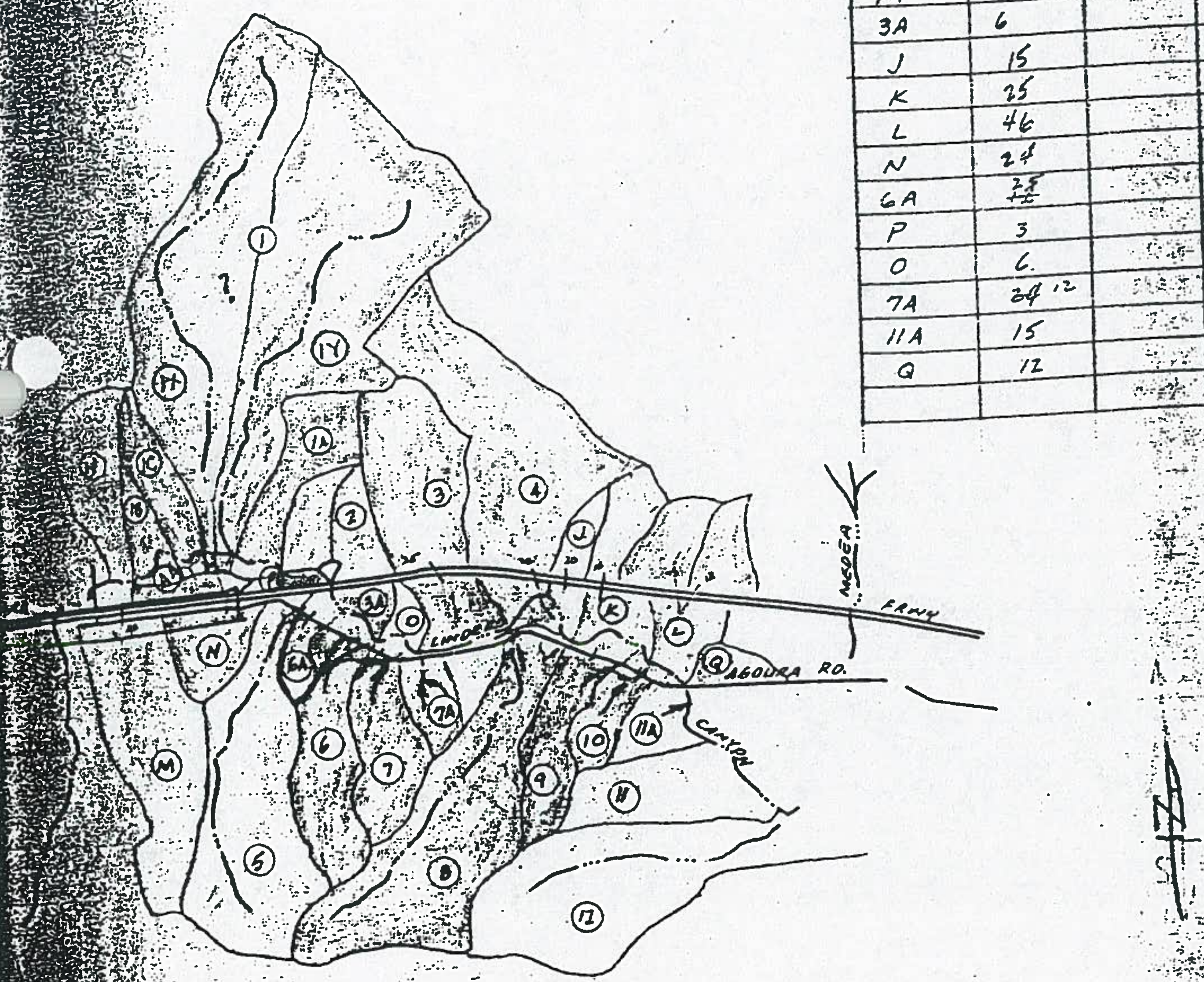
Results		
Wtd. Mannings Coefficient	0.060	
Water Surface Elevation	61.13	ft
Flow Area	21.20	ft²
Wetted Perimeter	37.48	ft
Top Width	37.41	ft
Height	1.13	ft
Critical Depth	61.16	ft
Critical Slope	0.063155	ft/ft
Velocity	4.48	ft/s
Velocity Head	0.31	ft
Specific Energy	61.45	ft
Froude Number	1.05	

Flow is supercritical.

