

**CITY OF KINGMAN  
DOWNTOWN TREATMENT PLANT  
SEWER ALIGNMENT STUDY  
Project ENG14-113**

March 4, 2016



*Prepared for:*

**City of Kingman**  
Mr. Phil Allred, PE  
Assistant City Engineer  
310 N. 4th Street  
Kingman, AZ 86401  
Phone: (928) 753-8124

*Prepared by:*

**EPS Group, Inc.**  
Brandon Squire, PE  
125 South Avondale Boulevard  
Suite 115  
Goodyear, Arizona 85323  
Phone: (623) 547-4661  
Fax: (623) 547-4662



**TABLE OF CONTENTS**

**1.0 INTRODUCTION..... 1**

**2.0 EXISTING CONDITIONS ..... 1**

**3.0 PROPOSED ALTERNATIVES ..... 4**

    3.1 ALTERNATIVE 1 ..... 4

    3.2 ALTERNATIVE 2 ..... 4

    3.3 ALTERNATIVE 3 ..... 5

    3.4 ALTERNATIVE 4 ..... 6

**4.0 CONSTRUCTION COSTS..... 7**

**5.0 CONCLUSIONS ..... 8**

**Tables**

Table 1: City of Kingman 1970 Sewer Main ..... 2

Table 2: City of Kingman 1970 Sewer Lateral ..... 3

Table 3: City of Kingman 1984 Sewer Main ..... 3

**APPENDICES**

**Appendix A Exhibits**

Exhibit 1: Existing Lines Evaluated ..... 10

Exhibit 2: Gravity Sewer Option ..... 11

Exhibit 3: Lift Station Option ..... 12

Exhibit 4: Gravity and Lift Station Option..... 13

**Appendix B Opinion of Costs**

Alternative 1 Opinion of Costs ..... 16

Alternative 2 Opinion of Costs ..... 17

Alternative 3 Opinion of Costs ..... 18

Alternative 4 Opinion of Costs ..... 19

**Appendix C Gravity Sewer Line, Lift Station, and Force Main Calculations**

Highway 66 Gravity Sewer Line Calculations ..... 22

Old Trails Gravity Sewer Line Calculations ..... 23

Andy Devine Gravity Sewer Line Calculations..... 24

Park Street Lift Station ..... 25

Park Street Force Main..... 26

Highway 66 Lift Station ..... 27

Highway 66 Force Main..... 28

Old Trails Lift Station ..... 29

Old Trails Force Main ..... 30

## 1.0 INTRODUCTION

EPS Group, Inc. (EPS) has been retained by the City of Kingman to explore alternative sewer alignments for the existing sewer main that is currently located within Clack Canyon. This area is extremely rocky, making construction very difficult. This line conveys sewage from the downtown area of Kingman to the Downtown Treatment Plant operated by the City of Kingman. The city does not have any documented easements on private property. However, it is anticipated that the City may obtain a prescriptive easement due to the permissive use of this property for over 30 years. The line is located within the floodplain in all areas and the floodway in a significant portion of the study area. Therefore, the City would like to reroute the sewer so that it is within public right-of-way<sup>1</sup> or defined easements and out the floodway/floodplain. This report will present four alternative alignments for this sewer relocation along with their associated cost estimates.

## 2.0 EXISTING CONDITIONS

Currently an 8-inch and 10-inch gravity sewer line conveys sewage from the downtown Kingman area to the Downtown Treatment Plant. Construction of these lines occurred in 1970 for the main line in Clack Canyon and 1984 for the connecting Old Trails Line. These lines are generally within private property, with the exception of approximately 2,000 feet of the 1984 line from the Goldroad Ave to the west which is in property owned the City of Kingman. The remainders of the lines are not within any City owned easements. However, it is anticipated that the City may obtain a prescriptive easement due to the permissive use of this property for over 30 years. There are no known capacity issues with the lines. Segments of the line are not accessible by vehicles for repairs or maintenance. The line is also partially located with the BSNF Railway easement/right-of-way (ROW). The City has obtained license agreements to allow the line with the railroad easement/ROW for a portion of the system but has not obtained an agreement for all city sewer lines. The line is generally within the Floodplain of Clack Canyon creek. It is also located within the Floodway in some segments. See Exhibit 1: Existing Lines Evaluated in Appendix A. The lines are shown as Existing 1970 Sewer Main Evaluated, Existing 1970 Sewer Lateral Evaluated, and Existing 1984 Sewer Main Evaluated.

The following tables show the existing line sizes, slopes, and capacities. The capacity was determined by Manning's Equation, based on pipe diameter and slope. It is assumed that no lines are surcharged. Table 1 shows the Existing 1970 Sewer Main. It is broken into three segments. Segment 3 is upstream of the confluence of the 1970 Sewer Lateral. Segment 2 is between the confluence of the 1970 Sewer Lateral and the confluence of the 1984 Sewer Main. Segment 1 is downstream from the confluence of the 1984 Sewer Main. Segment 1 drains into the Downtown Wastewater Treatment Plant.

---

<sup>1</sup> It should be noted that although there is no instrument dedicating right of way, right of way on Old Trails Road is presumed due to historic maps indicating the existences of right of way.

Table 1: City of Kingman 1970 Sewer Main

PIPE	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Diameter (inches)	Velocity (flow full) (ft/s)	Pipe Capacity (flow full) (gpd)
<b>Segment 1</b>								
1	225.52	3224.63	3222.82	1.81	0.80%	12	4.07	2,065,265
2	201.50	3232.25	3227.53	4.72	2.34%	8	5.31	1,198,013
3	203.00	3237.12	3232.25	4.87	2.40%	8	5.38	1,213,275
4	264.33	3243.45	3237.12	6.33	2.39%	8	5.37	1,210,745
5	400.00	3253.06	3243.45	9.61	2.40%	8	5.38	1,213,275
6	455.64	3260.98	3253.06	7.92	1.74%	8	4.58	1,033,066
7	160.00	3263.86	3260.98	2.88	1.80%	8	4.66	1,050,727
8	99.29	3265.66	3263.86	1.80	1.81%	8	4.67	1,053,642
<b>Segment 2</b>								
9	44.71	3266.81	3265.66	1.15	2.57%	8	5.56	1,255,510
10	76.46	3268.39	3266.81	1.58	2.06%	8	4.98	1,124,054
11	188.80	3272.28	3268.39	3.89	2.06%	8	4.98	1,124,054
12	143.89	3273.72	3272.28	1.44	1.00%	8	3.47	783,166
13	129.01	3276.01	3273.72	2.29	1.78%	8	4.63	1,044,873
14	100.00	3277.81	3276.01	1.80	1.80%	8	4.66	1,050,727
15	113.22	3279.84	3277.81	2.03	1.79%	8	4.64	1,047,804
16	131.78	3282.20	3279.84	2.36	1.79%	8	4.64	1,047,804
17	379.82	3289.06	3282.20	6.86	1.81%	8	4.67	1,053,642
<b>Segment 3</b>								
18	267.65	3294.01	3289.06	4.95	1.85%	8	4.72	1,065,220
19	54.50	3294.41	3294.15	0.26	0.48%	8	2.40	542,593
20	66.15	3299.18	3294.41	4.77	7.21%	8	9.32	2,102,913
21	135.62	3301.67	3299.18	2.49	1.84%	8	4.71	1,062,337
22	200.49	3306.18	3301.67	4.51	2.25%	8	5.21	1,174,748
23	130.00	3309.11	3306.19	2.93	2.25%	8	5.21	1,174,748
24	69.40	3309.37	3309.11	0.26	0.38%	8	2.14	482,776
25	159.00	3309.97	3309.37	0.60	0.37%	8	2.11	476,381
26	143.64	3310.51	3309.97	0.54	0.38%	8	2.14	482,776
27	51.01	3311.40	3310.51	0.89	1.75%	8	4.59	1,036,031
28	110.00	3313.32	3311.40	1.93	1.75%	8	4.59	1,036,031
29	140.00	3315.77	3313.32	2.45	1.75%	8	4.59	1,036,031
30	113.06	3317.75	3315.77	1.98	1.75%	8	4.59	1,036,031
31	100.00	3319.50	3317.75	1.75	1.75%	8	4.59	1,036,031
32	156.38	3324.38	3319.50	4.88	3.12%	8	6.13	1,383,346
33	161.64	3324.75	3324.43	0.32	0.20%	10	1.80	635,032

As shown in Table 1 the minimum capacity of each segment of the 1970 Sewer Main is as follows:

Minimum Capacity Segment 1	1,033,066	gpd
Minimum Capacity Segment 2	783,166	gpd
Minimum Capacity Segment 3	476,381	gpd

The capacity of the existing 1970 Sewer Lateral can be found in the table below,

Table 2: City of Kingman 1970 Sewer Lateral

PIPE	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Diameter (inches)	Velocity (flow full) (ft/s)	Pipe Capacity (flow full) (gpd)
35	240.74	3298.75	3294.15	4.60	1.91%	8	4.80	1,082,356
36	319.82	3304.90	3298.86	6.04	1.89%	8	4.77	1,076,675
37	392.23	3308.20	3304.99	3.21	0.82%	10	3.65	1,285,842
38	60.99	3308.55	3308.30	0.25	0.41%	10	2.58	909,227
39	141.36	3311.92	3308.60	3.32	2.35%	10	6.17	2,176,780

Minimum Capacity 909,227 gpd

The capacity of the existing 1984 Sewer main can be found in the table below.

