



**The City of**  
**OKLAHOMA CITY**  
UTILITIES DEPARTMENT

**February 28, 2022**

**Project Title:** Replacement of Two Water Transmission Mains

**Project Location:** Pennsylvania Avenue from NW 1st Street to NW 10th Street

**Project Number:** WC-1020

**Estimated Project Cost:** \$6,500,000

**Project Description:** This project will remove two existing 30-inch water transmission mains from service and replace them with a single water transmission main. The attached Study Area figure shows the project vicinity.

**Project Background:** The Oklahoma City Water Utilities Trust (OCWUT) owns, operates, and maintains a water treatment and distribution system. The existing 30-inch transmission mains have reached the end of their useful life and need to be replaced. A single transmission main will replace the existing mains and be sized to accommodate future system needs. The new pipeline will consist of 24-inch, 30-inch, and 42-inch pipe sizes as shown on the attached Proposed Replacement Pipes figure. OCWUT completed a preliminary capacity model and alignment analysis which is provided as additional project information.

**Project Intent:** The consultant for this project will provide preliminary design, final design, bidding, construction administration and management, inspection, and as-built services necessary to complete the project.



Figure 2 Proposed Replacement Pipes

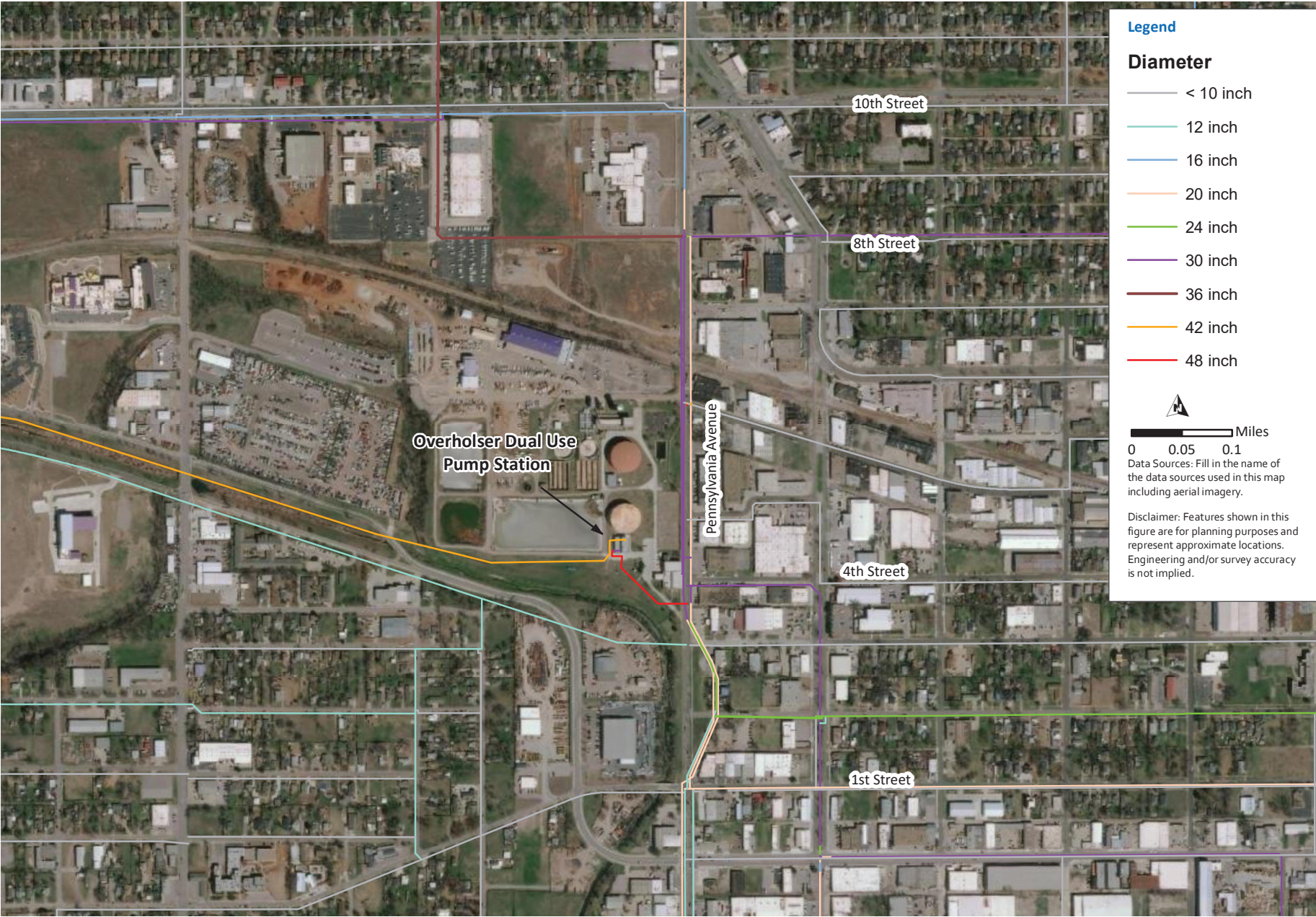


Figure 1 Study Area

# WC-1020 30-INCH WATER MAIN REPLACEMENT CAPACITY MODEL AND PRELIMINARY ALIGNMENT

Date: February 15, 2022

Project No.: 200677

City of Oklahoma City, Oklahoma

Prepared By: Kevin Rood, Richard Humpherys, and Binita Thapa

Reviewed By: Tom Crowley and Amber Wooten

## 1.0 Executive Summary

Key findings from this analysis are:

1. The two existing 30-inch transmission mains along Pennsylvania Avenue can be replaced with a single pipeline sized as follows:
  - a. 42-inch diameter pipe between 4th Street and 8th Street.
  - b. 24-inch pipe between 8th Street and 10th Street.
  - c. 30-inch pipe between 1st Street and 4th Street.
2. The east existing 30-inch transmission pipe is adequate to deliver water while the new transmission pipeline is being constructed without seasonal constraints.
