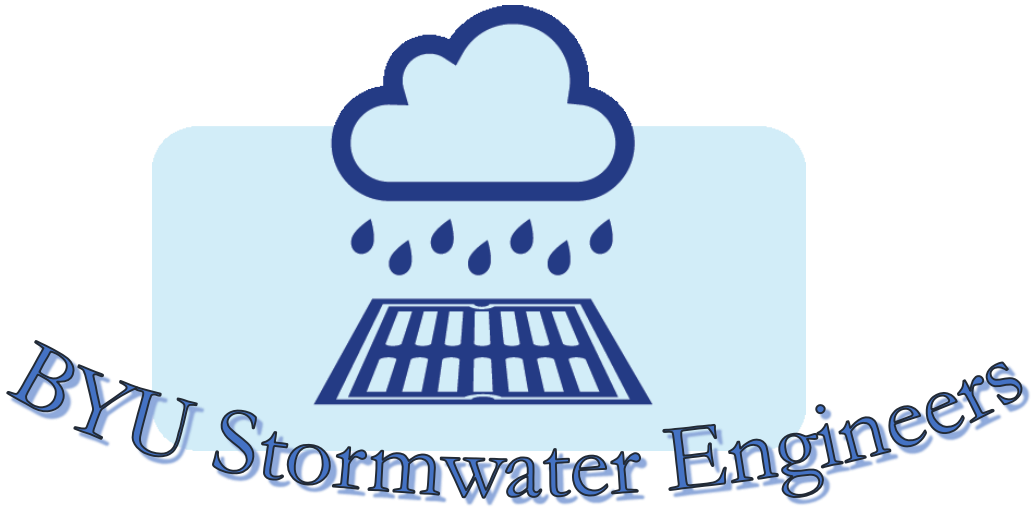
CEEn-2016CPST-007

Flood Control Plan Feasibility Study



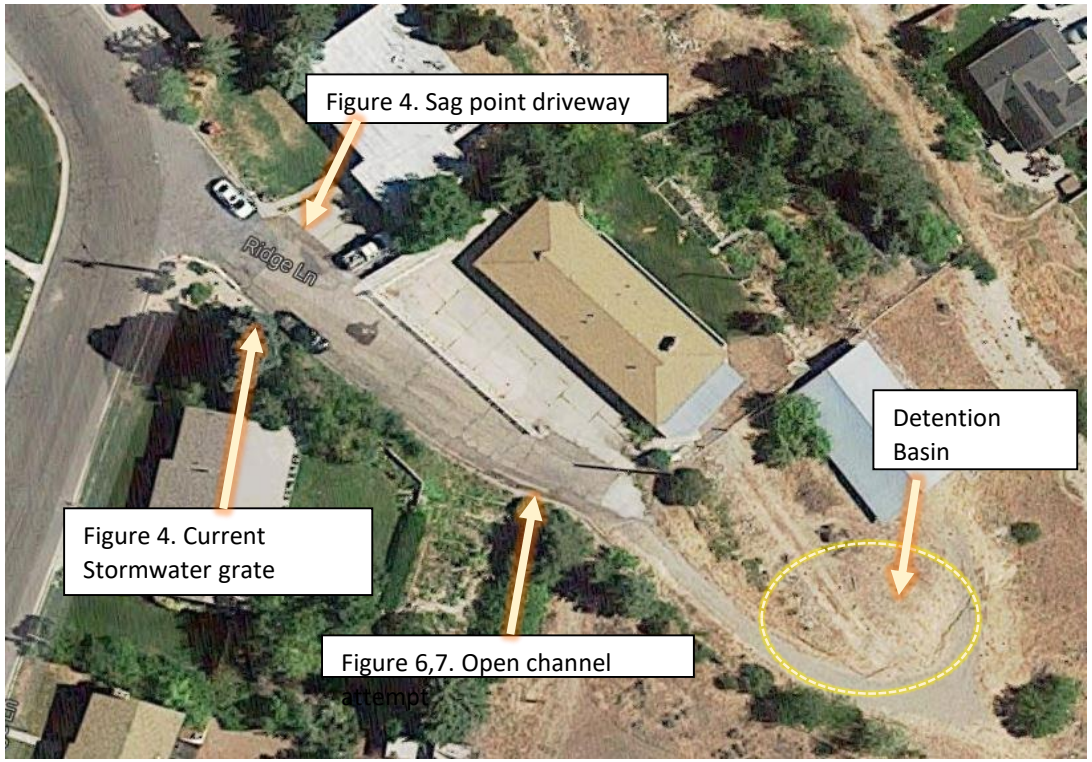
Team leader Matt Johnson with

Donald Anderson and Fabian Zamorano

Introduction

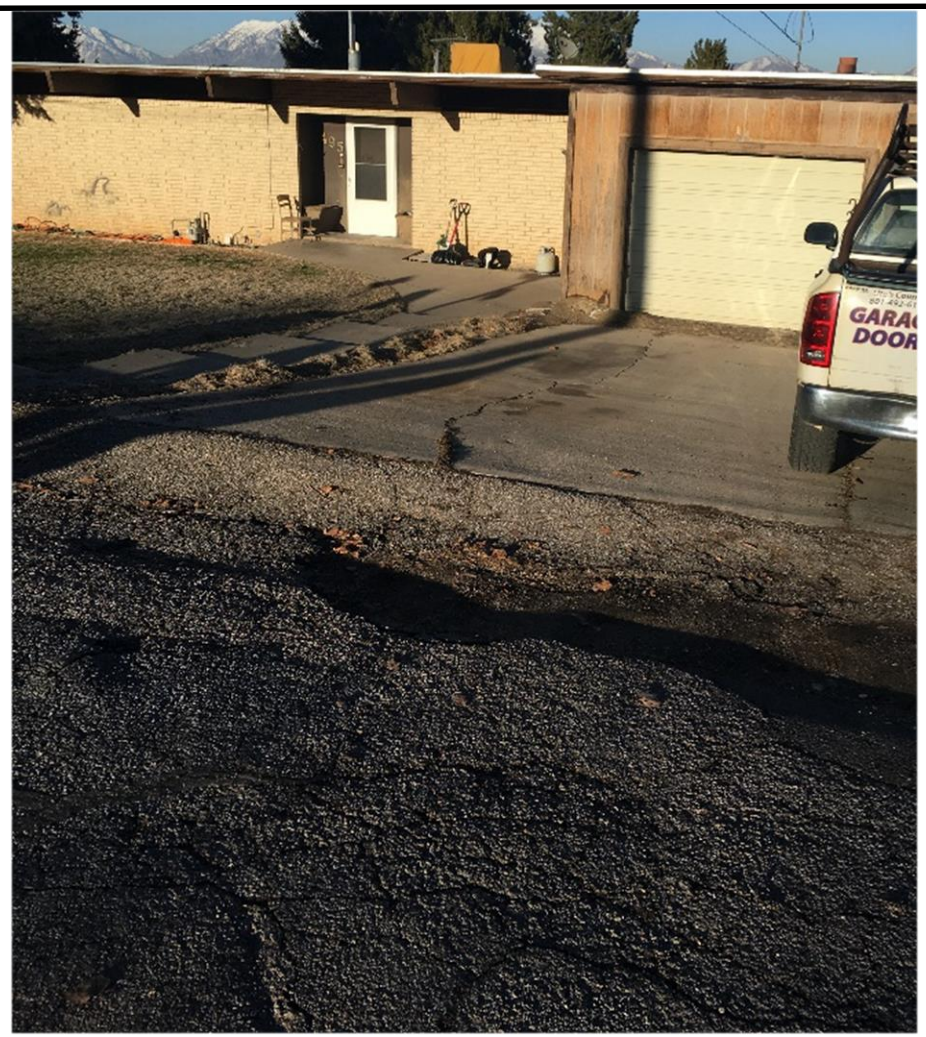
Ridge Lane, Payson City Utah

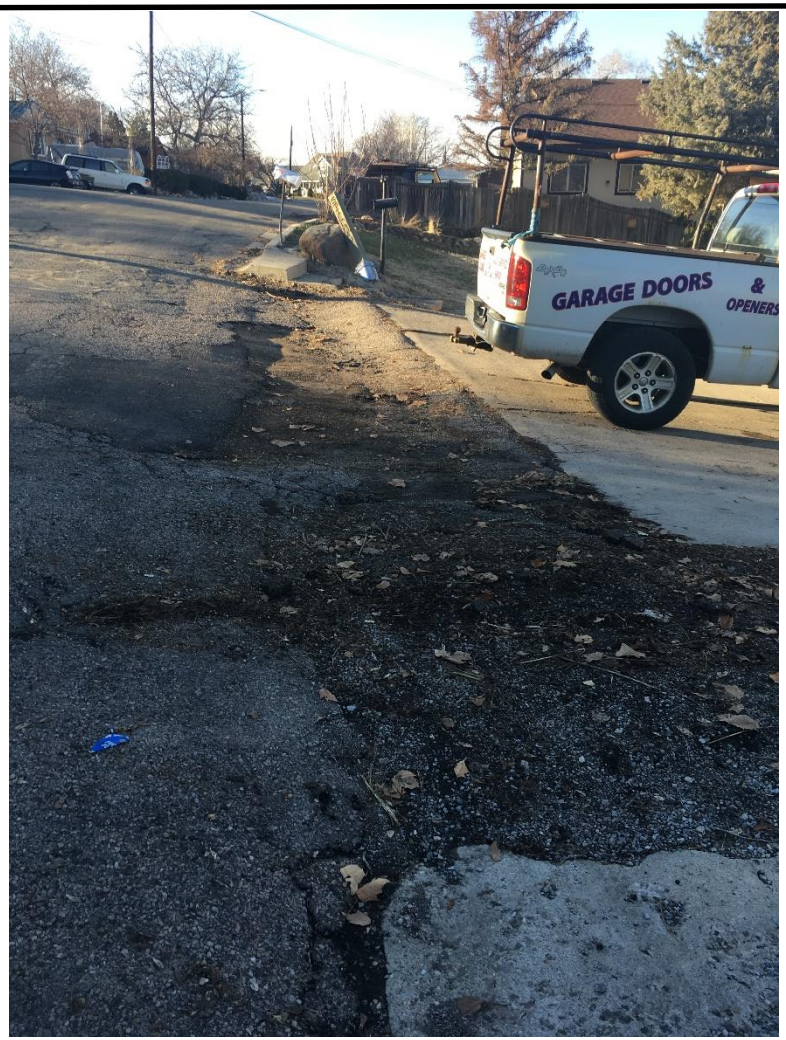
Floods during storm events



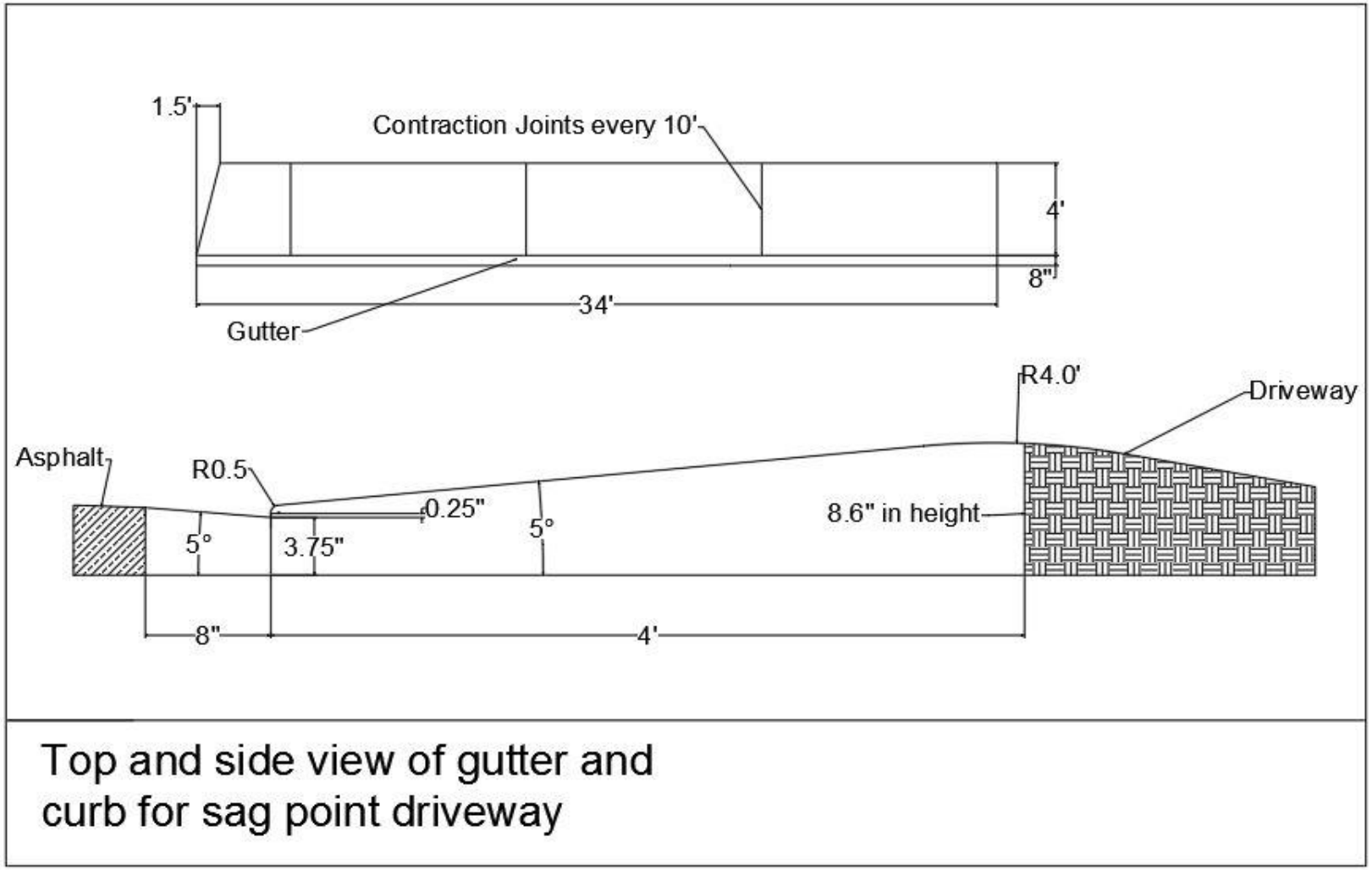
Site Visit

Site Visit





Curb and Gutter



Top and side view of gutter and curb for sag point driveway

