BURNS McDONNELL

CITY OF LEE'S SUMMIT, MISSOURI

WATER MASTER PLAN

FINAL REPORT

APRIL 2023

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City of Lee's Summit, Missouri
Water Master Plan
Project No. 136566

Report Index

Certification

I hereby certify, as a Professional Engineer in the state of Missouri, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the City of Lee's Summit, Missouri or others without specific verification or adaptation by the Engineer.

Ryan Scott, P.E. (MO License 2020007468)

Date: April 21, 2023

1.0 Purpose and Scope

Burns & McDonnell responded to the City of Lee's Summit, Missouri Request for Qualifications No. 2021-063 for Water Master Plan Services administered by the Procurement and Contract Services Department on behalf of Lee's Summit Water Utilities. Upon award of the Water Master Plan Services Project Burns & McDonnell worked with Water Utilities on the scope of services and is generally summarized in this section of the report.

1.1 Purpose

This Water Master Plan (WMP) provides a roadmap for the distribution system to address short-term needs and meet long-term goals for projected water demands based on the growth identified in the City's 2021 Ignite Comprehensive Plan. This WMP includes an update and calibration confirmation of the water distribution system hydraulic model, an evaluation of system hydraulics for current and projected demand conditions, and a capital improvement projects (CIPs) with associated opinions of probable construction cost. The existing system and the short-term 5-year and 20-year planning periods are evaluated under a range of demand conditions with the model to determine the hydraulic capability of the distribution system with respect to pumping, pressure, water supply, storage, fire flow, and water age. Results from the model evaluations and other analyses are compared with industry standard levels of service and with input from City staff to develop capital improvements. Long-term water demand projections are prepared to identify supply needs of a 50-year planning period to initiate a long-term water supply plan. The 50-year planning period and associated demand projection is not evaluated in the model.

1.2 Scope

The scope of this project includes the following items:

1. Model Update:
    a. Review the current water system geodatabase for the hydraulic model update.
    b. Update the model with water mains greater than or equal to four inches in diameter and any smaller water mains required for system connectivity and topography.
    c. Geocode annual average water demand from a recent year that is representative of current meter demographics from the customer billing system data.
    d. Validate model boundary conditions and current operational controls.
2. Field testing and model calibration confirmation:
    a. Data collection at pump stations, ground and elevated storage tanks, and other monitoring points in the distribution system from SCADA system.
    b. Fire hydrant testing.
    c. Deploy data loggers for pressure recording in the distribution system.

   d. Conduct sites visits at distribution system facilities to review operational control and layout relevant to model calibration efforts.
   e. Debug the model update and create a working model of the existing water distribution system with operational controls boundaries.
   f. Prepare calibration tables comparing measured field test data with model results for each fire hydrant test, the pressure at data logger locations, and associated SCADA points.
3. Level of service:
   a. Coordinate with City to select the following criteria based on industry best practices, mid-tier goals, and minimum acceptable performance:
      i. Storage needs and contractual requirements.
      ii. Pumping capacity.
      iii. Velocity and headloss for transmission and distribution.
      iv. Maximum and minimum pressure for normal service conditions.
      v. Fire flow requirement.
4. Diurnal analysis:
   a. Determine peak hour, minimum hour, and equalization storage factors.
   b. Prepare distribution system diurnal patterns for each pressure zone.
   c. Prepare a representative 24-hour diurnal pattern for each pressure zone and integrate it into the model.
5. Demand projections:
   a. Review historical water usage and billed consumption by customer class.
   b. Project meters by customer class and prepare demand projection for the 5-year (year 2025) and 20-year (year 2040) planning periods.
   c. Determine demand allowance for large new water-use customers and timing.
   d. Review opportunities for efficiencies of service with neighboring service providers which could affect water demand projections.
6. Supply planning:
   a. Prepare range of demand projections for the 50-year planning period and identify timing and amount of supply deficiencies.
   b. Review opportunities for efficiencies of service with neighboring providers which could affect supply needs including emergency service opportunities.
   c. Develop a supply plan with escalations in advance of projected deficiencies.
   d. Develop recommendations for supply projects to address projected deficiencies and water quality compatibility needs.
7. Distribution system master planning:
   a. Identify growth areas and associated schedule for the 5-year and 20- year planning periods.

    b. Use future growth mapping, including redevelopment areas, from City's comprehensive plan to spatially allocate both meter and associated demand projections for the 5-year and 20-year planning periods.
8. Distribution system modelling:
    a. Evaluate existing distribution system hydraulics for strengths and weaknesses based on level of service criteria in an extended period simulation (EPS) for the maximum day demand. Evaluate water age in the distribution system and residence time in elevated storage.
    b. Evaluate the 5-year and 20-year distribution system hydraulics for strengths and weaknesses based on the level of service criteria in an EPS for the maximum day demand. Identify capital improvement projects for transmission and distribution system capacity (linear), storage, and pumping.
    c. Evaluate the capacity of the existing distribution system to supply emergency interconnect locations with neighboring water utilities in an EPS for the maximum day demand. Identify capital improvement projects to increase distribution system capacity to these locations.
9. Storage evaluation:
    a. Determine available storage and effective storage volumes in each pressure zone.
    b. Evaluate storage needs of the distribution system including contractual requirements and reserves for equalization, fire flow, and emergency service for the existing and projected maximum day demands for each planning period.
    c. Identify demand trigger to supplement a storage deficit with sizing recommendations for additional storage in each planning period.
10. Capital improvement plan:
    a. Develop planning-level unit-costs for linear distribution system improvements.
    b. Prepare project cost components for engineering, and contingency.
    c. Prepare opinions of probable construction cost for recommended capital improvement projects including linear distribution, storage, and pumping.
    d. Prepare opinions of probable construction cost for recommended capital improvements to the supply system.
    e. Identify implementation trigger(s) recommended improvements categorized as:
        i. Distribution: hydraulic, development, fire flow, small mains, operational, and redundancy/resiliency.
        ii. Supply: supply-demand and water quality.
    f. Prepare a comprehensive prioritized listing of all capital improvement projects by planning period.
    g. Integrate other projects identified by the City in the capital improvements plan; associated reports, project scheduling, and costs provided by City.

2.0 Existing Distribution System

The City purchases wholesale water from KC Water and the City of Independence, Missouri from multiple locations forming a supply system that conveys water to two pressure zones, hereinafter called the North zone and the South zone, and is illustrated in Figure 2-1. The supply system for the North zone includes direct service to the distribution system through Lakewood meter vault (KC Water) and indirect service through Velie and Maybrook meter vaults (both Independence) that converge at Bowlin ground storage tank and pump station. The supply system for the South zone includes indirect service to the distribution system through Velie and Gregory (KC Water) meter vaults and each converging at High Service ground storage tank and pump station. The supply system for the South Zone also includes indirect service through the Jackson-Cass transmission main system at South Terminal (KC Water) ground storage tank and pump station. A process schematic of distribution system facilities is illustrated in Figure 2-2.

2.1 North Zone

The North zone includes the distribution system generally bound by NE Anderson Dr on the north side (or south of Little Blue River), City limits bordering Blue Springs Lake and Lake Jacomo (north of NE Woods Chapel Rd) on the east side, 83rd St on the south side, and Lee's Summit Rd on the west side. Elevation in the North zone ranges from 760 ft to 980 ft. KC Water supplies the North zone via Lakewood meter vault and Independence supplies the North zone via Maybrook meter vault which supplies booster pumping at Bowlin pump station and from Velie meter vault which is only relied upon seasonally to fill Bowlin ground storage from which Bowlin high service pumping draws from. The North zone distribution system and associated facilities is illustrated in Figure 2-3.

2.1.1 Maybrook Meter Vault

Independence provides direct and indirect service to the North zone through Maybrook meter vault via Bowlin Pump Station. Maybrook meter vault is located northeast of the intersection of NE Maybrook Rd and NE Misty Meadow Dr, near the southwest corner of Voy Spears Jr Elementary School. A 16-inch diameter transmission main from the meter vault runs approximately 1.3 miles to Bowlin pump station and supplies booster pump No.'s 1 and 2. During low seasonal demands booster pumping is not required in the North zone and the bypass line is opened in Bowlin pump station.

2.1.2 Bowlin Pump Station

Bowlin pump station includes three pumps supplied by water from Independence. Pump No.'s 1 and 2 are supplied from the Maybrook meter vault and boost pressure into the North zone. Pump No. 3 draws suction from Bowlin tank and pumps into the North zone. All pumps have a variable frequency drive (VFD) and are used extensively in the current control scheme

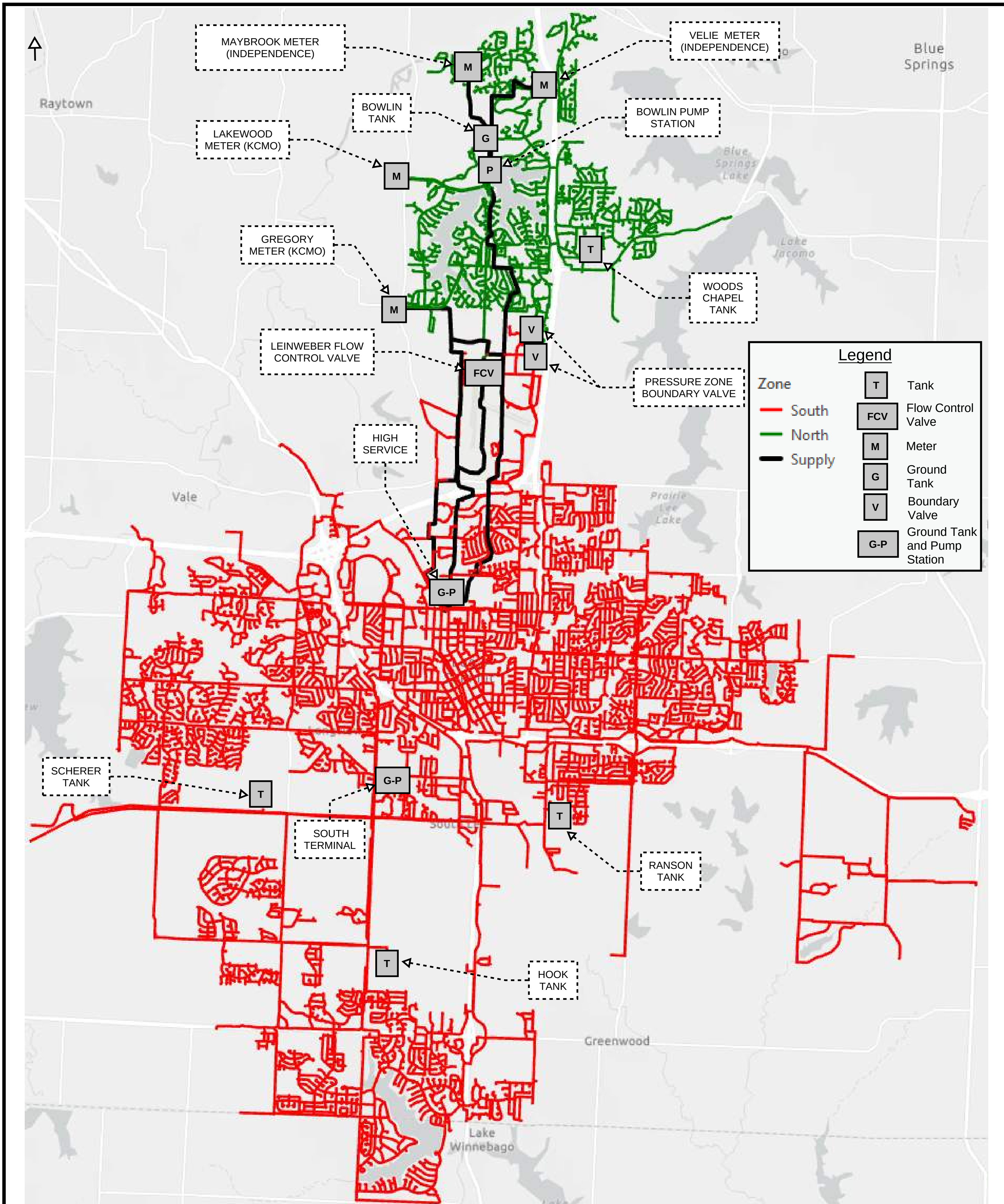

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FIGURE 2-1

SUPPLY & DISTRIBUTION SYSTEMS

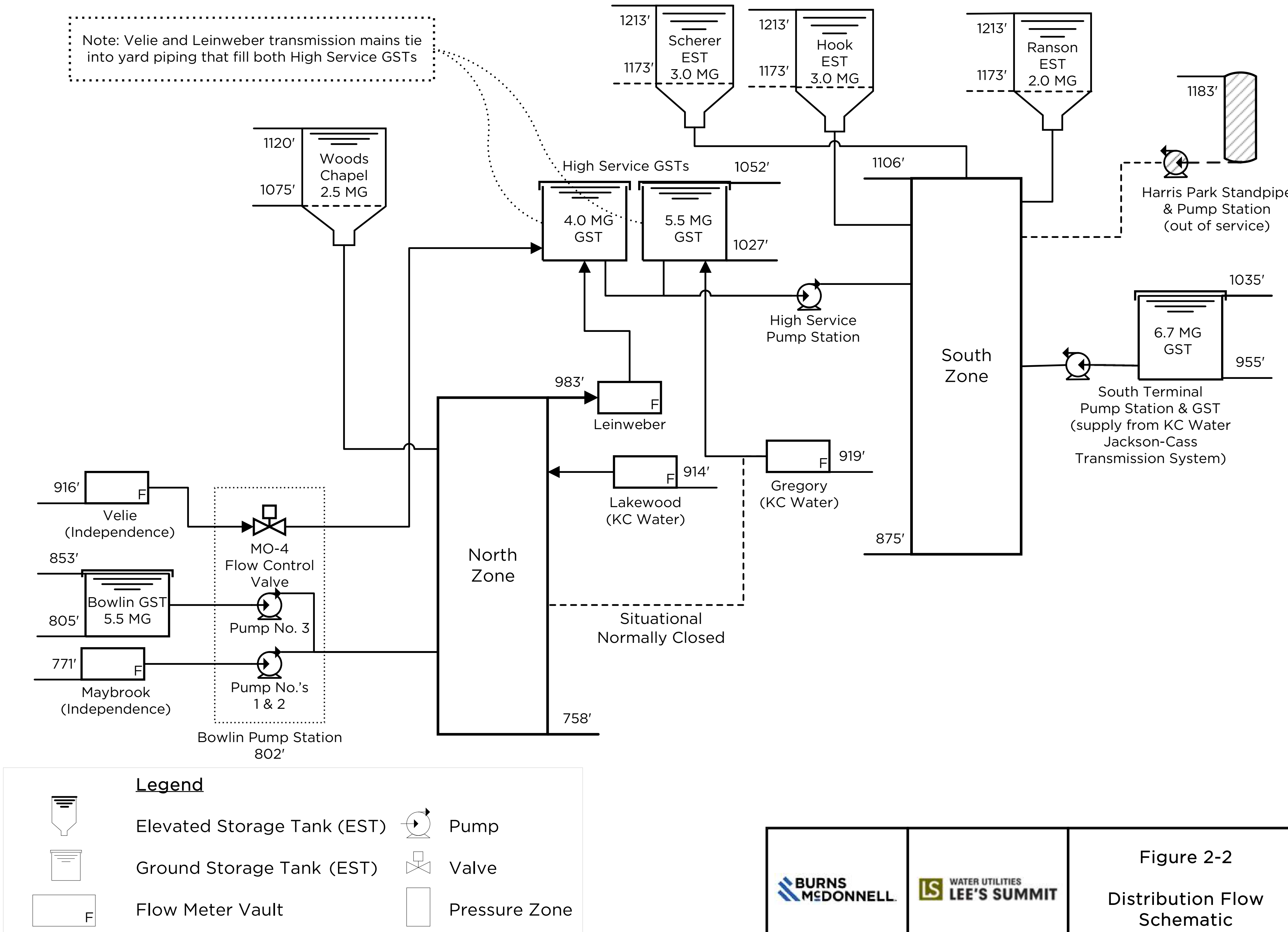

Figure 2-2

Distribution Flow Schematic

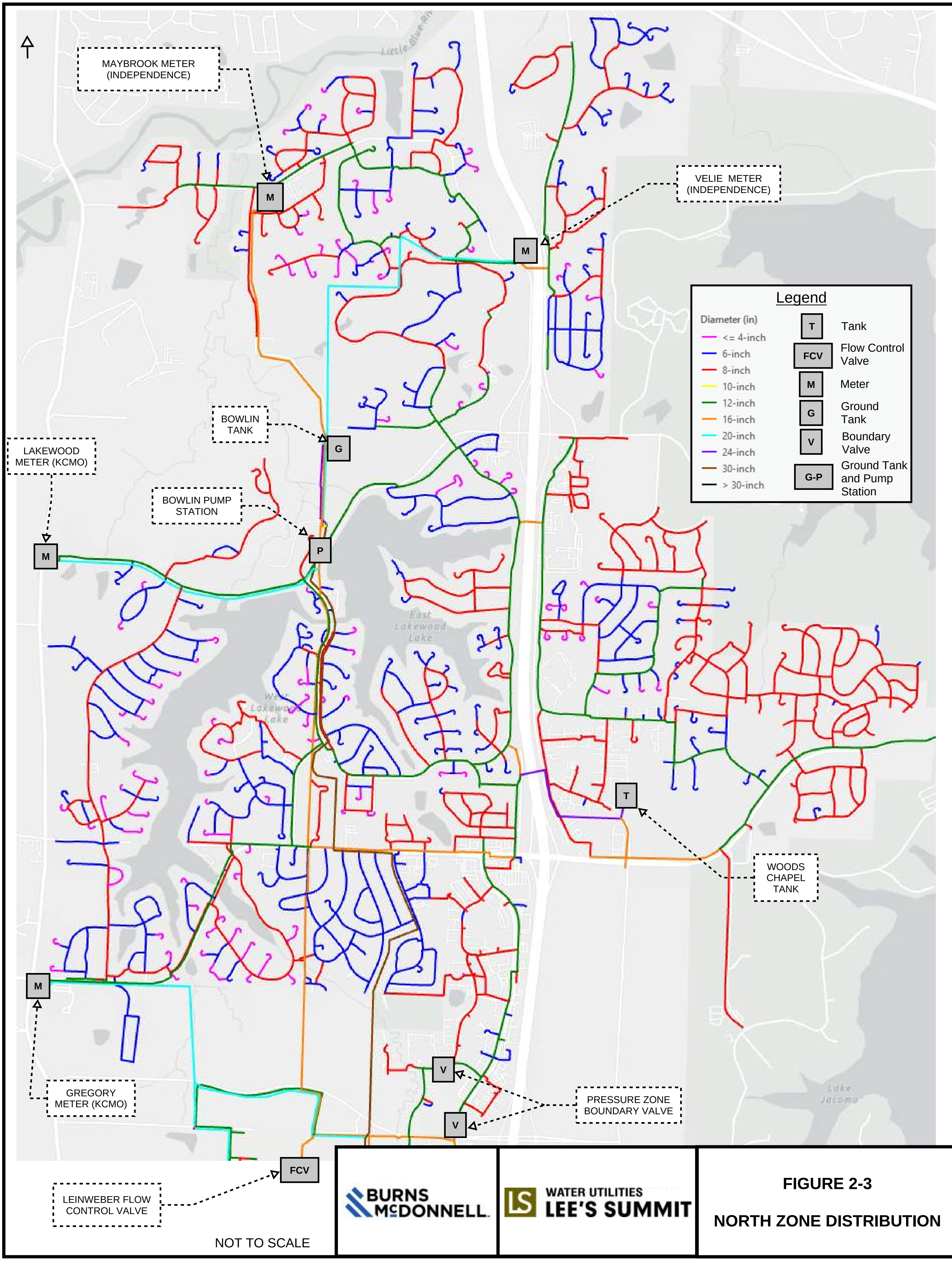

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FIGURE 2-3

NORTH ZONE DISTRIBUTION

which governs supply from the Lakewood meter vault. A description of this control scheme provided by City staff and implemented in April 2022 is included in Appendix A. Pump details are summarized in Table 2-1 below.

Table 2-1: Bowlin Pump Data

Pump No.	Manufacturer	Motor Size (Hp)	Speed (rpm)	Head (ft)	Flow (gpm)	Flow (MGD)
1	Peerless	60	1,760	55	2,800	4.0
2	Peerless	60	1,760	55	2,800	4.0
3	Peerless	500	1,775	330	4,500	6.5

A variety operating conditions are available to operators depending on system demand and contractual wholesale purchase requirements from Independence and are listed below:

- Operating Conditions:
  - Direct service through Maybrook meter vault via flow control valve in the bypass line of Pump No.'s 1 and 2 (pumps off).
  - Pump No.'s 1 and 2 simultaneously.
  - Pump No. 3 only.
- Contractual Wholesale Capacity Requirements:
  - 2.5 MGD daily average through Maybrook meter vault.
  - 5.0 MGD daily average through Velie meter vault.
  - 7.5 MGD total daily average.

Bowlin tank is filled by opening an altitude valve connected to the Velie meter vault supply. Downstream of the altitude valve and tank, Velie meter vault supply is conveyed through the pump station where a flow control valve is used to fill High Service tanks which supply the South zone. For clarity, Bowlin tank is not used to fill High Service tanks and is only used seasonally during summer months when system demand is higher than the annual average. Tank details are summarized in Table 2-2 below.

Table 2-2: Bowlin Tank Data

Type	Grade Reference	Volume (MG)	Head Range (ft)	Overflow EL (ft)	Base EL (ft)
Ground	Above	5.5	48	853	805

2.1.3 Lakewood Meter Vault

KC Water provides direct service to the North zone through the Lakewood meter vault located near the intersection of NW Lee's Summit Rd and NW Lakewood Blvd. Pressure is measured upstream and downstream of the flow control valve in the meter vault to supplement the supply from Bowlin pump station and maintain a range of elevated storage levels in Woods Chapel tank. The control valve modulates and supplies water to the North zone after both booster Pump No.'s 1 and 2 are at full speed and Woods Chapel tank levels continue falling. The City's automated control scheme is documented in Appendix A. A 20-inch diameter pipe from KC Water supplies the meter vault and a 20-inch pipe exits the meter vault and ties into the North zone distribution system. Contractual supply terms at Lakewood meter vault are 4.5 MGD at 80 psi and up to 5.4 MGD instantaneous as indicated in the Water Purchase Agreement dated May 2002, however City staff has indicated the larger supply capacity now comes from Gregory meter vault and the current lower supply capacity is from Lakewood meter vault in an amount comparable to the contractual capacity at Gregory of 1.5 MGD.

2.1.4 Woods Chapel Tank

Woods Chapel tank is a composite elevated tank and floats on system pressure in the North zone located just east of the intersection of NE Lakewood Way and NE Port Dr. The integrated control schemes of Bowlin pump station and the control valve at Lakewood meter vault function to maintain a relatively tight range of water levels in the Woods Chapel tank. Tank details are summarized in Table 2-3 below.

Table 2-3: Woods Chapel Tank Data

Type	Type	Volume (MG)	Head Range (ft)	Overflow EL (ft)	Base Bowl EL (ft)
Elevated	Cylindrical	2.5	45	1,120	1,075

2.2 South Zone

The South zone includes the distribution system, by in large, south of I-470 to City limits with some exception to neighboring water districts. A small area north and west of I-470 south of NE Meadowview Dr is in the South zone and isolated from the North zone with two normally closed valves near the intersection of NE Meadowview Dr and NE Akin Blvd and near the intersection of NE Strother Rd and Ralph Powell Rd. The water service area to the east is bound by Public Water Supply District 13 (PWSD13), City limits and James A Reed Memorial Wildlife Area; to the south, the water service area is bound by PWSD12, Cass County PWSD6 and Cass County PWSD13. The water service area to the west is bound by City limits that border the cities of Grandview, and Kansas City, Missouri. Elevation in the South zone ranges from 875 ft to 1,106 ft. The South zone distribution system and associated facilities are illustrated in Figure 2-4.

KC Water supplies the South zone through South Terminal tank and pump station and through Gregory meter vault which fills ground storage at High Service pump station. Independence supplies the South zone through Velie meter vault which fills ground storage at High Service pump station. The South zone can also be supplied by the North zone through Gregory meter vault valving that may require closing KC Water supply as the hydraulic gradient from the North zone is generally lower than the hydraulic gradient from KC Water. The North zone can also supply water through the Leinweber flow control valve vault and dedicated transmission to ground storage at High Service tanks.

The Harris Park facility includes ground storage and pumping but is no longer relied upon. When this facility was in service, it was used seasonally for daily peaking demands. For the purposes of this report, the level of service for storage, pumping, and pressure does not include the Harris Park facility and is recommended to permanently remove these assets from service. It is recommended that the City maintain ownership of the property if another

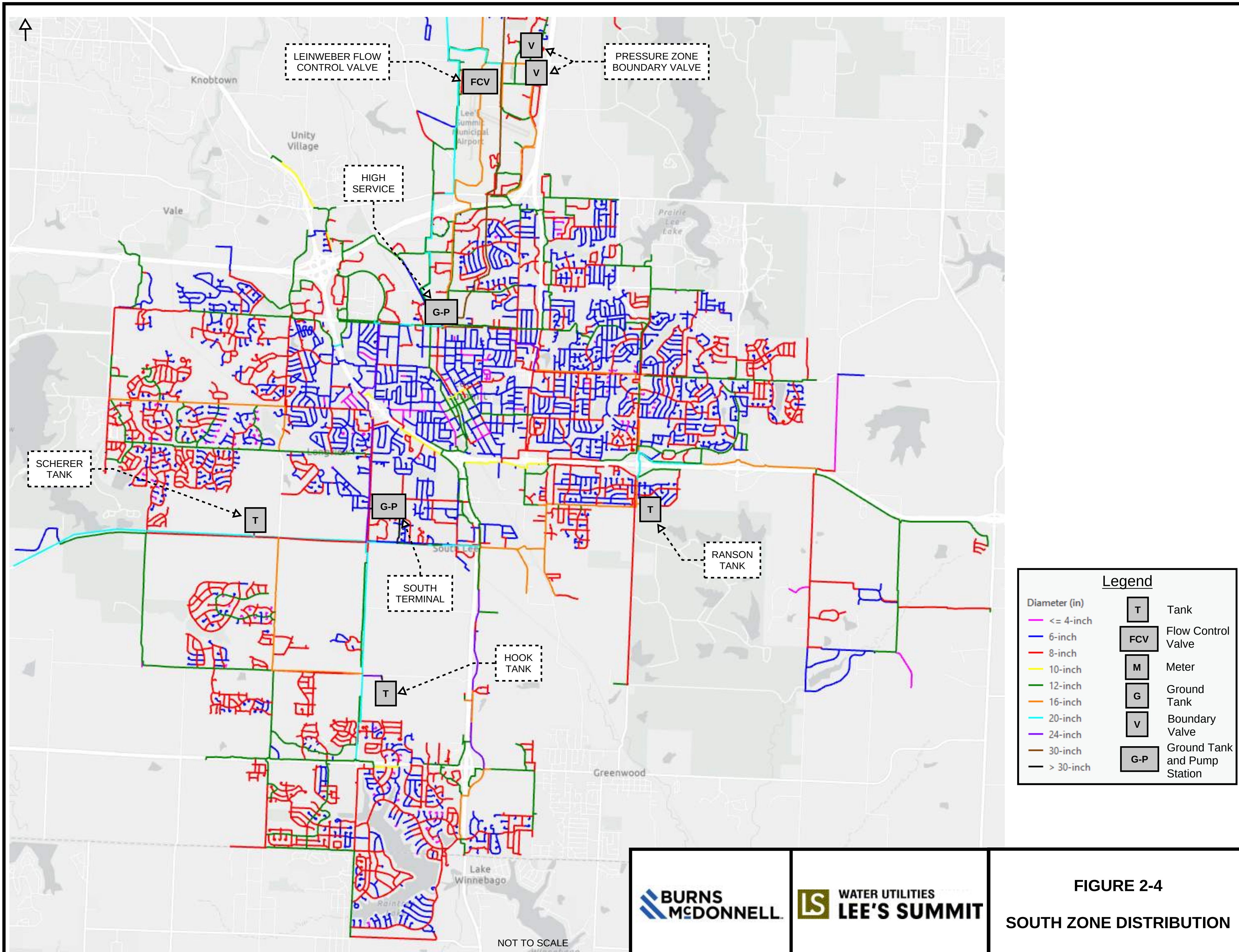

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FIGURE 2-4

SOUTH ZONE DISTRIBUTION

infrastructure investment is needed at this location to support future growth and development.

2.2.1 High Service Pump Station

High Service pump station includes four vertical turbine pumps with the same rated head and flow. These pumps draw suction from a clearwell beneath the pump station that is supplied by two ground storage tanks. Each pump has VFD capability and operates in parallel with South Terminal high service pumping; the control scheme is included in Appendix A. Pump details are summarized in Table 2.4 below.

Table 2-4: High Service Pump Data

Pump No.	Manufacturer	Motor Size (Hp)	Speed (rpm)	Head (ft)	Flow (gpm)	Flow (MGD)
1	Fairbanks	350	1,770	220	5,000	7.2
2	Fairbanks	350	1,770	220	5,000	7.2
3	Fairbanks	350	1,770	220	5,000	7.2
4	Fairbanks	350	1,770	220	5,000	7.2

Water supply from Independence through Velie meter vault, water supply from the North zone through Leinweber flow control vault, and water supply from KC Water through Gregory meter vault converge at High Service ground storage which include a below grade 4.0 MG tank and an above grade 5.5 MG tank adjacent to each other on the same site. As indicated previously, water supply from the North zone can also be conveyed to High Service ground storage through Gregory meter vault, but this is a situational condition in nature. Under normal operation throughout most of the year, the principal supply mechanism for storage at High Service is through Velie and Gregory meter vaults. Tank details are summarized in Table 2-5 below.

Table 2-5: High Service Storage Data

Type	Grade Reference	Volume (MG)	Head Range (ft)	Overflow EL (ft)	Base EL (ft)
Ground	Below	4.0	25	1,052	1,027
Ground	Above	5.5	25	1,052	1,027

2.2.2 Gregory Meter Vault

KC Water provides indirect service to the South zone through Gregory meter vault which conveys water to ground storage at High Service pump station. Gregory meter vault is located just east of the intersection of Lee's Summit Rd and NW Gregory Blvd and includes parallel 12-inch water mains from KC Water that connect in the vault then increases to 20-inch leaving the vault for approximately 4.5 miles to ground storage at High Service. Contractual supply terms at Gregory meter vault are 1.5 MGD at 79 psi and up to 1.8 MGD instantaneous. As indicated above in Section 2.1.3, Gregory meter vault currently delivers more flow consistent with what is contractually stated for Lakewood meter vault at 4.5 MGD.

2.2.3 Velie Meter Vault

Independence provides indirect service to the South zone through Velie meter vault which conveys water to ground storage at High Service pump station. Velie meter vault is located just east of the intersection of NE Velie Rd and NE Anderson Dr and includes a 20-inch water main from Independence and a 20-inch water main leaving the vault. The 20-inch water main runs 0.3 miles from the vault then increasing to 24-inch diameter for approximately 1.5 miles to Bowlin pump station; from Bowlin pump station a 30-inch transmission main runs approximately 6.0 miles to the High Service ground storage tanks. Contractual supply terms at Velie meter vault are 5.0 MGD and a take or pay structure.

2.2.4 South Terminal Pump Station

South Terminal pump station includes four vertical turbine can-style pumps with the same rated head and flow. The pumps draw suction from ground storage and have VFD capability. South Terminal pump station operates in parallel with High Service pump station; the control scheme is included in Appendix A. The pump station and ground storage tank are owned and operated by the City. KC Water has a pump station within the same building but draws suction from the Jackson-Cass transmission main, not ground storage although piping and valving is in place to do so. KC Water supplies the ground storage tank through the Jackson-Cass transmission system extending from KC Water's East Bottoms pump station; KC Water owns and operates the Jackson-Cass transmission system. Pump details are summarized in Table 2-6 below.

Table 2-6: South Terminal Pump Data

Pump No.	Manufacturer	Motor Size (Hp)	Speed (rpm)	Head (ft)	Flow (gpm)	Flow (MGD)
1	Floway	350	1,785	200	5,500	7.9
2	Floway	350	1,785	200	5,500	7.9
3	Floway	350	1,785	200	5,500	7.9
4	Floway	350	1,785	200	5,500	7.9

A 42-inch diameter connection to the Jackson-Cass transmission main fills the South Terminal ground storage tank. Discharge from the tank is conveyed through a valve vault in the yard that provides dual supply to both the City's and KC Water's pump stations, though normal operation of the tank discharge is supply to the City's pump station only. KC Water's pump station draws suction from the Jackson-Cass transmission main. The site layout and piping stub-outs are designed to implement a future low-head storage tank. Tank details are summarized in Table 2-7 below.

Table 2-7: South Terminal Tank Data

Type	Grade Reference	Volume (MG)	Head Range (ft)	Overflow EL (ft)	Base EL (ft)
Ground	Partially Buried	6.7	80	1,035	955

2.2.5 Elevated Storage

Elevated storage in the South zone includes Ranson, Hook, and Scherer tanks. All tanks float together, though the proximity of Ranson tank to the major demand center in the South zone has created an observable lead-lag condition amongst tank drafting where the hydraulic gradients in Hook and Scherer followed Ranson. The South zone control scheme was updated in late spring 2022 to provide pumping in parallel from High Service and South Terminal pump stations in lieu of a lead-lag-lag order. Additionally, a 12-inch pressure zone boundary valve was found open providing a conduit to supply water from the South zone to the North zone. The hydraulic gradient in South zone elevated storage came more in sync after the pumping control scheme was updated and the pressure zone boundary valve was closed.

Ranson tank is located just east of the intersection of SE Bailey Rd and SE Ranson Rd. Hook tank is located just east of the intersection of SW Hook Rd and SW Ward Rd. Scherer tank is located west of the intersection of SW Scherer Rd and SW Pryor Rd in front of Lee's Summit Fire Station No. 7. Tri-County Water Authority (TCWA) owns and operates a 16-inch transmission main that routes through the City passing by Ranson and Scherer tanks. Two-way emergency service connections on the inlet/outlet pipe are in place at each tank. Tank details are summarized in Table 2-8 below.

Table 2-8: South Zone Elevated Storage Data

Tank	Type	Type	Volume (MG)	Head Range (ft)	Overflow EL (ft)	Base Bowl EL (ft)
Ranson	Elevated	Cylindrical	2.0	40	1,213	1,173
Scherer	Elevated	Cylindrical	3.0	40	1,213	1,173
Hook	Elevated	Cylindrical	3.0	40	1,213	1,173

2.2.6 Emergency Connections

Emergency connections in the South zone are summarized below:

- Supply from neighboring utility to City:
  - Scherer Rd: from KC Water on 20-inch connection at western-most City limit at SW Scherer Pkwy and east of SE Raytown Rd.
  - Sampson Rd: from KC Water on the 12-inch connection located near the intersection of SW Hook Rd and SW Sampson Rd.
  - MO Hwy 150: from KC Water on 12-inch connection at western City limit on MO Hwy 150 and east of Horridge Rd.
  - TCWA: from TCWA on 8-inch connection north of Haines Rd.
  - TCWA at Ranson tank: 16-inch connection at tank site.
  - TCWA at Scherer tank: 16-inch connection at tank site.
  - Unity Village: from KC Water on the 12-inch connection near Unity Village north of NW Colbern Rd and east of NW Blue Pkwy.
  - View High Rd: from KC Water at Paragon Star.
- Supply from City to neighboring utility:
  - Cass County PWSD3: 8-inch connection at the intersection of SW County Line Rd/E 155th St/E Cass Jackson Rd and Ward Rd.

- Pleasant Hill: 12-inch connection near intersection of SE Hackamore Dr and Doc Henry Rd.
- Jackson County PWSD12 Meter A: 8-inch connection at the intersection of SE Hook Ln and SE Ranson Rd.
- Jackson County PWSD12 Meter B: 8-inch connection at the intersection of MO Hwy 150 and Doc Henry Rd.

3.0 Water Demand

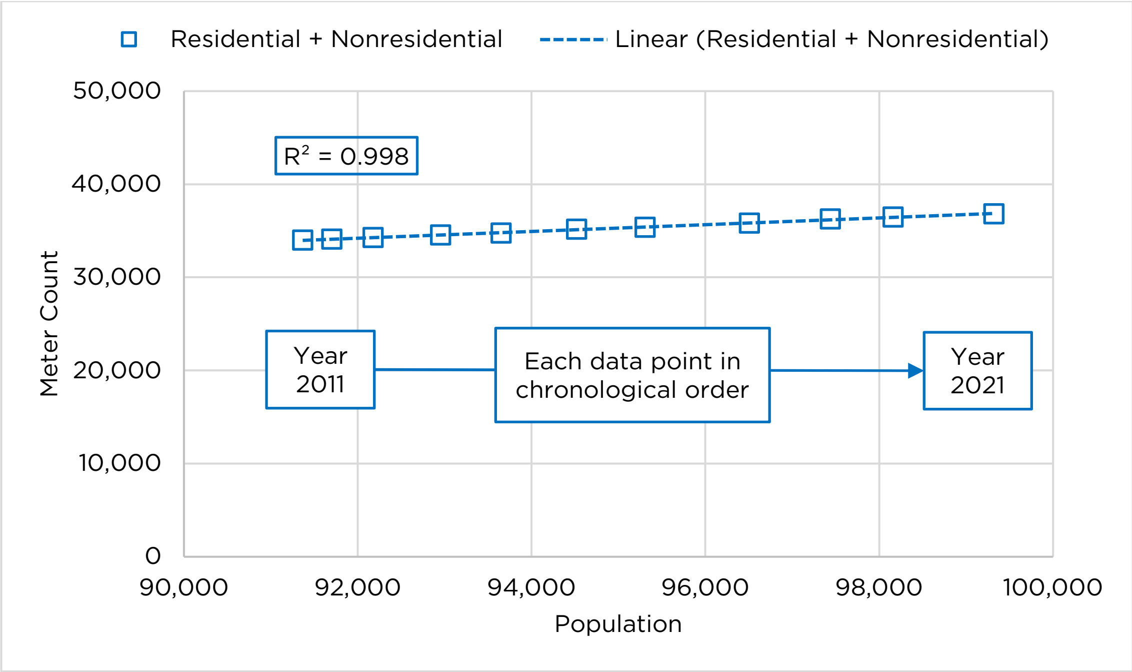
This Section summarizes the demand projections evaluated with the hydraulic model for which capital improvements and associated demand triggers are sized and implemented. The demand projection extends to the 2025 and 2040 planning periods to align with the City's recently completed Ignite Comprehensive Plan, dated 2021. The methodology projects meters by customer class and applies water usage in terms of gallons per meter day (gpmd) unique to each customer class to evaluate demand.

