Coyote Springs Riparian Habitat Restoration Assessment

AARK Stream Restorations, LLC.

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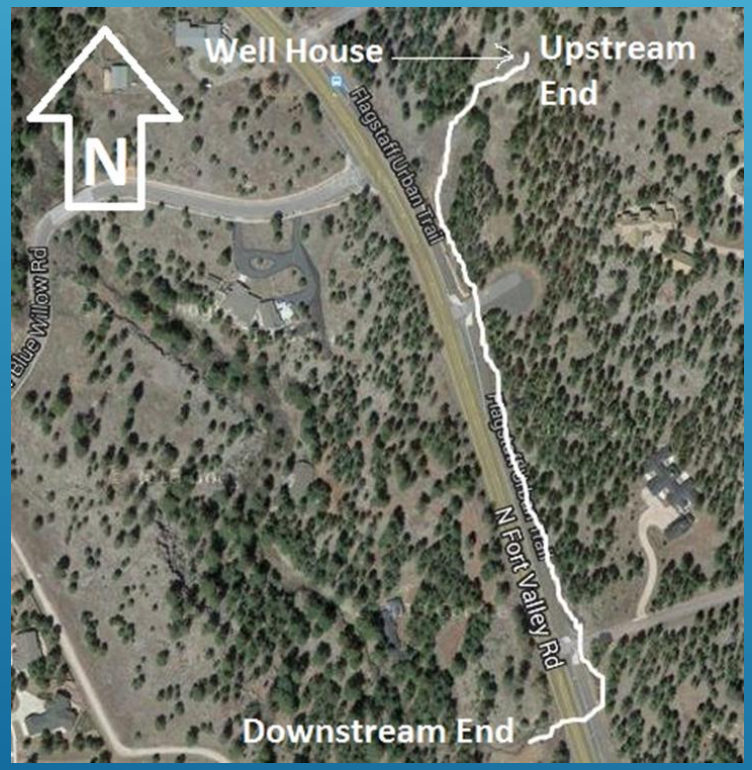
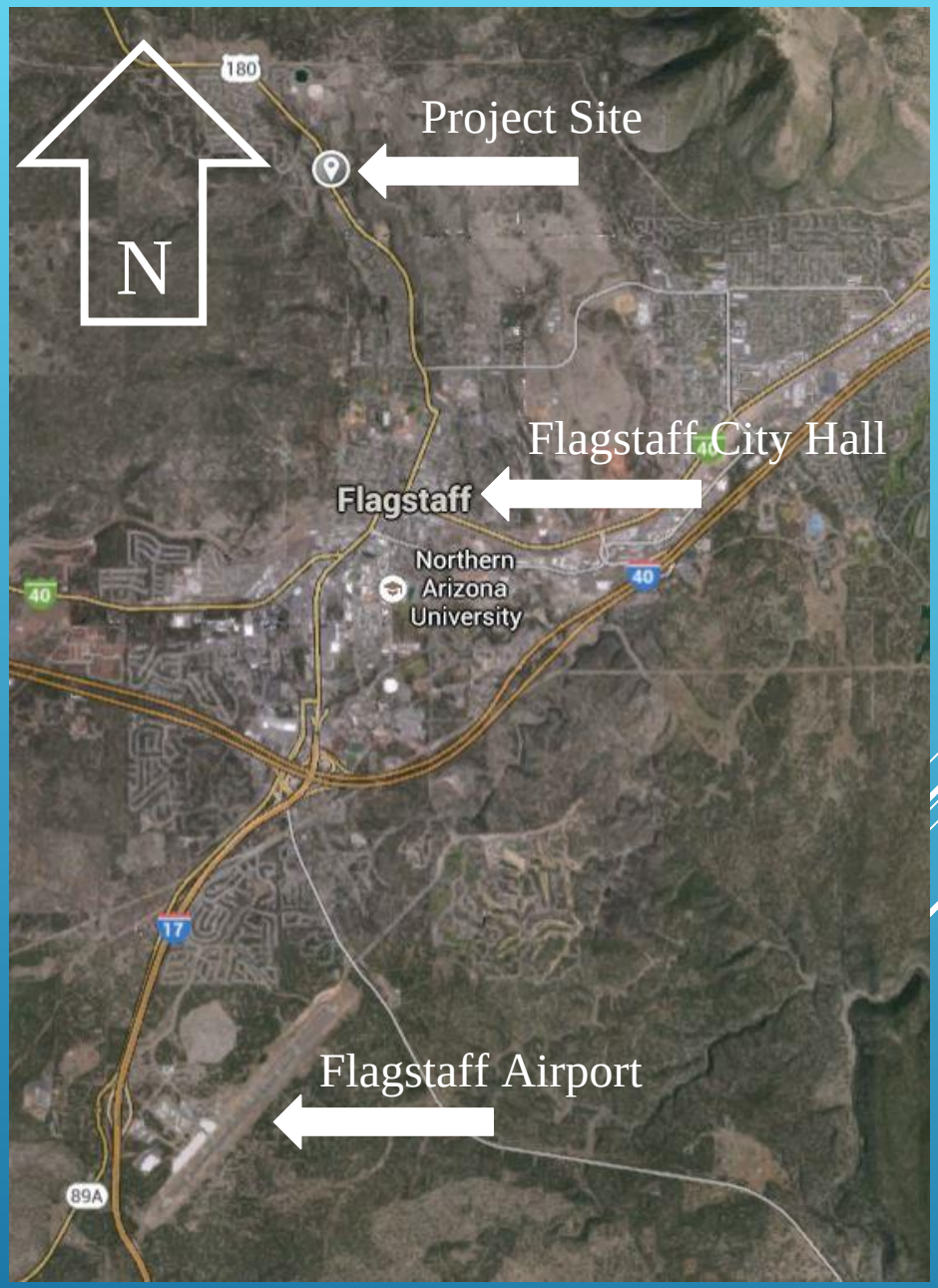
NORTHERN ARIZONA UNIVERSITY

Coyote Springs Location

- Located along N Fort Valley Rd (HWY 180)
- Coyote Springs Estate
- ~1,360 Ft Stream Reach





Both Images: From Google Maps

Kyle

Project Understanding

- Client: Cindy Perin, Coyote Springs HOA
- Perennial stream from wellhouse
- Riparian habitat assessment
- Analyze stream reach, culvert inlets and outlets, pooling area, and channel

Left: Deer Near Well House

Above: Stream Reach With Overgrown Vegetation Looking South From Start of Stream From Wellhouse

Kyle

Field Evaluation

- Trickling flow
- Shallow stream
- Overgrown vegetation
- Pooling area
- Slope stabilization netting

Left: Culvert Inlet Overgrown

Above: Upstream Channel

Above: Turf Reinforcement Netting

Kyle

Hydrology

Perennial Stream Flow, Q				
Test No	Time, sec	Distance, Ft	Velocity, ft/s	Q, cfs
1	6.8	3	0.441	0.040
2	5.3	3	0.566	
3	6.8	3	0.441	
		Avg	0.483	
Channel Area, ft^2		0.08333		

