Arizona Water Jacks: Oak Creek Low Water Crossing

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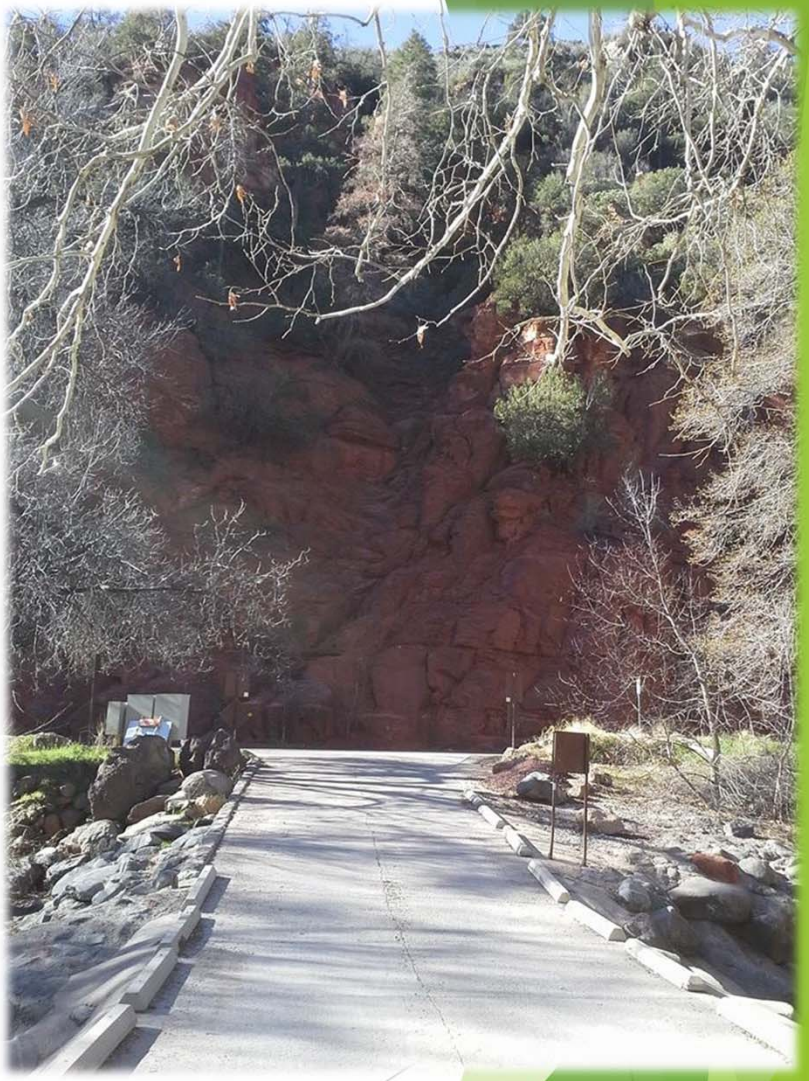
Overview

- Description and Constraints
- Technical Analyses
- Impacts
- Alternatives
- Final Design



View of the crossing facing 89A

Project Description

- Low water crossing through Oak Creek
- Service the Shangri-La Subdivision
- Floods are problematic
  - Flood of 1993
- Only egress and ingress to subdivision

Location of subdivision

Source: Google Earth

Existing Conditions

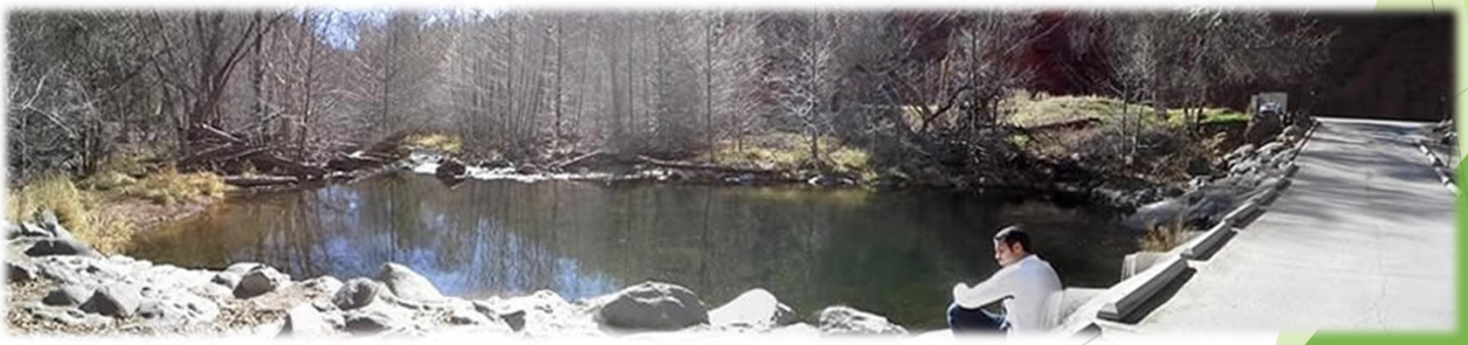
Scouring taking place downstream (notice the eroding concrete)

The soil deposit deflects the water to flow through the two culverts located closest to 89A

