APPENDIX C

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Memo

To:	Gary Thalken, Dave Biersdorf, Gary Brandt, Brian Kramer		
From:	Kent Prior, Brian Bakke, Scott Aurit	Project:	Oak Creek Trunk Sewer
CC:	Terry McArthur, Justin Semin		
Date:	May 3, 2005	Job No:	20843

RE: Draft Sewer Alignment Evaluation

The purpose of the Oak Creek Basin and Trunk Sewer lines alignment evaluation is to determine the optimal alignments to provide for current and future growth in the basin. The procedure for identifying the optimal alignments is as follows:

1. Evaluate and model the existing, Tier I, and future wastewater flow rates and capacities in the existing trunk sewer from manhole 68 (located on the west side of the Lincoln Airport main runway) east to the Theresa Street WWTF.

2. Identify improvements for the existing trunk sewer and compare these improvements to the Facility Plan Update (October 2002). The capacities from the improvements are utilized for the evaluation of the collection system capacities.

3. Evaluate the existing, Tier I, and future wastewater flow rates and capacities in the existing collection system.

4. Based on the available capacities identified in the trunk sewer; determine where these future development areas will be located. Identify the necessary collection system improvements to serve existing, Tier I, and future development areas.

Trunk Sewer Evaluation

The existing trunk sewer was evaluated and modeled to determine the existing and Tier I flow rates and capacities. No Tier II areas have been identified to-date. A manhole survey was conducted to obtain the actual invert elevations of the trunk sewer for the modeling. The results of the model are indicated in Table 1.

Table 1 – Trunk Sewer from Manhole 68 to Theresa Street WWTF

Submergence	Flow at Manhole 68	Flow at Theresa St. WWTF
None	26.0 cfs	50.1 cfs
0.25 Feet	27.8 cfs – Tier I	51.8 cfs
0.50 Feet	28.5 cfs	52.6 cfs

The results indicate that the trunk sewer needs to operate with 0.25 feet of submergence to convey the required 27.8 cfs for a Tier I flow condition.

Trunk Sewer Improvements

The Lincoln Wastewater Facilities Plan (Appendix A) indicates improvements that would be required to the trunk sewer to convey flows without submergence. The modeling of the trunk sewer confirmed that some sewer sections require paralleling, but the locations of the improvements were

not consistent with the Facility Plan. The proposed improvements to eliminate submergence for Tier I conditions based on the modeling are presented the Table 2.

Table 2 – Trunk Sewer Improvements Required for Tier I Flows without Submergence			
Downstream Manhole	**Upstream Manhole**	**Length**	**Parallel Sewer Size (in)**
321	322	344	48
191	192	546	48
204	205	398	27
209	232	611	27

If the improvements to the trunk sewer identified in Table 2 are constructed, the trunk sewer capacity created at Manhole 68 is 36.0 cfs, which is 8.2 cfs beyond the required Tier I flow condition. Utilizing the City's design flow equation and the differential service areas between 27.8 cfs and 36.0 cfs, an additional 1492 acres of service area is created as indicated in Table 3.

Table 3 – Additional Service Area Capacity	
Flow (cfs)	**Area (acres)**
8.2	*1134.5*
36.0	5967
27.8	- 4475
Differential	**1492**

Collection System Evaluation
Portions of the existing collection system are unable to convey existing and Tier I flows. The following locations have been identified for removal or replacement:

- **Siphon** across Oak Creek along W. Mathis (remove and replace)
- **E-2**, Trunk Sewer from Manhole 68 to NW 38th Street along W. Mathis (undersized/parallel)
- **E-3**, Sewer along W. Mathis from NW 38th Street to NW 41st Street (relay/parallel/replace)
- **E-3**, Sewer along NW 41st Street from W. Mathis to Air Park (relay/parallel/replace)
- **E-5**, Sewer along NW 41St Street from W. Cumming northeast to Airport Rd. (future construction of intermodal project).
- **E-6b**, Sewer along Airport Rd. (undersized/parallel)
- **E-6c**, Sewer along NW 27th Street (undersized/parallel)

Collection System Improvements
The trunk sewer improvements identified provide a flow capacity for the existing, Tier I, and future flow rates. A flow rate of 8.2, which equates to 1492 acres of future development, was identified with the improvements to the trunk sewer. A determination of the where the 1492 acres will be placed in the basin will effect the optimum sizing and location of the collection system improvements. For the initial evaluation it was assumed that two options were most likely for the additional development acres.

- Option 1 assumed development of 530 acres on the west side of Oak Creek west of Bowling Lake and 962 acres on the east side of Oak Creek north of Highway 34.

- Option 2 assumed development of all 1492 acres east of Oak Creek and north of Highway 34.

Each option was further divided into three alternatives with sewer segments broken out with identifying colors for comparison between each alternative. A summary of each alternative is provide below and is indicated on the attached figures.

Option 1 – Alternative 1 (530 acres west and 962 acres east)
Option 1-Alternative 1 will include a 48 inch trunk sewer extension from Manhole 68 to a new siphon across Oak Creek (Red-1). The sewer will be divided north of the siphon to serve the east and west sides of Oak Creek.

To serve the east side of Oak Creek, a 36 inch sewer (Red-2) will extend from the siphon northwest to NW 38th Street. The existing 30 inch sewer along W. Mathis and NW 41st Street (E-3) will be replaced with a new 30 inch sewer to eliminate the flow constrictions currently present in the sewer. The 30 inch sewer will extend east along Air Park Road to NW 38th Street then extend north along NW 38th Street to W. Cumming Street (Yellow-2). From W. Cumming Street, a 24 inch sewer (Orange-1) will extend north to W. Webster Street. From W. Webster Street a 24 inch sewer (Orange-2) will parallel Airport Road. The 24 inch sewer (Orange-3) will then extend north and parallel a tributary of Oak Creek to Highway 34.

To serve the west side of Oak Creek, a siphon and 42 inch sewer (Purple) will extend along the south and west side of Oak Creek to W. Mathis. A 27 inch sewer (Pink-1) will extend north from W. Mathis to Air Park Road. A 24 inch sewer (Pink-2) will then extend north to W. Cumming Street

Table 4: Option 1 – Alternative 1

Segment	Flow (cfs)	Diameter (in)	Length (ft)
Red-1	36.0	48	2700
Red-2	18.5	36	2100
Purple	19.8	42	3750
E-3	18.5	30	4100
Yellow-1	-	-	-
Yellow-2	8.3	30	3700
Orange-1	4.2	24	2300
Orange-2	4.2	24	1450
Orange-3	4.2	24	3300
Blue	-	-	-
Pink-1	8.4	27	3450
Pink-2	8.4	24	2900

Option 1 – Alternative 2 (530 acres west and 962 acres east)
Option 1-Alternative 2 will include a 48 inch trunk sewer extension from manhole 68 to a new siphon across Oak Creek (Red-1). The sewer will be divided north of the siphon to serve the east and west sides of Oak Creek.