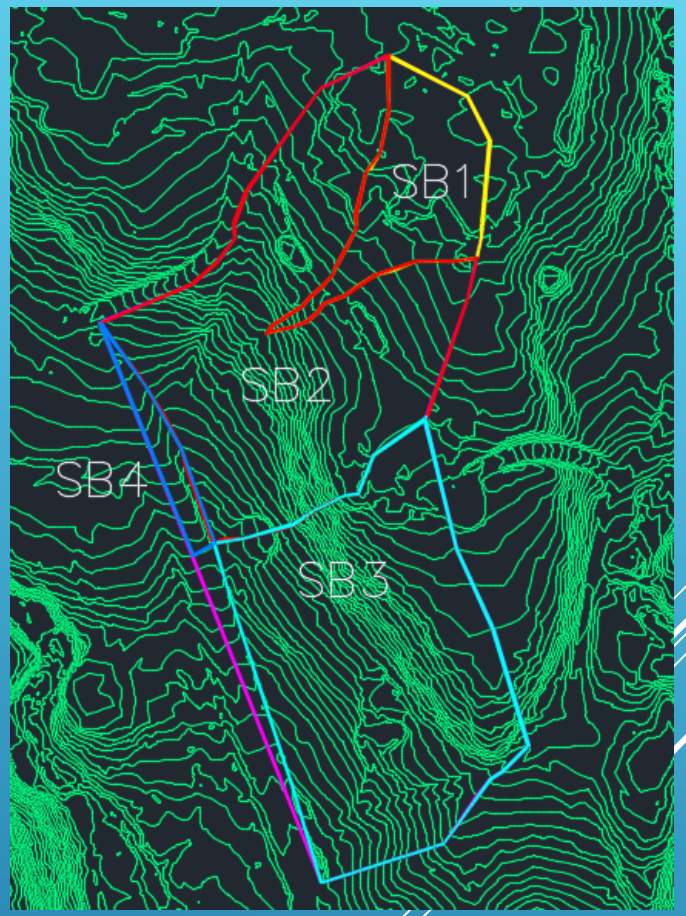
- Coconino County Drainage Design Manual
- Discharges to analyze culverts and channels
- Based on 25-year, 10 minute duration

Coconino County Rational Method:

$$Q = C_f CIA$$

Rainfall Intensity, I (in/hr)			
Duration (min)	25 yrs	50 yrs	100 yrs
5	6.84	7.68	8.52
10	5.34	6	6.66
15	4.4	4.92	5.48
30	2.86	3.22	3.58
60	1.76	1.98	2.21

Sub-Basin Discharges							
Sub Basin	Area (Sf)	Area (Acre)	Runoff Coefficient, C	Duration (min)	Rainfall Intensity (in/hr)	Precip Factor, Cf	Q (cfs) 25-yr
SB1	126,566	2.91	0.15	10	5.34	1.1	2.56
SB2	502,116	11.53	0.15	10	5.34	1.1	10.16
SB3	401,354	9.21	0.10	10	5.34	1.1	5.41
SB4	30,594	0.70	0.95	10	5.34	1.1	3.92
Total	1,060,630	24.35					22.05



Above: Watershed Delineation

Kyle

Rosgen Level 2 Analysis

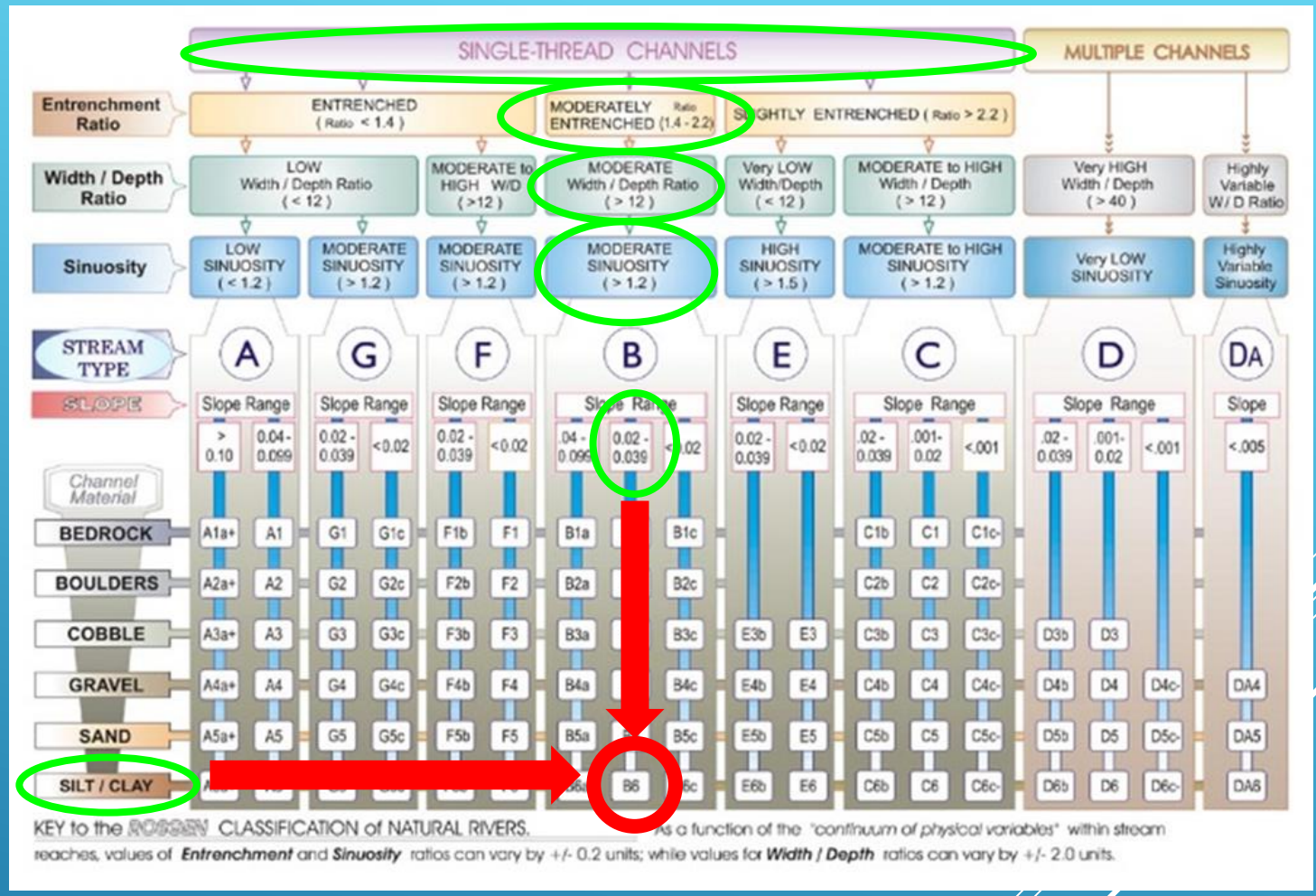
Determination of Stream Type

- Single Thread Channel
- Moderately Entrenched
- Moderate to High Width to Depth
- Low to Moderate Sinuosity
- Slope 0.0389 ft/ft
- Silt / Clay Soil

Stream Reach Was Determined to be Rosgen Level 2: B6

Coyote Springs Stream Classification Summary	
Stream Length (ft)	1360.82
Valley Length (ft)	1346.68
Change in Elevation (ft)	53.00
Entrenchment Ratio (ft/ft)	1.81
Width to Depth Ratio (ft/ft)	24.78
Channel Sinuousity (ft/ft)	1.01
Stream Slope (ft/ft)	0.04

Above: From Excel



Citation: Rosgen Classification Scheme, Technical Supplement 3E, NEH 654.