3. A hydraulic transient analysis was completed by GEI consultants for the Dual Use Pump Station (DUPS) on January 11, 2016. This transient analysis was reviewed considering the current improvements, and the results of this analysis are still valid for the current planned configuration.
4. The new transmission pipeline will generally follow the alignment of the west 30-inch transmission pipeline and be installed in the southbound lane of Pennsylvania Avenue. Per discussions with Line Maintenance and Public Works, this arrangement, although not the preferred approach, is acceptable for this particular condition.
5. The budgetary opinion of probably construction cost for this project is expected to be between \$6.3 and \$11.1 million based upon a AACE Class IV estimate level.

## 2.0 Introduction

The Oklahoma City Water Utilities Trust (OCWUT) manages the City's drinking water system. OCWUT recently constructed the DUPS on the former Overholser Water Treatment Plant (WTP) site. The DUPS replaces a high service pump station that pumped treated water from the Overholser WTP into the distribution system.

## PROJECT MEMORANDUM

The DUPS normally receives water from the Draper Water Treatment Plant (Draper WTP) and will receive water from the Hefner Water Treatment Plant (Hefner WTP) through the Council Road pipeline in the near future. Water enters an existing 5-million-gallon storage tank and then is pumped into the water distribution system to boost pressures in downtown Oklahoma City. The DUPS delivers water into multiple transmission mains running north and south along Pennsylvania Avenue, just east of the pump station (see description below for size and location of existing transmission mains). These mains are nearing the end of their useful life and need to be replaced. The purpose of this project is to assist in planning to replace these pipelines by accomplishing the following tasks:

1. Determine the size of a single replacement pipe for the two existing 30-inch water transmission pipelines.
2. Determine if leaving one 30-inch main going north in Pennsylvania Avenue will provide adequate water transmission while the new replacement pipe is being constructed. This will permit a portion or all of the replacement pipe to be constructed in the existing alignment for the second 30-inch pipeline.
3. Identify a preliminary pipeline alignment for the replacement pipe.