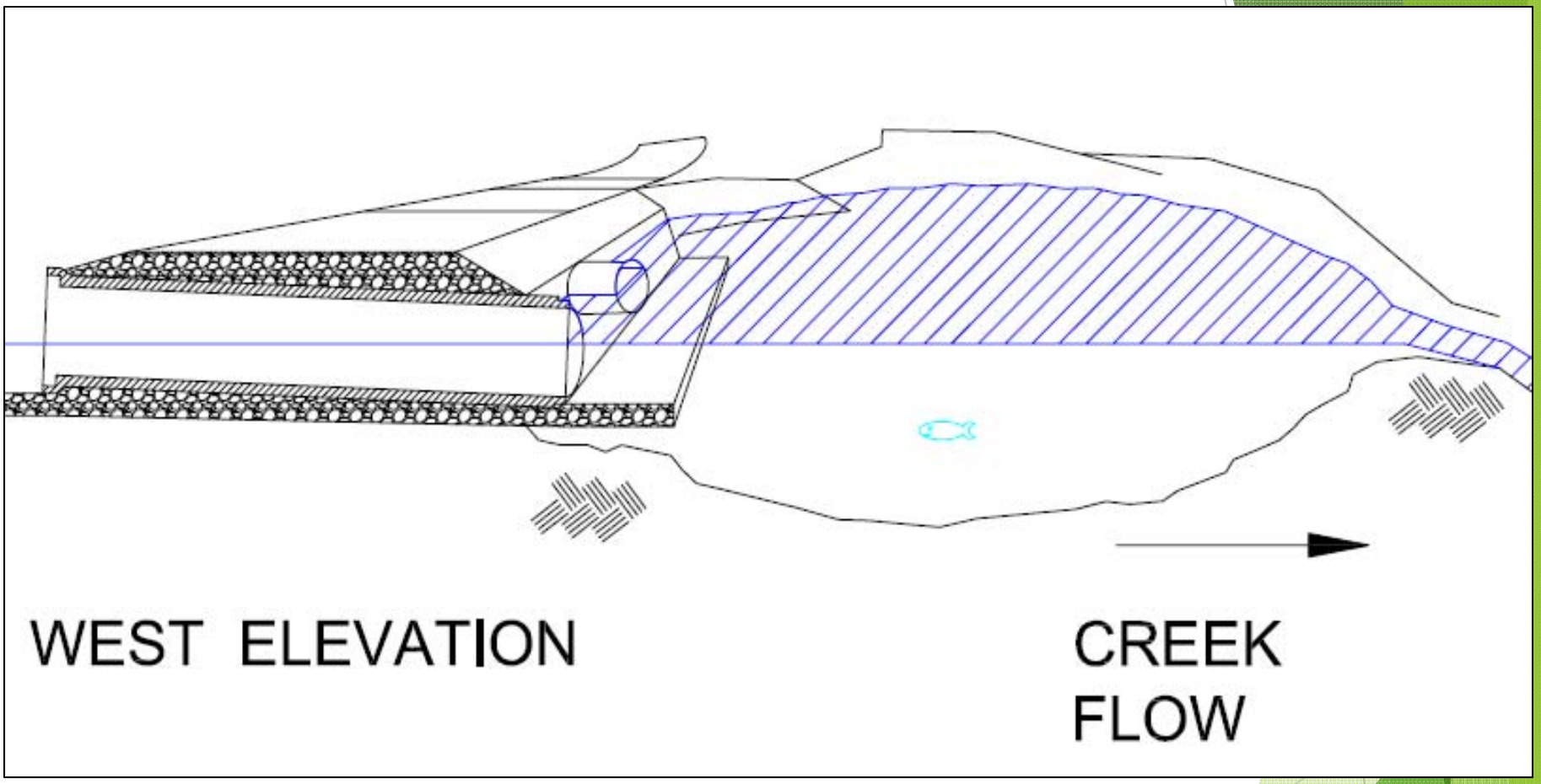
What Is Needed

- Armoring for current crossing
  - Scouring
- New crossing

Oak Creek curving into the crossing



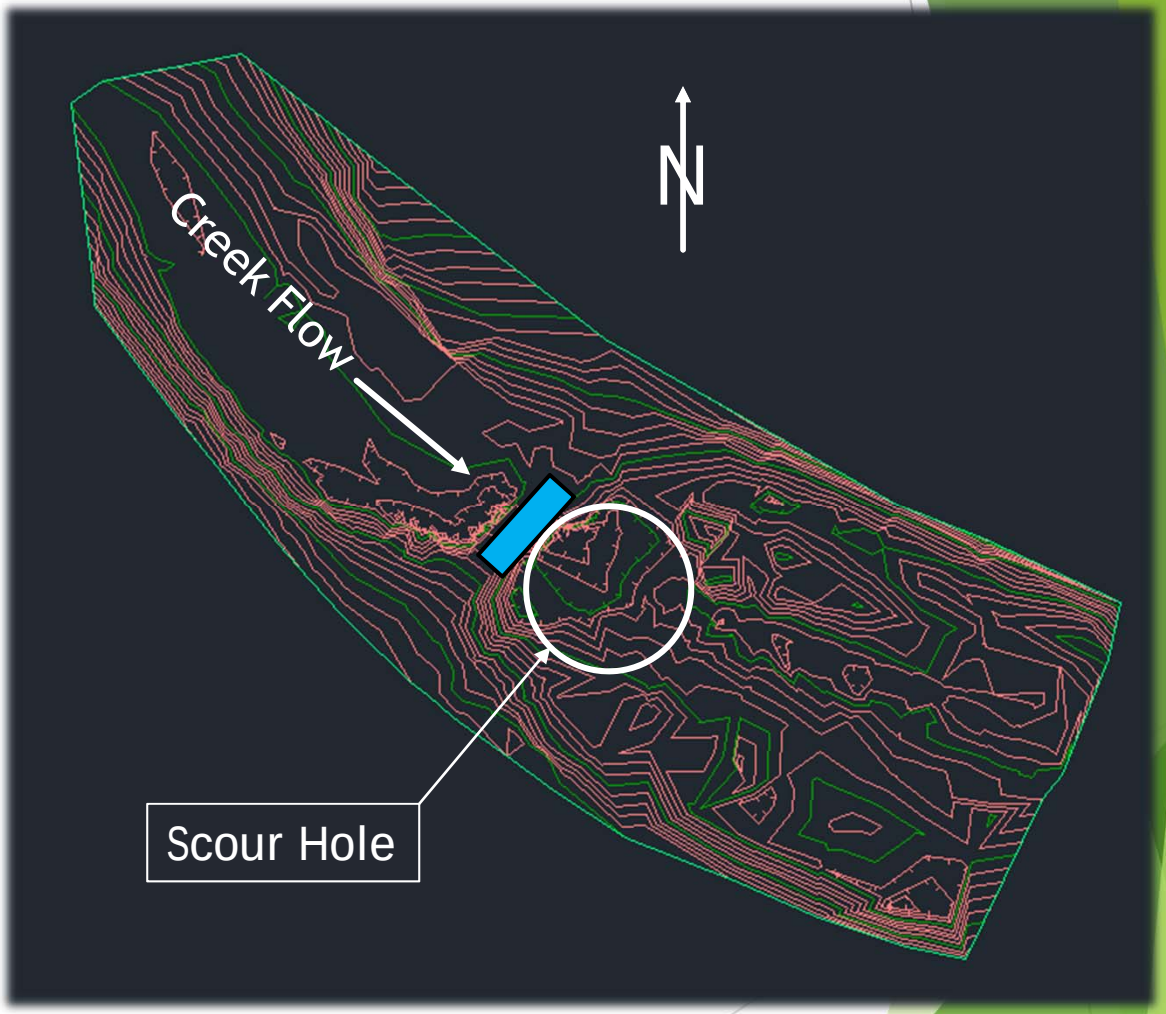
The scour hole downstream from the crossing