Figure 4. Sag point driveway

Storm and Sanitary Analysis

Manufacturer part number:	N/A
Number of inlets:	1
Inlet type:	Combination Inlet
Inlet location:	On Sag
Combination inlet type:	Curb Opening & Grate
Curb opening and grate type:	Equal Length Inlet

Physical properties

Catchbasin invert elevation:	4733	ft
Inlet rim elevation:	4735.9	ft
Ponded area:	10	ft²
Initial water surface elevation:	0	ft
External inflows:	YES	
Grate clogging factor:	25	%
Roadway/gutter bypass link:		

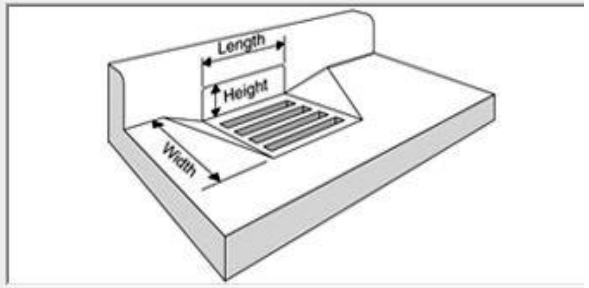
Roadway & gutter specifications

Roadway longitudinal slope:		ft/ft
Roadway cross slope:	0.02	ft/ft
Roadway Manning's:	0.016	
Gutter cross slope:	0.062	ft/ft
Gutter width:	1	ft
Gutter depression:	3.00	in
Upstream roadway links:		

Combination inlet specifications

Grate type:	Parallel Bar P-1-7/8	
Grate length:	36.00	in
Grate width:	24.00	in
Curb opening clogging factor:	0	%
Curb opening length:	36.00	in
Curb opening height:	3.00	in