Recent historical trends since 2011 between meter counts and population are nearly linear; therefore, meter projections by customer class are projected in proportion to the population projection provided in the Comprehensive Plan. Customer classes are paired down to residential and nonresidential to characterize the water usage profile unique to the City. The water demand projection is calculated as the product of the meter projection and water usage profile.

3.1 Meter Count and Population Trending

The demand projection integrates the population projection indicated in the Comprehensive Plan within the meter projection. The historical relationship between meter count and population is proportional as illustrated by a nearly linear trendline. The coefficient of determination, or R^2 value, indicates how closely estimated values of the trendline reflect the data set. A high correlation, in terms of the R^2, occurs when the coefficient is at or near 1.0. The linear trendline of meter counts verse population is illustrated in Figure 3-1 and indicates a coefficient of 0.998.

Figure 3-1: Meter Demographics vs. Population



3.2 Average Day Sales

Average day sales history by customer class is listed in Table 3-1. Nonresidential is largely commercial type customers such as mixed use, civic, manufacturing/warehouses and offices but also includes larger meter sizes for higher density residential properties such as apartments, hotels, midrise mixed-use, stacked duplex, and fourplex. Residential represents typical low-density neighborhood-type housing. Since 2008 residential sales consistently range between 69 and 73 percent and average approximately 70 percent of total sales. Nonresidential sales consistently range between 27 and 31 percent and average 30 percent of total sales.

Table 3-1: Average Day Sales

Year	Average Day Sales (MGD)			Average Day Sales Percentage		
	Residential	Nonresidential	Total	Residential	Nonresidential	Total
2008	7.2	3.0	10.1	71%	29%	100%
2009	5.9	2.6	8.5	69%	31%	100%
2010	5.6	2.4	8.0	70%	30%	100%
2011	6.0	2.6	8.6	70%	30%	100%
2012	6.7	2.8	9.5	71%	29%	100%
2013	7.8	3.0	10.8	72%	28%	100%
2014	6.4	2.6	9.0	71%	29%	100%
2015	6.0	2.6	8.6	70%	30%	100%
2016	5.9	2.6	8.5	69%	31%	100%
2017	6.0	2.8	8.8	69%	31%	100%
2018	5.9	2.6	8.5	69%	31%	100%
2019	6.4	2.6	9.0	71%	29%	100%
2020	5.7	2.3	8.0	71%	29%	100%
2021	6.4	2.3	8.7	73%	27%	100%
			Average	70%	30%	100%

3.3 Meter Projection

The mix of residential and nonresidential meters is very consistent. Since 2008 the residential meters range between 92 and 93 percent and nonresidential range between 7 and 8 percent of the total; the average for each class is approximately 93 and 7 percent, respectively. Total meter counts are projected in proportion to the population projection; the residential meter projection is then weighted by the historical average of 93 percent of the total meter count and similarly, the nonresidential meter projection is weighted by the historical average of 7 percent of the total meter count. A summary of the projected meter growth rate is listed below and represented in Table 3-2:

- Total residential and nonresidential is 708 meter per year (m/yr).
- Residential
  - Approximately 641 m/yr through 2025.
  - Approximately 696 m/yr from 2025 to 2040.
  - Average is approximately 684 m/yr.
- Nonresidential
  - Approximately 92 m/yr through 2025.
  - Approximately 53 m/yr from 2025 to 2040.
  - Average is approximately 61 m/yr.

Table 3-2: Meter Projection

Year	Meters						Population
	Residential	Nonresidential	Total	Residential	Nonresidential	Total	
2008	31,037	2,500	33,537	93%	7%	100%	90,785
2009	31,248	2,561	33,809	92%	8%	100%	91,586
2010	31,275	2,508	33,783	93%	7%	100%	92,927
2011	31,452	2,540	33,992	93%	7%	100%	91,364
2012	31,554	2,558	34,112	93%	7%	100%	91,697
2013	31,723	2,565	34,288	93%	7%	100%	92,172
2014	32,140	2,398	34,538	93%	7%	100%	92,949
2015	32,374	2,400	34,774	93%	7%	100%	93,646
2016	32,733	2,427	35,160	93%	7%	100%	94,515
2017	33,026	2,353	35,379	93%	7%	100%	95,302
2018	33,368	2,448	35,816	93%	7%	100%	96,504
2019	33,804	2,476	36,280	93%	7%	100%	97,433
2020	33,980	2,492	36,472	93%	7%	100%	98,155
2021	34,300	2,507	36,807	93%	7%	100%	99,316
2021	35,167	2,524	37,691				100,300
2025	37,732	2,890	40,622	93%	7%	100%	108,100
2040	48,168	3,690	51,858				138,000

3.4 Water Usage and Nonrevenue Water

Water usage in terms of gallon per meter day (gpmd) includes nonrevenue water by bridging historical meter count and the average day demand which is based on average day sales. For the purposes of this demand projection, the difference between average day demand and average day sales represents nonrevenue water. The total average day demand is the total wholesale purchase amounts from KC Water and Independence. Average day demand for residential and nonresidential customers is determined by multiplying the historical average day sales by 70 and 30 percent, respectively, to reflect the historical consistency indicated in Table 3-1. Average day demand by customer class and historical nonrevenue water is listed in Table 3-3.

Table 3-3: Average Day Demand by Customer Class

Year	Average Day Sales (MGD)			Average Day Demand (MGD)			Nonrevenue Water
	Residential	Nonresidential	Total	Residential	Nonresidential	Total	
2008	7.2	3.0	10.1	7.5	3.1	10.7	5%
2009	5.9	2.6	8.5	6.6	3.0	9.5	10%
2010	5.6	2.4	8.0	6.3	2.7	9.0	10%
2011	6.0	2.6	8.6	6.8	2.9	9.7	11%
2012	6.7	2.8	9.5	8.2	3.4	11.6	19%
2013	7.8	3.0	10.8	7.8	3.0	10.8	0%
2014	6.4	2.6	9.0	7.4	3.0	10.4	13%
2015	6.0	2.6	8.6	6.4	2.8	9.2	7%
2016	5.9	2.6	8.5	7.0	3.1	10.2	16%
2017	6.0	2.8	8.8	6.8	3.1	10.0	12%
2018	5.9	2.6	8.5	6.9	3.1	9.9	14%
2019	6.4	2.6	9.0	6.9	2.8	9.7	7%
2020	5.7	2.3	8.0	7.5	3.1	10.6	24%
2021	6.4	2.3	8.7	7.4	2.7	10.1	14%

Water usage by customer class is the average day demand, which includes nonrevenue water, is divided by meter count to get gpmd. Historical water usage is listed in Table 3-4 and ranges between 198 and 260 gpmd for residential and between 1,075 and 1,325 gpmd for nonresidential. The average water usage for residential and nonresidential since 2008 is 220 gpmd and 1,200 gpmd, respectively. The 10-year average water usage for residential and nonresidential since 2012 is higher at 221 and 1,218 gpmd, respectively, and is used in the demand projection.

Table 3-4: Water Usage by Customer Class

Year	Average Day Demand (MGD)		Meter Count		Water Usage (gpmd)	
	Residential	Nonresidential	Residential	Nonresidential	Residential	Nonresidential
2008	7.5	3.1	31,037	2,500	243	1,252
2009	6.6	3.0	31,248	2,561	211	1,154
2010	6.3	2.7	31,275	2,508	200	1,075
2011	6.8	2.9	31,452	2,540	215	1,137
2012	8.2	3.4	31,554	2,558	260	1,325
2013	7.8	3.0	31,723	2,565	246	1,165
2014	7.4	3.0	32,140	2,398	231	1,238
2015	6.4	2.8	32,374	2,400	198	1,171
2016	7.0	3.1	32,733	2,427	215	1,279
2017	6.8	3.1	33,026	2,353	207	1,323
2018	6.9	3.1	33,368	2,448	206	1,249
2019	6.9	2.8	33,804	2,476	204	1,115
2020	7.5	3.1	33,980	2,492	222	1,234
2021	7.4	2.7	34,300	2,507	217	1,078
			2012-2021 (10-yr) Average		221	1,218

Peak water usage occurred in 2012 at 260 gpmd and 1,325 gpmd for residential and nonresidential respectively and represents the most recent dry year within the data set. A conservative approach to projecting demand includes a dry-year adder as dry-periods will eventually occur in the future. However, after review with City staff regarding the population projection in the Comprehensive Plan, from which the meter projections are proportional to, a consensus was reached that the population growth rate of approximately 27 percent by 2040 is adequately conservative and, in combination with a conservative maximum day demand ratio, as detailed in the following paragraph, a dry year adder is not required in the demand projection.

3.5 Demand Projection

The average day demand projection is based on the meter projection and water usage for residential and nonresidential customer classes, and large user opportunity. The maximum day demand projection applies a maximum day to average day demand ratio of 2.20 which is the recent peak ratio experienced 2019 and is listed in Table 3-5. This is a conservative approach considering the frequency at which the ratio is greater than 2.10 and the 10-year average of 1.90.

Table 3-5: Maximum Day Demand Ratio

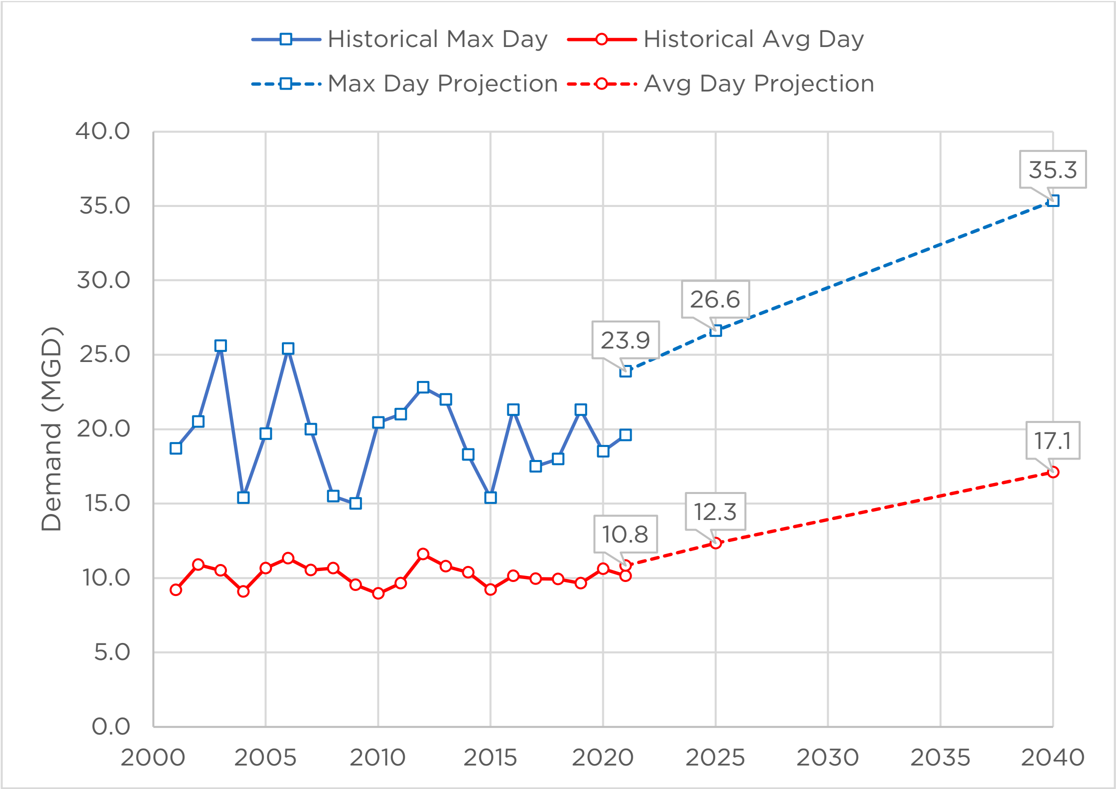
Year	Demand (MGD)		Max Day Ratio
	Avg Day	Max Day	
2008	10.7	15.5	1.45
2009	9.5	15.0	1.57
2010	9.0	20.4	2.28
2011	9.7	21.0	2.18
2012	11.6	22.8	1.97
2013	10.8	22.0	2.04
2014	10.4	18.3	1.76
2015	9.2	15.4	1.67
2016	10.2	21.3	2.10
2017	10.0	17.5	1.76
2018	9.9	18.0	1.81
2019	9.7	21.3	2.20
2020	10.6	18.5	1.74
2021	10.1	19.6	1.93
		Average	1.89
		2012-2021 (10-yr) Average	1.90
		2012-2021 (10-yr) Peak	2.20

The maximum day demand ratio is not applied to large user demand in the projection to reflect any customer type with consistent 24-hour, or derivative thereof, consumption needs. A summary of the meter projection by customer class, water usage by customer class, average day demand projection by customer class, maximum day demand ratio, and the maximum day demand projection evaluated with the hydraulic model is listed in Table 3-6 and illustrated in Figure 3-2.

Table 3-6: Demand Projection

Year	Meter Projection		Water Usage (gpmd)		Avg Day (MGD)			Max Day Ratio	Max Day (MGD)
	Residential	Nonresidential	Residential	Nonresidential	Residential	Nonresidential	Large User		
2021	35,167	2,524	221	1,218	7.8	3.1	0.0	2.20	23.9
2025	37,732	2,890			8.3	3.5	0.5		26.6
2040	48,168	3,690			10.6	4.5	2.0		35.3

Figure 3-2: Demand Projection



4.0 Water Supply Planning

The City's water supply capacity is evaluated in this section of the report. The net water needs analysis compares the current contractual supply with the long-term demand projection to determine the amount and timing for additional capacity needs. A range of long-term demand projections are based on varying growth rates consistent with the demand projection methodology presented in Section 3.0 for a 50-year planning period extending to 2071. Options to supplement supply deficits include exercising current contractual escalations, new wholesale service, and/or a combination thereof.

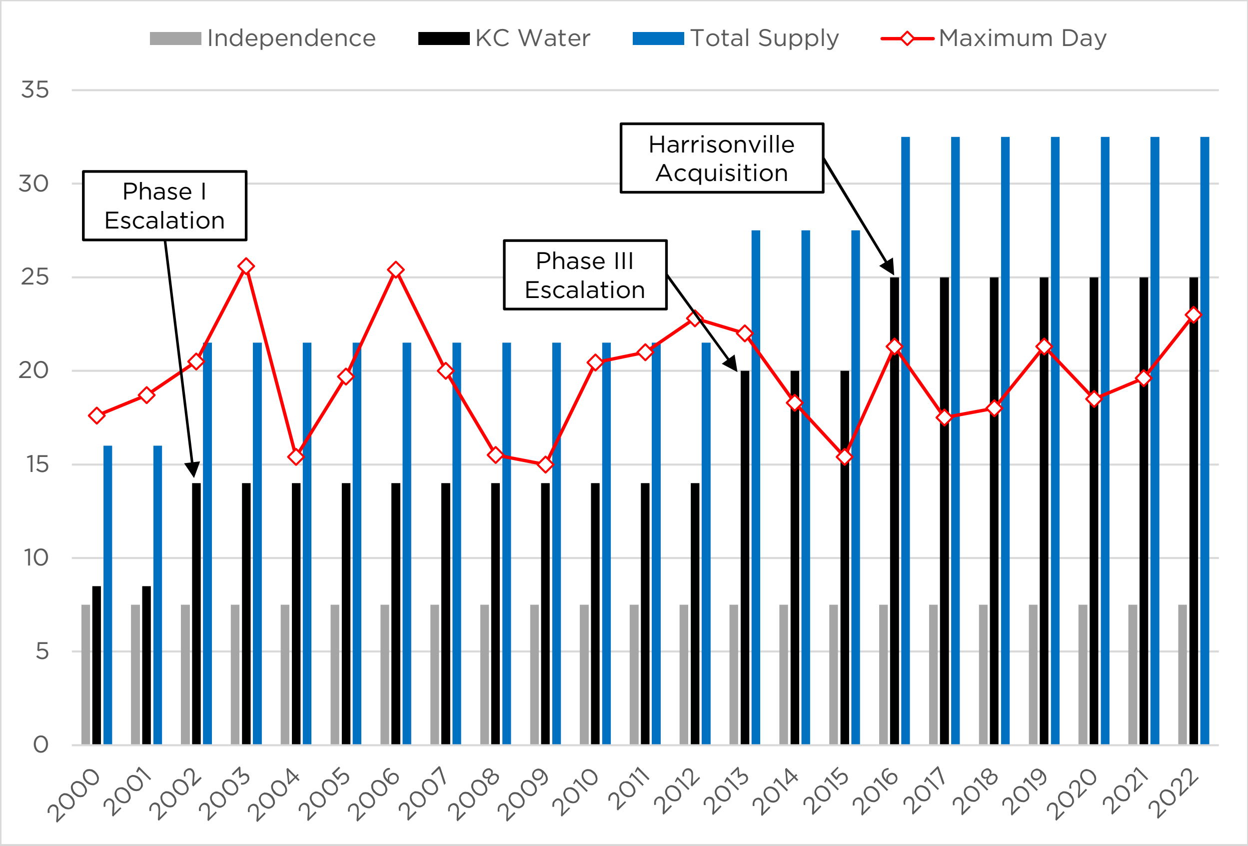
4.1 Current Contractual Capacity

The current total contractual supply capacity from Independence and KC Water is 32.5 MGD. Supply from Independence is delivered to the Maybrook and Velie meter vaults and totals 7.5 MGD. Supply from KC Water is delivered to South Terminal, Lakewood meter vault, and Gregory meter vault and totals 25.0 MGD. The supply capacity from each provider and the City's maximum day demand history is illustrated in Figure 4-1. Other contractual details associated with the supply from each source is summarized below:

- Independence:
  - Purchase no less than 50 percent of City's supply for a 20-year term beginning in 2020 and subject to the following:
    - Maximum and minimum withdrawals of 2.5 MGD and 1.7 MGD respectively at Maybrook meter vault.
    - Maximum and minimum withdrawals of 5.0 MGD and 1.5 MGD respectively at Velie meter vault.
    - Instantaneous rate of usage at 7.5 MGD through Maybrook and Velie meter vaults combined.
- KC Water:
  - In 2013 the City acquired 5.0 MGD in the Jackson-Cass transmission system at South Terminal formerly held by the City of Harrisonville, Missouri. For clarity, this is not included in the current KC Water Purchase Agreement as it was executed in 2002.
  - Deliver up to 20.0 MGD for a 33-year term beginning in 2002 and renewable for an additional 33 years up to two times:
    - 13.0 MGD at South Terminal.
    - 1.5 MGD at Gregory meter vault.
    - 1.0 MGD at Lee's Summit Rd.
    - 4.5 MGD at Lakewood meter vault.
  - City is responsible for emergency storage equivalent to the average day demand plus equalization storage equivalent to a minimum of half the average day demand.

- Provisional increase to 28.0 MGD upon completion of Phase IV Improvements detailed in the Construction Agreement referenced by the Water Purchase Agreement. This provision increases supply at South Terminal to 21.0 MGD.
- KC Water acknowledges the City's agreement with Independence and any future agreement with Tri-County Water Authority (TCWA) or Public Water Supply District No. 13 (PWSD13) of Jackson County for a maximum supply of 2.0 MGD for sole use within the boundaries of PWSD13.

Figure 4-1: Supply and Demand History (MGD)



4.2 Net Water Needs Analysis

A range of long term 50-year demand projections are based on varying growth rates consistent with the demand projection methodology presented in Section 3.0 to the year 2071. The short-term 20-year demand projection by which the distribution system capacity is evaluated is maintained in the long-term projection. The range of long-term projections pivot from the end of the short-term projection in 2040 and extend to 2071. Low, moderate, and high long-term projections reflect varying growth rates. The low projection reflects the meter installation growth rate from 2010 to 2020 at approximately 282 m/yr. The high projection is based on the representative meter installation growth rate relative to the population projection in the Comprehensive Plan at approximately 708 m/yr. The moderate projection is an average of the low and high demand projection in year 2071.

The low, moderate, and high maximum day long term demand projections are 40.9 MGD, 45.2 MGD, and 49.4 MGD respectively and are illustrated in Figure 4-2 with the total contractual supply capacity. The net water needs analysis details the current contractual supply deficit and timing for each long-term demand projection. The deficit occurs within the 20-yr demand projection and escalates relative to the growth rates for each long-term demand projection. Results of the net water needs analysis are listed in Table 4-1 are based on low, moderate, and high growth scenarios and associated demand projections and reflect the total current contractual supply capacity of 32.5 MGD from KC Water and Independence; it does not include provisional supply escalations associated with the KC Water Agreement. These provisions are evaluated in the Water Supply Planning section of this chapter.

Figure 4-2: Long-Term Demand Projections (MGD)

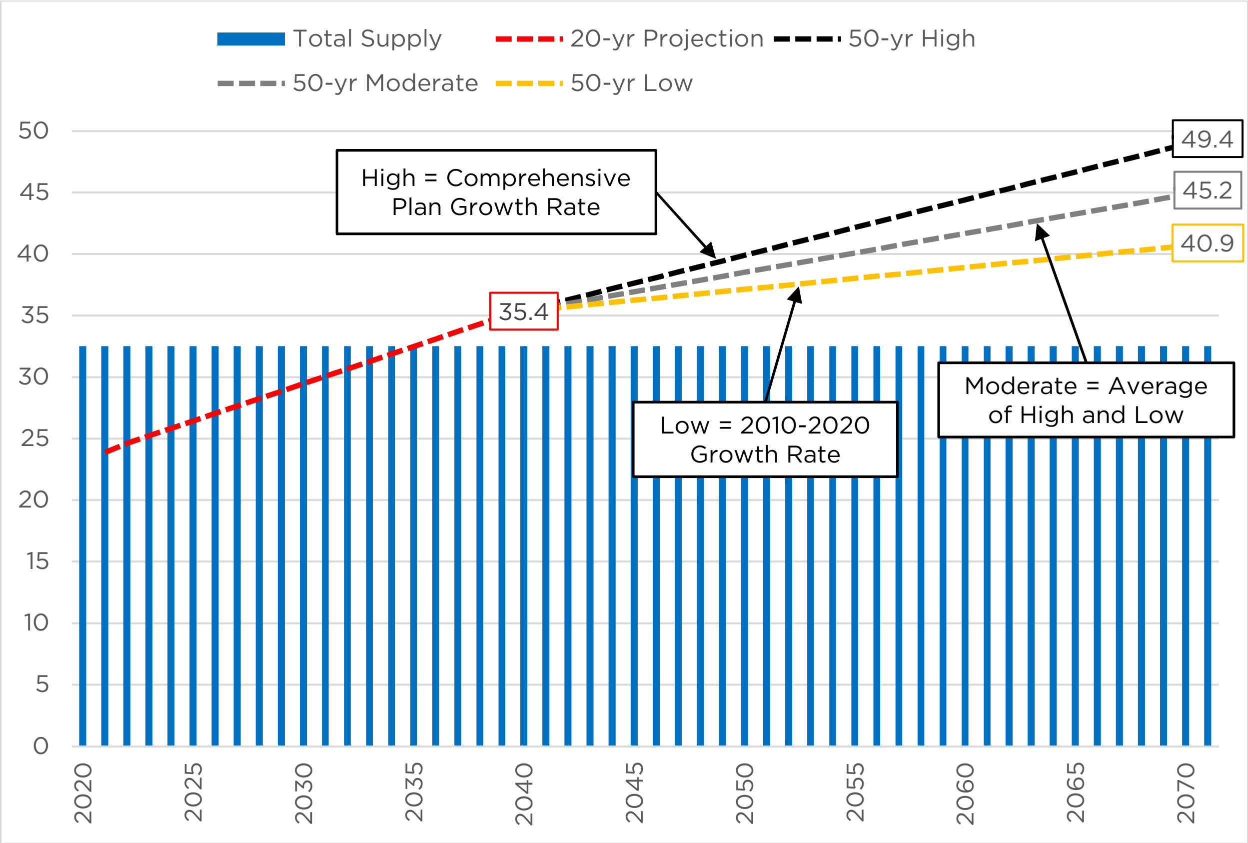


Table 4-1: Net Water Needs Analysis (MGD)

Year	Low Projection			Moderate Projection			High Projection		
	Max Day	Supply	Deficit	Max Day	Supply	Deficit	Max Day	Supply	Deficit
2035	32.5	32.5	0.0	32.5	32.5	0.0	32.5	32.5	0.0
2040	35.4	32.5	2.9	35.4	32.5	2.9	35.4	32.5	2.9
2071	40.9	32.5	8.4	45.2	32.5	12.7	49.4	32.5	16.9

4.3 Water Supply Planning and Cost Development

Water supply planning for the moderate projection maximum day demand of 45.2 MGD is selected by the City and includes options to supplement supply deficits by exercising contractual supply escalations with KC Water, increasing supply from KC Water and/or

Independence, new wholesale service, and/or any combination thereof. Though there are many combinations available and in varying amounts with varying contractual effects, City staff identified the conditions and associated priority listed below to develop supply options for the purposes of this Water Master Plan. These prioritized options largely capture the range of supply options from contractual increases to a new provider.

- Higher priority: exercise Phase IV supply escalation from KC Water.
- Higher priority: maintain sole source status under KC Water agreement.
- Moderate priority: exercise TCWA or PWSD13 supply provision under KC Water agreement.
- Moderate priority: supplement deficit by increasing supply from KC Water and/or Independence.
- Low priority: supplement deficit by increasing supply from an alternative provider.

The conditions and associated priority for additional supply resulted in four options and are summarized in Table 4-2, below.

Table 4-2: Water Supply Planning Options (MGD)

Options	KC Water Agreement				Independence	New Supply		Total
	Current Capacity	KC Water Phase IV	TWA or PWSD13 Provision	Increase KC Water	Maintain Contract	Increase Independence	TWA	
1	25.0	8.0	2.0	2.7	7.5	--	--	45.2
2	25.0	8.0	--	4.7	7.5	--	--	45.2
3	25.0	8.0	--	--	7.5	4.7	--	45.2
4	25.0	8.0	--	--	7.5	--	4.7	45.2

The order-of-magnitude cost opinions prepared by Burns & McDonnell relating to costs, quantities, demand, or pricing (including, but not limited to, property costs, construction, operations or maintenance costs, and/or energy or commodity demand and pricing), are opinions based on Burns & McDonnell's experience, qualifications, judgment, and information from vendors and published sources such as Means. Burns & McDonnell has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's means and methods, unavoidable delays, construction contractor's method of pricing, demand or usage, population demographics, market conditions, changes in technology, government regulations and laws, and other economic or political factors affecting such opinions. The City of Lee's Summit, Missouri acknowledges that actual results may vary significantly from the representations and opinions herein, and nothing herein shall be construed as a guarantee or warranty of conclusions, results, or cost opinions. Burns & McDonnell makes no guarantee or warranty (actual or implied) that actual rates, demand, pricing, costs, performance, schedules, quantities, technology, and related items will not vary from the opinions contained in the estimates, projections, results, or other statements or opinions prepared by Burns & McDonnell. The construction cost index for Kansas City in November 2022 is 13293.26.

Unit cost information for linear capital improvements is based on recent water main projects in the Kansas City metropolitan area. Unit costs for 8-inch through 20-inch diameter water mains are PVC (AWWA C900) and 30-inch is ductile iron pipe and do not include rock removal. Typical water main construction items used in the unit cost development are detailed in Table 4-3, below.

Table 4-3: Water Main Construction Items

Basic Water Main Components	Pavement Replacement	Miscellaneous	Other Potential Items (where applicable)
Pipe	Pavement Repair	Service Connects	Vaults
Valves	Curb and Gutter	Service Lines	Boring
Fittings	Driveway	Pressure Testing	Casing Pipe
Fire Hydrants	Traffic Control	Disinfection	Directional Drilling
Excavation	Demolition	Seeding	Tree Removal
Blow Off Assemblies	Haul Off	Erosion Control	
		Site Restoration	

Capital improvements include contingency at 20 percent of the construction cost and engineering at 15 percent of the subtotal cost for construction and contingency. The total opinion of probable construction cost for each capital improvement project is in today's dollars and includes construction, contingency, and engineering. Please note that cost opinions can increase for individual linear improvements, or portions thereof in terms of length, if rock excavation is required which can be highly variable.

4.3.1 Option 1

Option 1 for long term water supply planning includes implementing Phase IV of the KC Water Agreement for 8.0 MGD at South Terminal by 2035 or as the total system demand approaches 32.5 MGD. Implementing Phase IV requires a 72-inch transmission main between the Missouri River Tunnel Upshaft and East Bottoms pump station in the KC Water distribution system and, as indicated in the agreement terms, Lee's Summit is responsible for 40 percent of the design and construction cost. A minimum 24-hour storage volume of approximately 8.0 MG is recommended for the additional 8.0 MGD capacity at South Terminal and exceeds the storage requirements of the KC Water Agreement. The remaining timeline for supply increases and associated improvements is summarized below and shown in Figures 4-3 and 4-4 respectively:

- By 2056, or as the total system demand approaches 40.5 MGD, exercise the supply provision of 2.0 MGD in the KC Water Agreement with either TWA or PWSD13.
    - Implement a 2.0 MGD wholesale connection (meter vault) near the intersection of NE Colbern Rd and NE Blackwell Rd and tie into the dedicated 30-inch supply main (Velie) just south of the municipal airport that fills the ground storage tanks at High Service pump station.
- By 2062, or as the total system demand approaches 42.5 MGD, implement a 2.7 MGD wholesale connection (meter vault) with KC Water near the existing Gregory meter vault and tie into the 20-inch transfer line to the Leinweber supply main. The current control mode for the Leinweber supply system is inactive and normally closed but

Options	KC Water Agreement				Independence	New Supply		Total
	Current Capacity	KC Water Phase IV	TWA or PWSD13 Provision	Increase KC Water	Maintain Contract	Increase Independence	TWA	
1	**25.0**	**8.0**	**2.0**	**2.7**	**7.5**	--	--	**45.2**
2	25.0	8.0	--	4.7	7.5	--	--	45.2
3	25.0	8.0	--	--	7.5	4.7	--	45.2
4	25.0	8.0	--	--	7.5	--	4.7	45.2

Year	Demand Trigger (MGD)	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost (OPC)
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$20,200,000
2056	40.5	S1-L1, S1-MV1,	2.0	42.5	$ 4,975,000
2062	42.5	S1-L2, S1-MV2	2.7	45.2	$ 1,865,000
Total[1]					$ 27,040,000

Notes:
1. OPC includes $10,900,000 for low head storage at South Terminal and $9,300,000 represents Lee's Summit payment term of 40 percent of the design and construction for the 72-inch diameter waterline from the Missouri River Tunnel Upshaft to East Bottoms Pump Station.
2. Most recent available cost opinion for the 72-inch diameter water line prepared by Others in April 2014 (ENR CCI 10,890) and adjusted with October 2022 (ENR CC13,152.48) plus additional 30 percent contingency.

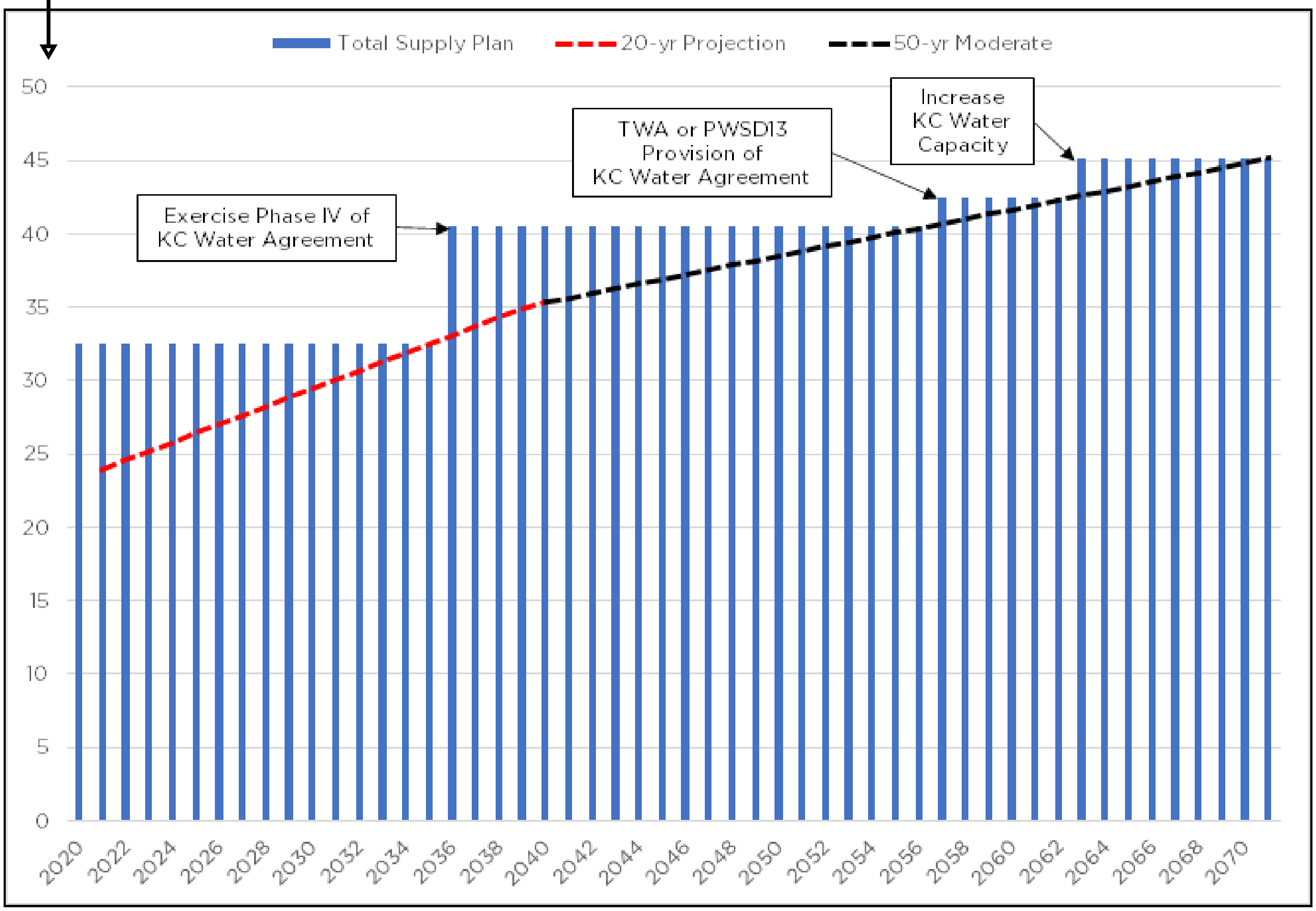


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FIGURE 4-3

OPTION 1
WATER SUPPLY PLAN

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S1-L1	Linear Supply	Dedicated transmission from new meter vault near NE Colbern Rd and NE Blackwell Rd, east along Colbern Rd, Hwy 291 crossing, along NE Missouri Rd and tie into existing 30-inch Velie supply transmission	17,000	16	$ 3,230,000	$ 646,000	$ 581,000	$ 4,699,000
S1-MV1	Service Connection	Meter vault near intersection of NE Colbern Rd and NE Blackwell Rd	NA	NA	$ 200,000	$ 40,000	$ 36,000	$ 276,000
S1-L2	Linear Supply	Dedicated transmission from new meter vault near Gregory meter vault (intersection of NW Gregory Rd and Lee's Summit Rd), south to NE Strother Rd, east along NE Strother and tie into existing 20-inch supply line feeding Leinweber valve vault	4,800	20	$ 1,152,000	$ 230,000	$ 207,000	$ 1,589,000
S1-MV2	Service Connection	Meter vault near existing Gregory meter vault	NA	NA	$ 200,000	$ 40,000	$ 36,000	$ 276,000

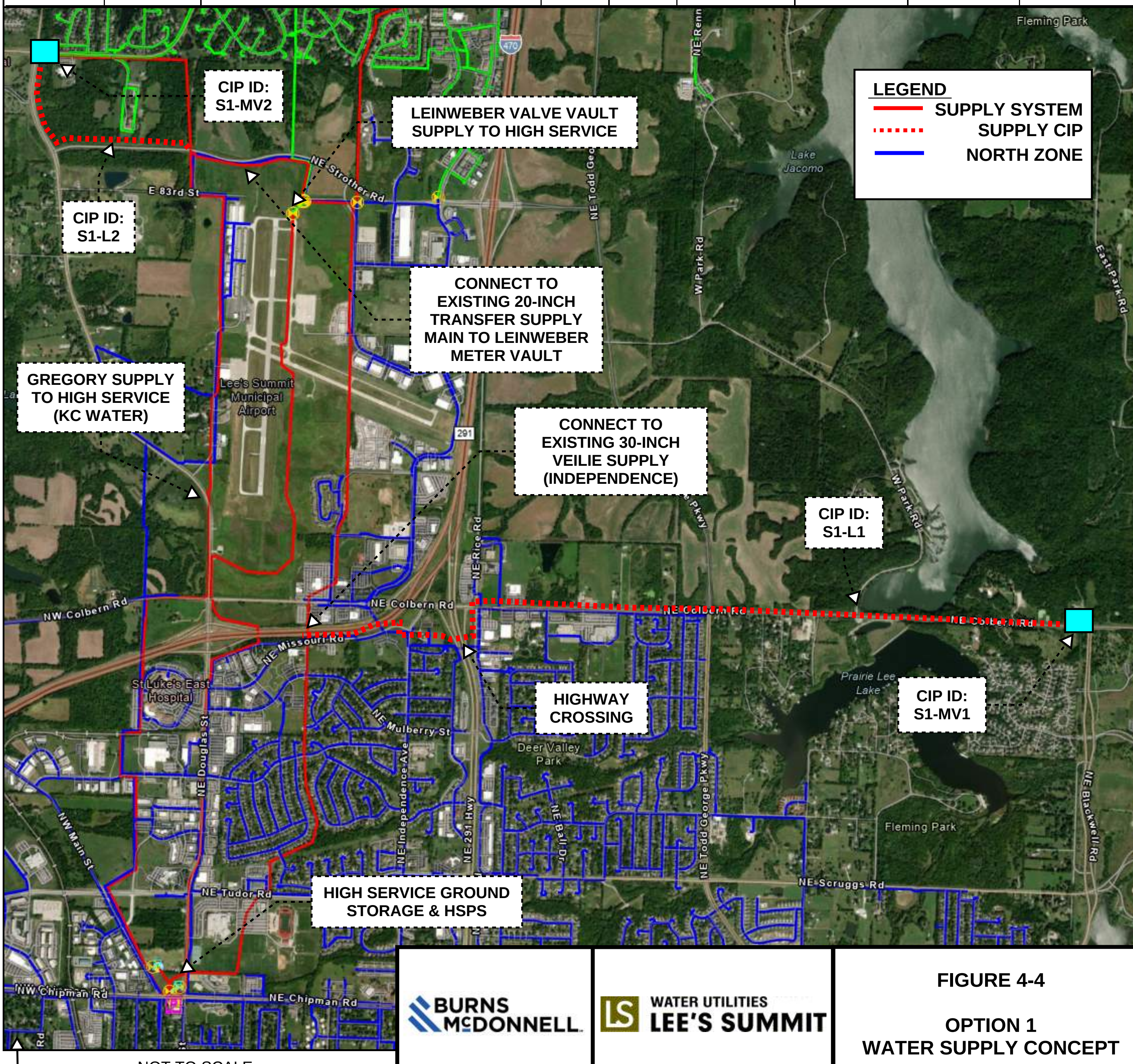

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FIGURE 4-4

OPTION 1
WATER SUPPLY CONCEPT

should be maintained with this option. The Leinweber supply system provides the ability to convey water from the North zone through the Leinweber control valve and into ground storage at High Service pump station.

