

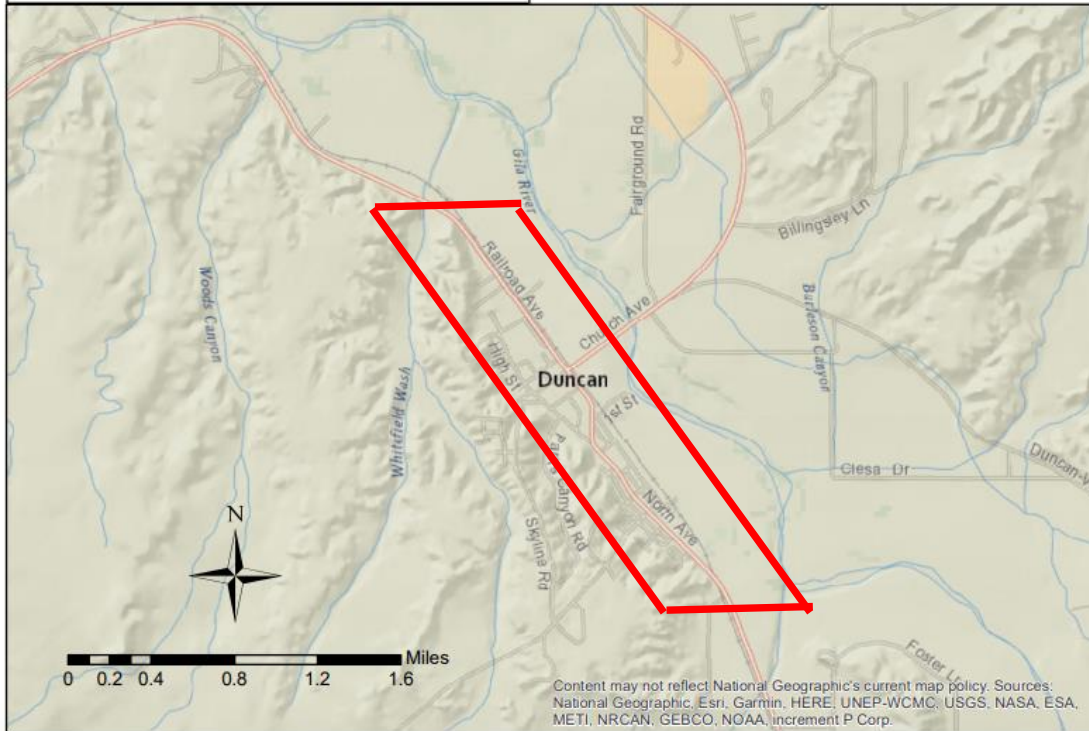
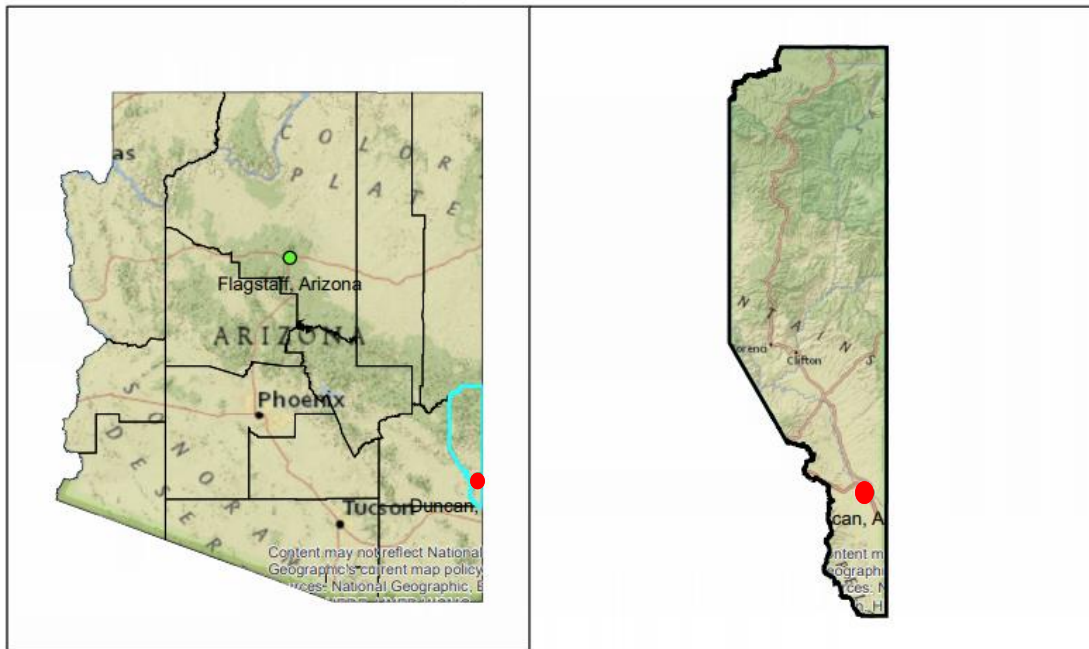
DUNCAN, ARIZONA HIGHWAY AND LEVEE ALIGNMENT

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Technical Advisor: Brendan Russo, PhD

Grader: Mark Lamer, PE

CENE 486C- 12/7/2018



- This project has been going on for 4 years
 - ❖ *Year 1: Floodplain Analysis 1-D Model and Conceptual Levee Alignment Along Gila River (2015)*
 - ❖ *Year 2: Floodplain Analysis 2-D Model (2016)*
 - ❖ *Year 3: Flood Mitigation (2017)*
 - *Year 4: Highway and Levee Alignment (2018)*

