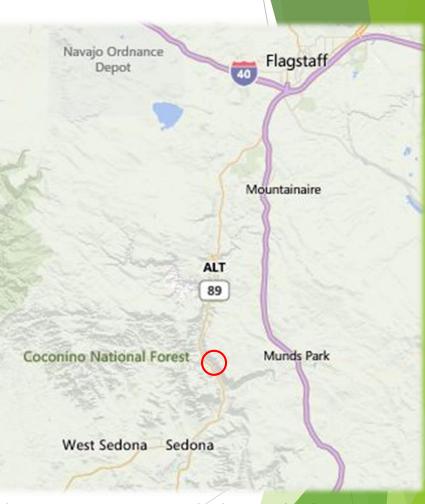
# Arizona Water Jacks: Oak Creek Low Water Crossing

Devin Kelley Hilary Sizemore Fawaz Alotaibi Bruce Connolly

### About the Project

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



The project site (circled in red) showing its relation to Flagstaff and Sedona

Courtesy of Bing Maps

#### **Client and Technical Advisor**

Client - Beth Ann Dzierson, Head of POA

Technical Advisor - Mark Lamer, P.E., MEng., Instructor at NAU

#### Needs of the Client

Protect the current crossing
 Scouring
 Geomorphology
 Design a new crossing



The geomorphology of Oak Creek (notice the natural beach on the left side)

#### **Stakeholders**

- Client Beth
   Ann Dzierson
   (Head of POA)
- Shangri-La residents



The road heading down towards the water crossing

### **Existing Conditions**

- 40 feet long and 14 <sup>1</sup>/<sub>2</sub> feet wide
- Four 48" concrete culverts
- Weight limit of 30 tons

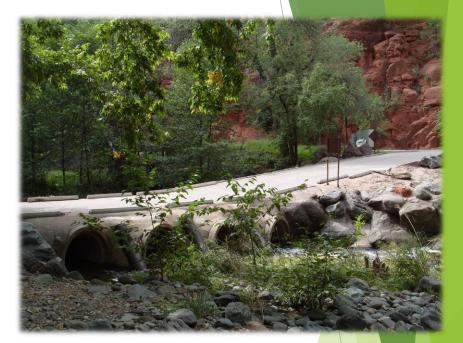


The sign shown the weight limit of the current crossing

#### **Existing Conditions**



The view of the crossing looking towards 89-A



The crossing as seen from the natural beach

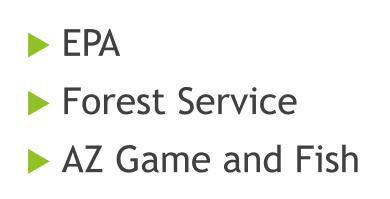
#### Scope (Research)





The flora in the crossing's surrounding area

#### Scope (Research)









#### Scope (Modeling)

Project Survey
USGS
HEC-HMS
HEC-RAS



#### Surveying around Oak Creek at the project site

#### Scope (Impacts)



Economy





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

http://northernword.com/2009/01/more\_from\_sedona/

#### Scope (Analysis and Design)

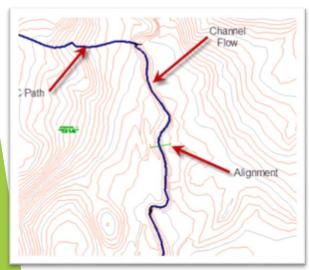
- Low Water Crossing Designs
- Techniques to Armor Existing Crossing

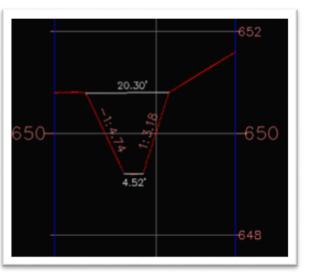


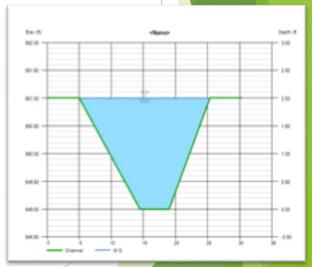
The large rocks are piled on the banks to prevent soil erosion