To serve the east side of Oak Creek, a 36 inch sewer (Red-2) will extend from the siphon northwest to NW 38th Street. The existing 30 inch sewer along W. Mathis and NW 41st Street (E-3) will be replaced with a new 27 inch sewer to eliminate the flow constrictions currently present in the sewer. A second 18 inch sewer (Yellow-1) will extend from W. Mathis north along NW 38th Street to Air Park Road. A 30 inch sewer will extend east along Air Park Road to NW 38th Street then extend north along NW 38th Street to W. Cumming Street (Yellow-2). From W. Cumming Street, a 24 inch sewer (Orange-1) will extend north to W. Webster Street. From W. Webster Street a 24 inch sewer (Orange-2) will parallel Airport Road. The 24 inch sewer (Orange-3) will then extend north and parallel a tributary of Oak Creek to Highway 34.

To serve the west side of Oak Creek, a siphon and 42 inch sewer (Purple) will extend along the south and west side of Oak Creek to W. Mathis. A 27 inch sewer (Pink-1) will extend north from W. Mathis to Air Park Road. A 24 inch sewer (Pink-2) will then extend north to W. Cumming Street.

Table 5: Option 1 – Alternative 2			
Segment	**Flow (cfs)**	**Diameter (in)**	**Length (ft)**
Red-1	36.0	48	2700
Red-2	18.5	36	2100
Purple	19.8	42	3750
E-3	12.8	27	3000
Yellow-1	5.7	18	3000
Yellow-2	8.3	30	3700
Orange-1	4.2	24	2300
Orange-2	4.2	24	1450
Orange-3	4.2	24	3300
Blue	-	-	-
Pink-1	8.4	27	3450
Pink-2	8.4	24	2900

Option 1 – Alternative 3 (530 acres west and 962 acres east)
Option 1-Alternative 3 will include a 48 inch trunk sewer extension from Manhole 68 to a new siphon across Oak Creek (Red-1). The sewer will be divided north of the siphon to serve the east and west sides of Oak Creek.

To serve the east side of Oak Creek, a 30 inch sewer (Red-2) will extend from the siphon northwest to NW 38th Street. The existing 30 inch sewer along W. Mathis and NW 41st Street (E-3) will be replaced with a new 27 inch sewer to eliminate the flow constrictions currently present in the sewer. A siphon and 30 inch sewer (Blue) will be constructed across Oak Creek along W. Cuming Street to convey flows from north of W. Cumming. From W. Cumming Street, a 24 inch sewer (Orange-1) will extend north to W. Webster Street. From W. Webster Street a 24 inch sewer will parallel Airport Road. The 24 inch sewer (Orange-3) will then extend north and parallel a tributary of Oak Creek to Highway 34.

To serve the west side of Oak Creek, a siphon and 42 inch sewer (Purple) will extend along the south and west side of Oak Creek to W. Mathis. A 30 inch sewer (Pink-1) will extend north from W. Mathis to Air Park Road. A 30 inch sewer (Pink-2) will then extend north to W. Cumming Street

Table 6: Option 1 – Alternative 3			
Segment	**Flow (cfs)**	**Diameter (in)**	**Length (ft)**
Red-1	36.0	48	2700
Red-2	12.8	30	2100
Purple	25.3	42	3750
E-3	12.8	27	3000
Yellow-1	-	-	-
Yellow-2	-	-	-
Orange-1	4.2	24	2300
Orange-2	4.2	24	1450
Orange-3	4.2	24	3300
Blue	8.3	30	1320
Pink-1	14.3	30	3450
Pink-2	14.3	30	2900

Option 2 – Alternative 1 (1492 acres east)
Option 2-Alternative 1 will include a 48 inch trunk sewer extension from Manhole 68 to a new siphon across Oak Creek (Red-1). The sewer will be divided north of the siphon to serve the east and west sides of Oak Creek.

To serve the east side of Oak Creek, a 42 inch sewer (Red-2) will extend from the siphon northwest to NW 38th Street. The existing 30 inch sewer along W. Mathis and NW 41st Street (E-3) will be replaced with a new 36 inch sewer to eliminate the flow constrictions currently present in the sewer. The 36 inch sewer (Yellow-2) will extend east along Air Park Road to NW 38th Street then extend north along NW 38th Street to W. Cumming Street. From W. Cumming Street, a 27 inch sewer (Orange-1) will extend north to W. Webster Street. From W. Webster Street a 27 inch sewer (Orange-2) will parallel Airport Road. The 27 inch sewer (Orange-3) will then extend north and parallel a tributary of Oak Creek to Highway 34.

To serve the west side of Oak Creek, a siphon and 36 inch sewer (Purple) will extend along the south and west side of Oak Creek to W. Mathis. A 21 inch sewer (Pink-1) will extend north from W. Mathis to Air Park Road. A 21 inch sewer (Pink-2) will then extend north to W. Cumming Street

Table 7: Option 2 – Alternative 1			
Segment	**Flow (cfs)**	**Diameter (in)**	**Length (ft)**
Red-1	36.0	48	2700
Red-2	21.5	42	2100
Purple	16.7	36	3750
E-3	21.5	36	4100
Yellow-1	-	-	-
Yellow-2	10.9	36	3700
Orange-1	7.3	27	2300
Orange-2	7.1	27	1450
Orange-3	7.1	27	3300
Blue	-	-	-
Pink-1	5.8	21	3450
Pink-2	5.8	21	2900

Option 2 – Alternative 2 (1492 acres east)
Option 1-Alternative 2 will include a 48 inch trunk sewer extension from manhole 68 to a new siphon across Oak Creek (Red-1). The sewer will be divided north of the siphon to serve the east and west sides of Oak Creek.

To serve the east side of Oak Creek, a 42 inch sewer (Red-2) will extend from the siphon northwest to NW 38th Street. The existing 30 inch sewer along W. Mathis and NW 41st Street (E-3) will be replaced with a new 27 inch sewer to eliminate the flow constrictions currently present in the sewer. A second 21 inch sewer (Yellow-1) will extend from W. Mathis north along NW 38th Street to Air Park Road. A 36 inch sewer will extend east along Air Park Road to NW 38th Street then extend north along NW 38th Street to W. Cumming Street (Yellow-2). From W. Cumming Street, a 27 inch sewer (Orange-1) will extend north to W. Webster Street. From W. Webster Street a 27 inch sewer (Orange-2) will parallel Airport Road. The 27 inch sewer (Orange-3) will then extend north and parallel a tributary of Oak Creek to Highway 34.