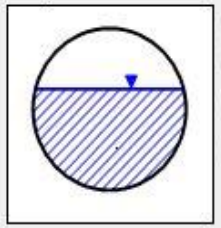
Inlet illustration



Analysis summary

Peak flow during analysis:	12.00	cfs
Peak flow intercepted by inlet:	N/A	cfs
Peak flow bypassing inlet:	N/A	cfs
Inlet efficiency during peak flow:	N/A	%
Gutter spread during peak flow:	22.83	ft
Gutter flow depth during peak flow:	0.91	ft

Shape



Open channel
Pipe
Culvert
Direct
Circular

Properties

Number of barrels:	1	
Diameter:	15.000	in

Physical properties

Length:	179.41	ft
Inlet invert elevation:	4733	ft
Outlet invert elevation:	4721.6	ft
Manning's roughness:	0.015	
Flap gate		

Flow properties

Entrance losses:	0.5	
Exit/bend losses:	0.5	
Additional losses:	0	
Initial flow:	0	cfs
Maximum flow:	0	cfs

Analysis summary

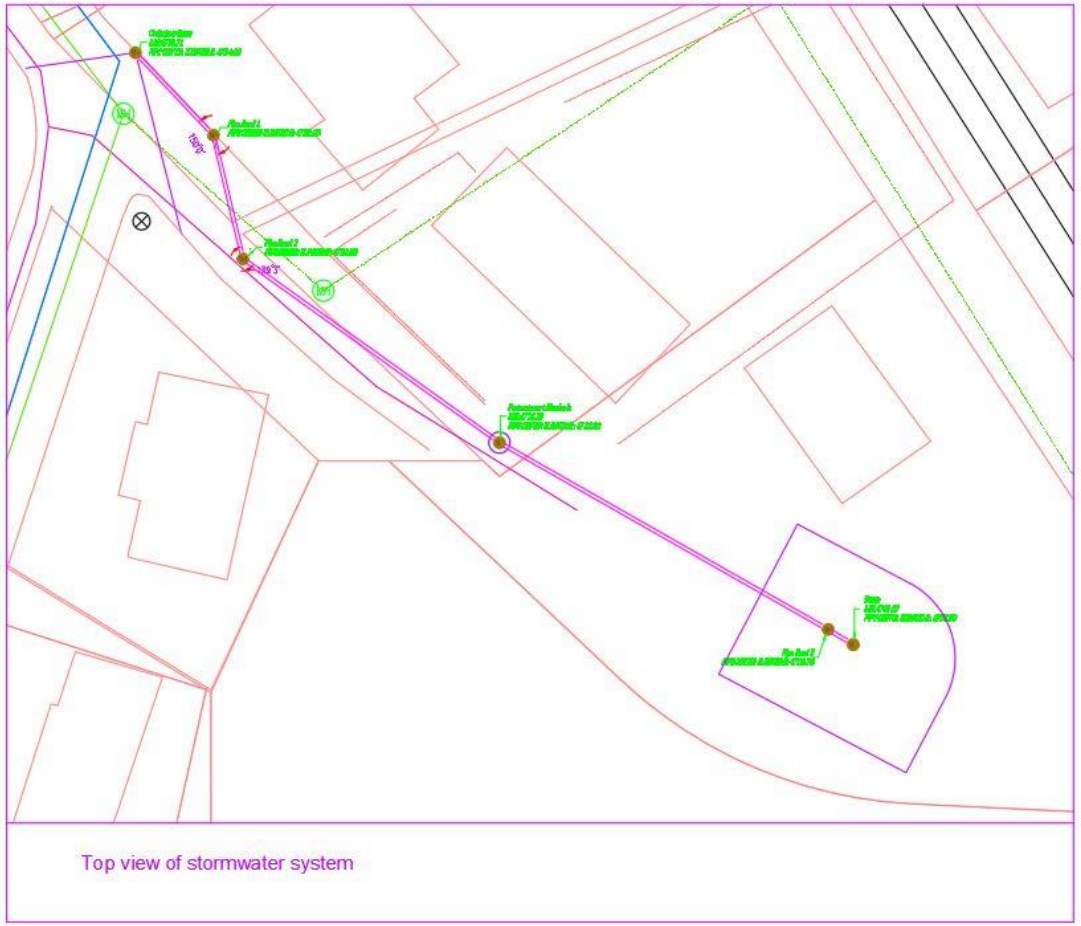
Constructed slope:	0.0635	ft/ft	Max velocity attained:	12.24 ft/sec
Design flow capacity:	14.11	cfs	Max/design flow ratio:	0.86
Peak flow during analysis:	12.13	cfs	Max/total depth ratio:	0.76
Additional flow capacity:	1.98	cfs	Total time surcharged:	0 min

Connectivity

From (Inlet):	Inlet-08	Swap	Invert elevation:	4733 ft
To (Outlet):	Jun-02		Invert elevation:	4718 ft