Figure 1: Map of Duncan, Arizona

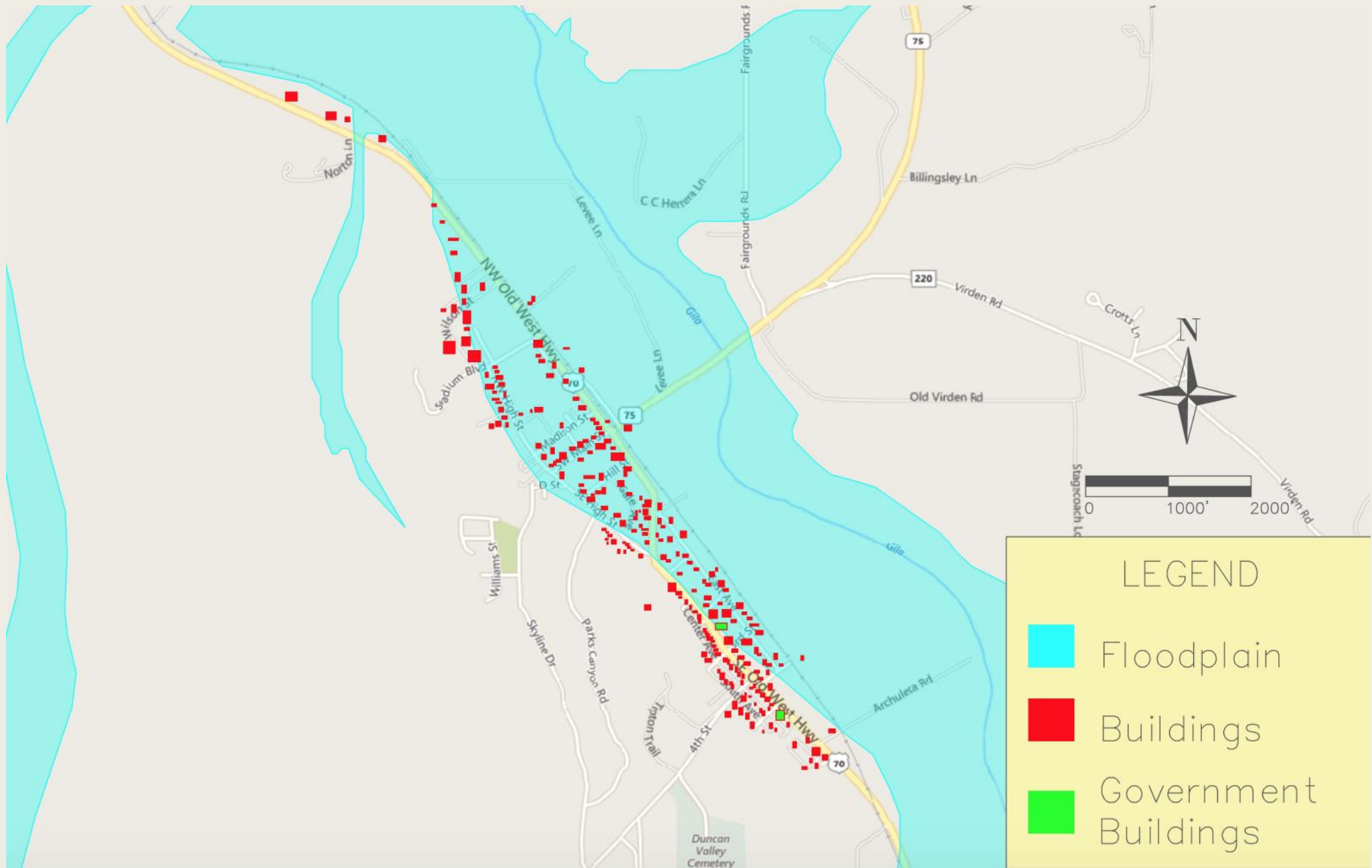


Figure 2: Map of Duncan, AZ, Floodplain Zone [3]

Crash Data Analysis

Table 1: 2017 ADOT Data Report [1] [2].

Town	Number of Crashes				Number of People		Alcohol Related		
	Total	Fatal	Injury	Property Damage Only	Killed	Injured	Crashes	Killed	Injured
Duncan	3	1	1	1	1	2	1	1	0

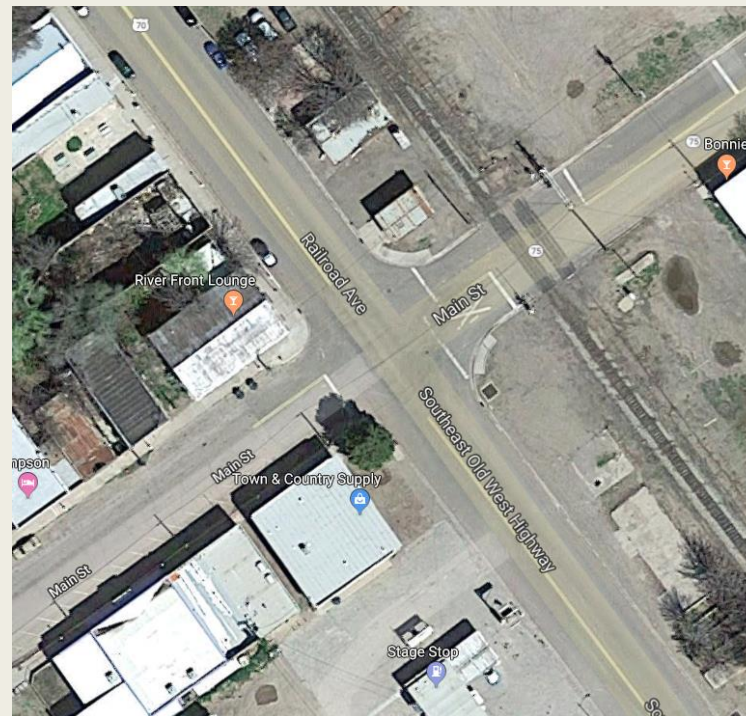


Figure 3: Map of Duncan, AZ, Intersection of Main Street (SR 75) and Railroad Ave (SR 70)

Traffic Analysis

Table 2: 2017 ADOT data report [1] [2].

AADT Report			
Route	BMP ¹	EMP ²	AADT ³
SR 75	378.92	379.46	2,792
US 70	349.48	378.48	1056
	378.48	378.91	1567
	378.91	379.48	3470
Crash Data			
County	Number of Crashes		
Greenlee	84		

1. BMP - Beginning Mile Post
2. EMP - End Mile Post
3. AADT- Annual Average Daily Traffic

Traffic Characteristics

Table 3: 2017 ADOT Data Report [1] [2].

Terms	Value
Average Annual Daily Traffic (AADT) 2017	2184 Vehicles
Growth Factor	1%
K Factor- the proportion of AADT occurring in 1 hour	9%
D Factor-% of traffic moving in the peak travel direction	59%
Average Annual Daily Traffic-Single Trucks	129 Vehicles
Average Annual Daily Traffic-Combo Trucks	85 Vehicles
T Factor- % of trucks in 1 hour	10%
Future Annual Average Daily Traffic	2925 Vehicles

Table 4: 2017 ADOT Data Report [1] [2].

Terms	Criteria
Existing Speed	45 miles per hour
Estimated Free Flow Speed	39.5 miles per hour
Design Speed	60 miles per hour
Lanes	2
Slopes of Elevated Highway	4 Horizontal: 1 Vertical
Shoulder Length	6 feet on each side
Current LOS	A