To serve the west side of Oak Creek, a siphon and 36 inch sewer (Purple) will extend along the south and west side of Oak Creek to W. Mathis. A 21 inch sewer (Pink-1) will extend north from W. Mathis to Air Park Road. A 21 inch sewer (Pink-2) will then extend north to W. Cumming Street.

Table 8: Option 2 – Alternative 2			
Segment	**Flow (cfs)**	**Diameter (in)**	**Length (ft)**
Red-1	36.0	48	2700
Red-2	21.5	42	2100
Purple	16.7	36	3750
E-3	12.8	27	3000
Yellow-1	8.8	21	3000
Yellow-2	10.9	36	3700
Orange-1	7.3	27	2300
Orange-2	7.3	27	1450
Orange-3	7.3	27	3300
Blue	-	-	-
Pink-1	5.8	21	3450
Pink-2	5.8	21	2900

Option 2 – Alternative 3 (1492 acres east)

Option 1-Alternative 3 will include a 48 inch trunk sewer extension from Manhole 68 to a new siphon across Oak Creek (Red-1). The sewer will be divided north of the siphon to serve the east and west sides of Oak Creek.

To serve the east side of Oak Creek, a 30 inch sewer (Red-2) will extend from the siphon northwest to NW 38th Street. The existing 30 inch sewer along W. Mathis and NW 41st Street (E-3) will be replaced with a new 27 inch sewer to eliminate the flow constrictions currently present in the sewer. A siphon and 30 inch sewer (Blue) will be constructed across Oak Creek along W. Cuming Street to convey flows from north of W. Cumming. From W. Cumming Street, a 27 inch sewer (Orange-1) will extend north to W. Webster Street. From W. Webster Street a 27 inch sewer (Orange-2) will parallel Airport Road. The 27 inch sewer (Orange-3) will then extend north and parallel a tributary of Oak Creek to Highway 34.

To serve the west side of Oak Creek, a siphon and 42 inch sewer (Purple) will extend along the south and west side of Oak Creek to W. Mathis. A 30 inch sewer (Pink-1) will extend north from W. Mathis to Air Park Road. A 30 inch sewer (Pink-2) will then extend north to W. Cumming Street

Table 9: Option 2 – Alternative 3			
Segment	**Flow (cfs)**	**Diameter (in)**	**Length (ft)**
Red-1	36.0	48	2700
Red-2	12.8	30	2100
Purple	25.3	42	3750
E-3	12.8	27	3000
Yellow-1	-	-	-
Yellow-2	-	-	-
Orange-1	4.2	24	2300
Orange-2	4.2	24	1450
Orange-3	4.2	24	3300
Blue	8.3	30	1320
Pink-1	8.4	27	3450
Pink-2	8.4	24	2900

Oak Creek.

Tier I Condition. As Oak Creek Basin continues to grow, future development in sub-basin NW-2 will generate flow from the west (into OC-7) and sub-basins NW-3 and NW-6 will generate flows from the north (into OC-5 and the West Highlands Trunk Sewer). The Future 25-year Condition depicts about 1,100 and 1,865 acres of development respectively in these sub-basins with corresponding wastewater flows of 8.7 and 12.7 cfs. The current overloading conditions in the 27- and 30-inch lines will be exacerbated by the anticipated future growth.

Tier I Recommendations. The portions of NW-3 and NW-6 sub-basins that will contribute 12.7 cfs from the north can be handled in the existing 30-inch West Highlands Trunk Sewer. This assumes that its slope is at least 0.001 ft/ft. Once information has been provided for this line, the West Highlands Trunk Sewer can be properly analyzed for both present and future conditions. The 27-inch and 30-inch pipes need to be paralleled to relieve the existing overloaded condition and to prepare for 21.4 cfs of future flows. Recommended new construction includes 2,196 LF of 24-inch line from MH#AA7-21 to 10, and 2,817LF of 36-inch pipe between MH#AA7-10 to 298. The slope on these pipes is assumed to be the same as the slope of the lines they parallel.

The 48-inch reinforced concrete pipe (RCP) system starting one manhole further downstream has two problem areas. The first segment between MH#A6-209 and 208 is 98 LF and has a capacity 20.7cfs short of that required to meet future needs. This flow can be handled by installing a parallel a 54-inch pipe at the same low slope – 0.0001. The second problem segment is 687 LF with a slope of 0.000029 and does not have adequate capacity for the 25-year flow condition. If the 1,888 LF segment between MH#A6-199 and 196 could be unearthed and re-laid with a uniform slope, it would have the capacity needed (39.1cfs). A concern with this scenario is that the pipe may have been originally installed with an inconsistent slope due to utility conflicts.

The existing 54-inch RCP segment of the line also needs a minor improvement to convey the future flows. From MH#B6-321 to B6-319, 6.5 cfs of capacity is needed to accommodate future flows. A 27-inch parallel line is recommended to provide the future capacity required for this 438 LF segment of line.

Tier II Condition and Recommendations. Same as Tier I above.

Table 8-1. Summary of Recommendations for Existing Collection System

Basin	Upstream Manhole	Downstream Manhole	Existing Line Diameter (in)	Length (ft)	Unit Cost ($/ft)	Total $	Notes
Oak Creek	AA7-10	AA7-6	27	458	195	90,000	Construction of 36" pipe to parallel this line
Oak Creek	A6-199	A6-196	48	1888	100	190,000	Unearth and re-bury at a consistent slope

