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Summit Residential Neighbourhood Earthen Channel/Culvert re-assessment

CENE 486C FINAL PRESENTATION

11/13/2020

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INTRODUCTION AND BACKGROUND

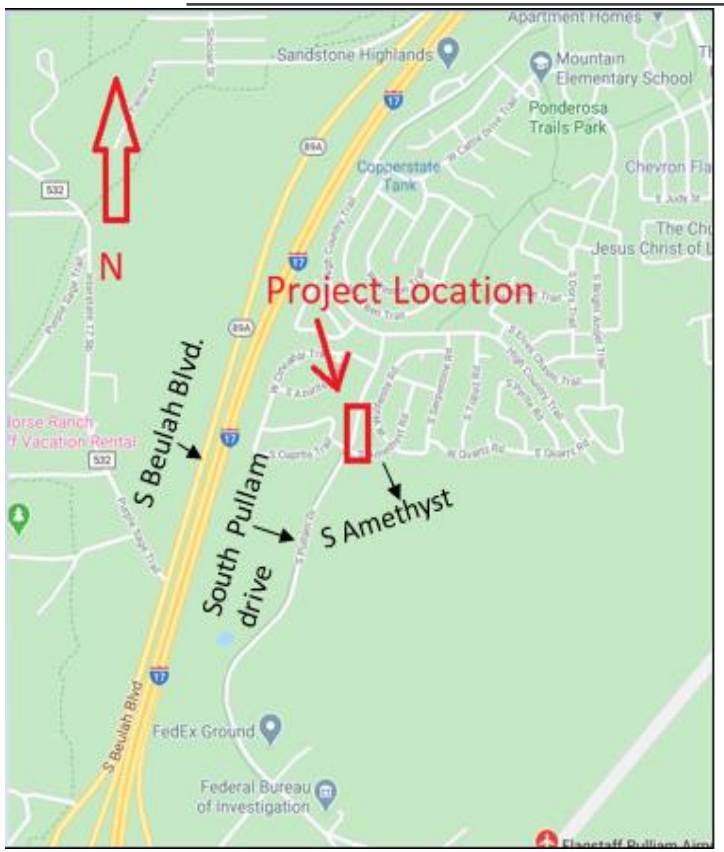

Figure1: google map location of project location [1]

- Project is located along South Pulliam Dr, Flagstaff Arizona 86005
- Stability and slope issue
- Channel is being re-assessed
- A storm drain was designed

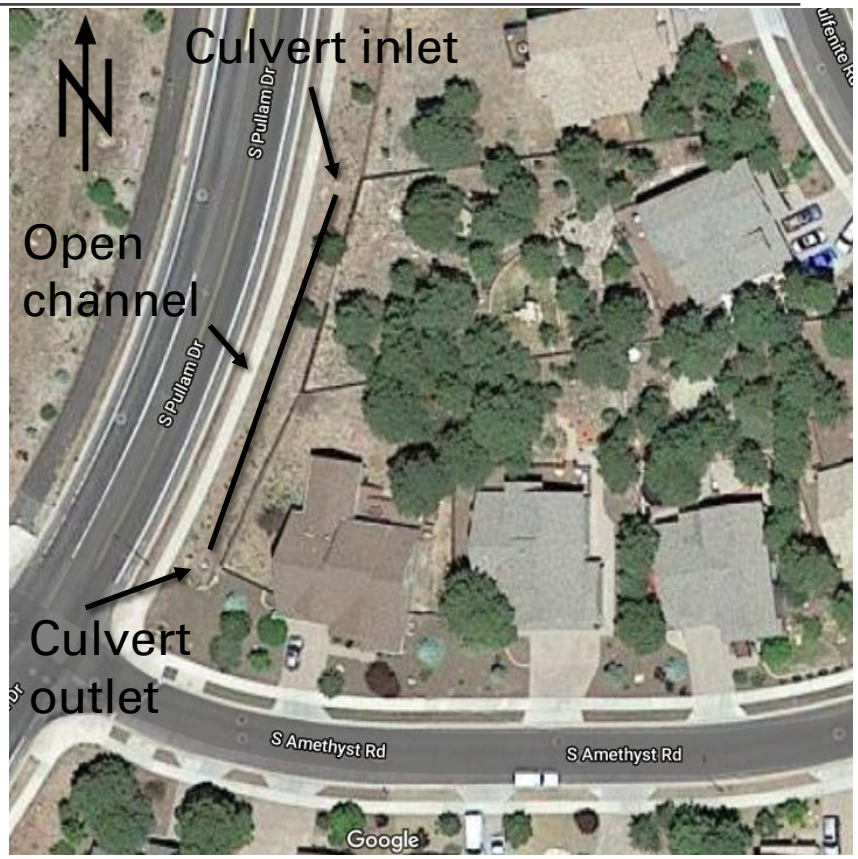

Figure 2: Aerial map of the open channel and area of interest [2]

SITE INVESTIGATION
SITE VISIT

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- Initial Site investigation preformed
- Additional site visit was conducted through google earth
- Existing features
  - Single barrel culverts
  - 24-inch corrugated metal pipe
  - Channel length: 526 ft
  - Average depth of channel: 3 feet

Figure 3: channel condition

Figure 4: Open channel

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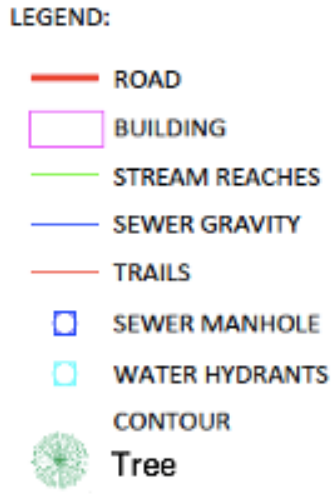
SURVEYING/DATA PROCESSING

- Lidar 2013 Data
  - Contours
  - Stream reaches
  - Sewer gravity
  - Trails
  - Sewer manhole
  - Water hydrants
  - Building
  - Roads

Figure 5 : Total station surveying equipment.