AJ

Culvert Analysis

- Results From Bentley CulvertMaster
- The City of Flagstaff Stormwater Management Design Manual :

  25 years flow = 22.05 cfs
  100 years flow = 31.25 cfs

Culverts dimensions, status and control							
Culvert	Length (ft)	Material	Diameter (in)	Inlet	Outlet	Control	Outlet Clearance (in)
Culvert 1	90	Corrugated	24	vegetation	Sedimentation	Outlet	2
Culvert 2	50	Corrugated	24	Pooling area	vegetation	Outlet	12
Culvert 3	100	Corrugated	24	Some rocks	vegetation	Outlet	23

Above: From Excel

Above: From Google Maps

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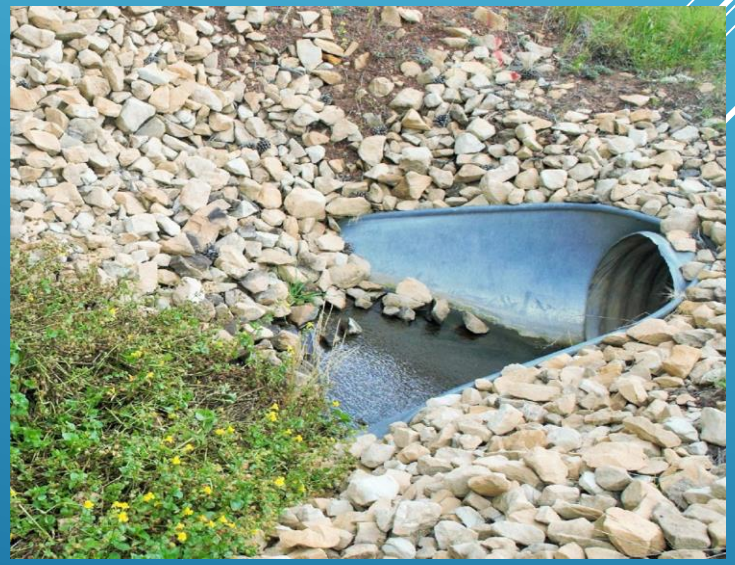
Culvert Analysis Cont.

Above: Culvert 2 Inlet

Right: Culvert 2 Outlet

Above: Culvert 1 Inlet

Above: Culvert 1 Outlet



Above: Culvert 3 Inlet

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Channel Analysis-Normal Depth

Normal Depth analysis from FlowMaster				
Cross Section	Normal Depth(ft)	Velocity (ft/s)	Discharge (ft^3/s)	Flow Type
1(Well House)	0.56	1.71	12.72	Subcritical
2	0.5	1.65	12.72	Subcritical
3	0.7	1.63	12.72	Subcritical
4	0.48	1.21	12.72	Subcritical
5	0.68	1.56	12.72	Subcritical
6	0.63	1.73	12.72	Subcritical
Culvert 1				
7	1.01	2.12	22.05	Subcritical
8	1.45	2.68	22.05	Subcritical
9	0.69	1.76	22.05	Subcritical
10(Pooling Area)	0.95	2.12	22.05	Subcritical
Culvert 2				
11	1.96	2.87	22.05	Subcritical
12	1.79	2.9	22.05	Subcritical
Culvert 3				

- Cross sections 4 through 12 are adjacent to Highway 180
- Results from Bentley FlowMaster

Above: From Excel

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Channel Analysis-Flow Capacity

Flows from FlowMaster compared to 25-yr and 100-yr flow					
Cross Section	Discharge (ft^3/s)	25-yr		100-yr	
		Discharge (ft^3/s)	Pass?	Discharge (ft^3/s)	Pass?
1(Well House)	5.98	12.72	NO	18.02	NO
2	53.39	12.72	YES	18.02	YES
3	16.25	12.72	YES	18.02	NO
4	29.24	12.72	YES	18.02	YES
5	314.37	12.72	YES	18.02	YES
6	198	12.72	YES	18.02	YES
Culvert 1					
7	25.83	22.05	YES	31.25	NO
8	75.23	22.05	YES	31.25	YES
9	13.34	22.05	NO	31.25	NO
10(Pooling Area)	44.98	22.05	YES	31.25	YES
Culvert 2					
11	33.93	22.05	YES	31.25	YES
12	16.23	22.05	NO	31.25	NO
Culvert 3					

Above: From Excel

- Cross sections 4 through 12 are adjacent to Highway 180
- Is the FLOW contained in the channel?
- Results From Bentley FlowMaster

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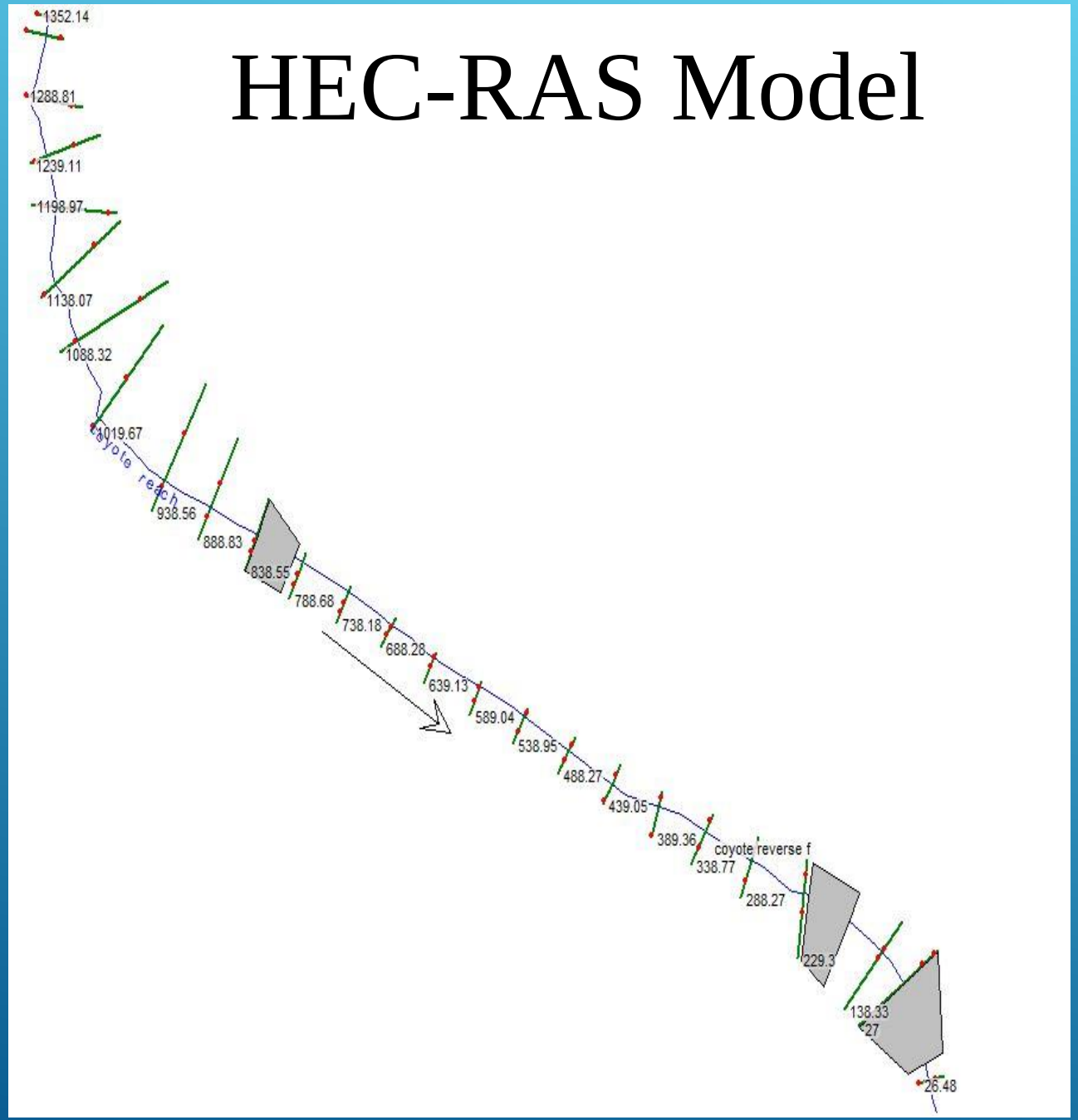
HEC-RAS Model