### **3.0 Pipeline Diameter and Phasing Evaluation**

#### **3.1 Overholser Dual Use Pump Station and Pipeline Descriptions**

The 30-inch Water Main Replacement Capacity Model and Preliminary Alignment study area includes the DUPS and the adjacent pipelines connecting the pump with the distribution system. The DUPS is located along Pennsylvania Avenue between 4th and 7th Street. Figure 1 presents the location of the DUPS and the pipelines to be evaluated along Pennsylvania Avenue.

The water transmission mains along Pennsylvania Avenue going north from the DUPS contains the following water mains:

- 30-inch cast iron/ductile iron waterline portions of which were installed in the 1930s.
- 30-inch ductile waterline installed in the 1980s.
- 20-inch waterline, material unknown.

The distribution system and transmission mains going south from the DUPS consist of 12-, 20-, and 24-inch mains.



Figure 1 Study Area

## PROJECT MEMORANDUM

Under project WT-0115 Overholser WTP Improvements, a new DUPS and 5-million-gallon (MG) ground storage tank (north) were installed on the site. The DUPS consists of five pumps. Four pumps have a design flowrate of 9.33 million gallons per day (mgd) with 85 pounds per square inch (psi) of total dynamic head (TDH) pressure, for a total firm capacity of 37.2 mgd. A fifth jockey pump was provided with a design of 5 mgd at 75 psi. The DUPS was designed to maintain a pressure range of 70 to 90 psi in the distribution system at Pennsylvania Avenue. The Overholser site is being converted from a treatment facility to a storage tank farm and booster pump station as part of a plan to strengthen the distribution system interconnect between the Hefner and Draper WTPs providing a more reliable, resistant, and redundant system.

### 3.2 Hydraulic Evaluation

Carollo used the OCWUT distribution system model with the InfoWater Pro hydraulic modeling software in this analysis.

To determine an initial pipe diameter to replace the existing mains, a pipe diameter of the replacement main was set to be at least equal to the cross-sectional areas of the pipes to be replaced. Then the pipe diameters were evaluated in the hydraulic model to verify that the water velocities did not exceed 5 feet per second for pipes 36 inches in diameter and smaller. Pipes with a diameter of 42 inches and higher can have velocities up to 6 feet per second. Then the ability of one 30-inch main to deliver water north from the pump station was evaluated with near term demands to determine if the existing 30-inch main has the capacity to deliver water while the replacement main was being constructed.

#### 3.2.1 Water Demands

Water demands for this study were set based on recent 2021 actual water production and the 2021 master planning demands in the hydraulic model for 2021 and 2031. The hydraulic model demands are higher than current water use and represent demands that are anticipated in the future. Table 1 lists the scenarios and the water demand for each of the six demand conditions.

Table 1 Water Demands Used to Evaluate Pennsylvania Avenue Pipelines

Scenario/Simulation	Water Demand (mgd)	Overholser Pressure Setpoint (psi)
2021 Actual Winter	78	90
2021 Actual Summer	137	90
2021 Model Winter	126	90
2021 Model Summer	243	85
2031 Model Winter	172	85
2031 Model Summer	331	75

#### 3.2.2 Water Main Diameters

Water main diameters were initially determined based on finding an equivalent pipe cross sectional area. Proposed diameters are as follows:

1. A single 42-inch diameter pipe would replace the two 30-inch water mains between the pump station connection and 8th street.
2. A 24-inch pipe would replace the existing 24-inch pipe between 8th Street and 10th Street.
3. A 30-inch pipe would replace two 12-inch and one 20-inch pipe between 4th Street and 1st Street.

Figure 2 presents the proposed pipelines and locations.