[illegible] AREA [illegible]

28.00 / 9 = 2.67 USE FOR DESIGN "Q"

Q/AC	AC	AREA			
2.35	196	1X	144	460	385
		1Y	170		454
3.3	15	2	29	50	78
2.85	70	3	70	200	187
2	85	4	115	190	307
3	111	5	98	330	262
2.1	68	6	~~44~~ 22	150	~~477~~ 85
3	24	7	33	89	88
4.27	89	8	107	380	286
2.5	28	9	31	70	83
2.9	17	10	17	50	45
		AA	8		21
		1B	13		35
		1C	22		59
		1A	40		107
		3A	6		16
		J	15		40
		K	25		87
		L	46		123
		N	24		64
		6A	~~22~~ 28		~~72~~ 57
		P	3		8
		O	6		16
		7A	24 12		~~64~~ 32
		11A	15		40
		Q	12		32



LINDERO CANYON

A.1 METHOD FOR CALCULATING STANDARD URBAN STORMWATER MITIGATION PLAN FLOW RATES AND VOLUMES BASED ON 0.75-INCHES OF RAINFALL: WORKSHEET

PROJECT NAME

PM 15762 PARCEL 2
W.O. 537

NOMENCLATURE

A_I	=	Impervious Area (acres)
A_P	=	Pervious Area (acres)
A_U	=	Contributing Undeveloped Upstream Area (acres)
A_{Total}	=	Total Area of Development and Contributing Undeveloped Upstream Area (acres)
C_D	=	Developed Runoff Coefficient
C_U	=	Undeveloped Runoff Coefficient
I_X	=	Rainfall Intensity (inches / hour)
Q_{PM}	=	Peak Mitigation Flow Rate (cfs)
T_C	=	Time of Concentration (minutes, must be between 5-30 min.)
V_M	=	Mitigation Volume (ft^3)

EQUATIONS

$A_{Total} = A_I + A_P + A_U$

$A_I = (A_{Total}$ * % of Development which is Impervious)

$A_P = (A_{Total}$ * % of Development which is Pervious)

$A_U = (A_{Total}$ * % of Contributing Undeveloped Upstream Area***)

$C_D = (0.9 * Imp.) + [(1.0 - Imp.) * C_U]$ If $C_D < C_U$, use $C_D = C_U$

$Q_{PM} = C_D * I_X * A_{Total} * (1 \text{ hour} / 3{,}600 \text{ seconds}) * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$

$= C_D * I_X * A_{Total} * (1.008333 \text{ ft}^3\text{-hour / acre-inches-seconds})$

$T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$

$V_M = (0.75 \text{ inches}) * [(A_I)(0.9) + (A_P + A_U)(C_U)] * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$

$= (2{,}722.5 \text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$

***** Contributing Undeveloped Upstream Area is an area where stormwater runoff from an undeveloped upstream area will flow directly or indirectly to the Post-Construction Best Management Practices (BMPs) proposed for the development. This additional flow must be included in the flow rate and volume calculations to appropriately size the BMPs.**

PROVIDE PROPOSED PROJECT CHARACTERISTICS

A· otal 3.04 Acres

T: pe of Development HOSPITAL

Pr edominate Soil Type # 28

% of Project Impervious 80%

% of Project Pervious 20%

% of Project Contributing
U: developed Area 0%

A_I 2.432 Acres

A_I 0.608 Acres

A_I 0 Acres

APPENDIX A VOLUME & FLOW RATE CALCULATIONS

DETERMINING THE PEAK MITIGATED FLOW RATE (Q_{PM}):

In order to determine the peak mitigated flow rate (Q_{PM}) from the new development, use the Los Angeles County Department of Public Works *Hydrology Manual*. Use the Modified Rational Method for calculating the peak mitigation Q_{PM} for compliance with the Standard Urban Stormwater Mitigation Plan (SUSMP). Use attached **Table 1** for all maximum intensity (I_X) values used.

By trial and error, determine the time of concentration (T_C), as shown below:

<u>CALCULATION STEPS</u>:

1 Assume an initial T_C value between 5 and 30 minutes.

T_C: 30 minutes

2 Using Table 1, look up the assumed T_C value and select the corresponding I_X intensity in inches/hour.

I_X: 0.193 inches/hour

3 Determine the value for the Undeveloped Runoff Coefficient, C_U, using the runoff coefficient curve corresponding to the predominant soil type.

C_U 0.100

4. Calculate the Developed Runoff Coefficient, $C_D = (0.9 * \text{Imp.}) + [(1.0 - \text{Imp.}) * C_U]$
=(0.9)(0.8)+(0.2)(0.100)=0.74

C_D 0.741

5. Calculate the value for $C_D * I_X$

$C_D * I_X$ 0.143

6. Calculate the time of concentration, $T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$ =
0.143 350 0.135

Calculated T_C 60 minutes

7. Calculate the difference between the initially assumed T_C and the calculated T_C, if the difference is greater than 0.5 minutes. Use the calculated T_C as the assumed initial T_C in the second iteration. If the T_C value is within 0.5 minutes, round the acceptable T_C value to the nearest minute.