Both: From HEC-RAS Software

River Sta	Profile	Q Total	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft/s)	(sq ft)	(ft)	
1352.14	PF 1	22.05	3.51	6.28	16.39	1.00
1338.22	PF 1	22.05	3.07	7.19	24.50	1.00
1288.81	PF 1	22.05	3.43	6.43	17.74	1.00
1239.11	PF 1	22.05	3.18	6.94	21.53	0.99
1198.97	PF 1	22.05	3.06	7.19	24.79	1.00
1138.07	PF 1	22.05	2.98	7.40	27.25	1.01
1088.32	PF 1	22.05	2.70	8.17	38.20	1.03
1019.67	PF 1	22.05	2.74	8.04	35.83	1.02
938.56	PF 1	22.05	3.31	6.67	20.67	1.03
888.83	PF 1	22.05	3.40	6.48	17.91	1.00
838.55	PF 1	22.05	3.86	5.71	12.23	1.00
838		Culvert				
788.68	PF 1	22.05	3.94	5.60	11.57	1.00
738.18	PF 1	22.05	3.97	5.55	11.48	1.01
688.28	PF 1	22.05	4.25	5.19	9.76	1.03
639.13	PF 1	22.05	5.12	4.31	5.39	1.01
589.04	PF 1	22.05	4.10	5.38	10.65	1.02
538.95	PF 1	22.05	3.37	6.55	17.98	0.98
488.27	PF 1	22.05	3.73	5.91	13.95	1.01
439.05	PF 1	22.05	3.14	7.03	23.86	1.02
389.36	PF 1	22.05	3.02	7.30	26.61	1.02
338.77	PF 1	22.05	3.63	6.07	14.99	1.01
288.27	PF 1	22.05	3.89	5.67	12.29	1.01
229.3	PF 1	22.05	3.24	6.80	20.49	0.99
139		Culvert				
138.33	PF 1	22.05	5.24	4.21	5.02	1.01
106.39	PF 1	22.05	4.72	4.68	6.94	1.01
27		Culvert				
26.48	PF 1	22.05	3.01	7.34	27.64	1.03

Velocity Spike

Velocity Spike

- Average Velocity of 3.46 ft/s
- Energy in Stream Fluctuates Causing Sediment to Move

AJ

Problem Areas

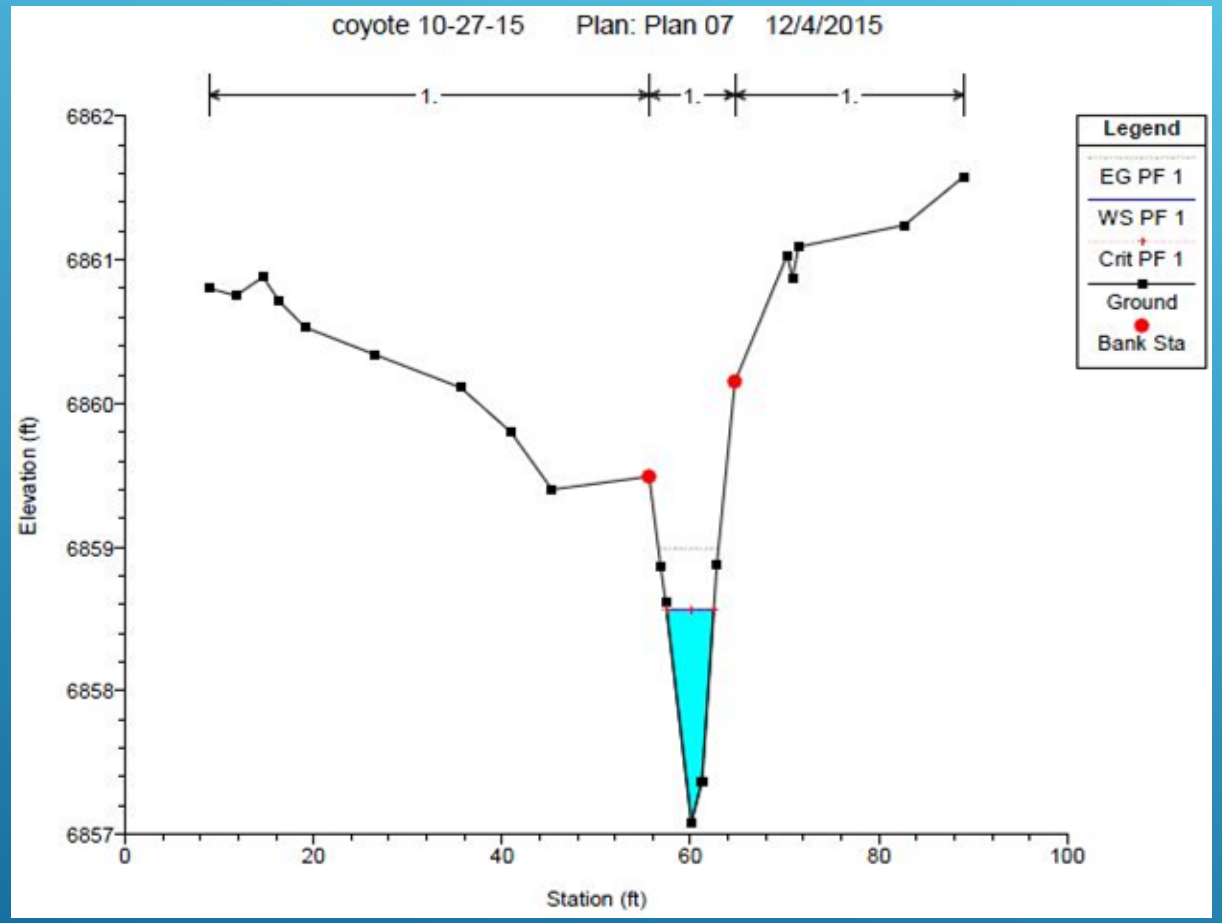
Overgrown Pooling Area at Creekside Drive and Highway 180