Existing Features

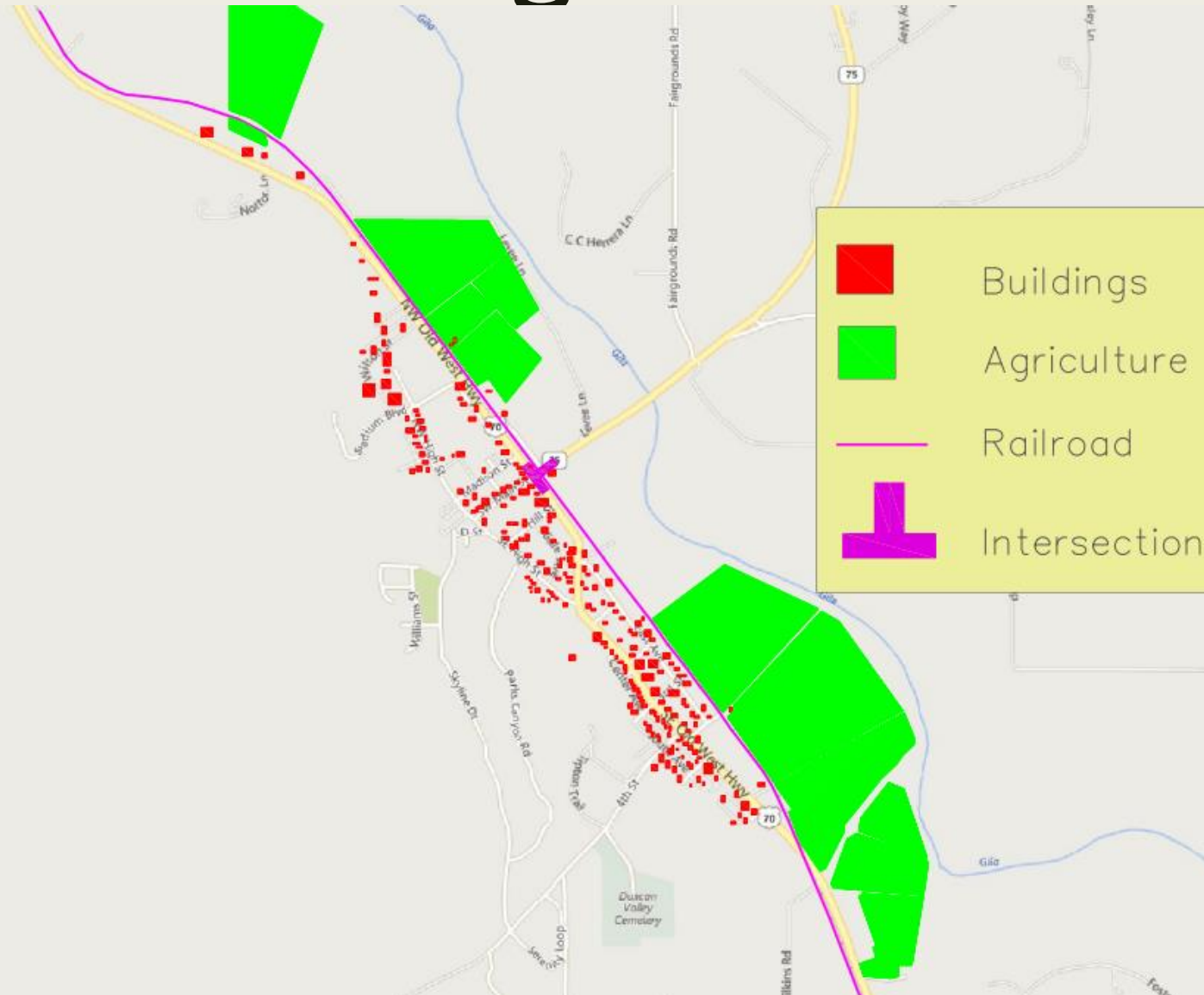


Figure 4: Map of Duncan, AZ Existing Features

Corridor Design

Corridor Design	
Turning Lane (12')	12 feet
Slope (2 sides)	51 feet
Lane Width (2 lanes)	24 feet
Shoulder Width (6' each side)	12 feet
Total Average Width	99 feet

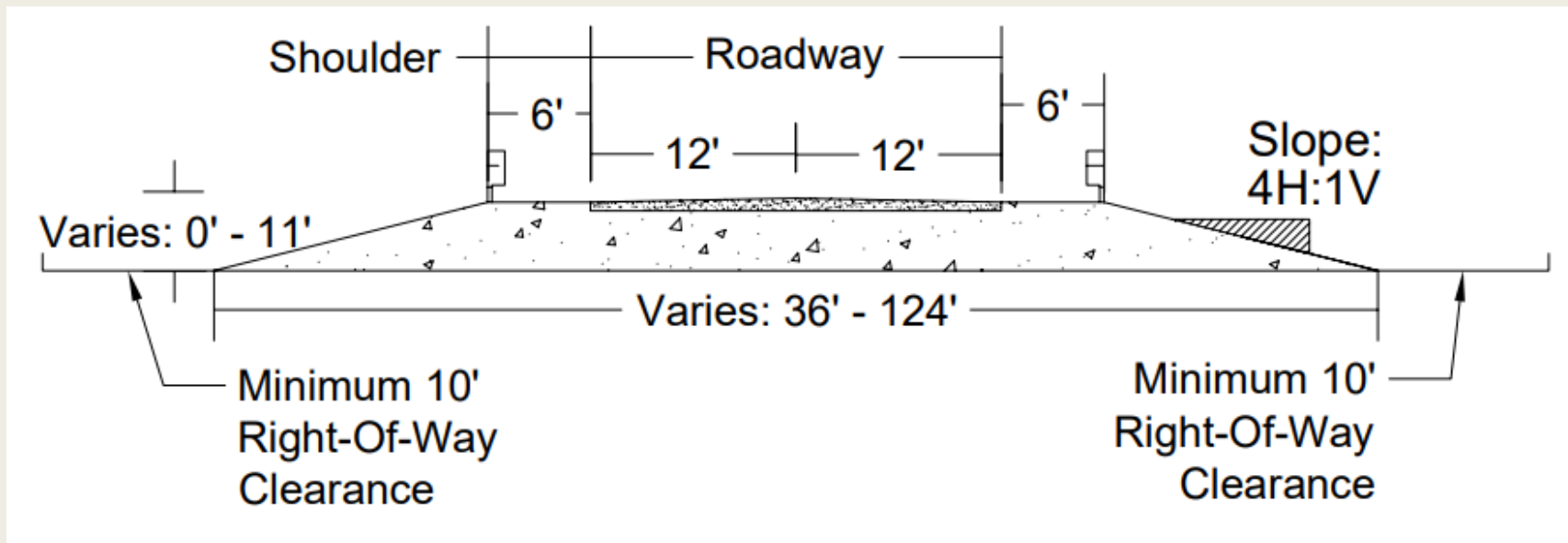
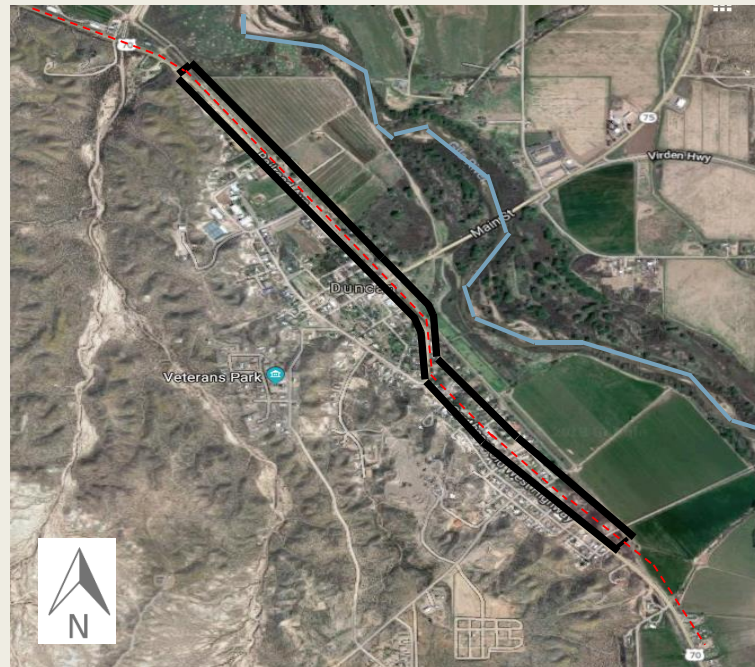
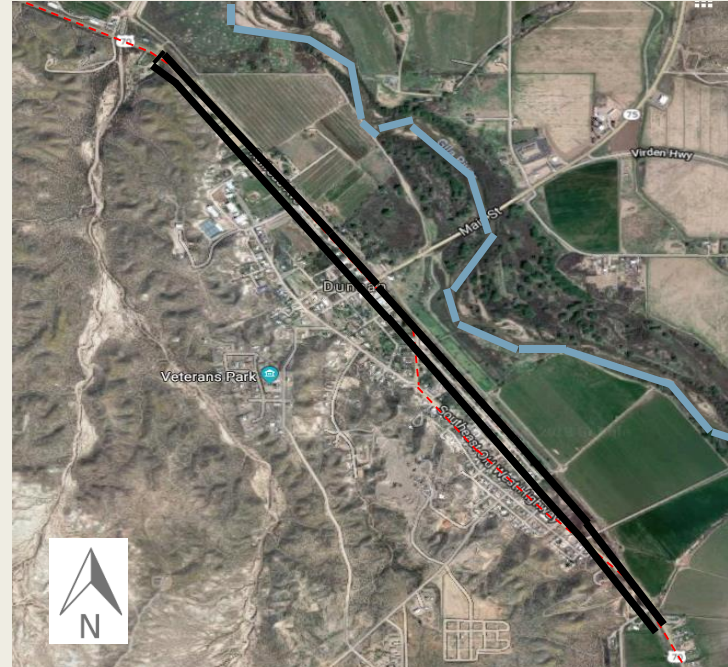