Table 3: City of Kingman 1984 Sewer Main

PIPE	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Diameter (inches)	Velocity (flow full) (ft/s)	Pipe Capacity (flow full) (gpd)
40	466.57	3268.74	3265.66	3.08	0.66%	8	2.82	636,247
41	231.13	3279.02	3268.74	10.28	4.45%	8	7.32	1,652,090
42	92.24	3279.72	3279.02	0.70	0.76%	8	3.03	682,748
43	105.67	3281.14	3279.72	1.42	1.34%	8	4.02	906,580
44	148.16	3285.12	3281.14	3.98	2.69%	8	5.69	1,284,487
45	188.41	3287.99	3285.12	2.87	1.52%	8	4.28	965,551
46	130.46	3288.54	3287.99	0.55	0.42%	8	2.25	507,549
47	106.25	3289.01	3288.54	0.47	0.44%	8	2.30	519,493
48	234.75	3294.88	3289.01	5.87	2.50%	8	5.49	1,238,293
49	205.91	3295.56	3294.88	0.68	0.33%	8	1.99	449,894
50	168.90	3296.12	3295.56	0.56	0.33%	8	1.99	449,894
51	121.65	3296.52	3296.12	0.40	0.33%	8	1.99	449,894
52	170.88	3297.02	3296.52	0.50	0.29%	8	1.87	421,748

53	105.72	3298.12	3297.02	1.10	1.04%	8	3.54	798,675
54	403.88	3300.98	3298.12	2.86	0.71%	8	2.92	659,907
55	158.22	3302.98	3300.98	2.00	1.26%	8	3.90	879,101
56	286.89	3305.83	3302.98	2.85	0.99%	8	3.45	779,240

Minimum Capacity      421,748    gpd

### 3.0 PROPOSED ALTERNATIVES

EPS is presenting four alternatives within this report to re-route the sewer. One alternative is the do nothing option. Another option is a primarily gravity sewer option. The third option is pumping all flows. The final option is a combination gravity sewer and lift station option. Each of the scenarios is discussed below.

#### 3.1 ALTERNATIVE 1

The Do Nothing Option has the lowest capital cost. However, this option does not remedy any of the concerns discussed above. Under this option, the City may be required to obtain easements for this existing sewer alignment, if any dispute with the railroad over the right to have the line on railroad property arose. It is anticipated that if they railroad would not grant easements at a reasonable cost, the City would claim a Prescriptive Easement for the lines within the railroad property. The City would still incur a cost for the easements, in addition to legal costs associated with proving the prescriptive easement. It is anticipated that use fees will be required from the railroad. In addition, if any improvements are made to provide access to the existing sewer line, floodplain use permits and a 404 Permit may be required. A Watercourse Master Plan may be required to determine that improvements within the floodway do not have an adverse impact on the watercourse. An evaluation of the condition of the existing line and any flood protection improvements that may be required should be undertaken by the City.

#### 3.2 ALTERNATIVE 2

This alternative evaluates the concept of most lines flowing by gravity to the existing wastewater treatment facility. The scenario collects all flows north of Andy Devine Avenue and conveys the flow in a 10-inch line following the alignment of State Route Highway 66 to a point west of the existing treatment plant. A smaller diameter pipe may be used, but a significantly greater than minimum slope would be required. Due to the cost of excavation in rock, depth of the sewer is minimized by using the flattest sewer possible. At that point, the sewer line would turn east and connect into the existing sewer line flowing into the treatment plant. This line would be designed with a capacity to match the Segment 1 capacity of the 1970 Sewer Main Line of 1,033,066 gpd less the capacity of the capacity carried in the 1984 Sewer Main plus the flow from the Park Street Lift Station described below. This line will require a capacity of 669,203 gpd. This alignment would require a slope of 0.25%. See Appendix C for calculations. It appears that only one property, the Powerhouse Museum located at 120 West Andy Devine Avenue may require an individual sewer pump station to get sewer into a line on Andy Devine Avenue.

The area of Park Street and Commercial Street will require a lift station to carry the flows over the hill to a connection point with the proposed gravity sewer line. Based on aerial photography approximately 65 units could flow to this lift station. The US Census shows 2.46 people per unit in Kingman. ADEQ recommends a dry weather flow of 80 gallons per capita per day for sewage calculations. One hundred gallons per capita per day was used to accommodate wet weather and as a factor of safety. The average daily flow is 15,990 gpd. Using the ADEQ peaking factors for lift stations (greater of  $PF = 17 * DU^{0.42}$  or  $PF = 11.2 * pop^{0.42}$ ), this proposed lift station would have a capacity of 113 gpm. It would need to overcome 59 feet of total dynamic head. A 3-inch force main would carry this flow and discharge into the Highway 66 gravity sewer line described above. The force main would have a velocity of 5.13 feet per second. See Appendix C for calculations.

The flow currently carried by the existing 1984 Sewer Main would be conveyed by an 8-inch line following the Old Trails Road alignment to the treatment plant. After the New Old Trails Road Sewer Line is installed the existing 1984 Sewer Main would be abandoned. This new line would require a capacity of 421,748 gpd. The proposed 8-inch line would have a slope of 0.34%. See Appendix C for calculations.

See Exhibit 2: Gravity Sewer Option in Appendix A for the alignments of these proposed sewer lines.

The gravity line located in State Route Highway 66 presents a very difficult construction scenario. The line would be located in a very steep embankment as it flows from the highway alignment to the treatment plant. At the base of the embankment is a railroad track. The sewer line would be required to be located a minimum of 5.5-feet under the rail and would require boring under the railroad. The boring pits would be located within the embankment. In addition, this construction would be in areas of solid rock. This option is not feasible.

However, the gravity line within the Old Trails Road alignment is a viable option.

### **3.3 ALTERNATIVE 3**

This alternative proposes the pumping of all sewage using three lift stations. This option evaluated the possibility of pumping all flows north of Andy Devine Avenue to a discharge point. This lift station would be designed to have a capacity to match the overall capacity of the 1970 Sewer Main Line less the capacity of the 1984 Sewer Main plus the flow from the Park Street Lift Station or 627,309 GPD. For evaluation and cost analysis purposes, this Highway 66 lift station would have a maximum capacity of 436 gpm and capable of overcoming a total dynamic head of 95 feet. A 6-inch force main will carry the flow to the discharge point. The force main will have a velocity of 4.94 feet per second. See Appendix C for calculations. Two segments of gravity sewer line to convey the sewage that had been carried by the 1970 Sewer Lateral will be required. One gravity line from the east has a minimum required slope for an 8-inch line of 0.39%. The Flow from this line will be the overall capacity of the 1970 Sewer Main less the capacity from the 1984

Sewer Main and the Capacity of the line from the jail as described below. The other line from the southwest (from the jail) has a minimum required slope for an 8-inch line of 0.34%. The flow from this line will come from the capacity of the overall 1970 Sewer Main less the Capacity of the 1970 Sewer Lateral. See Appendix C for calculations. It appears that only one property, the Powerhouse Museum located at 120 West Andy Devine Avenue may require an individual sewer pump station to get sewer into a line on Andy Devine Avenue.