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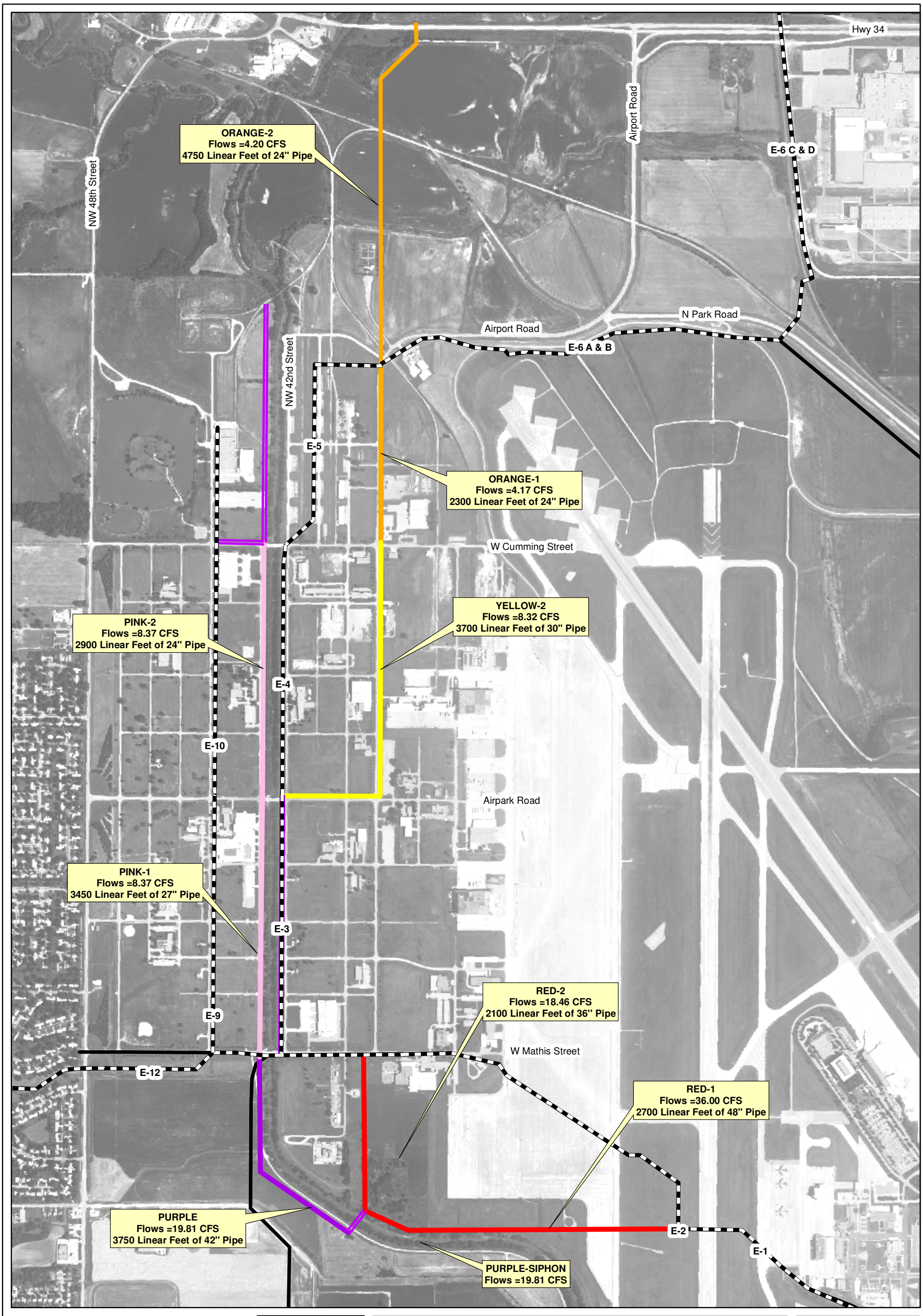

HDR

Option 1 - Alternative 1

Oak Creek Basin and Trunk Sewer

DATE
12/7/05

FIGURE
1

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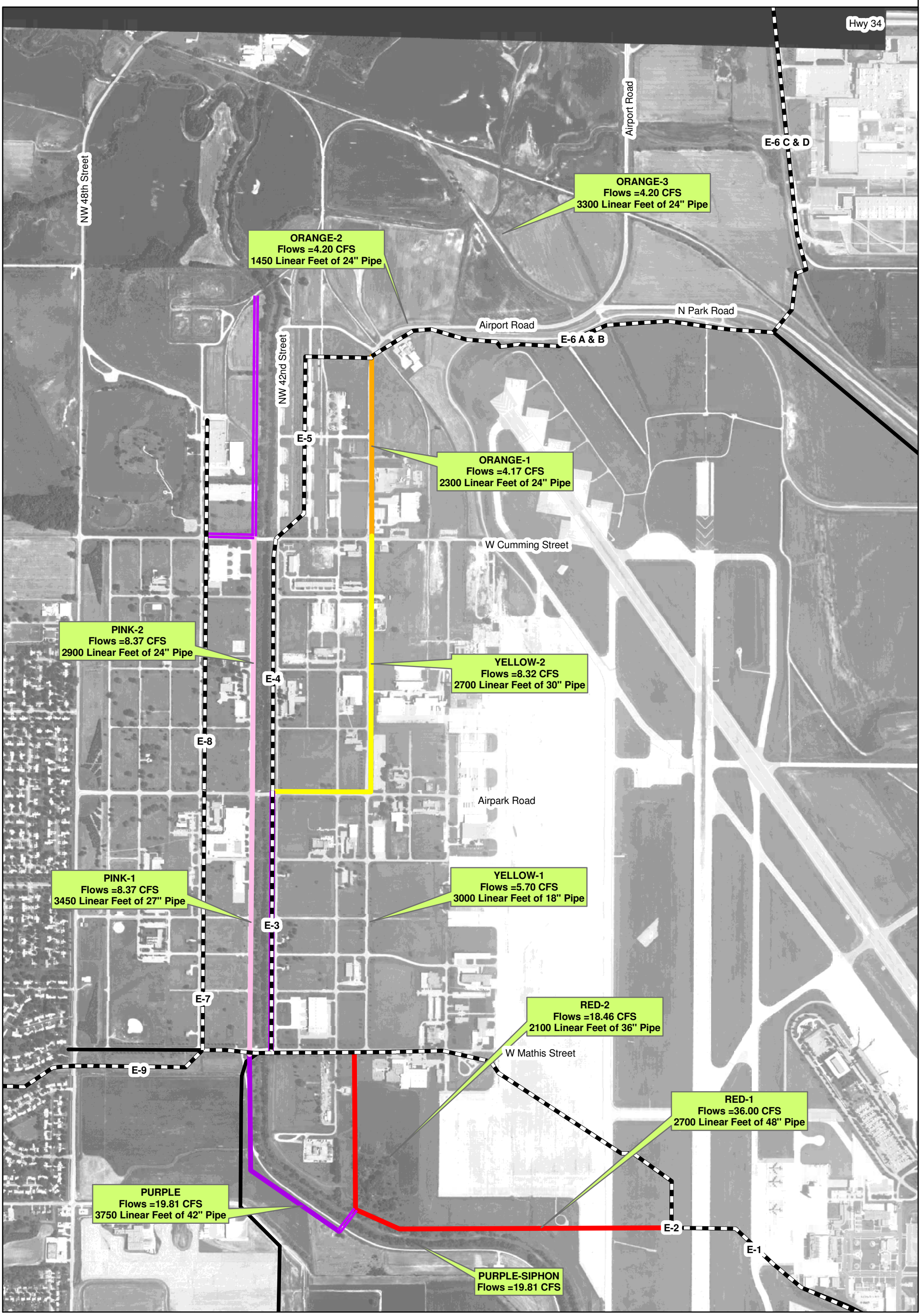