TOPOGRAPHIC MAP

- Arcmap data input
- Plainmetric features added



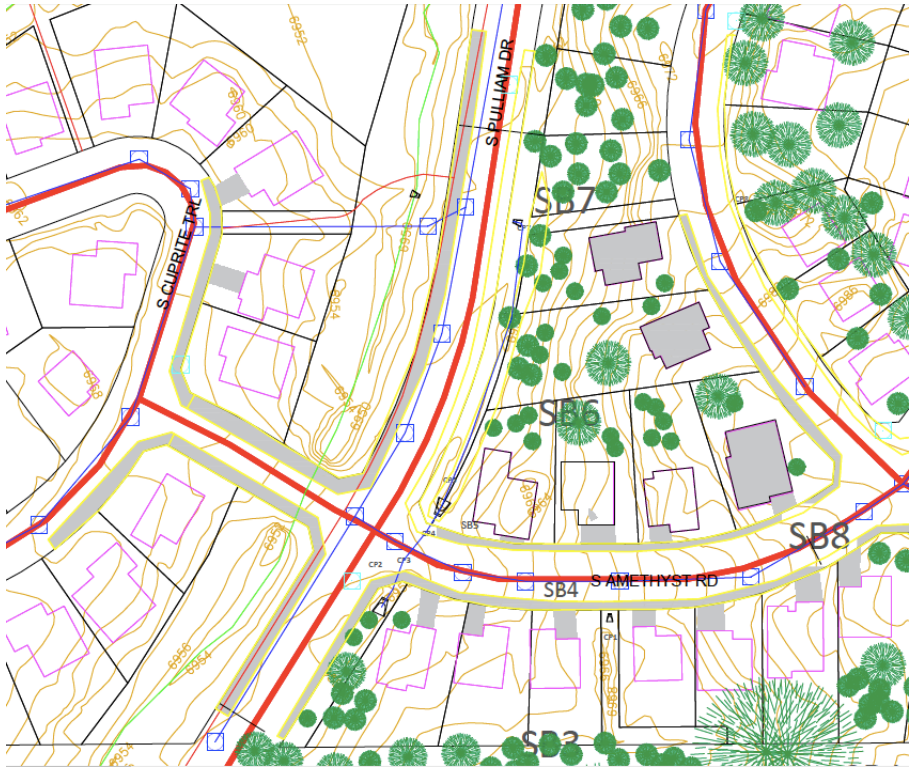


Figure 6 : Topographic map of location

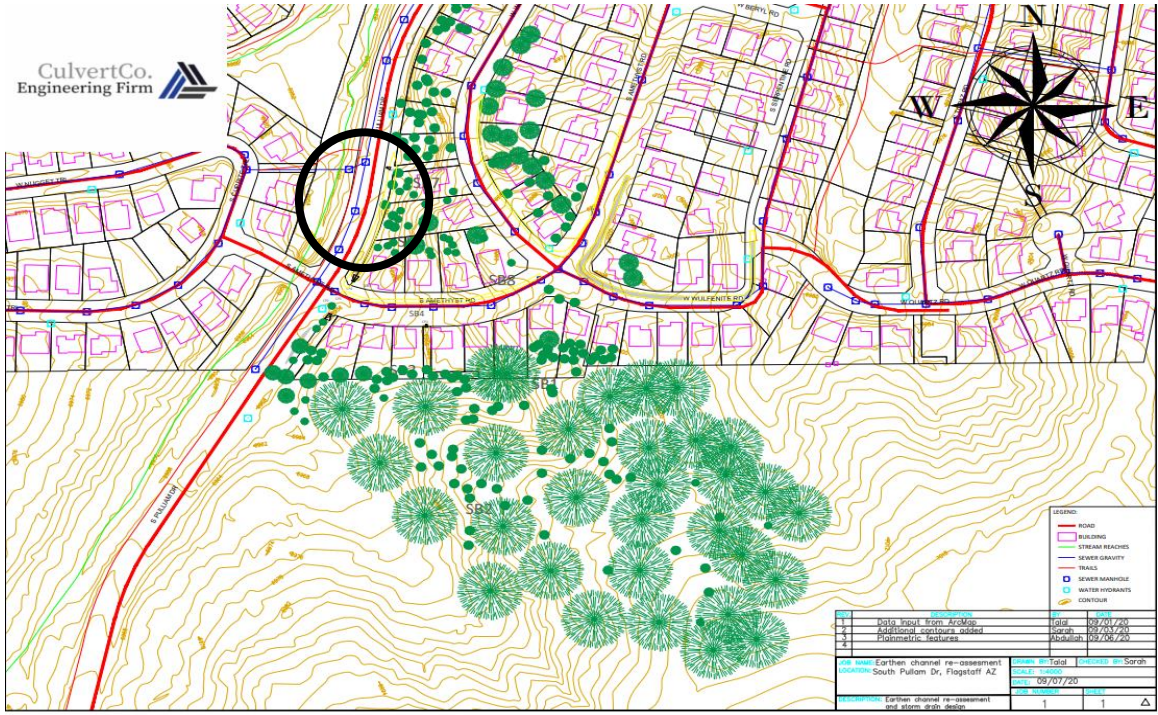


Figure 7: Topographic map

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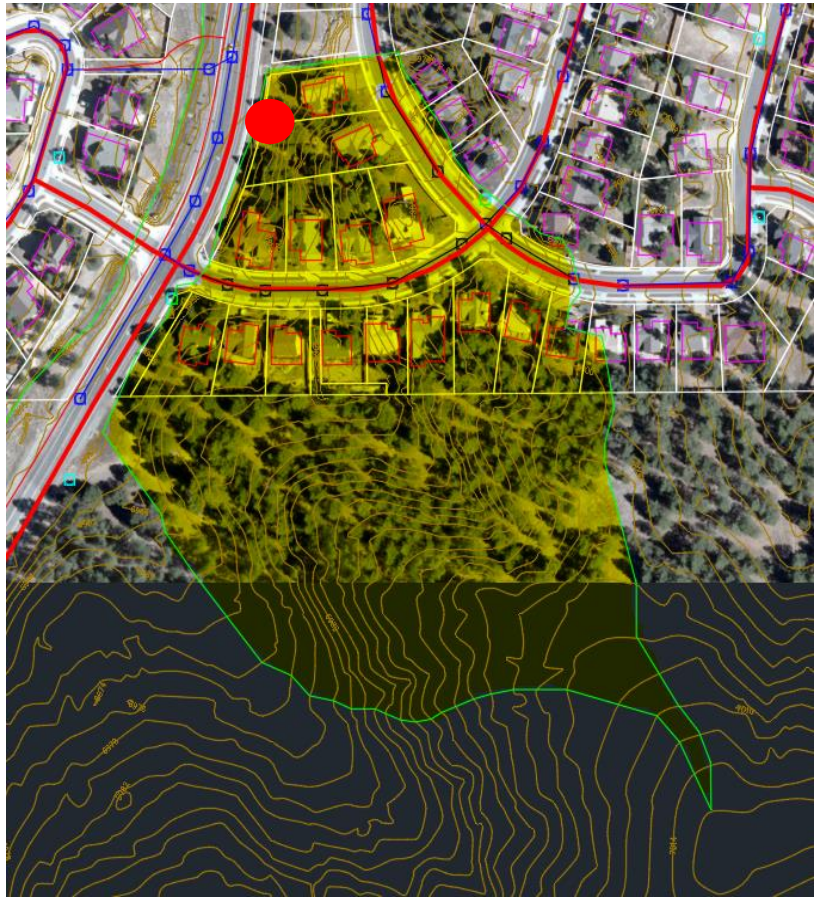
HYDROLOGIC DATA DERIVATION
MAJOR BASIN DELINEATION



- Major basin delineated in AutoCAD (Area: 11.8 Acres)
- Sub-basin identified with yellow border.
- Time of concentration path delineated with cyan.

Figure 8: Major basin delineated in AutoCAD

Figure 9: Sub-Basin and Tc Path

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TIME OF CONCENTRATION RESULTS

- Rational method used to calculate TC
- This method was used to double check HEC-HMS results
- TC path split into parts based on type of flow