4.3.2 Option 2

Option 2 for long term water supply planning includes implementing Phase IV of the KC Water Agreement for 8.0 MGD at South Terminal by 2035, or as the total system demand approaches 32.5 MGD. This also includes the Phase IV associated improvements detailed in Option 1 above with respect to the 72-inch transmission main in KC Water's system and additional City storage at South Terminal. Option 2 has two alternatives where only one would be selected if the City proceeds with this option. The remaining timeline for supply increases and associated improvements with Alternative A1 and Alternative A2 is summarized below and shown in Figures 4-5, 4-6, and 4-7 respectively:

- Alternative A1:
  - By 2056, or as the total system demand approaches 40.5 MGD, implement a 5.0 MGD wholesale connection with KC Water (meter vault) expandable to 10.0 MGD near the Highway 150 elevated tank (a KC Water facility) with a 5.0 MGD pump station (also expandable to 10.0 MGD) for direct pumping and distribution into the South zone. For clarity, the 5.0 MGD wholesale connection and pump station are rounded up from 4.7 MGD.
  - The 5.0 MGD capacity expansion of these facilities should be considered if the City desires a higher degree of supply resiliency from KC Water by transferring some portion of the capacity burden on the Jackson-Cass transmission system to this location. This alternative removes the single-point of failure status currently fixed with the Jackson-Cass transmission system, but also has South zone demand limitations for level of service criteria up to 10.0 MGD. For perspective, the South zone average and maximum day demand projections in 2040 are approximately 13.0 and 30.6 MGD.
    - For clarity, if both the City and KC Water determine this project is mutually beneficial, these improvements could be implemented any time before the demand trigger is projected to occur in 2056.
    - Providing wholesale service at this location before the demand trigger may extend the time needed to implement the Phase IV improvements (72-inch transmission). Additionally, the Highway 150 elevated tank is routinely taken out of service to maintain water quality in the South Booster Booster service level due to inadequate turnover; a wholesale connection could draw directly from the tank improving the turnover and water quality if the proposed pump station is operated daily.
  - This may require pumping capacity improvements in the KC Water distribution system (South Booster Booster service level) and should be evaluated further with input from KC Water; amendments to the KC Water Agreement should also be discussed.
- Alternative A2:
  - By 2056, or as the total system demand approaches 40.5 MGD, implement a 4.7 MGD wholesale connection (meter vault) with KC Water near the existing Gregory meter vault and tie into the 20-inch transfer line to the Leinweber supply main, tie into the Leinweber supply system, and tie into the 30-inch Velie supply

Options	KC Water Agreement				Independence	New Supply		Total
	Current Capacity	KC Water Phase IV	TWA or PWSD13 Provision	Increase KC Water	Maintain Contract	Increase Independence	TWA	
1	25.0	8.0	2.0	2.7	7.5	--	--	45.2
2	**25.0**	**8.0**	--	**4.7**	**7.5**	--	--	**45.2**
3	25.0	8.0	--	--	7.5	4.7	--	45.2
4	25.0	8.0	--	--	7.5	--	4.7	45.2

Option 2 - Alternative A1

Year	Demand Trigger	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$20,200,000
2056	40.5	S2-PS1, S2-L1, S2-MV1	4.7	45.2	$ 19,488,000
Total[1]					$ 39,688,000

Option 2 - Alternative A2

Year	Demand Trigger	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$20,200,000
2056	40.5	S2-L2, S2-L3, S2-L4, S2-MV2	4.7	45.2	$ 4,518,000
Total[1]					$ 24,718,000

Notes:
1. OPC includes $10,900,000 for low head storage at South Terminal and $9,300,000 represents Lee's Summit payment term of 40 percent of the design and construction for the 72-inch diameter waterline from the Missouri River Tunnel Upshaft to East Bottoms Pump Station.
2. Most recent available cost opinion for the 72-inch diameter water line prepared by Others in April 2014 (ENR CCI 10,890) and adjusted with October 2022 (ENR CCI 13,152.48) plus additional 30 percent contingency.

ALTERNATIVES ARE NOT PAIRED; OPTION 2 IS EITHER ALTERNATIVE A1 OR ALTERNATIVE A2

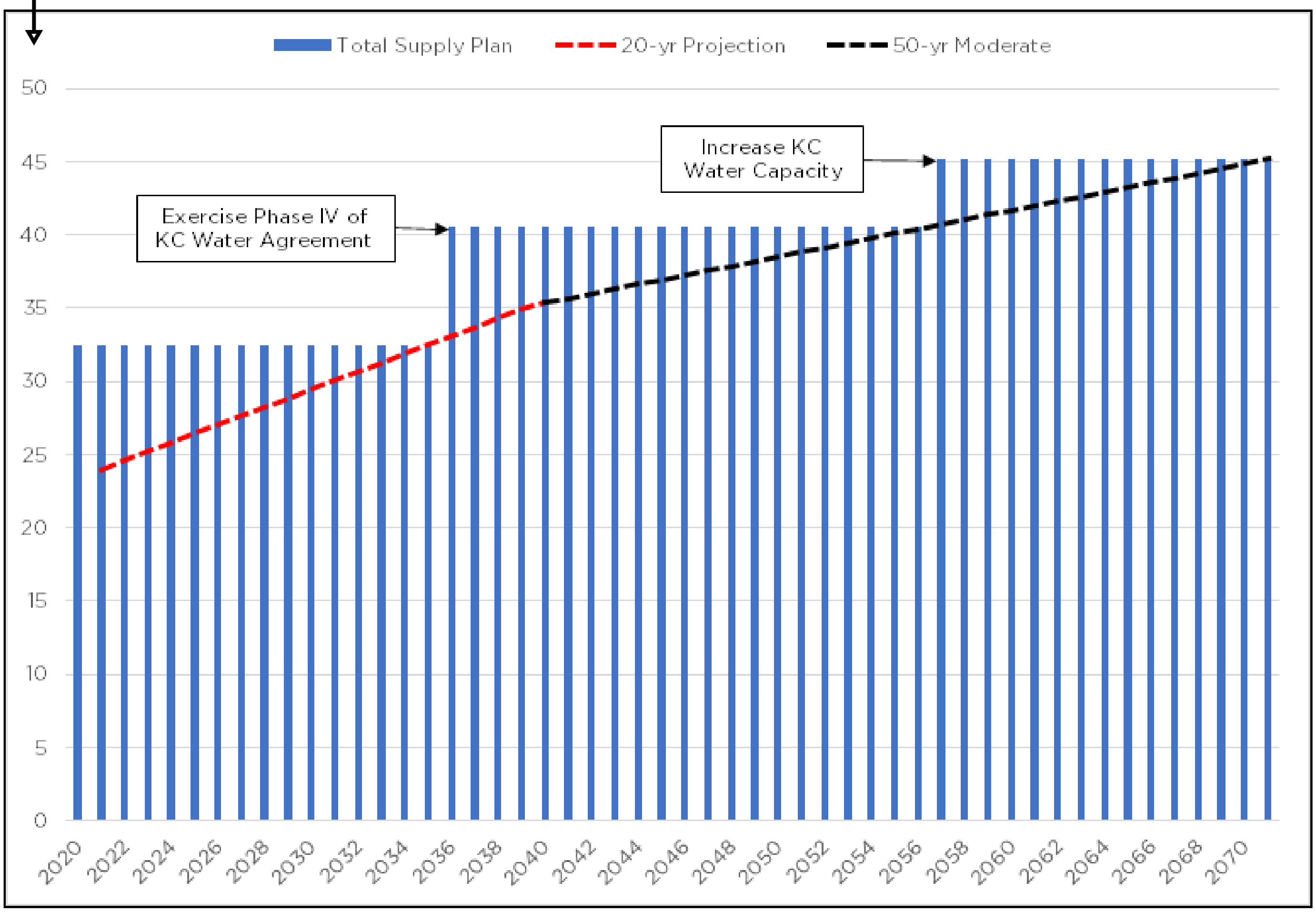

FIGURE 4-5

OPTION 2 & ALTERNATIVES WATER SUPPLY PLAN

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S2-PS1	Direct Distribution Pumping	5 MGD pump station (expandable to 10 MGD) near KC Water Hwy 150 Tank at intersection of Horridge Rd and Outer Belt Rd; pump into South zone	NA	NA	$11,490,000	$2,298,000	$2,758,000	$16,546,000
S2-L1	Linear Supply	24-inch direct distribution to South zone from CIP S2-PS1 along Outer Belt Rd to SW Pryor Rd	4,000	24	$ 1,932,000	$ 386,000	$ 348,000	$ 2,666,000
S2-MV1	Service Connection	Between KC Water Hwy 150 Tank and CIP ID S2-PS	NA	NA	$ 200,000	$ 40,000	$ 36,000	$ 276,000

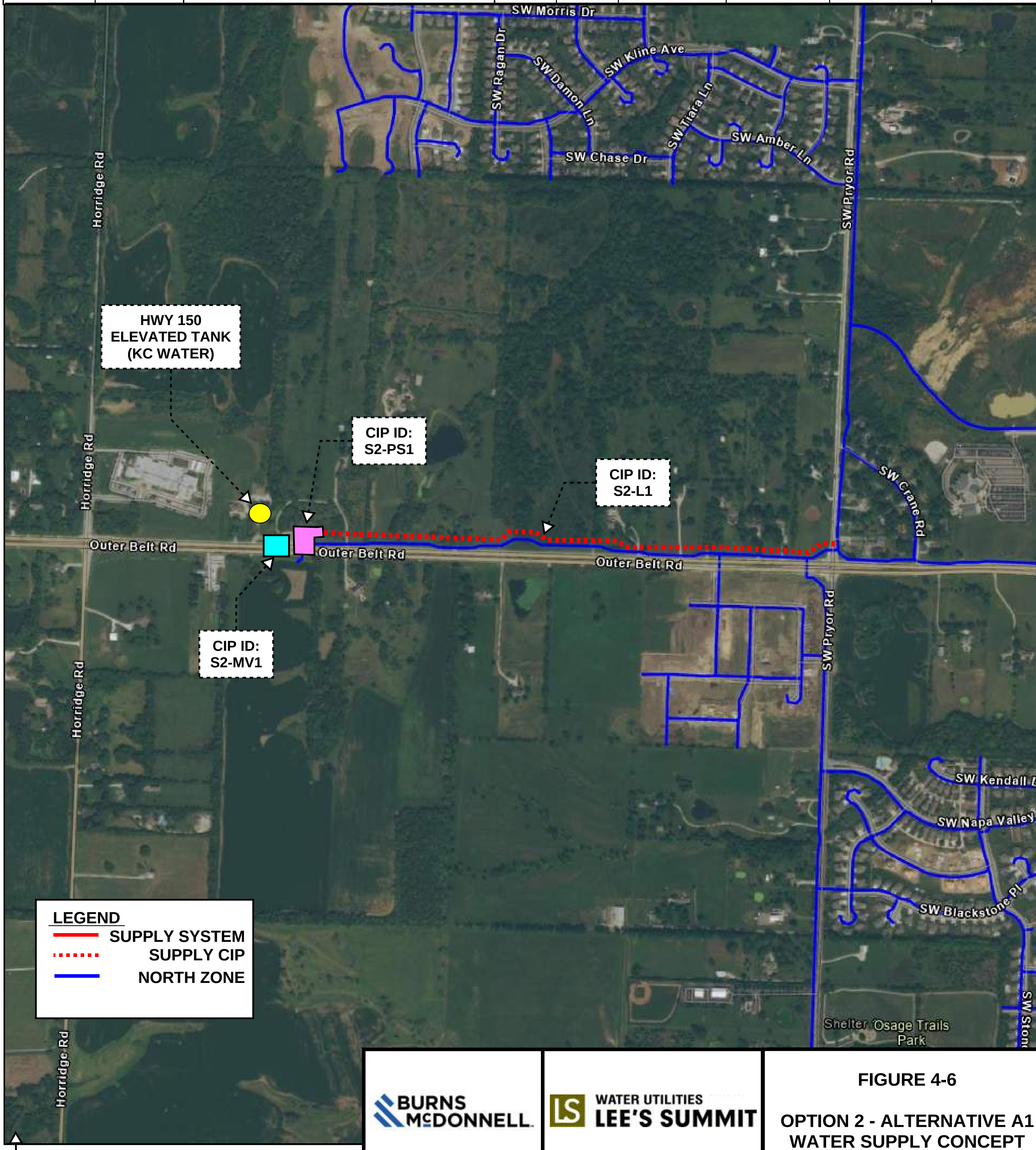

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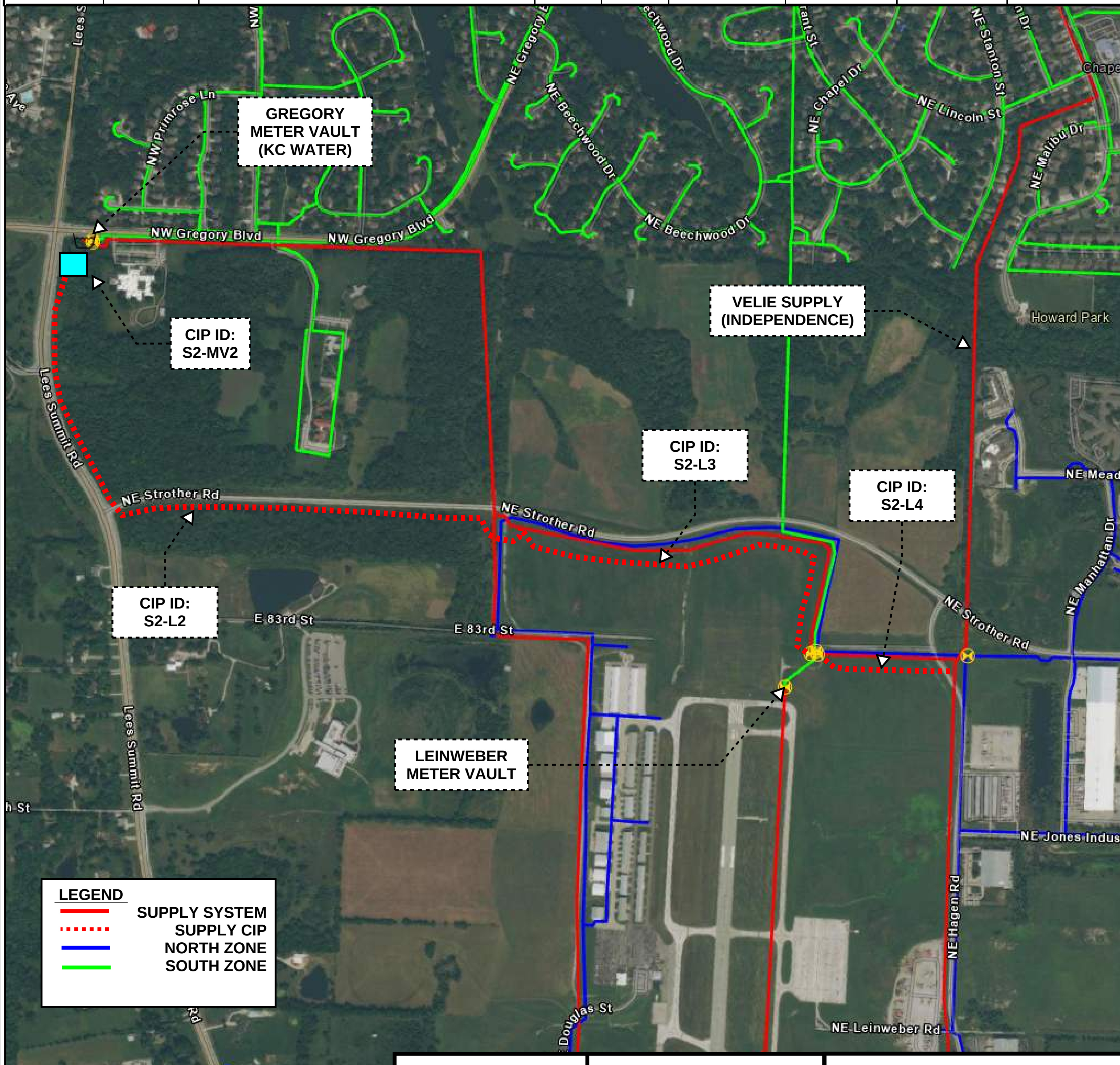
FIGURE 4-6

OPTION 2 - ALTERNATIVE A1 WATER SUPPLY CONCEPT

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S2-L2	Linear Supply	Dedicated transmission from new meter vault near Gregory meter vault, south to NE Strother Rd, east along NE Strother Rd and tie into existing 20-inch supply line feeding Leinweber valve vault	4,800	24	$ 2,318,000	$ 464,000	$ 417,000	$ 3,199,000
S2-L3	Linear Supply	From CIP ID S2-L2 and paralelling existing 20-inch supply line to Leinweber meter vault	3,200	12	$ 576,000	$ 115,000	$ 104,000	$ 795,000
S2-L4	Linear Supply	From CIP ID S2-L3 and paralelling existing 20-inch supply line feeding Velie 30-inch supply line	1,000	12	$ 180,000	$ 36,000	$ 32,000	$ 248,000
S2-MV2	Service Connection	Meter vault near existing Gregory meter vault	NA	NA	$ 200,000	$ 40,000	$ 36,000	$ 276,000



NOT TO SCALE

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FIGURE 4-7

OPTION 2 - ALTERNATIVE A2 WATER SUPPLY CONCEPT main; all of which deliver water to the ground storage tanks at High Service pump station. The current control mode for the Leinweber supply system is inactive (closed) but should be maintained with this option. The Leinweber supply system provides the ability to convey water from the North Zone through the Leinweber control valve and into ground storage at High Service pump.

4.3.3 Option 3

Option 3 for long term water supply planning includes implementing Phase IV of the KC Water Agreement for 8.0 MGD at South Terminal by 2035, or as the total system demand approaches 32.5 MGD. This also includes the Phase IV associated improvements detailed in Option 1 above with respect to the 72-inch transmission main in KC Water's system and additional City storage at South Terminal. The remaining timeline for supply increases and associated improvements is summarized below and shown in Figures 4-8 and 4-9 respectively:

- By 2056, or as the total system demand approaches 40.5 MGD, increase the wholesale supply from Independence at the Velie meter vault by 4.7 MGD by paralleling the existing supply main between the meter vault and Bowlin pump station with a mix of 24-inch and 20-inch mains (in series) and connecting to the 30-inch Velie supply main that conveys water to ground storage at High Service pump station.
- Increasing the City's supply from Independence above 7.5 MGD is permissible within the City's contract with Independence. However, this will change the City's status in the KC Water Agreement from sole source to dual source and can trigger a change in the water rates.

4.3.4 Option 4

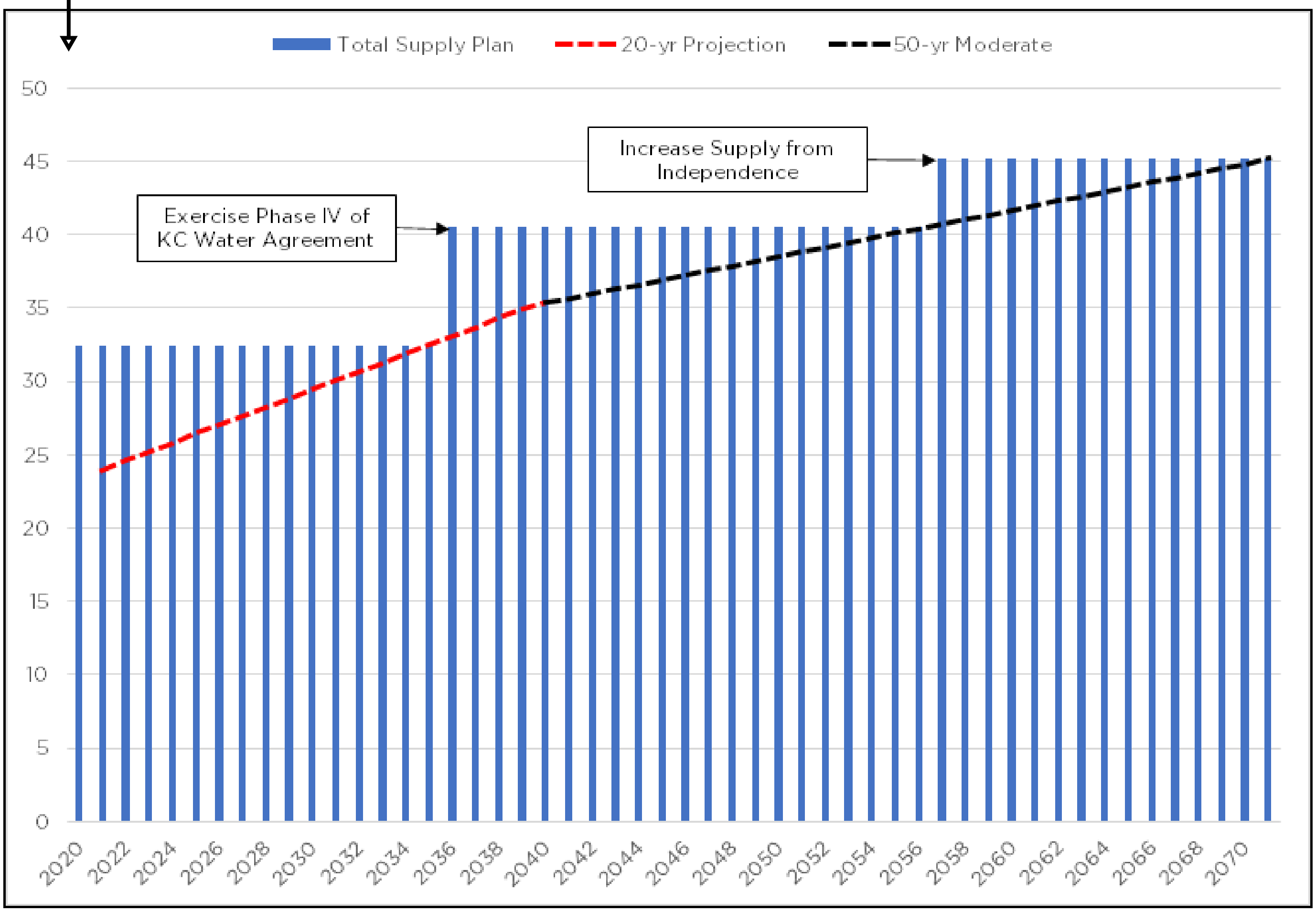
Option 4 for long term water supply planning includes implementing Phase IV of the KC Water Agreement for 8.0 MGD at South Terminal by 2035, or as the total system demand approaches 32.5 MGD. This also includes the Phase IV associated improvements detailed in Option 1 above with respect to the 72-inch transmission main in KC Water's system and additional City storage at South Terminal. The remaining timeline for supply increases and associated improvements is summarized below and shown in Figures 4-10 and 4-11 respectively:

- By 2056, or as the total system demand approaches 40.5 MGD, implement a 5.0 MGD wholesale connection (meter vault) with TWA expandable to 10.0 MGD near the intersection of NE Colbern Rd and NE Blackwell Rd with a 5.0 MGD pump station (also expandable to 10.0 MGD) for pumping into the 30-inch Velie supply main that fills ground storage at High Service pump station. For clarity, the 5.0 MGD wholesale connection and pump station are rounded up from 4.7 MGD.
    - A shared storage tank with TCWA between the wholesale connection and the TCWA system, or elsewhere upstream of the proposed pump station if City elects to own and operate the tank, should be included to minimize impacts to the City's proposed BPS and on the TCWA system. The size, shared storage allocation, and/or sole storage volume, is contingent upon factors beyond the scope of this evaluation, such as both the City and TCWA system demands,

Options	KC Water Agreement				Independence	New Supply		Total
	Current Capacity	KC Water Phase IV	TWA or PWSD13 Provision	Increase KC Water	Maintain Contract	Increase Independence	TWA	
1	25.0	8.0	2.0	2.7	7.5	--	--	45.2
2	25.0	8.0	--	4.7	7.5	--	--	45.2
3	**25.0**	**8.0**	--	--	**7.5**	**4.7**	--	**45.2**
4	25.0	8.0	--	--	7.5	--	4.7	45.2

Year	Demand Trigger	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$20,200,000
2056	40.5	S3-L1, S3-L2, S3-MV1	4.7	45.2	$ 5,804,000
Total[1]					$26,004,000

Notes:
1. OPC includes $10,900,000 for low head storage at South Terminal and $9,300,000 represents Lee's Summit payment term of 40 percent of the design and construction for the 72-inch diameter waterline from the Missouri River Tunnel Upshaft to East Bottoms Pump Station.
2. Most recent available cost opinion for the 72-inch diameter water line prepared by Others in April 2014 (ENR CCI 10,890) and adjusted with October 2022 (ENR CC13,152.48) plus additional 30 percent contingency.



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WATER UTILITIES LEE'S SUMMIT

FIGURE 4-8

OPTION 3 WATER SUPPLY PLAN

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S3-L1	Linear Supply	Parallel existing 20-inch supply from CIP ID s3-MV1 near Velie meter vault to Bowlin Tank	7,400	24	$ 3,574,000	$ 715,000	$ 643,000	$ 4,932,000
S3-L2	Linear Supply	From Bowlin Tank to Bowlin Pump Station	1,800	20	$ 432,000	$ 86,000	$ 78,000	$ 596,000
S3-MV1	Service Connection	Meter vault near existing Velie meter vault	NA	NA	$ 200,000	$ 40,000	$ 36,000	$ 276,000

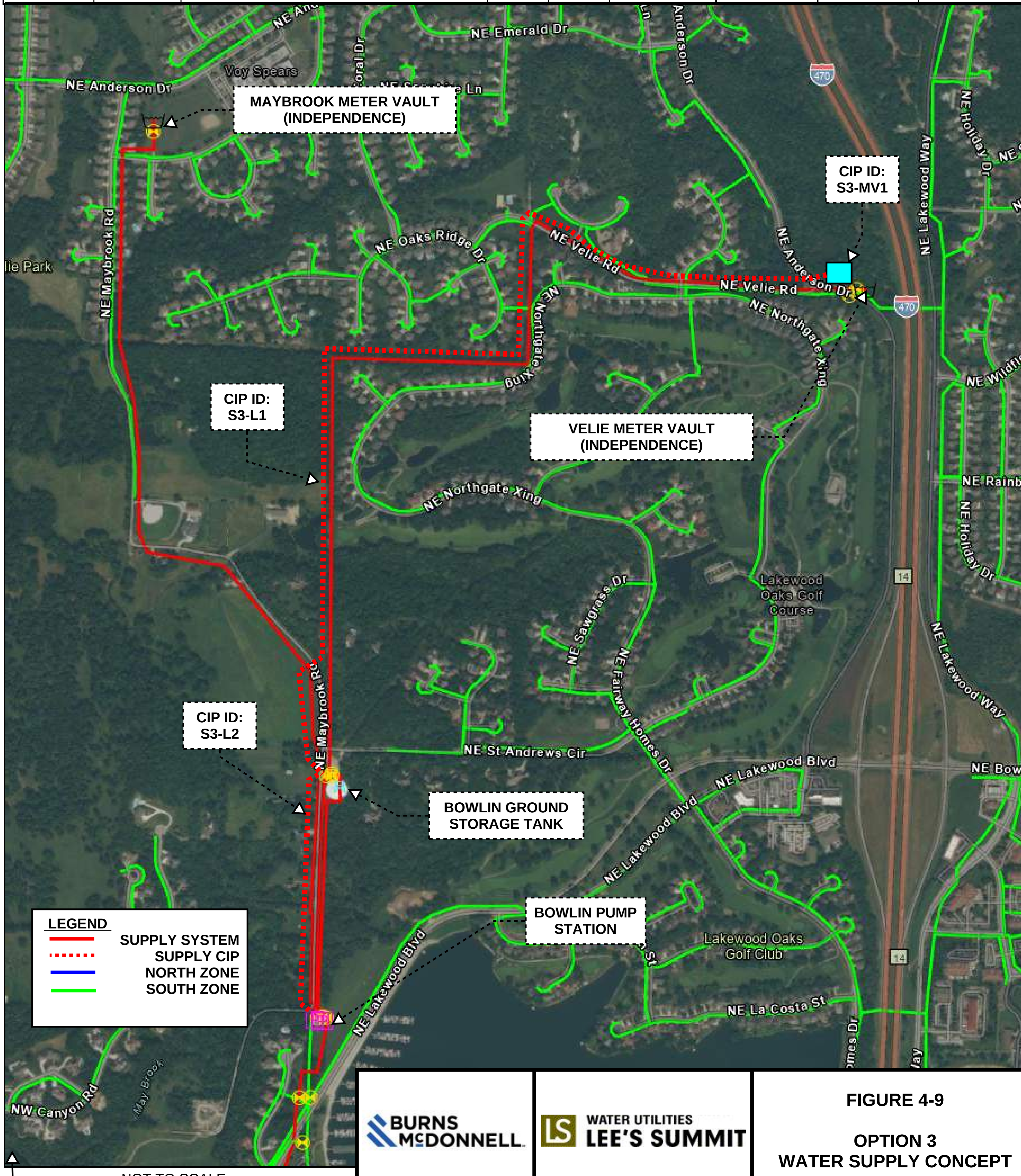

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FIGURE 4-9

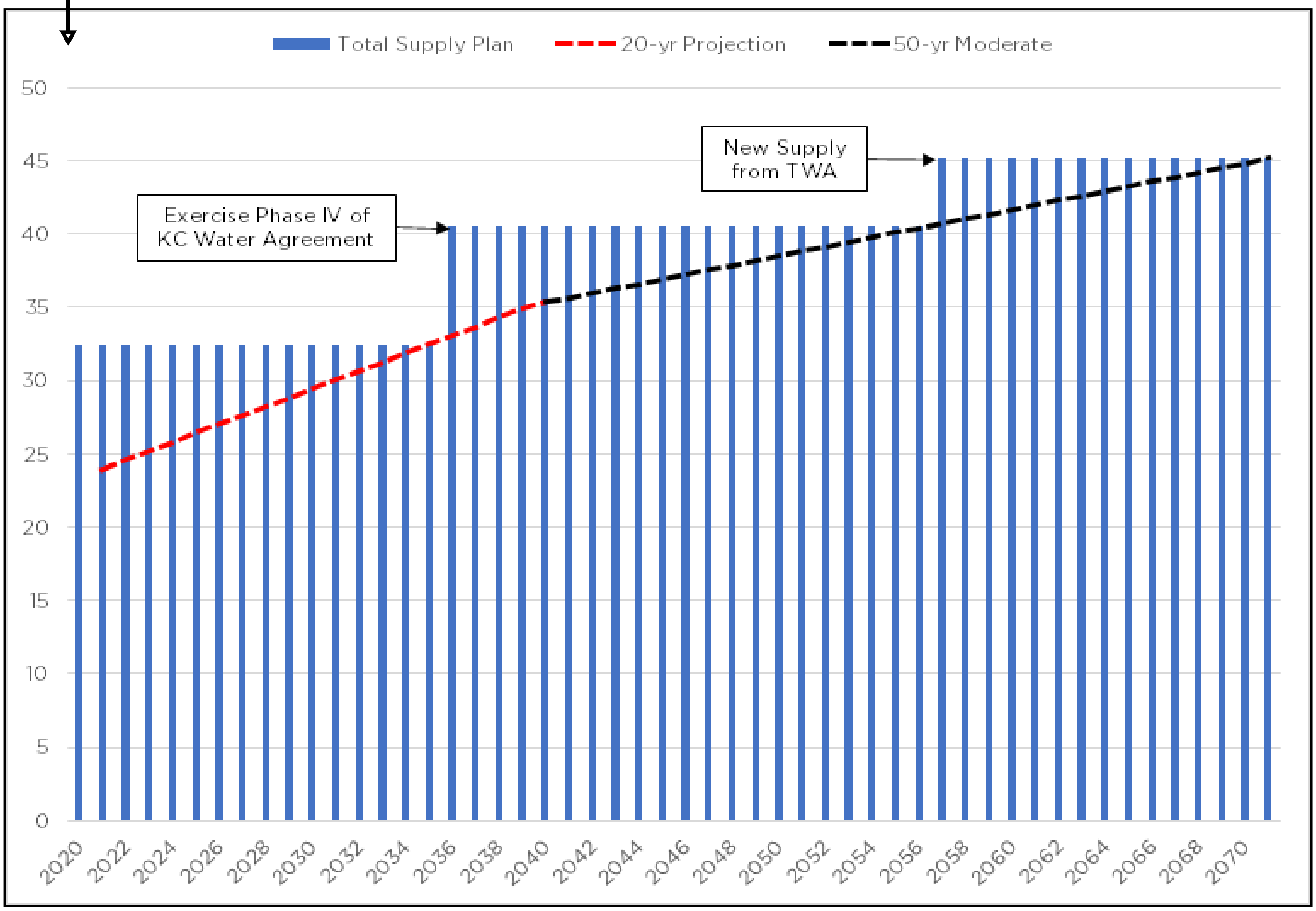
OPTION 3
WATER SUPPLY CONCEPT

Options	KC Water Agreement				Independence	New Supply		Total
	Current Capacity	KC Water Phase IV	TWA or PWSD13 Provision	Increase KC Water	Maintain Contract	Increase Independence	TWA	
1	25.0	8.0	2.0	2.7	7.5	--	--	45.2
2	25.0	8.0	--	4.7	7.5	--	--	45.2
3	25.0	8.0	--	--	7.5	4.7	--	45.2
4	**25.0**	**8.0**	--	--	**7.5**	--	**4.7**	**45.2**

Year	Demand Trigger	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$20,200,000
2056	40.5	S4-PS1, S4-L1, S4-MV1	4.7	45.2	$ 34,214,000
Total[1]					$ 54,414,000

Notes:

1. OPC includes $10,900,000 for low head storage at South Terminal and $9,300,000 represents Lee's Summit payment term of 40 percent of the design and construction for the 72-inch diameter waterline from the Missouri River Tunnel Upshaft to East Bottoms Pump Station.
2. Most recent available cost opinion for the 72-inch diameter water line prepared by Others in April 2014 (ENR CCI 10,890) and adjusted with October 2022 (ENR CC13,152.48) plus additional 30 percent contingency.



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WATER UTILITIES LEE'S SUMMIT

FIGURE 4-10

OPTION 4
WATER SUPPLY PLAN

operations, and controls at this location, etc., and therefore an opinion of probable construction cost is not included herein.

- Increasing the City's supply from Independence above 7.5 MGD is permissible within the City's contract with Independence. However, this will change the City's status in the KC Water Agreement from sole source to dual source and can trigger a change in the water rates.

4.4 Conclusions

Options for water supply planning are based on the moderate growth scenario resulting in long term, or 50-year demand projection, of 45.2 MGD for the City. A summary of the capital improvement plan for each supply option and associated opinion of probable cost for each improvement with the demand trigger and anticipated projection year is listed in Table 4-4.

Table 4-4: Water Supply Planning Options Summary

50-year Capital Improvement Cost Opinion Summary - Supply System					
Option 1					
Year	Demand Trigger (MGD)	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$ 20,200,000
2056	40.5	S1-L1, S1-MV1,	2.0	42.5	$ 4,975,000
2062	42.5	S1-L2, S1-MV2	2.7	45.2	$ 1,865,000
Total					$ 27,040,000
Option 2 - Alternative A1[3]					
Year	Demand Trigger (MGD)	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$ 20,200,000
2056	40.5	S2-PS1, S2-L1, S2-MV1	4.7	45.2	$ 19,488,000
Total					$ 39,688,000
Option 2 - Alternative A2[3]					
Year	Demand Trigger (MGD)	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$ 20,200,000
2056	40.5	S2-L2, S2-L3, S2-L4, S2-MV2	4.7	45.2	$ 4,518,000
Total					$ 24,718,000
Option 3					
Year	Demand Trigger (MGD)	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$ 20,200,000
2056	40.5	S3-L1, S3-L2, S3-MV1	4.7	45.2	$ 5,804,000
Total					$ 26,004,000
Option 4					
Year	Demand Trigger (MGD)	CIP	CIP Capacity (MGD)	Total Supply Capacity (MGD)	Opinion of Probable Cost
2035	32.5	KC Water Phase IV[1,2]	8.0	40.5	$ 20,200,000
2056	40.5	S4-PS1, S4-L1, S4-MV1	4.7	45.2	$ 34,214,000
Total					$ 54,414,000

Notes:
1. OPC includes $10,900,000 for low head storage at South Terminal and $9,300,000 represents Lee's Summit payment term of 40 percent of the design and construction for the 72-inch diameter waterline from the Missouri River Tunnel Upshaft to East Bottoms Pump Station.