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Option 1 - Alternative 2

Oak Creek Basin and Trunk Sewer

DATE 5/2/05

FIGURE 3

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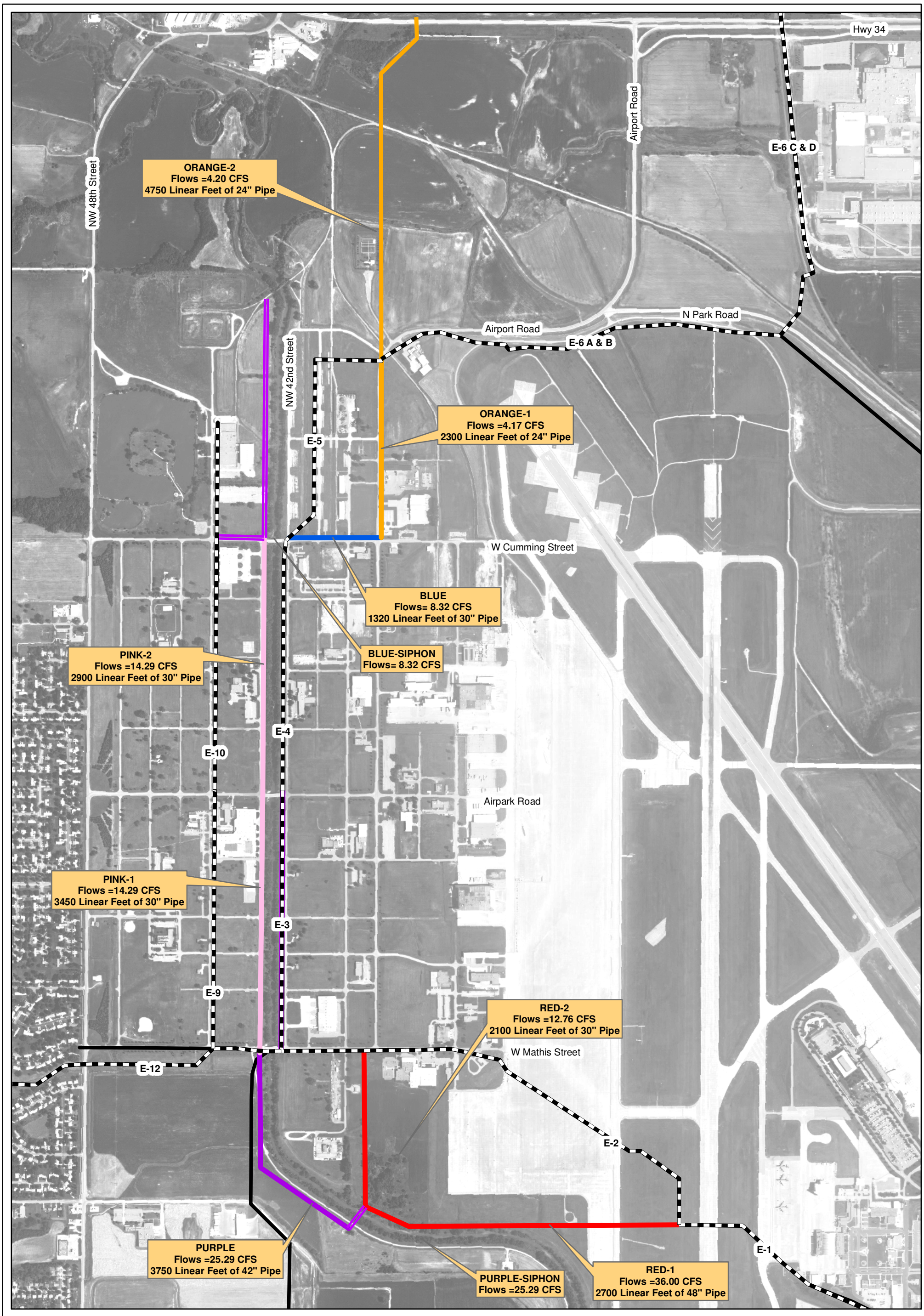

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Option 1 - Alternative 3

Oak Creek Basin and Trunk Sewer

DATE 12/7/05

FIGURE 3

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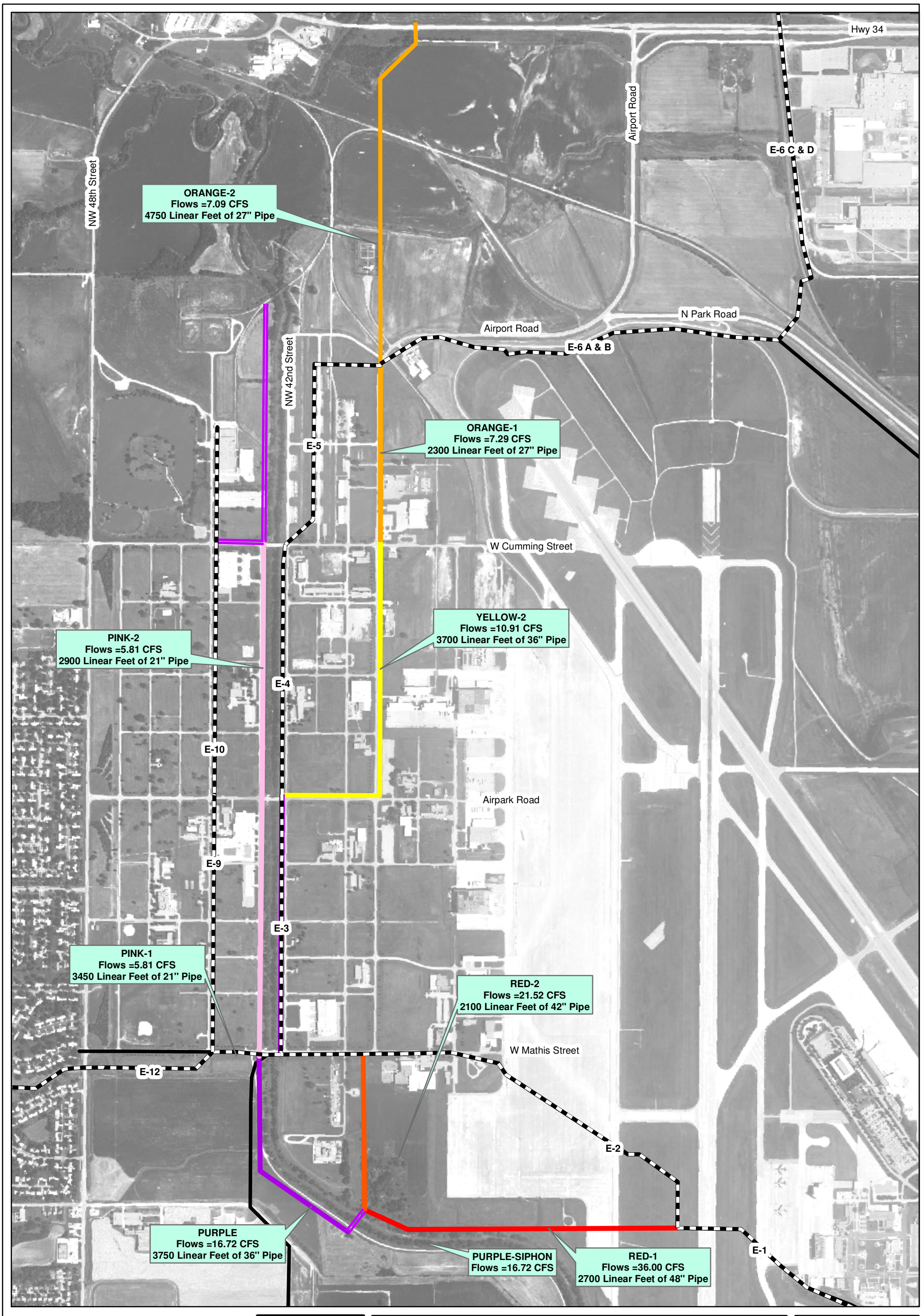