Figure 5: Typical Cross Sections of the Levee Design

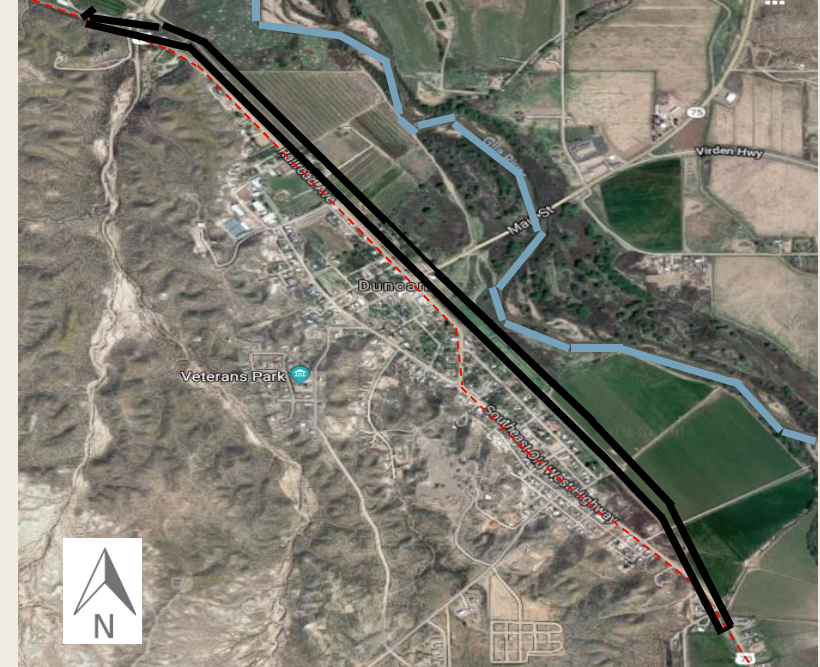
Levee Road Alignment Options



Alignment Option 1: Raising
Current Highway



Alignment Option 2: Running
Along Agricultural Dike

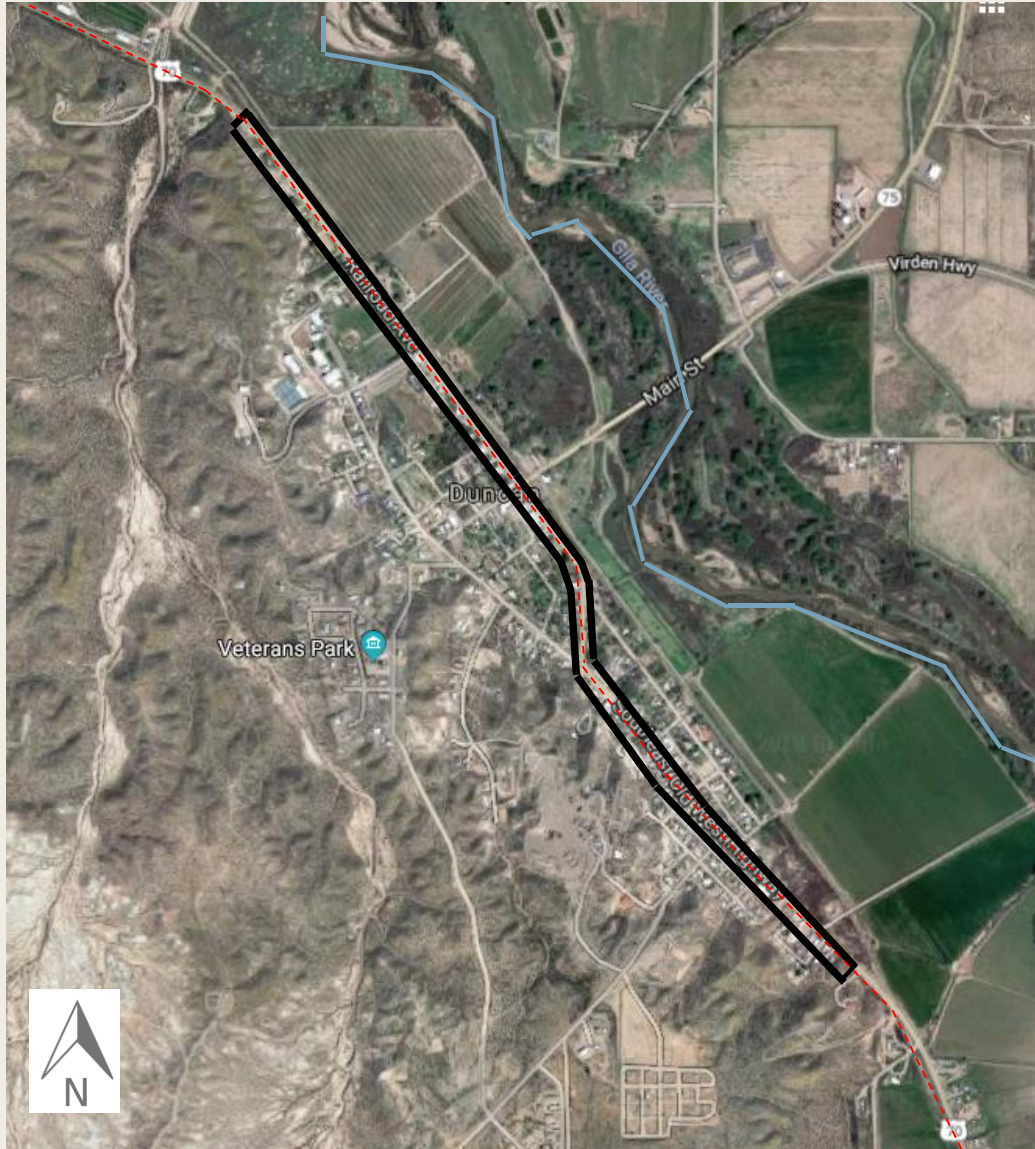


Alignment Option 3:
Running Parallel to Railroad
on Agricultural Land

Legend:

- Corridor
- - - Existing Highway
- Gila River

Alignment Option 1: Raising Current Highway



- Max Corridor Width- 108 feet
- LOS A
- Design Speed of 60 mph

Legend:

- Corridor
- - - Existing Highway
- Gila River

Figure 6: Schematic for Horizontal Alignment Option 1 [4]

Highway Capacity Software (HCS)

Alignment Option 1: Raising Current Highway

Table 5: HCS Input Data for Alignment Option 1 [5]

Input Data	
Term	Value
Highway Class	Class 2
Shoulder Width	6 feet
Lane Width	12 feet
Terrain Type	Level
Peak- Hour Factor, PHF	0.88
% No-Passing Zone	100
Access Points/Miles	14
Two-Way Hourly Volume, V	105 vehicles/hr
Directional Split	60/40 %



- Level of Service (LOS): A
- Design Speed of 60 mph- achieved
- Percent Time Spent Following: 34.4%

