



LEVEE DESIGN FOR DUNCAN,
ARIZONA

AHMAD ALFALLAJI

ENVIRONMENTAL ENGINEER

ABDULAZIZ EBRAHIM

ENVIRONMENTAL ENGINEER

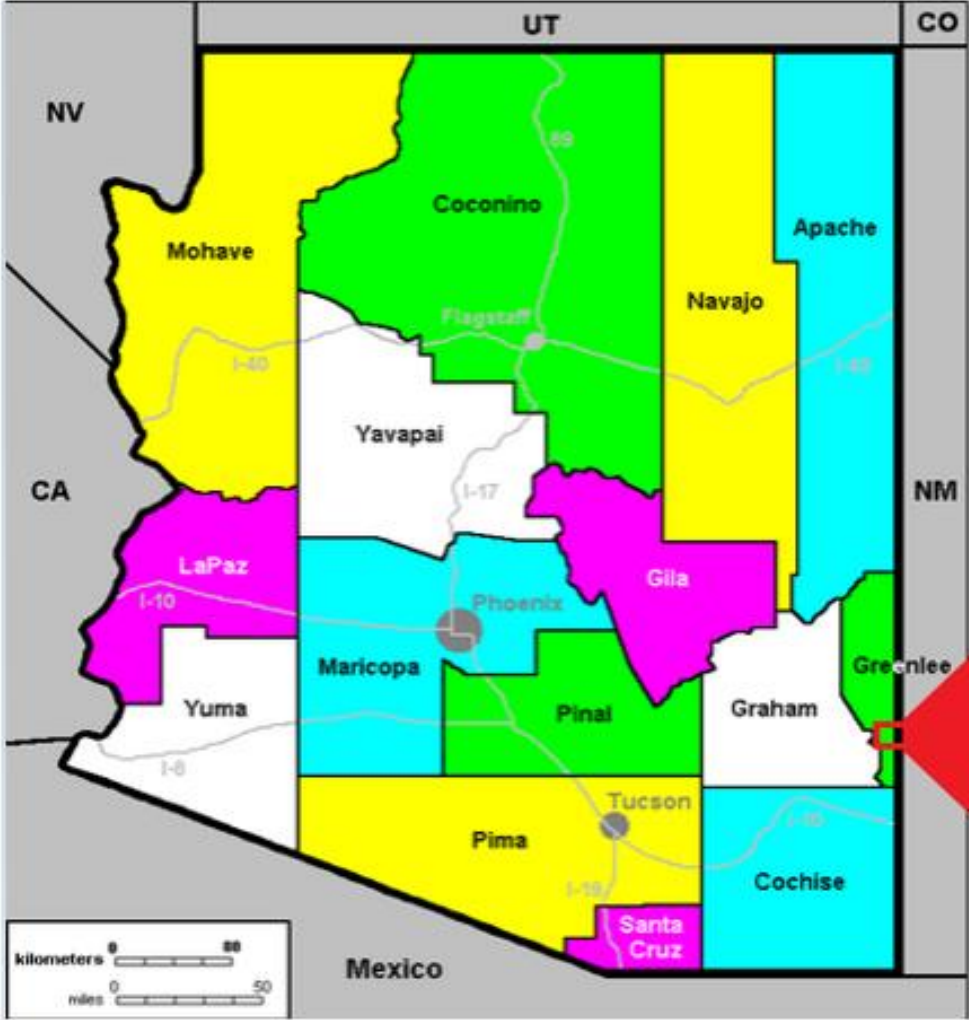