The area of Park Street and Commercial Street will require a lift station as discussed in section 3.2. This proposed lift station would have a capacity of 113 gpm. It would need to overcome 59 feet of total dynamic head. A 3-inch force main would carry this flow and discharge into the Highway 66 lift station described above. The force main would have a velocity of 5.13 feet per second. See Appendix C for calculations.

The proposed Highway 66 lift station would discharge to the proposed Old Trails Lift Station. All sewage would be pumped through an 8-inch force main following the Old Trails Road alignment to the treatment plant. This lift station and force main would have a capacity 1,049,056 gpd. For evaluation and cost analysis purposes, this Old Trails lift station would have a pumping capacity of 729 gpm and overcome 67 feet of total dynamic head. The force main would have a velocity of 4.65 feet per second. See Appendix C for calculations. This force main would discharge at the Downtown Wastewater Treatment Plant.

See Exhibit 3: Lift Station Option in Appendix A for the alignments of these lines.

Both the Highway 66 and the Old Trails lift stations and force mains are viable options. Both lift stations and force mains accomplish the desire of the City of Kingman to relocate the sewer lines in to ROW. Both lift stations are constructible.

### **3.4 ALTERNATIVE 4**

The alternative utilizes both gravity flow and lift stations. This alternative evaluated the concept of pumping all flows north of Andy Devine Avenue to a connection point with the proposed Old Trails Line. A gravity flow line and lift station as discussed in section 3.3 would be required for this alternative. It appears that only one property, the Powerhouse Museum located at 120 West Andy Devine Avenue may require an individual sewer pump station to get sewer into a line on Andy Devine Avenue.

The area of Park Street and Commercial Street will require a lift station as discussed in section 3.2. This proposed lift station would have a capacity of 113 gpm. It would need to overcome 59 feet of total dynamic head. A 3-inch force main would carry this flow and discharge into the Highway 66 lift station described above. The force main would have a velocity of 5.13 feet per second. See Appendix C for calculations.

The Highway 66 lift station would discharge into a gravity line and combine with the remainder of the sewage. It would be carried by a 12-inch line following the Old Trails Road alignment to the treatment plant. This line would carry flows currently carried by the 1984 Sewer Main and the proposed Highway 66 Lift Station and would require a capacity of 1,049,056 gpd. The proposed 12-inch line would have a slope of 0.21%. See Appendix C for calculations.

See Exhibit 4: Gravity and Lift Station Option in Appendix A for the alignments of these lines.

The proposed Highway 66 lift station and force main will relocate the sewer line out of the floodplain and into City ROW. This is a constructible project. The gravity line within the Old Trails Road alignment is able to flow by gravity and connect to the existing gravity line just upstream of the treatment plant. This alignment relocates the sewer line to City ROW. It also reduces the operation cost of Alternative 3 by eliminating one lift station.

#### 4.0 CONSTRUCTION COSTS

The construction costs summaries for the four alternatives are:

<b>Alternative</b>	<b>Cost</b>
Alternative 1*	\$480,000
Alternative 2**	\$14,775,734
Alternative 3	\$9,559,213
Alternative 4	\$8,614,218
Alternative 4 – Phased	\$8,750,410

Please refer to Appendix B for the detailed breakdown of each alternative’s cost.

\*Construction Cost listed however this alternative does not solve the issues with the sewer, one of the other alternatives will be required if there is a failure of the existing line.

\*\*Construction Cost listed however this alternative is not constructible.

## 5.0 CONCLUSIONS

Although Alternative 1 has the lowest capital cost, it does not remedy the problems associated with the lack of access, requirement for railroad easements, and the sewer line location within floodplain.

Alternative 2 has the lowest operational costs due to the lack of pump stations. However, this alternative is not constructible.

Alternative 3 has the highest operational costs due to the operation of three lift stations.

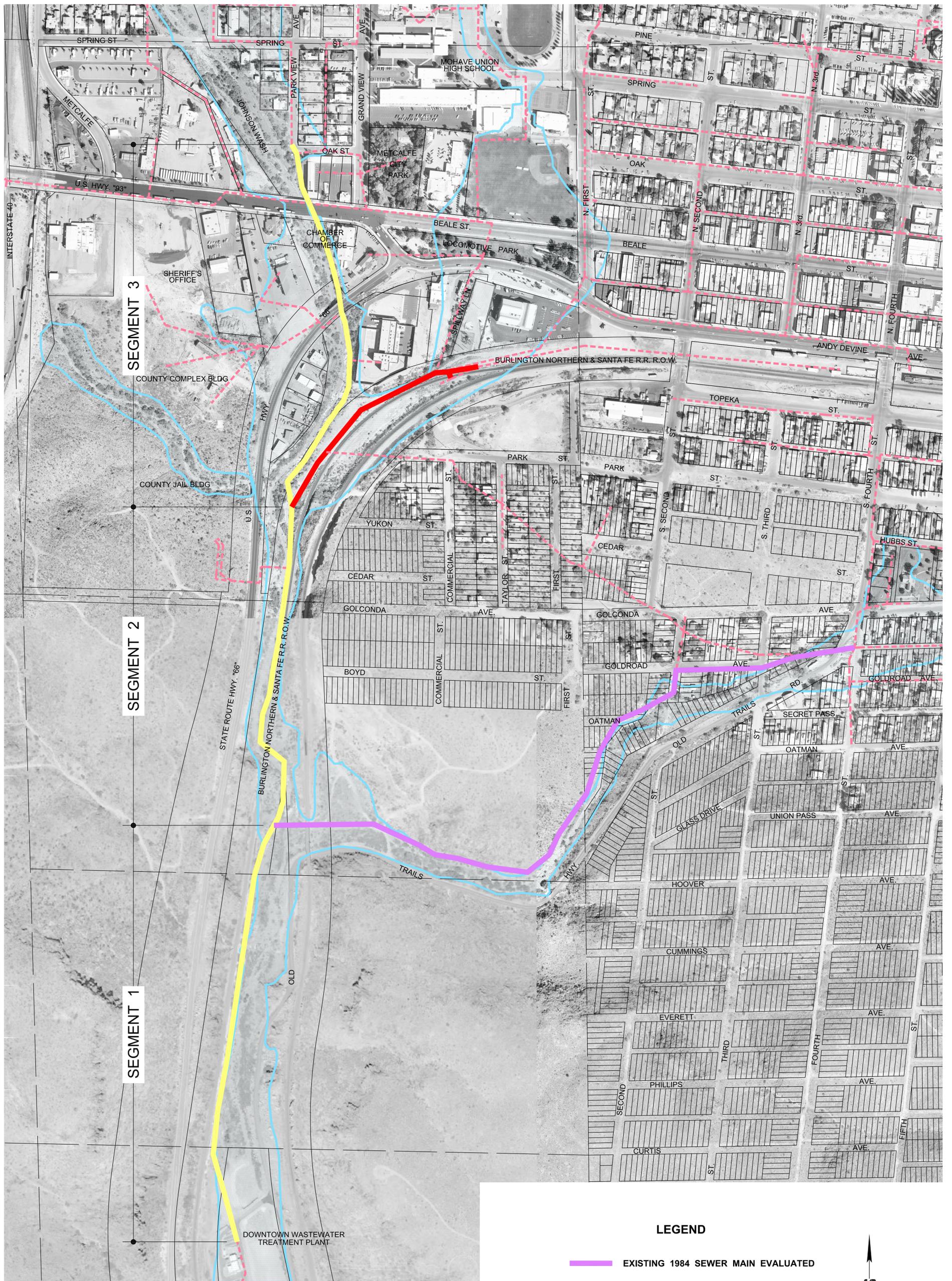
Alternative 4 is constructible and limits the operational cost. This is the recommended alternative.

If this Alternative 4 is phased it should be noted that the existing 1984 Sewer Main does not have the capacity to carry the flow from the proposed Highway 66 lift station and the existing 1984 Sewer Main. An interim pump in the Proposed Highway 66 Lift Station with a capacity of 264 gpm could be installed. This flow is the minimum pump rate in the proposed 6-inch force main to allow the minimum required 3.0 feet per second velocity. This has a flow of 380,078 gpd. Therefore maximum flow in the existing 1984 Sewer Main, before the proposed Old Trails Sewer Line will need to be constructed, can be 41,670 gpd (421,748-380,078).