Design, Analysis & Results

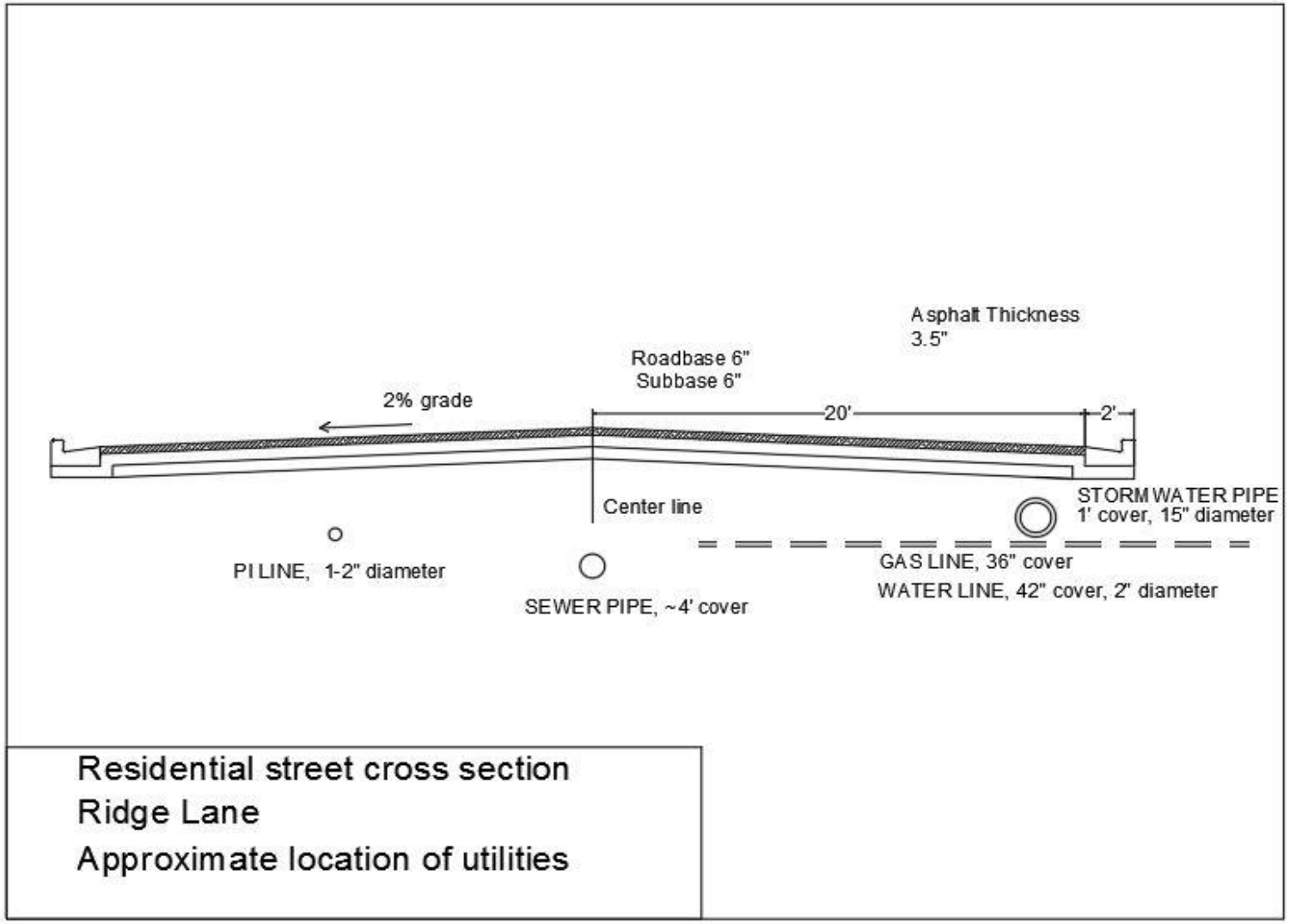
- Used AutoCAD Civil 3D, Storm and Sanitary Analysis, and Watershed Modeling Software.
- Had to determine approximate location of underground lines.
- Decided to go with an underground 15" pipe.



Top view of stormwater system

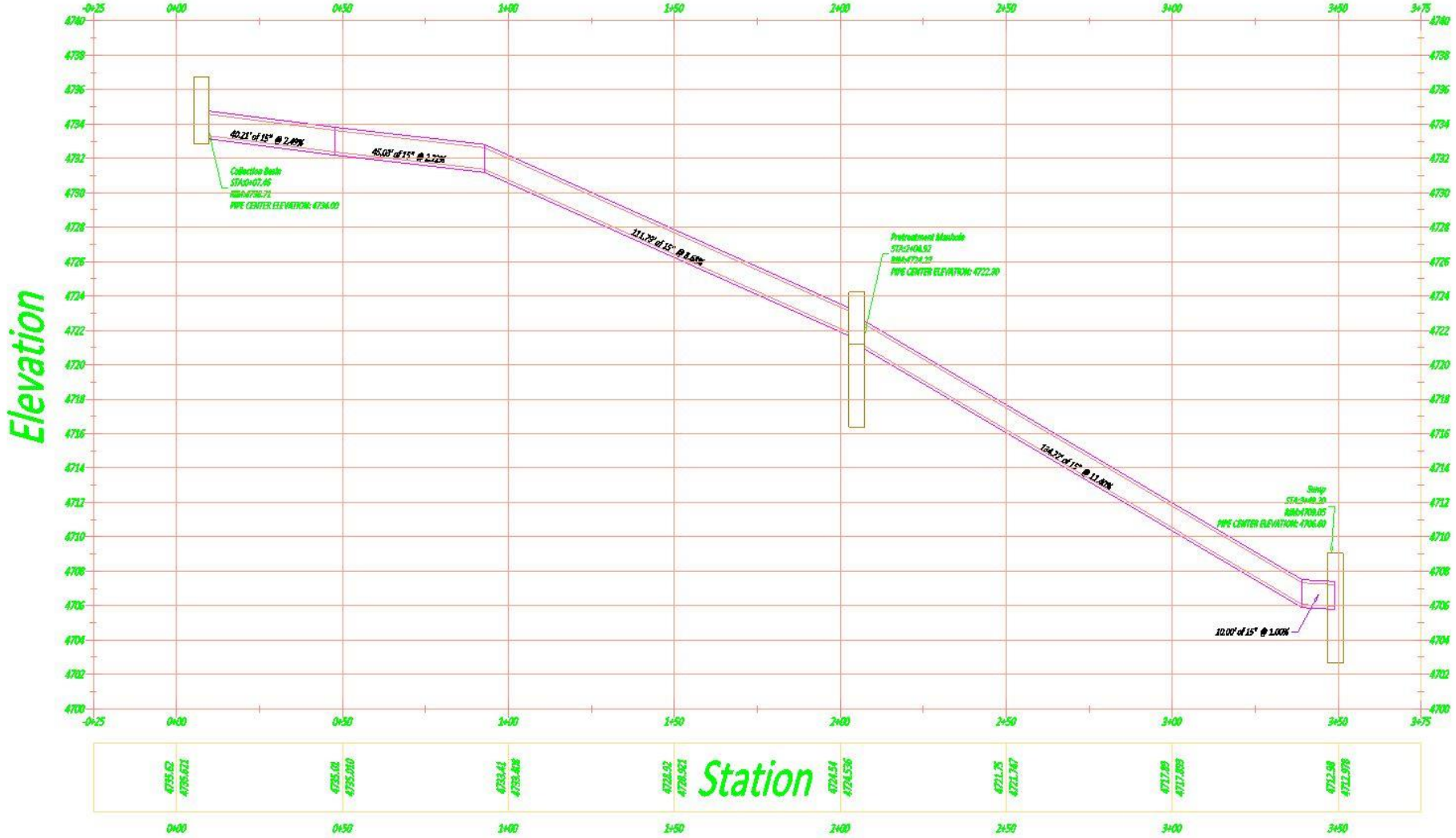
150°0'
139°3'