JENNALISE RAPINCHUK

CIVIL ENGINEER

CHARLES WILSON

CIVIL ENGINEER

Project Location-Duncan, Arizona



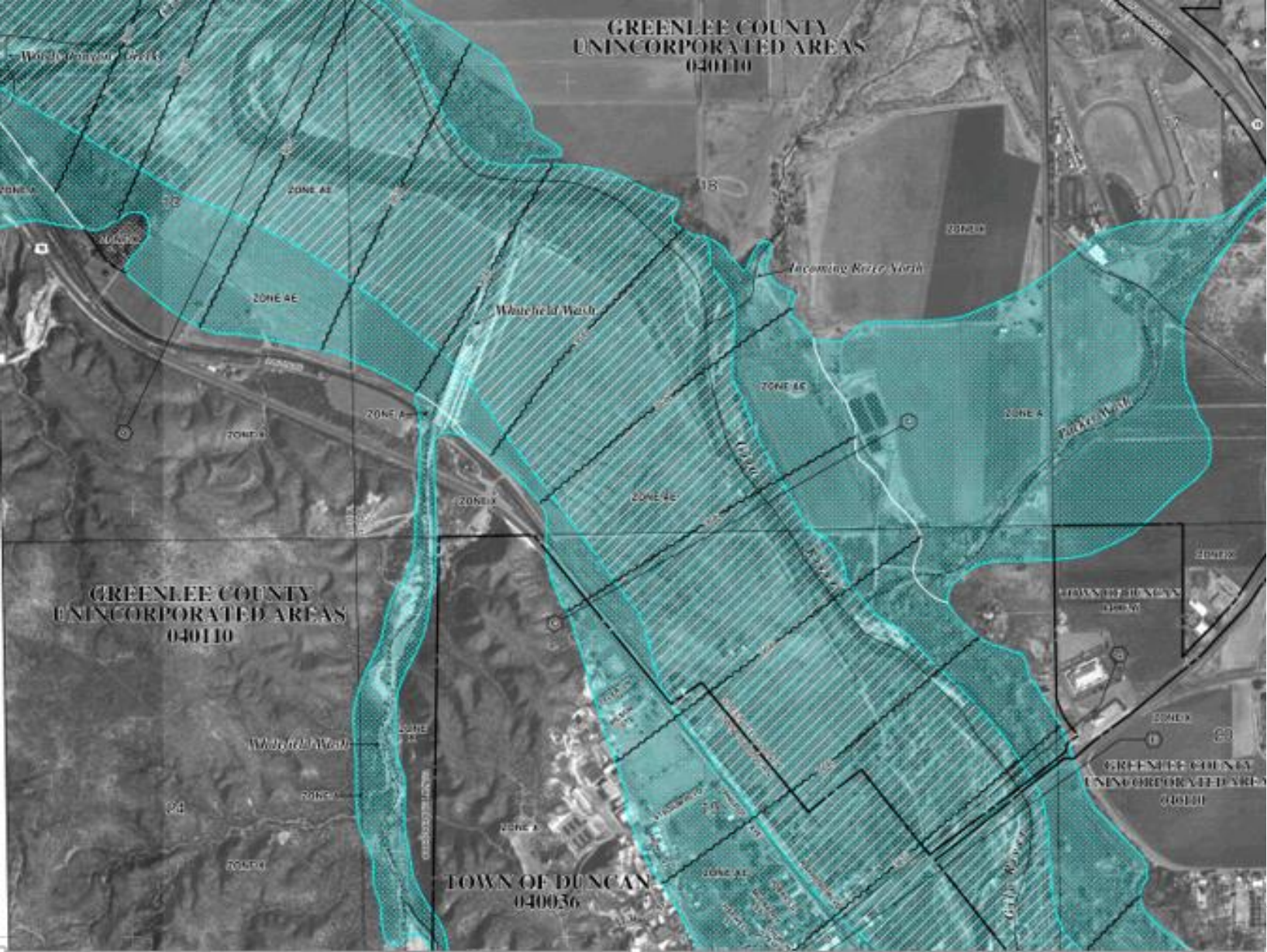
Google, "Maps," 2015.