## **APPENDIX A**

Exhibits

Exhibit 1: Existing Lines Evaluated



SEGMENT 3

SEGMENT 2

SEGMENT 1

**LEGEND**

- EXISTING 1984 SEWER MAIN EVALUATED
- EXISTING 1970 SEWER MAIN EVALUATED
- EXISTING 1970 SEWER LATERAL EVALUATED
- - - - EXISTING SEWER LINES
- 100 YEAR FLOODPLAIN LIMITS



SCALE : 1" = 200'  
FEBRUARY 2016

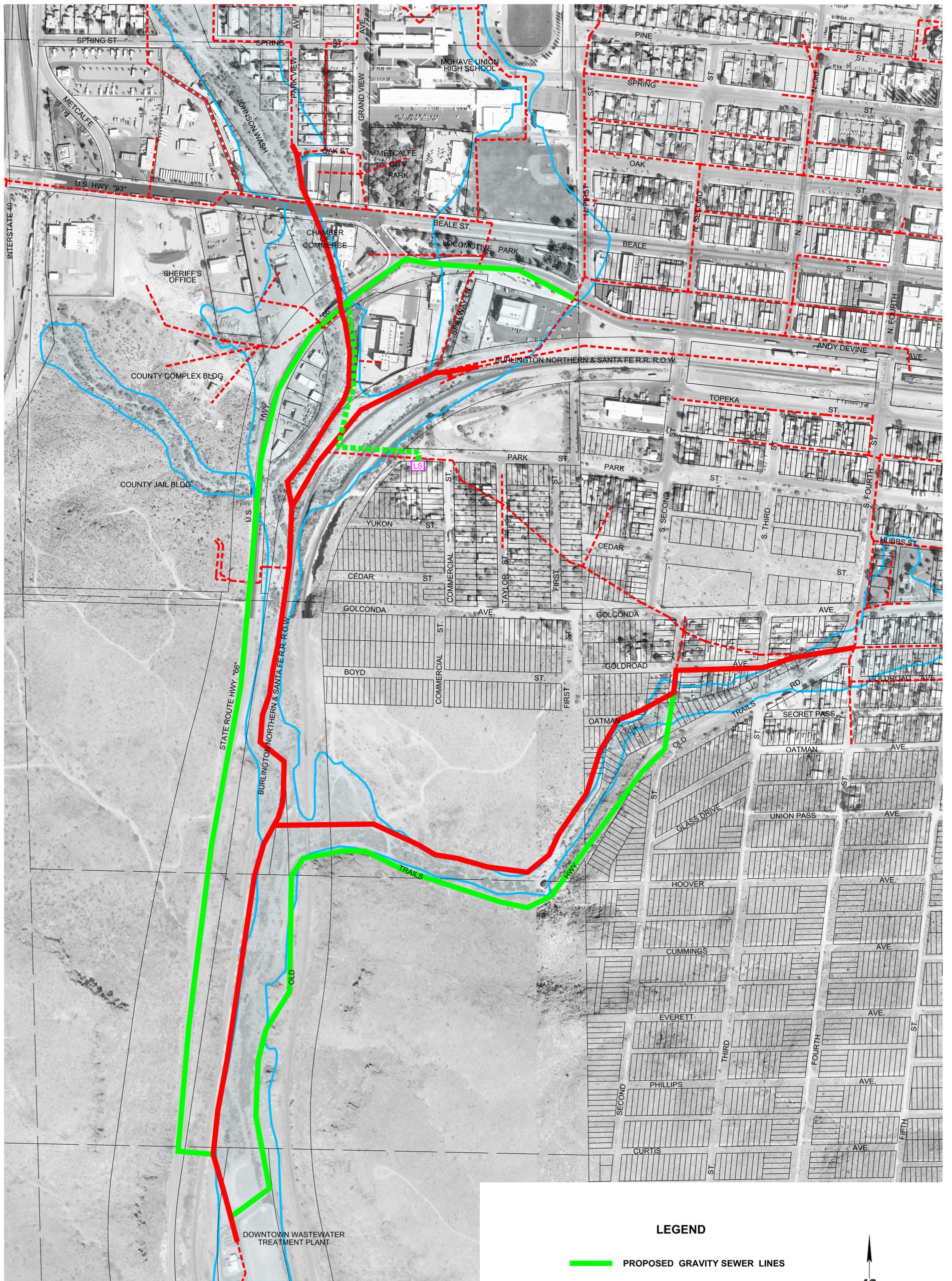


1626 N. Litchfield Rd., Suite 301  
Goodyear, AZ 85395  
T:623.547.4461 | F:623.547.4662  
www.epsgroupinc.com

**EXHIBIT 1**  
EXISTING SEWER LINES EVALUATED

Exhibit 2: Gravity Sewer Option

Alternative 2



**LEGEND**

- PROPOSED GRAVITY SEWER LINES
- - - PROPOSED SEWER FORCE MAIN
- LS PROPOSED SEWER LIFT STATION
- EXISTING SEWER LINES EVALUATED
- - - EXISTING SEWER LINES
- 100 YEAR FLOODPLAIN LIMITS