Existing cross section showing the scour hole downstream

Surveying

- Topography
- Used for HEC-RAS model



Topography of project site

Flood Data

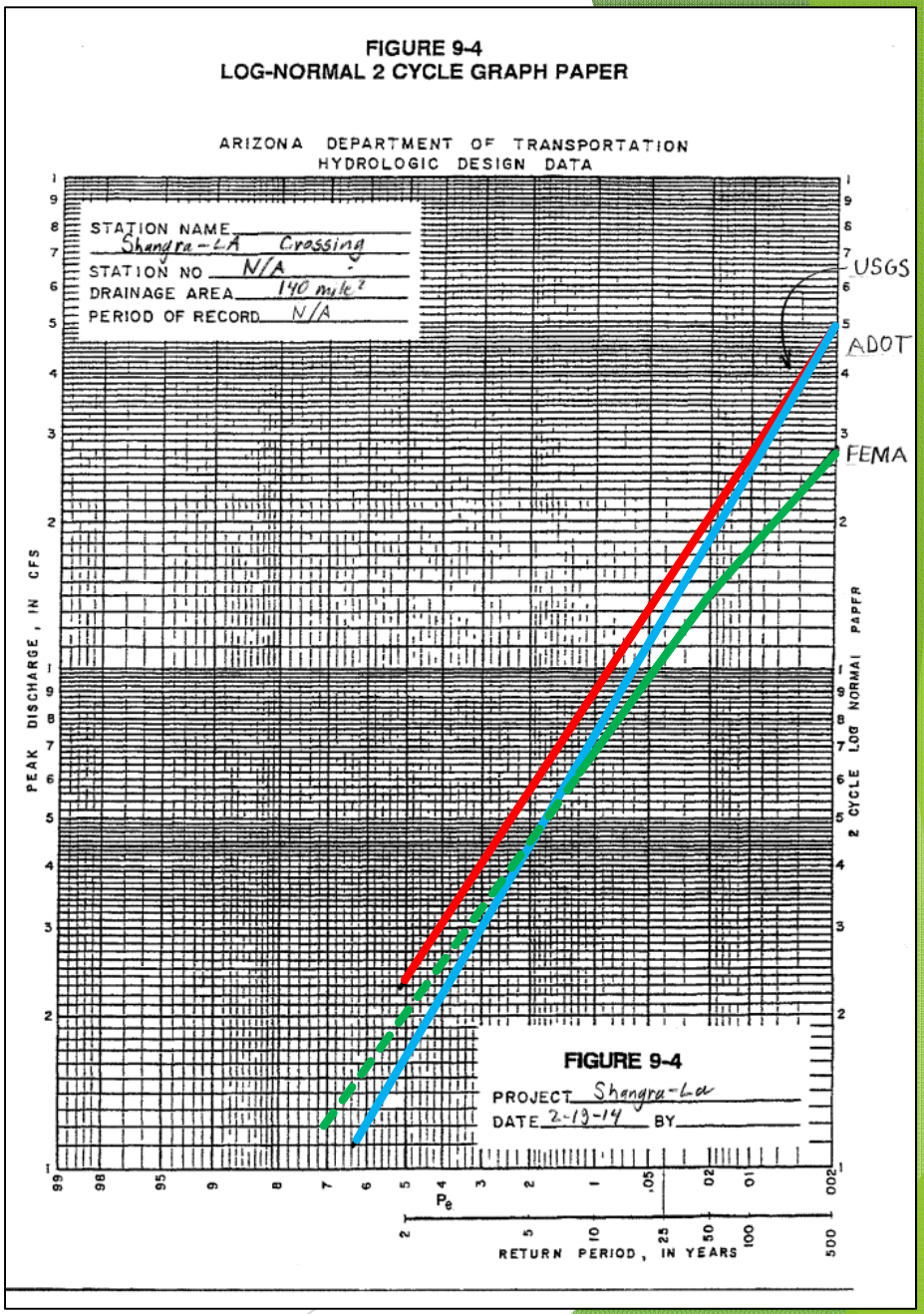
FEMA Flood Frequency

10-year – 7,050 cfs

50-year – 13,980 cfs

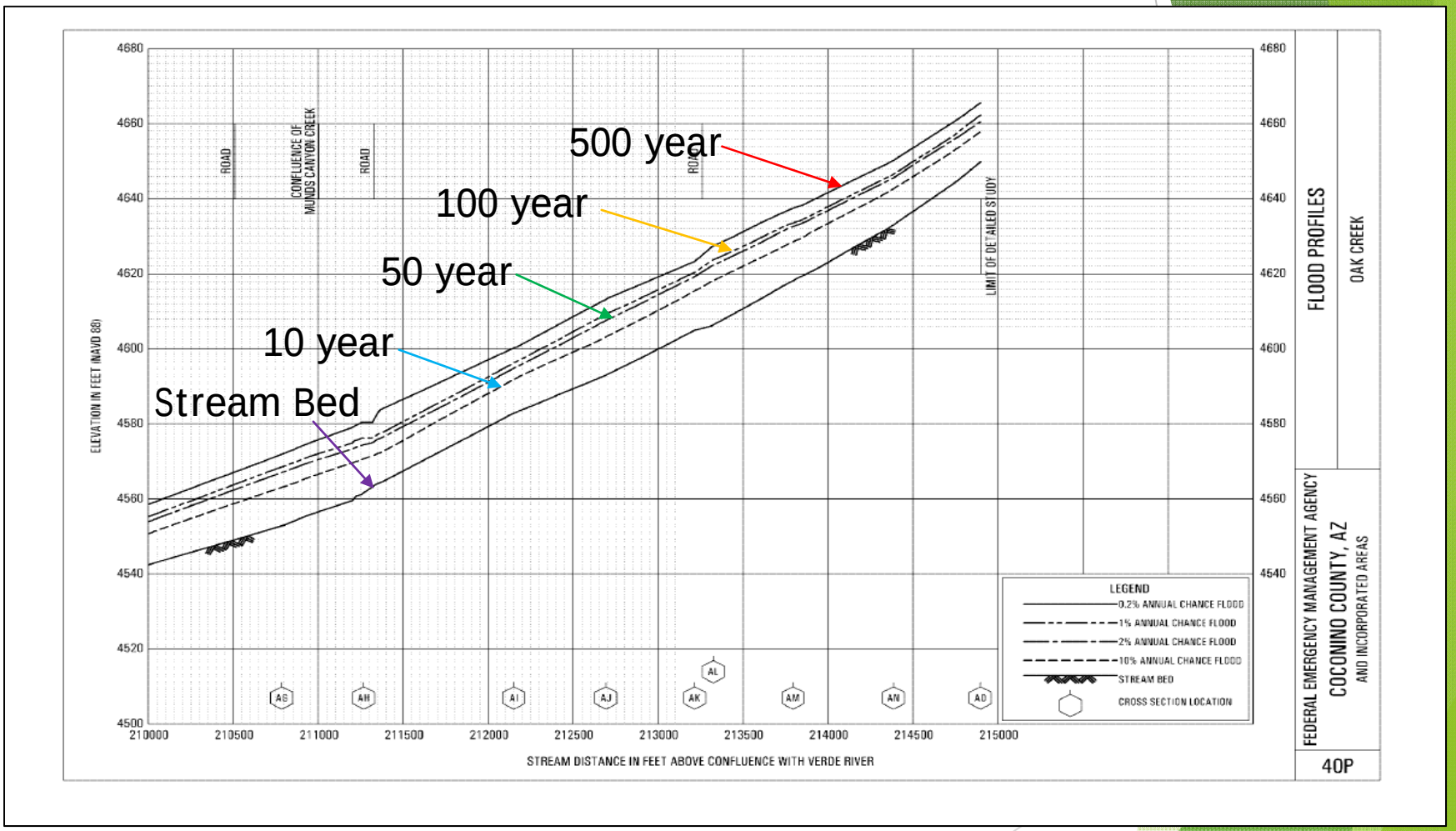
100-year – 17,140 cfs