Table 1:Time of concentration results for each sub-basin.

Sub-Basin	Tc(min)
SB1	5.1
SB2	0.9
SB3	1.6
SB4	2.0
SB5	0.4
SB6	0.2

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RATIONAL METHOD RUNOFF RESULTS

Table 2 : 50 Years storm event

Sub-Basin	Cf	C	Tc	i (in/hr)	A (acres)	Q (cfs)
SB1	1.2	0.14	5.14	7.43	2.997	3.608
SB2	1.2	0.51	0.92	7.43	2.609	11.956
SB3	1.2	0.50	1.59	7.43	0.722	3.1943
SB4	1.2	0.24	2.03	7.43	0.435	0.9146
SB5	1.2	0.40	0.38	7.43	1.301	4.6209
SB6	1.2	0.49	0.24	7.43	0.847	3.6821
					Total	**27.975**

Table 3 : 100 Years storm event

Sub-Basin	Cf	C	i (in/hr)	A (acres)	Q (cfs)
SB1	1.25	0.14	8.6	2.997	4.349
SB2	1.25	0.51	8.6	2.609	14.414
SB3	1.25	0.50	8.6	0.722	3.851
SB4	1.25	0.24	8.6	0.435	1.102
SB5	1.25	0.40	8.6	1.301	5.571
SB6	1.25	0.49	8.6	0.847	4.439
				Total	**33.729**