SCALE : 1" = 200'  
FEBRUARY 2016

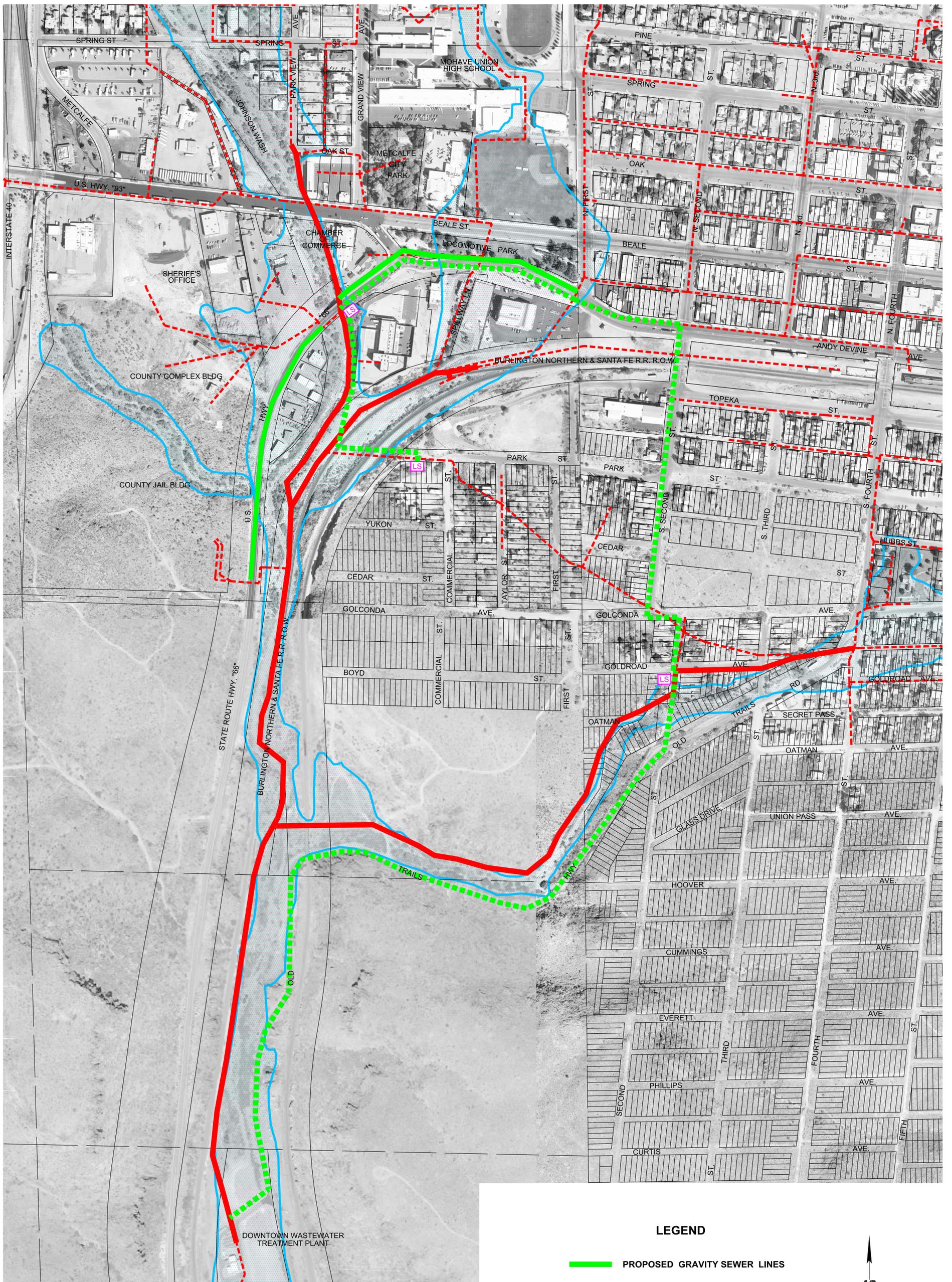


1626 N. Litchfield Rd., Suite 301  
Goodyear, AZ 85395  
T: 623.547.4461 | F: 623.547.4662  
www.epsgroupinc.com

**EXHIBIT 2**  
GRAVITY SEWER OPTION  
ALTERNATIVE 2

Exhibit 3: Lift Station Option

Alternative 3



**LEGEND**

- PROPOSED GRAVITY SEWER LINES
- - - - - PROPOSED SEWER FORCE MAIN
- LS PROPOSED SEWER LIFT STATION
- EXISTING SEWER LINES EVALUATED
- - - - - EXISTING SEWER LINES
- 100 YEAR FLOODPLAIN LIMITS



SCALE : 1" = 200'  
FEBRUARY 2016

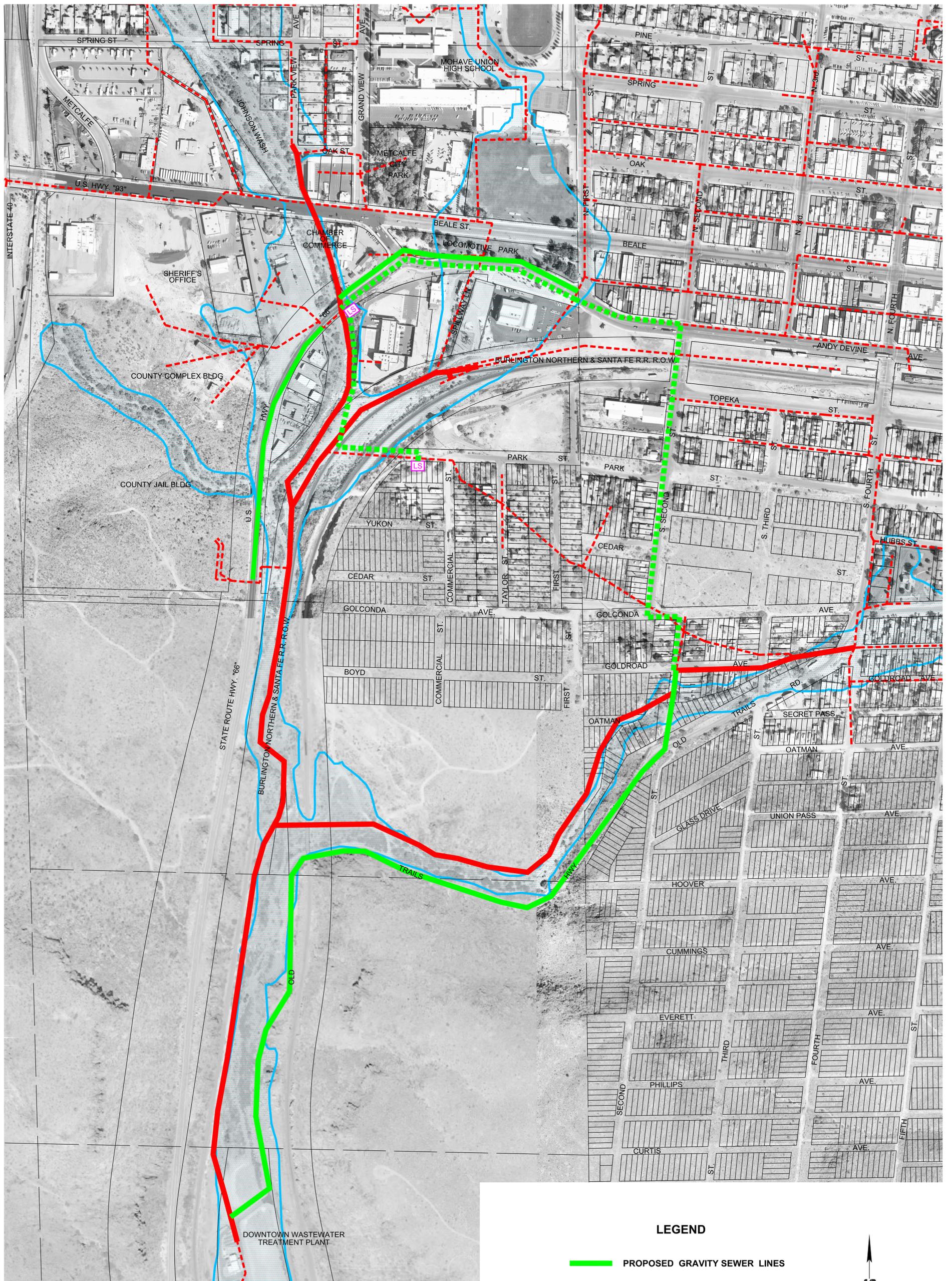


1626 N. Litchfield Rd., Suite 301  
Goodyear, AZ 85395  
T: 623.547.4461 | F: 623.547.4662  
www.epsgroupinc.com

**EXHIBIT 3**  
LIFT STATION OPTION  
ALTERNATIVE 3

Exhibit 4: Gravity and Lift Station Option

Alternative 4



**LEGEND**

- PROPOSED GRAVITY SEWER LINES
- - - PROPOSED SEWER FORCE MAIN
- LS PROPOSED SEWER LIFT STATION
- EXISTING SEWER LINES EVALUATED
- - - EXISTING SEWER LINES
- 100 YEAR FLOODPLAIN LIMITS



SCALE : 1" = 200'  
FEBRUARY 2016



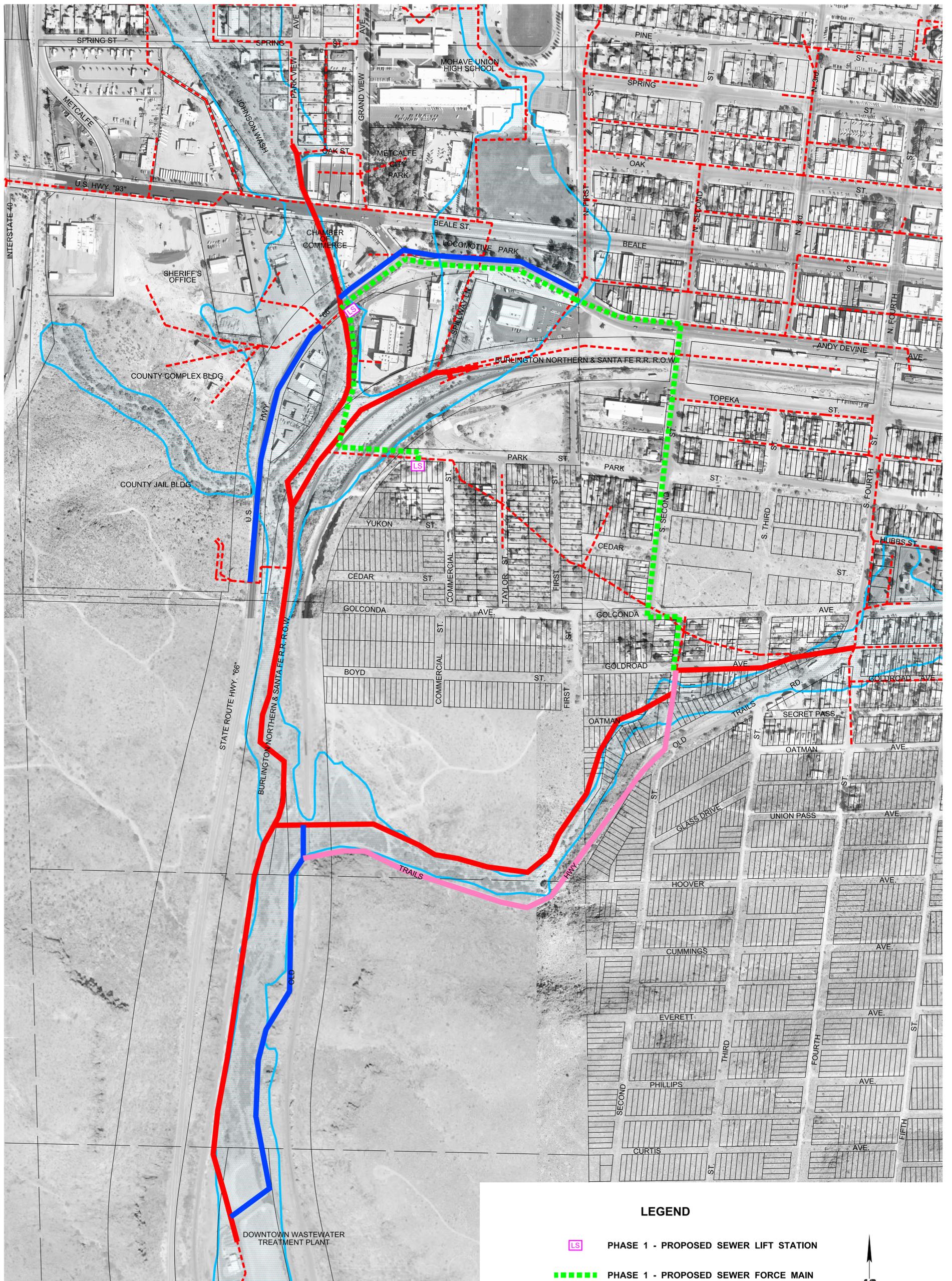
1626 N. Litchfield Rd., Suite 301  
Goodyear, AZ 85395  
T: 623.547.4461 | F: 623.547.4662  
www.epsgroupinc.com