2ft Diameter Culvert Clogged By Sediment Due to Energy Fluctuations

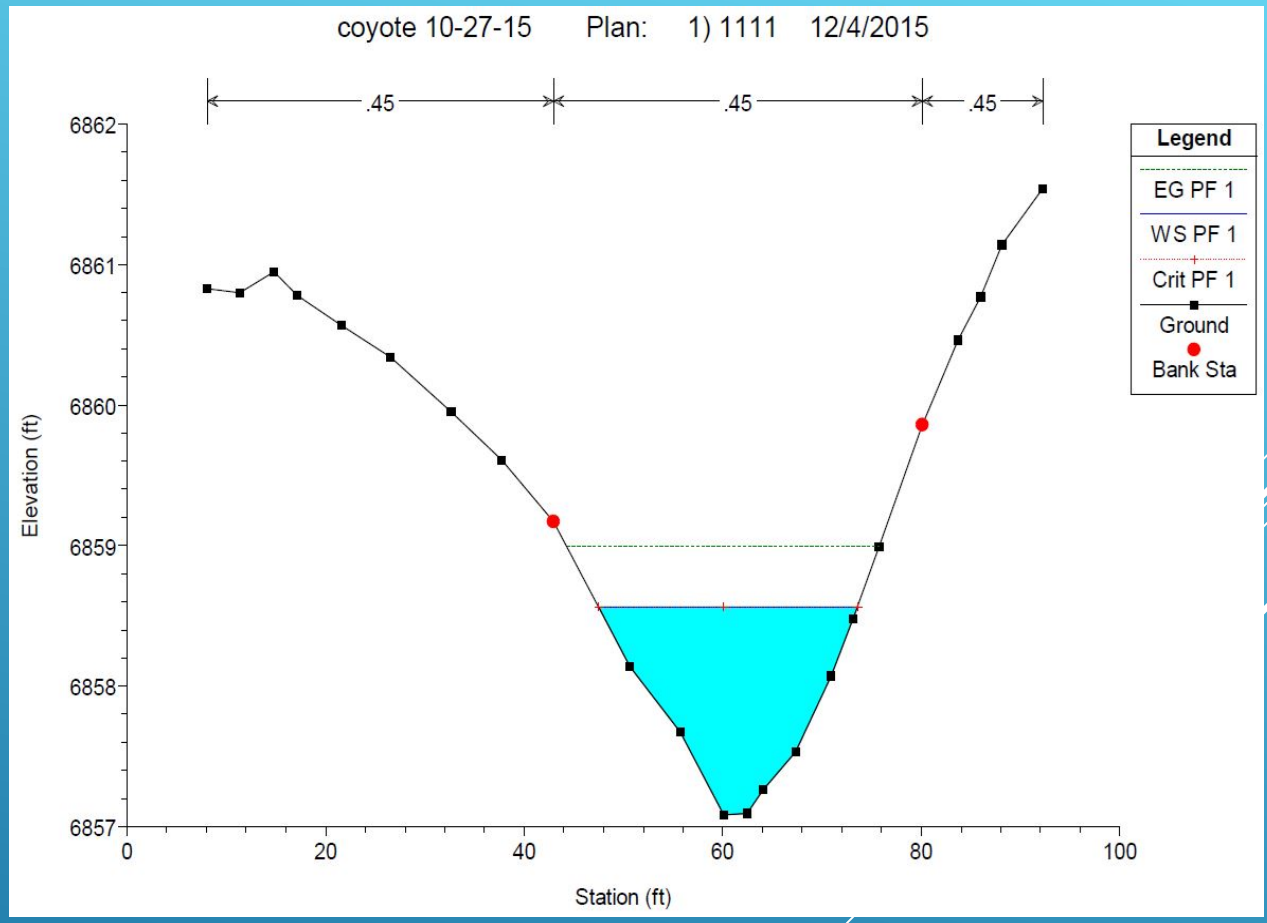
Turf Reinforcement Matting on Downstream End of Stream Looking North-West

AJ

Proposed Alternative



- Existing Downstream HEC-RAS Cross Section
- Velocity of 5.24 ft/s
- Turf Reinforcement Mat
- Right Bank Slope of 0.75 ft/ft



- Proposed Downstream HEC-RAS Cross Section
- Velocity of 3.69 ft/s
- Right Bank Slope of 0.18 ft/ft

AJ

Operation and Maintenance

- Subcontract
- Estimate & consultation
- Plant species consideration
- Removal of weeds
- Revegetation
- Bi-annual maintenance: spring & fall
- Educate the public
- Volunteering opportunity

Above: North View of Stream with Artificial Rocks

Rachel

Cost of Implementation

DIV	Description		Materials	Labor	Equipment	Subcontract	Line Total	Cost/SF	%Total
1	Excavation		$ -	$ -	$ -	$ 5,336.00	$ 5,336.00	$ 3.92	23.91%
2	Maintanence		$ -	$ -	$ -	$ 600.00	$ 600.00	$ 0.44	2.69%
3	Special Cleaning		$ -	$ -	$ -	$ 10,300.00	$ 10,300.00	$ 7.57	46.16%
SubTotals			**$ -**	**$ -**	**$ -**	**$ 16,236.00**	**$ 16,236.00**	**$ 11.94**	**72.76%**
Sales Tax		4.95%	$ -	$ -	$ -	$ 803.68	$ 803.68	$ 0.59	3.60%
Contingency		20.00%	$ -	$ -	$ -	$ 3,247.20	$ 3,247.20	$ 2.39	14.55%
SubTotals			**$ -**	**$ -**	**$ -**	**$ 20,286.88**	**$ 20,286.88**	**$ 14.92**	**18.15%**
Profit		10.00%	$ -	$ -	$ -	$ 2,028.69	$ 2,028.69	$ 1.49	9.09%
Totals			**$ -**	**$ -**	**$ -**	**$ 22,315.57**	**$ 22,315.57**	**$ 16.41**	**100.00%**
						Check	$ 22,315.57	$ 16.41	100.00%

Above: From Excel

Rachel

Final Summary

- Field Evaluation
- Hydrology & Hydraulics
  - Watershed Delineation
  - Channel and Culvert Analysis
  - HEC-RAS
- Operation & Maintenance
  - Subcontract
  - Community Involvement
- Final Proposed Alternative
  - Implement O&M Plan
  - Alter Downstream Area

Abdullatif

Acknowledgements

- Cindy Perin, Client, Coyote Springs HOA
- Bridget Bero, PhD, PE, Professor
- Mark Lamer, PE, Professor
- Wilbert Odem, PhD, PE, Professor
- Junyi Shan, Graduate Assistant

Many thanks to those who helped our team directly or indirectly!