500- year – 28,000 cfs



USGS, ADOT, and FEMA flood analysis comparisons

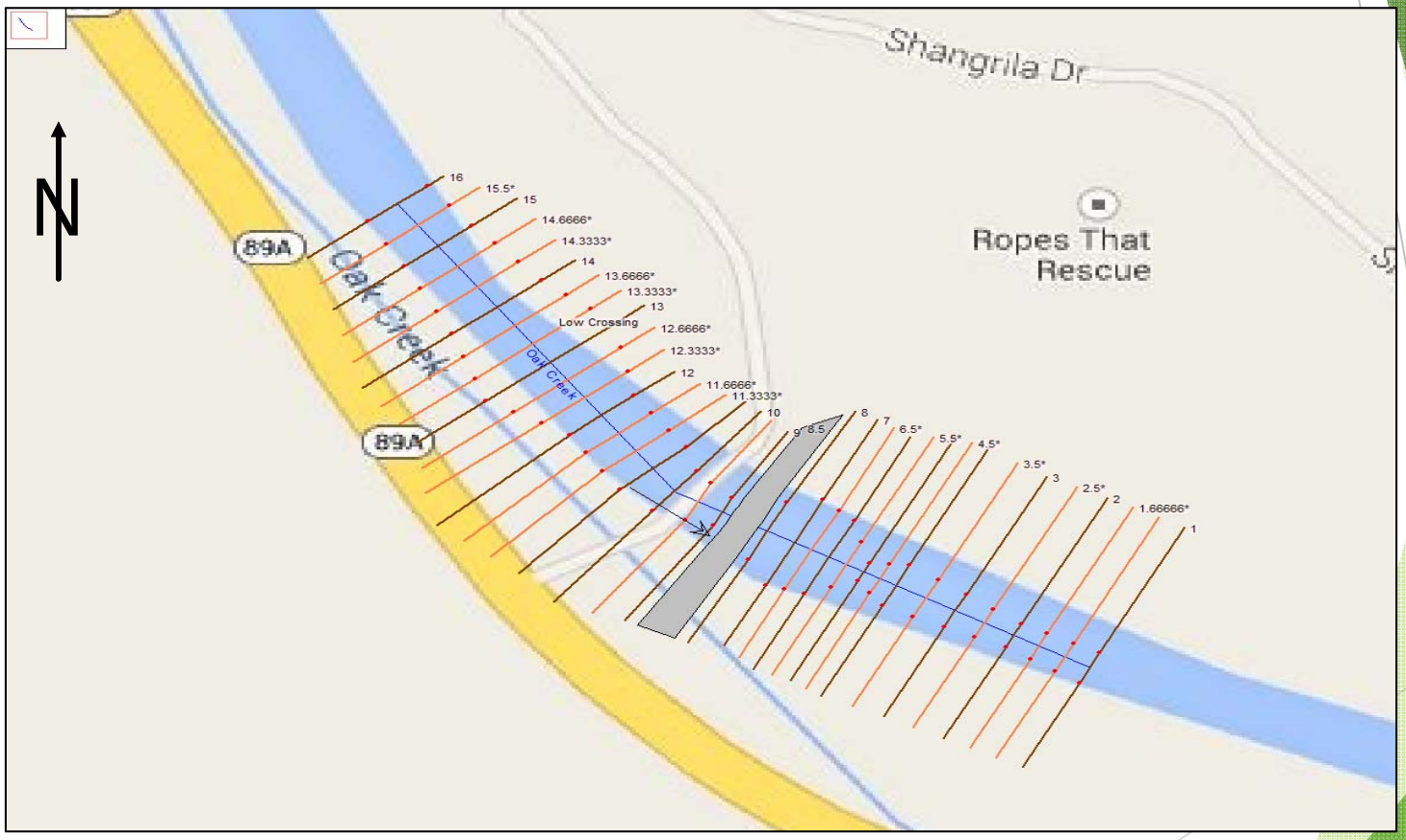
Flood Data



FEMA Flood Profiles

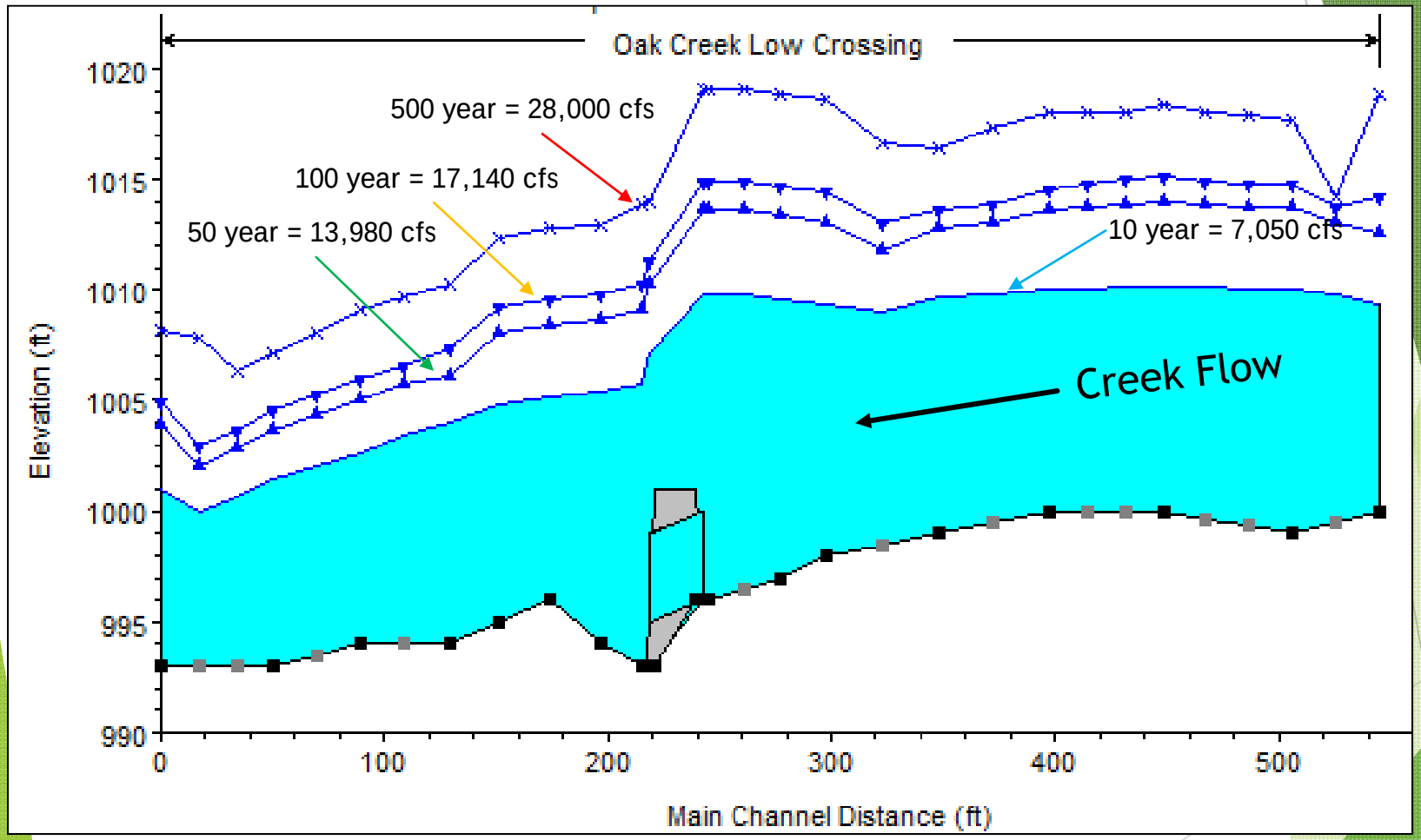
HEC-RAS (Rivers and Streams)

- Model Oak Creek



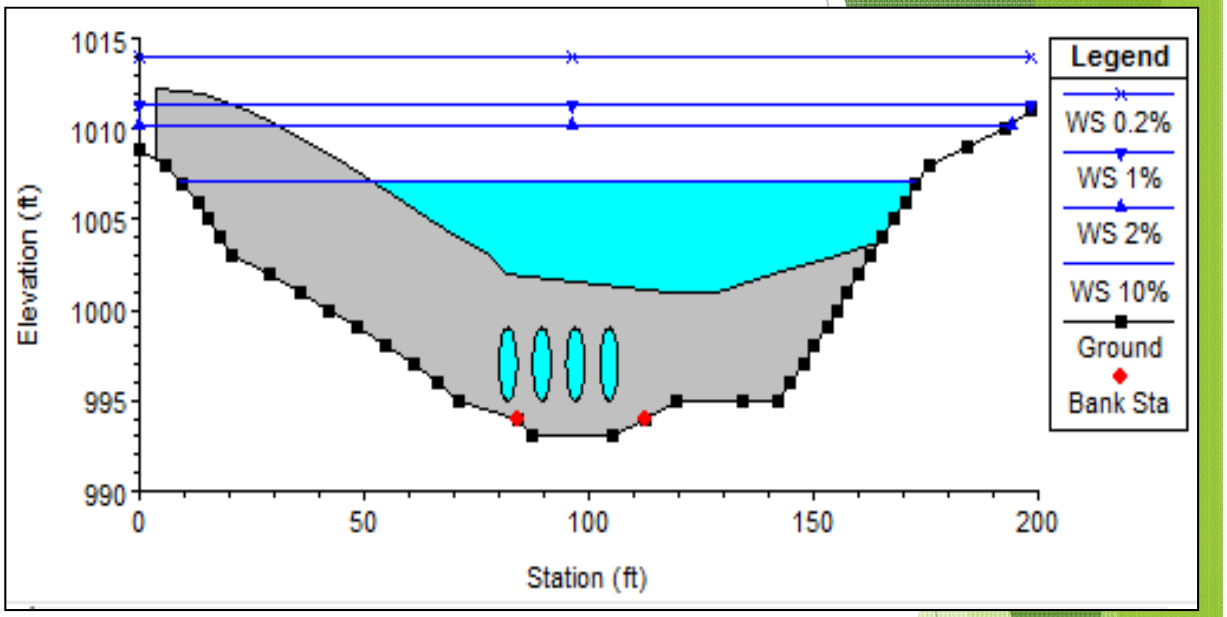
Various cross sections generated by the model