### Scope (Analysis and Design)

- AutoCAD
- Hydraflow Express
- Bentley WaterGEMS
- Culvert Master







## Scope (Exclusions)

Geotechnical Evaluation

Traffic Control

Structural Design



#### Schedule

| ask      |                         |          |              |               |               | Oct 13, '13 |    | v 3, 13 |       | v 24, '13 | Dec 15 |    | Jan 5, '14 |    | an 26, '14 | Feb 16, |     | Mar 9, '14 |    | ar 30, '14 | Apr 20, '1 |
|----------|-------------------------|----------|--------------|---------------|---------------|-------------|----|---------|-------|-----------|--------|----|------------|----|------------|---------|-----|------------|----|------------|------------|
|          |                         | Duration |              |               | Predecessors  | 7 15 23     | 31 | 8       | 16 24 | 2         | 10 18  | 26 | 3 11       | 19 | 27 4       | 12 20   | 28  | 8 16       | 24 | 1 9        | 17 25      |
|          | WEBSITE                 | 112 days | Fri 10/18/13 |               |               |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | ▲ Research              | 51 days  |              | 8 Mon 1/20/14 | •             |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Army Corps              | 50 days  | Mon 11/11/13 |               |               |             |    | _       |       |           |        |    |            |    |            |         |     |            |    |            |            |
| •        | AZ DEQ                  | 50 days  | Mon 11/11/13 |               | 3SS           |             |    | -       |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | ADOT                    | 50 days  | Mon 11/11/13 |               | 4SS           |             |    | -       |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | EPA                     | 50 days  | Mon 11/11/13 |               | 5SS           |             |    | -       |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Forest Service          | 50 days  | Mon 11/11/13 |               | 6SS           |             |    | -       |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Game & Fish             | 50 days  | Mon 11/11/13 | 8 Fri 1/17/14 | 7SS           |             |    | -       |       |           |        |    |            |    |            |         |     |            |    |            |            |
| •        | Safety                  | 50 days  | Mon 11/11/13 |               | 8SS           |             |    | -       |       |           |        |    |            |    |            |         |     |            |    |            |            |
| •        | Research Complete       | 50 days  | Mon 11/11/13 | Fri 1/17/14   | 9SS           |             |    | 4       |       |           |        |    |            |    | ,          |         |     |            |    |            |            |
| •        | ▲ MODELING              | 63 days  | Sat 11/16/13 | Wed 2/12/14   | L I           |             |    | Г       |       |           |        |    |            |    |            | 1       |     |            |    |            |            |
|          | Project Survey          | 23 days  | Sat 11/16/13 | Wed 1/29/14   |               |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
| •        | USGS Data               | 10 days  | Thu 1/30/14  | Wed 2/12/14   | 10            |             |    |         |       |           |        |    |            |    | +          | •       |     |            |    |            |            |
|          | HEC-HMS                 | 10 days  | Thu 1/30/14  | Wed 2/12/14   | 10,12         |             |    |         |       |           |        |    |            |    | +          |         |     |            |    |            |            |
| •        | HEC-RAS                 | 10 days  | Thu 1/30/14  | Wed 2/12/14   | 10,12         |             |    |         |       |           |        |    |            |    | 4          |         |     |            |    |            |            |
| •        | Modeling Complete       | 0 days   | Wed 2/12/14  | Wed 2/12/14   |               |             |    |         |       |           |        |    |            |    |            | 2/12    |     |            |    |            |            |