Figure 2 Proposed Replacement Pipes



## PROJECT MEMORANDUM

### 3.2.3 Hydraulic Analyses

A total of six scenarios were analyzed to validate the proposed pipeline diameters using the water demands listed in Table 1. One key factor in determining the flows going through the pump station is the pressure setpoint of the pumps. Table 1 shows the pump pressure setpoints that were used in the analyses. The pressure setpoint is set higher with the lower demand conditions because a higher setpoint was needed to create a condition where the pump station needed to operate at a higher flowrate. During the higher demand conditions, the pump station did not need as high of a setpoint to operate at a higher flow. Table 2 summarizes the estimated flowrates and water velocities in the future pipes for each scenario.

Table 2      **Calculated Maximum Velocities and Flowrates in The Proposed Transmission Mains Along Pennsylvania Avenue**

Simulation	48-inch joining N Penn Ave		30-inch between 1st and 4th Street, flowing from 4th to 1st Street		42-inch between 4th and 8th Street		24-inch between 8th and 10th Street	
	Max Velocity (ft/s)	Max flow rate (mgd)	Max Velocity (ft/s)	Max flow rate (mgd)	Max Velocity (ft/s)	Max flow rate (mgd)	Max Velocity (ft/s)	Max flow rate (mgd)
2021 Actual Winter	2.5	20	1.5	5	2.2	14	0.1	0.2
2021 Actual Summer	3.0	24	1.9	6	2.4	15	0.1	0.2
2021 Model Winter <sup>(1)</sup>	2.8	23	1.7	5	2.3	14	0.1	0.2
2021 Model Summer <sup>(1)</sup>	5.3	43	3.9	12	3.4	21	0.1	0.2
2031 Model Winter <sup>(1)</sup>	3.1	25	2.1	7	2.2	13	0.1	0.1
2031 Model Summer <sup>(1)*</sup>	5.4	44	3.8	12	3.6	22	0.1	0.2

Notes:

(1) The "model Summer/Winter" scenarios utilize the "2021" and "2031" estimated demands from the 2005 Water Master Plan which are larger than the 2021 actual demands.

(2) ft/s = feet per second.

The model results show that the velocity in the proposed pipes is less than 5 feet per second (ft/s) for pipes less than 36 inches in diameter and less than 6 ft/s for pipes 42 inches in diameter and greater. In the 2021 and 2031 summer demand condition, the flows exceeded the design capacity of the pump station, indicating that the pump station could be required to deliver flows greater than the current design flow. Selective replacement of the jockey pump/duty pumps may be necessary in the future to satisfy these estimated larger system demands.

The model calculated flows in the 24-inch main between 8th Street and 10th Street are low and may appear to indicate that a smaller pipe would be adequate. The 24-inch pipe was left in the recommendation because there could be different demand conditions that are not represented in the model, or future growth north of 10th Street that could require additional capacity.

## PROJECT MEMORANDUM

The maximum flows through the 42-inch pipeline in the 2021 actual winter and summer demand conditions is 15 mgd based upon the plant's operational reports. Since the pipeline is expected to be designed and constructed in the near term, the 2021 demands are assumed to be representative of demands during pipeline construction. A flowrate of 15 mgd flowing through a 30-inch diameter pipeline would have a velocity of less than 5 ft/s. Consequently, a single 30-inch pipe will be adequate to provide water north from the pump station while the proposed 42-inch pipeline is being constructed regardless of the pumping season (winter or summer).

### 3.3 Hydraulic Evaluation Conclusions and Recommendations

1. The following pipe diameters are recommended for the replacement pipes along Pennsylvania Avenue:
  - a. 30-inch pipeline along Penn Ave. from 1st Street to 4th Street.
  - b. 42-inch pipeline along Penn Ave. from 4th Street to 8th Street.
  - c. 24-inch pipeline along Penn Ave from 8th Street to 10th Street.
2. One existing 30-inch pipeline is adequate to deliver water supplies north on Pennsylvania Avenue while the 42-inch pipeline is being constructed.
3. A hydraulic transient analysis was completed by GEI consultants for the DUPS on January 11, 2016. This transient analysis was reviewed in light of the current improvements, and the results of this analysis are still valid for the current planned configuration.