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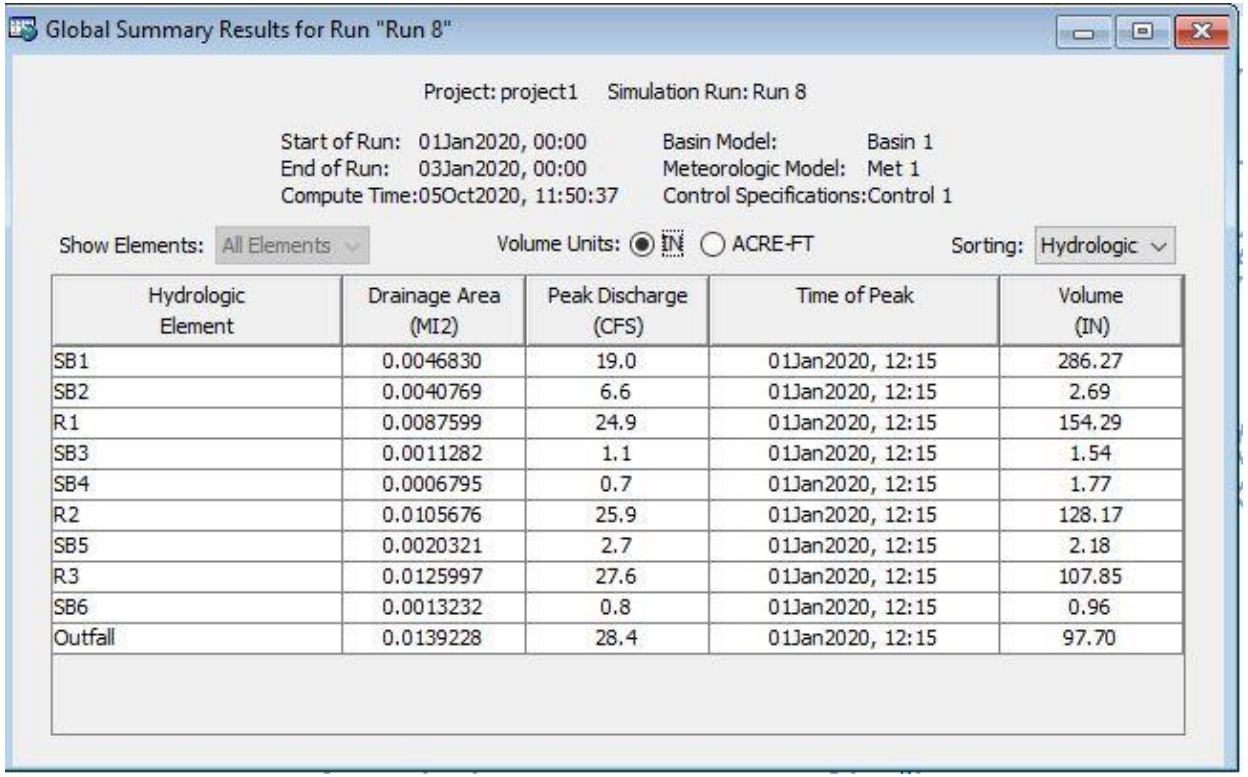
HEC-HMS MODEL RESULTS

Table 4: HEC-HMS and rational method Results

Storm event	HEC-HMS	Rational Method
100-year storm Discharge (cfs)	36.4	33.7
50-year storm Discharge (cfs)	28.4	27.9
10-year storm Discharge (cfs)	16.9	15.9



Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
SB1	0.0046830	19.0	01Jan2020, 12:15	286.27
SB2	0.0040769	6.6	01Jan2020, 12:15	2.69
R1	0.0087599	24.9	01Jan2020, 12:15	154.29
SB3	0.0011282	1.1	01Jan2020, 12:15	1.54
SB4	0.0006795	0.7	01Jan2020, 12:15	1.77
R2	0.0105676	25.9	01Jan2020, 12:15	128.17
SB5	0.0020321	2.7	01Jan2020, 12:15	2.18
R3	0.0125997	27.6	01Jan2020, 12:15	107.85
SB6	0.0013232	0.8	01Jan2020, 12:15	0.96
Outfall	0.0139228	28.4	01Jan2020, 12:15	97.70

Figure 10: Global Summary Results

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HEC-HMS MODEL RESULTS

Table 5: HEC-HMS and rational method Results

Storm event	HEC-HMS	Rational Method
100-year storm Discharge (cfs)	36.4	33.7
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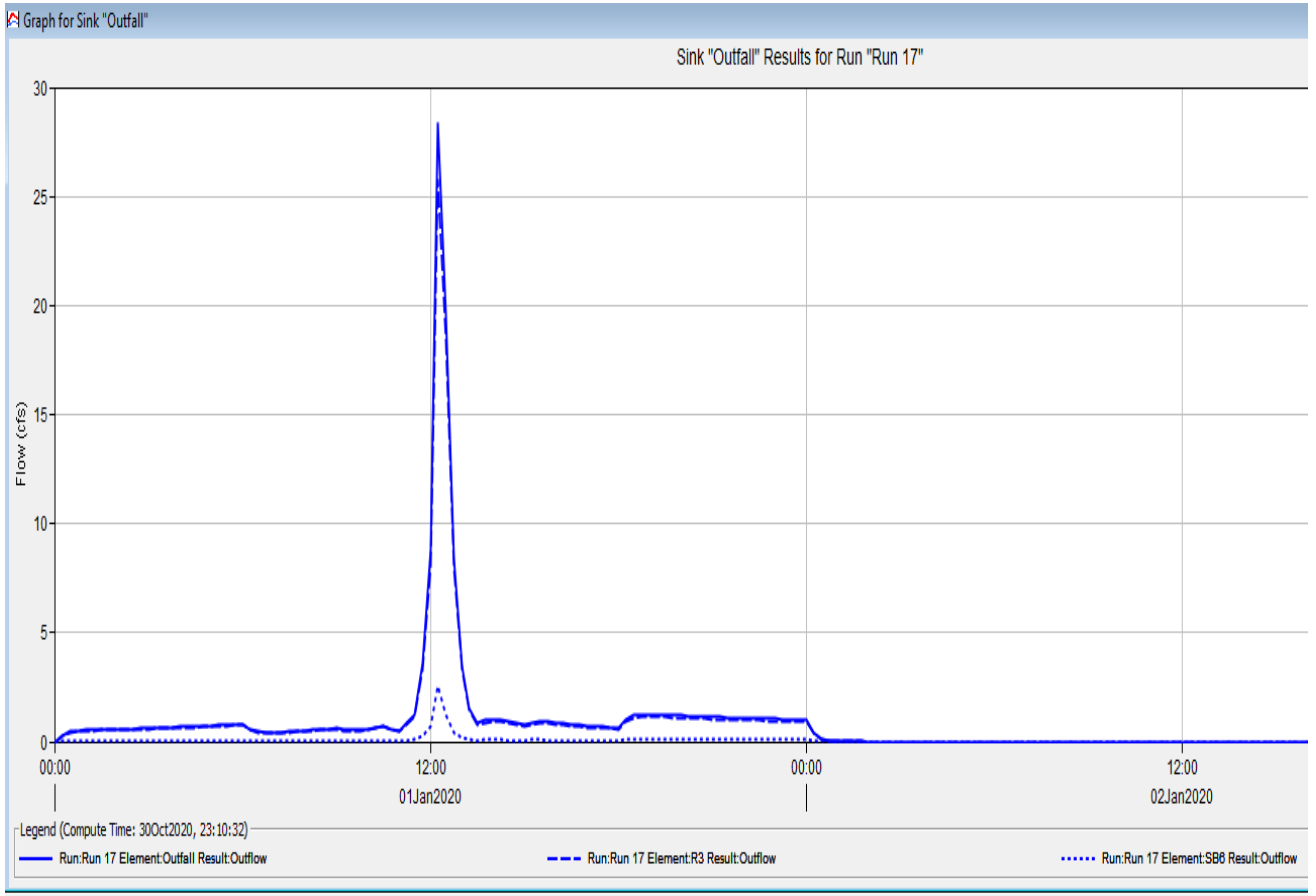

