Prescott Dells Ranch
(Dewey Site Design)

Crossed Arrow Engineering

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CENE-486C

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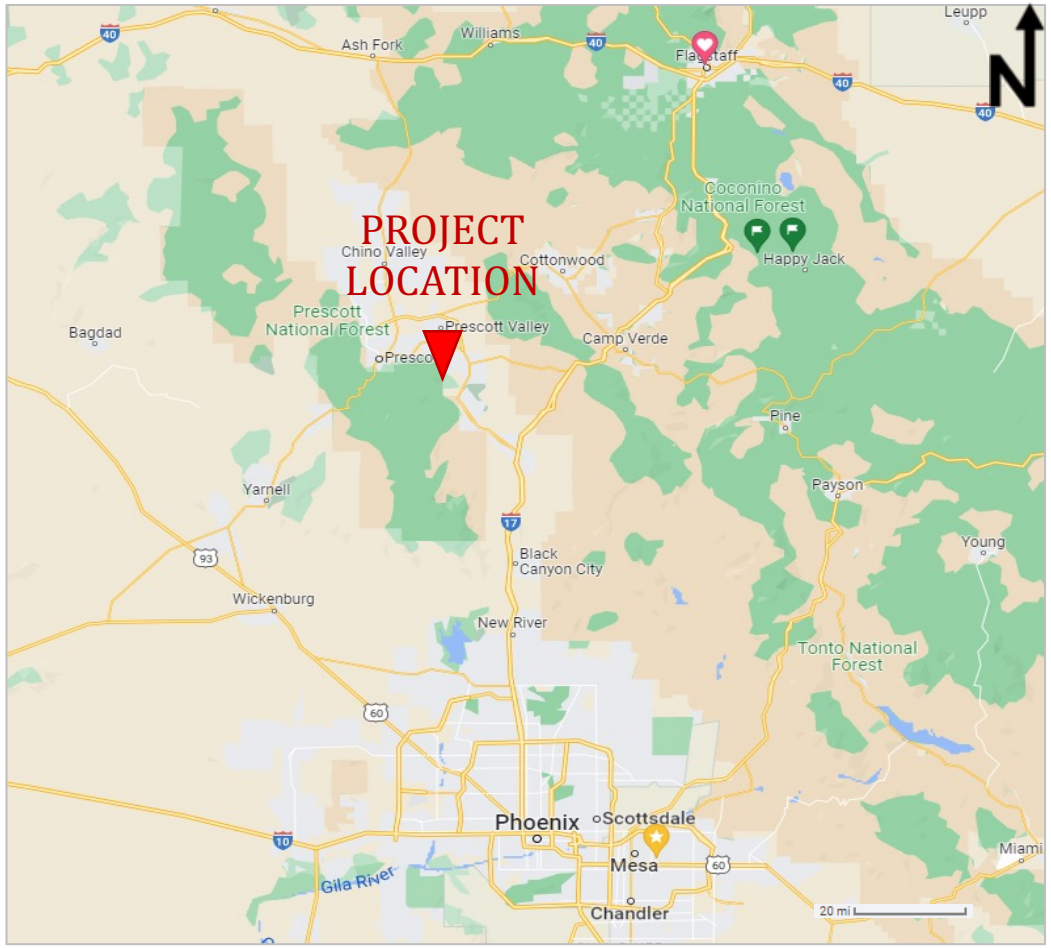
1 Project Information



[2] Figure 1. Vicinity Map of Approximate Location

Location

11800 E Prescott Dells Ranch Rd

Purpose

Site design, grading and drainage plan

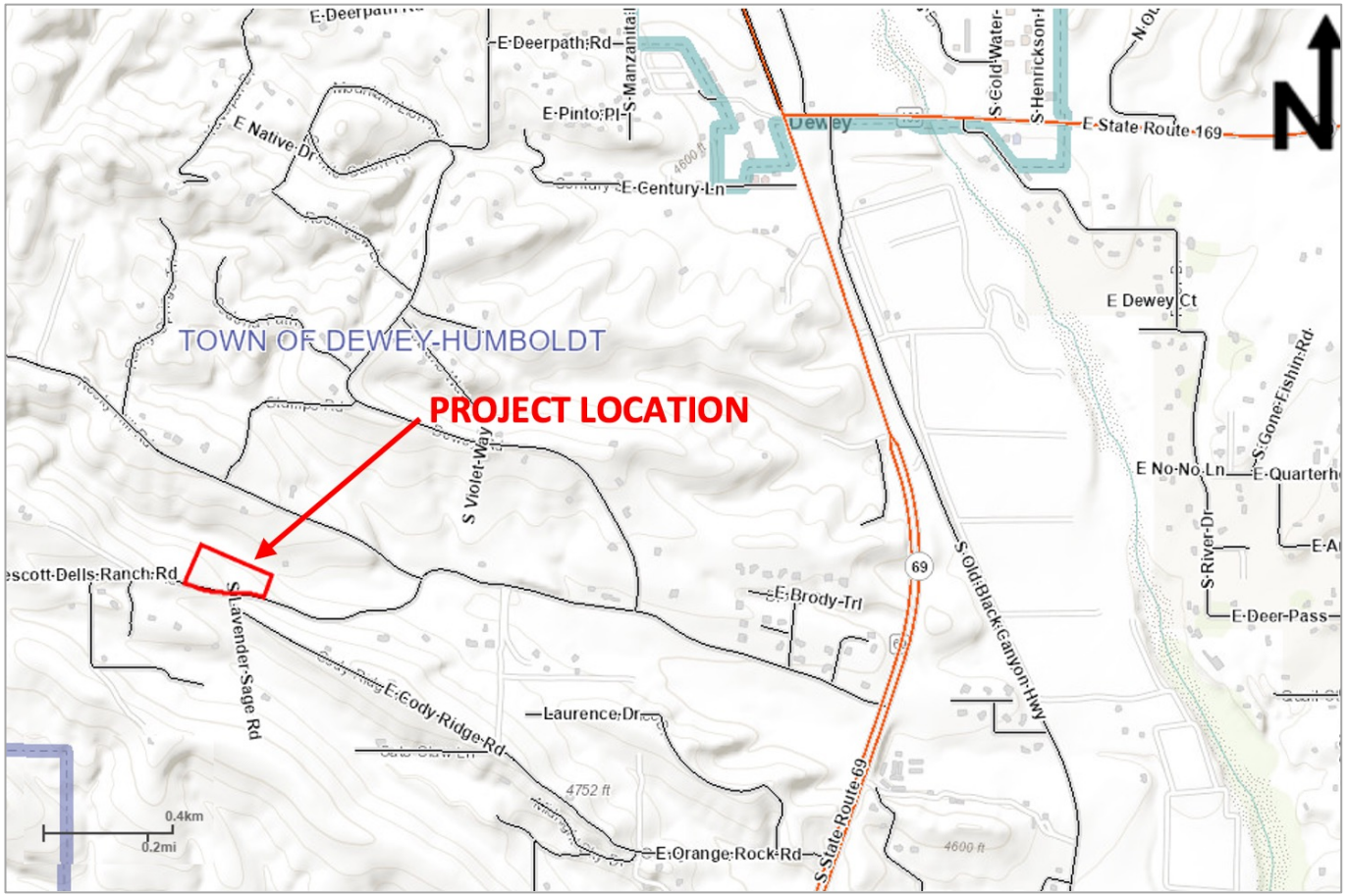
Per Yavapai County Standards [3]