TABLE FOR ITERATIONS:

Iteration No.	Initial T_C (min)	I_X (in/hr)	C_U	C_D	C_D*I_X (in/hr)	Calculated T_C (min)	Difference (min)
1	12	[illegible]	0.155				
2							
3							
4							
5							
6							
7							
8							
9							
10							

Acceptable T_C value 30 minutes

8. Calculate the Peak Mitigation Flow Rate,

$Q_{PM} = C_D * I_X * A_{Total} * (1.008333\ ft^3\text{-hour / acre-inches-seconds})$

0.143 3.04

Q_{PM} 0.438 cfs

TABLE 1

INTENSITY - DURATION DATA FOR 0.75-INCHES OF RAINFALL
FOR ALL RAINFALL ZONES

Duration, T_C (min)	Rainfall Intensity, I_x (in/hr)
5	0.447
6	0.411
7	0.382
8	0.359
9	0.339
10	0.323
11	0.309
12	0.297
13	0.286
14	0.276
15	0.267
16	0.259
17	0.252
18	0.245
19	0.239
20	0.233
21	0.228
22	0.223
23	0.218
24	0.214
25	0.210
26	0.206
27	0.203
28	0.199
29	0.196
30	0.193

DETERMINING THE VOLUME (V_M)

In order to determine the volume (V_M) of stormwater runoff to be mitigated from the new development, use the following equation:

2.432 0.608 0 0.100

$$V_M = (2{,}722.5 \text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)] = 5957.97 \text{ ft}^3$$

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PROJECT NAME

PM 15762 PARCEL 2

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22	0.223
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27	0.203
28	0.199
29	0.196
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1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Acceptable T_C value 30 minutes

8. Calculate the Peak Mitigation Flow Rate,
$Q_{PM} = C_D * I_X * A_{Total} * (1.008333\ ft^3\text{-hour / acre-inches-seconds})$
0.161 1.2

Q_{PM} 0.195 cfs

DETERMINING THE PEAK MITIGATED FLOW RATE (Q_{PM}):

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By trial and error, determine the time of concentration (T_C), as shown below:

CALCULATION STEPS:

1. Assume an initial T_C value between 5 and 30 minutes.

T_C 30 minutes

2. Using Table 1, look up the assumed T_C value and select the corresponding I_X intensity in inches/hour.

I_X 0.193 inches/hour

3. Determine the value for the Undeveloped Runoff Coefficient, C_U, using the runoff coefficient curve corresponding to the predominant soil type.

C_U 0.100

4. Calculate the Developed Runoff Coefficient, $C_D = (0.9 * \text{Imp.}) + [(1.0 - \text{Imp.}) * C_U]$

C_D 0.836

5. Calculate the value for $C_D * I_X$

$C_D * I_X$ 0.161

6. Calculate the time of concentration, $T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$

0.161 570 0.016

Calculated T_C 30 minutes

7. Calculate the difference between the initially assumed T_C and the calculated T_C, if the difference is greater than 0.5 minutes. Use the calculated T_C as the assumed initial T_C in the second iteration. If the T_C value is within 0.5 minutes, round the acceptable T_C value to the nearest minute.

PROVIDE PROPOSED PROJECT CHARACTERISTICS

A_{Total} 1.2 Acres

Type of Development STREET

Predominate Soil Type # 28

% of Project Impervious 92%

% of Project Pervious 8%

% of Project Contributing Undeveloped Area 0%

A_I 1.1 Acres

A_P 0.1 Acres

A_U 0 Acres

NOMENCLATURE

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A_U	=	Contributing Undeveloped Upstream Area (acres)
A_{Total}	=	Total Area of Development and Contributing Undeveloped Upstream Area (acres)
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C_U	=	Undeveloped Runoff Coefficient
I_X	=	Rainfall Intensity (inches / hour)
Q_{PM}	=	Peak Mitigation Flow Rate (cfs)
T_C	=	Time of Concentration (minutes, must be between 5-30 min.)
V_M	=	Mitigation Volume (ft^3)

EQUATIONS

$$A_{Total} = A_I + A_P + A_U$$

$$A_I = (A_{Total} * \text{\% of Development which is Impervious})$$

$$A_P = (A_{Total} * \text{\% of Development which is Pervious})$$

$$A_U = (A_{Total} * \text{\% of Contributing Undeveloped Upstream Area***})$$

$$C_D = (0.9 * \text{Imp.}) + [(1.0 - \text{Imp.}) * C_U] \qquad \text{If } C_D < C_U\text{, use } C_D = C_U$$

$$Q_{PM} = C_D * I_X * A_{Total} * (1\text{ hour} / 3{,}600\text{ seconds}) * (1\text{ ft} / 12\text{ inches}) * (43{,}560\text{ ft}^2 / 1\text{ acre})$$

$$= C_D * I_X * A_{Total} * (1.008333\text{ ft}^3\text{-hour / acre-inches-seconds})$$

$$T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$$

$$V_M = (0.75\text{ inches}) * [(A_I)(0.9) + (A_P + A_U)(C_U)] * (1\text{ ft} / 12\text{ inches}) * (43{,}560\text{ ft}^2 / 1\text{ acre})$$

$$= (2{,}722.5\text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$$

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