Road Cut

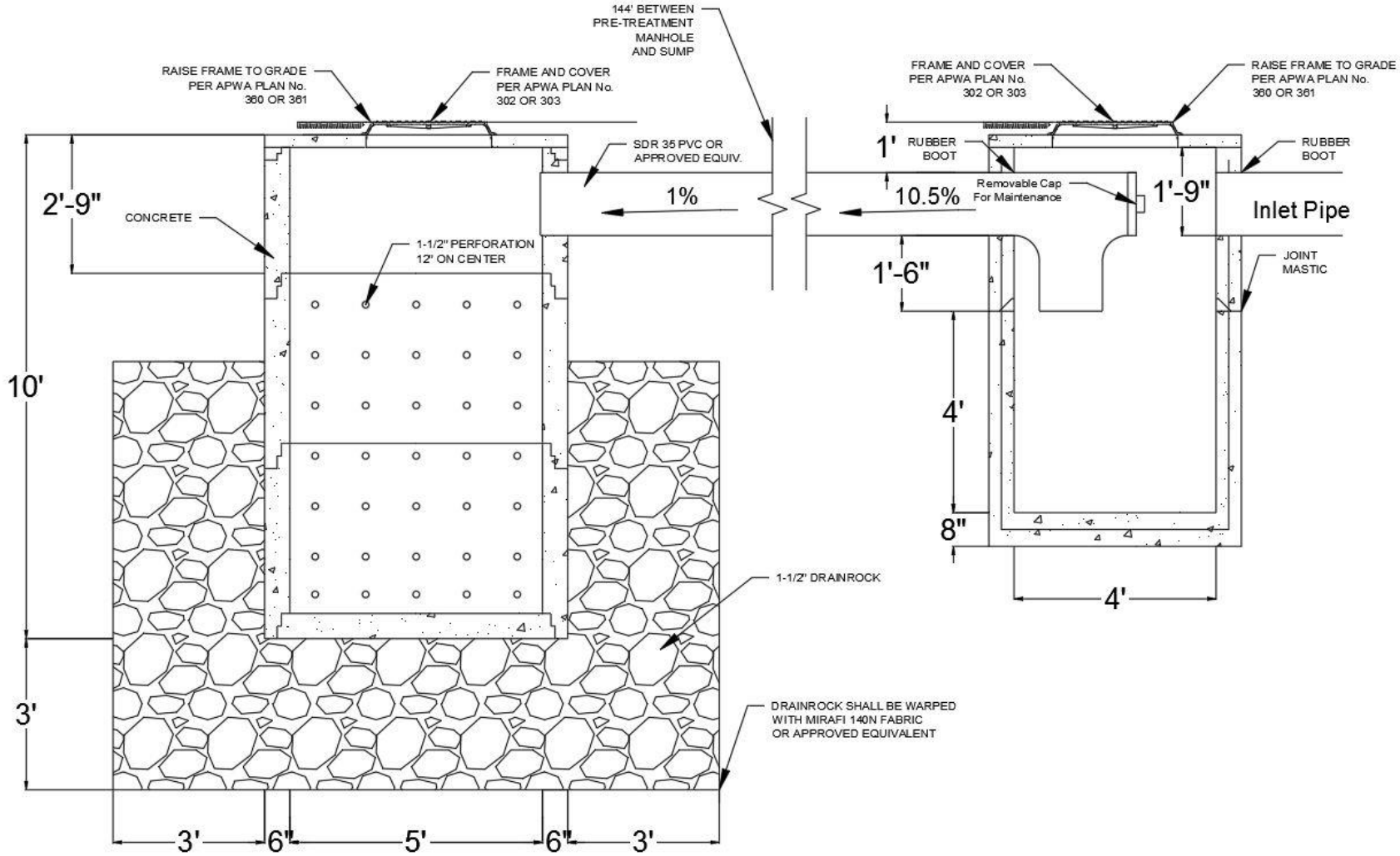


Residential street cross section
Ridge Lane
Approximate location of utilities

Profile View



Sump and Pre-Treatment Manhole



Detention Pond Sizing

Detention Pond sizing
Date: 3/27/2017

User Inputs

AREA DETAILS

Landscaping =	5	Acres
Building =	2.5	Acres
Hard Surface =	3.5	Acres

STORM EVENT DETAILS

Select City: Payson
Select Event: 25 year
Select Tc (min): 10

CALCULATED VARIABLES

Total Area = 11.000 Acres (total acreage of si
C = 0.63 weighted run-off coefficie