Client and Technical Advisor

Client: Taylor Layland, REMAL Consulting

Technical Advisor: Jeffrey Heiderscheidt, PhD

1 Project Information



[4] Figure 2 Project Location Map

Elevation

4800 ft

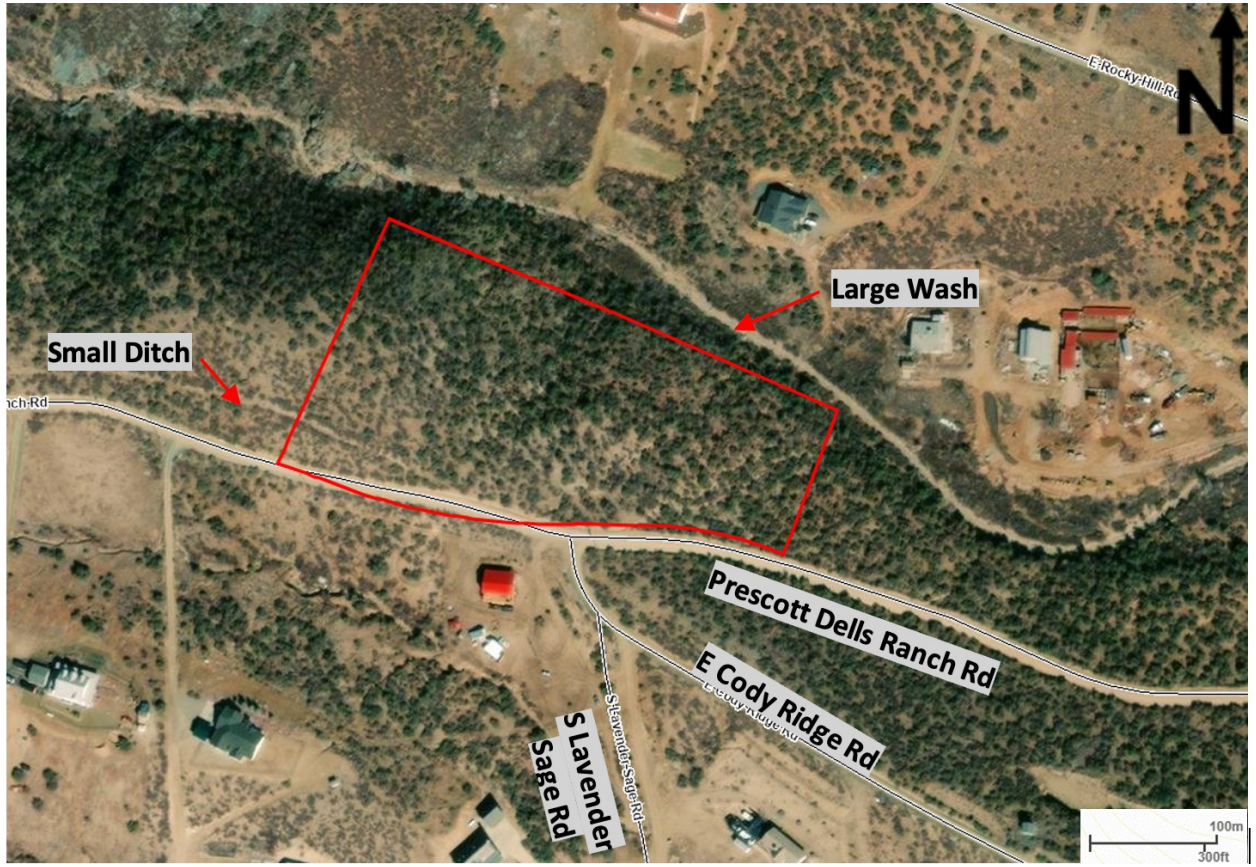
Constraints

- Minimum setback: 50 ft
- Single family residential only

Limitations

- No site visit

2 Site Investigation



[4] Figure 3 Soil Survey Area

- Soil Survey from NRCS [5]
- Information to be used in Hydrologic Analysis
- Group 'C' = Slow water transmission and infiltration rate

Table 1 Soil Properties

Hydrologic Soil Group	C
Soil Type	Balon gravelly sandy clay loam
Depth to Restrictive Feature	≥ 80 inches
Depth to Water Table	≥ 80 inches
Mean Annual Precipitation	≈ 14 inches