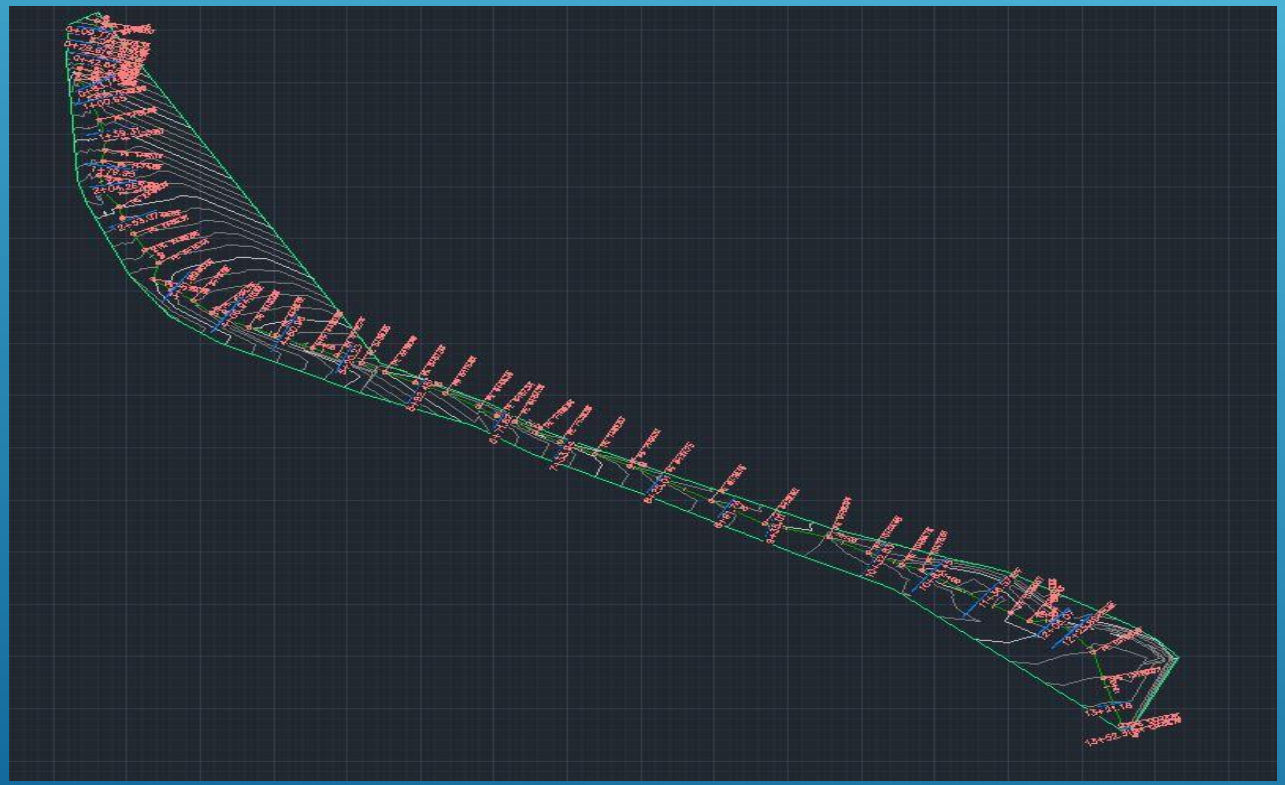
Left: Looking Downstream Next to Highway 180

Rachel

Resources Used

- All Images Taken By Team Members Unless Otherwise Noted
- Overviews From Google Maps
- Microsoft Project
- Tables From Excel
- USGS Website
- Technical Supplement 3E of the USDA National Engineering Handbook 654
- AJ Comito CENE 568 Rosgen Memo
- HEC-RAS
- Bentley CulvertMaster
- Bentley FlowMaster
- Coconino County and City of Flagstaff Drainage Design Requirements

Coyote Springs Stream Cross Section Information



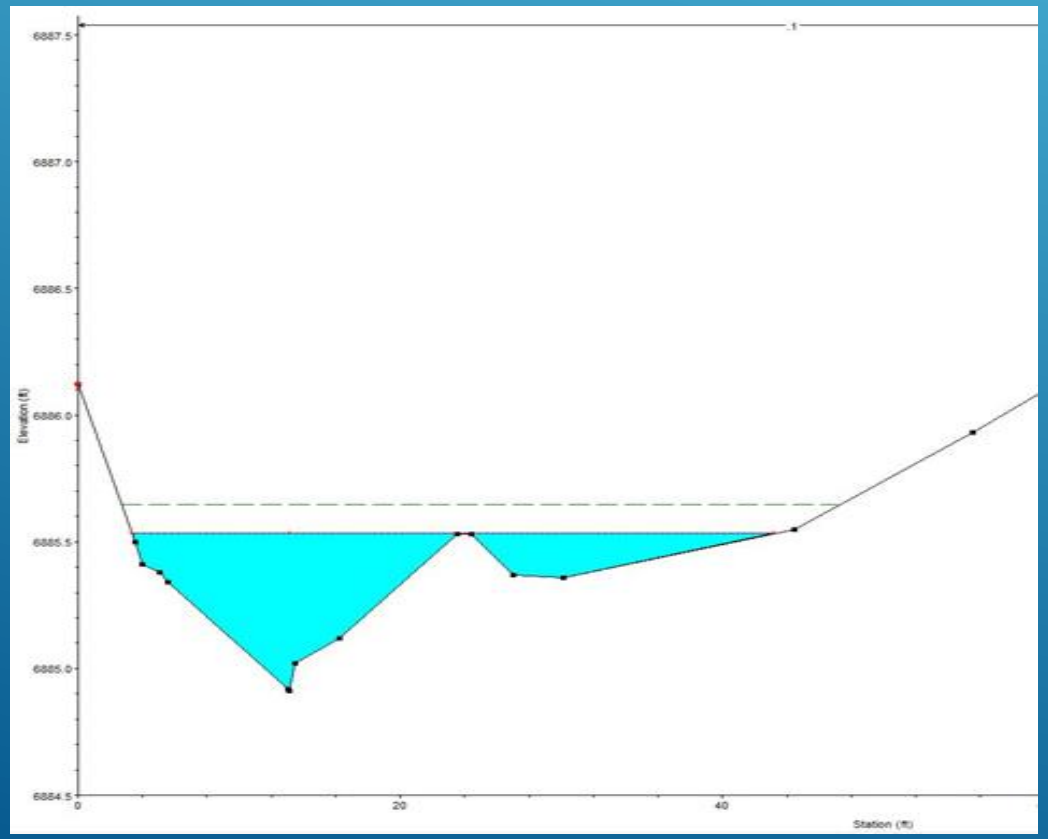
Above: AutoCAD Cross Sections
Right: Cross Sections With Data in Excel