Project Information

- Duncan is agricultural based and heavily reliant on the Gila River
- Built along the floodplain
- Current levee begins failing beyond 10 year flooding events
 - 1978 flood caused 9 million dollars in damage



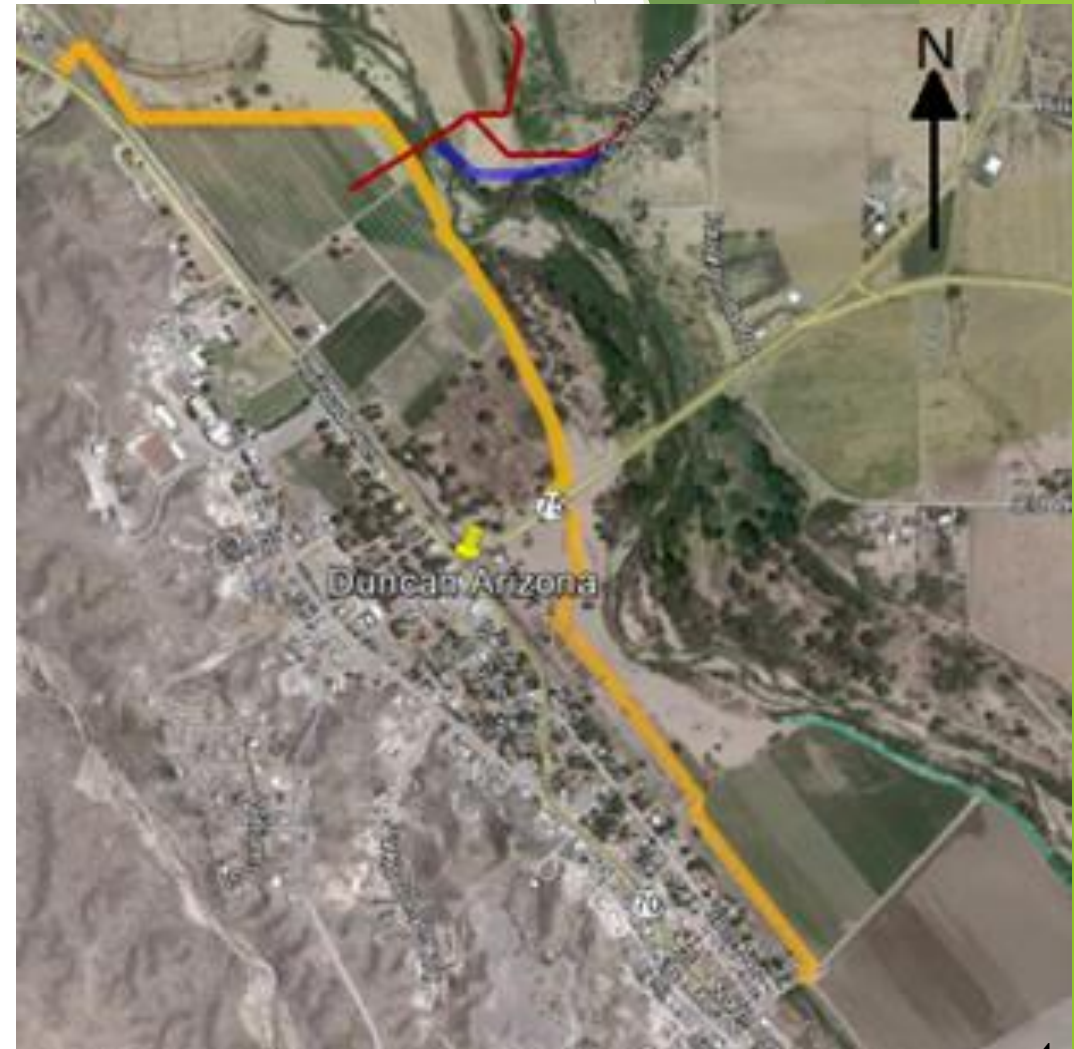
Flood Insurance Rate Map of Duncan



<https://msc.fema.gov/portal/search?AddressQuery=Duncan%2C%20Arizona>

Expectations from the Client

- **Client:** Phil Ronnerud, Greenlee County Engineer
- **Expectation:** Assess current levee and improve its design to accommodate larger floods
- **Purpose:** Protect the Town of Duncan from future flood damage