3 Hydrologic Analysis

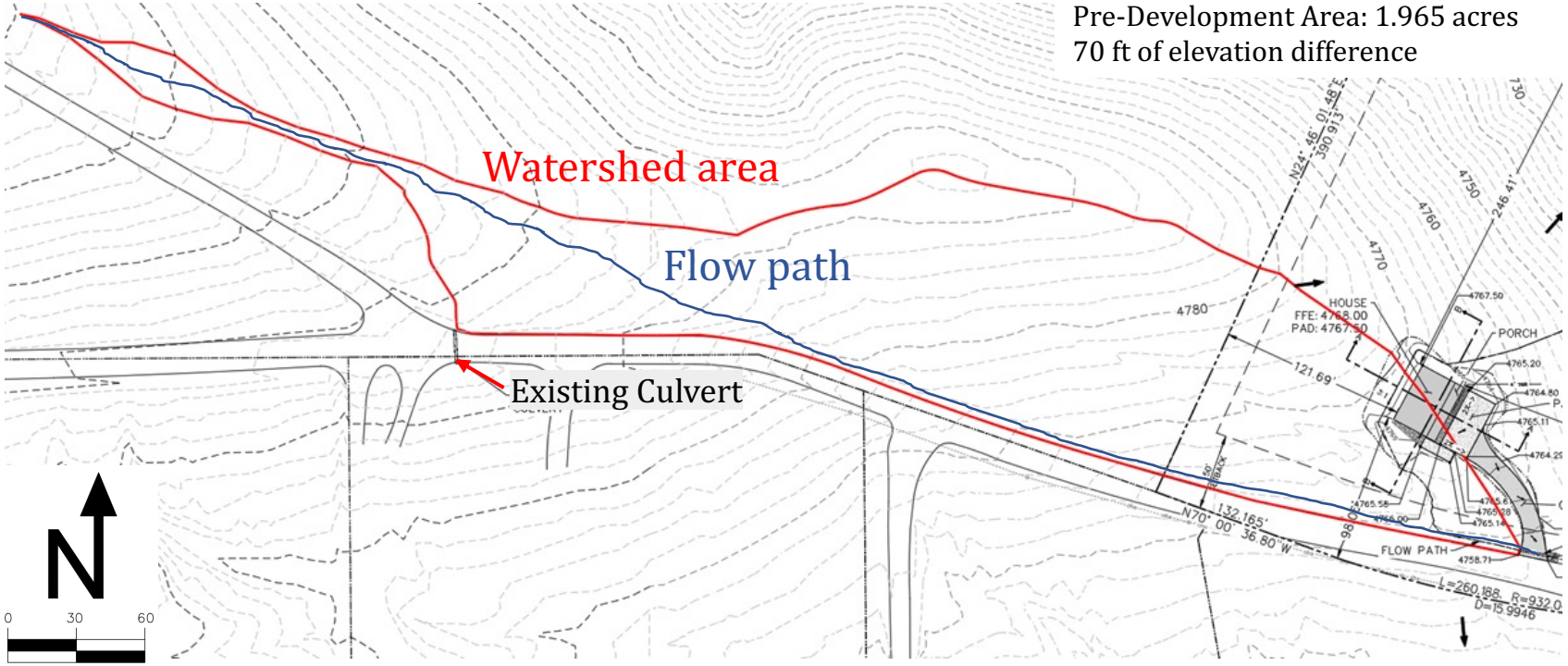


Figure 4 Pre-Development Watershed Area

Methodology

ADOT Rational Method Tool [6]

Storm Event

25-year storm

Existing Conditions

Watershed Area: 1.965 acres
Length: 0.201 miles
Elevation change: 70 ft
Predominant Landform Type: Rangeland

3 Hydrologic Analysis

Table 2 Input data in ADOT Rational Method Tool

Slope (ft/mi)	348.26
Kb	0.1
Time of concentration (hr)/(min)	0.082/4.9

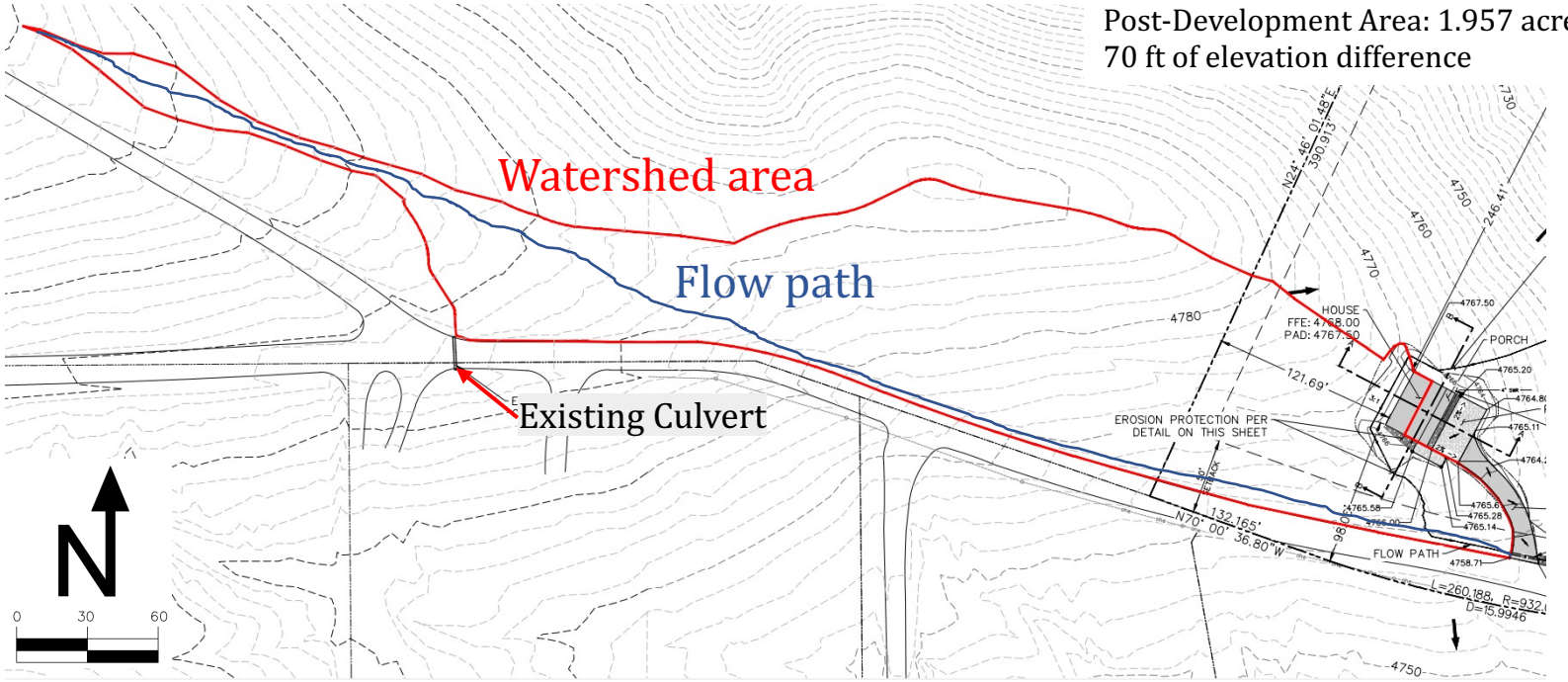
- Rational Method Equation
- Time of Concentration, T_c Equation

Figure 5 ADOT Rational Method Tool [6]

Table 3 ADOT Rational Method Calculations for pre-development

Design Storm Event	Discharge - Q (cfs)	Rational Coefficient - C	Rainfall Intensity - I (in/hr)	Area - A (acres)	Calculated T_c (min)	Applied T_c (min)
2-Year	1.1	.20	2.84	1.965	6.7	10
10-Year	2.1	.23	4.68	1.965	5.4	10
25-Year	3.6	.31	5.68	1.965	**4.9**	**10**
100-year	6.2	.40	6.84	1.965	4.4	10

3 Hydrologic Analysis



Post-Development Area: 1.957 acres
70 ft of elevation difference

Figure 6 Post-Development Watershed

- Area-averaged C-value

Table 4 Composite C-value Calculation

25-year		
	Area (acres)	**Average 'C'**
Pavement and rooftops	0.0127	0.885
Desert Landscaping 1	1.9443	0.775
C_{comp}	0.776	

3 Hydrologic Analysis

Table 5 Pre-Development Site data

Pre-Development Site Data	
Total Area (acre)	1.965
C	0.775
Q (cfs)*	8.92
Intensity (in/hr)	5.86
Length(mile)	0.201
ΔH Elevation (ft)	70
Slope (ft/mi)	348.26
Landform type	Rangeland
Kb	0.1
Tc (applied) (min)	10
Tc (computed) (min)	4.9