## 4.0 Alignment Analysis

### 4.1 Proposed Water Pipeline Routing

The corridor along North Pennsylvania Avenue from NW 1st Street to NW 10th Street has many utilities that are both parallel and perpendicular to the street (see Table 3). Pavement sections has been widened in the past from the original two lanes when the waterlines were originally constructed (Early 1930s) to four lanes with turning lanes at the major intersections thereby, limiting the available space in the right-of-way (ROW) on both sides of the street (see Figure 3 ). If the proposed improvements were constructed outside of the pavement section, additional easement and/or ROW would have to be acquired. Again, the proximity of the existing buildings and/or structures along Penn would preclude obtaining easement on the East side of Penn north of NW 4th Street and the location of existing utilities would impair construction south of NW 4th Street to NW 1st Street. There is some open land on the West Side of Penn, but the Utilities Department Line Maintenance Division operations and the DUPS impact this area.

Table 3 Utilities within the Pennsylvania Corridor

Utility	Contact
OKIE 811	geocall@callokie.com
OCWUT Water Pipelines	OKC Water & Waste- Phone: (405) 297-2727
OCWUT Sanitary Sewer	OKC Water & Waste- Phone: (405) 297-2727
Oklahoma City Public Works Storm Sewer	Barry Lodge (405) 297.3825
OG&E	
AT&T Transmission	Rahm <jrahm@sdt-1.com>
ATT&T	VOHS, LENNY <lv2121@att.com>
Oklahoma Natural Gas	ongmapping@onegas.onmicrosoft.com
Chickasaw Phone	<a href="mailto:etomlinson@chickasawphone.net">etomlinson@chickasawphone.net</a>
Cox Communications	Troy <a href="mailto:Skorkowsky@cox.com">Skorkowsky@cox.com</a>