2. Most recent available cost opinion for the 72-inch diameter water line prepared by Others in April 2014 (ENR CCI 10,890) and adjusted with October 2022 (ENR CC13,152.48) plus additional 30 percent contingency.
3. With respect to Option 2, Alternatives A1 and A2 are not paired; Option 2 includes either A1 or A2 but not both.

4.5 Recommendation

After review and discussion with City staff, the City's preference is pursuit of a water supply plan that does not change the City's status as a sole source within the KC Water Agreement and to maintain the current water rates with KC Water. Therefore, Options 3 and 4 are not recommended. City expressed interest in Options 1 and 2 in the future as demand triggers approach. Whichever option, course of action, and/or combination and/or derivative thereof is selected, supply planning and improvements should be evaluated and implemented no less than 5 to 7 years in advance of their respective demand triggers.

City staff engaged and coordinated meetings with TCWA, PWSD13, and PWSD12 to discuss supply opportunities throughout the development of this report for practicality as portions of their water service area and/or distribution system traverse City limits. Maintaining sole source compliance within the KC Water Agreement allows the opportunity to enter into an agreement with either TCWA or PWSD13 for a maximum supply of 2.0 MGD and the City indicated potential for this if it provides an opportunity acquire at least the water system assets of TCWA or PWSD13 residing within City limits or in undeveloped water service areas of neighboring water suppliers within City limits.

The City acknowledges any acquisition of water system assets, as of the date of this report, is more likely connected with PWSD13 due to both utility service (water and wastewater) and City boundaries overlapping; but this does not suggest or posture that asset acquisition is limited to PWSD13 only. The City has emergency connections in at Ranson and Scherer Rd elevated tanks with TCWA and the end user and extent of the TCWA supply main through the City along Scherer Rd is the City of Grandview, MO to the west. The City should consider water demand, pressure requirements, condition assessment, growth potential, growth type, fire flow requirements, etc. for further evaluation of any water supply option that includes asset acquisition.

5.0 Water Master Planning

This section of the report provides the hydraulic analysis criteria, diurnal evaluation, fire flow requirements, and water master planning. The hydraulic analysis criteria are compared with model results to determine if a capital improvement is warranted for compliance with these industry standard levels of service. The diurnal evaluation yields multiple planning level information including the minimum and peak hour factors whose associated demand conditions are evaluated in the hydraulic model. The diurnal evaluation also provides the equalization storage requirement, which is applied in the storage analysis, along with the fire flow requirement, which both set the minimum storage requirement for the distribution system. The master planning component in this section includes future growth areas identified by City staff and the demand allocation with which development driven improvements are sized and their location.

5.1 Level of Service

Hydraulic analyses are conducted with the model to evaluate the ability of the distribution system to convey equalization storage, pump the projected water demands, and identify deficiencies with respect to capacity, pressure, and fire flow. This represents the level of service the City provides its customers and is the basis for which improvements are sized and recommended. The level of service conditions applied in the distribution system analyses is listed in Table 5-1. Model scenarios for the existing system, 2025, and 2040 planning periods are evaluated for the following demand conditions to determine the distribution system's capabilities, need, and location for additional capacity, storage, and pumping in compliance with level of service criteria:

- Existing System:
  - Extended period simulation under maximum day demands for hydraulic analysis.
  - Extended period simulation under maximum day demands for water age analysis.
  - Extended period simulation under average day demands for water analysis.
  - Static simulation under maximum day demands for fire flow analysis.
- 2025 and 2040 Planning Years:
  - Extended period simulation under maximum day demands for hydraulic analysis.
  - Static simulation under maximum day demands for fire flow analysis.

Table 5-1: Level of Service Criteria

Feature	Criterion	Minimum Performance	Mid Level Goals	Best Practices	Master Plan
Pressure	Minimum	> 20 psi for all conditions	> 40 psi for normal conditions	> 50 psi for normal conditions	Mid Level
			> 20 psi for fire flow	> 25 psi for fire flow	
	Maximum	< 140 psi	Lesser of 100 psi or water main break HGL		Minimum
Pumping	Capacity	Total firm capacity (each supply) >= maximum day; each zone			As indicated
Water Mains	Velocity	Distribution < 5 fps; transmission (no service connections) < 7 fps under peak hour on the maximum day demand			As indicated
	Headloss	< 6 ft/1,000 ft under peak hour on the maximum day			
Storage	Equalization	Contractual Requirement	Volumetric demand in excess of 24-hour average (maximum day x equalization factor)		Contractual Requirement
	Fire	Maximum fire flow requirement = 4,000 gpm for 4 hours = 0.96 MG			As indicated
	Emergency	Contractual Requirement		Conditional per City	Contractual Requirement
	Total (Effective)	Contractual + Fire		Equalization + greater of fire or emergency	Contractual Requirement
Fire	Flow & Pressure	1,000 gpm at 20 psi	1,500 gpm at 20 psi	1,500 gpm at 25 psi	Mid Level

5.2 Diurnal Analysis

Diurnal patterns represent changes in water demand over the course of a day, reflecting times when the customers are using more water or less water than the daily average. The average demand over the 24-hour period is 100 percent on the diurnal pattern. The equalization storage requirement, peak hour factor, and minimum hour factor are also results of the diurnal analysis. The equalization storage requirement refers to the amount of storage needed for daily peaking when the system demand exceeds system supply. Results of the diurnal analysis for each zone are listed in Table 5-2. Diurnal patterns applied in the EPS for the North and South zones are illustrated in Figures 5-1 and 5-2 respectively.

Table 5-2: Diurnal Analysis Results

Date	Demand (MGD)			Equalization (%)		Min Hour Factor		Peak Hour Factor	
	South	North	Total	South	North	South	North	South	North
7/22/2021	19.4	3.6	23.0	11	13	0.76	0.59	1.82	1.63
7/23/2021	19.3	3.4	22.7	9	15	0.79	0.64	1.64	1.59
7/24/2021	17.9	3.2	21.1	8	15	0.78	0.53	1.49	1.68
8/5/2021	15.0	3.0	18.0	12	17	0.69	0.57	1.83	1.88

Figure 5-1: North Zone Diurnal Pattern

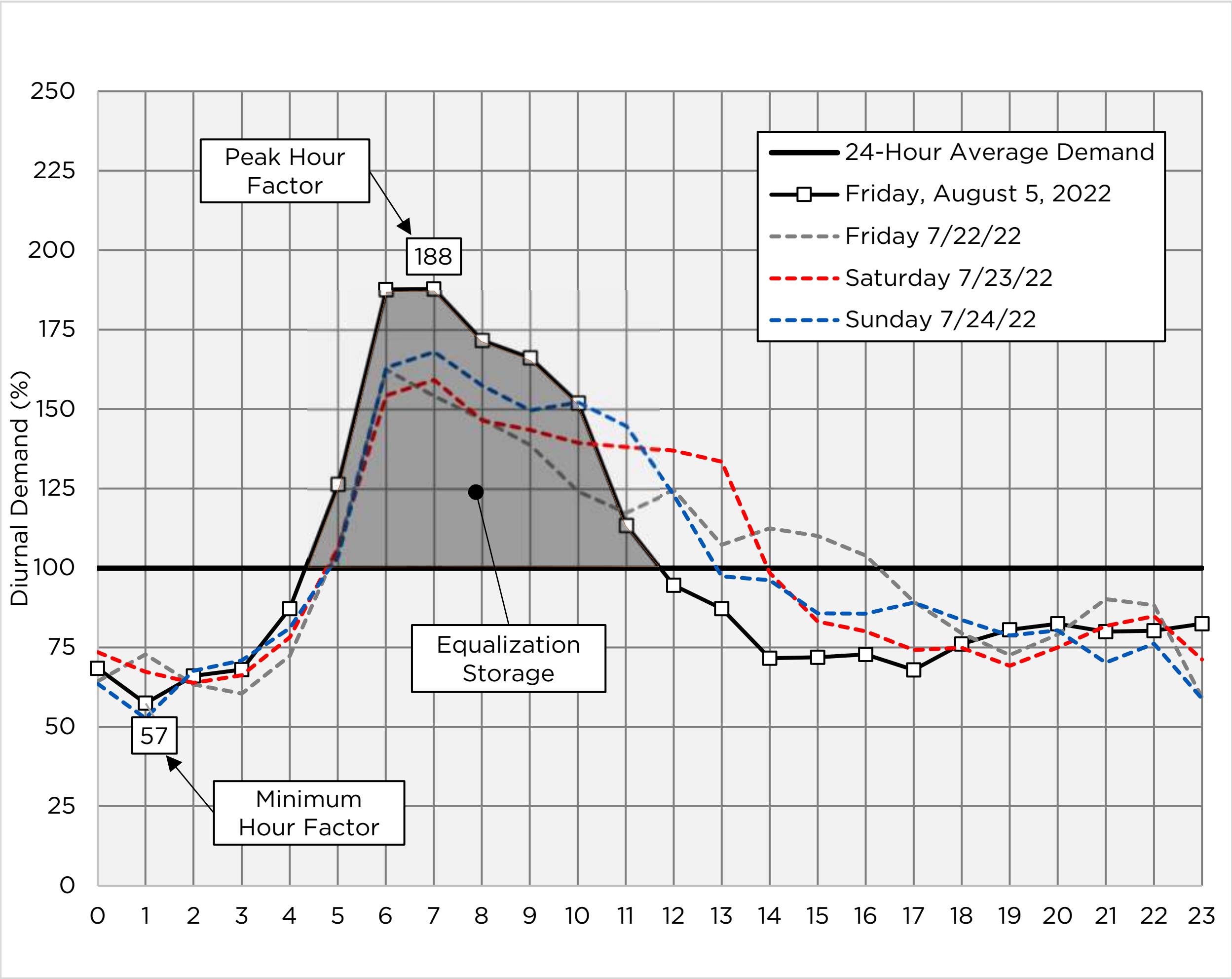
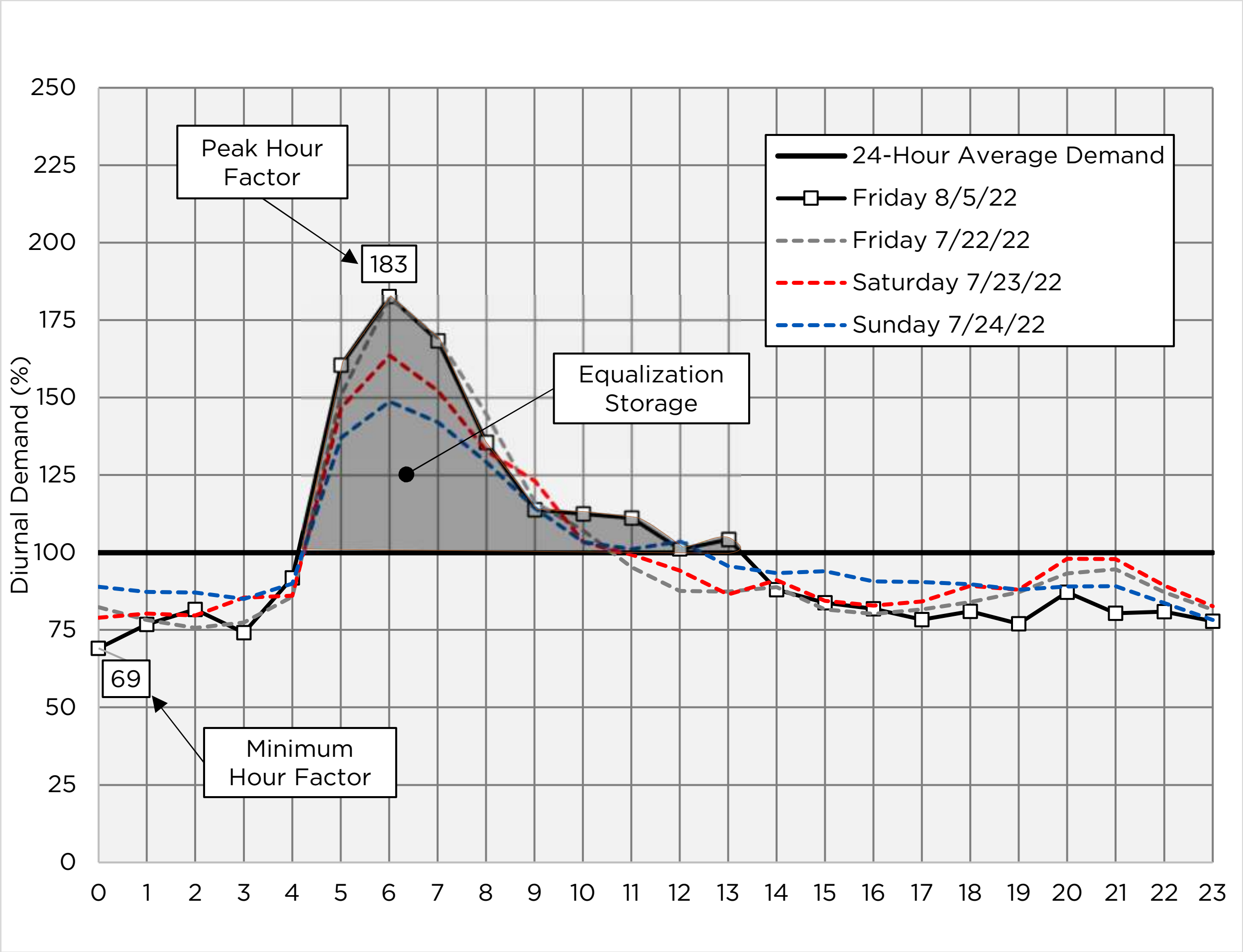


Figure 5-2: South Zone Diurnal Pattern



5.3 Fire Flow Requirements

Distribution system storage for fire protection includes water that must always be available to fight the most severe fires. The fire storage requirement in the distribution system is 4,000 gpm for 4 hours, or the equivalent to 0.96 MG. To meet the City's fire flow requirements, fire flow improvements are based on the distribution system delivering 1,500 gpm while maintaining a minimum residual of 20 psi in the distribution system.

5.4 Water Master Planning

The City identified growth areas for the 2025 and 2040 planning periods in the Ignite Comprehensive Plan with a population projection of 138,000 by 2040, a 38 percent increase, amongst five activity centers and areas of undeveloped land within City limits. The meter projections associated with the population growth applied in the demand projections, as described in Section 3.0, are detailed below in Tables 5-3 and 5-4 for activity centers and undeveloped land areas for the 2025 and 2040 planning periods respectively.

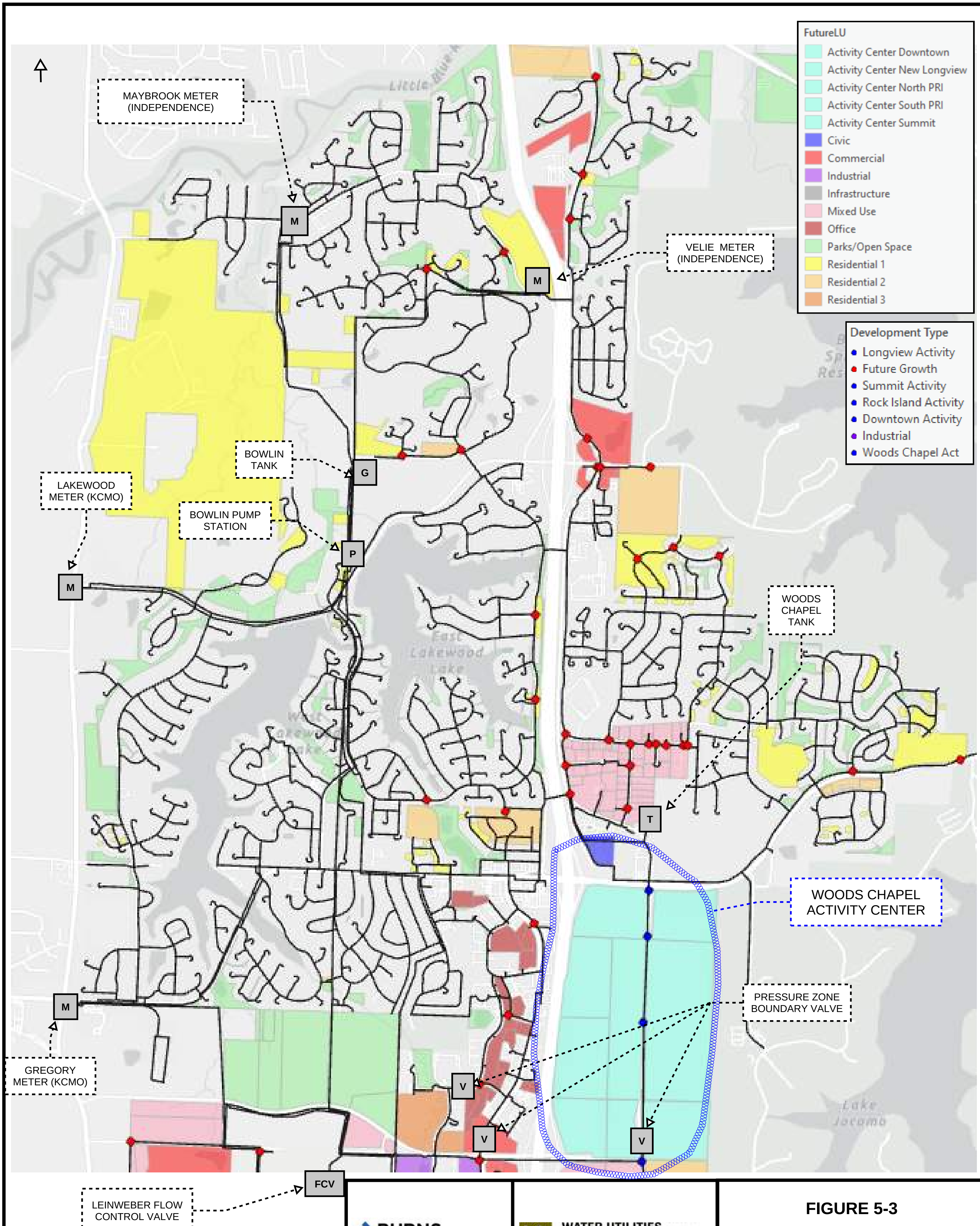
Table 5-3: 2025 Demands for Comprehensive Plan Growth Strategy

Growth Area	Land Use	Max Day Demand (MGD)		Population	Meters	
		Residential	Nonresidential		Residential	Nonresidential
Rock Island	Activity Center	0.24	0.12	1,448	499	45
Woods Chapel	Activity Center	0.14	0.07	828	285	26
Downtown	Activity Center	0.13	0.06	745	257	23
Longview	Activity Center	0.07	0.03	414	143	13
Summit	Activity Center	0.10	0.05	621	214	19
Residential Undeveloped Areas	Residential 1	0.44	--	2,405	534	--
	Residential 2	0.17	--	925	565	--
	Residential 3	0.02	--	107	193	--
Non-Residential Growth in Undeveloped Areas	Civic	--	0.002	2	--	1
	Commercial	--	0.11	111	--	42
	Mixed Use	--	0.18	175	--	66
	Office	--	0.02	21	--	8
Large User	Industrial	0.50		--	--	
Subtotal		2.46		7,800	2,931	
Existing Service Area		23.9		100,300	37,691	
Total		26.4		108,100	40,622	

Table 5-4: 2040 Demands for Comprehensive Plan Growth Strategy

Growth Area	Land Use	Max Day Demand (MGD)		Population	Meters	
		Residential	Nonresidential		Residential	Nonresidential
Rock Island	Activity Center	1.17	0.58	7,000	2,414	216
Woods Chapel	Activity Center	0.67	0.33	4,000	1,379	124
Downtown	Activity Center	0.60	0.30	3,600	1,242	111
Longview	Activity Center	0.34	0.17	2,000	690	62
Summit	Activity Center	0.50	0.25	3,000	1,035	93
Residential Undeveloped Areas	Residential 1	2.13	--	11,624	2,581	--
	Residential 2	0.82	--	4,471	2,730	--
	Residential 3	0.09	--	516	931	--
Non-Residential Undeveloped Areas	Civic	--	0.01	8	--	3
	Commercial	--	0.54	538	--	202
	Mixed Use	--	0.85	844	--	317
	Office	--	0.10	100	--	38
Large User	Industrial	2.0		--	--	
Subtotal		11.5		37,700	14,167	
Existing Service Area		23.9		100,300	37,691	
Total		35.4		138,000	51,858	

The Comprehensive Plan includes mapping for future land use classifications and activity centers and, collectively, represents the future growth area for water service. The Thoroughfare master plan (major roads) provides the alignment for proposed water mains associated with future growth in undeveloped areas. The spatial demand allocation for future growth is illustrated in Figures 5-3 and 5-4 for the North and South zones respectively. Both planned and water main projects under construction are included in the model based on the targeted completion dates provided by the City but are not included in the capital improvements plan.



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WATER UTILITIES LEE'S SUMMIT

FIGURE 5-3

NORTH ZONE DEMAND ALLOCATION

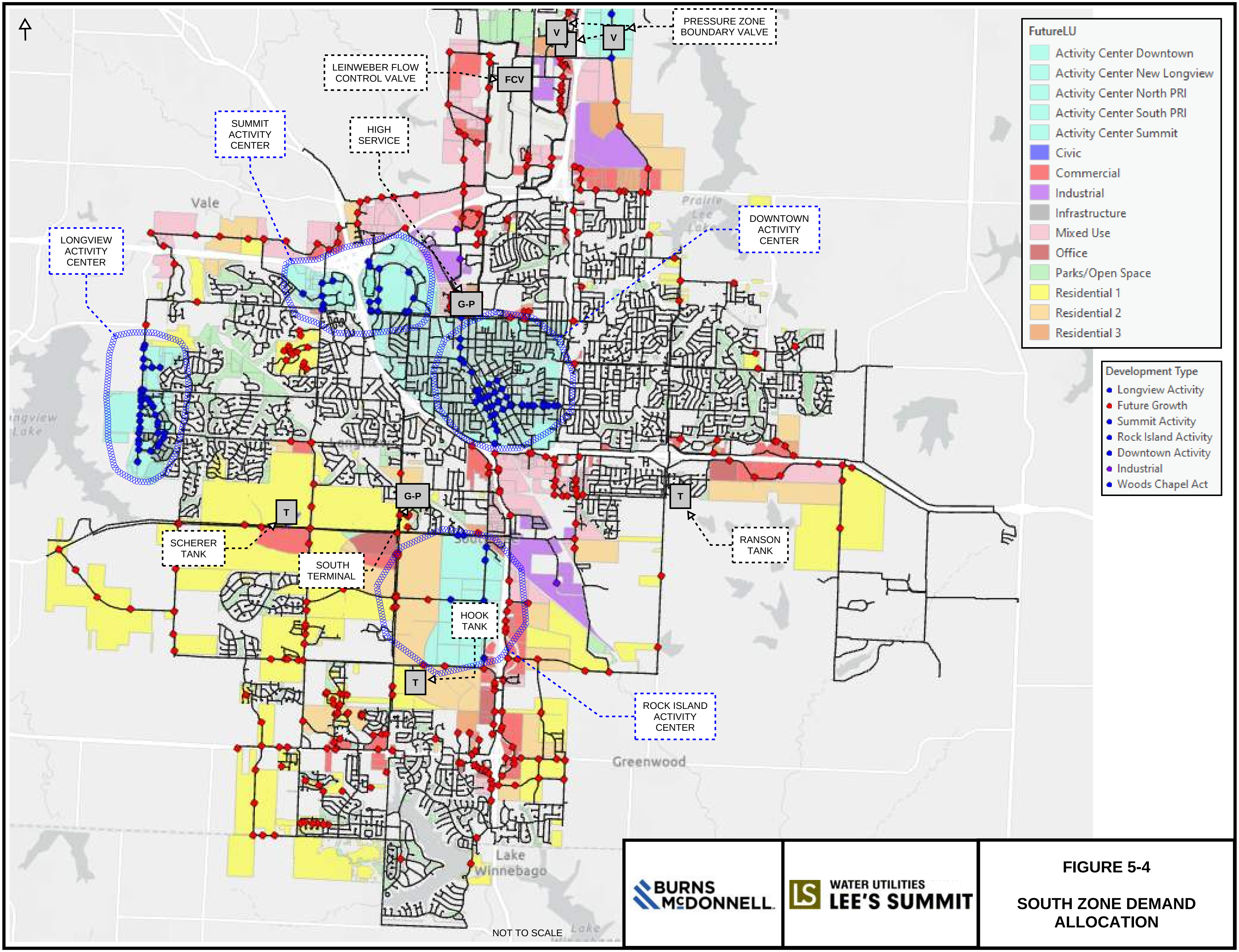


FIGURE 5-4

SOUTH ZONE DEMAND ALLOCATION

6.0 Model Update and Calibration

This Section of the report discusses the model update, model simulation types, field testing, and model calibration efforts. Field testing is conducted in the distribution system and is needed to calibrate the model to simulate the hydraulic behavior of the distribution system. This includes integrating operational controls and system demands into the model as well. The model calibration status effectively represents the confidence level to simulate system conditions under varying demand conditions and system controls.

6.1 Model Development

The hydraulic model evaluates steady state conditions for fire flow analyses and extended period simulations for hydraulic analyses of pressurized networks. The pipe network in the model is based on a numbering system for each pipe segment and junctions (nodes). Pipe information includes length, start node, end node, Hazen-Williams roughness coefficient (or C-value), and diameter. Junction information includes elevation, demand, demand patterns, and coordinates. Other information on pumps, storage, and supply sources such as pump curves, tank head range tank overflow elevation, hydraulic valve settings, and fixed-head supply sources (i.e. KC Water and Independence connections) are also incorporated into the model. The model includes all pipes in the water system GIS greater than or equal to 4-inches in diameter. Water demand is spatially allocated in the model based on the 2020 customer billing information (annual average billed consumption with nonrevenue water) and physical meter address. This process includes quality control checks and results in a model with an accurate representation of the quantity and location for water demand in the distribution system.

6.2 Static Simulation Modelling

Static simulations are developed for each fire hydrant test for model calibration and the fire flow analysis of the existing system and future planning periods. Model input data for static simulations include system demand, tank level, and pump status (on/off and speed), fire hydrant test flow data, and pump curves to simulate steady-state hydraulics of the test. The model calculates frictional headloss from the C-values assigned to pipe and produces results for pipe flow, pipe velocity, pipe headloss, system pressure, and hydraulic gradients in the distribution system. Tank filling/drafting status and pump flow-head results are also produced at distribution system facilities.

6.3 Extended Period Simulation Modelling

An EPS analysis simulates tank cycling (drafting and filling status), pumping operations, hydraulic control valve conditions, and changes in distribution system hydraulics (pressure and flow) in response to varying demand conditions established by each pressure zone's unique diurnal pattern. An EPS is a series of static analyses connected by operational controls and resulting hydraulic outcomes (action-reaction) from one simulation to the next. The operational controls for the storage and pumping facilities are representative of SCADA trending during field testing. EPS model scenarios include the maximum day demand for hydraulic analyses of the existing system and future planning periods. EPS scenarios also include average and maximum day demands for water age analyses of the existing system. The water age analysis identifies areas in the distribution system with the greatest potential for low disinfectant residuals and high water age.

6.4 Field Testing

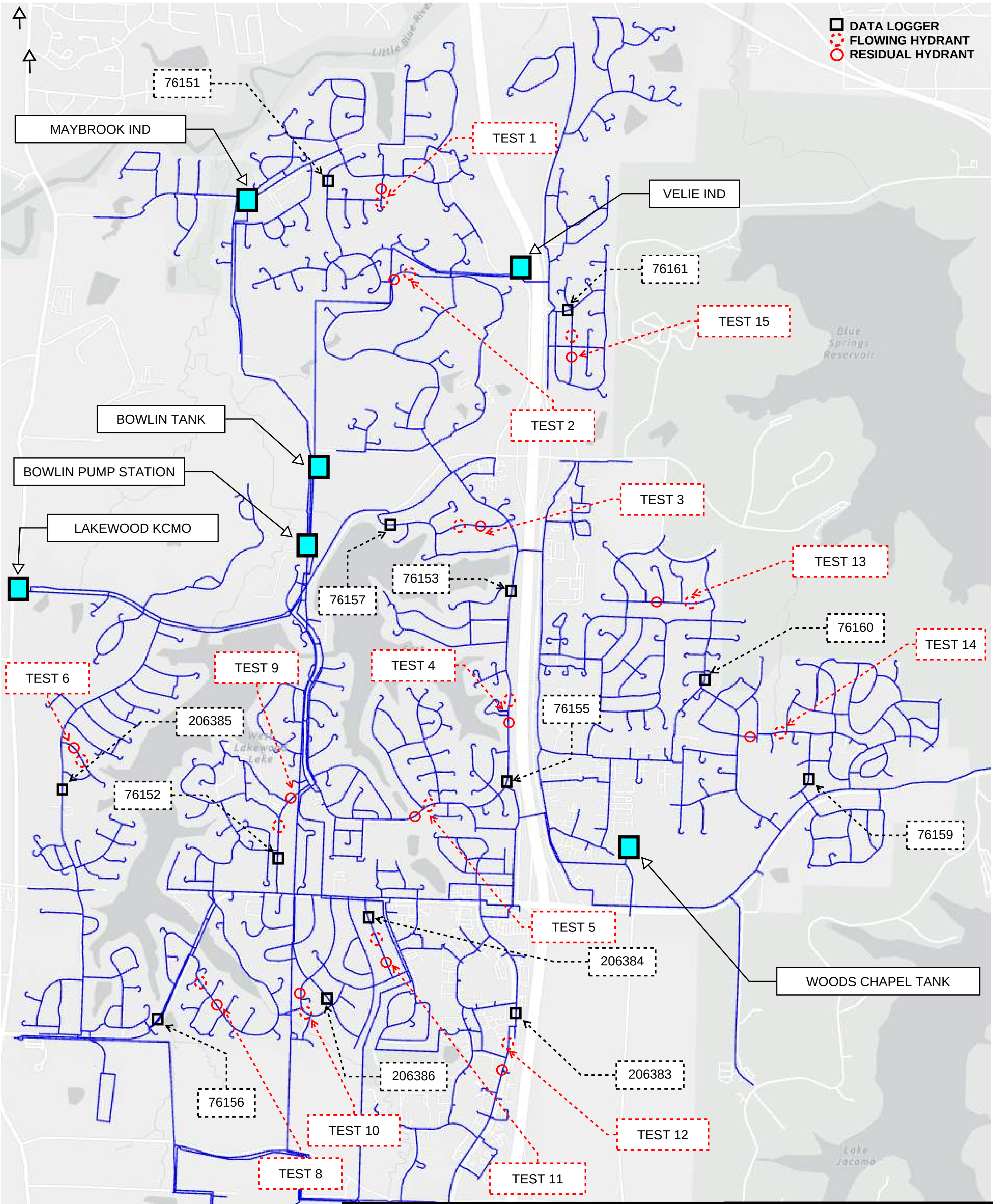
Field testing was conducted in late April 2022 in the North zone, early May 2022 in the South zone, and included fire hydrant testing and data logger deployment. Data loggers are positioned on fire hydrants connected to water mains ranging between 6-inch and 12-inches in diameter and record system pressure continuously. Fire hydrant testing is performed to induce hydraulic stress in the distribution system by creating headloss, or a pressure drop, which is recorded by data loggers; the localized conditions at the fire hydrant test are also recorded. SCADA historian information (flow, pressure, tank level, etc.) is also collected at distribution system facilities such as tanks and pump stations at the time of each fire hydrant test and is listed below.

- North Pressure Zone:
  - Tank level at Woods Chapel elevated tank.
  - Flow at Maybrook and Lakewood meter vaults; Maybrook pressure measured at Bowlin pump station.
  - Tank level, suction pressure, discharge pressure, pump status, and pump speed at Bowlin ground storage tank and pump station.
  - Static pressure, residual pressure, and fire hydrant flow from 15 fire hydrant tests in the distribution system.
  - Pressure from 14 data loggers in the distribution system.
- South Pressure Zone:
  - Tank level at Ranson, Scherer, and Hook elevated tanks.
  - Tank level, suction pressure, discharge pressure, pump status, pump speed at High Service and South Terminal ground storage tanks and pump stations.
  - Static pressure, residual pressure, and fire hydrant flow from 22 fire hydrant tests in the distribution system.
  - Pressure from 14 data loggers in the distribution system.

Fire hydrant testing procedures includes opening a hydrant, termed as the “flowing” hydrant, and measuring pressure at open hydrant and at an adjacent hydrant termed as the “gauged” hydrant. The gauged hydrant is typically the nearest hydrant upstream or downstream of the open hydrant and connected to the same water main. Flow from the open hydrant is calculated based on the residual pressure. Figures 6-1 and 6-2 identify each fire hydrant test and data logger location in the North and South zones respectively; field test forms are included in Appendix D.

6.5 Static Model Calibration

Model calibration is performed by adjusting the C-value on pipes until the pressure measured at a fire hydrant test and at each data logger is produced in the model under static and residual conditions. The C-values are adjusted in the model to simulate pressure within 5 psi of the field test results up to 80 psi; above 80 psi, the C-values are adjusted to simulate pressure within 10 percent of the field test results. The C-values assigned in the model



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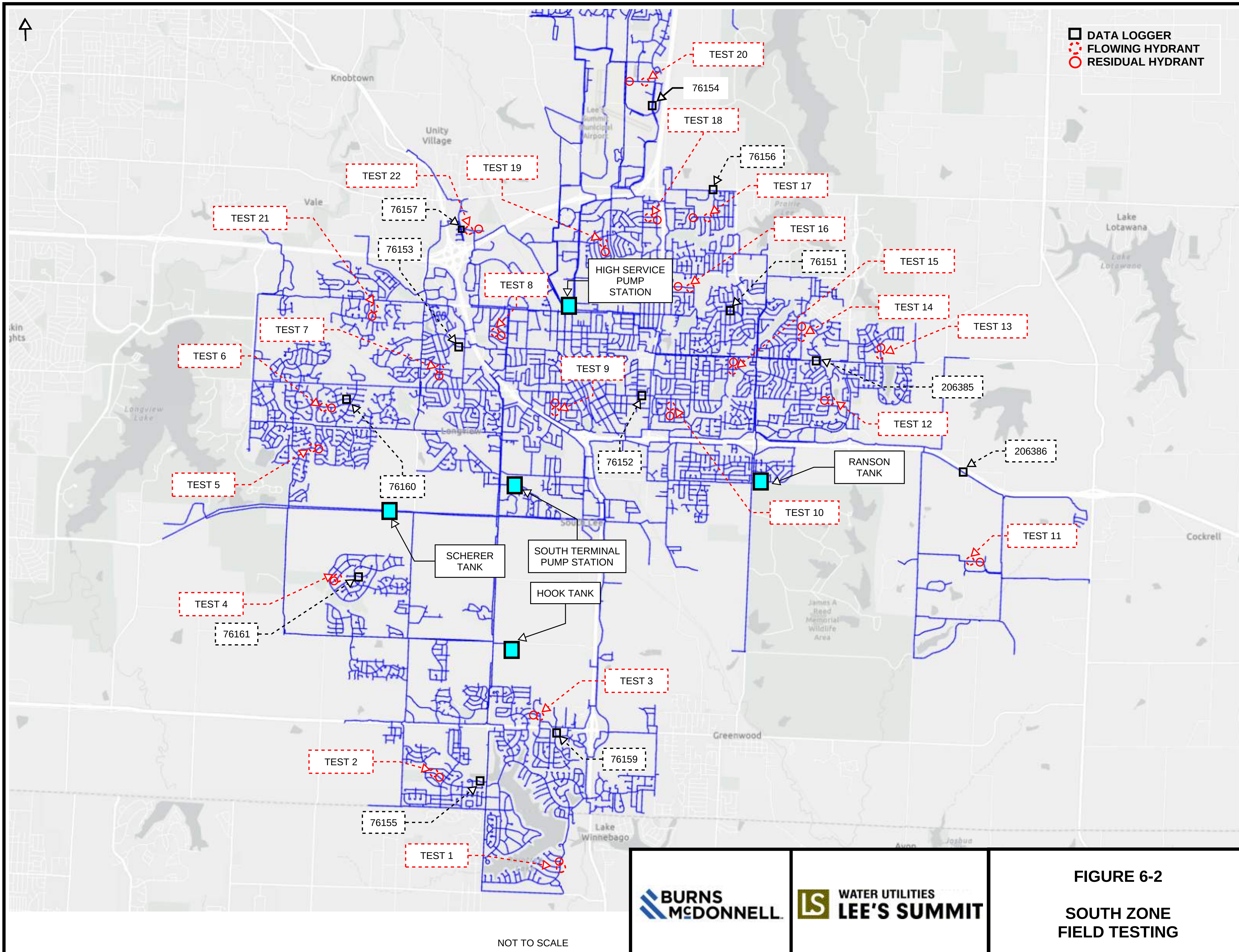
WATER UTILITIES LEE'S SUMMIT

FIGURE 6-1

NORTH ZONE FIELD TESTING



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WATER UTILITIES LEE'S SUMMIT

FIGURE 6-2

SOUTH ZONE FIELD TESTING

represent the relative internal roughness and provide an indication of the degree of roughness within a pipe. Pipes with high C-values convey water with little frictional headloss, but C-values generally decrease with age. Pipes with low C-values can be indicative of partially closed valves in the distribution system, partially closed valves on the fire hydrant service lateral, distribution system scaling, or other water quality issues. When C-values degrade beyond a certain point, pipe replacement should be considered.