Changed

Table 6 Post-Development Site data

Post-Development Site Data	
Total Area (acre)	1.965
Coefficient C_1	0.885
Coefficient C_2	0.775
Area (roof) (acre)	0.0127
Area (Landscape) (acre)	1.9443
C_{comp}	0.776
Q (cfs)*	8.94
Intensity (in/hr)	5.86
Length (mi)	0.201
ΔH Elevation (ft)	70
Slope (ft/mi)	348.26
Landform type	Rangeland
K_b	0.1
T_c (applied) (min)	10
T_c (computed) (min)	2.7

4 Hydraulic Analysis

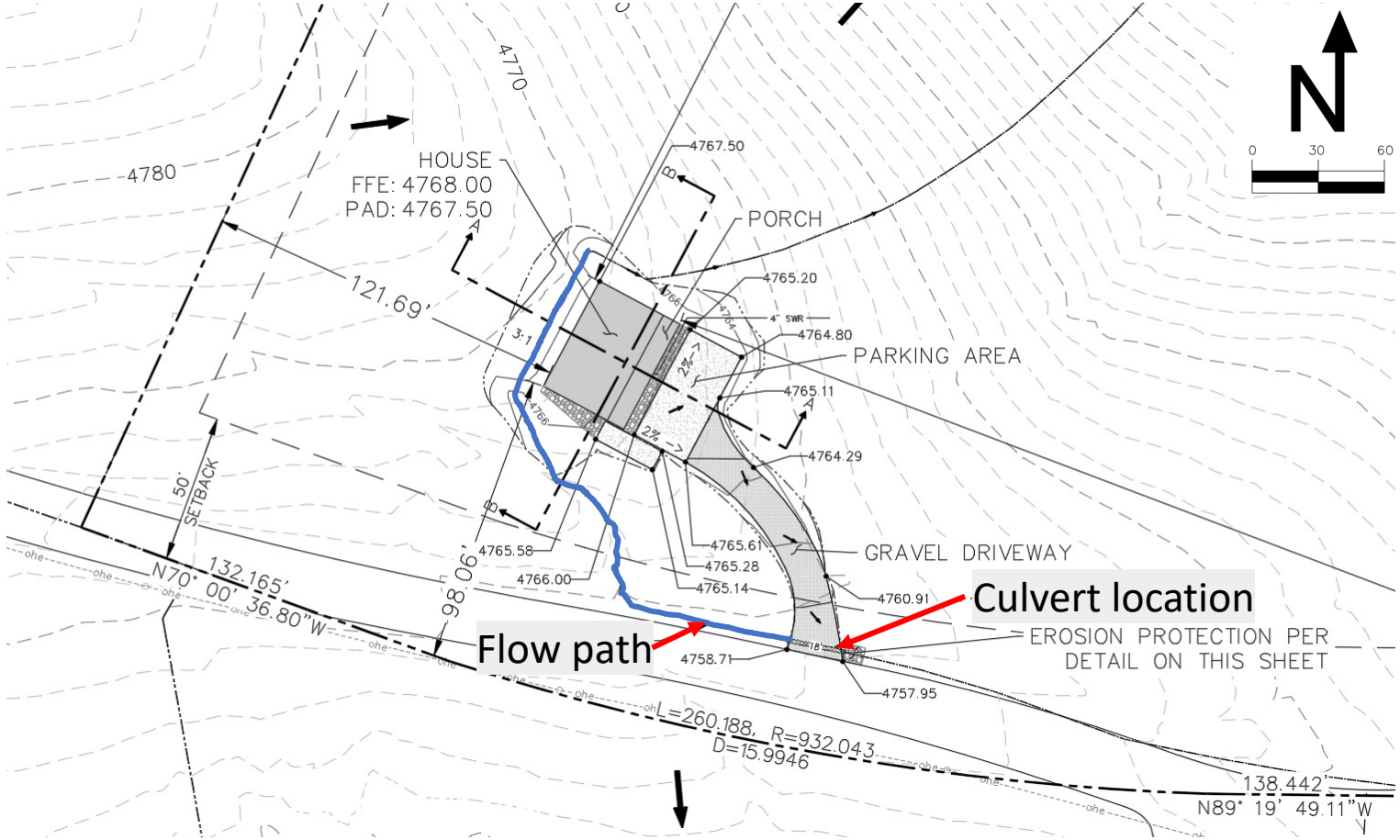


Figure 7 Proposed flow path through culvert

Table 7 Exiting Conditions for Culvert

Length – L (ft)	18
ΔH (ft)	0.59
Slope – S (ft/ft)	0.033
Shape	Circular

4 Hydraulic Analysis

Table 8 Culvert Hydraulic Design Standards for Yavapai County [7]

Culvert Hydraulic Design Standards	
Design Variable	Design Standard
Minimum Velocity	5 fps for Q_{design} Lesser of 3 fps for 0.5 x Q_{design} or 3 fps at flow depth = 1’
Maximum Velocity	20 fps
Minimum Slope	0.005 ft/ft

- Continuity Equation
- Energy Equation in the culvert

Table 9 Potential Solutions for Culvert

Solution ID	Flow Regime	Material	Exit Velocity (ft/s)	Inlet HW Elev. (ft)	Tailwater Elev. (ft)	Normal Depth (ft)	Compliance for Manual
1	Supercritical	CMP	6.56	4758.23	4756.75	1.02	Yes
2	Supercritical	Concrete	9.07	4759.05	4756.75	0.78	Yes
3	Supercritical	Smooth walled-HDPE	9.47	4758.68	4756.75	0.77	Yes

4 Hydraulic Analysis

Table 10 Potential Solutions Comparison [8]

Potential Solution	Material	Lifespan (yr)	Exit Velocity (fps)	Cost ($/ft)
1	CMP	15~40	6.56	60.00
2	Concrete	>100	9.07	125.00
3	Smooth walled-HDPE	100	9.47	55.00

Table 11 Decision Matrix

Solution	Lifespan	Exit Velocity	Cost	Total
18”-CMP	1	3	3	7
15”-Concrete	3	1	1	5
15”-HDPE	3	1	2	6

Winner!