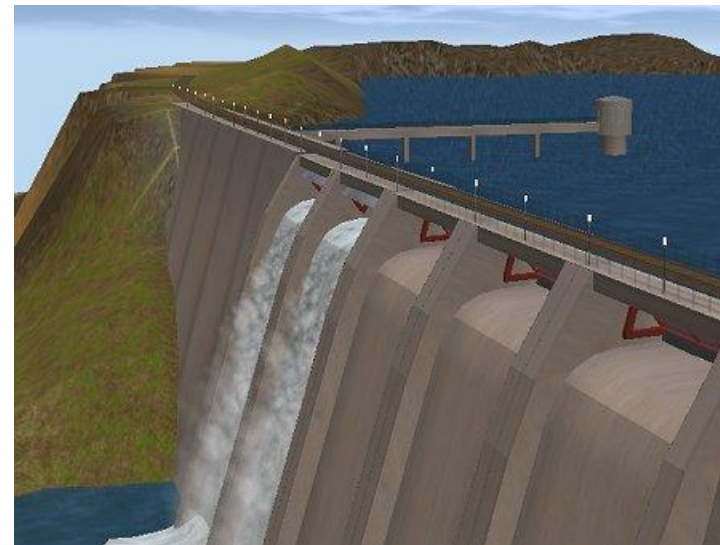
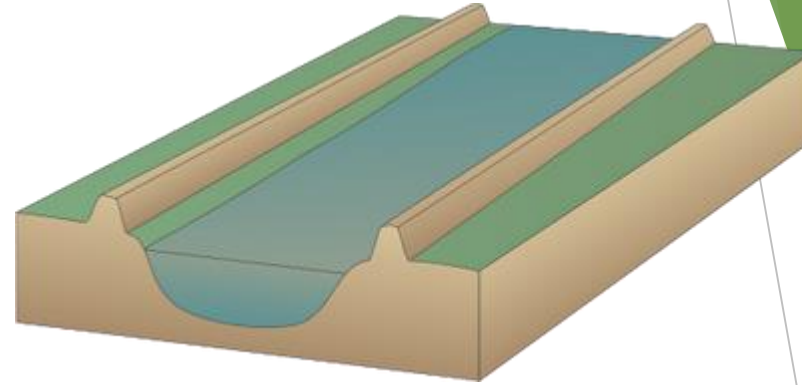
Levee Function

What is a levee?

- An embankment running parallel along a river
- Prevents flooding in the floodplain

How is a levee different from a dam?

- A dam perpendicularly intersects a river
- A lake forms behind the dam, and the land in front of the dam has a controlled river



Gila River Flows Relevant to Duncan

Duncan, Arizona Flood Information		
Flood Event	Flow	Other
Normal	250	
	7,000	Levee damage occurs
	20,000	Levee fails from overtopping
100 Year	28,500	
1978 Flood	60,000	Over \$9 million in damage

Levee Certification vs. Accreditation

Having a certified levee:

- An engineer has examined the levee and decided that it will function properly
- The levee will keep the floodplain safe from flooding
- This is a mandatory first step for accreditation

Having a FEMA accredited levee:

- The levee in place meets FEMA standards
- FEMA will redraw the floodplain with the levee in place
- Ideally, Duncan will no longer be located in the Gila River floodplain

FEMA Design Guidelines

In order to meet FEMA guidelines for accreditation, this levee must:

- Be able to withstand erosive forces of a 100 year flood event
- Be tall enough to withhold the flood of a 100 year flood event
 - Have an additional 3 feet of freeboard above the base flood elevation, and 1 additional foot near structures, or where flow is restricted
- Have minimum seepage
 - Any seepage that occurs cannot lower the stability of the levee

For a complete list of FEMA accreditation guidelines, see section 65.10(b-d) of the NFIP regulations