Alignment Option 1: Raising Current Highway- Horizontal Alignment



Levee Length:
1.30 Miles

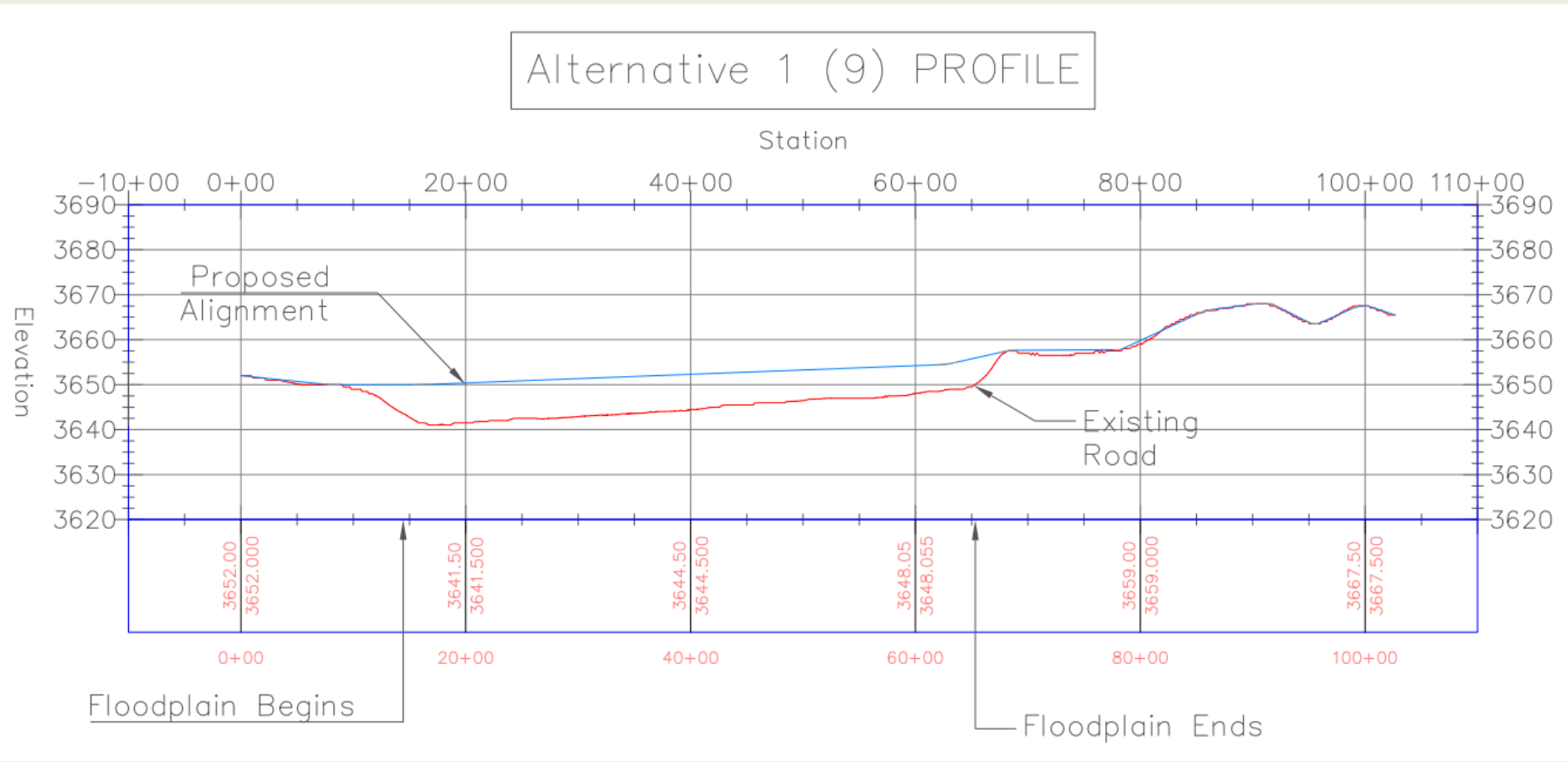
Cut Material:
1,300 Cubic yards

Fill Material:
85,300 Cubic yards

Removal of 22 Homes

Figure 7: Alignment Option 1- Horizontal Alignment

Alignment Option 1: Raising Current Highway- Vertical Alignment



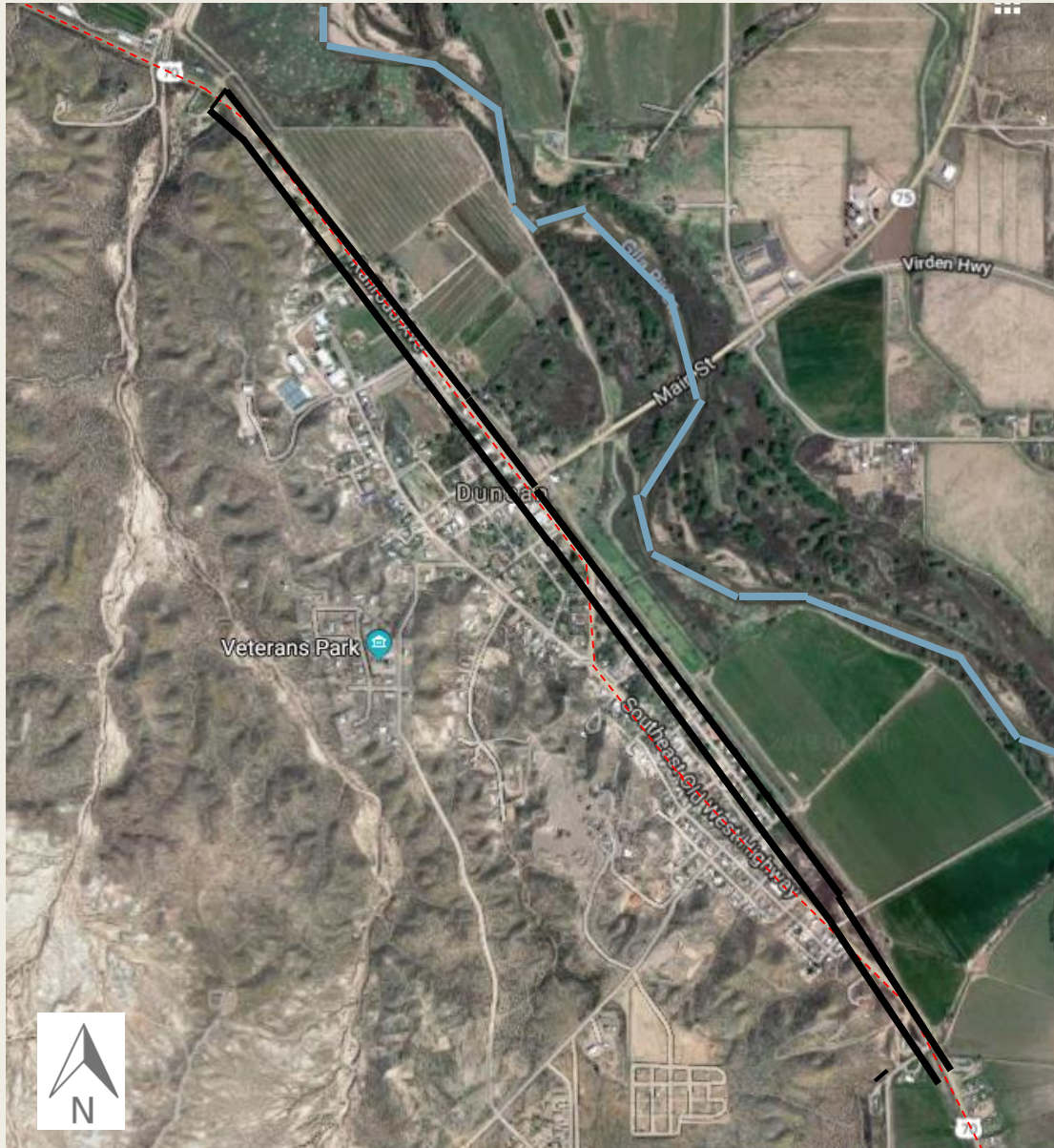
Maximum Existing
Elevation:
3669'

Minimum Existing
Elevation:
3641'

Levee Elevation:
3650' -3655'

Figure 8: Alignment Option 1- Vertical Alignment

Alignment Option 2: Running Along Agricultural Dike



- Max Corridor Width- 108 feet
- LOS A
- Design Speed of 60 mph

Legend:

- Corridor
- - - Existing Highway
- Gila River

Figure 9: Schematic for Horizontal Alignment Option 2 [4]

Highway Capacity Software (HCS)

Alignment Option 2: Running Along Agricultural Dike

Table 6: HCS Input Data for Alignment Option 2 [5]

Input Data	
Term	Value
Highway Class	Class 2
Shoulder Width	6 feet
Lane Width	12 feet
Terrain Type	Level
Peak- Hour Factor, PHF	0.88
% No-Passing Zone	100
Access Points/Miles	3
Two-Way Hourly Volume, V	105 vehicles/hr.
Directional Split	60/40 %