**EXHIBIT 4**

GRAVITY AND LIFT STATION OPTION  
ALTERNATIVE 4

Exhibit 5: Gravity and Lift Station Option – Phased

Alternative 4 - Phased



**LEGEND**

- LS PHASE 1 - PROPOSED SEWER LIFT STATION
- PHASE 1 - PROPOSED SEWER FORCE MAIN
- PHASE 2 - PROPOSED GRAVITY SEWER LINES
- PHASE 3 - PROPOSED GRAVITY SEWER LINES
- EXISTING SEWER LINES EVALUATED
- - - - EXISTING SEWER LINES
- 100 YEAR FLOODPLAIN LIMITS



SCALE : 1" = 200'  
FEBRUARY 2016



1626 N. Litchfield Rd., Suite 301  
Goodyear, AZ 85395  
T: 623.547.4461 | F: 623.547.4662  
www.epsgroupinc.com

**EXHIBIT 5**

GRAVITY AND LIFT STATION OPTION - PHASED  
ALTERNATIVE 4 - PHASED

## **APPENDIX B**

### Opinion of Costs

## Alternative 1 Opinion of Costs

**Preliminary Opinion of Probable Costs  
Downtown Sewer Improvements  
Alternative 1**

Date: March 4, 2016  
Prepared By: BLS

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Watercourse Master Plan	1	LS	\$ 200,000	\$ 200,000
2	Engineering	1	LS	\$ -	\$ -
3	Railroad easements	1	LS	\$ 200,000	\$ 200,000
4	Construction Administration	1	LS	\$ -	\$ -
<b>Subtotal:</b>					<b>\$ 400,000</b>
Contingency (20%):					\$ 80,000
<b>Preliminary Opinion of Probable Construction Cost Total:</b>					<b>\$ 480,000</b>

Because the Consultant does not control the cost of labor, materials, equipment or services furnished by others, methods of determining prices, or competitive bidding or market conditions, any opinions rendered as to costs, including but not limited to opinions as to the costs of construction and materials, shall be made on the basis of its experience and represent its judgment as an experienced and qualified professional, familiar with the industry. The Consultant cannot and does not guarantee that proposals, bids or actual costs will not vary from its opinions of cost. If the Client wishes greater assurance as to the amount of any cost, it shall employ an independent cost estimator. Consultant's services required to bring costs within any limitation established by the Client will be paid for as Additional Services.

## Alternative 2 Opinion of Costs

**Preliminary Opinion of Probable Costs  
Downtown Sewer Improvements  
Alternative 2**

Date: March 4, 2016  
Prepared By: BLS

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	10" Gravity Sewer Line	5,485	LF	\$ 80	\$ 438,800
2	5' Diameter Manholes	13	EA	\$ 4,500	\$ 59,350
3	Individual Lot Grinder Pump Lift Station & Pipe	1	LS	\$ 8,000	\$ 8,000
4	Park Avenue Lift Station -113 gpm	1	LS	\$ 300,000	\$ 300,000
5	3" Force Main	1,120	LF	\$ 25	\$ 28,000
6	8" Gravity Sewer	4,210	LF	\$ 50	\$ 210,500
7	5' Diameter Manholes	10	EA	\$ 4,500	\$ 46,600
8	Jack and Bore Under Railroad (from Hwy 66)	1	LS	\$ 5,000,000	\$ 5,000,000
9	Trench Pavement Repair	110,340	SF	\$ 25	\$ 2,758,500
10	Rock Saw for Pipe	10,815	LF	\$ 85	\$ 919,275
11	Rock Saw for Manholes	24	EA	\$ 5,000	\$ 117,722
<b>Construction Subtotal</b>					<b>\$ 9,886,747</b>
Taxes					\$ 346,036
12	Watercourse Master Plan	1	LS	\$ 200,000	\$ 200,000
13	Engineering	1	LS	\$ 988,700	\$ 988,700
14	Railroad easements (new crossing of railroad)	1	LS	\$ 200,000	\$ 200,000
15	Construction Administration	1	LS	\$ 692,100	\$ 692,100
<b>Subtotal:</b>					<b>\$ 12,313,583</b>
Contingency (20%):					\$ 2,462,717
<b>Preliminary Opinion of Probable Construction Cost Total:</b>					<b>\$ 14,776,300</b>

Because the Consultant does not control the cost of labor, materials, equipment or services furnished by others, methods of determining prices, or competitive bidding or market conditions, any opinions rendered as to costs, including but not limited to opinions as to the costs of construction and materials, shall be made on the basis of its experience and represent its judgment as an experienced and qualified professional, familiar with the industry. The Consultant cannot and does not guarantee that proposals, bids or actual costs will not vary from its opinions of cost. If the Client wishes greater assurance as to the amount of any cost, it shall employ an independent cost estimator. Consultant's services required to bring costs within any limitation established by the Client will be paid for as Additional Services.

### Alternative 3 Opinion of Costs

**Preliminary Opinion of Probable Costs  
Downtown Sewer Improvements  
Alternative 3**

Date: March 4, 2016  
Prepared By: BLS

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	8" Gravity Sewer	2,650	LF	\$ 50	\$ 132,500
2	5' Diameter Manholes	8	EA	\$ 4,500	\$ 35,500
3	Highway 66 Lift Station - 436 gpm	1	LS	\$ 600,000	\$ 600,000
4	6" Force Main	3,530	LF	\$ 40	\$ 141,200
5	Park Avenue Lift Station -113 gpm	1	LS	\$ 300,000	\$ 300,000
6	3" Force Main	1,120	LF	\$ 25	\$ 28,000
7	Individual Lot Grinder Pump Lift Station & Pipe	1	LS	\$ 8,000	\$ 8,000
8	Old Trails Lift Station - 729 gpm	1	LS	\$ 750,000	\$ 750,000
9	8" Force Main	4,320	LF	\$ 70	\$ 302,400
10	Trench Pavement Repair	123,000	SF	\$ 25	\$ 3,075,000
11	Rock Saw for Pipe	11,620	LF	\$ 85	\$ 987,700
12	Rock Saw for Manholes	8	EA	\$ 5,000	\$ 39,444
12	Rock Saw for Lift Stations	3	EA	\$ 15,000	\$ 45,000
<b>Construction Subtotal</b>					<b>\$ 6,444,744</b>
Taxes					\$ 225,566
13	Watercourse Master Plan	1	LS	\$ 200,000	\$ 200,000
14	Engineering	1	LS	\$ 644,500	\$ 644,500
15	Railroad easements	1	LS	\$ -	\$ -
16	Construction Administration	1	LS	\$ 451,200	\$ 451,200
<b>Subtotal:</b>					<b>\$ 7,966,011</b>
Contingency (20%):					\$ 1,593,202
<b>Preliminary Opinion of Probable Construction Cost Total:</b>					<b>\$ 9,559,213</b>

Because the Consultant does not control the cost of labor, materials, equipment or services furnished by others, methods of determining prices, or competitive bidding or market conditions, any opinions rendered as to costs, including but not limited to opinions as to the costs of construction and materials, shall be made on the basis of its experience and represent its judgment as an experienced and qualified professional, familiar with the industry. The Consultant cannot and does not guarantee that proposals, bids or actual costs will not vary from its opinions of cost. If the Client wishes greater assurance as to the amount of any cost, it shall employ an independent cost estimator. Consultant's services required to bring costs within any limitation established by the Client will be paid for as Additional Services.