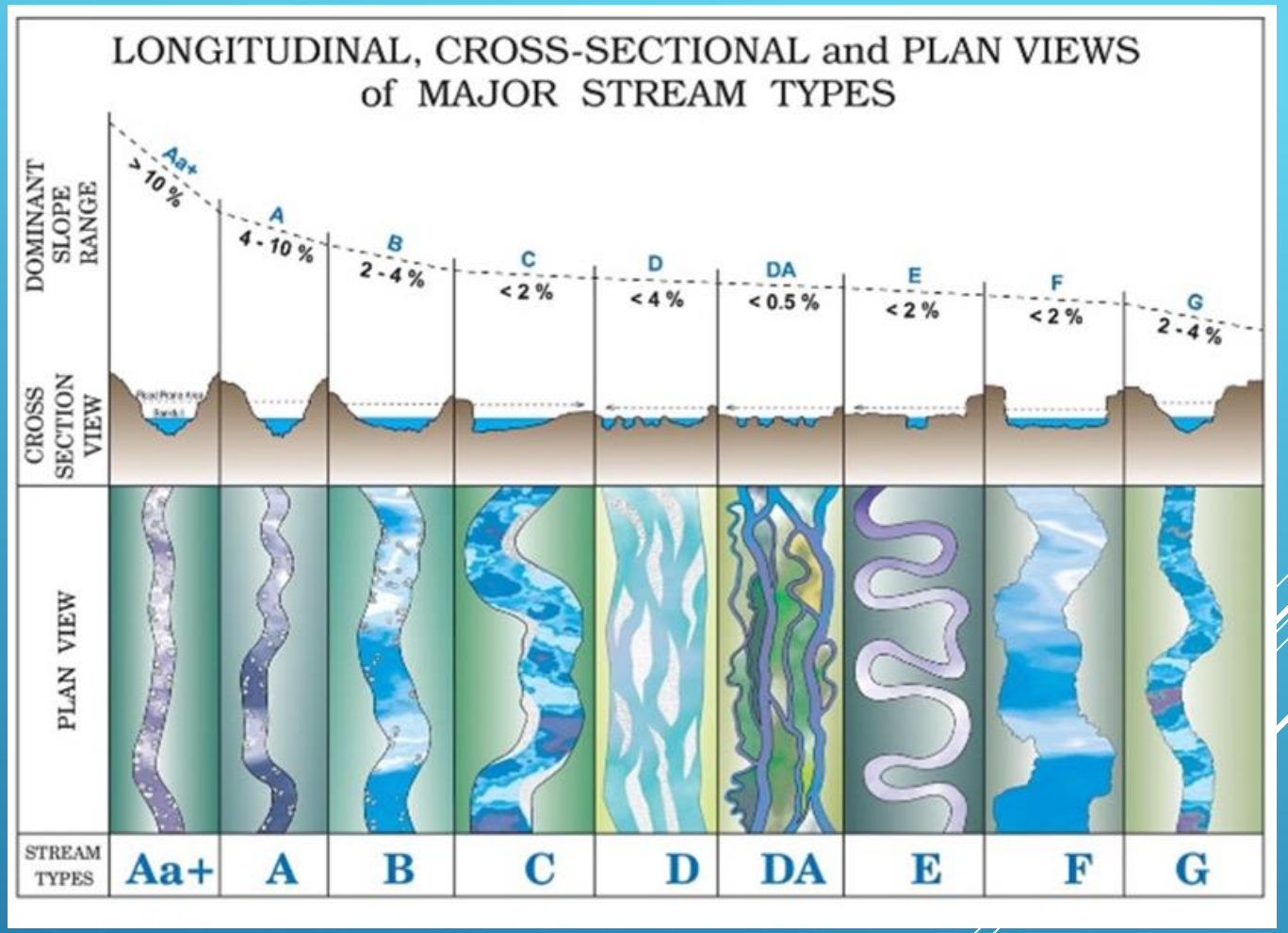
XS	Bankfull Channel Width (ft)	Flood Prone Width (ft)	Channel Elevation (ft)	Bankfull WS Elvation (ft)
1	1.46	5.42	6909.91	6909.94
2	4.16	3.40	6907.52	6907.60
3	0.98	4.50	6899.90	6899.98
4	1.18	3.23	6896.40	6896.46
5	9.44	4.65	6894.04	6894.15
6	3.92	4.38	6890.86	6890.91
7	0.94	5.60	6888.23	6888.37
8	1.83	4.65	6884.91	6885.00
9	1.16	5.64	6880.78	6880.90
10	1.34	3.57	6878.69	6878.81
11	4.16	3.55	6876.94	6876.99
12	0.93	2.55	6874.80	6874.86
13	2.08	2.14	6873.05	6873.19
14	0.94	3.45	6871.90	6871.98
15	0.81	5.86	6869.65	6869.81
16	1.37	6.87	6868.97	6869.14
17	0.69	6.92	6867.44	6867.53
18	3.17	6.23	6866.22	6866.34
19	1.45	1.42	6865.29	6865.34
20	1.65	10.85	6864.34	6864.40
21	2.71	11.24	6862.29	6862.41
22	1.01	2.57	6860.40	6860.47
23	3.47	2.95	6858.72	6858.77
24	1.25	2.14	6857.76	6858.05
25	1.32	1.52	6857.74	6857.90
26	10.26	1.32	6856.71	6856.75
27	1.75	1.74	6855.73	6855.78
Averages:	2.42	4.38	6875.53	6875.62

Rosgen Level 1

Determined Stream Slope: 3.89%
Relatively Low Sinuosity
Average Shallow and Wide Cross Sections

From Above Information The Stream is Determined to be Rosgen Level 1: B





Above: Rosgen Classification Scheme,
Technical Supplement 3E, NEH 654
Left: Example Cross Section from HEC-RAS

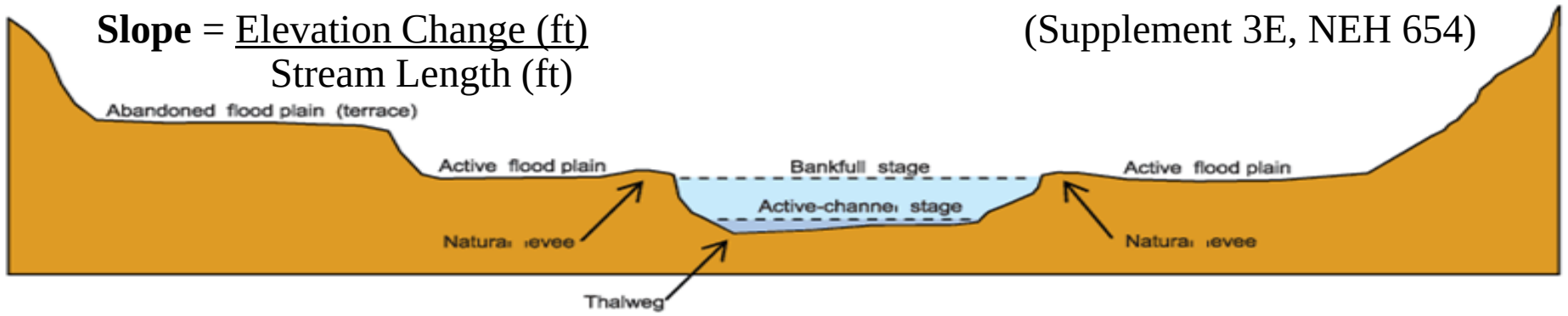
Rosgen level 2 Equations

Entrenchment ratio = Flood prone area width (ft) (Supplement 3E, NEH 654)
Bankfull channel width (ft)

Width to Depth ratio = Bankfull channel width (ft) (Supplement 3E, NEH 654)
Bankfull mean depth (ft)

Channel Sinuosity = Stream Length (ft) (Supplement 3E, NEH 654)
Valley Length (ft)

Slope = Elevation Change (ft) (Supplement 3E, NEH 654)
Stream Length (ft)



Above: Schematic diagram showing geomorphic features of a stream channel
http://pubs.usgs.gov/sir/2005/5153/