- Level of Service (LOS): A
- Design Speed of 60 mph- achieved
- Percent Time Spent Following: 34.4%

Alignment Option 2: Running Along Agricultural Dike- Horizontal Alignment



Levee Length:
1.91 Miles

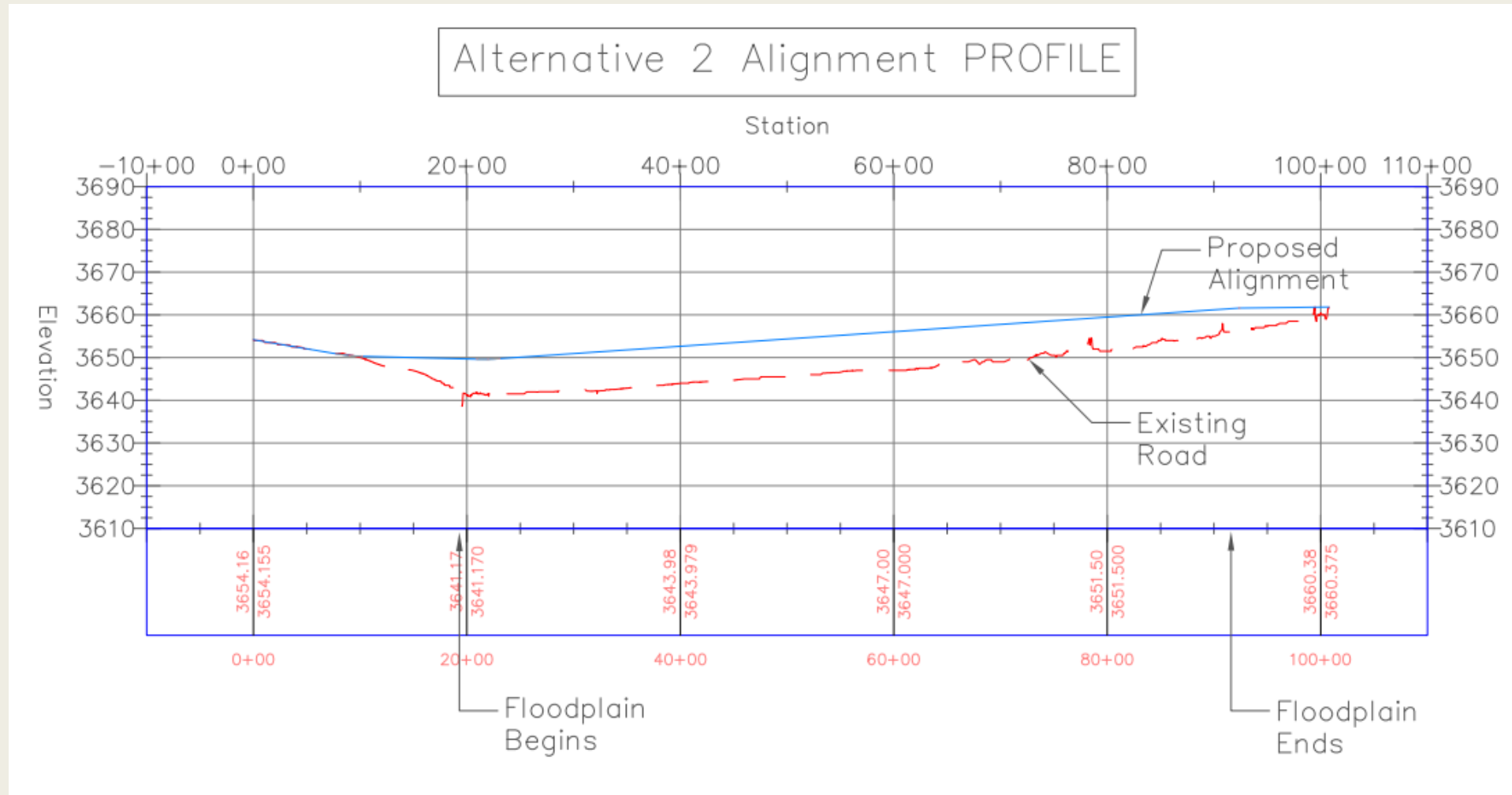
Cut Material:
4,500 Cubic yards

Fill Material:
138,000 Cubic yards

Removal of 41 Homes

Figure 10: Alignment Option 2- Horizontal Alignment

Alignment Option 2: Running Along Agricultural Dike- Vertical Alignment



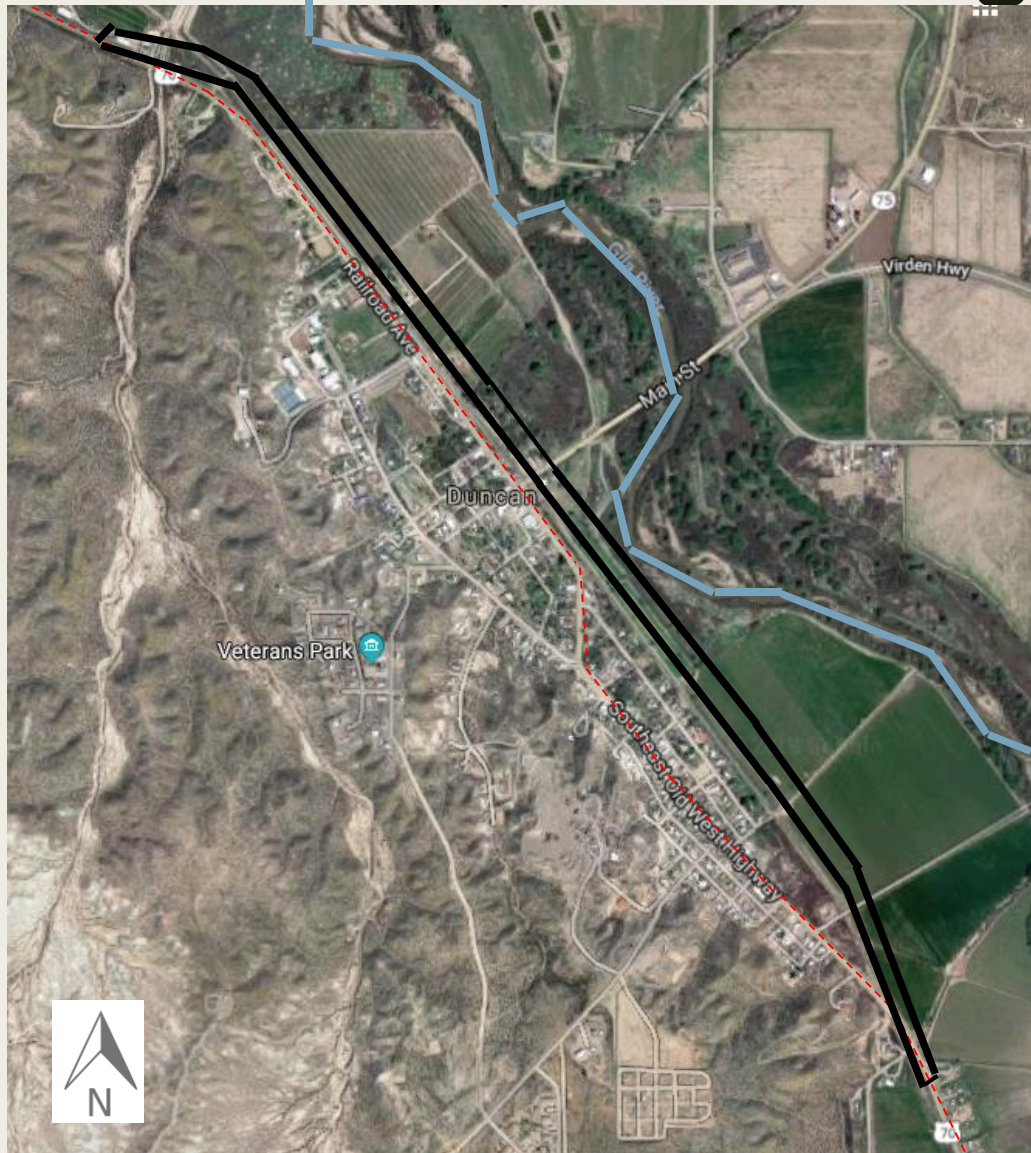
Maximum
Existing Elevation:
3661'