5 Plan Set Production

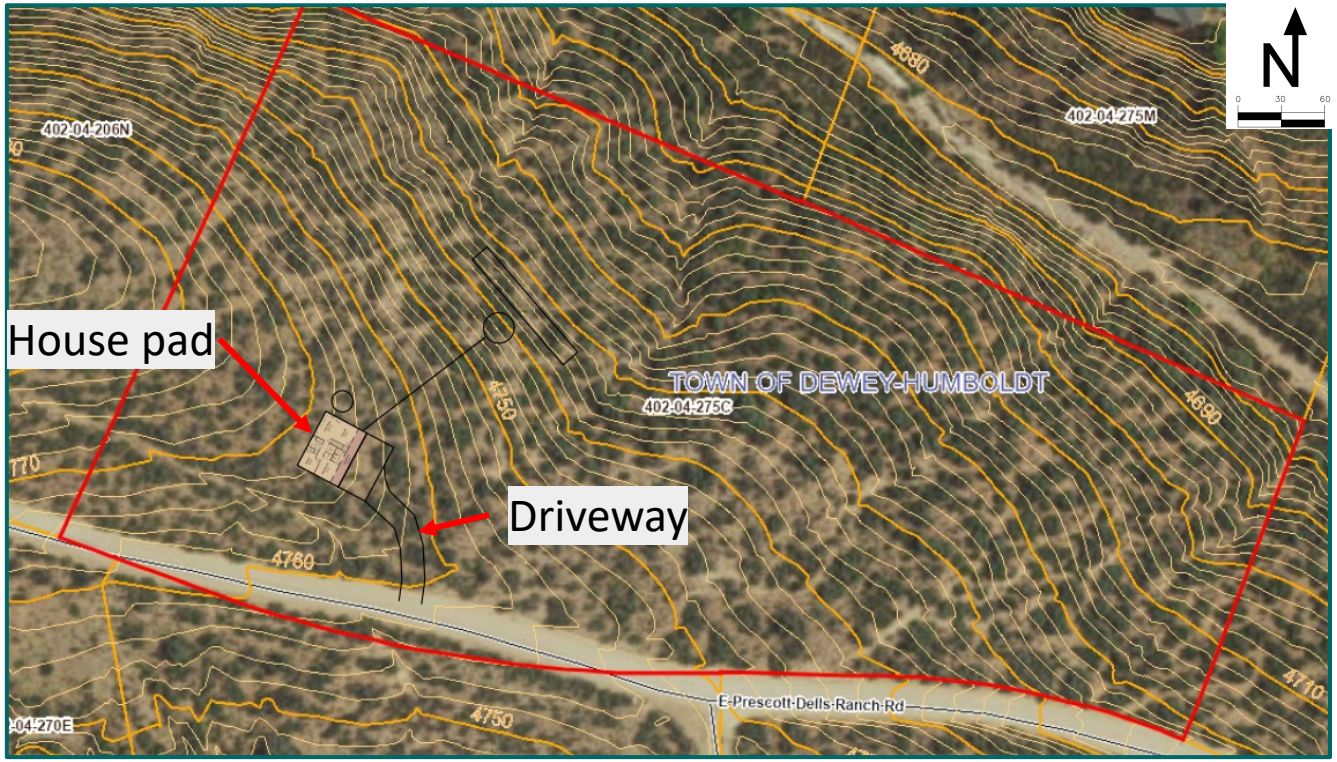


Figure 8 Proposed location of structures

Client requests and standards

- FF (Finish Floor) Elevation: 4768 ft
- Pad Elevation: 6in. Below Finish Floor
- Approximate Existing Ground Slope ≈ 10%
- Side slope of cut walls 3:1

5 Plan Set Production

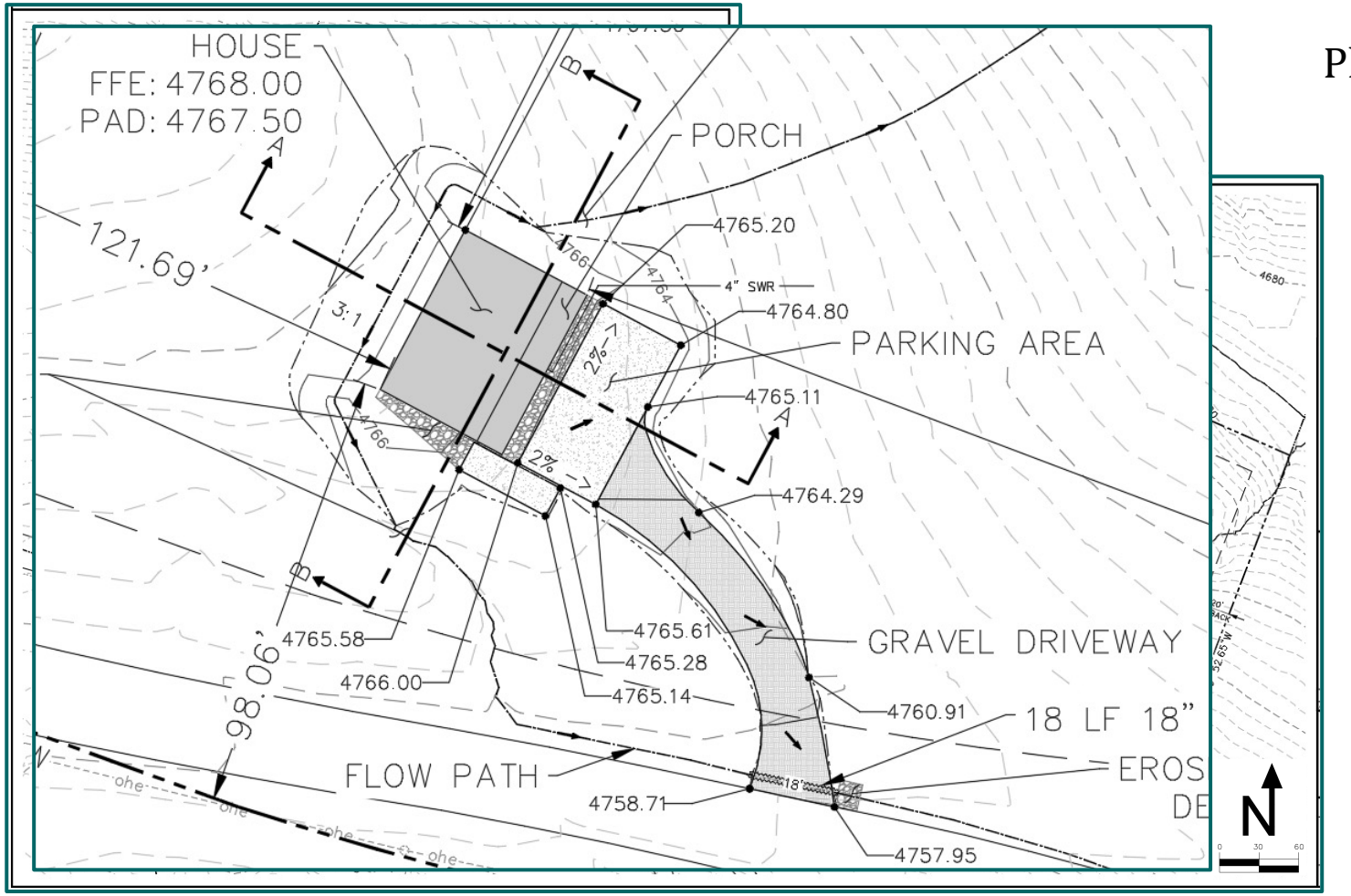


Figure 9 Grading/Drainage

Plan Set Requirements

- Designed according to Yavapai County Standards [3]
- Cut/Fill Quantities
- Property Limits
- 2 cross sectional details orthogonal to each other
- Location of existing structures
- Required notes