## Alternative 4 Opinion of Costs

**Preliminary Opinion of Probable Costs  
Downtown Sewer Improvements  
Alternative 4**

Date: March 4, 2016  
Prepared By: BLS

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	8" Gravity Sewer	2,650	LF	\$ 50	\$ 132,500
2	5' Diameter Manholes	18	EA	\$ 4,500	\$ 82,100
3	Highway 66 Lift Station - 436 gpm	1	LS	\$ 600,000	\$ 600,000
4	6" Force Main	3,530	LF	\$ 40	\$ 141,200
5	Park Avenue Lift Station -113 gpm	1	LS	\$ 300,000	\$ 300,000
6	3" Force Main	1,120	LF	\$ 25	\$ 28,000
7	Individual Lot Grinder Pump Lift Station & Pipe	1	LS	\$ 8,000	\$ 8,000
8	12" Gravity Sewer	4,210	LF	\$ 85	\$ 357,850
9	Trench Pavement Repair	121,680	SF	\$ 25	\$ 3,042,000
10	Rock Saw for Pipe	11,510	LF	\$ 85	\$ 978,350
11	Rock Saw for Manholes	18	EA	\$ 5,000	\$ 91,222
12	Rock Saw for Lift Stations	2	EA	\$ 15,000	\$ 30,000
					\$ 5,791,222
<b>Construction Subtotal</b>					<b>\$ 5,791,222</b>
Taxes					\$ 202,693
13	Watercourse Master Plan	1	LS	\$ 200,000	\$ 200,000
14	Engineering	1	LS	\$ 579,200	\$ 579,200
15	Railroad easements	1	LS	\$ -	\$ -
16	Construction Administration	1	LS	\$ 405,400	\$ 405,400
<b>Subtotal:</b>					<b>\$ 7,178,515</b>
Contingency (20%):					\$ 1,435,703
<b>Preliminary Opinion of Probable Construction Cost Total:</b>					<b>\$ 8,614,218</b>

Because the Consultant does not control the cost of labor, materials, equipment or services furnished by others, methods of determining prices, or competitive bidding or market conditions, any opinions rendered as to costs, including but not limited to opinions as to the costs of construction and materials, shall be made on the basis of its experience and represent its judgment as an experienced and qualified professional, familiar with the industry. The Consultant cannot and does not guarantee that proposals, bids or actual costs will not vary from its opinions of cost. If the Client wishes greater assurance as to the amount of any cost, it shall employ an independent cost estimator. Consultant's services required to bring costs within any limitation established by the Client will be paid for as Additional Services.

Alternative 4 Opinion of Costs - Phased

**Preliminary Opinion of Probable Costs  
Downtown Sewer Improvements  
Alternative 4 - Phased**

Date: March 4, 2016  
Prepared By: BLS

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
<b>Phase 1</b>					
1	Highway 66 Lift Station - 246 gpm	1	LS	\$ 550,000	\$ 550,000
2	6" Force Main	3,530	LF	\$ 40	\$ 141,200
3	Park Avenue Lift Station -113 gpm	1	LS	\$ 300,000	\$ 300,000
4	3" Force Main	1,120	LF	\$ 25	\$ 28,000
5	Individual Lot Grinder Pump Lift Station & Pipe	1	LS	\$ 8,000	\$ 8,000
6	Trench Pavement Repair	42,360	SF	\$ 25	\$ 1,059,000
7	Rock Saw for Pipe	4,650	LF	\$ 85	\$ 395,250
8	Rock Saw for Lift Stations	2	EA	\$ 15,000	\$ 30,000
Construction Subtotal					\$ 2,511,450
Taxes					\$ 87,901
9	Watercourse Master Plan	1	LS	\$ 200,000	\$ 200,000
10	Engineering	1	LS	\$ 368,200	\$ 368,200
11	Railroad easements	1	LS	\$ -	\$ -
12	Construction Administration	1	LS	\$ 175,900	\$ 175,900
<b>Subtotal:</b>					<b>\$ 3,343,451</b>
Contingency (20%):					\$ 668,690
<b>Phase 1 Subtotal:</b>					<b>\$ 4,012,141</b>
<b>Phase 2</b>					
13	12" Gravity Sewer	2,100	LF	\$ 85	\$ 178,500
14	8" Gravity Sewer	2,650	LF	\$ 50	\$ 132,500
15	5' Diameter Manholes	14	EA	\$ 4,500	\$ 61,000
16	Rock Saw for Pipe	2,100	LF	\$ 85	\$ 178,500
17	Rock Saw for Manholes	14	EA	\$ 5,000	\$ 67,778
18	Trench Pavement Repair	22,080	SF	\$ 25	\$ 552,000
Construction Subtotal					\$ 1,170,278
Taxes					\$ 40,960
19	Watercourse Master Plan	1	LS	\$ -	\$ -
20	Engineering	1	LS	\$ -	\$ -
21	Railroad easements	1	LS	\$ -	\$ -
22	Construction Administration	1	LS	\$ 87,800	\$ 87,800
<b>Subtotal:</b>					<b>\$ 1,299,038</b>
Contingency (20%):					\$ 259,808
<b>Phase 2 Subtotal:</b>					<b>\$ 4,028,160</b>
<b>Phase 3</b>					
21	12" Gravity Sewer	2,580	LF	\$ 85	\$ 219,300
22	5' Diameter Manholes	7	EA	\$ 4,500	\$ 30,300
23	Highway 66 Lift Station - New 436 gpm pumps only	1	LS	\$ 100,000	\$ 100,000
24	Rock Saw for Pipe	2,580	LF	\$ 85	\$ 219,300
25	Rock Saw for Manholes	7	EA	\$ 5,000	\$ 33,667
26	Trench Pavement Repair	30,960	SF	\$ 25	\$ 774,000
Construction Subtotal					\$ 1,376,567
Taxes					\$ 48,180
27	Watercourse Master Plan	1	LS	\$ -	\$ -
28	Engineering	1	LS	\$ -	\$ -
29	Railroad easements	1	LS	\$ -	\$ -
30	Construction Administration	1	LS	\$ 103,300	\$ 103,300
<b>Subtotal:</b>					<b>\$ 1,528,047</b>
Contingency (20%):					\$ 305,609
<b>Phase 3 Subtotal:</b>					<b>\$ 4,738,269</b>
<b>Preliminary Opinion of Probable Construction Cost Total:</b>					<b>\$ 8,750,410</b>

Because the Consultant does not control the cost of labor, materials, equipment or services furnished by others, methods of determining prices, or competitive bidding or market conditions, any opinions rendered as to costs, including but not limited to opinions as to the costs of construction and materials, shall be made on the basis of its experience and represent its judgment as an experienced and qualified professional, familiar with the industry. The Consultant cannot and does not guarantee that proposals, bids or actual costs will not vary from its opinions of cost. If the Client wishes greater assurance as to the amount of any cost, it shall employ an independent cost estimator. Consultant's services required to bring costs within any limitation established by the Client will be paid for as Additional Services.