Minimum
Existing Elevation:
3641'

Levee Elevation:
3650'-3661'

Figure 11: Alignment Option 2- Vertical Alignment

Alignment Option 3: Running Parallel to Railroad on Agricultural



- Max Corridor Width- 124 feet
- LOS A
- Design Speed of 60

Legend:

- Corridor
- - - Existing Highway
- Gila River

Figure 12: Schematic for Horizontal Alignment Option 3 [4]

Highway Capacity Software (HCS)

Alignment Option 3: Running Parallel to Railroad on Agricultural

Table 7: HCS Input Data for Alignment Option 3 [5]

Input Data	
Term	Value
Highway Class	Class 2
Shoulder Width	6 feet
Lane Width	12 feet
Terrain Type	Level
Peak- Hour Factor, PHF	0.88
% No-Passing Zone	100
Access Points/Miles	3
Two-Way Hourly Volume, V	105 vehicles/hr
Directional Split	60/40 %



- Level of Service (LOS): A
- Design Speed of 60 mph- achieved
- Percent Time Spent Following: 34.4%

Alignment Option 3: Running Parallel to Railroad on Agricultural- Horizontal Alignment



Levee Length:
2.12 Miles

Cut Material:
1,300 Cubic yards

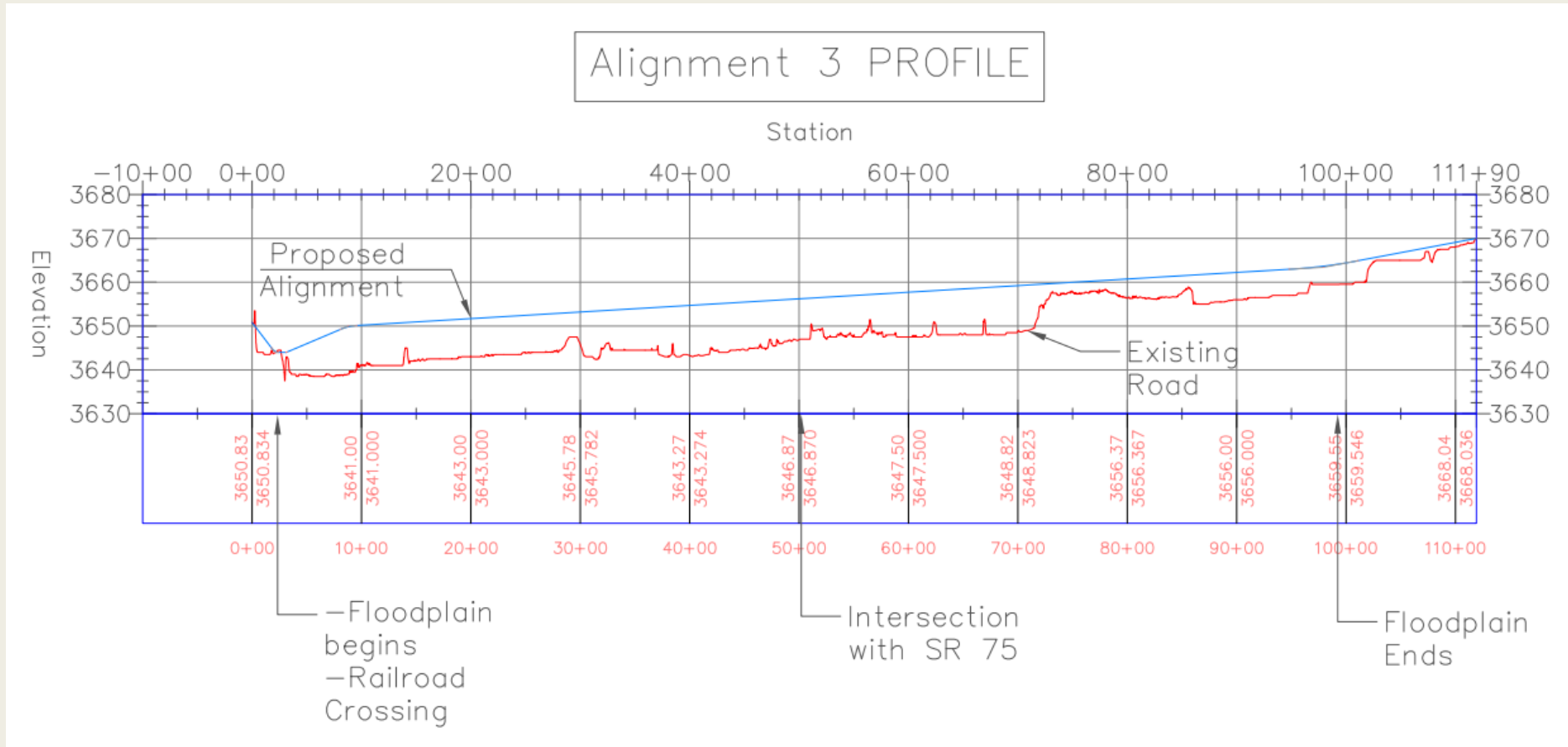
Fill Material:
171,000
Cubic yards

Elevated Intersection
with SR 75 at Elevation
3656'

Take over
approximately 26 acres
of land

Figure 13: Alignment Option 3- Horizontal Alignment

Alignment Option 3: Running Parallel to Railroad on Agricultural- Vertical Alignment



Maximum Existing Elevation: 3670'

Minimum Existing Elevation: 3638'

Intersection Elevation: 3655.7'

Levee Elevation: 3650'- 3670'

Figure 14: Alignment Option 3- Vertical Alignment

Cost Assessment- Land Value Assessment

Table 8: Land Value Assessment Individual Costs [6]

	Cost
Range of Housing Cost	\$1,400-193,000
Cost Per Acre of Agricultural Land	\$13,000

Table 9: Land Value Assessment Total Costs [6]

Design Alternative	Cost Per Unit	Total Cost
Alternative 1: Along Existing Highway	22 Homes	\$1,430,400
Alternative 2: Along Agricultural Dike	41 Homes	\$2,416,400
Alternative 3: Along Agricultural Land	Approximately 26 Acres of Land	\$338,000

Cost Assessment- Quantity Take-off

Table 10: Design Individual Costs [7]

Cost	
Cut	\$9 / Cubic yard
Fill	\$18 / Cubic yard
Levee	\$1,922 / Linear Foot

Table 11: Design Parameters [7]

	Cut (yd ³)	Fill (yd ³)	Levee Length (ft)
Alternative #1	1,229	85,293	6,800
Alternative #2	4,450	138,257	10,077
Alternative #3	1,240	170,939	11,190

Cost Assessment- Alternatives Total Cost

Table 12: Alternatives Total Cost

	Alignment #1	Alignment #2	Alignment #3
Material Cut Cost	\$11,054	\$40,042	\$11,159
Material Fill Cost	\$1,535,261	\$2,488,615	\$3,076,893
Land Value	\$1,430,400	\$2,416,400	\$338,000
Levee Length Cost	\$13,069,600	\$19,367,885	\$21,507,655
20-year Maintenance Cost	\$1,166,638	\$1,145,109	\$1,271,619
20% Feasibility Blow-up	\$17,210,315	\$25,458,049	\$26,205,326
Total Cost	\$20,650,000	\$30,550,000	\$31,500,000