5 Plan Set Production

Table 16 Civil 3D Volume Comparison

Area (ft^2)	Cut (yd^3)	Fill (yd^3)	Net (yd^3)
6683.69	124.82	117.1	7.72 (Cut)

Figure 12 Section A-A Project Site

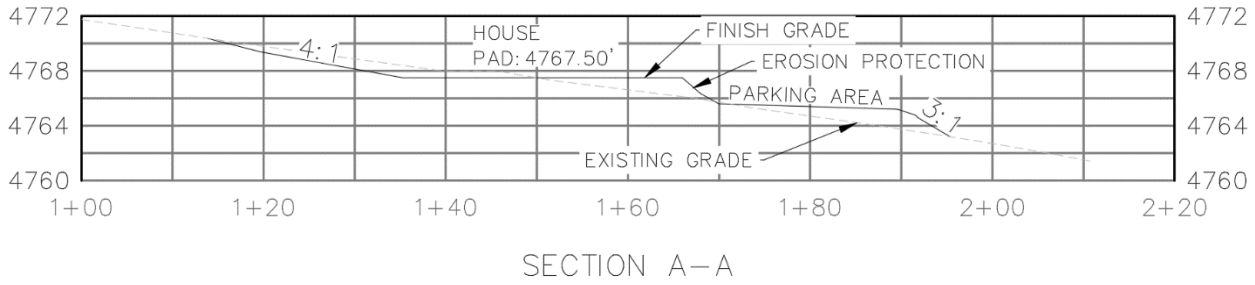
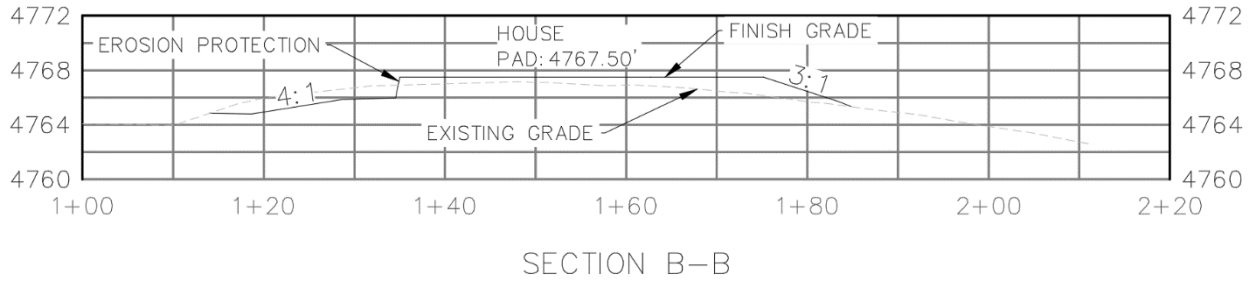