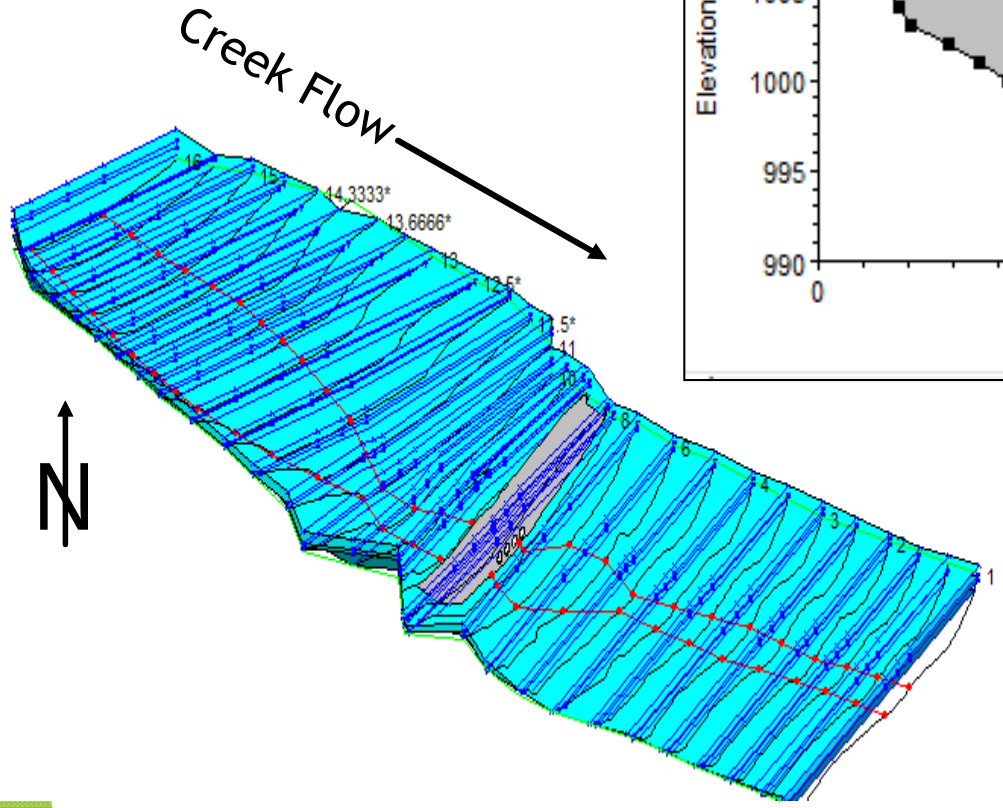
HEC-RAS (Rivers and Streams)



Full reach of Oak Creek under various year floods

HEC-RAS (Rivers and Streams)





3D view of Oak Creek with crossing shown in gray

Impacts

- Political
- Social
- Environmental

Oak Creek is vital to many aspects of the local community, such as Slide Rock State Park which attracts tourists

http://static.panoramio.com/photos/large/2208432.jpg

Alternatives - Armoring

http://upload.wikimedia.org/wikipedia/commons/f/fb/Spundwand.jpg

http://www.riverdale.com/images/basket2.jpg

http://www.atlanta-structural.com/imgs/Concrete%20Retaining%20Wall.jpg

Alternatives - Armoring

Current Crossing Armoring					
Parameters	Weight	Rock Armoring	Sheet Pile	Gabion Baskets	Retaining Walls
Cost	0.2	5	3	4	1
Effectiveness	0.3	4	5	4	4
Aesthetics	0.05	2	1	2	2
Safety	0.15	4	3	3	4
Creek Impact	0.15	4	2	4	1
Lifespan	0.15	4	4	4	4
	Total	4.1	3.5	3.75	2.85

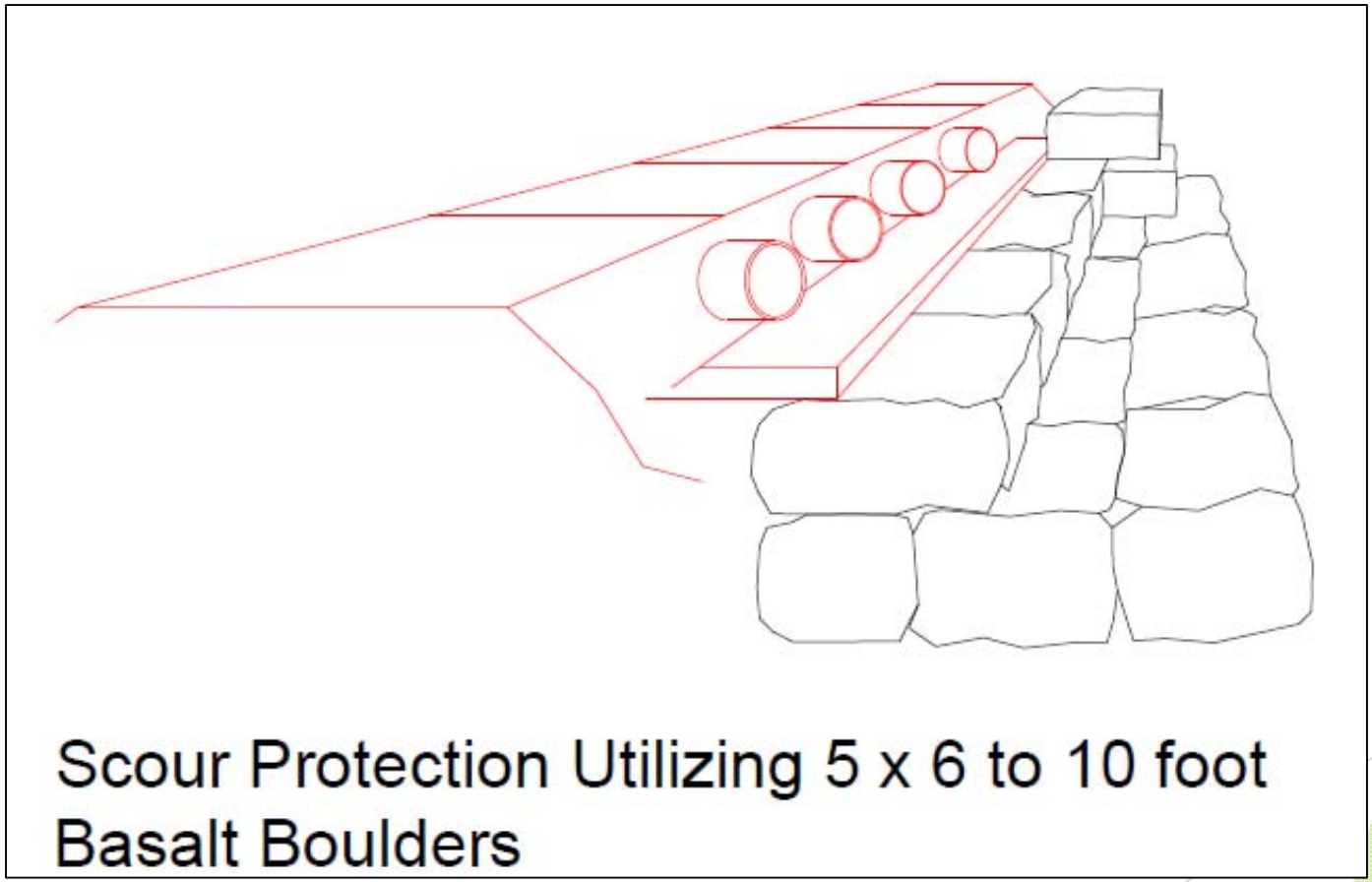
Scoring: 1 - Worst
5 - Best

Parameter	Definition
Cost	Overall cost to construct
Effectiveness	Effectiveness to allow debris to pass
Aesthetics	Geometry and beauty of the design
Safety	Allowability of flow to pass under crossing and threat to public health
Creek Impact	Chance of causing erosion and disturbance to creek
Lifespan	Longevity of design

Final Armoring Design (Rock Armoring)

- Least expensive option
- Low creek impact
  - Basalt rocks
- Minimal construction

Final Armoring Design (Rock Armoring)