Final Summary Table

Table 13: Final Summary Table

Value	Alignment 1	Alignment 2	Alignment 3
Total Cost	\$28,650,000	\$30,550,000	\$31,500,000
Agricultural Land	N/A	N/A	Approx. 26 Acres
Property Taken (Acres)	23.6	23.2	25.7
Houses Taken	22	41	N/A
Properties Taken	30	51	30
Divides the City	Yes	Yes	No

Schedule

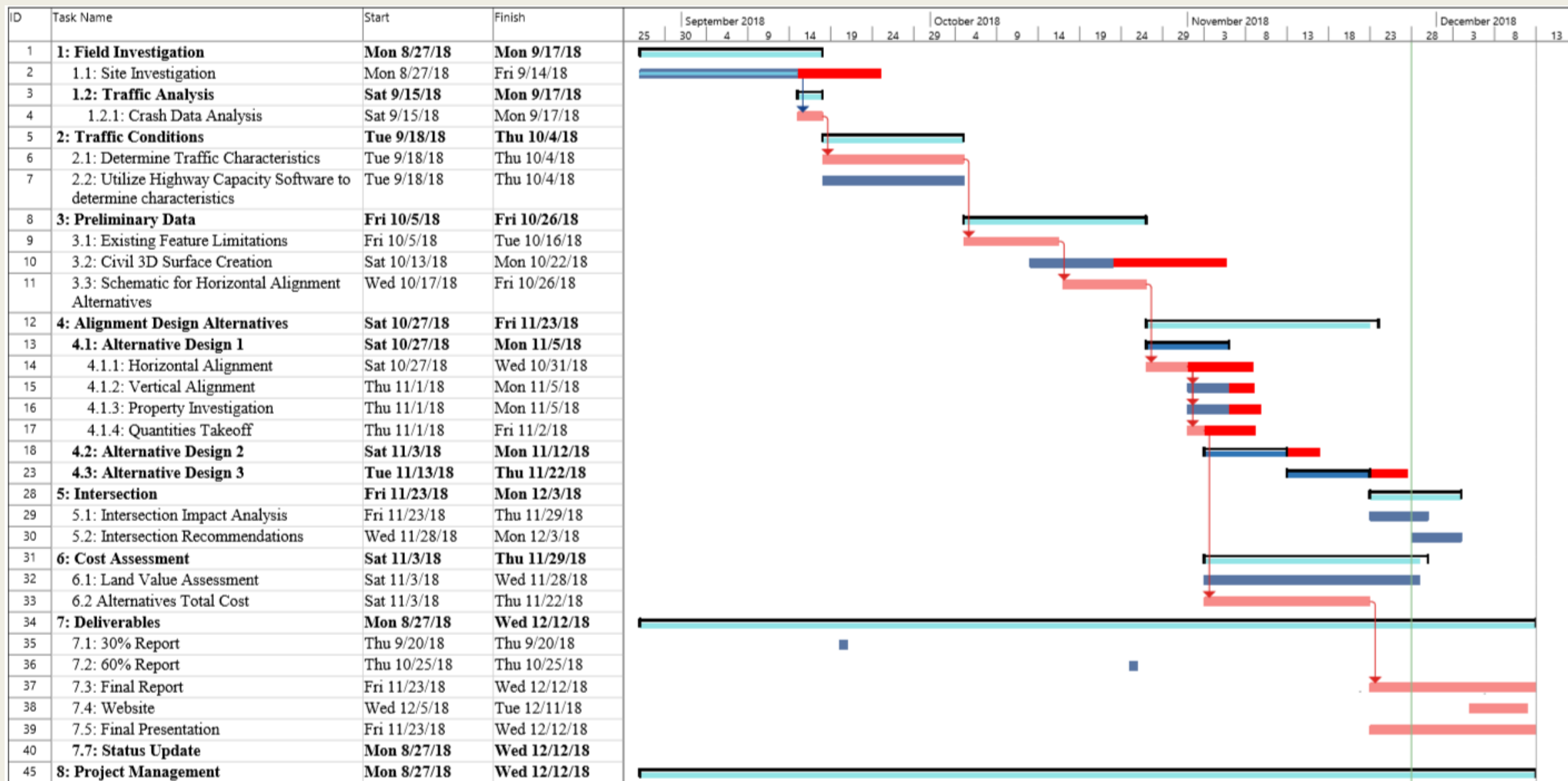


Figure 15: Schedule of Project

Engineering Cost Hour Matrix

Proposed Matrix

Task Name	Sr. Engineer	Prof. Engineer	EIT (4 Combined)	Drafter /Tech	Admin-istrator	Task Total
1: Field Investigation	4	24	80	0	0	108
2: Traffic Conditions	2	7	48	0	0	57
3: Preliminary Data	3	10	64	13	0	90
4: Alignment Design Alternatives	7	22	144	29	12	214
5: Intersection	2	5	32	7	2	48
6: Cost Assessment	2	5	32	0	8	47
7: Deliverables	7	22	144	0	20	193
8: Meetings	2	5	34	0	7	48
Total Hours	29	100	578	49	49	805

Table 14: Proposed Cost Hour Matrix

Final Matrix

Task Name	Sr. Engineer	Prof. Engineer	EIT (3 Combined)	Drafter /Tech	Admin-istrator	Task Total
1: Field Investigation	0	3	9	0	0	12
2: Traffic Conditions	2	5	36	0	0	43
3: Preliminary Data	9	27	180	10	0	226
4: Alignment Design Alternatives	5	16	108	22	12	163
5: Intersection	0	1	6	1	2	10
6: Cost Assessment	1	4	24	0	8	37
7: Deliverables	6	18	120	0	20	164
8: Meetings	1	4	26	0	5.1	36
Total Hours	25	78	509	33	47	691

Table 15: Final Cost Hour Matrix

Cost of Engineering Work

Proposed Cost

Rate Table					
Staff	Pay Rate (\$/hr.)	Multiplier	Billing Rate (\$/hr.)	Hours	Cost (\$)
Sr. Engineer	60	3	180	29	\$5,220.00
Prof. Engineer	40	2.5	100	100	\$10,000.00
EIT	25	2.5	62.5	578	\$36,125.00
Drafter/Tech	25	2	50	49	\$2,450.00
Administrator	20	2	40	49	\$1,960.00
ADOT Coordinator	30	2	60	20	\$1,200.00
OTHER EXPENSES					
	Cost (\$/mi.)	Trips	Miles		
Travel	0.7	2	600		\$840.00
	Cost (\$/night)		Rooms		
Hotel	150	-	6		\$900.00
			Total Cost		\$58,695.00

Table 16: Proposed Cost of Engineering Work

Final Cost

Rate Table					
Staff	Pay Rate (\$/hr.)	Multiplier	Billing Rate (\$/hr.)	Hours	Cost (\$)
Sr. Engineer	60	3	180	25	\$4,576.50
Prof. Engineer	40	2.5	100	78	\$7,762.50
EIT	25	2.5	62.5	509	\$31,781.25
Drafter/Tech	25	2	50	33	\$1,640.00
Administrator	20	2	40	47	\$1,884.00
ADOT Coordinator	30	2	60	20	\$1,200.00
				Total Cost	\$48,844.25

Table 17: Final Cost of Engineering Work

References

- [1] A. Smith, C. Bitsoie, . S. Schumacher and T. Whelan, "Base Flood," Duncan Flood Analysis Capstone Team, Flagstaff, 2017.
- [2] ADOT, "AADT Report Multimodal Planning," 2017. [Online]. Available: <https://www.azdot.gov/docs/default-source/planning/2017-aadt-publication-states-routes.pdf?sfvrsn=6>. [Accessed 2018 30 Aug].
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**Any
Questions?**