Figure 11: Unit hydrograph

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CULVERTMASTER MODEL

Table 6: Culvert 1 results.

Discharge	8.59 cfs
Headwater Depth/Height	0.83 ft
Control Type	Inlet control

Table 7 : Culvert 2 results.

Discharge	19.81 cfs
Headwater Depth/height	1.83 ft
Control Type	Outlet control

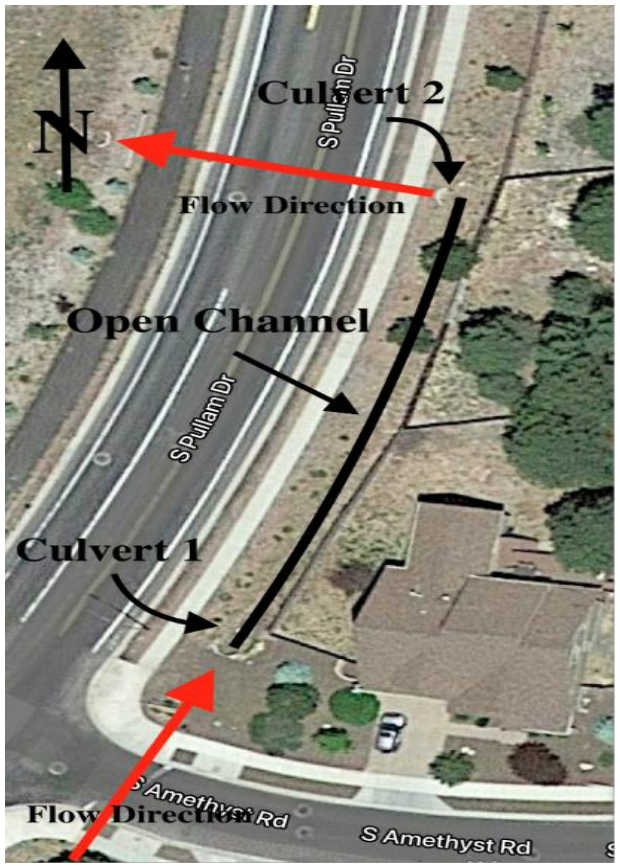

Figure 12: Culvert location.