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Option 2 - Alternative 1

Oak Creek Basin and Trunk Sewer

DATE
12/7/05

FIGURE
4

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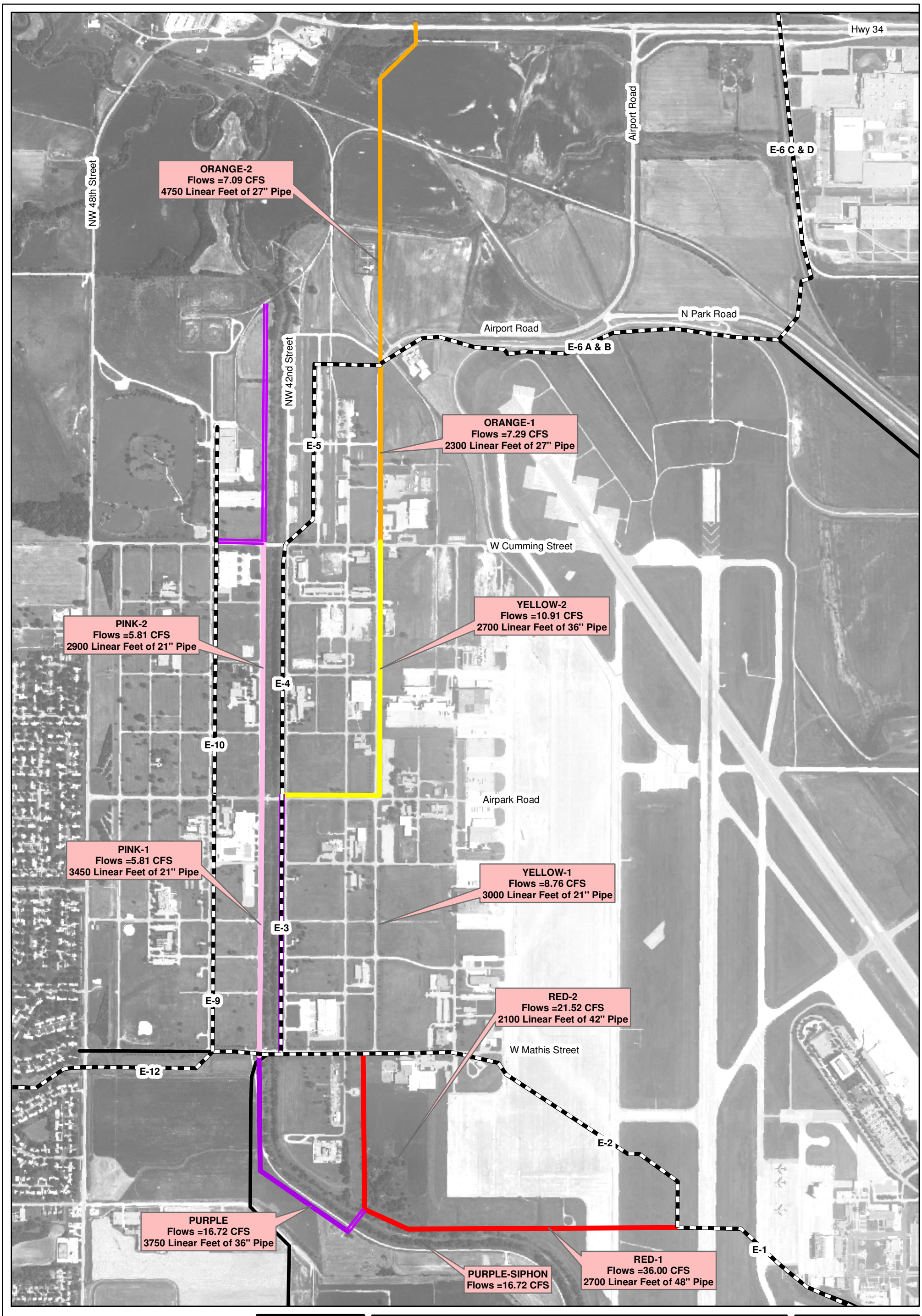