|          | ▲ IMPACTS               | 15 days  | Fri 1/24/14  | Thu 2/13/14   |               |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Political               | 15 days  | Fri 1/24/14  | Thu 2/13/14   |               | ]           |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Social                  | 15 days  | Fri 1/24/14  | Thu 2/13/14   |               | ]           |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
| k.       | ANALYSIS                | 16 days  | Sat 2/15/14  | Fri 3/7/14    |               | 1           |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
| •        | Geomorph                | 16 days  | Sat 2/15/14  | Fri 3/7/14    | 10            | ]           |    |         |       |           |        |    |            |    |            | +       |     |            |    |            |            |
|          | AutoCAD                 | 15 days  | Mon 2/17/14  | Fri 3/7/14    | 10            | 1           |    |         |       |           |        |    |            |    |            | +       |     |            |    |            |            |
| •        | Hydraflow Express       | 16 days  | Sat 2/15/14  | Fri 3/7/14    | 10            | 1           |    |         |       |           |        |    |            |    |            | +       |     |            |    |            |            |
|          | Bently W. Gems          | 16 days  | Sat 2/15/14  | Fri 3/7/14    | 10            | 1           |    |         |       |           |        |    |            |    |            | +       |     |            |    |            |            |
|          | Culvert Master          | 16 days  | Sat 2/15/14  | Fri 3/7/14    | 10            | 1           |    |         |       |           |        |    |            |    |            | -       |     |            |    |            |            |
|          | Analysis Complete       | 0 days   | Fri 3/7/14   | Fri 3/7/14    |               |             |    |         |       |           |        |    |            |    |            |         | •   | 3/7        |    |            |            |
|          | 4 DESIGN                | 16 days  | Sat 3/8/14   | Fri 3/28/14   |               |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Structure               | 16 days  | Sat 3/8/14   | Fri 3/28/14   | 10,16,26      |             |    |         |       |           |        |    |            |    |            |         | - + | -          |    |            |            |
|          | Armor Existing Stucture | 16 days  | Sat 3/8/14   | Fri 3/28/14   | 10,16,26      | 1           |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Design Complete         | 0 days   | Sat 3/8/14   | Sat 3/8/14    |               |             |    |         |       |           |        |    |            |    |            |         |     | 3/8        |    |            |            |
|          | 4                       | 54 days  | Mon 2/17/14  | Thu 5/1/14    |               |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
| •        | 50% Design Report       | 19 days  | Mon 2/17/14  |               |               |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Interim Presentation    | 19 days  | Mon 2/17/14  | Thu 3/13/14   |               |             |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |
|          | Final Presentation      | 20 days  |              |               | 1,30,10,16,26 |             |    |         |       |           |        |    |            |    |            |         |     |            | -  |            |            |
|          | UGRADS Presentation     | 0 days   | Fri 4/25/14  | Fri 4/25/14   |               | 1           |    |         |       |           |        |    |            |    |            |         |     |            |    |            | 4/         |
|          | Final Report            | 24 days  |              |               | 1,30,10,16,26 | 1           |    |         |       |           |        |    |            |    |            |         |     |            | -  |            |            |
| <i>•</i> | Project Complete        | 0 days   | Thu 5/1/14   | Thu 5/1/14    |               | 1           |    |         |       |           |        |    |            |    |            |         |     |            |    |            |            |