FLOWMASTER MODEL

- Two cross sections identified
- River station 95
- River station 115

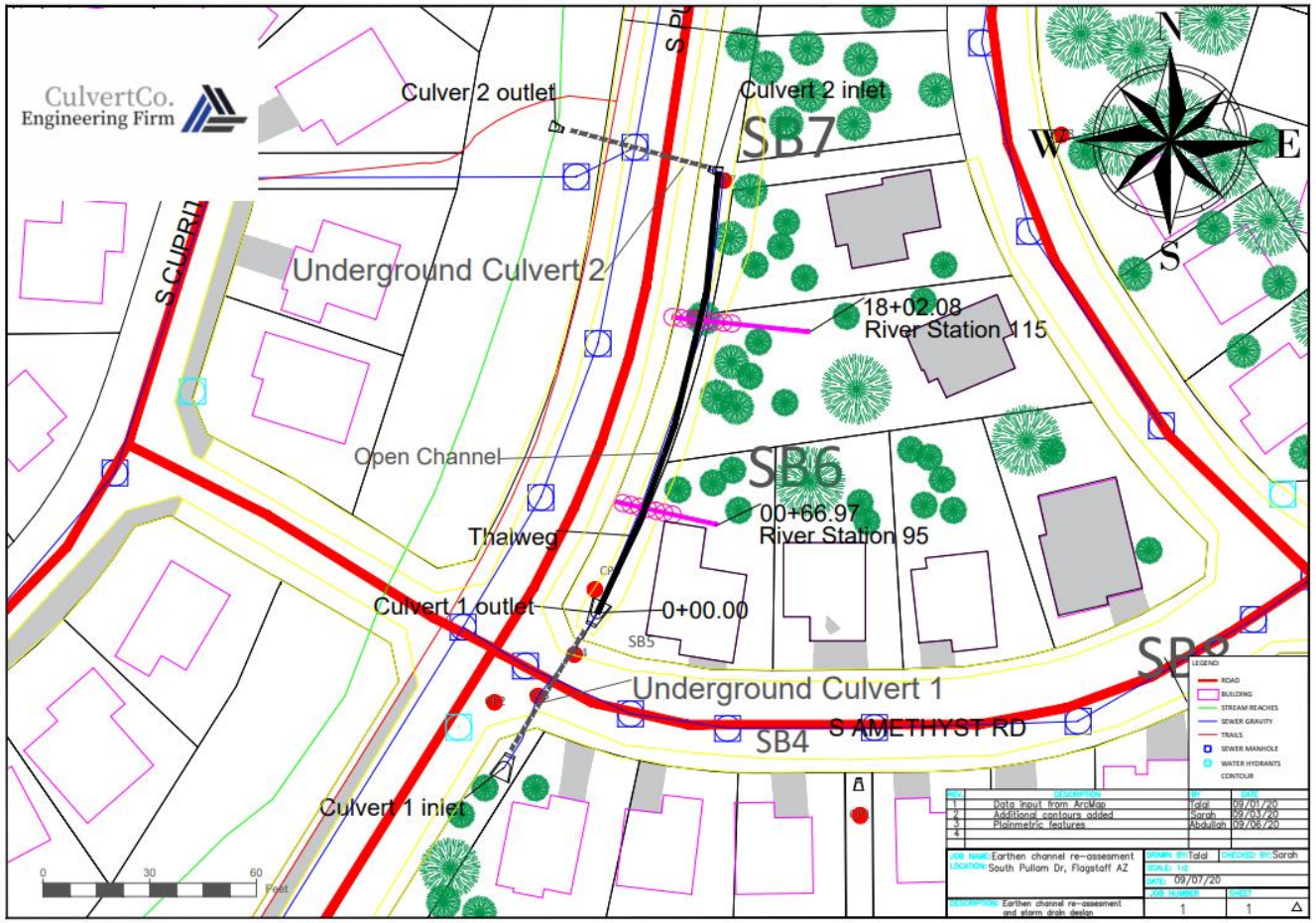

Figure 13 : Location of river station.

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FLOWMASTER MODEL EXISTING CHANNEL

Table 8 : FlowMaster results for river station 95 (50-year storm design)

Normal Depth	14.4 inches
Velocity	4.10 ft/s
Flow type	Subcritical

Table 9: FlowMaster results for river station 115 (50-year storm design)

Normal Depth	8.2 inches
Velocity	3.42 ft/s
Flow type	Subcritical

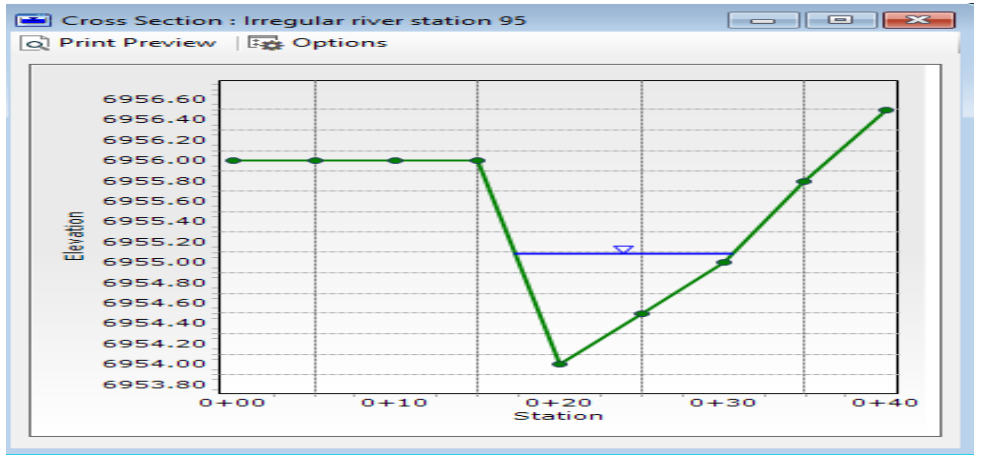


Figure 14 : river station 95 cross section.

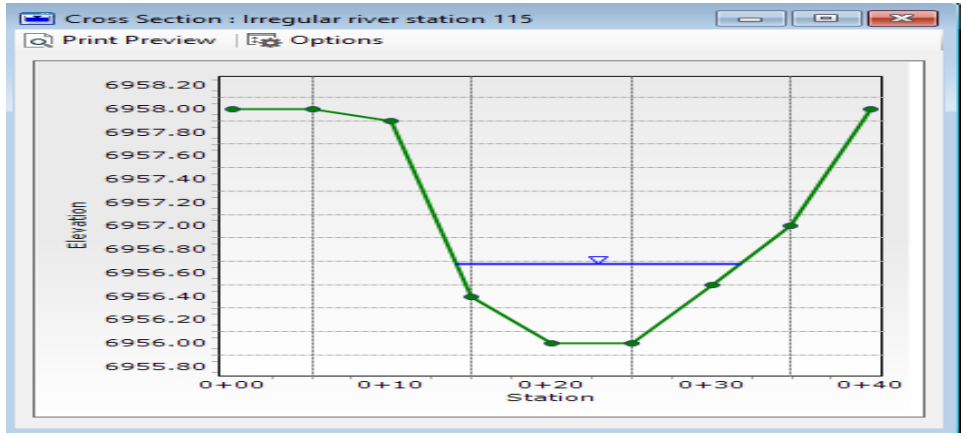


Figure 15 : river station 115 cross section.