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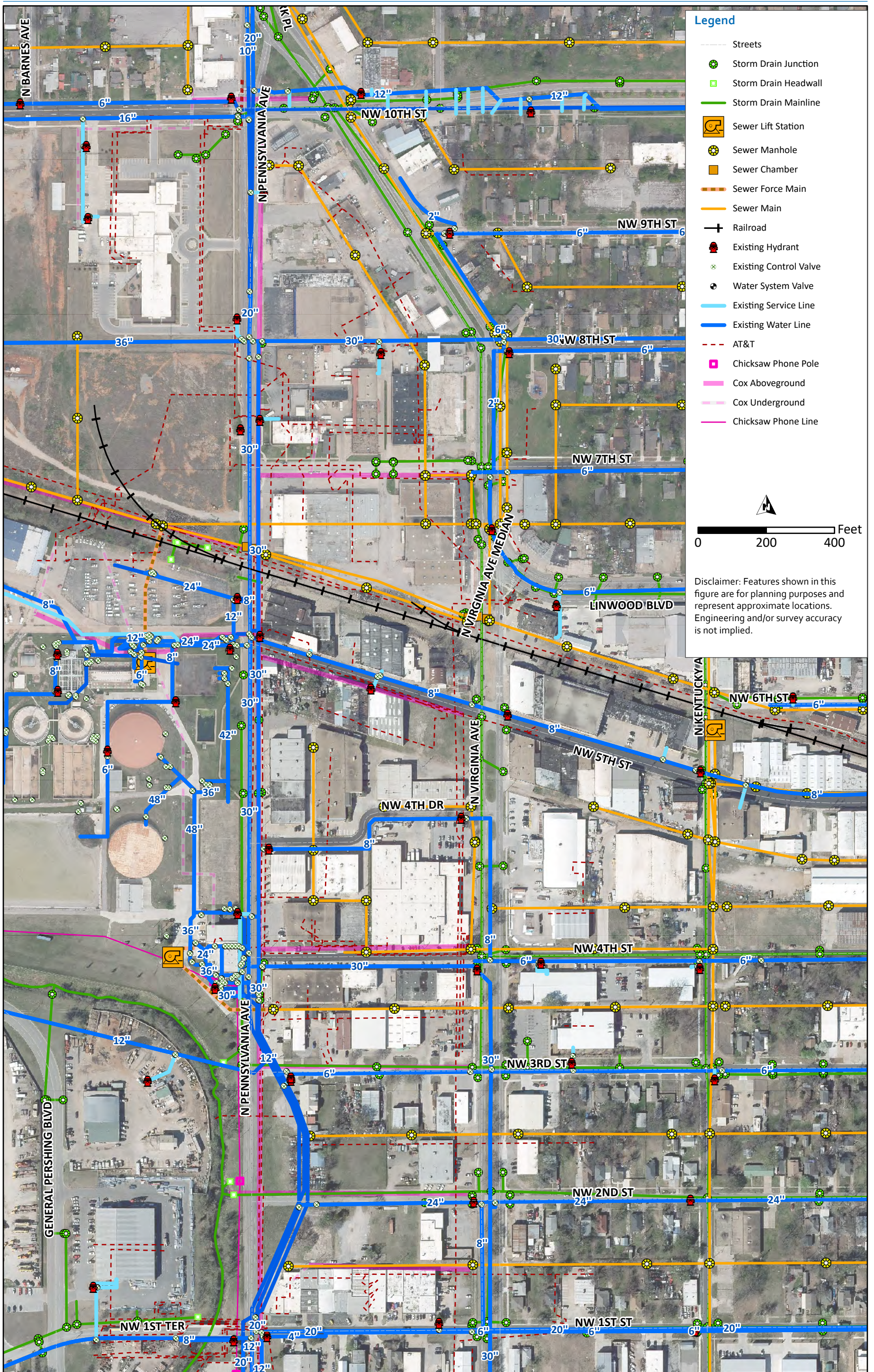
As a result of the limitations in the ROW, it has been determined that the selected alignment is to follow the alignment of the existing waterline under Pennsylvania Avenue.

Overall, this effort will necessitate the use of existing line valves and the use of insertion line stops to allow the system to remain functional during construction. Since the existing pipeline is within the pavement of Pennsylvania, a significant amount of pavement will need to be removed and replaced with this project as well as, street closures and a traffic routing plan.

Since the DUPS and one of the existing 30-inch waterlines must remain in service during construction, it is important that the proposed waterline will be constructed in segments with each segment tested and accepted as it is completed, allowing each segment to be brought online and into service to allow the distribution system to remain fully functional.

To address the differing elements of this project it is broken down into four segments which are shown in detail in Appendix A.

1. South Segment - NW 1st Street to the DUPS
2. DUPS Connection Segment
3. Middle Segment - DUPS to NW 8th Street
4. North Segment - NW 8th Street to NW 10th Street.



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#### **4.2 South Segment - NW 1st to the Overholser Dual Use Pump Station**

The South Segment is that portion of the waterline in Pennsylvania beginning at Northwest 1st Street and extending north to just south of the DUPS. This project is to begin at NW 1st Street with connection to three existing waterlines: a 20-inch waterline along the west curb line of Penn, a 12-inch waterline near the center of Penn, and a 20-inch waterline in the east driving lane on north bound Penn. These interconnections would be completed one at a time to keep the distribution system fully functional.

A 30-inch pipeline is proposed to be constructed in the west lane of south bound Pennsylvania. This alignment would be completed with only minimum conflict with existing utilities and would necessitate the use of existing line valves and insertion line stops to complete the construction and tie-ins. A 24-inch connection to the existing system is also proposed at NW 2nd Street, and a 12-inch waterline with a sub-feed of a 6-inch waterline would be proposed at NW 4th Street.