Model calibration results are listed in Appendix E for the North and South zones. The C-values applied in the model calibration effort adequately represent the testing conditions for the system demands experienced at the time of each test. It should be noted that five (5) static calibration tests did not meet the criteria of plus or minus 5 pounds to the data logger, the locations and justification as follows:

1. North Zone:
    a. Northgate Drive: adjusting locational pipe C-values has marginal effect within the vicinity of Data Logger 76161. Further adjustment of C-values impacts the calibration status on batch pipes for other tests conducted nearby.
    b. NE Gateway Dr & Goshen Drive: adjusting locational pipe C-values has marginal effect. Further adjustment of C-values impacts the calibration status on batch pipes for other tests conducted nearby.
    c. Potential Cause: partially closed valves near this location, fire hydrant assembly issues, incorrect pressure gauge reading and/or documentation.
2. South Zone:
    a. SW 11th Terrace: static pressure at Hydrant C measures 16 psi higher than Hydrant A. The proximity of the fire hydrants, comparable grade elevations, and system conditions at the time of the test do not suggest a pressure difference this large is likely under normal conditions. It is assumed this value was a data capture error in the field and is not included as a calibration point.
    b. SW Hickory Lane: adjusting locational pipe C-values has marginal effect. Further adjustment of C-values impacts the calibration status on batch pipes for other tests conducted nearby.
    c. E 130 Street: adjusting locational pipe C-values has marginal effect. Further adjustment of C-values impacts the calibration status on batch pipes for other tests conducted nearby.
    d. Potential Cause: partially closed valves near this location, fire hydrant assembly issues, incorrect pressure gauge reading and/or documentation.

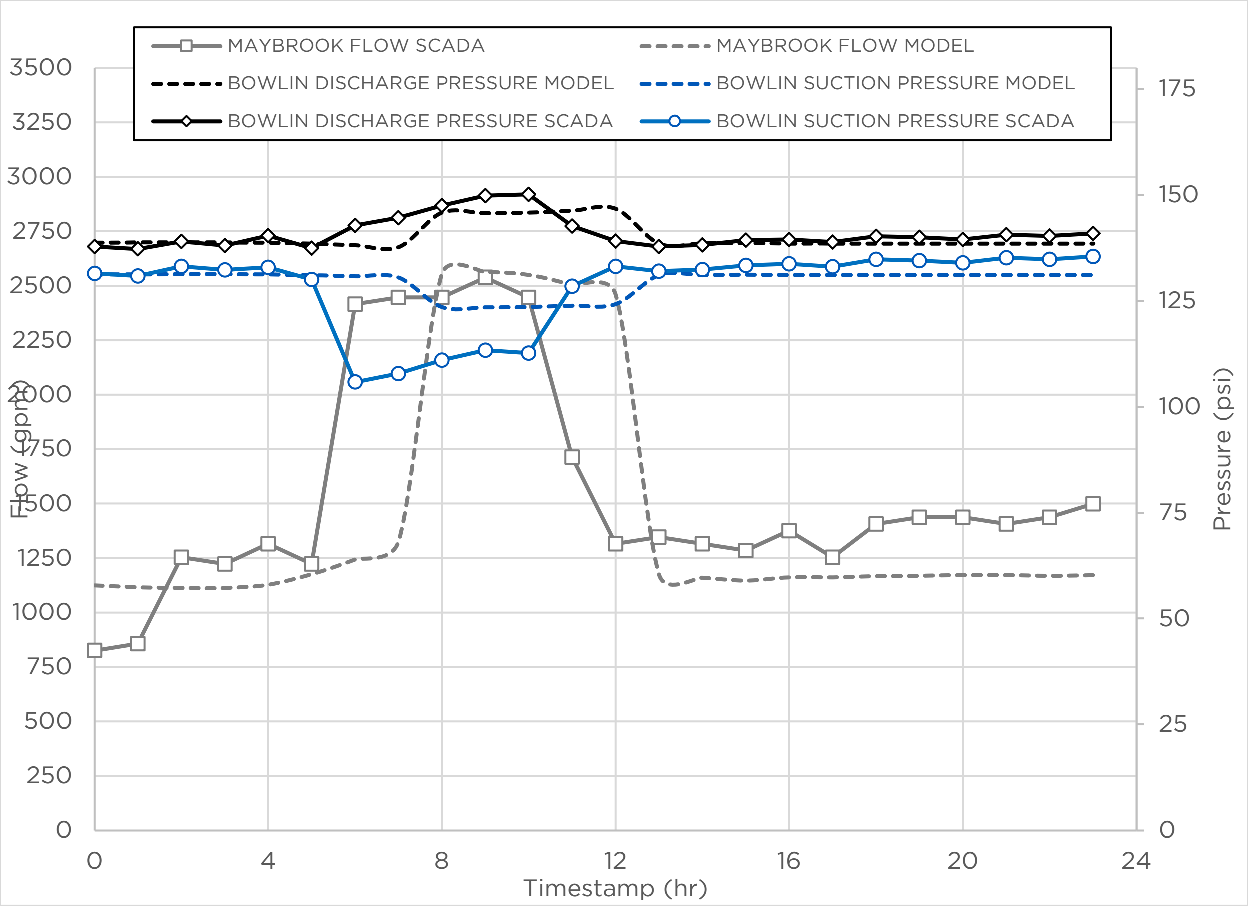
6.6 EPS Model Calibration

EPS calibration reflects the model's ability to simulate operational controls at each facility for varying demand conditions experienced over 24-hours. Water system SCADA information and detailed control schemes provided by City staff for a high flow (demand) day in August 2022 is integrated into the model to validate the static calibration efforts and confirm the real-world operations are reflected in the model.

The City recently integrated new control schemes for the North and South zones after field testing and static model calibration efforts. The current control scheme is integrated into the

EPS calibration scenario for the system conditions on August 5, 2022. The EPS model results are compared with SCADA trending for each elevated tank (tank level) and each pump station (flow and discharge pressure) in the North and South zones and are illustrated in Figures 6-3 through 6-7.

Figure 6-3: North Zone EPS Calibration at Bowlin Pump Station



Model results for flow and pressure, as illustrated in Figure 6-3, reflect a delay or attenuation period of approximately 2 hours compared with SCADA. This is attributed to simulating the actual control scheme for the entire North pressure zone versus simulating pump start/stop/speed and Lakewood supply based on timer controls. A timer control would shore up this attenuation time to match the SCADA data in a calibration mode, but it is more important that the model results reflect the pattern illustrated from SCADA data in a calibration mode so they can be applied to hydraulic analyses under different demand conditions (projections) in the future EPS modelling scenarios.

Figure 6-4: North Zone EPS Calibration at Lakewood Meter Vault

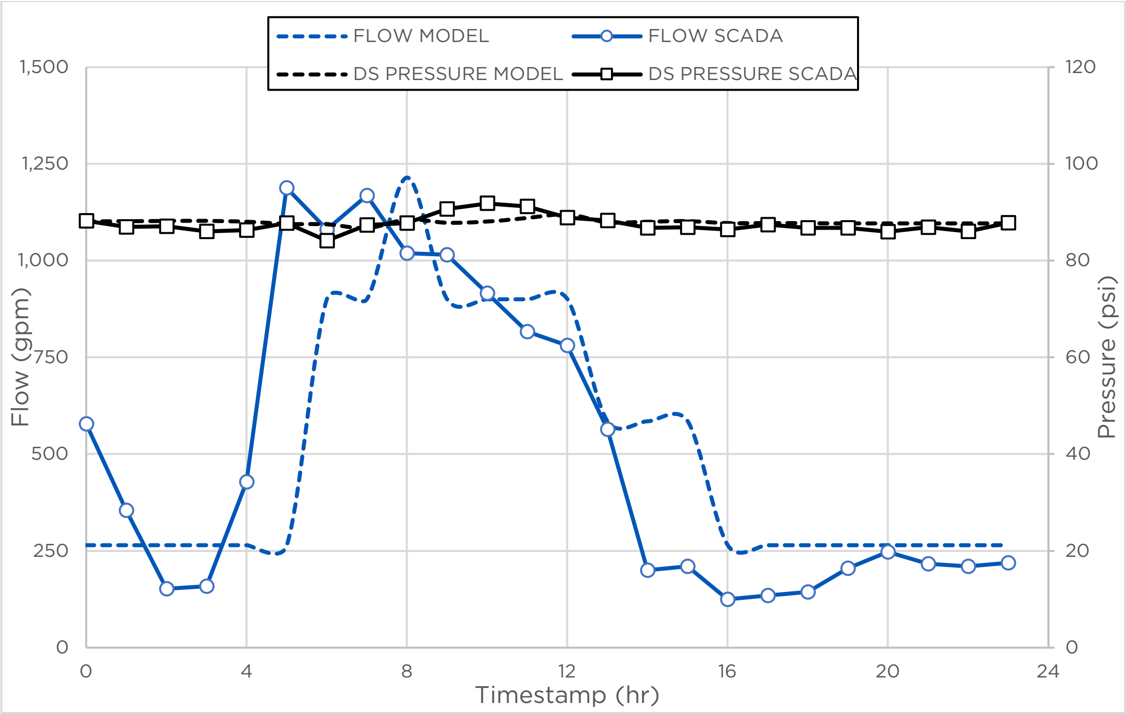


Figure 6-5: North Zone EPS Calibration at Woods Chapel Tank

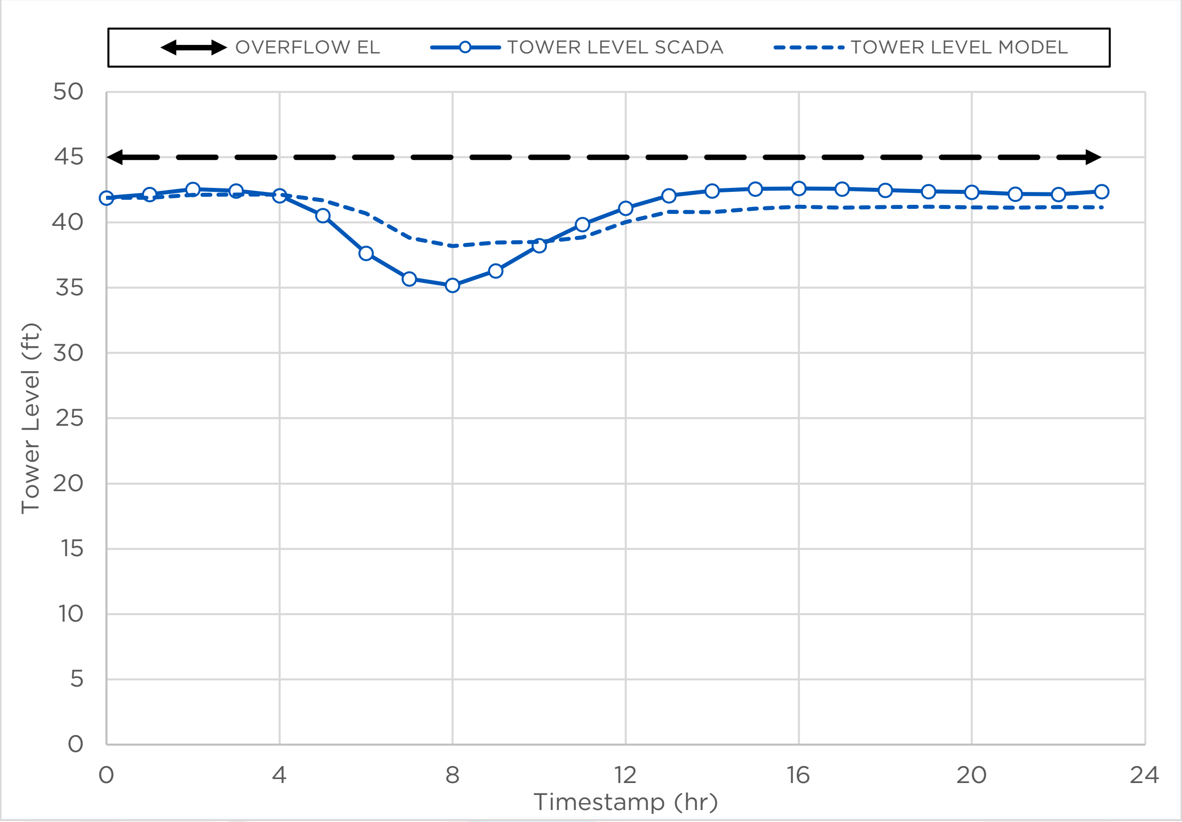


Figure 6-6: South Zone EPS Calibration at High Service and South Terminal Pump Stations

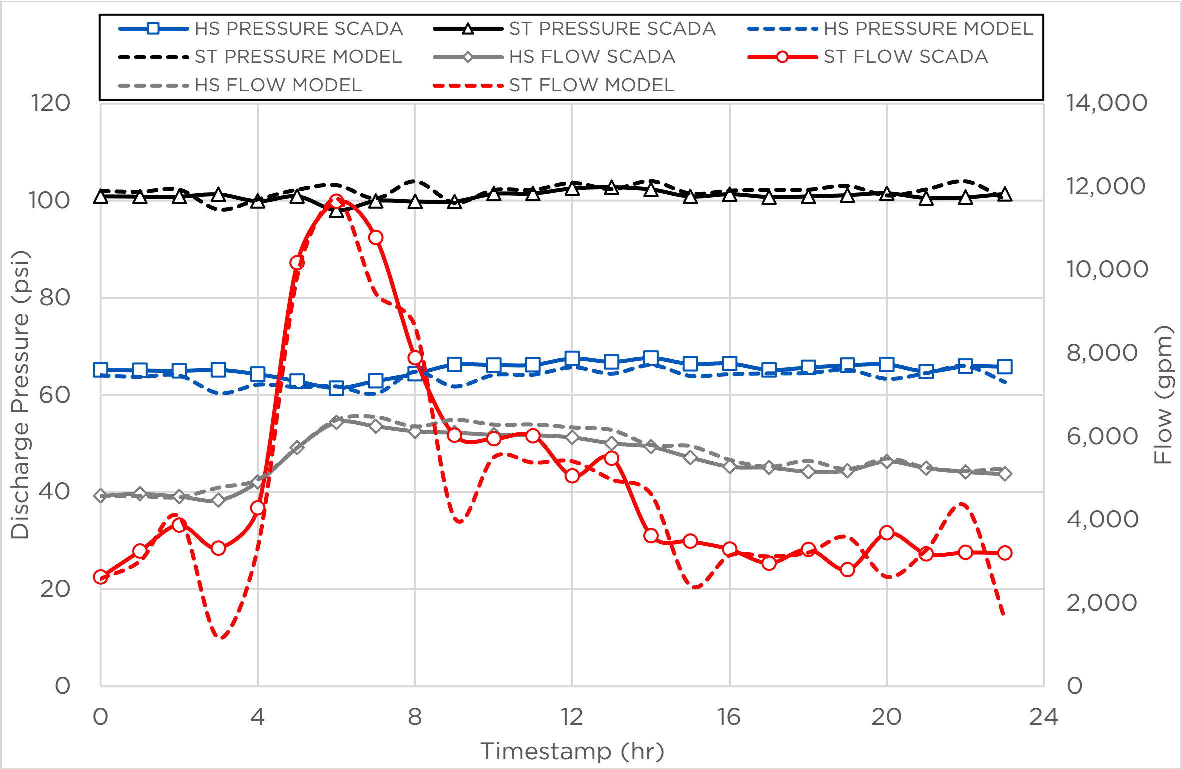
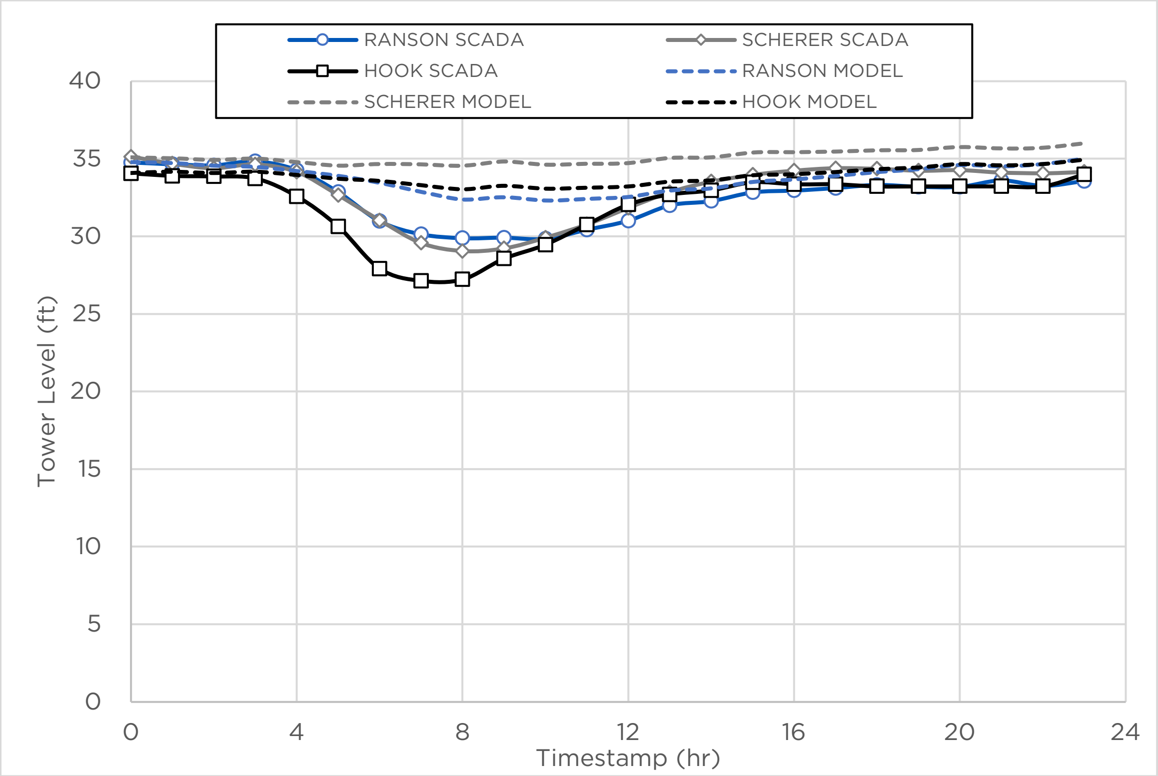


Figure 6-7: South Zone EPS Calibration at Ranson, Hook, and Scherer Tanks



7.0 Existing Distribution System Analysis

This section of the report includes a hydraulic analysis of the existing water distribution system based on a maximum day demand of 23.9 MGD (plus fire flow) and a water age analysis based on an average day demand of 10.8 MGD. The maximum day demands in the North and South zones are 3.7 MGD and 20.1 MGD. Results for high service pumping capacity, system pressure, storage, fire flow, and water age are included herein. This analysis is intended to identify strengths and weaknesses of the existing distribution system relative to the level of service conditions detailed in Section 5.0.

7.1 Pressure and Pumping

The existing system average pressure in the North zone under a maximum day demand is approximately 93 psi. Higher pressures ranging between 100 psi and 150 psi are in the residential neighborhoods along NE Anderson Dr and are a result being the lowest elevation in the North zone. Lower pressures ranging between 55 psi and 70 psi are along the pressure zone boundary just north of the municipal airport and to the east in high elevation areas surrounding Woods Chapel tank. The range of pressure in the North zone under maximum day demands are illustrated in Figure 7-1 and meet the level of service condition for minimum pressure. The high pressure area discussed above does exceed the maximum pressure of 140 psi, but this level of service is conditional based on the pressure rating of the pipe. If chronic water main breaks begin occurring the City should implement a sub-pressure zone by adding pressure reducing valves to lower the operating pressure while maintaining the ability to deliver fire flow demands; the latter fire flow functionality can be provided with a low pressure detect bypass valve to deliver high rates of flow if downstream pressure drops below 25 psi.

The existing system average pressure in the South zone under a maximum day demand is approximately 91 psi. Higher pressures ranging between 110 psi and 130 psi are in the residential neighborhoods near the intersection of NE Scruggs Rd and NE Bristol Dr and are a result of low elevation in the South zone. Higher pressure due to low elevation is also in the residential neighborhoods SW 3rd St and Winterpark Blvd and ranges between 110 psi and 150 psi. The range of pressure in the South zone under maximum day demands is illustrated in Figure 7-2.

System head curves at Bowlin, High Service, and South Terminal pump stations for existing system conditions are illustrated in Figures 7-3, 7-4, and 7-5 respectively. These curves are based on maximum day demand conditions and include the representative static head range of each pumping facility. Low system head curves are based on full ground storage on the suction side and empty elevated storage in the distribution system. Conversely, the high system head curves are based on empty ground storage on the suction side and full elevated storage in the distribution system. The static head range for each pump station is listed below:

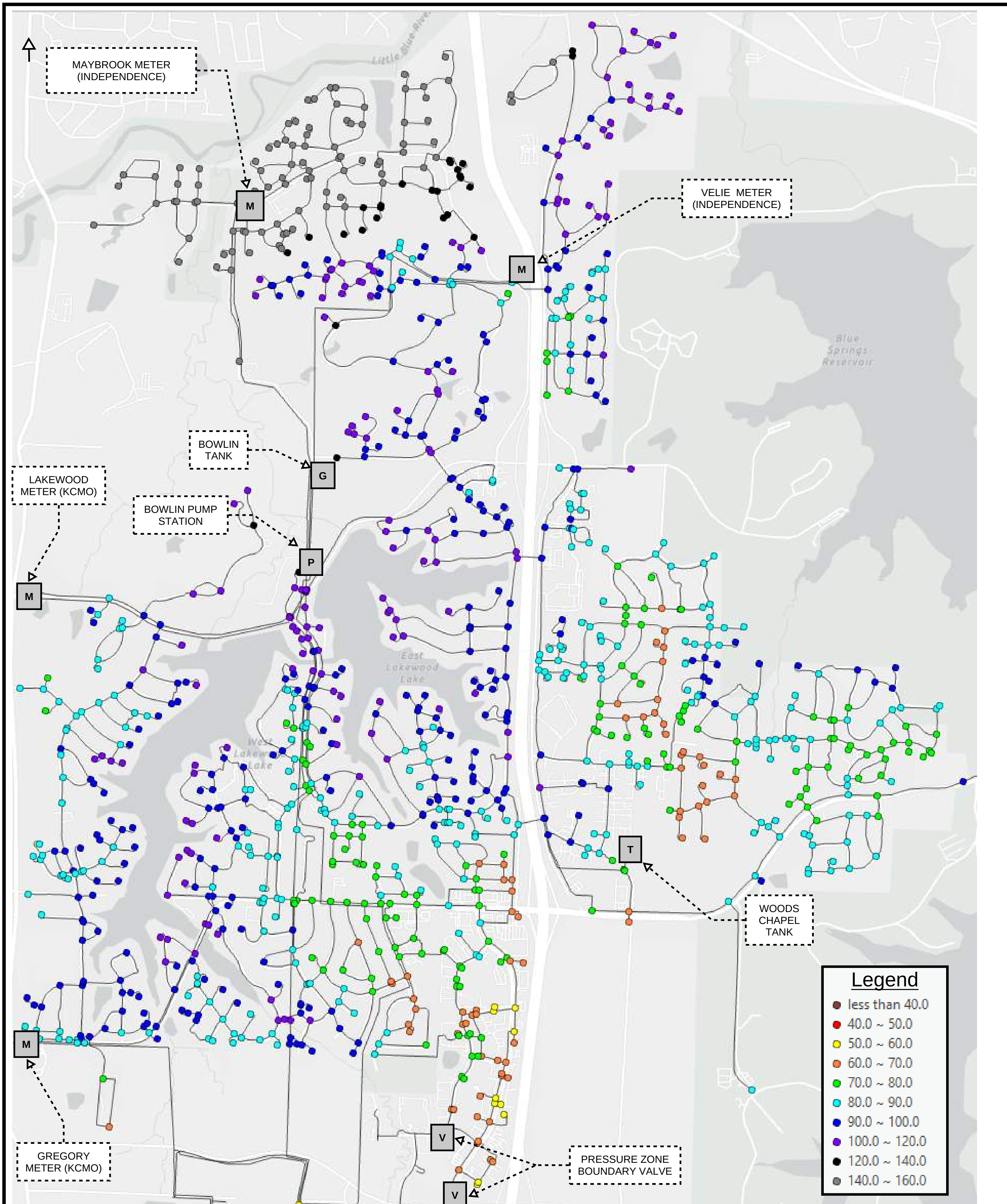


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FIGURE 7-1

NORTH PRESSURE ZONE AVERAGE PRESSURE EXISTING MAX DAY EPS

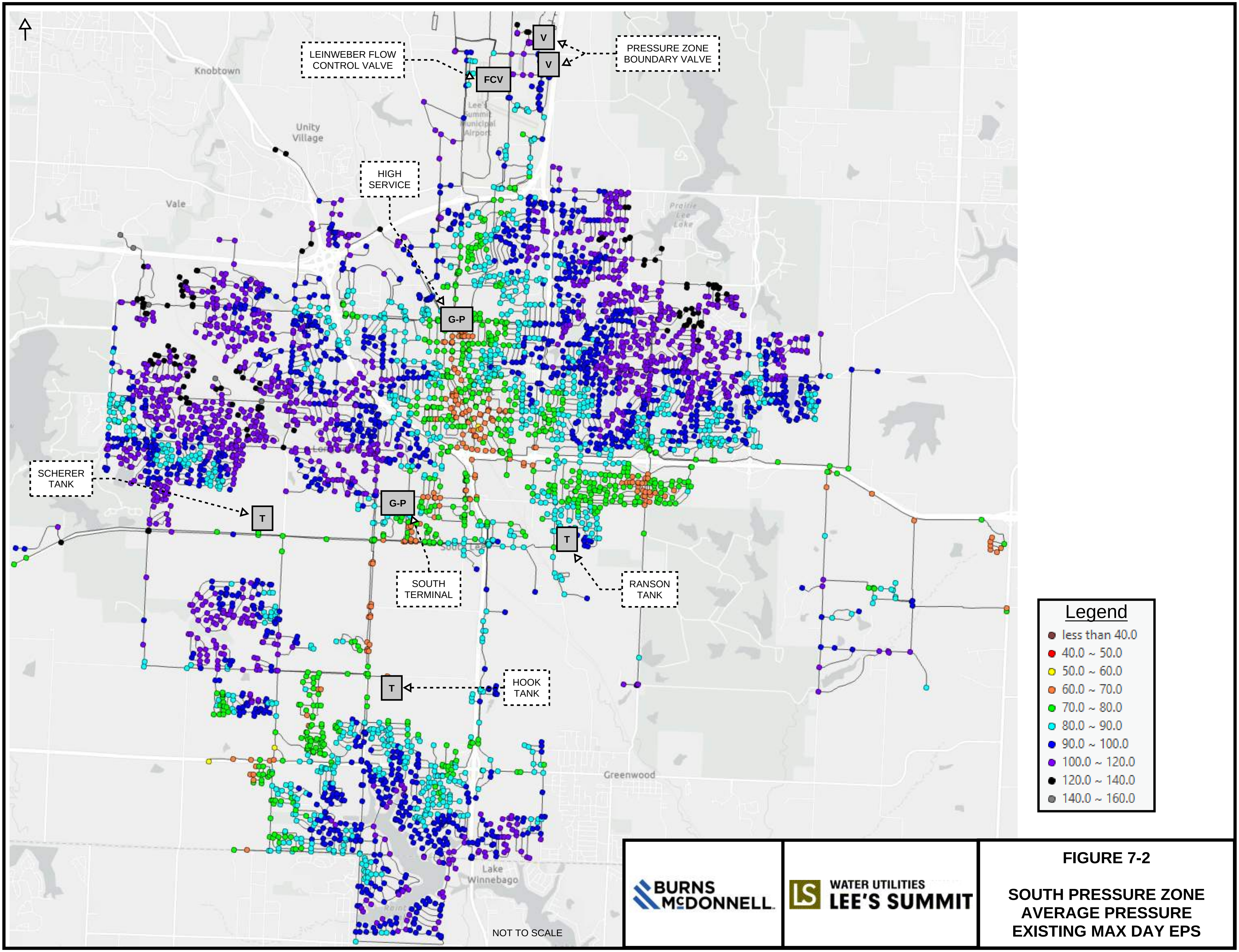

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FIGURE 7-2

SOUTH PRESSURE ZONE AVERAGE PRESSURE EXISTING MAX DAY EPS

- Bowlin booster pumps 1 and 2 is based on a constant suction pressure, or equivalent suction hydraulic grade line, at the booster pumps from Maybrook meter vault and the 45 ft head range of Woods Chapel elevated tank.
- Bowlin high service pump 3 is based on the 60 ft head range Bowlin ground storage tank and the 45 ft head range of Woods Chapel tank.
- High Service pump station is based on the 25 ft head range in the 4.0 MG and 5.5 MG ground storage tanks and the 40 ft head range of Ranson, Scherer, and Hook elevated tanks.
- South Terminal pump station is based on the 80 ft head range in the 6.7 MG ground storage tank and the 40 ft head range of Ranson, Scherer, and Hook elevated tanks.

Figure 7-3: Bowlin Pump Station System Head Curves

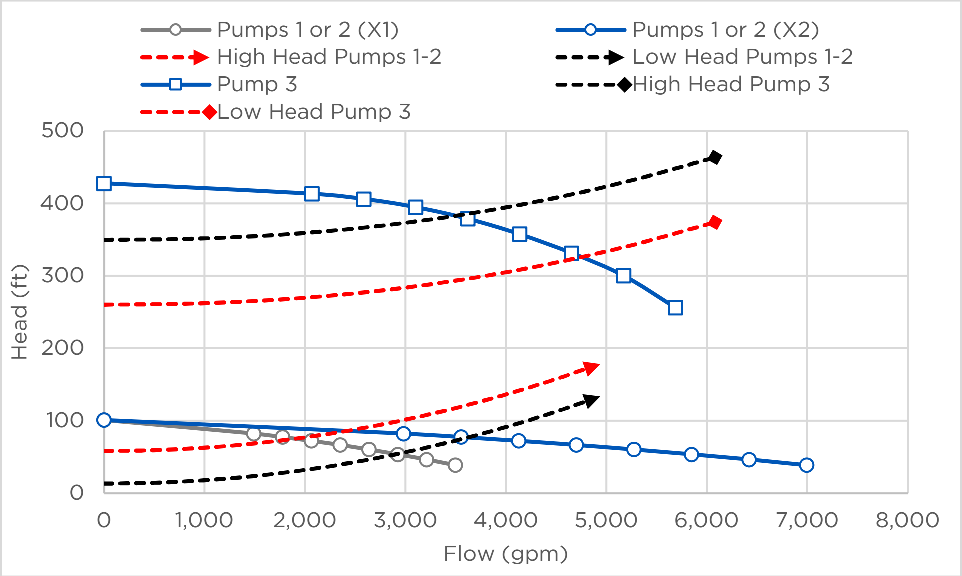


Figure 7-4: High Service Pump Station System Head Curves

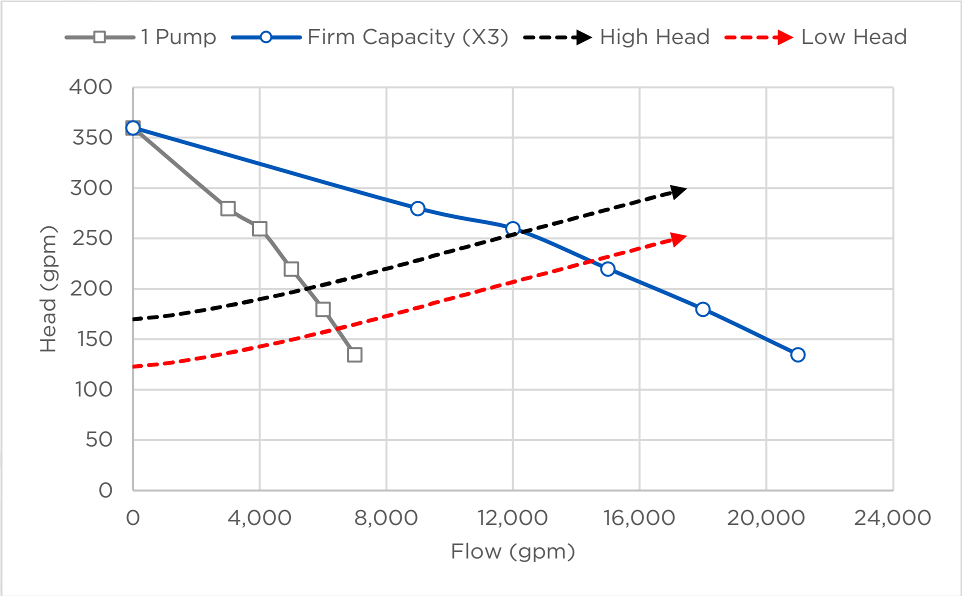
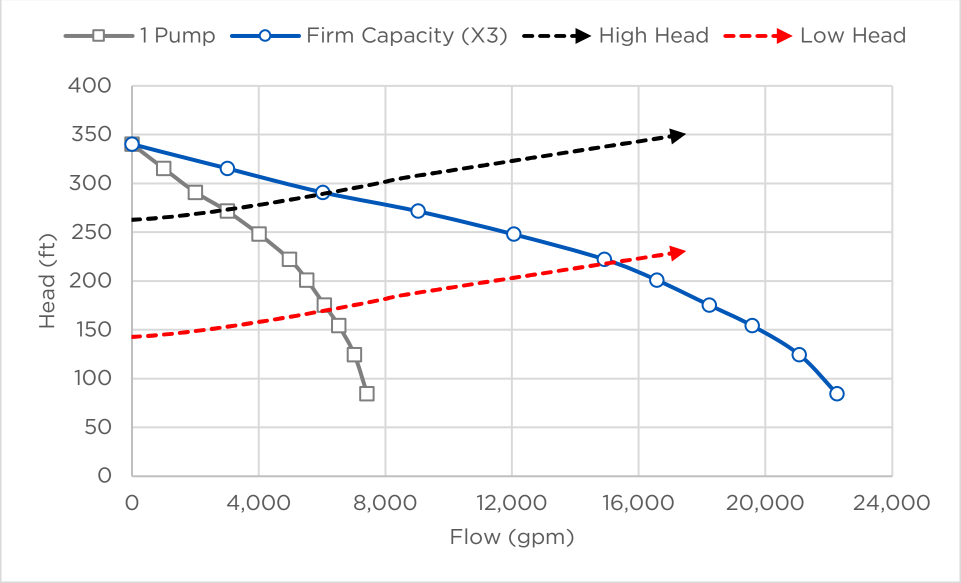


Figure 7-5: South Terminal System Head Curves



Review of the system head curves above indicates the existing pump stations are adequately sized to deliver maximum day demands with sufficient head to meet the level of service conditions for pressure.

7.2 Water Distribution

Maximum day demands are evaluated in the EPS model to identify high velocity and high headloss water mains and confirm the demands can be supplied by pumping and supply facilities and their associated control scheme. The level of service conditions for distribution system hydraulics includes water main velocity less than 5.0 fps and headloss less than 6 ft per 1,000 ft of pipe each (24-hr average). Water mains that only exceed the criteria under peak hour demands are typically not candidates for replacement in distribution systems with elevated storage, as is the situation in Lee's Summit, unless tank replenishment during low demand periods is an issue. The model results identified no high velocity or high headloss in the distribution system; therefore, no near-term high priority hydraulic water main improvements are required for this demand condition. The average water main velocity in the North and South zones is illustrated in Figures 7-6 and 7-7 respectively. The average headloss per 1,000 ft is illustrated in Figures 7-8 and 7-9 respectively.