ALTERNATIVE DESIGN

- Double 18 ” smooth wall HDPE (High density polyethylene parallel storm drain
- Double 18” concrete parallel storm drain
- Single 48” Corrugated metal pipes

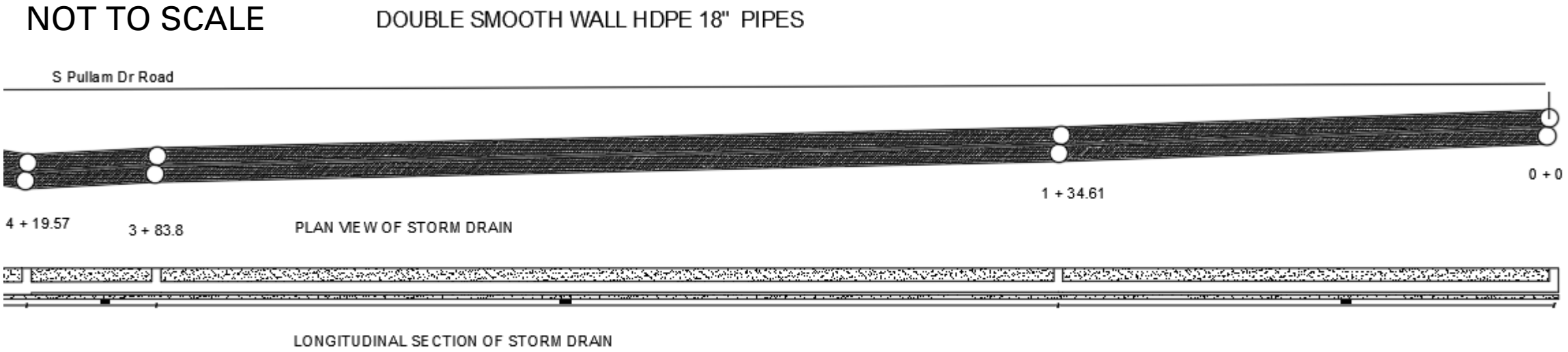
Example of CMP pipe

Example of HDPE pipe

Example of Precast concrete pipe

Double 18 ” smooth wall HDPE parallel storm drain

NOT TO SCALE



- Designed for 50 years storm event
- Checked for 100 years storm event
- N value of 0.011

Table 10: Flow master results for first alternative.

Results	Design (50-year storm)	Check (100-year storm)
Diameter	33.70 in	36.40 in
Velocity	4.53 ft/s	5.03 ft/s
Normal Depth	24.5 in	30.7 in

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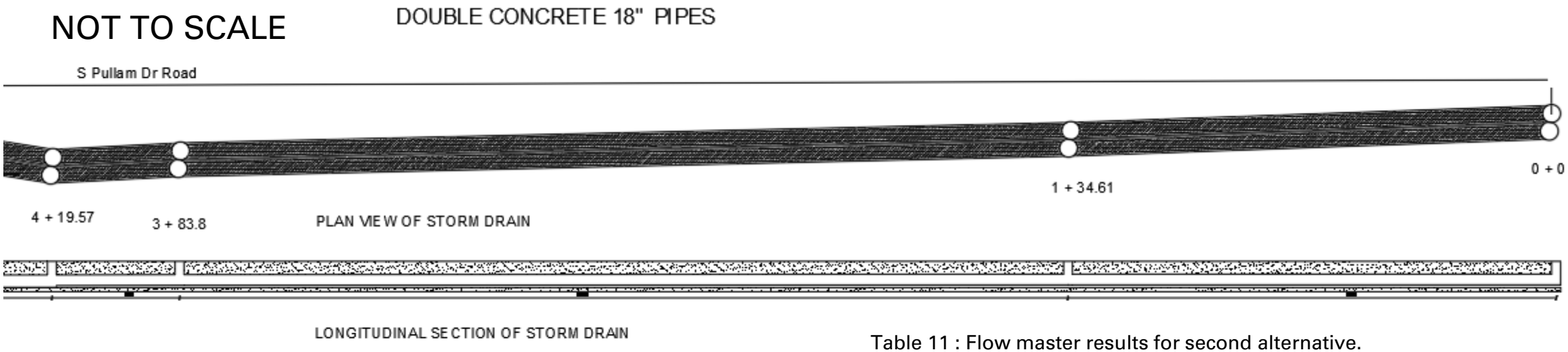
Double 18” concrete parallel storm drain

NOT TO SCALE



- Designed for 50 years storm event
- Checked for 100 years storm event
- N value of 0.013

Table 11 : Flow master results for second alternative.

Results	Design (50-year storm)	Check (100-year storm)
Diameter	35.9 in	38.8 in
Velocity	3.99 ft/s	4.44 ft/s
Normal Depth	28.1 in	30.9 in

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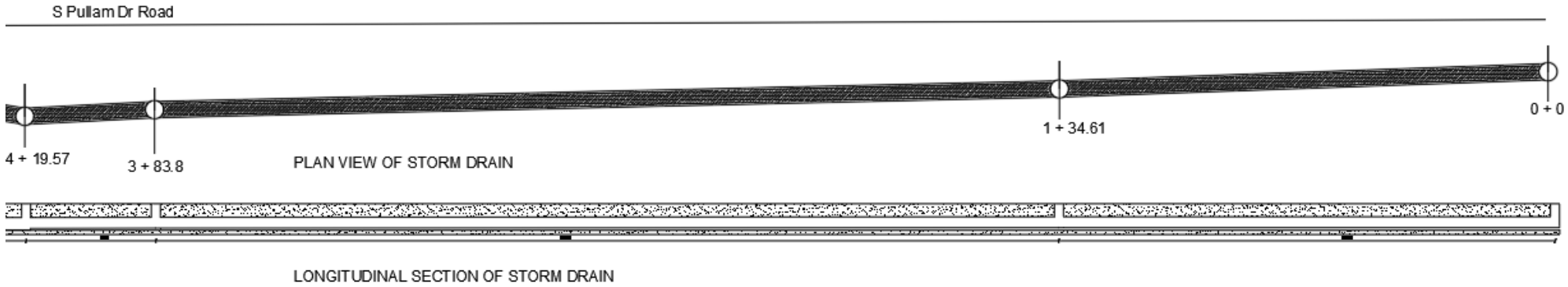
Single 48” Corrugated metal pipes