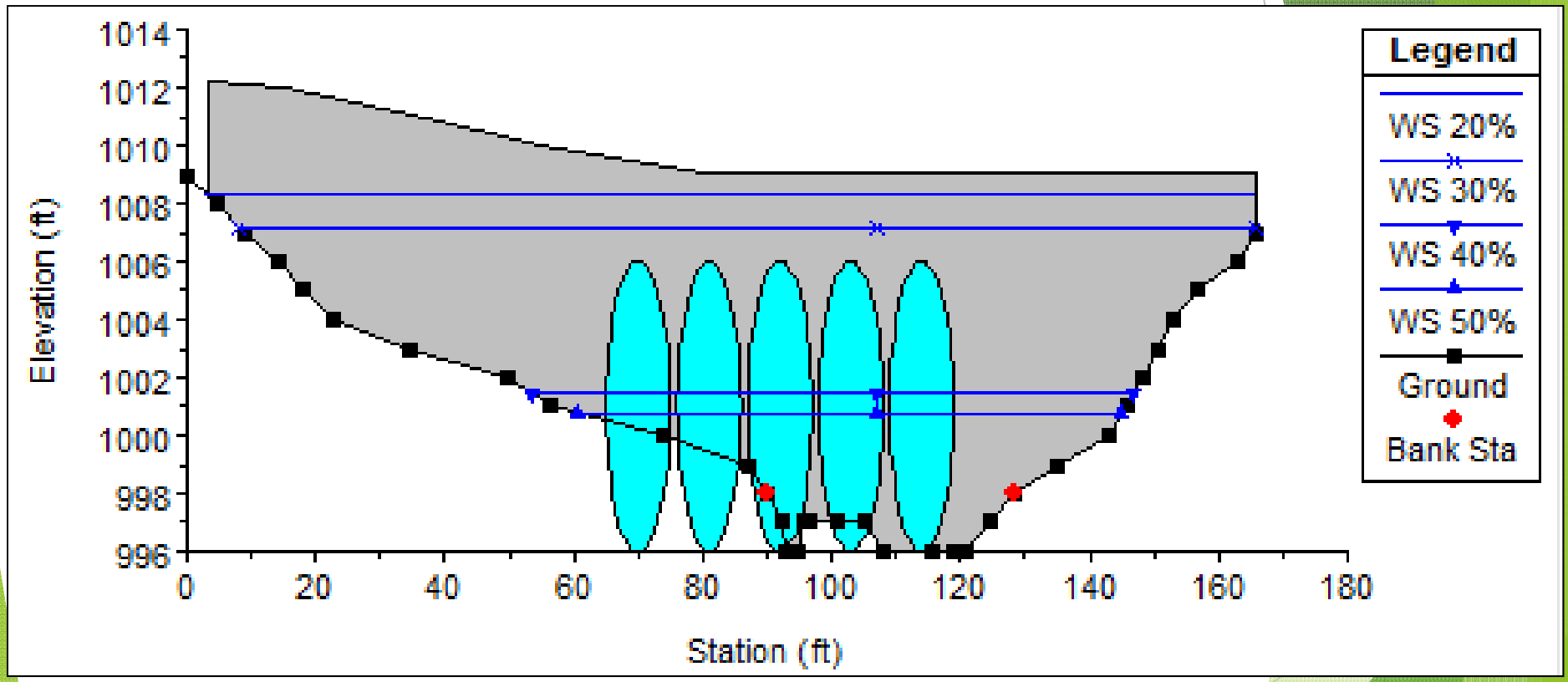
Scour Protection Utilizing 5 x 6 to 10 foot Basalt Boulders