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Option 2 - Alternative 2

Oak Creek Basin and Trunk Sewer

DATE 12/7/05

FIGURE 5

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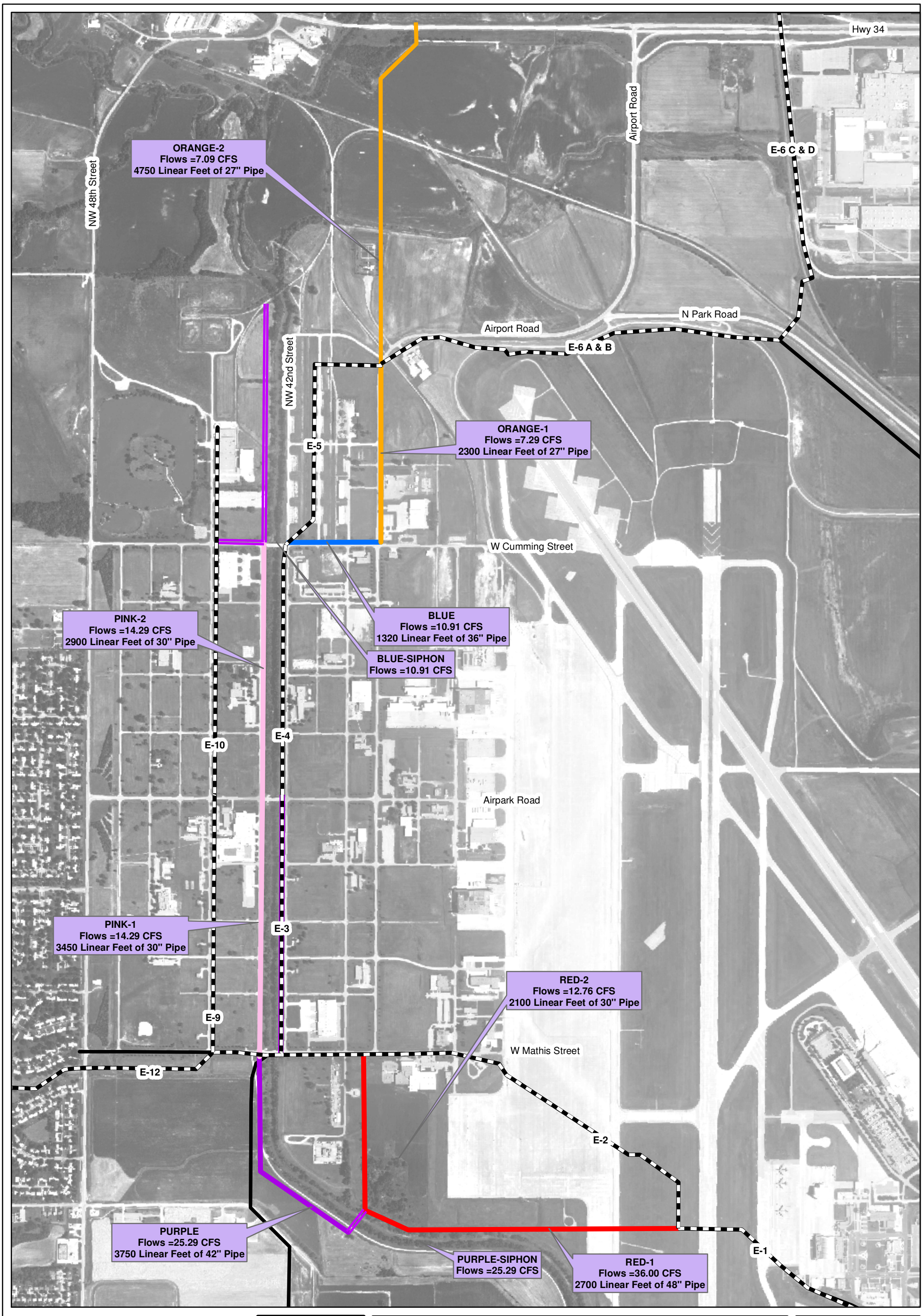

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Option 2 - Aternative 3

Oak Creek Basin and Trunk Sewer

DATE 12/7/05

FIGURE 6

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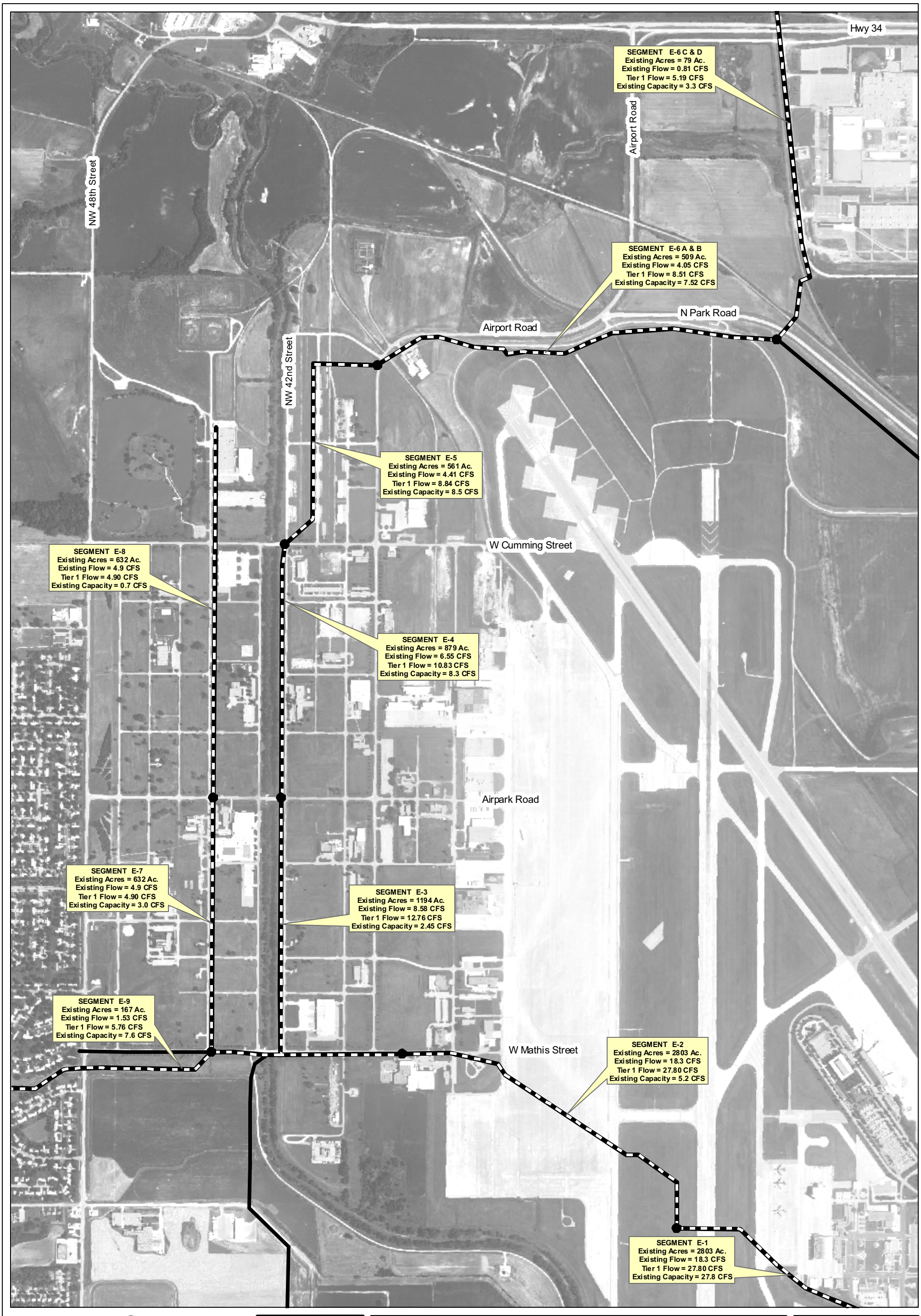