Soil Properties of Project Location

- Soils are commonly used for levees
- Soil type influences structural integrity of levee

Type of soil	K-Factor Rating	Hydraulic Conductivity (in./hr.)	% of area of interest
15: Glendale silty clay loam, 0 to 2 percent slopes	0.43	0.06 to 0.20	10.7%
16: Glendale-Gila complex, 0-5% slopes	0.43	0.20 to 0.57	5.0%
27: Pima silty clay loam, 0-2% slopes	0.43	0.06 to 0.20	57.4%
17: Torrifluents-Riverwash complex, 1-5% slopes	N/A	0.20 to 0.57	27.0%
Total for Area of Interest			100%



Environmental Protection Agency (EPA)

- Gila River is protected by the EPA under the Clean Water Act
- Section 404 of the Clean Water Act requires special permits for any water resource project
- Enforced by the Army Corps of Engineers



<https://wingandsong.files.wordpress.com/2012/04/redrock-gila-river.jpg>

Zoning and Right of Way

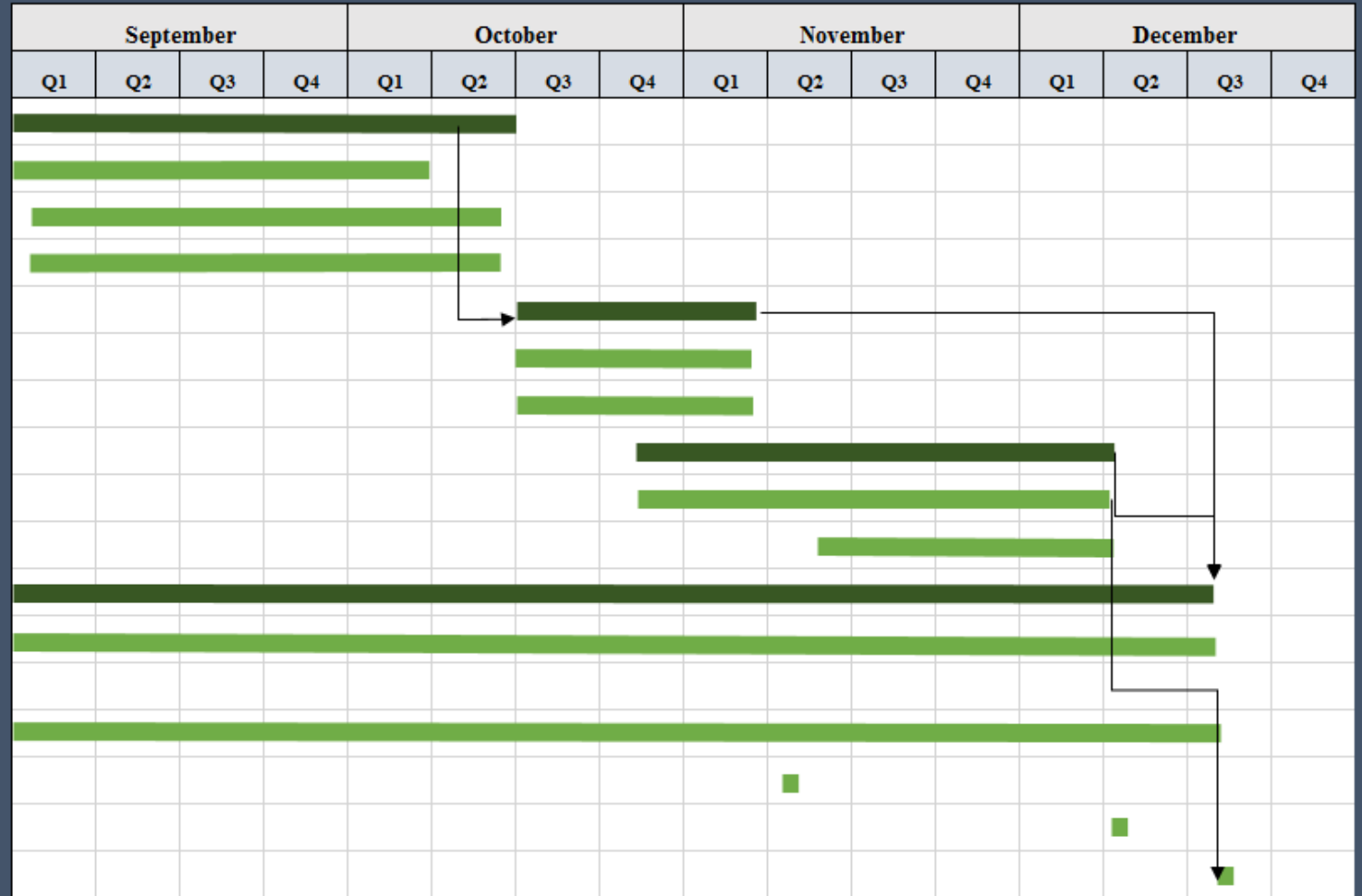
- Levee implementation will require a development permit and occupancy permit by the Greenlee County Engineer and Zoning Inspector
- Challenges may arise if the levee crosses over any private properties along the Gila River