#### Schedule showing Critical Path in dark orange

#### Hours Worked Estimate

- Hours assigned per subject per task
- Task hours totaled

|                | Senior Engineer | Engineer | Intern | Administrative |
|----------------|-----------------|----------|--------|----------------|
| Research       |                 |          |        |                |
| Army Corps     | 1.5             | 4        | 5      | 0.5            |
| AZDEQ          | 1.5             | 4        | 5      | 0.5            |
| ADOT           | 1.5             | 4        | 5      | 0.5            |
| EPA            | 1.5             | 4        | 5      | 0.5            |
| Forest Service | 1.5             | 4        | 5      | 0.5            |
| Game & Fish    | 1.5             | 4        | 5      | 0.5            |
| Safety         | 1.5             | 4        | 5      | 0.5            |
| Total          | 10.5            | 28       | 35     | 3.5            |

| Complete Estimate      | d Hours per Task p | per Role        |        |                |
|------------------------|--------------------|-----------------|--------|----------------|
|                        | Senior Engineer    | Engineer        | Intern | Administrative |
| Research               |                    |                 |        |                |
| Army Corps             | 1.5                | 4               | 5      | 0.5            |
| AZDEQ                  | 1.5                | 4               | 5      | 0.5            |
| ADOT                   | 1.5                | 4               | 5      | 0.5            |
| EPA                    | 1.5                | 4               | 5      | 0.5            |
| Forest Service         | 1.5                | 4               | 5      | 0.5            |
| Game & Fish            | 1.5                | 4               | 5      | 0.5            |
| Safety                 | 1.5                | 4               | 5      | 0.5            |
| Total                  | 10.5               | 28              | 35     | 3.5            |
|                        |                    |                 |        |                |
| Modeling               |                    |                 |        |                |
| HEC-HMS                | 2                  | 7               | 7      | (              |
| HEC-RAS                | 2                  | 7               | 7      | (              |
| USGS DATA              | 2                  | 7               | 7      | (              |
| Land Survey            | 8                  | 20              | 20     | (              |
| Total                  | 14                 | 41              | 41     | (              |
| Impact                 |                    | -               |        |                |
| Political              | 0.5                | 0.5             | 2      |                |
| Social                 | 0.5                | 0.5             | 2      | 3              |
| Total                  | 0.3                | 0.5             | 4      | 6              |
| 10101                  | -                  |                 |        |                |
| Analysis               |                    |                 |        |                |
| AutoCAD 3D             | 4                  | 8               | 8      | 0.5            |
| Geomorphology          | 4                  | 8               | 8      | 0.5            |
| Culvert Master         | 4                  | 8               | 8      | 0.5            |
| Hydraflow Express      | 4                  | 8               | 8      | 0.5            |
| Bentley W. Gems        | 4                  | 8               | 8      | 0.5            |
| Documentation          | 2                  | 8               | 8      | 5              |
| Total                  | 22                 | 48              | 48     | 10.5           |
| Docign                 |                    |                 |        |                |
| Design                 |                    |                 |        |                |
| Structure              | 4                  | 11              | 11     | (              |
| Armoring Exist.        | 4                  | 11              |        |                |
| Documentation<br>Total | 10                 | 10<br><b>32</b> |        |                |

#### **Cost Estimate**

| 1.0 Personnel          |                       |              |              |                |                      |  |  |  |  |  |
|------------------------|-----------------------|--------------|--------------|----------------|----------------------|--|--|--|--|--|
| Tasks                  | Senior Engineer       | Engineer     | Intern       | Administrative | Total Per Task (hrs) |  |  |  |  |  |
| Research (hrs)         | 10.5                  | 28           | 35           | 3.5            | 77                   |  |  |  |  |  |
| Modeling (hrs)         | 14                    | 41           | 41           | 0              | 96                   |  |  |  |  |  |
| Impact (hrs)           | 1                     | 1            | 4            | 6              | 12                   |  |  |  |  |  |
| Analysis (hrs)         | 22                    | 48           | 48           | 10.5           | 128.5                |  |  |  |  |  |
| Design (hrs)           | 10                    | 32           | 32           | 2              | 76                   |  |  |  |  |  |
| Total Per Role (hrs)   | 57.5                  | 150          | 160          | 22             | 389.5                |  |  |  |  |  |
| Pay Scale Per Role     | \$ 170.00             | \$ 90.00     | \$ 30.00     | \$ 45.00       |                      |  |  |  |  |  |
| Cost                   | \$ 9,775.00           | \$ 13,500.00 | \$ 4,800.00  | \$ 990.00      | \$ 29,065.00         |  |  |  |  |  |
| Total Personnel Cost   | \$ <b>1</b> 29,000.00 |              |              |                |                      |  |  |  |  |  |
| 2.0 Reimbursment       |                       |              |              |                |                      |  |  |  |  |  |
| Not to exceed          | \$ 1,000.00           |              |              |                |                      |  |  |  |  |  |
| 3.0 Subcontracts       |                       |              |              |                |                      |  |  |  |  |  |
| Structural Analysis    | \$ 15,000.00          |              |              |                |                      |  |  |  |  |  |
| Geotechnical Analysis  | \$ 15,000.00          |              |              |                |                      |  |  |  |  |  |
| Total Subcontracts     | \$ 30,000.00          |              |              |                |                      |  |  |  |  |  |
| 4.0 Total Service Cost | \$ 60,000.00          |              |              |                |                      |  |  |  |  |  |
| 5.0 Comparison         | Clients Budget        |              |              |                |                      |  |  |  |  |  |
|                        | \$ 80,000.00          | >            | \$ 60,000.00 |                |                      |  |  |  |  |  |
| Remaining Budget       | \$ 20,000.00          |              |              |                |                      |  |  |  |  |  |

### Budget Comparison

| 5.0 Comparison   | -  | Clients Budget |   |                 |
|------------------|----|----------------|---|-----------------|
|                  | \$ | 80,000.00      | > | \$<br>60,000.00 |
| Remaining Budget | \$ | 20,000.00      |   |                 |

- The budget allocated by Property Association
- Services are within budget

#### Conclusion

Armoring Current Crossing
New Crossing Design
Thorough Analysis
Below Budget