7.3 Storage Analysis

The amount of storage required in the distribution system is dependent on multiple factors related to diurnal usage, fire flow needs, the amount of emergency storage desired by the City, contractual requirements, and types of storage present such as ground and/or elevated tanks. Allocations for equalization storage, fire storage, and emergency storage for the distribution system are quantified to determine the minimum storage requirement and if a storage surplus or storage deficit exists; these allocations are discussed in further detail below:

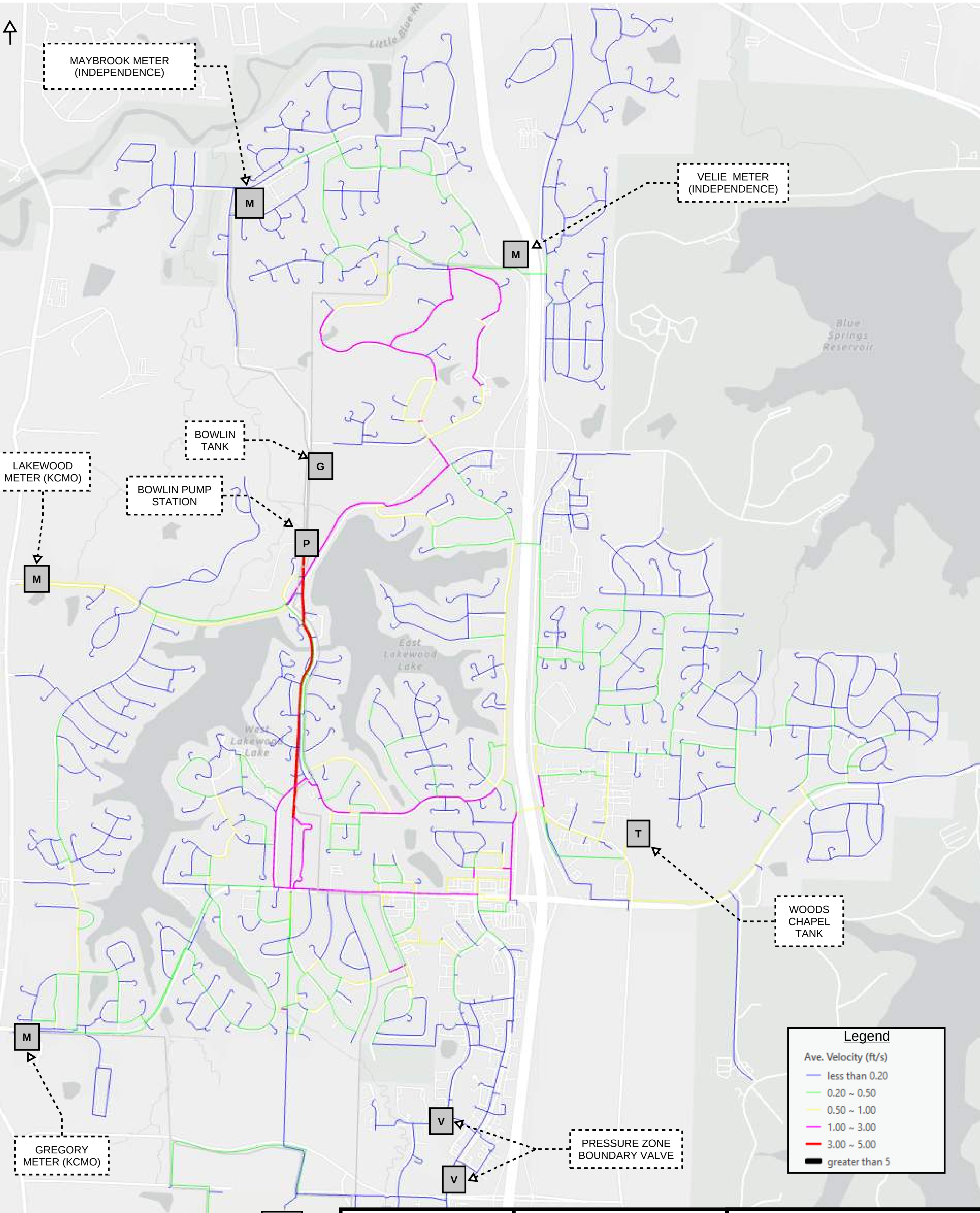


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FIGURE 7-6

NORTH PRESSURE ZONE AVERAGE VELOCITY EXISTING MAX DAY EPS

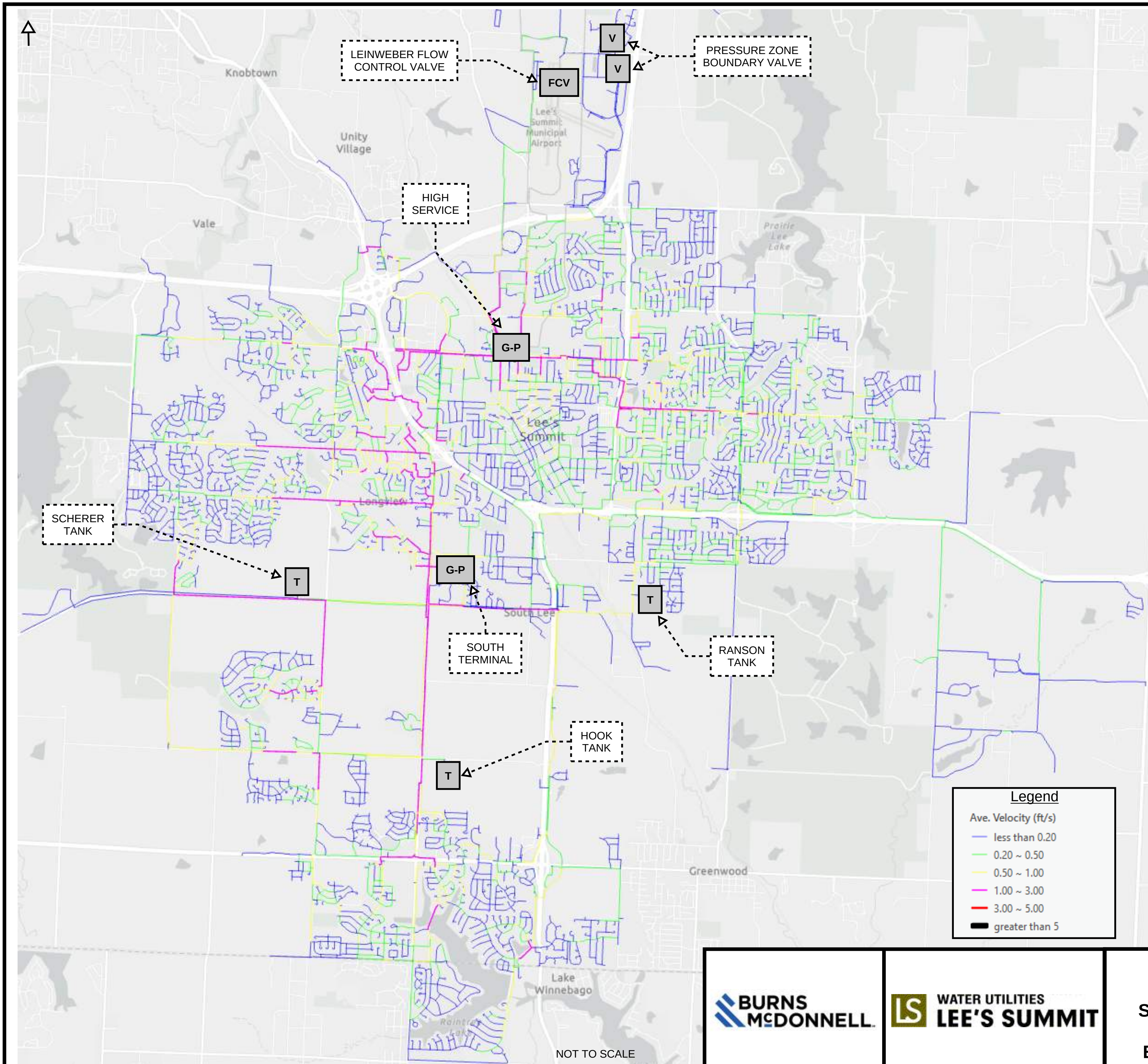

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FIGURE 7-7

SOUTH PRESSURE ZONE AVERAGE VELOCITY EXISTING MAX DAY EPS

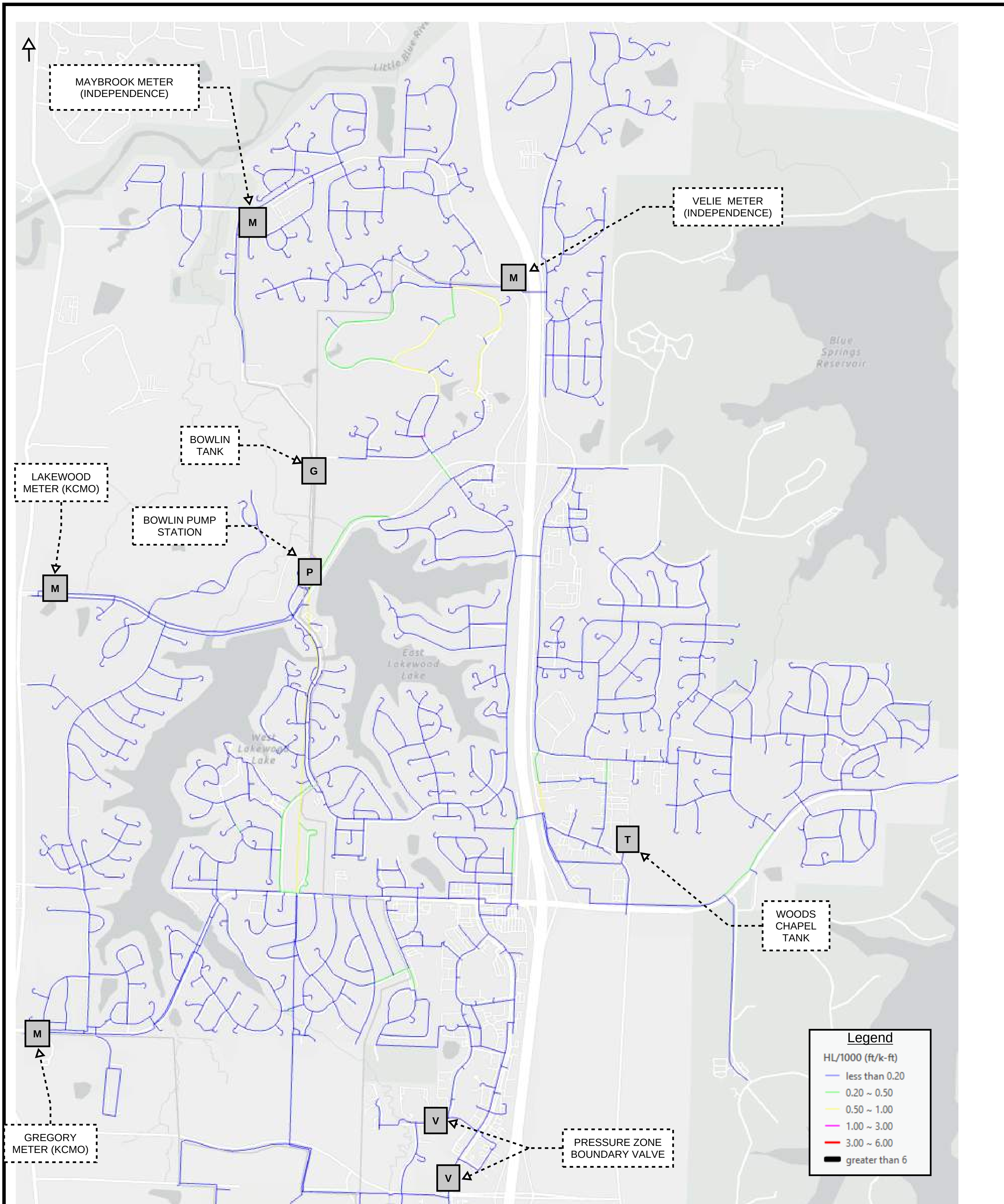

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FIGURE 7-8

NORTH PRESSURE ZONE HEADLOSS PER 1000' EXISTING MAX DAY EPS

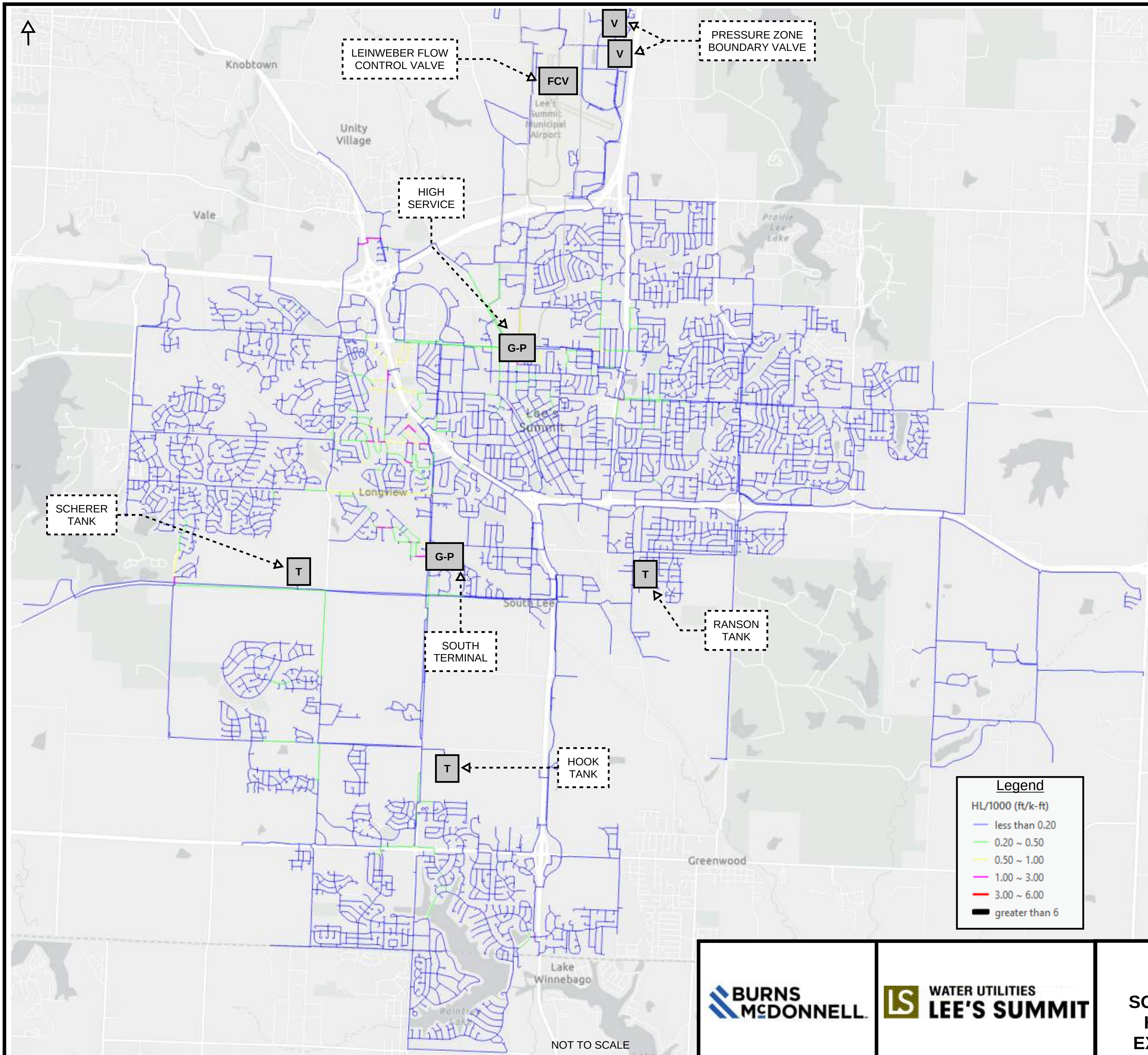

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FIGURE 7-9

SOUTH PRESSURE ZONE HEADLOSS PER 1000' EXISTING MAX DAY EPS

- Equalization reserve represents peaking demands greater than the 24-hour average demand that depletes system storage throughout the day. Equalization storage is typically considered the upper halves of elevated tanks that can be replenished over a 24-hour period.
- Fire reserve is the amount of storage required for fire flow conditions and is governed by the types of customer facilities in the distribution system. The City indicated a maximum fire flow requirement of 4,000 gpm for a 4-hour duration which is an equivalent volume of 0.96 MG.
- Emergency reserve is a quantity designated by the City and represents storage desired in excess of equalization and fire reserves. Emergency reserve also represents a storage surplus.
- A storage deficit occurs when the minimum storage requirement, which includes equalization plus fire storage, is less than the effective storage in the system.

The City also has contractual storage requirements tied to KC Water and Independence. A summary of the storage requirements for each supplier is listed below in addition to other recommendations that should be applied in the storage analysis.

- Independence:
  - Contractual storage requirement:
    - Equalization demands.
  - Recommendations for storage analysis:
    - Add maximum fire flow requirement.
    - Include contractual capacity for wholesale supply from Lakewood meter vault via KC Water. For clarity, supply from Lakewood meter vault is direct distribution into the North zone.
- KC Water:
  - Contractual storage requirement:
    - Equalization storage equivalent to a minimum of half the average day demand.
    - Emergency storage equivalent to the average day demand.
    - Minimum storage requirement is equalization plus emergency.
  - Recommendations for storage analysis:
    - It is uncertain if emergency includes fire storage within the context of the agreement; therefore, the assumption is to add the maximum fire flow requirement.
    - Minimum storage requirement includes equalization, emergency, plus fire.
- Storage Analysis Approach:
  - The storage requirements associated with the Water Purchase Agreement with KC Water exceed those with the Independence contract; therefore, the contractual storage requirements with KC Water are applied in the storage analysis.
  - Minimum storage requirement includes equalization, emergency, plus fire.

Distribution system storage can be held in elevated tanks or pumped from ground storage tanks; but not all storage is termed effective storage. Elevated storage is effective if the bottom elevation of the tank bowl can provide a minimum pressure of 20 psi in the distribution system under fire flow conditions. Ground storage is effective if the firm capacity of a pump station(s) exceeds the maximum day demand and has emergency power or, at a minimum, the ability to temporarily dock a transportable generator at the facility. Storage can also be shared amongst multiple zones. The effective storage of each facility in the North and South zones is discussed below and summarized in Tables 7-1 and 7-2 respectively.

- Bowlin pump station has switchgear for emergency power, though service capability is uncertain. The City indicated there is an existing CIP for emergency power at Bowlin pump station, but since pump 3 is the only pump that can deliver ground storage to the North zone there is no firm capacity. Therefore, Bowlin ground storage is not termed effective for the North zone.
- Bowlin pumps 1 and 2 are 4.0 MGD booster pumps supplied by a separate delivery point from Independence through the Maybrook meter vault. Since the City has a CIP in place for emergency power, the firm capacity for the boosted supply of 4.0 MGD, or an equivalent 24-hour boosted storage capacity of 4.0 MG, is termed effective storage for the North zone.
- The North zone has a direct wholesale connection with KC Water at Lakewood meter vault with a contractual capacity of 4.5 MGD, however operations in KC Water's system limit the reliable supply capacity to maximum of approximately 2.5 MGD as indicated by City staff. Therefore, the reliable supply capacity of 2.5 MGD, or an equivalent 24-hour supplied storage capacity of 2.5 MG, is termed effective storage for the North zone.
- Bowlin ground storage tank has piping/valving to supply the Velie main and convey it to ground storage at High Service pump station for the South zone. Shared storage amongst the North and South zones held at Bowlin tank is allocated based on the demand ratio (maximum day) of one to the other. The North:South demand ratios are a 16:84, 15:85, and 13:87 split of Bowlin ground storage tank for the existing, 2025, and 2040 planning periods respectively.
- The Leinweber control valve can supply ground storage at High Service pump station from the North zone; for the purposes of this report its storage contribution to the South zone is not included in the analysis and is a conservative approach.
- The total firm capacity of High Service and South Terminal pump stations is 45.4 MGD and exceeds the South zone maximum day demand of 30.8 MGD (2040 projection) and each has emergency power for firm capacity pumping; therefore, the total available volume at each facility is termed effective.
- For the purposes of this analysis the Harris Park facility is not included and is recommended for removal based on review with the City and is not used.

Table 7-1: North Zone Storage Summary

Facility/Supply	Available Storage (MG)	Effective Storage (MG)		
		Max Day (MGD)		
		3.7	3.9	4.7
		Existing	2025	2040
Bowlin ground storage tank	5.5	0.0	0.0	0.0
Woods Chapel elevated storage tank	2.5	2.5	2.5	2.5
Excess 24-hour supply capacity (Bowlin PS & Lakewood)	6.5	2.8	2.6	1.8
Total (MG)	14.5	5.3	5.1	4.3

Table 7-2: South Zone Storage Summary

Facility	Available Storage (MG)	Effective Storage (MG)		
		Max Day (MGD)		
		20.1	22.7	30.8
		Existing	2025	2040
Bowlin ground storage tank	5.5	4.6	4.7	4.8
High Service ground storage tank	4.0	4.0	4.0	4.0
High Service ground storage tank	5.5	5.5	5.5	5.5
South Terminal ground storage tank	6.7	6.7	6.7	6.7
Hook elevated storage tank	3.0	3.0	3.0	3.0
Scherer elevated storage tank	3.0	3.0	3.0	3.0
Ranson elevated storage tank	2.0	2.0	2.0	2.0
Total (MG)	29.7	28.8	28.9	29.0

Results of the storage analysis for the existing system are listed in Table 7-3 and indicate a surplus of 1.8 MGD in the North zone and a surplus of 14.2 MGD in the South zone. There are no immediate storage improvements needed to comply with the contractual requirements of KC Water or Independence. If there are operational concerns with supply from the Lakewood meter vault at the contractual capacity of 4.5 MGD then the City should continue working with KC Water for a solution to deliver this amount or consider amending the agreement to move the capacity to another location.

Table 7-3: Existing System Storage Analysis

Reserve	Item	North Zone	South Zone
Fire	Fire flow requirement (gpm)	4,000	4,000
	Duration (hrs)	4	4
	Fire reserve (MG)	1.0	1.0
Equalization	Half the average day demand (MG)	0.9	4.6
Emergency	Average day demand (MG)	1.7	9.1
	Storage Requirement (MG)	3.5	14.6
	Effective Storage (MG)	5.3	28.8
	Storage Surplus (MG) = Effective – Requirement	1.8	14.2

The City has a robust storage system, not only evidenced by the surplus indicated above, but also due to the shared storage ability between the North and South zones. Ground storage at Bowlin pump station (via Pump 3) and direct supply from Lakewood meter vault can be conveyed from the North zone to the South zone through the Leinweber control valve. The Leinweber control valve supplies ground storage at High Service pump station where it is pumped into the South zone.

7.4 Fire Flow Analysis

A static simulation is used to evaluate available fire flows throughout the distribution system at a residual pressure of 20 psi under the maximum day demand condition. Available fire flow is determined at select junctions that generally represent fire hydrants in the looped distribution system network, fire hydrants on dead ends, and other intermediate model junctions. The model can evaluate multiple fire flows concurrently, but for the purposes of this analysis the available fire flow is evaluated for a single event at a single location. The level of service for fire flow is 1,500 gpm and is added to domestic demand on these junctions. Junctions with available fire flow less than 1,500 gpm at 20 psi are investigated further via desktop analysis with aerial imagery and elevation; in some intendances hydrant ownership may be questionable (i.e. private hydrants connected to private loops that extend from City's water main). Additional field testing is recommended for confirmation of results in instances where available flows range between 1,300 gpm and 1,490 gpm which are relatively close to the level of service to determine if a capital improvement should be recommended.

The available fire flow results in the existing distribution system under the maximum day demands in the North and South zones is illustrated in Figures 7-10 and 7-11 respectively. Individual locations and/or areas with available fire flow less than 1,500 gpm are on older 4-inch water mains, 4-inch dead end water mains, and longer runs of 6-inch dead end water mains. A sensitivity analysis was conducted with the model at these locations and/or areas of non-compliance by replacing them with new 8-inch minimum water mains and a C-value of 140. Results of the sensitivity analysis indicated compliance with the level of service for fire flow at 1,500 gpm at a 20 psi residual.

7.5 Water Age Analysis

The water quality analysis evaluates water age in the existing distribution system to assist in predicting areas with the greatest potential with lower disinfectant residual. Water age is evaluated for average and maximum day demand at 10.8 MGD and 23.9 MGD respectively. The EPS water age analysis includes a duration adequate to capture the longest travel time within the distribution system for a unit of water to reach its destination; this is referred to as equilibrium or convergence and is variable based on the demand condition. The EPS duration for convergence under average day and maximum day demands is 30 days and 20 days respectively.

The average water age in each pressure zone is determined as the summation of the weighted average water age with respect to water demand of all model junctions in each pressure zone. For clarity, the water age results are relative to the supply systems included in the model for the North and South zones. Water age in the North zone resulting from water pumped from Bowlin pump station includes the travel time from Maybrook meter vault to Bowlin pump station; water age precipitating from Lakewood meter vault does not include travel time through the KC Water distribution system. Water age in the South zone resulting from water pumps from High Service pump station includes the travel time from the Gregory and Velie meter vaults, residence time in each ground storage tank, and travel time yard piping to the pump station. Water age resulting from water pumps from South Terminal pump station only includes residence time in the ground storage tank and travel time in yard piping to the pump station; it does not include the travel time through the Jackson-Cass

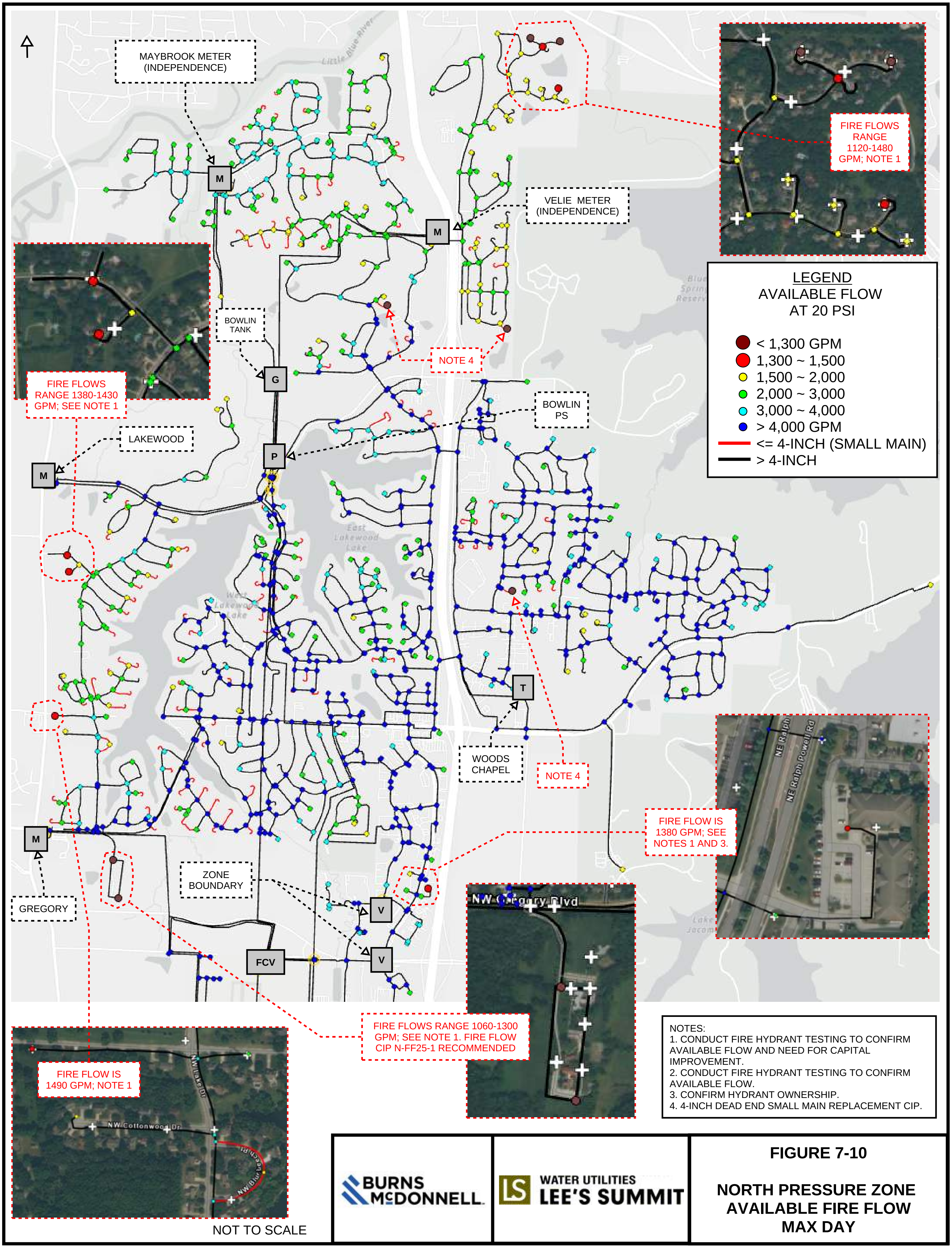

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FIGURE 7-10

NORTH PRESSURE ZONE AVAILABLE FIRE FLOW MAX DAY

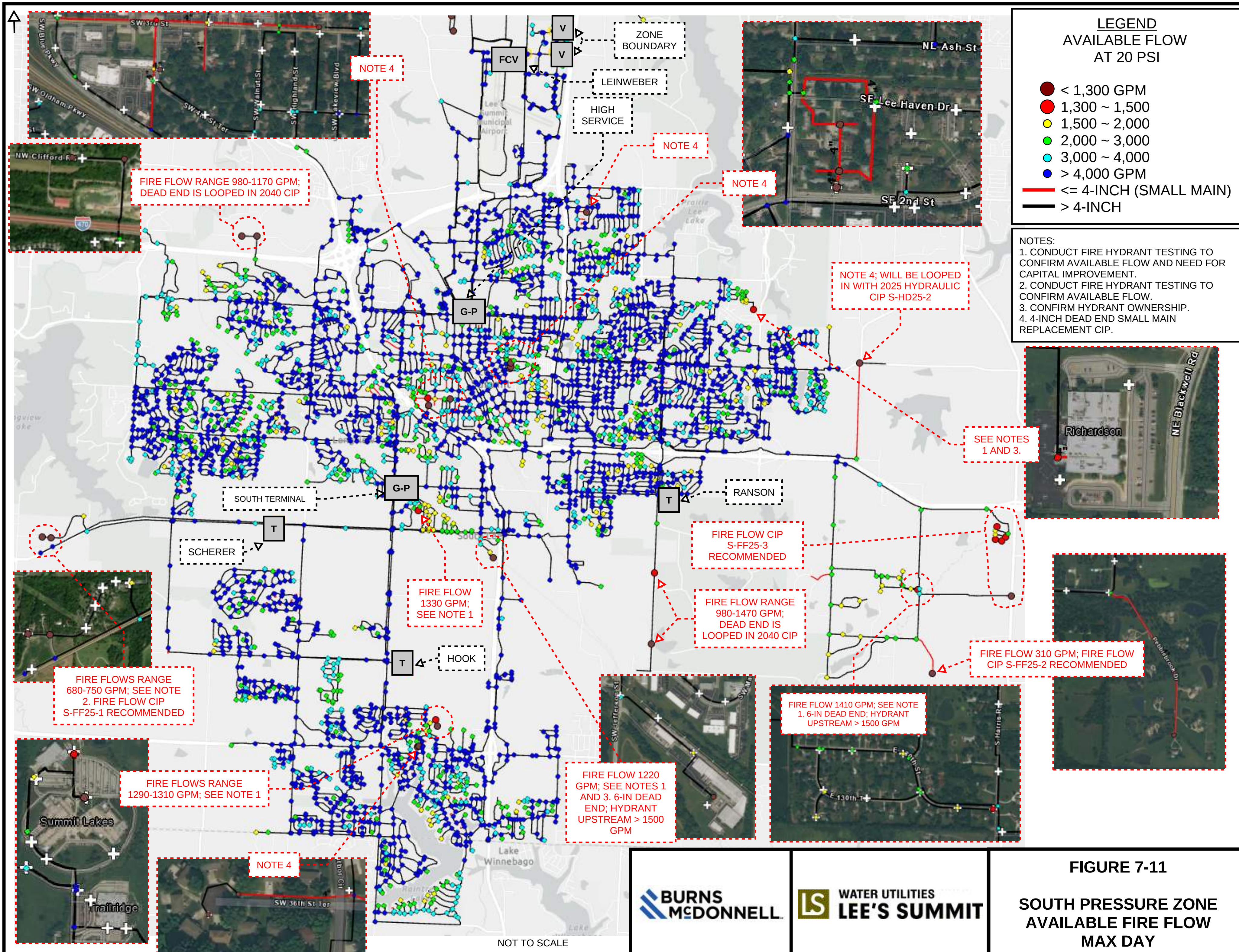

FIGURE 7-11

SOUTH PRESSURE ZONE AVAILABLE FIRE FLOW MAX DAY

transmission system. Because of the unknown water age or travel time through the KC Water distribution system, the Jackson-Cass transmission system, and Independence distribution system, the water age results are only intended to illustrate where high and low areas are relative to one another in each pressure zone under the model arrangement for the water supply system owned and operated by the City.

The average water age based on average day demands in the North and South zones is illustrated in Figures 7-12 and 7-13 respectively. Higher water ages in the North zone are in the areas north and east of Woods Chapel tank and primarily due to proximity of the tank and is further away from points of entry to the North zone. Similarly, higher water age in the South zone is in the northeastern areas which are further away from South Terminal pump station, also the lead pump station. The new operating controls at pump stations and Lakewood meter vault provide more water level stability, or less turnover, in elevated storage levels which can also contribute to higher water age. The localized, or concentrated, densities with water age greater than 96 hours represent dead end mains with little or no demand in most cases. The water age based on maximum day demands in the North and South zones are illustrated in Figure 7-14 and Figure 7-15. The average water age over the entire distribution system under maximum day demands and average day demands for each pressure zone as follows:

- North Pressure Zone:
    - Under average day demands the average age is 45.5 hours (1.9 days).
    - Under maximum day demands the average age is 19.2 hours (0.8 days).
- South Pressure Zone:
    - Under average day demands the average age is 59.0 hours (2.5 days).
    - Under maximum day demands the average age is 27.1 hours (1.1 days).

Under lower seasonal demands the City is proactive in maintaining storage amounts commensurate with the demand condition in both ground and elevated storage tanks; this is accomplished by removing Bowlin ground storage tank from service in the winter (temporary) and less reliance on South Terminal pump station.