## **APPENDIX C**

Gravity Sewer Line, Lift Station, and Force Main Calculations

## Highway 66 Gravity Sewer Line Calculations

**City of Kingman Proposed Highway 66 Sewer  
Gravity Option**

<b>Proposed Minimum Slope (%)</b>	<b>Proposed Pipe Diameter (inches)</b>	<b>Proposed Pipe Length (ft)</b>	<b>Proposed Velocity (flow full) (ft/s)</b>	<b>Proposed Pipe Capacity (flow full) (gpd)</b>	<b>Minimum Capacity Required Gravity Option</b>	<b>Minimum Slope Required Gravity Option Check</b>
0.61%	8	5485	2.71	611,672	669,203	No
0.25%	10	5485	2.01	709,987	669,203	X

# City of Kingman Proposed Highway 66 Sewer

## Lift Station Option

### Gravity and Lift Station Option

#### Gravity Line to Serve the Jail

Proposed Minimum Slope (%)	Proposed Pipe Diameter (inches)	Proposed Pipe Length (ft)	Proposed Velocity (flow full) (ft/s)	Proposed Pipe Capacity (flow full) (gpd)	Minimum Capacity Required Gravity Option	Minimum Slope Required Gravity Option Check
0.34%	8	1411	2.02	456,660	123,839	X

## Old Trails Gravity Sewer Line Calculations

**City of Kingman Proposed Old Trails Line  
Gravity Option**

<b>Proposed Minimum Slope (%)</b>	<b>Proposed Pipe Diameter (inches)</b>	<b>Proposed Pipe Length (ft)</b>	<b>Proposed Velocity (flow full) (ft/s)</b>	<b>Proposed Pipe Capacity (flow full) (gpd)</b>	<b>Minimum Capacity Required Gravity Option</b>	<b>Minimum Slope Required Gravity Option Check</b>
0.34%	8	4209	2.02	456,660	421,748	X

**City of Kingman Proposed Old Trails Line  
Gravity and Lift Station Option**

<b>Proposed Minimum Slope (%)</b>	<b>Proposed Pipe Diameter (inches)</b>	<b>Proposed Pipe Length (ft)</b>	<b>Proposed Velocity (flow full) (ft/s)</b>	<b>Proposed Pipe Capacity (flow full) (gpd)</b>	<b>Minimum Capacity Required Gravity Option</b>	<b>Minimum Slope Required Gravity Option Check</b>
1.80%	8	4209	4.66	1,050,727	1,049,056	X
0.55%	10	4209	2.99	1,053,081	1,049,056	X
0.21%	12	4209	2.08	1,058,134	1,049,056	X

Andy Divine Gravity Sewer Line Calculations

**City of Kingman Proposed Highway 66 Sewer  
Lift Station Option  
Gravity and Lift Station Option  
Gravity Andy Divine Sewer Line (East of Lift Station)**

<b>Proposed Minimum Slope (%)</b>	<b>Proposed Pipe Diameter (inches)</b>	<b>Proposed Pipe Length (ft)</b>	<b>Proposed Velocity (flow full) (ft/s)</b>	<b>Proposed Pipe Capacity (flow full) (gpd)</b>	<b>Minimum Slope Required Lift Station Option</b>	<b>Minimum Capacity Required Lift Station Option Check</b>
0.39%	8	1232	2.17	489,087	487,480	X

Park Avenue Lift Station

**City of Kingman Proposed Park Ave Lift  
Station**

**Gravity Option**

**Lift Station Option**

**Gravity Option & Lift Station Option**

**Lift Station Calculations**

65 Units served

2.46 People per Unit (based on us census)

100 gallons per person per day

246 gallons per unit per day

15990 average daily flow

Use Peaking factor per AAC R18-9-E301.D.1.ii for lift  
station service less than 600 unit

ADEQ Peak flow

Option 1    Option 2

98.1        113.1

Use 113 gpm for lift station pump capacity

Park Avenue Force Main

**Scenario: Park Ave Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Junction Table**

---

ID	Label	Elevation (ft)	Demand Collection	Demand (gpm)	Hydraulic Grade (ft)	Pressure (feet H2O)
30	J-1	3,319.00	<Collection: 1 item>	113	3,324.37	5
31	J-2	3,308.00	<Collection: 0 items>	0	3,367.00	59

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Park ave lift station 011516.wtg

**Scenario: Park Ave Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Pipe Table**

---

Label	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Length (ft)	Headloss (Friction) (ft)	Velocity (ft/s)
P-1	3.0	Ductile Iron	130.0	-113	1,114	42.63	5.13
P-2	96.0	Ductile Iron	130.0	-113	1	0.00	0.01

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Park ave lift station 011516.wtg

Highway 66 Lift Station





Highway 66 Force Main

**Scenario: Hwy 66 Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Junction Table**

---

ID	Label	Elevation (ft)	Demand Collection	Demand (gpm)	Hydraulic Grade (ft)	Pressure (feet H2O)
30	J-1	3,358.00	<Collection: 1 item>	842	3,363.13	5
31	J-2	3,324.00	<Collection: 0 items>	0	3,410.00	86

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Hwy 66 lift station 011416.wtg

**Scenario: Hwy 66 Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Pipe Table**

---

Label	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Length (ft)	Headloss (Friction) (ft)	Velocity (ft/s)
P-1	8.0	Ductile Iron	130.0	-842	3,525	46.87	5.38
P-2	96.0	Ductile Iron	130.0	-842	1	0.00	0.04

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Hwy 66 lift station 011416.wtg

**Scenario: Interim Hwy 66 Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Junction Table**

---

ID	Label	Elevation (ft)	Demand Collection	Demand (gpm)	Hydraulic Grade (ft)	Pressure (feet H2O)
30	J-1	3,358.00	<Collection: 1 item>	264	3,360.82	3
31	J-2	3,324.00	<Collection: 0 items>	0	3,383.00	59

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Interim Hwy 66 lift station 011516.wtg

**Scenario: Interim Hwy 66 Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Pipe Table**

---

Label	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Length (ft)	Headloss (Friction) (ft)	Velocity (ft/s)
P-1	6.0	Ductile Iron	130.0	-264	3,525	22.18	3.00
P-2	96.0	Ductile Iron	130.0	-264	1	0.00	0.01

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Interim Hwy 66 lift station 011516.wtg

Old Trails Lift Station

**City of Kingman Proposed Old Trail Sewer**  
**Lift Station Option**  
**Lift Station Calculations**

Inflow Name	Proposed Inflow Capacity (gpd)
Old Trail Line	421,748
Prop. Hwy 66 Lift Station	627,309
Total Inflow	1,049,056

This flow is considered peak flow because it is based on the flowing full capacity of the pipe.

Lift Station Calculations	
Peak Flow Rate	1,049,056 gpd
Equivalent population	13,113 people
Peaking Factor	1.81
Average Flow Rate	580,812 gpd
Pump Capacity	729 gpm

Upstream Population	Peaking Factor
1	4.00
100	3.62
200	3.14
300	2.9
400	2.74
500	2.64
600	2.56
700	2.5
800	2.46
900	2.42
1000	2.38
1001 to 10,000	$PF = (6.330 \times p^{-0.231}) + 1.094$
10,001 to 100,000	$PF = (6.177 \times p^{-0.233}) + 1.128$
More than 100,000	$PF = (4.500 \times p^{-0.174}) + 0.945$

People per Unit            2.46    Per US Census  
Number of Homes        2,951  
Based on Average Day Flow Rate  
Use Gravity peaking factor if greater than 600 units

upstream population	peaking factor
13,113	1.81

Old Trails Force Main

**Scenario: Old Trail Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Junction Table**

---

ID	Label	Elevation (ft)	Demand Collection	Demand (gpm)	Hydraulic Grade (ft)	Pressure (feet H2O)
30	J-1	3,320.00	<Collection: 1 item>	729	3,324.64	5
31	J-2	3,302.00	<Collection: 0 items>	0	3,369.00	67

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Old Trail lift station 011416.wtg

**Scenario: Old Trail Lift Station**  
**Current Time Step: 0.000Hr**  
**FlexTable: Pipe Table**

---

Label	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Length (ft)	Headloss (Friction) (ft)	Velocity (ft/s)
P-1	8.0	Ductile Iron	130.0	-729	4,366	44.36	4.65
P-2	96.0	Ductile Iron	130.0	-729	1	0.00	0.03

V:\Engineering\City of Kingman\15-034 Downtown Sewer Study\Sewer Line Capacity Calculations\Old Trail lift station 011416.wtg