Click to Calculate

C VALUE

Landscaping =	0.3	Between 0.1-0.4
Building =	0.9	Between 0.8-0.95
Hard Surface =	0.9	Between 0.85-0.9

CONSTANTS

g = 32.2 ft/s^2

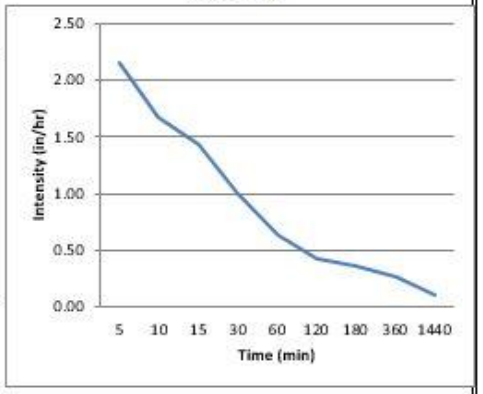
POND PROPERTIES

Head, h =	2	Feet	head is measured to centerline of outlet
Time of concentration =	10	min	maximum time required to travel to outlet of basin
Allowable release rate =	0.2778	cfs/acre	maximum allowable release rate from site

Lapsed Time (min)	Rainfall Intensity (in/hr)	Total Rainfall (in)	Rainfall Volume (cf)	Release Volume (cf)	Required Storage (cf)
A	B	C	D	E	F
5	2.16	0.18	4508	917	3592
10	1.68	0.28	7013	1833	5180
15	1.44	0.36	9017	2750	6267
30	1.00	0.50	12524	5500	7024
60	0.63	0.63	15780	11000	4780
120	0.43	0.86	21540	22000	-460
180	0.36	1.08	27051	33000	-5949
360	0.27	1.62	40576	66000	-25424
1440	0.11	2.61	65373	264000	-198627

Qp = 11.59 **cfs** **5,203** **gpm** $Q_p = A * C_w * I_p$
Tc = 10 **min**
Ip = 1.68 **in/hr (Input Rainfall Intensity Based Off of Tc)**
Storage = 7024 **cf** **0.161** **Acre-feet**

Storm Event
Intensity - Duration - Frequency Curve
Utah County



Detention Pond sizing
Date: 3/27/2017

User Inputs

AREA DETAILS

Landscaping =	5	Acres
Building =	2.5	Acres
Hard Surface =	3.5	Acres

STORM EVENT DETAILS

Select City: Payson
Select Event: 100 year
Select Tc (min): 1440

CALCULATED VARIABLES

Total Area = 11.000 Acres (total acreage of si
C = 0.63 weighted run-off coefficie

Click to Calculate

C VALUE

Landscaping =	0.3	Between 0.1-0.4
Building =	0.9	Between 0.8-0.95
Hard Surface =	0.9	Between 0.85-0.9

CONSTANTS

g = 32.2 ft/s^2

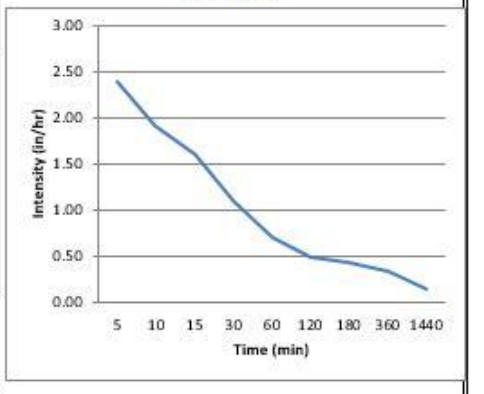
POND PROPERTIES

Head, h =	2	Feet	head is measured to centerline of outlet
Time of concentration =	10	min	maximum time required to travel to outlet of basin
Allowable release rate =	0.2778	cfs/acre	maximum allowable release rate from site