Alternatives – New Crossing

http://culvertdesign.com/wp-content/uploads/2012/09/BF8472_-059.jpg

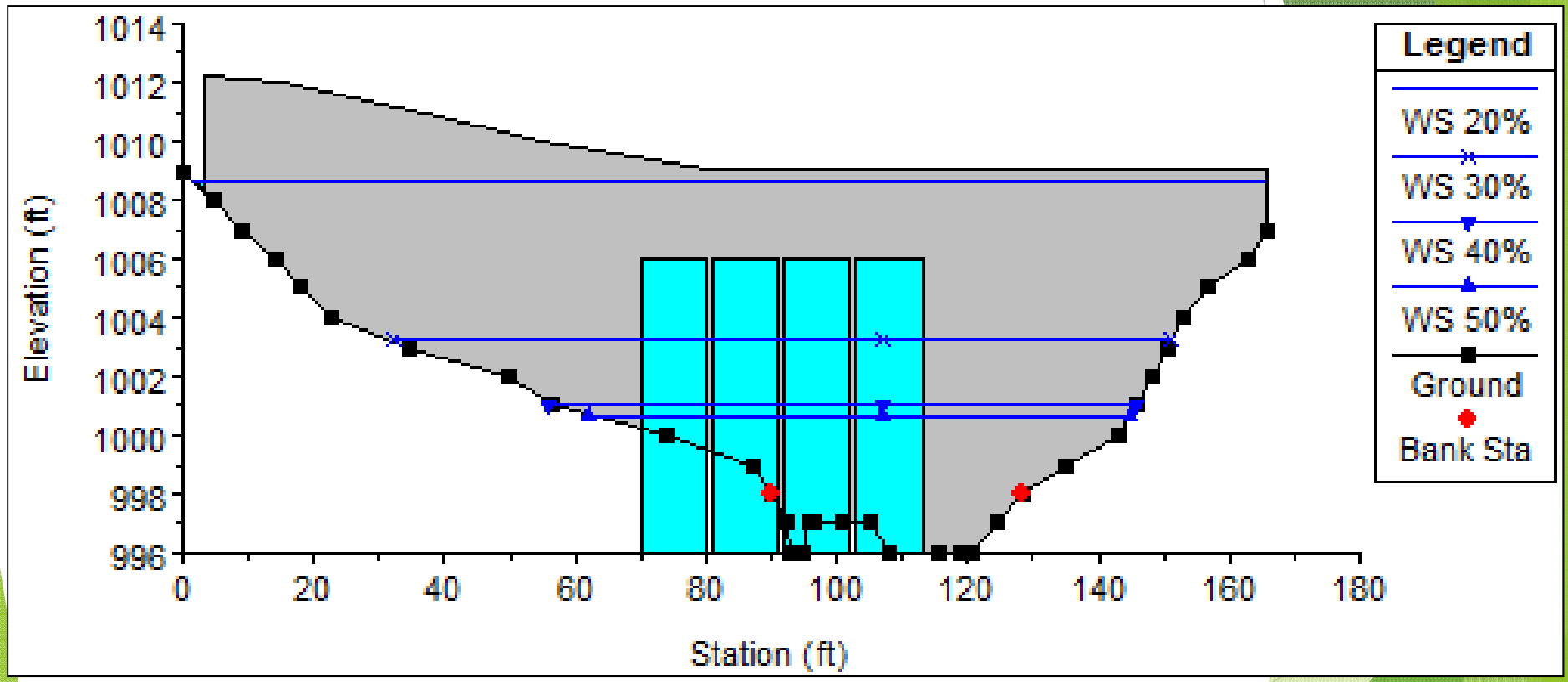
Photo courtesy of Contech®

HEC-RAS: Circular Culverts



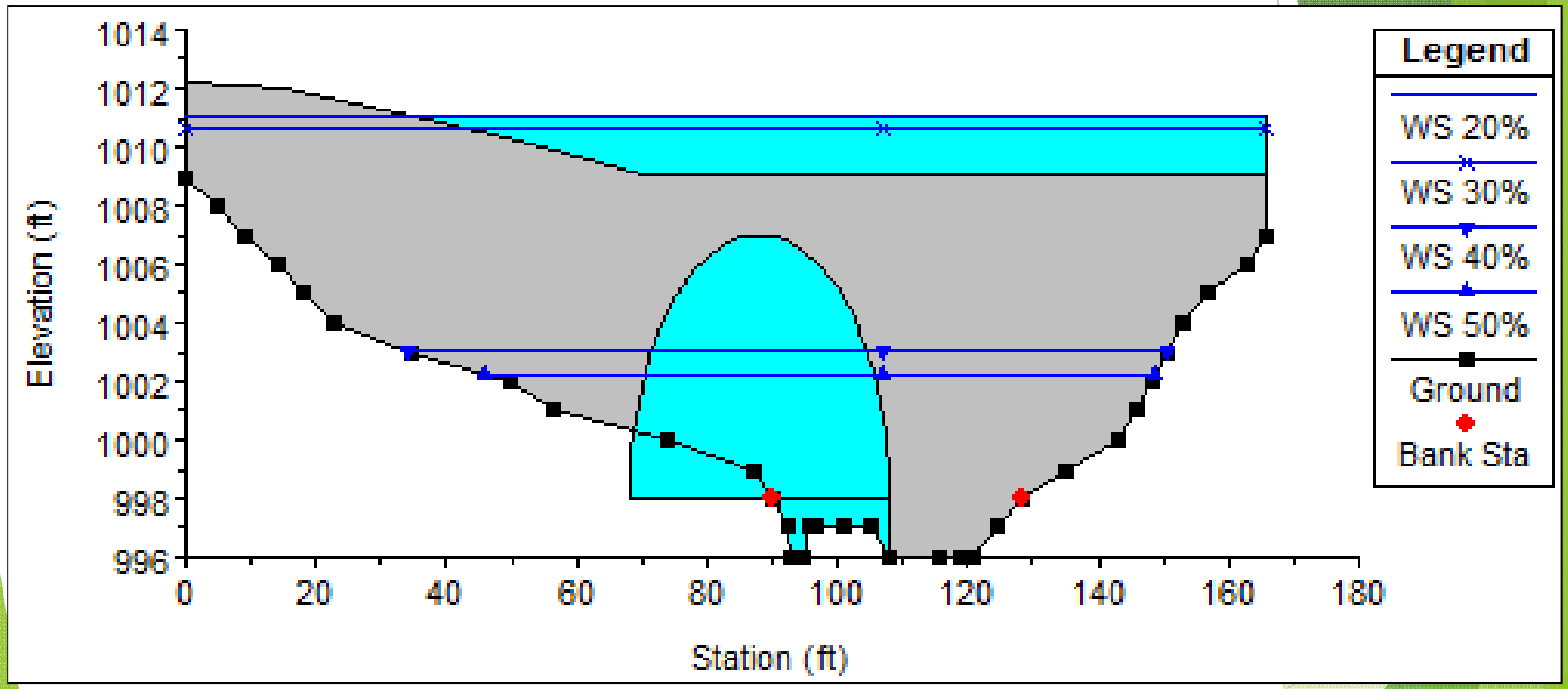
Five 10 ft. diameter culverts modeled

HEC-RAS: Box Culverts



Four 10 ft. by 10 ft. culverts modeled

HEC-RAS: Three-Sided Bridge



One 9 ft. arch with 40 ft span modeled

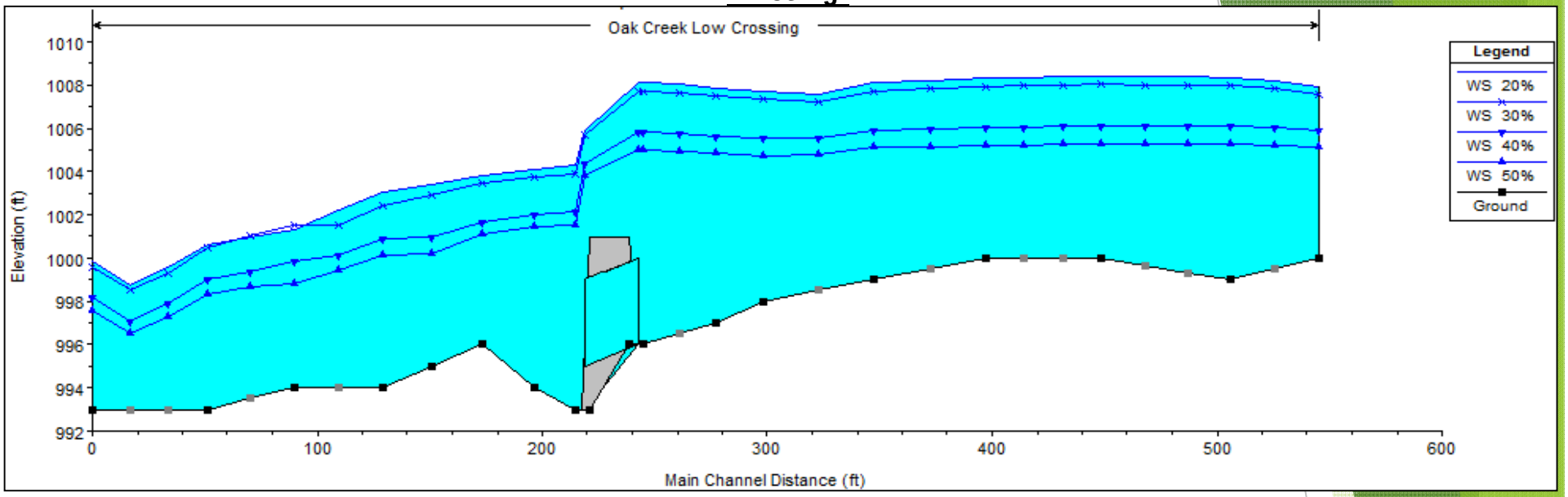
Alternatives – New Crossing

New Crossing Design				
Parameters	Weight	Circular Culverts	Box Culverts	Three-Sided Bridge
Cost	0.2	4	3	3
Effectiveness	0.3	2	4	5
Aesthetics	0.05	2	1	5
Safety	0.15	3	5	5
Creek Impact	0.15	1	2	4
Lifespan	0.15	2	4	4
		2.4	3.5	4.3

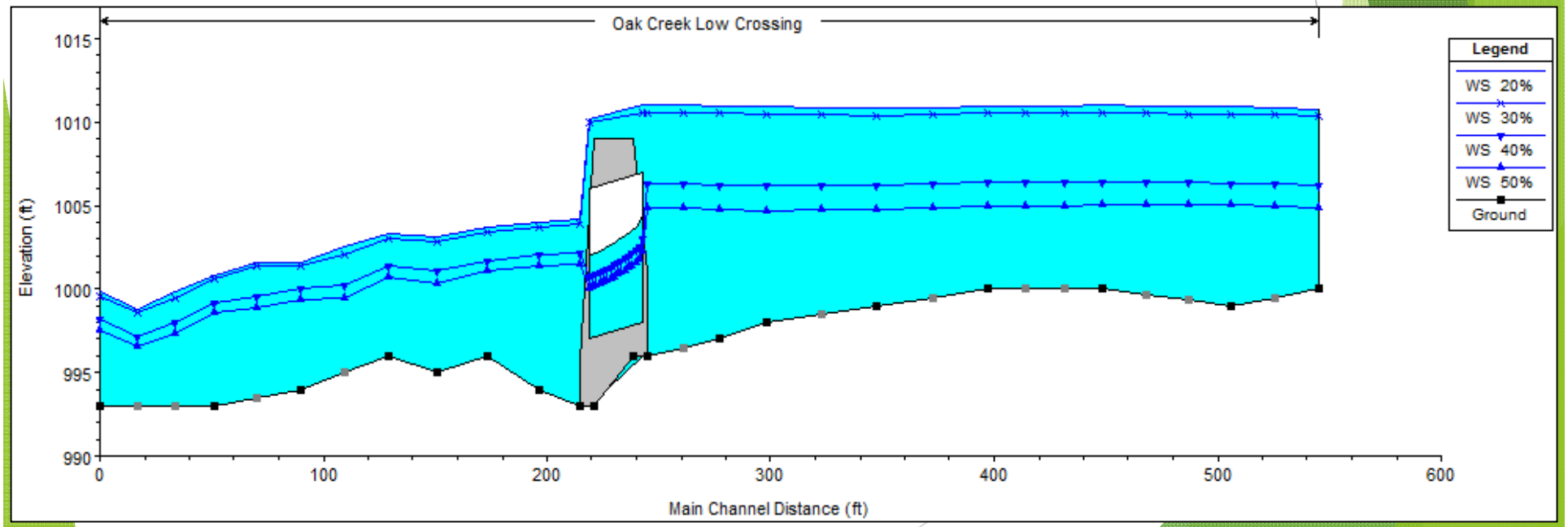
Scoring: 1 - Worst
5 - Best

Parameter	Definition
Cost	Overall cost to construct
Effectiveness	Effectiveness to allow debris to pass
Aesthetics	Geometry and beauty of the design
Safety	Allowability of flow to pass under crossing and threat to public health
Creek Impact	Chance of causing erosion and disturbance to creek
Lifespan	Longevity of design