NOT TO SCALE DETAILED DRAWINGS OF 48" Corrugated metal pipe



- Designed for 50 years storm event
- Checked for 100 years storm event
- N value of 0.024

Table 12 : Flow master results for third alternative.

Results	Design (50-year storm)	Check (100-year storm)
Diameter	44.50 in	48.80 in
Velocity	2.63 ft/s	2.80 ft/s
Normal depth	33 in	48 in

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DECISION MATRIX

Table 13 : Decision matrix of alternative designs based on four criteria.

Criteria	Double 18" smooth wall HDPE pipes	Double 18" reinforced Concrete pipes	Single 48" Corrugated metal pipes
Material cost per ft	$16.5	$30.5	$50
Construction cost	4	3	1
Material cost	5	3	2
Efficiency of design	5	4	4
Maintenance cost	4	3	3
Client preference	5	4	3
Total	23	17	13

Double 18" smooth wall HDPE Storm drainpipes was chosen as the final design based on the Decision matrix and client preference.

Scores:
1 = poor
5 = best

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FINAL DESIGN RECOMMENDATION

- Material: Smooth wall HDPE
- Diameter: 18″
- Type: Parallel connection

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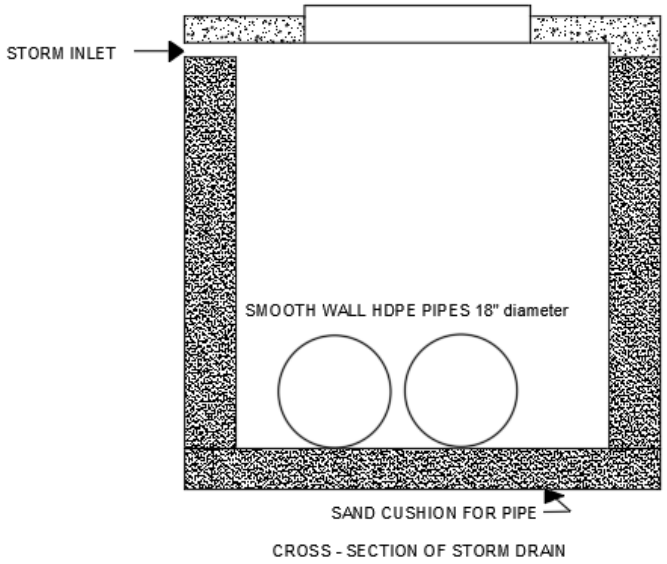
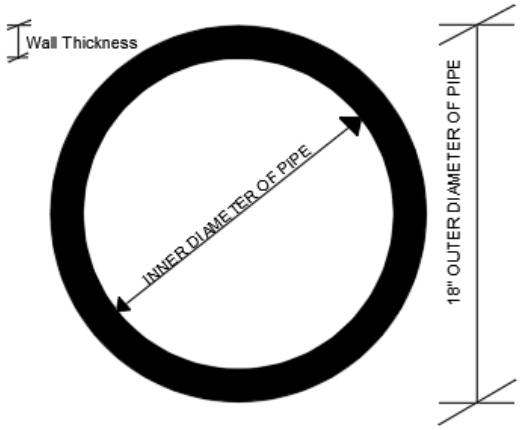


CROSS - SECTION OF STORM DRAIN



Cross - Section Of Pipe

Figure 16 : cross section of final double 18″ smooth wall HDPE pipe

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COST OF IMPLEMENTING THE DESIGN

Table 14: Implementing cost breakdown

Description			COST
Length of pipes	526 ft	Unit price	
Average Depth of channel	3 ft		
Width of channel	4 ft		
Labor	62.5 Hours	@ $70 per hour	$4,375.00
Manhole Construction:			
Radius of manhole	2 ft		
Perimeter	12.5 ft		
Average Height of manhole	7 ft		
Number of Bricks Required	59		
Bricks required for 6-manholes	360	@ $11 per brick	$3,958.29
Sand Required for this job	1052 cu.ft	@ $35 per Cu.ft	$1,365.00
Pipe materials:			
Double HDPE 18" pipes	526 ft	@ $16.5 per feet	$8,676.36
TOTAL			$18,374.65

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SOCIAL IMPACT

- Lower risk of flooding
- Decrease property damage
- Safer transportation along South Pullam Dr
- Loud noises during construction
- Safety of children and adults

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ENVIROMENTAL IMPACT

- Natural plant growth
- Increase pollutions
- Air quality

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ECONOMIC IMPACT

- Increase life span of road
- Lower flood insurance rate for residence within the neighborhood
- Construction cost
- Homeowners association will save money in long term
- Increase property value

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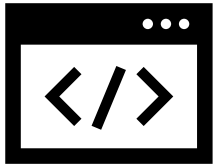
FOR MORE INFO PLEASE VISIT OUR WEBSITE



https://ceias.nau.edu/capstone/projects/CENE/2020/SummitNeighborhood/index.html

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WORK CITED

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