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Existing Sewer

Oak Creek Basin and Trunk Sewer

DATE
5/25/05

FIGURE
1

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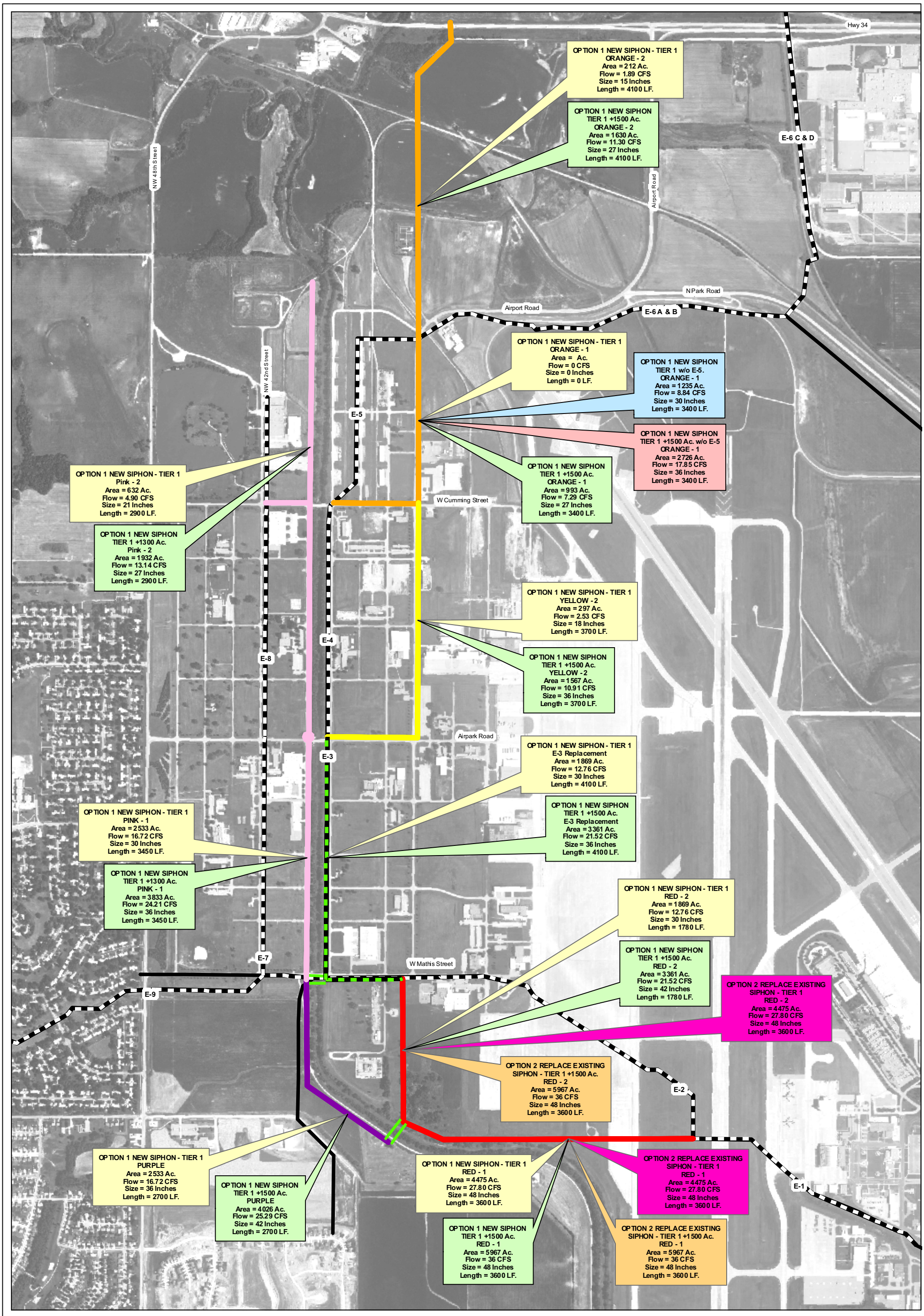

0 550 1,100 2,200 Feet

HDR

Potential Sewer Alignments

Oak Creek Basin and Trunk Sewer

DATE 5/25/05

FIGURE 2

Order of Magnitude Cost Estimate for Oak Creek Sewer Improvements

Option 1			
Segment	**Length**	**Pipe Size**	**Cost**
Red - 1	3600	48	$1,123,200
Red - 2	1780	30	$347,100
E-3	4100	30	$799,500
Yellow - 2	3700	18	$432,900
Orange -1	0	0	$0
Orange -2	4100	15	$399,750
Purple	2700	36	$631,800
Pink - 1	3450	30	$672,750
Pink - 2	2900	21	$395,850
			$4,803,000

Option 2			
Segment	**Length**	**Pipe Size**	**Cost**
Red - 1	3600	48	$1,123,200
Red - 2	2880	48	$898,560
E-3	3000	30	$585,000
Yellow - 2	3700	18	$432,900
Orange -1	0	0	$0
Orange -2	4100	15	$399,750
Relay Sewer	700	21	$95,550
Pink - 1	3450	30	$672,750
Pink - 2	2900	21	$395,850
			$4,604,000

Option 1A			
Segment	**Length**	**Pipe Size**	**Cost**
Red - 1	3600	48	$1,123,200
Red - 2	1780	42	$485,940
E-3	4100	36	$959,400
Yellow - 2	3700	36	$865,800
Orange -1	3400	27	$596,700
Orange -2	4100	27	$719,550
Purple	2700	42	$737,100
Pink - 1	3450	36	$807,300
Pink - 2	2900	27	$508,950
			$6,804,000

Option 2A			
Segment	**Length**	**Pipe Size**	**Cost**
Red - 1	3600	48	$1,123,200
Red - 2	2880	48	$898,560
E-3	3000	36	$702,000
Yellow - 2	3700	36	$865,800
Orange -1	3400	27	$596,700
Orange -2	2700	42	$737,100
Relay Sewer	700	21	$95,550
Pink - 1	3450	36	$807,300
Pink - 2	2900	27	$508,950
			$6,335,000

	Cost	**Differential**
Option 1	$4,803,000	1.04
Option 2	$4,604,000	-
Option 1A	$6,804,000	1.07
Option 2A	$6,335,000	-