NAU Crown Engineering Exclusions

- NAU Crown Engineering will not take part in the following:
 - FEMA certification process
 - Flood protection of areas in Duncan outside of the targeted levee
 - Land and permit approvals

Scope of Services and Schedule

ACTIVITY	Begin Date	End Date
Task 1 Data Collection	1-Sep	14-Oct
1.1 Geotechnical Assessment	1-Sep	6-Oct
1.2 Gila River Hydraulics/Hydrology	3-Sep	13-Oct
1.3 Surveying	3-Sep	14-Oct
Task 2 Site Assessment	15-Oct	6-Nov
2.1 Levee Assessment/HEC-RAS	15-Oct	6-Nov
2.2 Endangered Species Assessment	15-Oct	6-Nov
Task 3 Design of New Levee	28-Oct	9-Dec
3.1 Civil 3D Modeling	28-Oct	9-Dec
3.2 HEC-RAS Testing	10-Nov	9-Dec
Task 4 Project Management	1-Sep	18-Dec
4.1 Client Contact	1-Sep	18-Dec
4.2 Deliverables		
Website	1-Sep	18-Dec
50% Design Report	10-Nov	
Presentation	10-Dec	
Final Design Report	18-Dec	



Staffing and Cost of Engineering Services

Task	Classification	Required Hours
Task 1 Data Collection		
Survey data	EIT	40
Geotechnical Data	EIT	56
Hydraulics and Hydrology Data	EIT	56
Task 2 Site Assessment		
Examining Site	ENG	96
	SENG	32
HEC-RAS Simulation	ENG	64
Coordination with Endangered Species Act	SENG	48
Task 3 Design of New Levee		
Civil 3D Modeling	ENG	120
HEC-RAS Testing	ENG	48
Task 4 Project Management		
Public and Client Contact	SENG	48
Total		608



Classification	Hours	rate (\$/hr)	Cost
SENG	128	\$130	\$16,640
ENG	328	\$90	\$29,520
EIT	152	\$60	\$9,120
Travel (2 meetings)			
700 miles/meeting	\$0.40/mi	700 Miles	\$560
Hotel		\$70/night x 2 room	280
Vehicle Rental	2 Days	\$40/day	\$160
Per diem	2 day*4 people	\$32/day	512
Total Travel			\$1,512
Total			\$56,792

References

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- "Floodplain Management Ordinance," September 2007. [Online]. Available: <http://www.co.greenlee.az.us/engineering/floodplainordinance.pdf>.
- Arizona Department of Water Resources, Reconnaissance Report of the Gila River Flood Control Project, 1981. 13

A faded background image of a river valley. The foreground shows a rocky riverbed with some green grass. The middle ground features a wide river valley with sparse vegetation. In the background, there are several rounded mountains under a clear sky.

Questions?