The primary challenges with this segment are:

1. Connections to the existing waterlines in NW 1st Street.
2. Connection to the 24-inch waterline in NW 2nd Street.
3. Avoidance of Storm Sewer along NW 2nd Street.
4. Avoidance of a Storm Sewer and waterline at NW 3rd Street.
5. Avoidance of a Sanitary Sewer Force Main south of the DUPS.

#### **4.3 Overholser Dual Use Pump Station Connection Segment**

The DUPS Segment is the most complex portion of this project, because at least one 30-inch waterline must be operable at all times. There are two 30-inch crossover waterlines that interconnect the two 30-inch waterlines in Pennsylvania and two 30-inch lines, and one 20-inch discharge line, leaving the Dual Use DUPS. These lines, along with several isolation valves and line stops, will allow one existing 30-inch waterline to be in operation at all times.

The proposed 30-inch waterline will transition to a 42-inch waterline at the furthest south 30-inch Overholser connection and will continue north as a 42-inch waterline. The proposed 42-inch waterline would transition from the west lane of southbound Pennsylvania to the alignment of the existing 30-inch waterline near the center of the Street.

To keep the pump station online, the connection would be implemented in two steps: (1) the North 30-inch and middle 20-inch connections as one step, (2) the South 30-inch connection as the second.

The South 30-inch waterline will be kept in service to the eastern most 30-inch waterline and will be abandoned later in the project and a new 30-inch waterline line will be extended approximately 100 feet west to connect to the DUPS Discharge pipeline when the existing 30-inch line is abandoned. The middle 20-inch DUPS discharge will be connected to the 42-inch line initially, while the north 30-inch DUPS Discharge will feed into the existing waterlines through an existing 24-inch waterline. Line Stops will be required during construction. This 30-inch connection to the DUPS Discharge will happen later in the project. A significant challenge with this connection strategy will be the testing and disinfection of this improvement prior to placing the pipeline into service. Keeping the pipe clean during installation will be extremely important; temporary plugs, and swabbing the pipeline should be considered.

## PROJECT MEMORANDUM

The primary challenges with this segment are:

1. Connections to the existing DUPS Discharge Lines.
2. Connection to the 30-inch waterline in NW 4th Street.
3. Avoidance of Storm Sewer along Pennsylvania.
4. Construction issues with decommissioned Waterlines.
5. Cleanliness, Disinfection and Testing.

### **4.4 Middle Segment (Overholser Dual Use Pump Station to NW 8th Street)**

The Middle Segment is the longest stretch of waterline to be constructed and connects the DUPS to a 36-inch and 30-inch waterline in NW 8th Street which is a primary conveyer of water in this region. This segment is a 42-inch Waterline to be install in the same location as an existing 30-inch Waterline near the center of Pennsylvania Ave. To facilitate construction and to allow sections of waterline to be placed back into service as soon as possible, it is suggested that sections between valves be tested, accepted, and returned to service. However, interconnection to some of the existing smaller diameter waterlines would need to be connected at the end of the project so that the 30-inch Waterline on the East side of Pennsylvania can remain in service for the duration of the project.

One complication of this project is the crossing of the Union Pacific Railroad. Installation of a new 42-inch Waterline will require the need for boring and steel encasement of the waterline under the railroad generally from ROW to ROW. The top of the boring will be a minimum of twelve feet below grade because of the existing 30-inch waterline. This depth of boring will need significant boring and receiving pits on both sides of the railroad. As an option, there is an existing siphon in a sanitary sewer that crosses the 30-inch waterline that could be removed and converted to a straight gravity section, thereby reducing the long-term maintenance of a sanitary sewer siphon; provided the proposed waterline is coordinated with this possible construction. Additionally, there is a significant storm drainage structure on the south side of the railroad that will impact the elevation of the proposed waterline.

Another complication of this segment will be the crossing and connection to the 36-inch and 30-inch waterline at NW 8th Street. Since these lines connect to the 30-inch waterline in a cross the proposed 42-inch waterline will need to offset and be constructed under the existing waterlines be tested and accepted prior to connection to the existing lines.