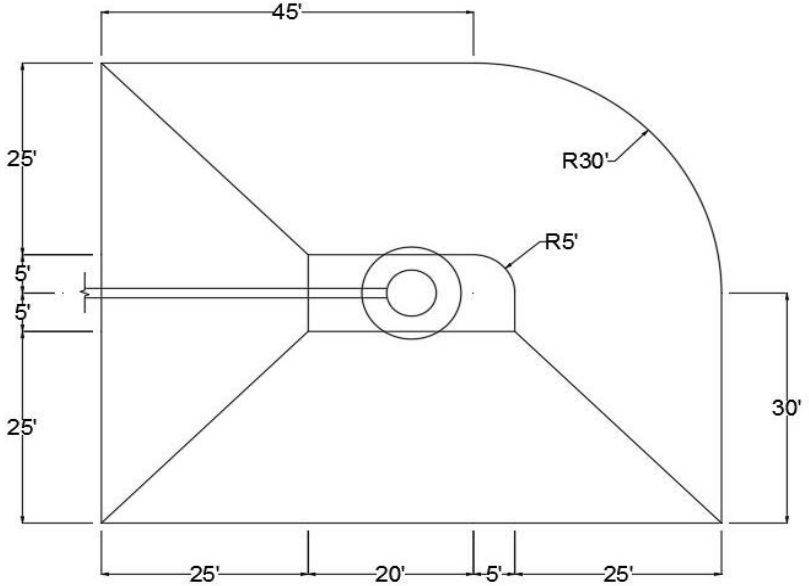
Lapsed Time (min)	Rainfall Intensity (in/hr)	Total Rainfall (in)	Rainfall Volume (cf)	Release Volume (cf)	Required Storage (cf)
A	B	C	D	E	F
5	2.40	0.20	5009	917	4093
10	1.92	0.32	8015	1833	6182
15	1.60	0.40	10019	2750	7269
30	1.10	0.55	13776	5500	8276
60	0.70	0.70	17533	11000	6533
120	0.50	1.00	25047	22000	3047
180	0.43	1.29	32311	33000	-689
360	0.33	2.00	50094	66000	-15906
1440	0.14	3.30	82655	264000	-181345

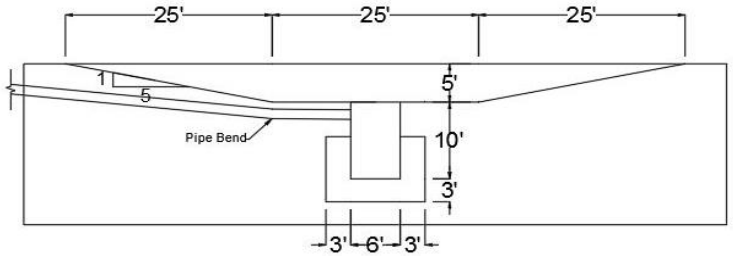
Qp = 0.95 **cfs** **426** **gpm** $Q_p = A * C_w * I_p$
Tc = 1440 **min**
Ip = 0.1375 **in/hr (Input Rainfall Intensity Based Off of Tc)**
Storage = 8276 **cf** **0.190** **Acre-feet**

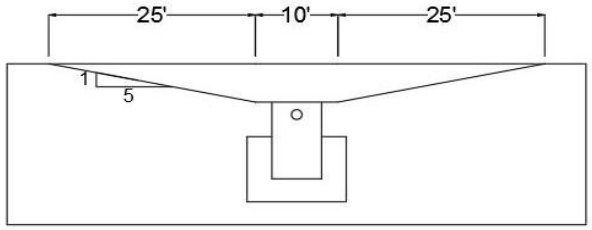
Storm Event
Intensity - Duration - Frequency Curve
Utah County



Detention Basin

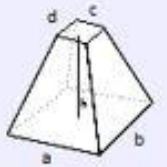




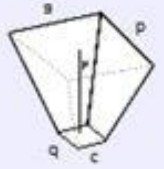


Pyramidal Frustum (Truncated Pyramid) - rectangular bases

```
a=4; b=6; /* the first base */
c=2; d=3; /* the second base */
h=3;      /* height */
print "Pyramidal frustum
 volume=", h/3*(a*b+c*d+(a*d+b*c)/2), "
 surface area=", a*b+c*d+(a+c)*hypot(h,(b-d)/2)+
  (b+d)*hypot(h,(a-c)/2)
```



Top			Bottom		
Length, a=	75	ft	Length, c=	25	ft
Width, b=	60	ft	Width, d=	10	ft
slope A/C =	0.2				
slope B/D =	0.2				
Depth, h=	5	ft			
Offset=	25				
Volume=	9791.667	ft^3			



Cost Estimate

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	ITEM COST
1	ASTM C76 15" Diameter Concrete Pipe	350	ft	$ 12.50	$ 4,375.00
2	Concrete for Curb and Gutter	120	ft	$ 20.00	$ 2,400.00
3	Pretreatment 4' Diameter Manhole	1		$ 2,550.00	$ 2,550.00
4	Sump 5' Diameter Manhole	1		$ 2,950.00	$ 2,950.00
5	Sump	1		$ 300.00	$ 300.00
6	Single Grate Inlet Catch Basin	1		$ 2,725.00	$ 2,725.00
7	Remove Surface Materials (Asphalt, Curb & Gutter)	250	ft	$ 8.75	$ 2,187.50
8	Remove Existing Storm Drainage Piping	0	ft	$ 16.00	$ -
9	Furnish Trench Backfill Materials	136	tons	$ 4.50	$ 610.42
10	Furnish Bedding Materials	152	tons	$ 10.50	$ 1,590.88
11	Roadway Patching	310	yd^3	$ 20.00	$ 6,202.79
12	Traffic Control & Flagging	19	days	$ 150.00	$ 2,775.76
13	Landscaping & Surface Restoration	1		$ 3,365.04	$ 3,365.04
14	Connection To Existing System	1		$ 2,800.00	$ 2,800.00
15	Mobilization	1		$ 5,212.91	$ 5,212.91
16	Constructing Detention Pond	1		$ 13,390.00	$ 13,390.00
				Construction Cost:	$ 53,435.30
				Construction Contingencies (20%):	$ 10,687.06
				Engineering Design and Construction Management (15%):	$ 8,015.29
				Total Cost:	$ 72,137.65
				Total Cost (Rounded):	$ 72,100.00

Conclusions & Recommendations

Highly recommend a seepage and slope stability analysis.

Project progress was dependent on actual site visit.

Entire project was done without any prior coursework ~ stormwater design is more of a acquired skill than a classroom subject.