Figure 13 Section B-B Project Site



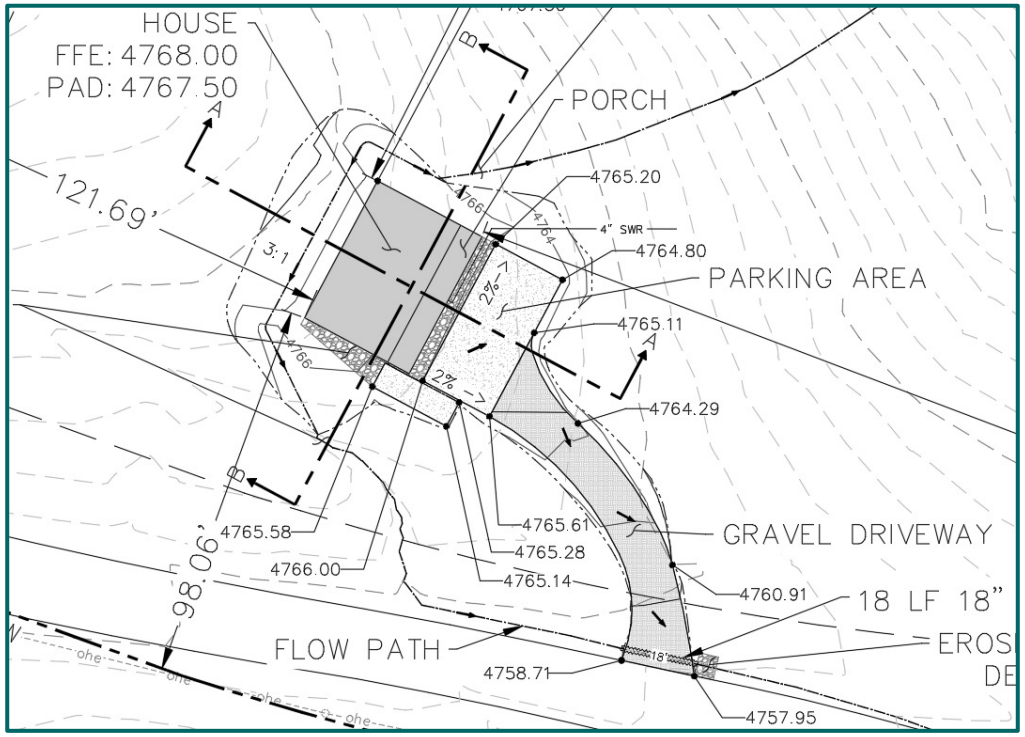


Figure 10 Project Site

5 Plan Set Production

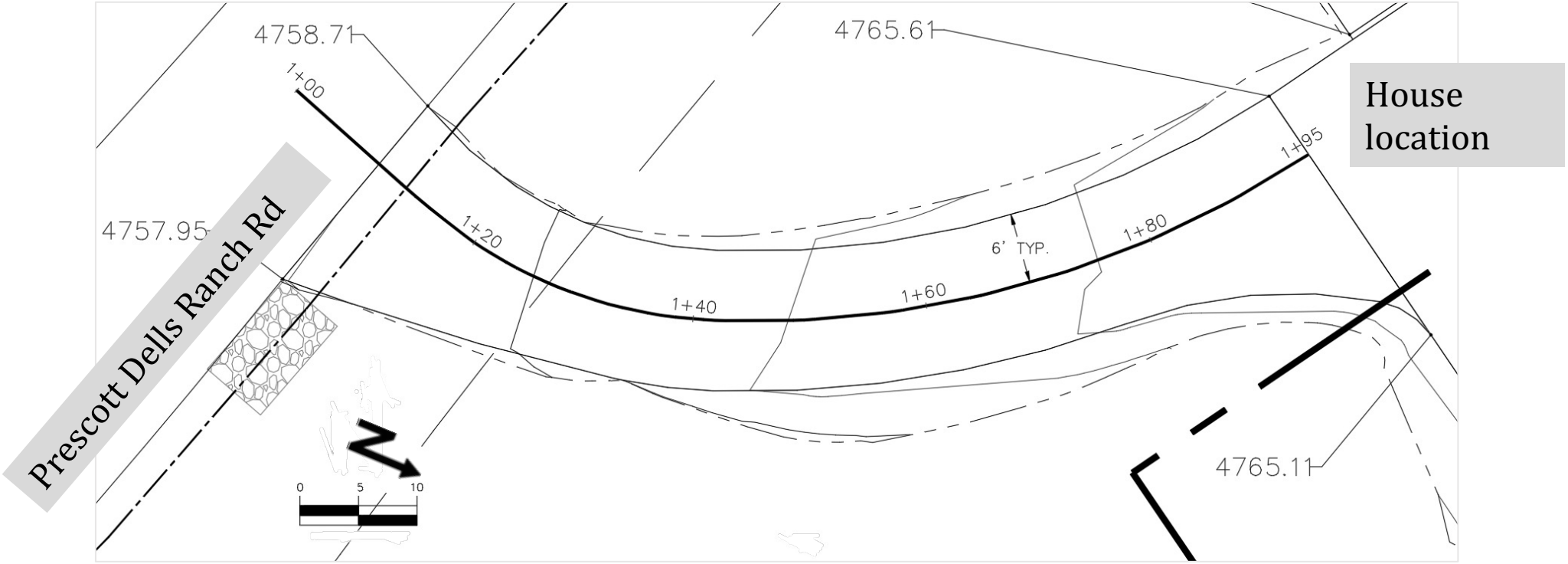


Figure 14 Driveway Plan View

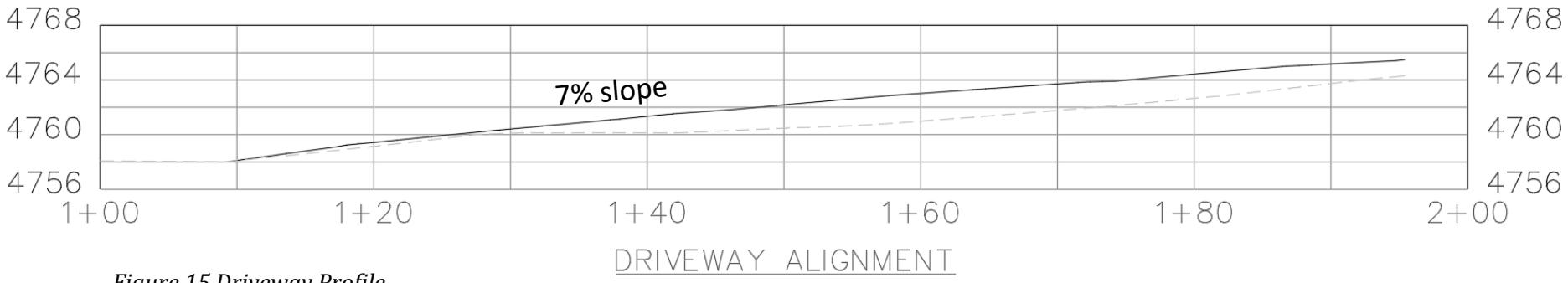


Figure 15 Driveway Profile

6 Site Design

Riprap Outlet Protection (*downstream of culvert)

Figure 9 Typical Erosion Protection [1]

Table 14 Calculations for Froude Number

Velocity (ft/s)	6.56
Depth of Flow (ft)	1.02
Froude number, F_r	1.02

Table 15 Design Criteria for Riprap Apron Sizing Chart

Criteria name	Calculated Value	Criteria	Criteria Met?
V (fps)	6.56	≤20	YES
$Q/D_c^{2.5}$	2. 38	≤6	YES
Y_t/D_c	0.35	0.35	YES

$1 \leq F_r \leq 2.5$ and $\frac{Q}{D_c^{2.5}} \leq 6$ permits use of Simplified Riprap Apron Method [7]

6 Site Design

Figure 11.6 Riprap Apron Sizing Chart for Circular Culvert Outlets

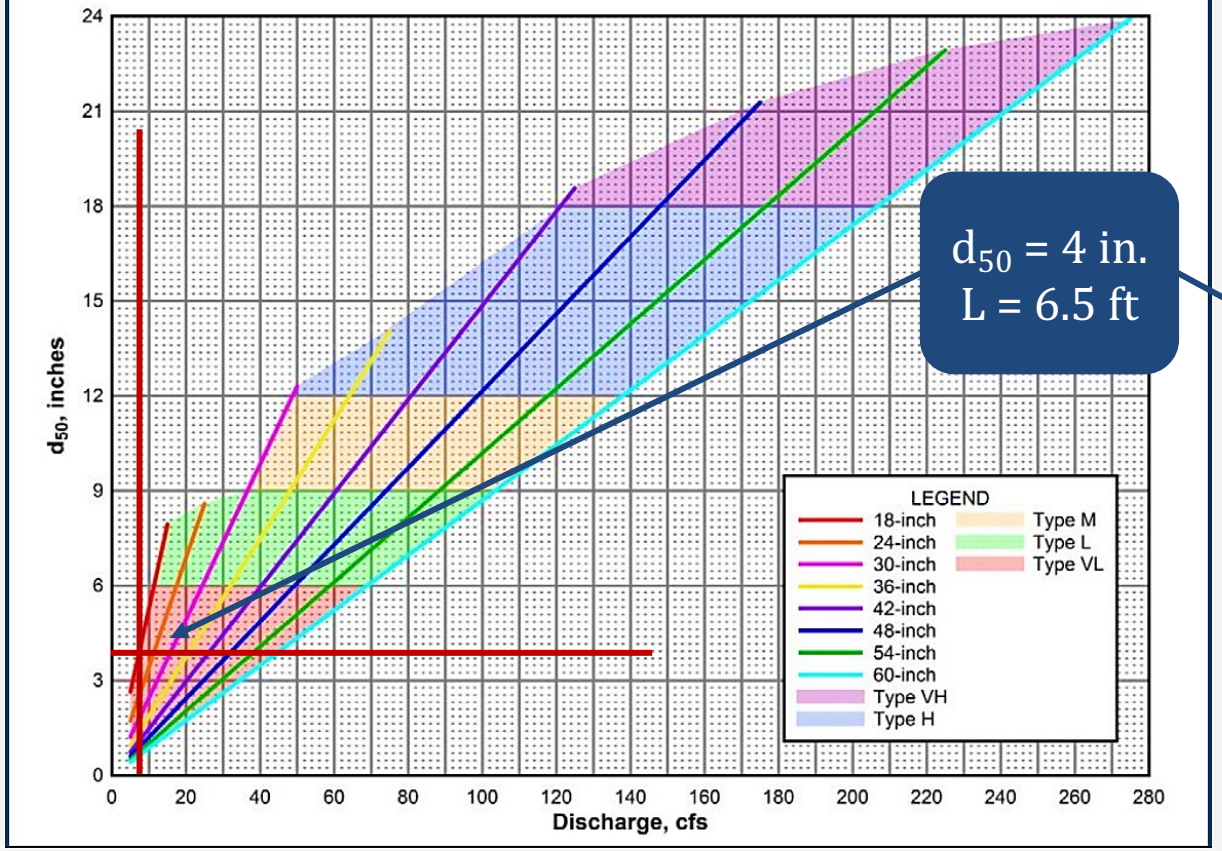


Figure 10 Riprap Apron Sizing Chart [7]