The primary challenges with this segment are:

1. Construction under the Union Pacific Railroad.
2. Connection to the 36-inch/ 30-inch waterline in NW Eight Street.
3. Traffic Control Plan and implementation.
4. Cleanliness, Disinfection and Testing.

### **4.5 North Segment (NW Eight Street to NW Tenth Street)**

The North Segment is another complex segment to construct must do to the issues associated with the streets and traffic. Tenth and Pennsylvania is a major intersection with a large volume of traffic that will impact construction. This line segment is proposed as a 24-inch waterline connecting to the proposed 42-inch waterline at NW Eighth Street and connect to a 16-inch, 20-inch, 10-inch, and 12-inch at Northwest Tenth Street. The proposed alignment is to follow the 20-inch waterline in Pennsylvania and will abandon the existing 10-inch South of NW Tenth Street, it is important to note that the service lines connected to the 10-inch will have to be relocated to the proposed 24-inch. This work effort will require the use of existing valves and line stops during construction.

## PROJECT MEMORANDUM

The primary challenges with this segment are:

1. Construction at the NW Tenth and Pennsylvania.
2. Connection to the existing waterline in NW Tenth Street.
3. Traffic Control Plan and implementation.
4. Cleanliness, Disinfection and Testing.

### 4.6 Opinion of Construction Cost

A budgetary cost estimate was developed based upon the proposed pipe sizes and alignment presented in Table 4. The costs are considered a Class 4 Budget Estimate (as defined by the Association for the Advancement of Cost Engineering) and are suitable for determining project feasibility. The expected accuracy range is within +50 percent or -15 percent. The costs include an estimating contingency of 30 percent and contractor overhead and profit of 9 percent. Capital costs and contingencies should be refined during design phase. Supporting details for cost estimate are provided in Appendix B.

Table 4 Opinion of Construction Cost

Description	Low	Average	High
Pipeline	\$ 2,700,000	\$ 3,177,000	\$ 4,766,000
Pavement	\$ 815,000	\$ 959,000	\$ 1,439,000
<b>Subtotal Construction Cost</b>	<b>\$ 3,515,000</b>	<b>\$ 4,136,000</b>	<b>\$ 6,205,000</b>
Contingency (30%)	\$ 1,055,000	\$ 1,241,000	\$ 1,862,000
Overhead and Profit (9%)	\$ 316,000	\$ 372,000	\$ 558,000
Sales Tax on 50% of Total Construction	\$ 151,000	\$ 178,000	\$ 267,000
<b>Opinion of Total Construction Cost</b>	<b>\$ 5,037,000</b>	<b>\$ 5,927,000</b>	<b>\$ 8,892,000</b>
Engineering, Legal and Administration (20%)	\$ 1,007,000	\$ 1,185,000	\$ 1,778,000
Owner's Reserve for Change Orders (5%)	\$ 252,000	\$ 296,000	\$ 445,000
<b>Opinion of Total Project Cost</b>	<b>\$ 6,296,000</b>	<b>\$ 7,408,000</b>	<b>\$ 11,115,000</b>

Notes:

- (1) Opinion of Total Project Cost in 2022 Dollars. More detailed cost estimate is provided in Appendix B.
- (2) Pipeline costs include the new 42-inch transmission main along Pennsylvania Avenue as well as other diameters used for making connections to existing distribution system and DUPS. Line item includes pipeline, valves, fittings, bore and encasement underneath the railroad, vaults, fire hydrants, and other items necessary to construct and bring pipeline online.
- (3) Pavement costs include removal and replacement of asphalt necessary to install the new transmission pipe primarily in the southbound lane(s) (consistent with the existing alignment). The cost also includes to mill and overlay the full width of Pennsylvania Avenue between First and Tenth Streets.
- (4) Cost estimate range is based on the AACE Class IV estimate.



PROJECT MEMORANDUM

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