Existing:

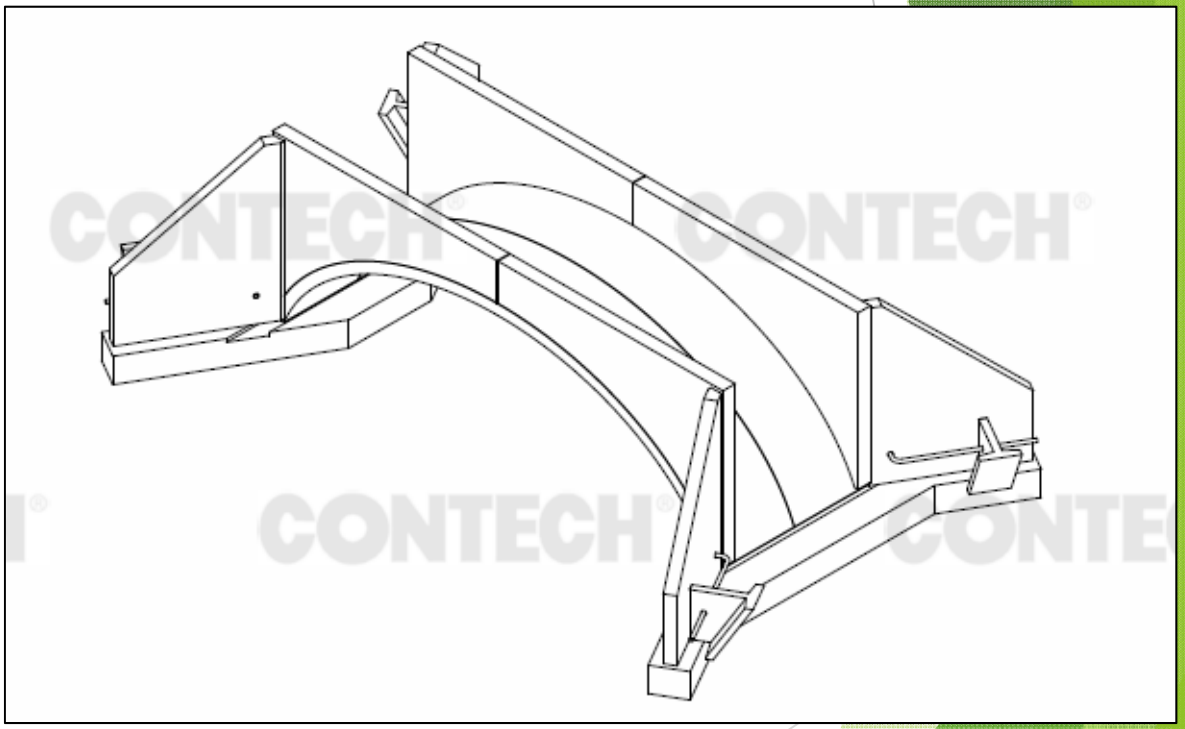


Three-Sided Bridge Design:

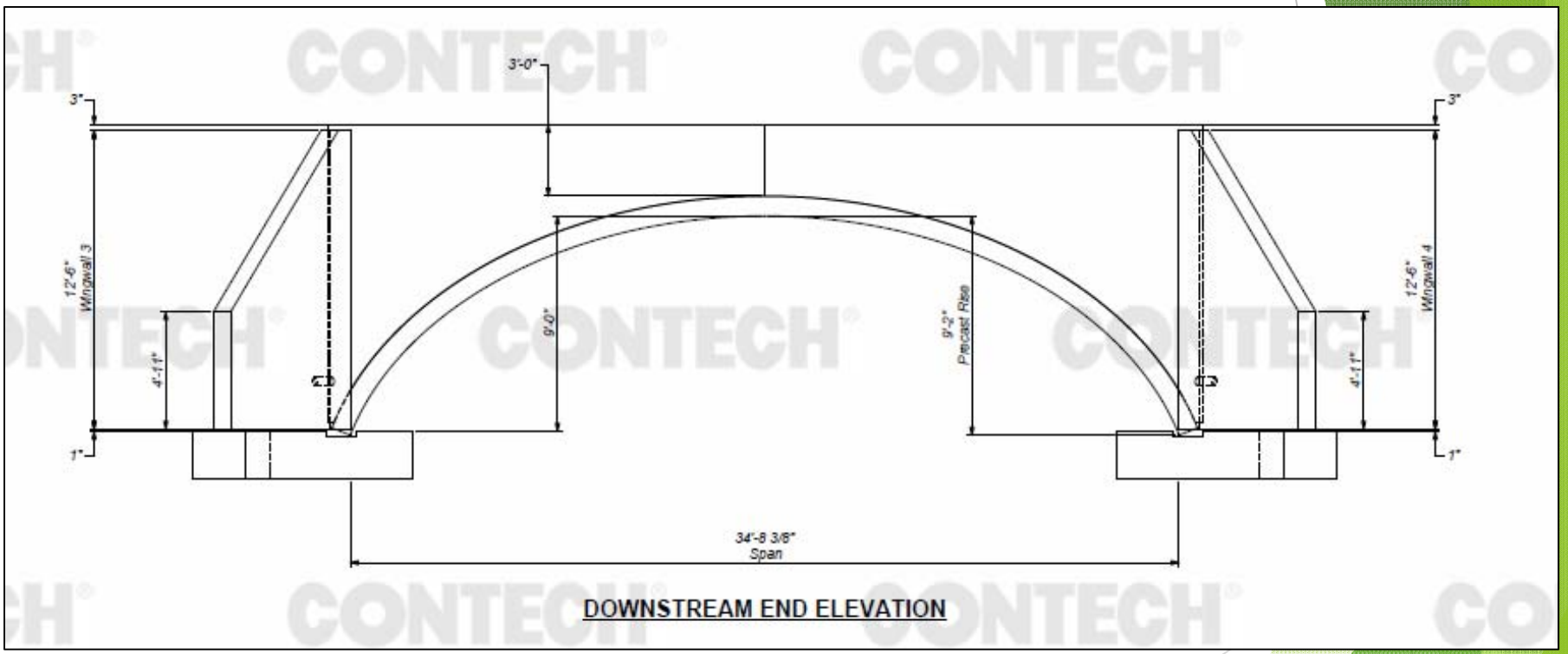


Final New Crossing Design (Three-Sided Bridge)

- Precast designs by Contech®
- Allows large clearance for debris to pass
- Natural stream bed bottom
  - Help minimize scour hole



Final New Crossing Design (Three-Sided Bridge)



Estimated Personnel Hours

Task	Project Engineer	Civil Engineer	Environmental Engineer	Administrative
Research (hrs)	18	24	41	0
Modeling (hrs)	13	24	126	0
Analysis (hrs)	72	44	47.5	0
Design (hrs)	11.5	72	7	0
Documentation (hrs)	8	9	37.5	60
Meetings (hrs)	22	36	23	34
Total per Personnel (hrs)	**144.5**	**209**	**282**	**94**
Total (hrs)	**730**			

Personnel and Material Cost

	Project Engineer	Civil Engineer	Environmental Engineer	Administrative
Total Hours	144.5	209	282	94
Pay Scale	$170	$60	$60	$45
Cost	$24,565	$12,540	$16,920	$4,230
Total Personnel	**$58,255**	**Estimated**	**$59,000**	
Rock Armoring	**$39,000**	ADOT Program and Project Management		
Total	**$97,255**	**Billed**	**$98,000**	

	Quoted Price	Service Company
Three-sided Bridge	**$150,000**	Contech
Total	**$150,000**	

Recognition

- Beth Ann Dzierson – Client
- Residents of Shangri-La Subdivision
- Mark Lamer – Technical Advisor

Questions?

Website:

http://www.cefns.nau.edu/capstone/projects/CENE/2014/OakCreek/