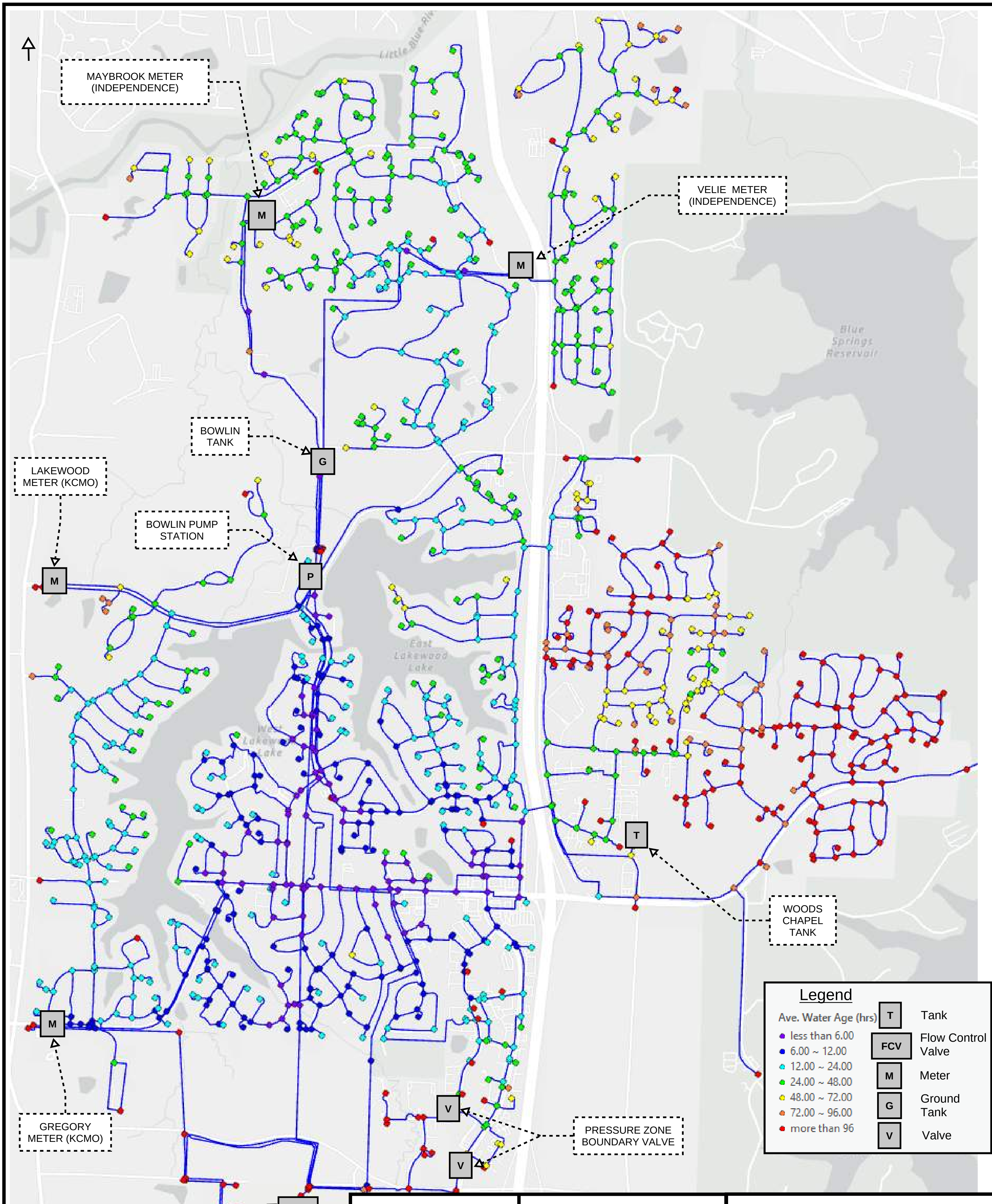

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FIGURE 7-12

NORTH PRESSURE ZONE AVERAGE WATER AGE AVERAGE DAY EPS

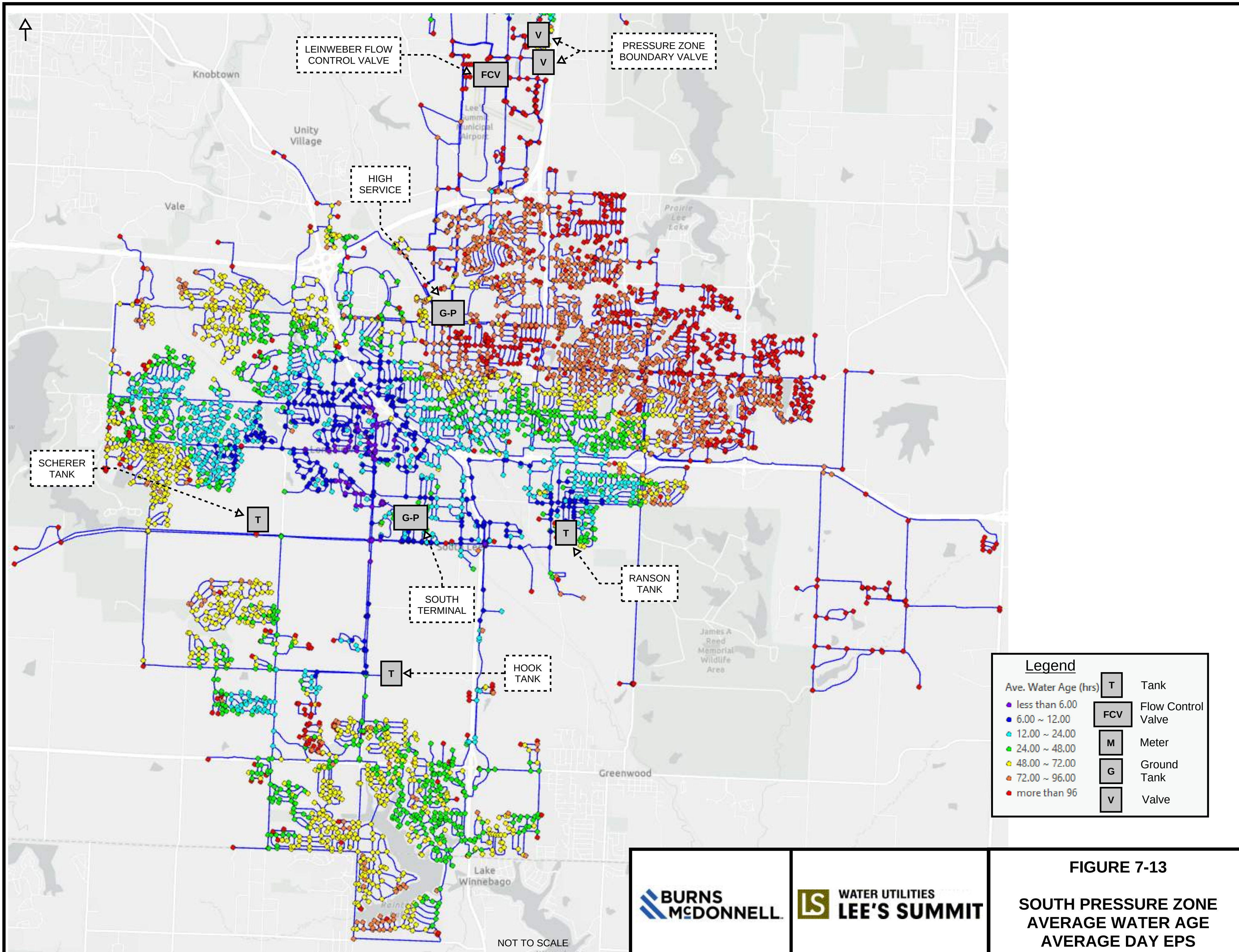

FIGURE 7-13

SOUTH PRESSURE ZONE AVERAGE WATER AGE AVERAGE DAY EPS

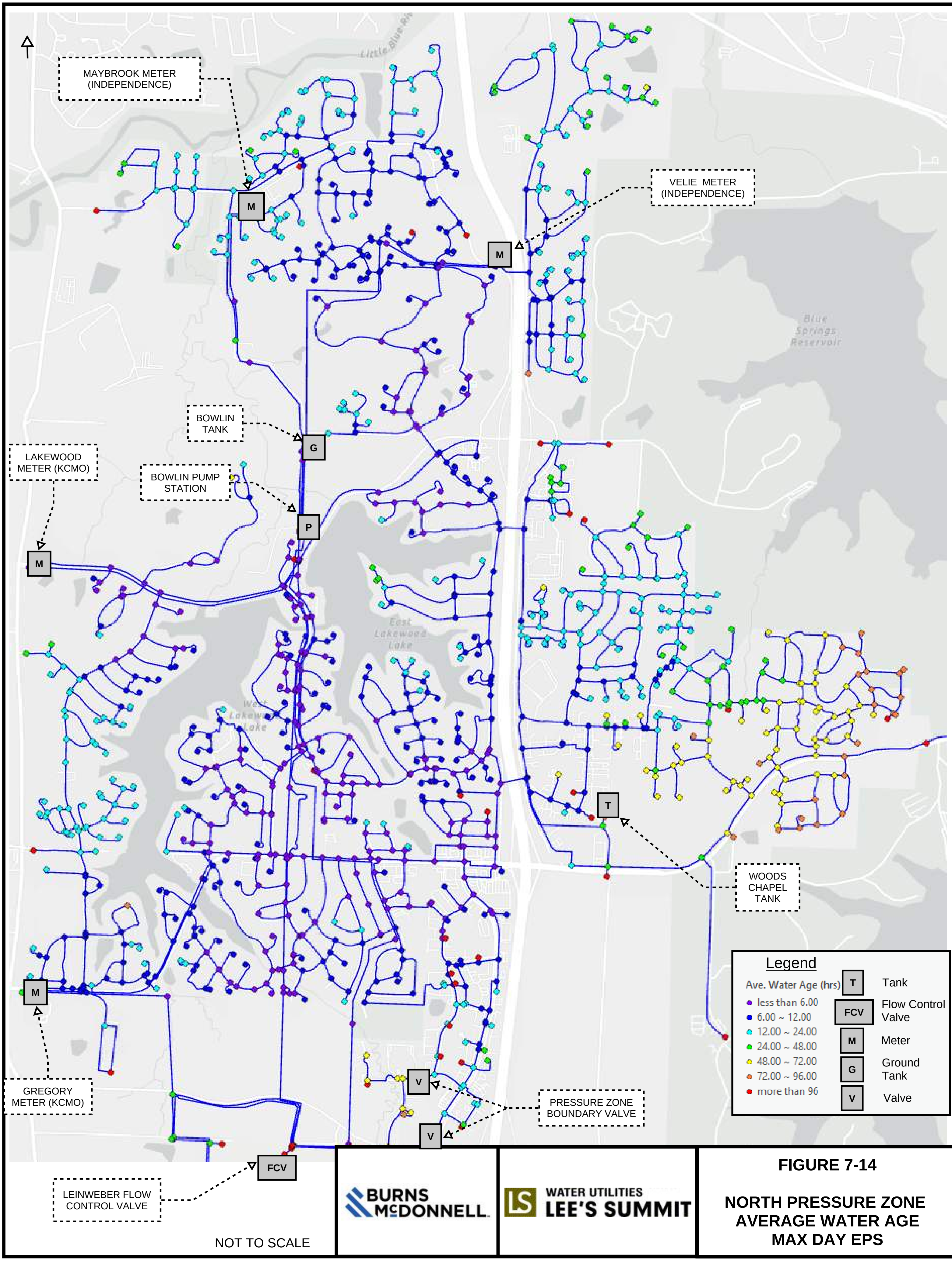

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FIGURE 7-14

NORTH PRESSURE ZONE AVERAGE WATER AGE MAX DAY EPS

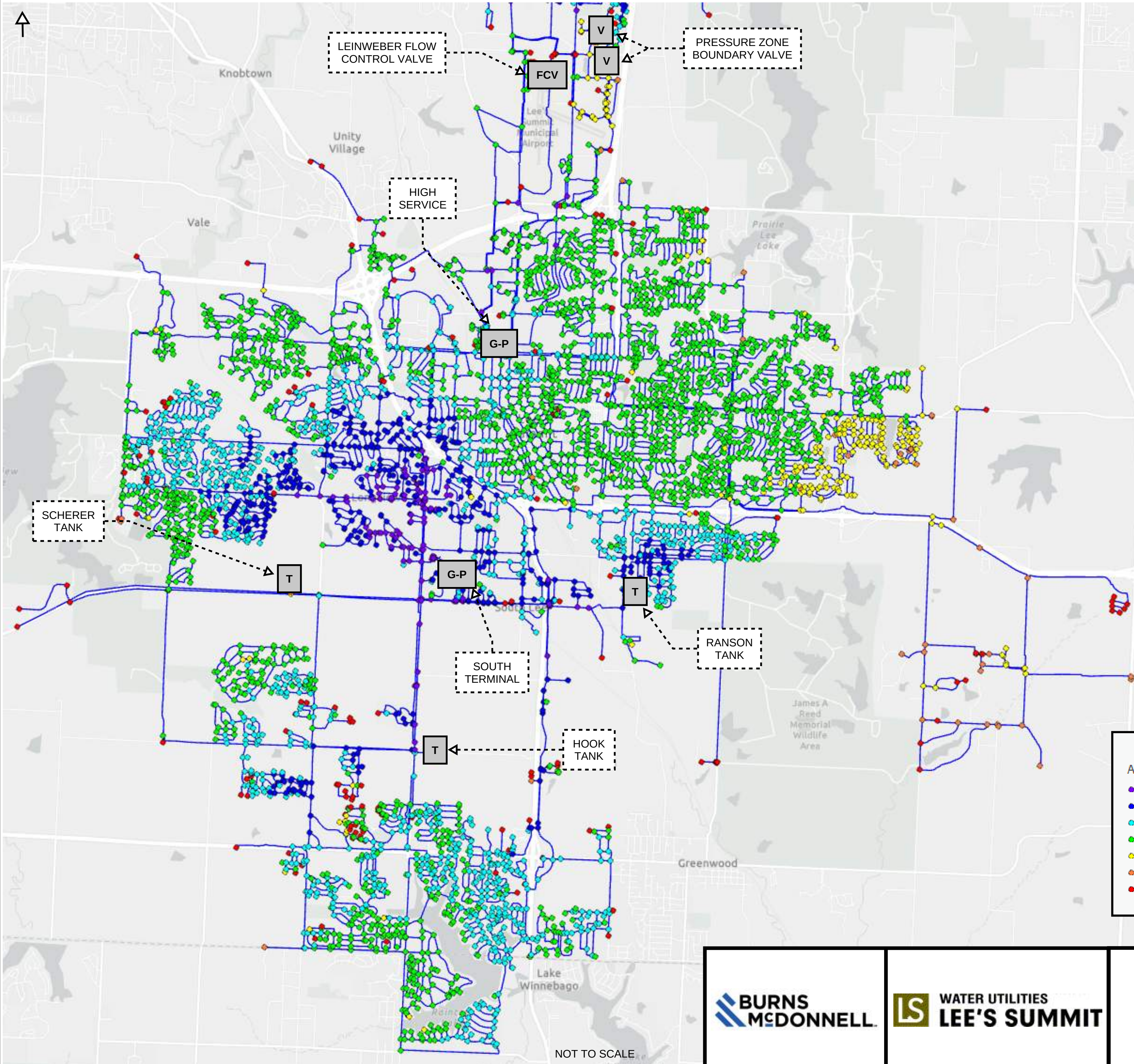

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FIGURE 7-15

SOUTH PRESSURE ZONE AVERAGE WATER AGE MAX DAY EPS

8.0 Future Distribution System Analysis

This section of the report includes the hydraulic analysis of the distribution system for the 2025 and 2040 planning periods for projected maximum day demands of 26.9 MGD and 35.4 MGD respectively. The 2025 demand projection includes a large user(s) demand of 0.5 MGD and the 2040 demand projections includes a large user(s) demand totaling 2.0 MGD. Results of the hydraulic analysis are compared with the level of service conditions to identify associated capital improvements for pumping, pressure, distribution, storage, and fire flow. Capital improvements associated with future growth are also included in the 2025 and 2040 model EPS scenarios and are representative of the development planning provided in the City's Comprehensive Plan; water main alignments for future growth in undeveloped areas of distribution system mostly parallel the Thoroughfare Master Plan included in the Comprehensive Plan as well as input from City staff.

8.1 Pressure and Pumping

The average pressure in the North and South zones under maximum day demands is marginally higher at 94 psi and 95 psi respectively and represents a net increase of 1 psi from existing system demands in both the 2025 and 2040 planning periods. The range of pressure and areas of high and low pressure in the North and South zones in both planning periods, as illustrated in Figures 8-1, 8-2, 8-3, and 8-4 respectively, is also consistent with the existing system results. Marginal differences in pressure with respect to the North zone are largely due to marginal differences in the projected demand and existing system demand. The maximum day demand in the North zone increases from 3.7 MGD to 3.9 MGD in 2025 and 4.7 MGD in 2040 and mirrors the lower growth opportunity which is approaching a buildout condition where peripheral expansion is limited by neighboring water service areas of Independence to the north, Blue Springs and Lake Jacomo to the east, and KC Water to the west.

Marginal differences in pressure with respect to the South zone are largely due to the capacity of the distribution system and the pumping capability in terms of flow and head and number of pumps at High Service and South Terminal pump stations. The pumping/supply capacity exceeds the demand projection for the North and South zones respectively as illustrated in Figures 8-5 and 8-6 respectively; therefore, no pumping improvements are needed in either zone through the 2040 planning period for capacity. It is important to note that the current operational capacity (approximately 2.5 MGD indicated by the City) from Lakewood is lower than the contractual capacity stated in the Water Purchase Agreement with KC Water. If the lower operational capacity is applied in desktop capacity evaluation illustrated in Figure 8-5, then the North zone still has a pumping capacity surplus through the end of the 2040 planning period. For clarity, Figure 8-5 reflects the contractual supply capacity of 4.5 MGD at Lakewood meter vault from KC Water.

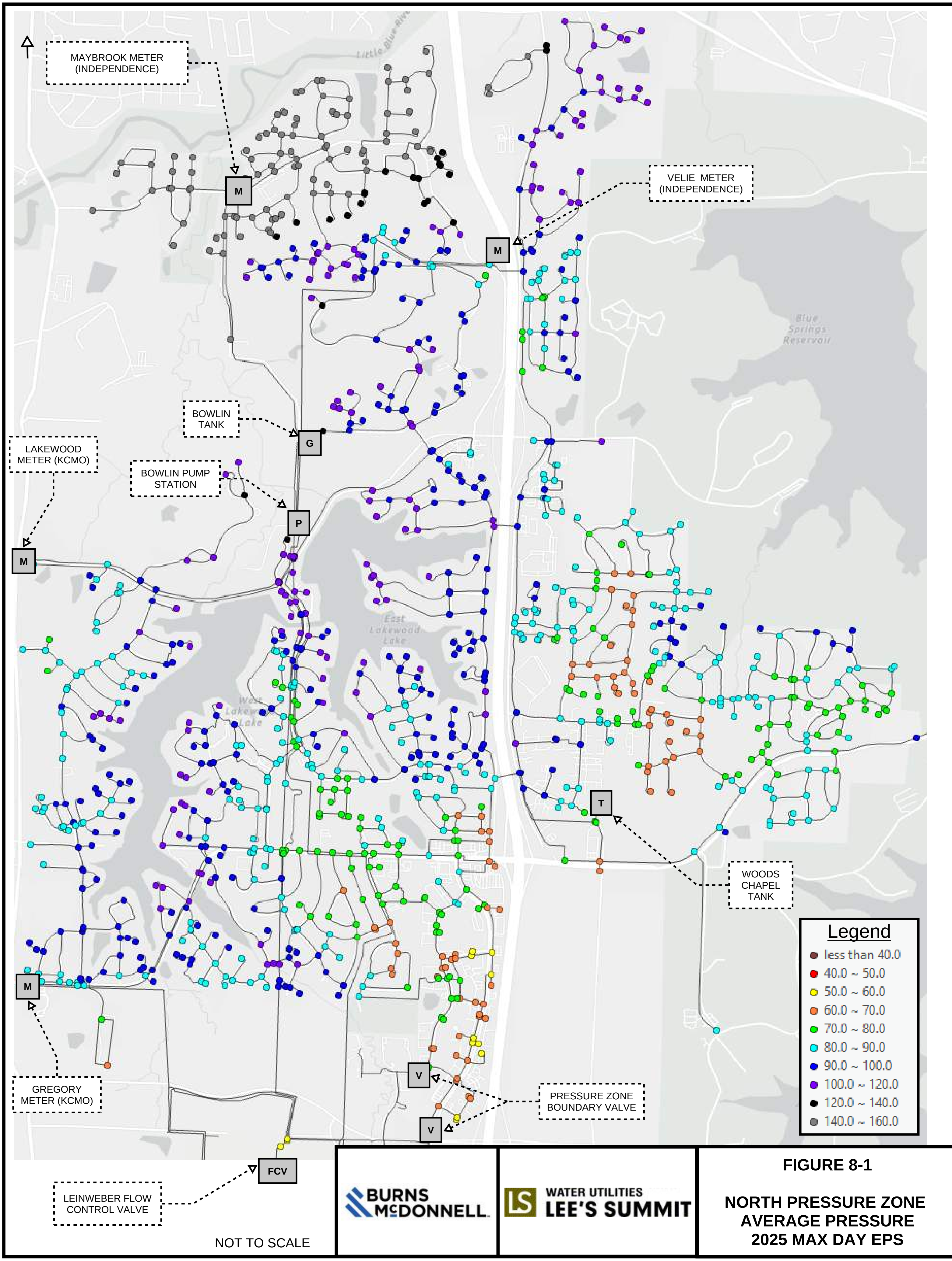

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FIGURE 8-1

NORTH PRESSURE ZONE
AVERAGE PRESSURE
2025 MAX DAY EPS

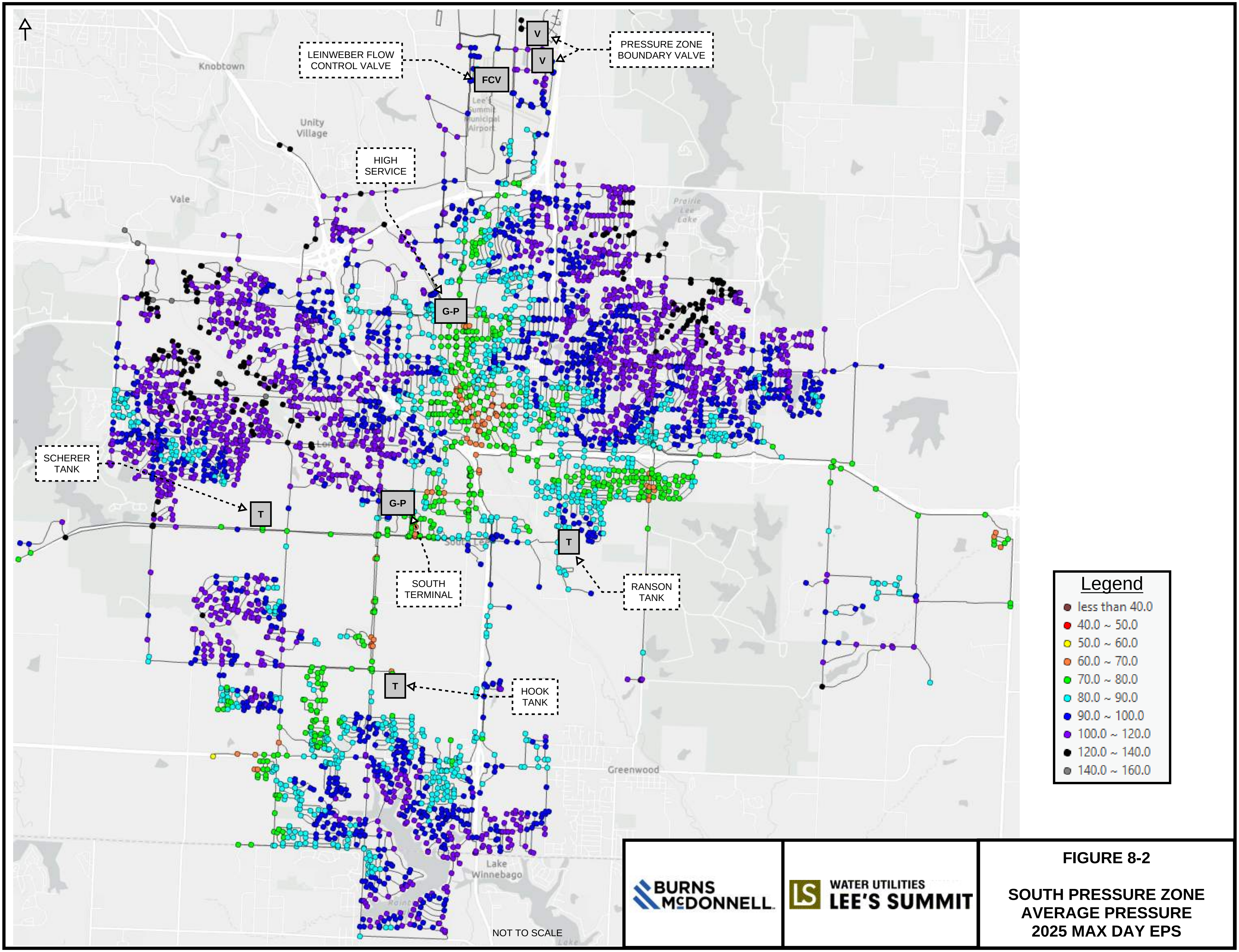

FIGURE 8-2

SOUTH PRESSURE ZONE AVERAGE PRESSURE 2025 MAX DAY EPS

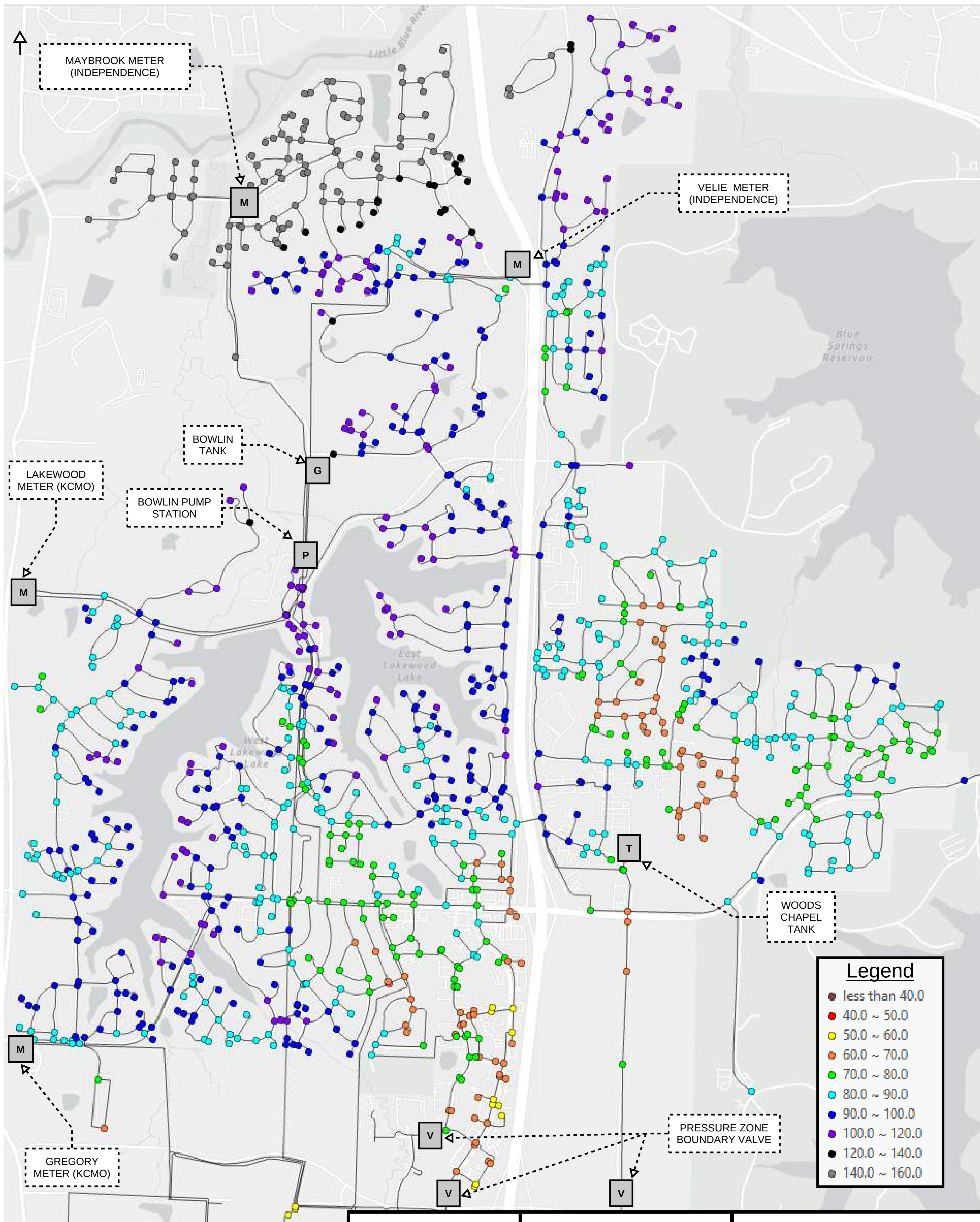

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FIGURE 8-3

NORTH PRESSURE ZONE AVERAGE PRESSURE 2040 MAX DAY EPS

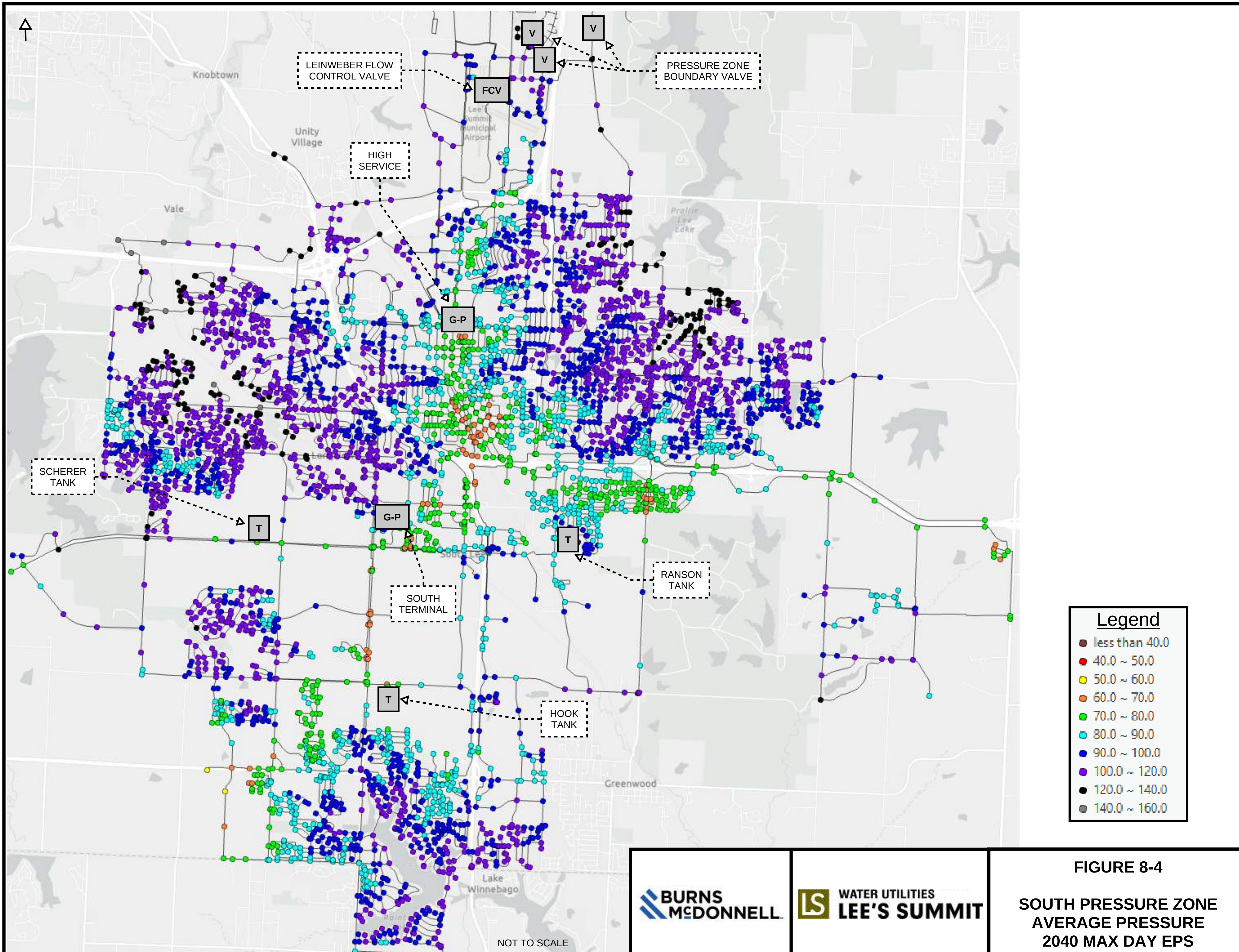

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FIGURE 8-4

SOUTH PRESSURE ZONE AVERAGE PRESSURE 2040 MAX DAY EPS

Figure 8-5: North Zone Pumping-Supply Capacity vs Demand (MGD)

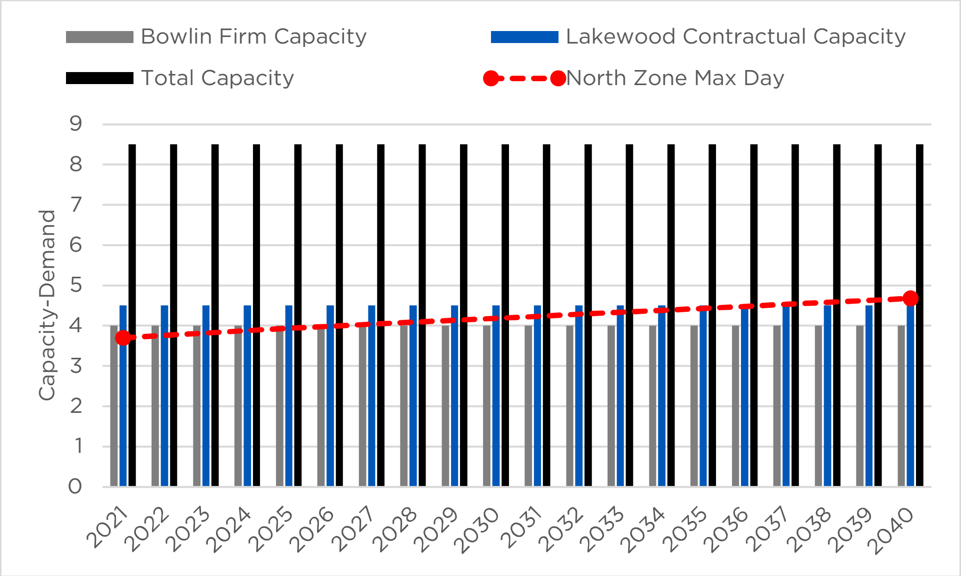
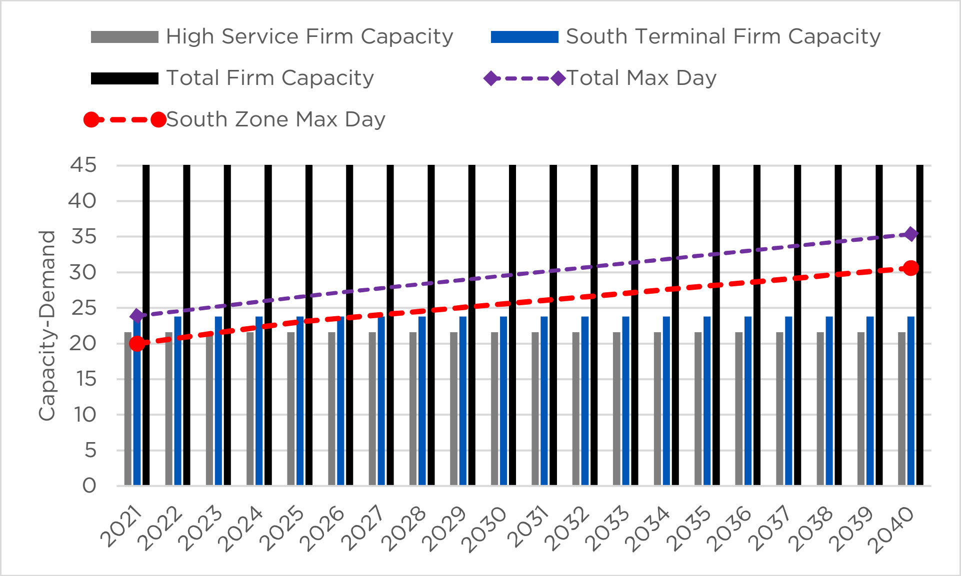


Figure 8-6: South Zone Pumping Capacity vs Demand (MGD)



8.2 Water Distribution

The model results indicated compliance with the level of service conditions for velocity and headloss under the projected maximum day demands of 26.6 MGD and 35.4 MGD in 2025 and 2040 respectively. Therefore, no high-priority hydraulic capacity water main improvements are required, in part by the adequacy of the existing distribution and in part by the hydraulic-development capital improvements needed to support future growth in undeveloped areas. The terms hydraulic and capacity or hydraulic capacity are synonymous, for the purposes of this report, characterizing a capital improvement as hydraulic-development is used to indicate that development-driven projects also improve hydraulic capacity of the existing distribution system when looped. Model results for velocity and headloss are illustrated in the figures listed below:

- Figures 8-7 and 8-8: 2025 average velocity in North and South zones respectively.
- Figures 8-9 and 8-10: 2025 average headloss in North and South zones respectively.
- Figures 8-11 and 8-12: 2040 average velocity in North and South zones respectively.
- Figures 8-13 and 8-14: 2040 average headloss in North and South zones respectively.

8.3 Storage Analysis

The same variables apply for the 2025 and 2040 storage analyses except for the increase in average day demands which constitutes higher storage requirements. Results of the 2025 storage analysis are listed in Table 8-1 and indicate a surplus in both zones.

Table 8-1: 2025 Storage Analysis

Reserve	Item	North Zone	South Zone
Fire	Fire flow requirement (gpm)	4,000	4,000
	Duration (hrs)	4	4
	Fire reserve (MG)	1.0	1.0
Equalization	Half the average day demand (MG)	0.9	5.3
Emergency	Average day demand (MG)	1.8	10.7
	Storage Requirement (MG)	3.6	16.9
	Effective Storage (MG)	5.1	28.9
	Storage Surplus (MG) = Effective - Requirement	1.4	11.9

The 1.4 MG surplus in the North zone is adequate for the demand profile and the largely dominant residential customer class. This surplus represents an emergency reserve for approximately 19 hours under an average day demand of 1.8 MGD. The 11.9 MG surplus in the South zone is adequate and represents an emergency reserve for approximately 27 hours under an average day demand of 10.7 MGD. There are no storage improvements or recommendations based on the effective storage in the distribution system and the 2025 demand projections.

Results of the 2040 storage analysis are listed in Table 8-2 and indicate a surplus in both zones. The 0.2 MG surplus in the North zone can be increased to 0.7 MG from the shared storage allocation in Bowlin ground storage tank if firm capacity is added to Bowlin pump 3 and emergency power is added in the future. But given the building footprint limitations at Bowlin pump station, the retrofit cost for a fourth pump may not be equitable for the relatively marginal surplus increase to 0.7 MG.