Figure 11.7 Riprap Apron Length for Circular Pipes (18-inch - 36-inch)

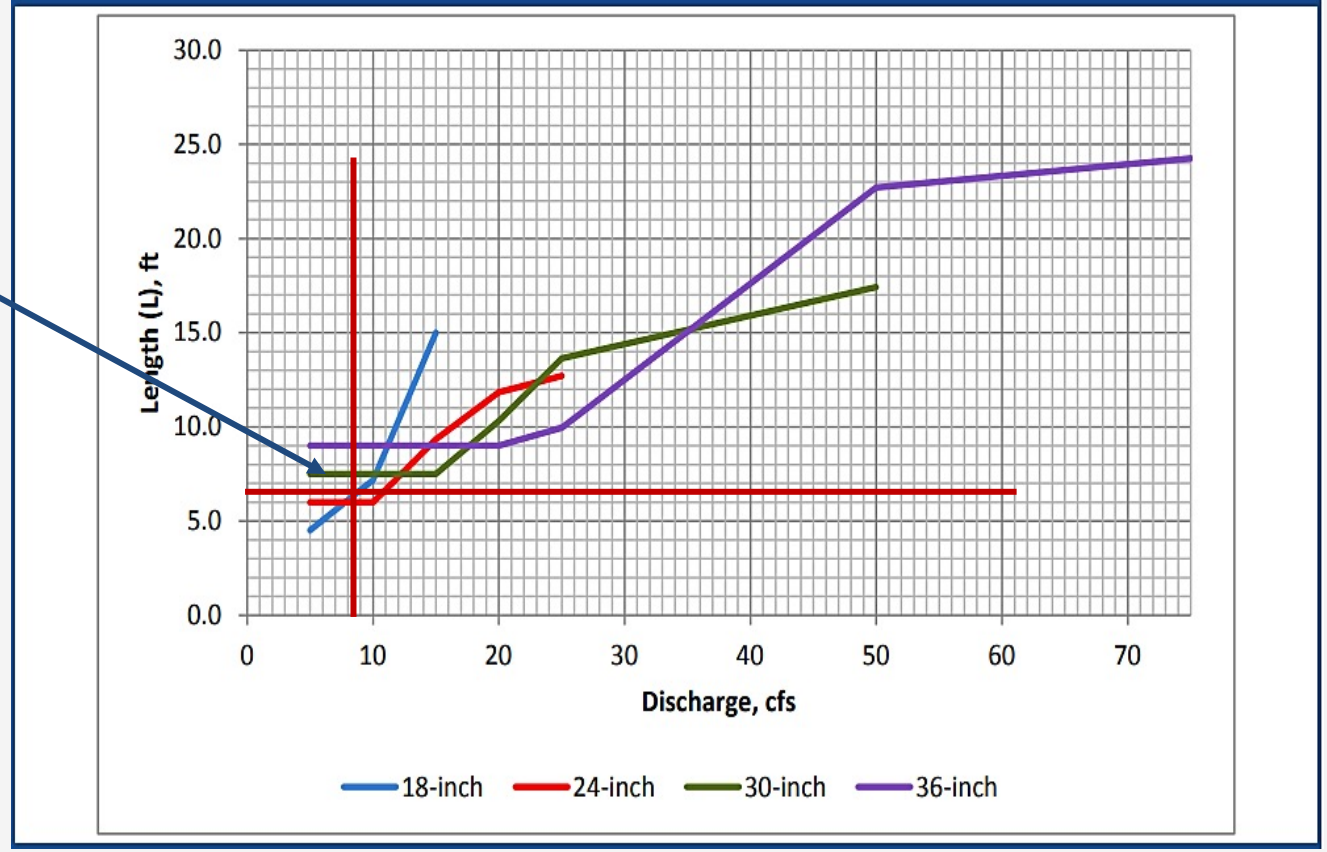


Figure 11 Riprap Apron Length Chart [7]

7 Impact Analysis

Social Impacts

+ New neighbors
+ Increase the enrollment at local schools and the attendance at local churches
+ Increase the local property value

- Eliminates neighbors' view
- Increased delay

Environmental Impacts

+ Reduce sedimentation

- Initial vegetation removal
- Displacement of wildlife
- Increased noise pollution
- Increase fuel consumption

Economic Impacts

+ Increase revenue for builder of the cabin
+ Increased population of the town

- Cost of electricity, water, and the occasional septic tank cleaning

8 Construction Cost Estimate

Table 17 Material Estimate [8]

Material	Quantity	Unit Price ($)	Cost ($)
Excavation and grading	242 yd^3	65	4,500
Remove excess material from site*	7.72 yd^3	45.75/ton	510
D_{50}=4in. Rock*	0.33 yd^3	30/ton	100
		Total	**5,110**

* Includes cost for delivery

Table 18 Labor Estimate [8]

Position	wage/hr	labor hours	Cost ($)
Foreman	$30.70	16	491
Equipment Operator	$39.25	56	2,204
Laborer	$28.70	64	1,837
		Total	**4,600**

Table 19 Equipment Estimate [8]

Equipment	Cost ($)
Heavy equipment, Dump Truck, Compactor	**4,500**

- Material Cost: $5,100
- Labor Cost: $4,600
- Equipment Cost: $4,500
- Total Cost: $ 14,200

3 References

[1] "Bing Images," Bing, [Online]. Available: https://www.bing.com/images/search?view=detailV2&ccid=Xd1%2fIXyE&id=35F349089916B3837E62C20D73A9816BF37EC391&thid=OIP.Xd1_IXyEzHCBwLpaiOz6oAHaFj&mediaurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.5ddd7f217c84cc7081c0ba5a88ecfaa0%3frik%3dkcN%252b82uBqXMNwg%2. [Accessed 21 October 2022].

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[5] U. S. D. o. Agriculture, "Soil Survey of Yavapai County, Arizona," 1968. [Online]. Available: https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=AZ. [Accessed 26 09 2022].

[6] ADOT, "ADOT Rational Method Tool," [Online]. Available: https://apps.azdot.gov/files/roadway-engineering/hydrology-manual-online-data/ADOTRational.zip. [Accessed 7 February 2022].

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[8] A. D. o. Transportation, "Estimated Engineering Construction Cost," ADOT, [Online]. Available: https://apps.azdot.gov/Applications/ReportViewerHost/ReportViewer/Viewer.aspx?ReportPath=/E2C2/E2C2BidHistory&cCty=MA&cDistrict=E&cItemNbr=&cRoute=&cTracsNbr=&dFromBidDate=12/6/2002&dFromMP=&dFromQty=&dToBidDate=12/6/2022&dToMP=&dToQty=&vcDescript=hdpe&vc. [Accessed 6 December 2022].