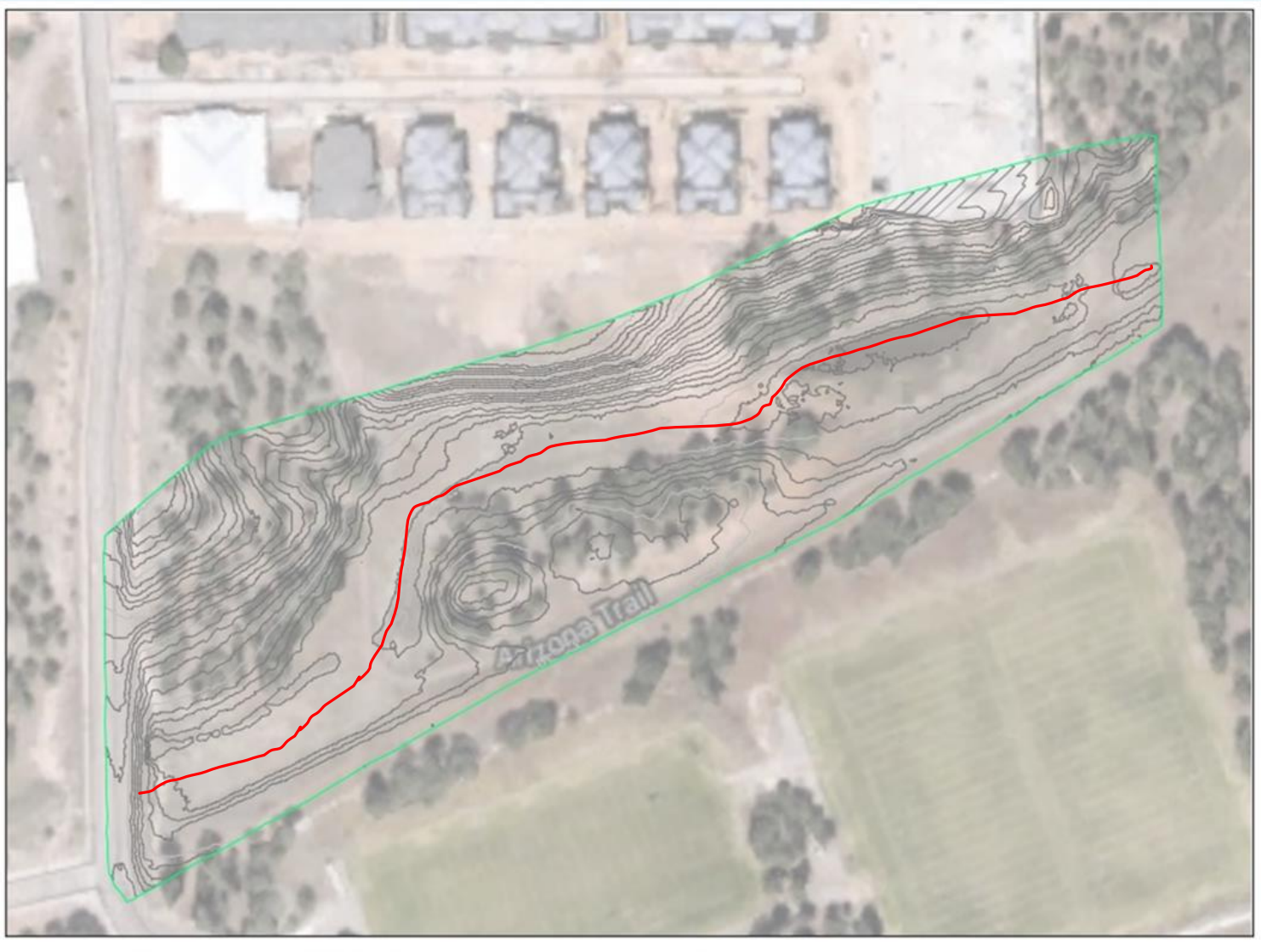
Rosgen Level 2 Sinclair Wash Comparison

XS	Bankfull Width (ft)	Bankfull Depth (ft)	Flood Pron Width (ft)
1	15	1.5	24
2	12	0.8	25
3	18	2	26
4	10	2	28
5	14	0.5	30
6	19	1.5	32
Average:	14.67	1.38	27.50

Sinclair Wash Classification Summary	
Stream Length (ft)	857.70
Valley Length (ft)	809.30
Change in Elevation (ft)	5.64
Average Bankfull Width (ft)	14.67
Average Bankfull Depth (ft)	1.38
Average Flood Pron Width (ft)	27.50
Entrenchment Ratio (ft/ft)	1.87
Width to Depth Ratio (ft/ft)	10.63
Channel Sinuousity (ft/ft)	1.06
Stream Slope (ft/ft)	0.01

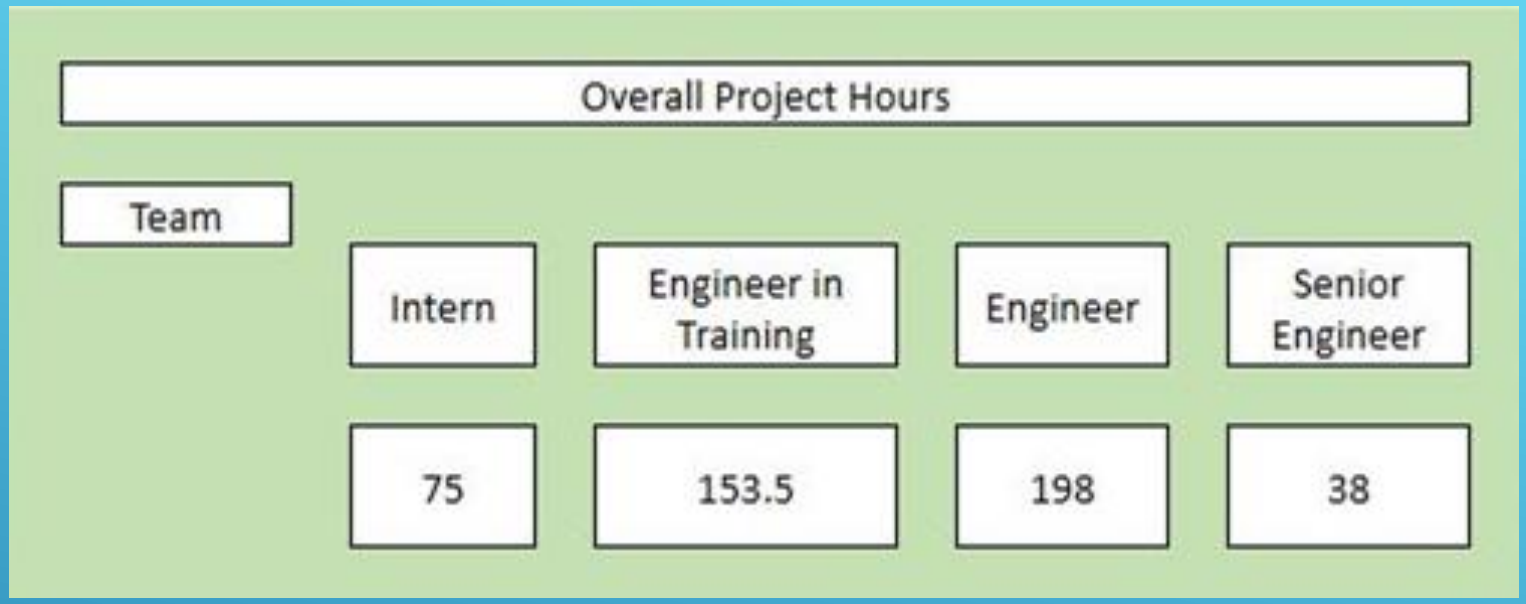
Above: From Excel

Stream Reach Was Determined to be Rosgen Level 2: B6a



Above: Sinclair Wash Near Practice Fields and Hilltop Townhomes From AutoCAD

Hours


Overall Project Hours
Team
Intern
Engineer in Training
Engineer
Senior Engineer
75
153.5
198
38

Plant Species

Scientific Name	Common Name	Invasive?
Agrostis stolonifera	Creeping bentgrass	Invasive
Ambrosia psilostachya	Cuman ragweed	Non-Invasive
Argemone munita	Prickling poppies	Non-Invasive
Deschampsia cespitosa	Tufted hairgrass	Invasive
Helianthus annuus	Common sunflower	Invasive
Potentilla recta	Sulfur cinquefoil	Invasive
Ribes cereum	Wax currant	Non-Invasive
Ratibida pinnata	Grayhead prairie coneflower	Invasive
Salix scouleriana	Scouler's willow	Non-Invasive
Schoenocrambe linearifolia	Slimleaf plainsmustard	Non-Invasive
Sisymbrium irio	London rocket	Invasive
Typha latifolia	Common cattail	Non-Invasive
Verbascum thapsus	Great mullein	Invasive
Vicia pulchella	Sweetclover vetch	Invasive

Above: From Excel