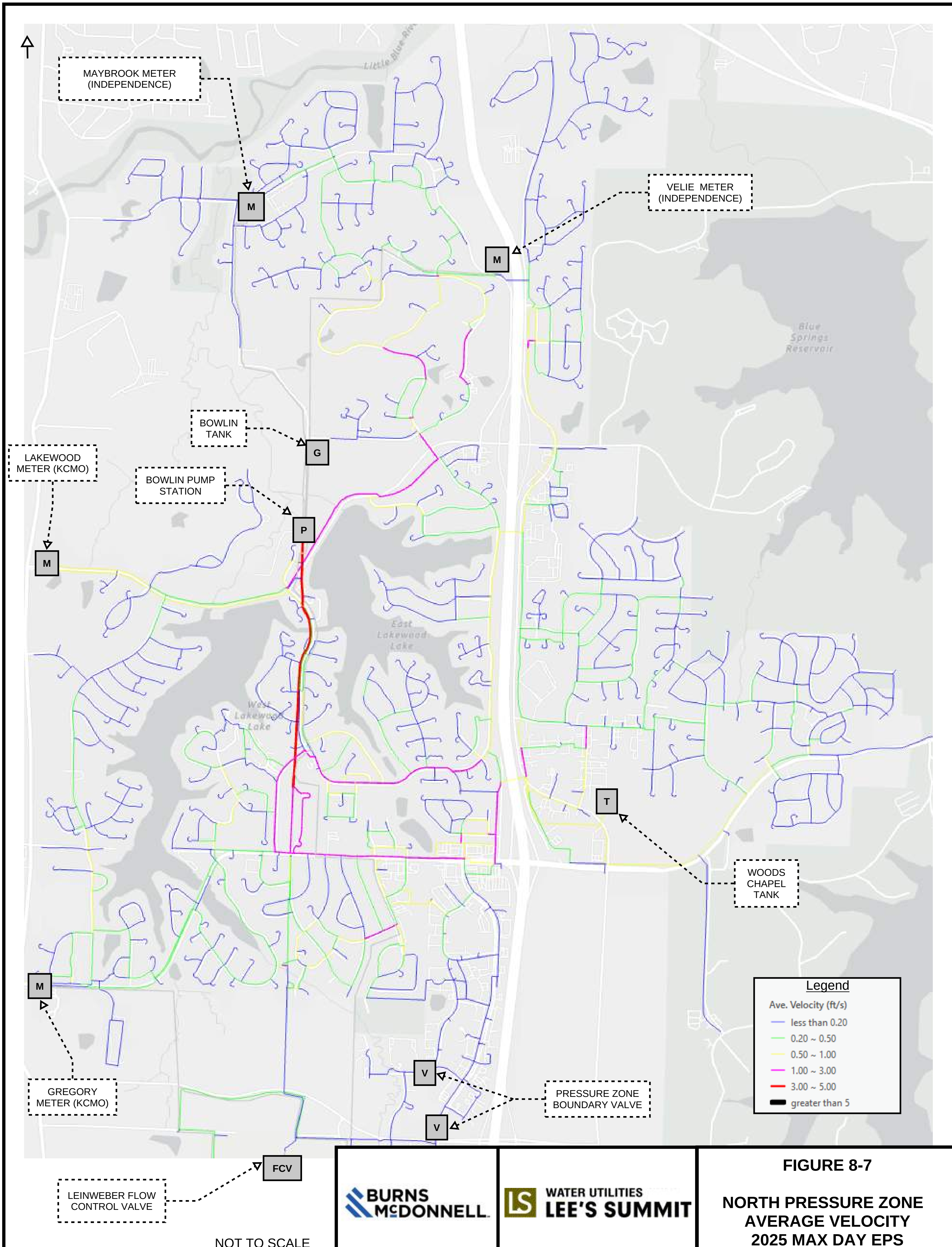


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FIGURE 8-7

NORTH PRESSURE ZONE AVERAGE VELOCITY 2025 MAX DAY EPS

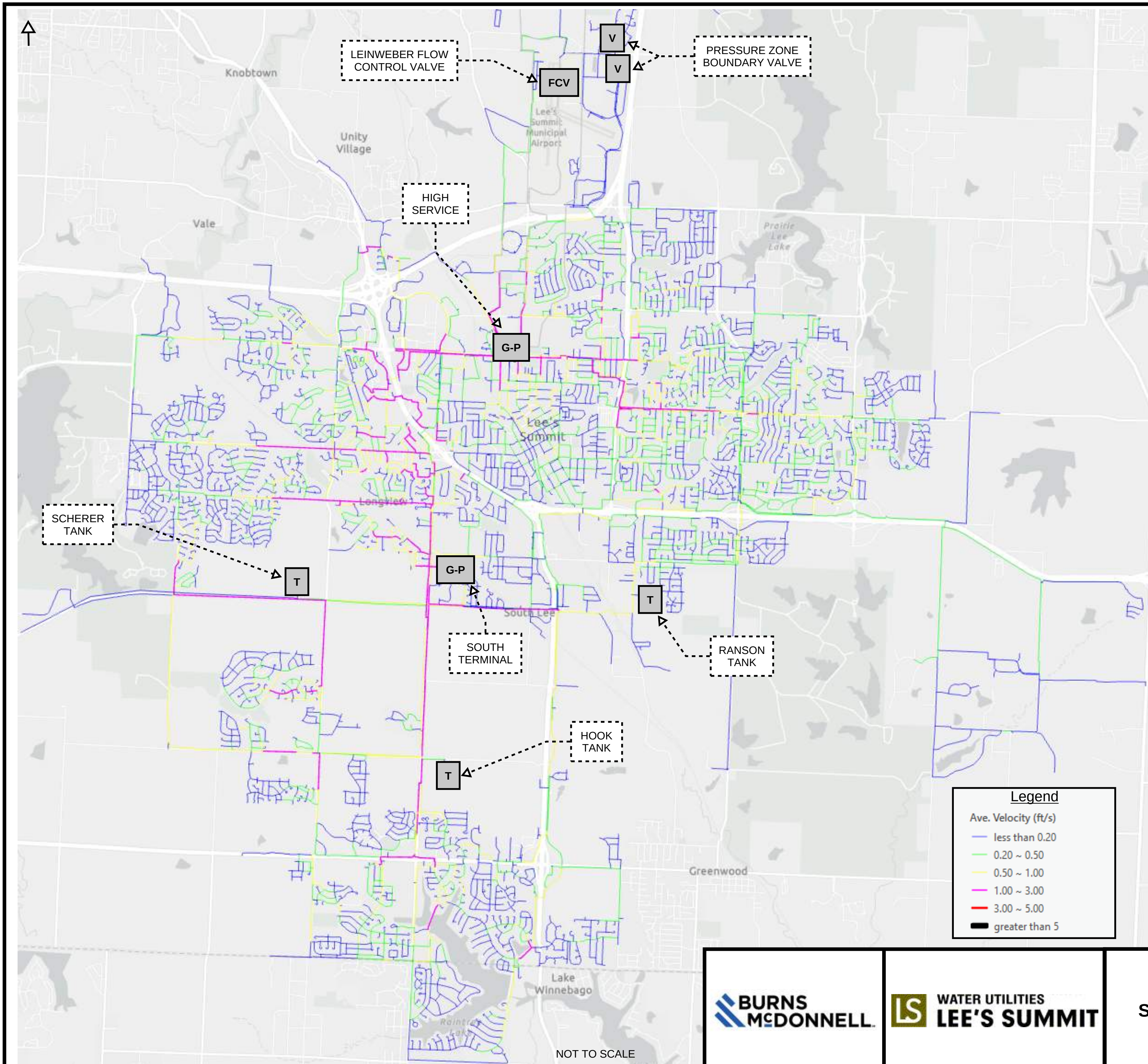

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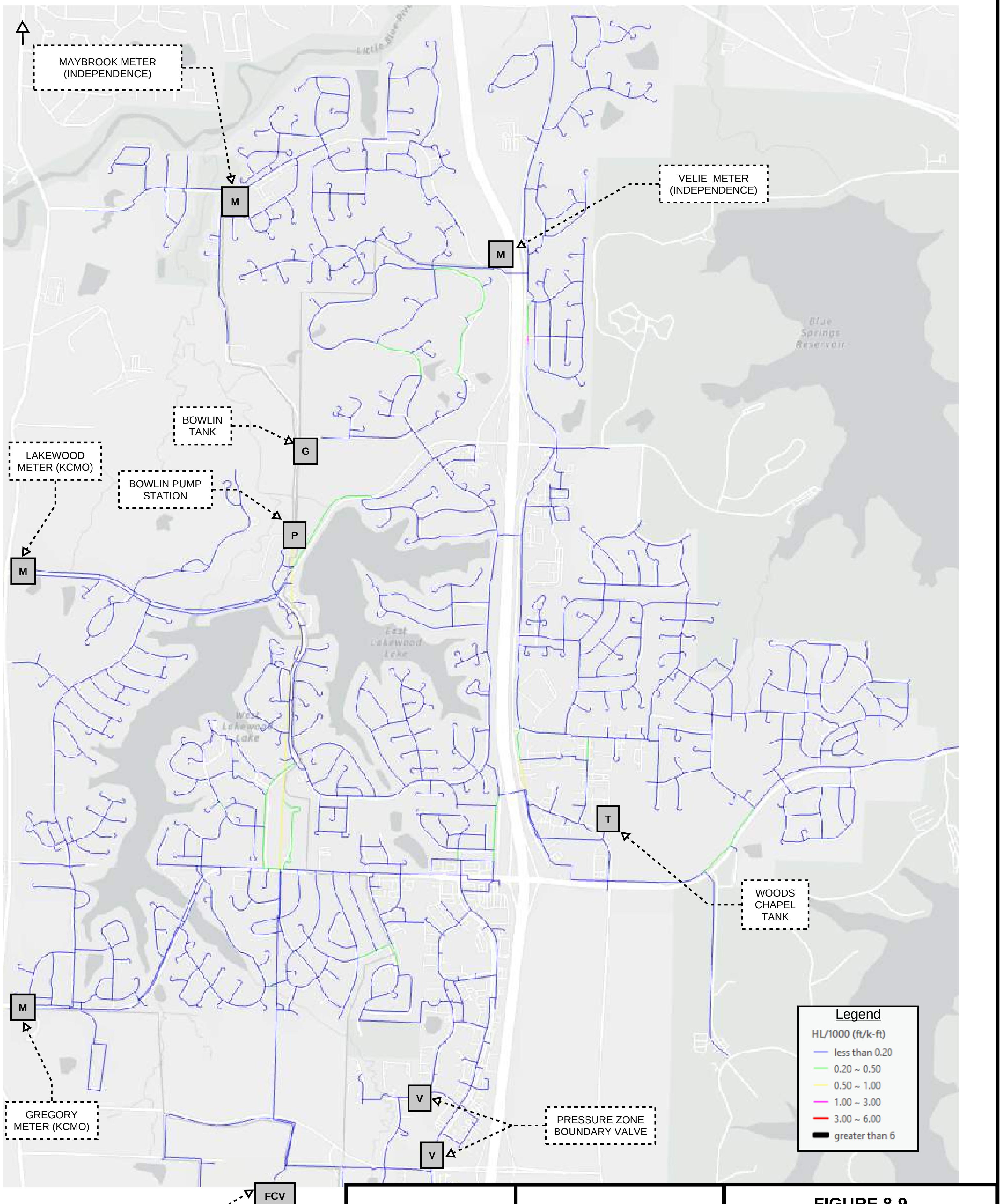
FIGURE 8-8

SOUTH PRESSURE ZONE AVERAGE VELOCITY 2025 MAX DAY EPS



NOT TO SCALE

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FIGURE 8-9

NORTH PRESSURE ZONE HEADLOSS PER 1000' 2025 MAX DAY EPS

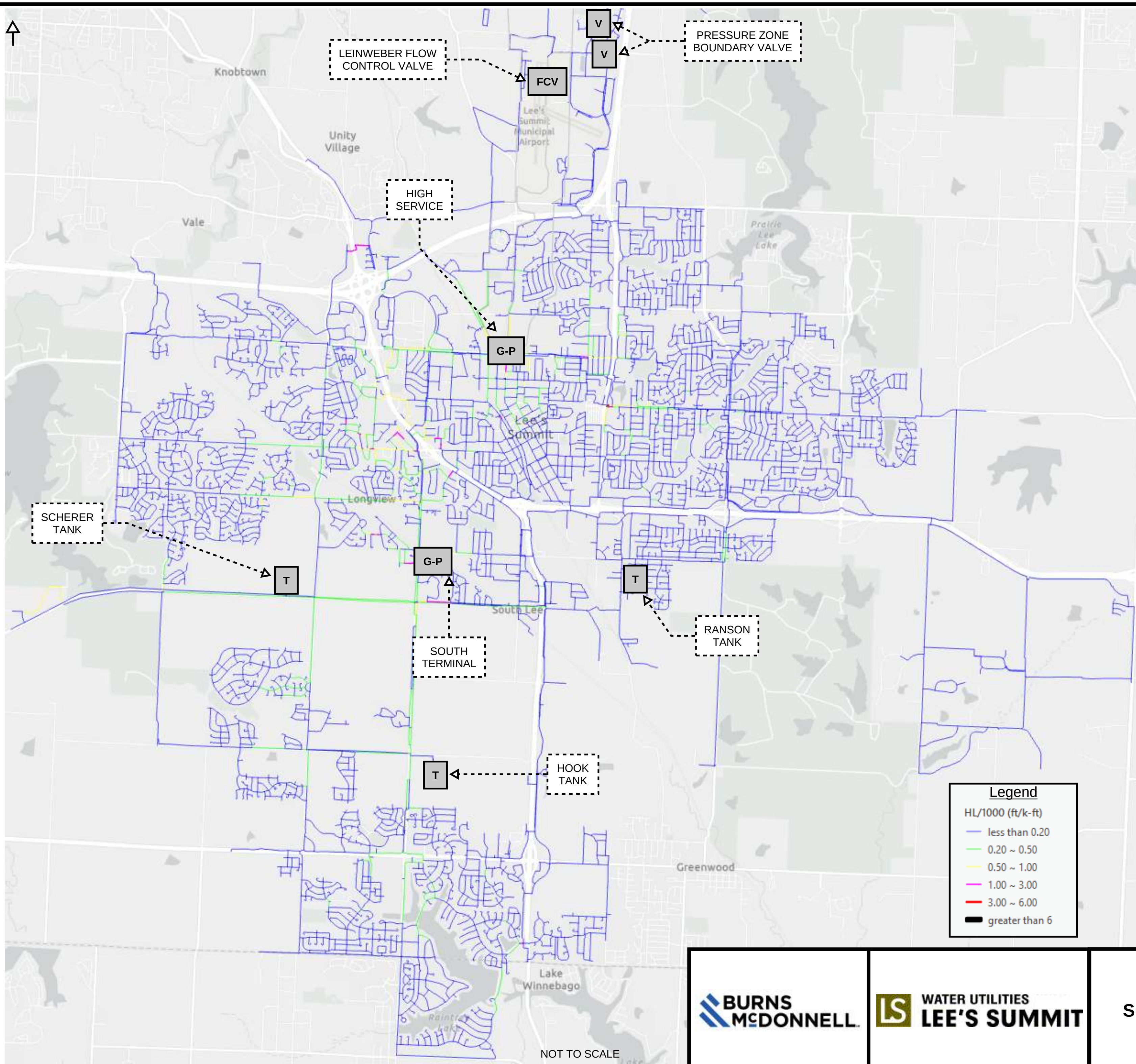

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FIGURE 8-10

SOUTH PRESSURE ZONE HEADLOSS PER 1000' 2025 MAX DAY EPS

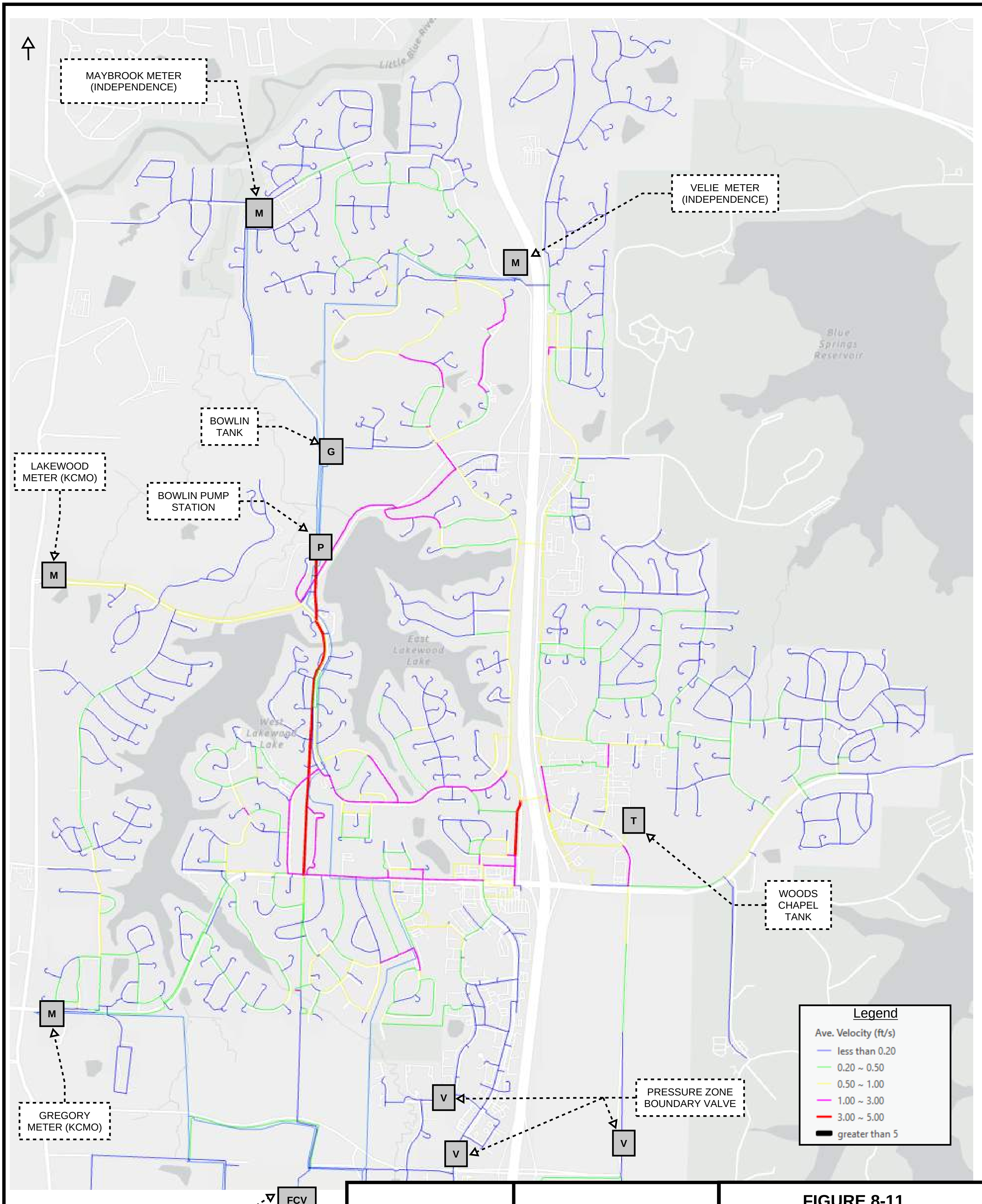

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FIGURE 8-11

NORTH PRESSURE ZONE AVERAGE VELOCITY 2040 MAX DAY EPS

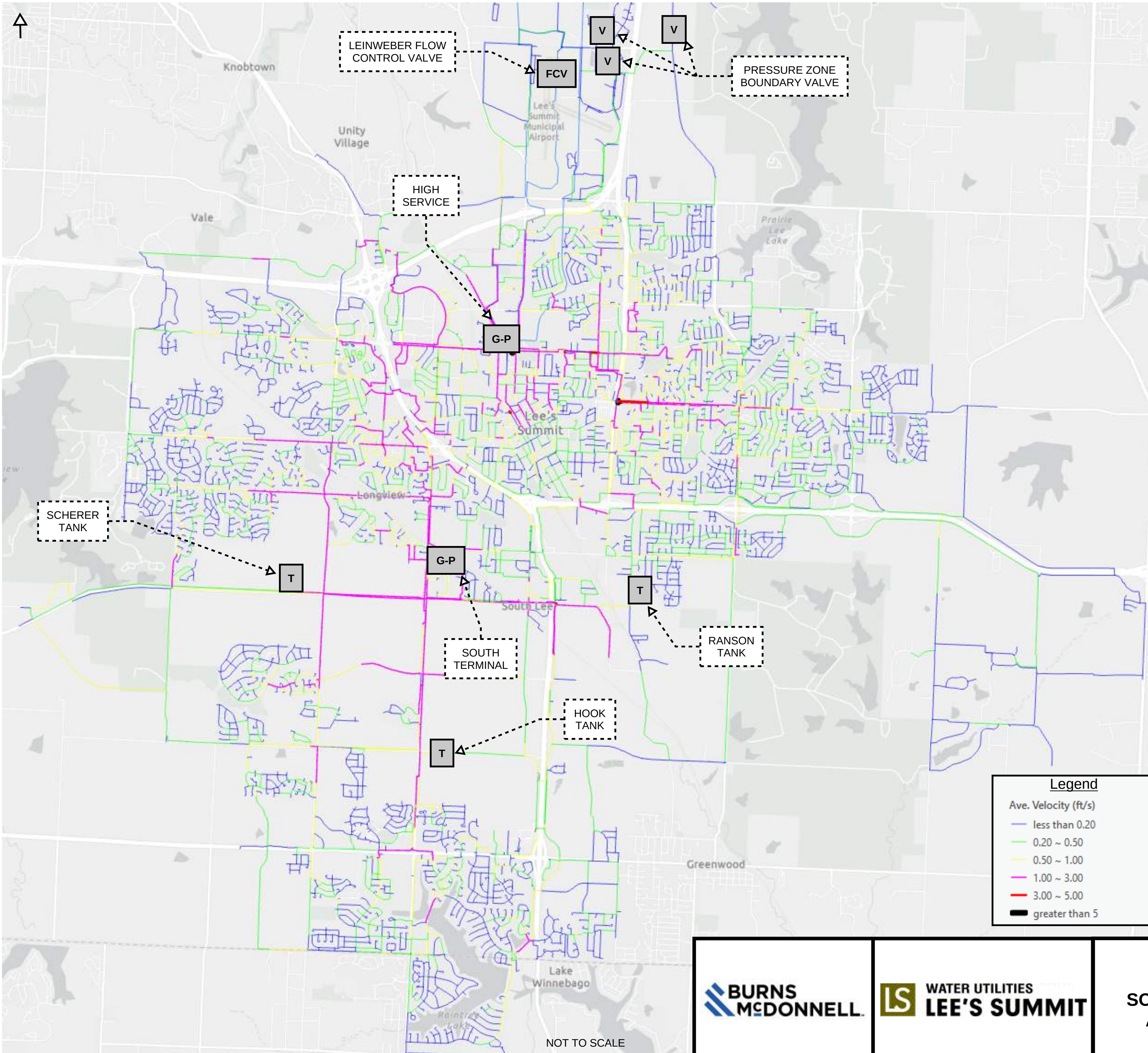

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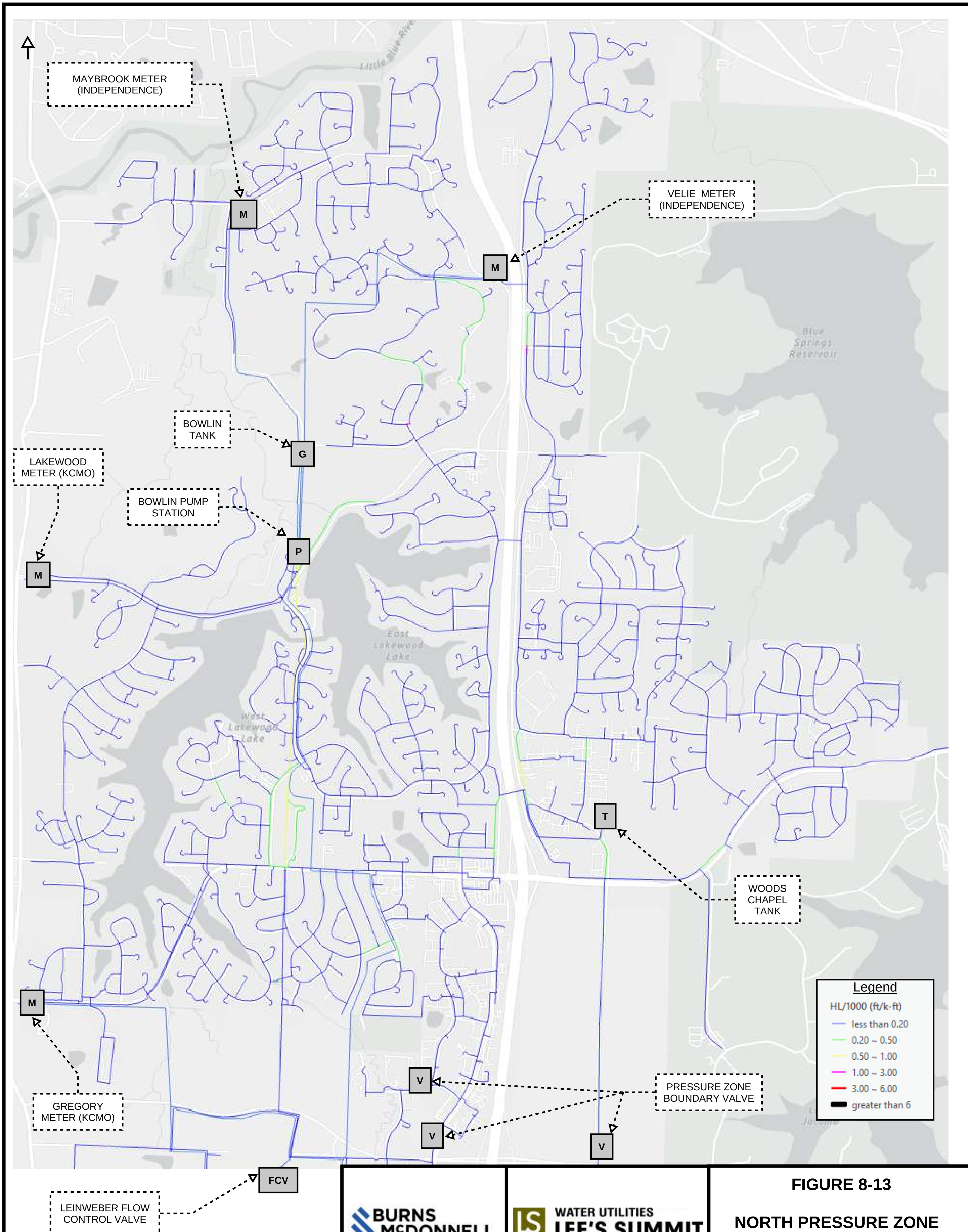
FIGURE 8-12

SOUTH PRESSURE ZONE AVERAGE VELOCITY 2040 MAX DAY EPS



NOT TO SCALE

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FIGURE 8-13

NORTH PRESSURE ZONE HEADLOSS PER 1000' 2040 MAX DAY EPS

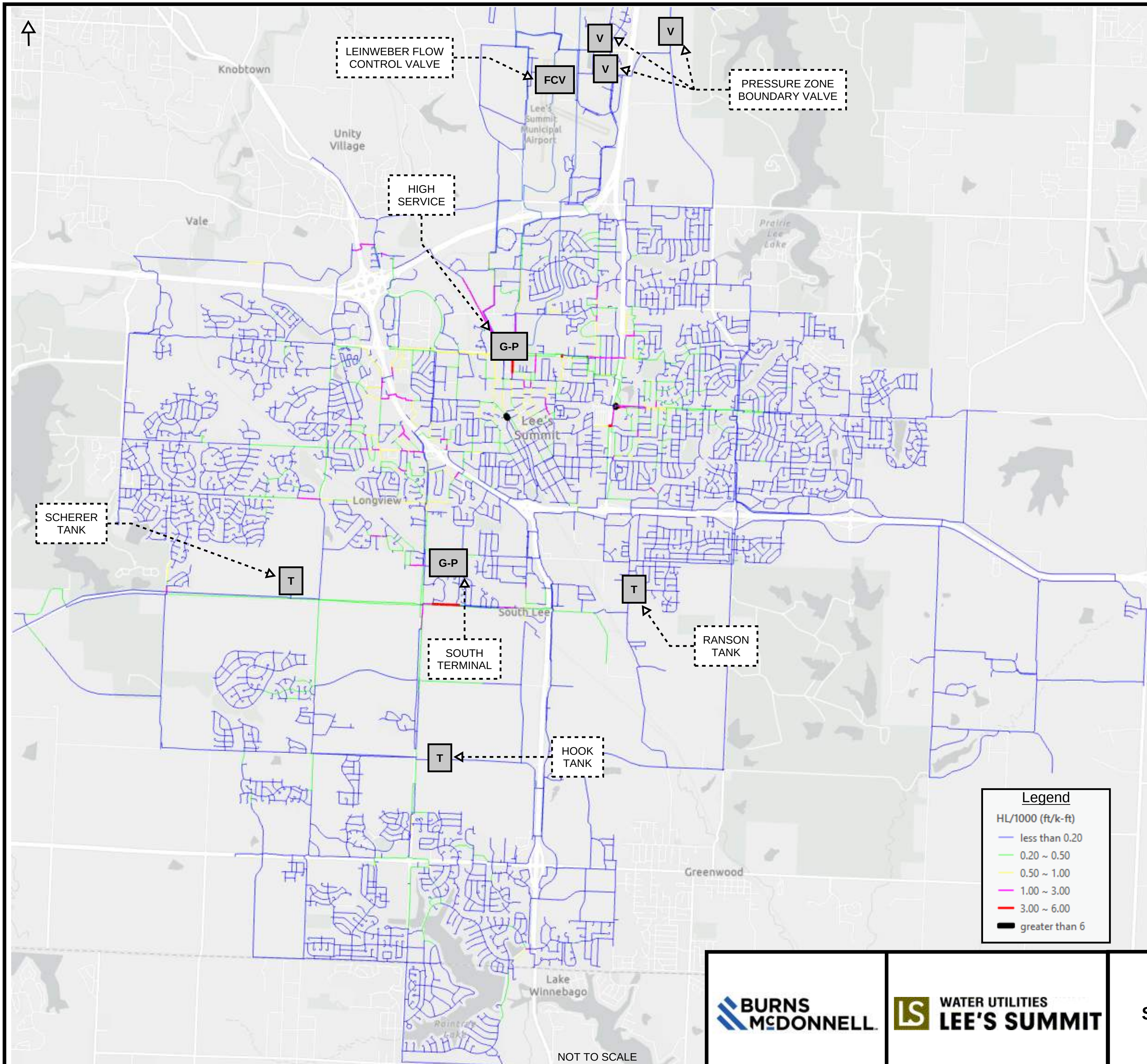

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FIGURE 8-14

SOUTH PRESSURE ZONE HEADLOSS PER 1000' 2040 MAX DAY EPS

Table 8-2: 2040 Storage Analysis

Reserve	Item	North Zone	South Zone
Fire	Fire flow requirement (gpm)	4,000	4,000
	Duration (hrs)	4	4
	Fire reserve (MG)	1.0	1.0
Equalization	Half the average day demand (MG)	1.1	7.5
Emergency	Average day demand (MG)	2.1	15.0
	Storage Requirement (MG)	4.2	23.4
	Effective Storage (MG)	4.3	29.0
	Storage Surplus (MG) = Effective - Requirement	0.2	5.5

The least invasive solution to increase the low storage surplus in the North zone without capital cost is opening the pressure zone boundary valves to supply the North zone from the South zone which has up to 5.5 MG of surplus to share. Essentially, this is the full volume of Bowlin ground storage tank conveyed through High Service ground storage and pumped into North zone by opening pressure zone boundary valves.

Alternatively, If the City prefers optimizing intra-zonal supply resiliency, then each pump at Bowlin pump station could be replaced with a new pump (all the same size) supplied by Bowlin tank. Bowlin tank would be in service year-round and Leinweber valve would be normally open to enhance tank turnover by supplying ground storage at High Service. This approach will increase electrical operating costs at Bowlin pump station because currently, during low seasonal demands, Maybrook supply delivers enough pressure to bypass the booster pumps (1 and 2) and directly supply the North zone. Maybrook and Velie would continually supply ground storage at High Service and blead off water to fill Bowlin tank as part of normal operations. Some pros and cons of this approach are listed below:

- Pros:
    - Optimize supply resiliency.
    - Avoid seasonal use of Bowlin ground storage tank which is accompanied by disinfection requirements that make operations difficult when bringing it in and out of service.
    - A lower operating level in Woods Chapel elevated tank to hold fire flow storage requirement only.
    - Increase effective storage in the North zone.
    - Lower the supply needs from Lakewood meter vault which has had operational issues upstream in the KC Water distribution system delivering the contractual supply capacity in recent history.
- Cons:
    - Increase electrical operating costs.
    - Capital cost investment of 3 new pumps and associated electrical with emergency power.
    - Shared storage allocation in Bowlin tank for the South zone is limited by maximum allowable flow through Leinweber valve.
    - Water age in ground storage at High Service will increase to the degree of the supply contribution through Leinweber valve; residence time in Bowlin tank and

then travel time to Bowlin pump station, through the North zone, and through the Leinweber valve/transmission main is greater than the current travel time through the dedicated 30-inch supply main from Velie meter vault and ground storage at High Service pump station.

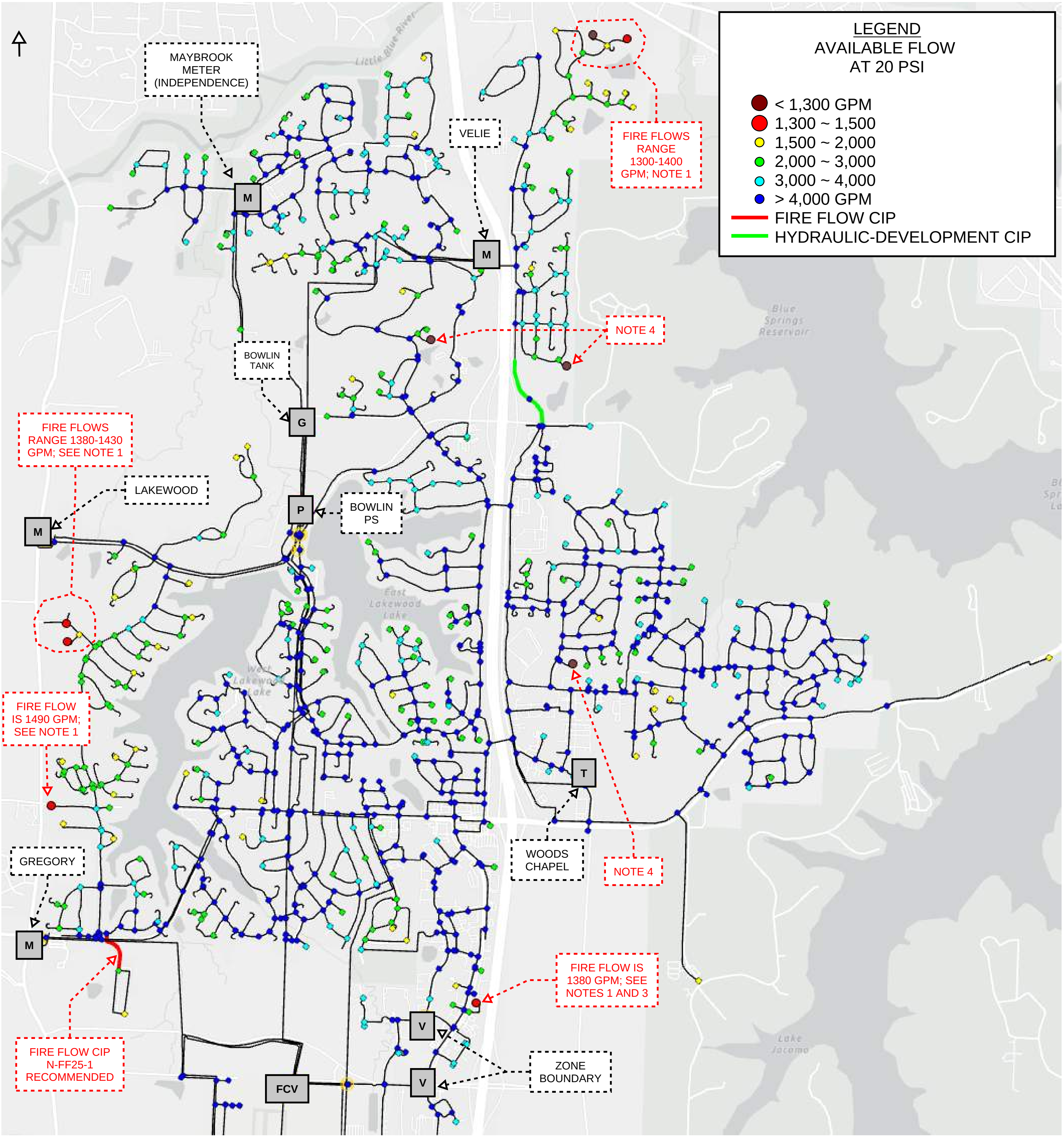
8.4 Fire Flow Analysis

The available fire flow results based on the maximum day demand projections in the North and South zones is illustrated in Figures 8-15 and 8-16 respectively for 2025 and in Figures 8-17 and 8-18 respectively for 2040. Individual locations and/or areas with available fire flow less than 1,500 gpm are older 4-inch water mains, 4-inch dead end water mains, and longer runs of 6-inch dead end water mains; similar to locations and/or areas as the existing system. Results of the sensitivity analysis indicated compliance with the level of service for fire flow at 1,500 gpm at a 20 psi residual with new 8-inch minimum water mains in these locations and/or areas.

8.5 Capital Improvement Projects

Capital improvements for 2025 fire flow projects, 2025 development-hydraulic projects, 2040 development-hydraulic projects, and recommendations for small main replacement projects are illustrated in Figures 8-19 and 8-20 for the North and South zones respectively. For clarity, all figures in this chapter (Chapter 8.0) of the report illustrating model results for pressure, velocity, headloss, and fire flow include each the capital improvement project illustrated in Figures 8-19 and 8-20. These improvements are sized for compliance with applicable level of service condition(s) and consistency with existing upstream and downstream water main sizes to prevent bottlenecks.

Small mains are considered 4-inches and less; however, not all small mains need to be replaced if they have adequate capacity for domestic demands in areas that do not have fire hydrants. This is common throughout the City's residential neighborhoods with 4-inch dead ends. For the purposes of this report, small main replacement projects only include looped 4-inch water mains in the distribution system network.



NOTES:
1. CONDUCT FIRE HYDRANT TESTING TO CONFIRM AVAILABLE FLOW AND NEED FOR CAPITAL IMPROVEMENT.
2. CONDUCT FIRE HYDRANT TESTING TO CONFIRM AVAILABLE FLOW.
3. CONFIRM HYDRANT OWNERSHIP.
4. 4-INCH DEAD END SMALL MAIN REPLACEMENT CIP.

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FIGURE 8-15

NORTH PRESSURE ZONE AVAILABLE FIRE FLOW 2025 MAX DAY

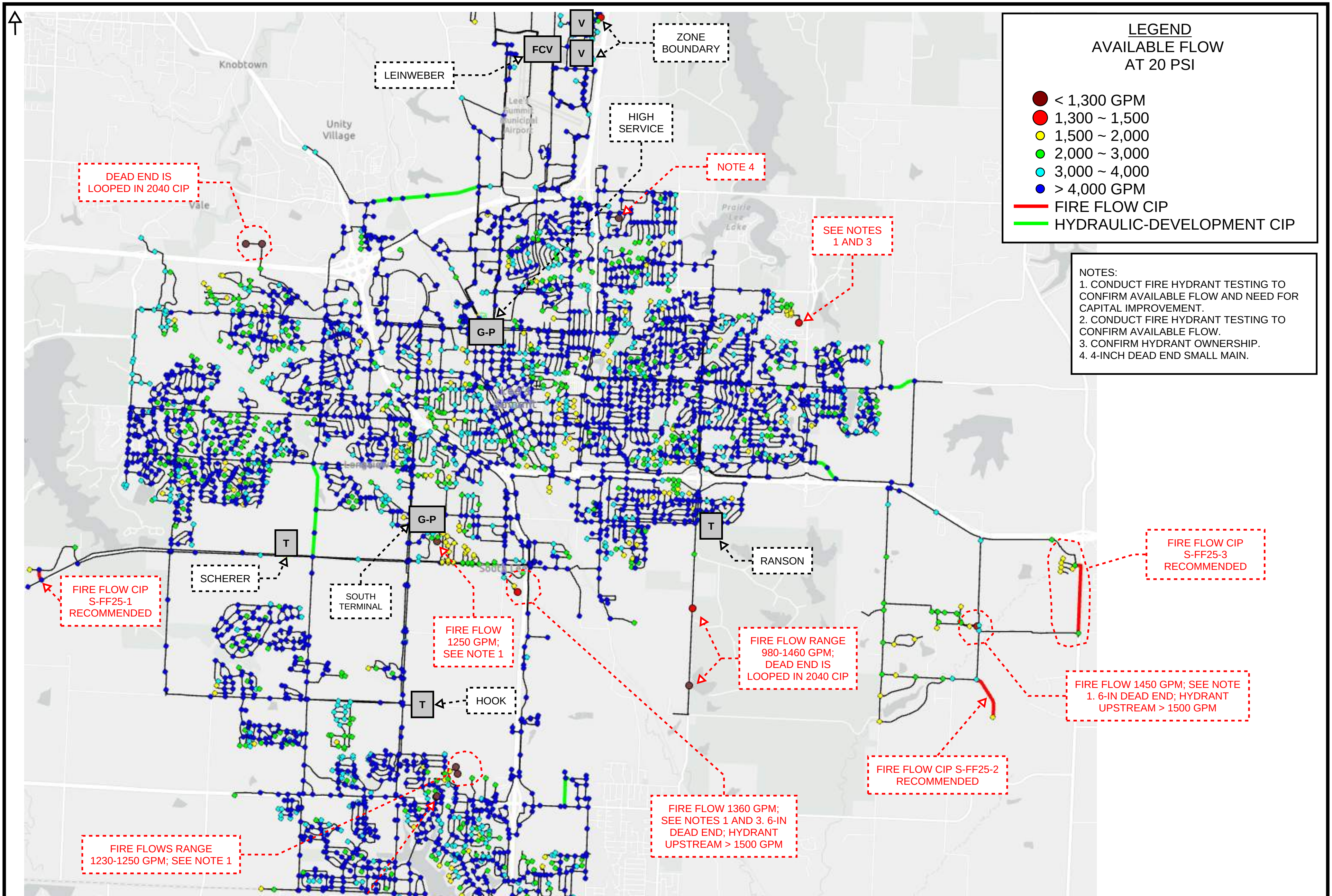
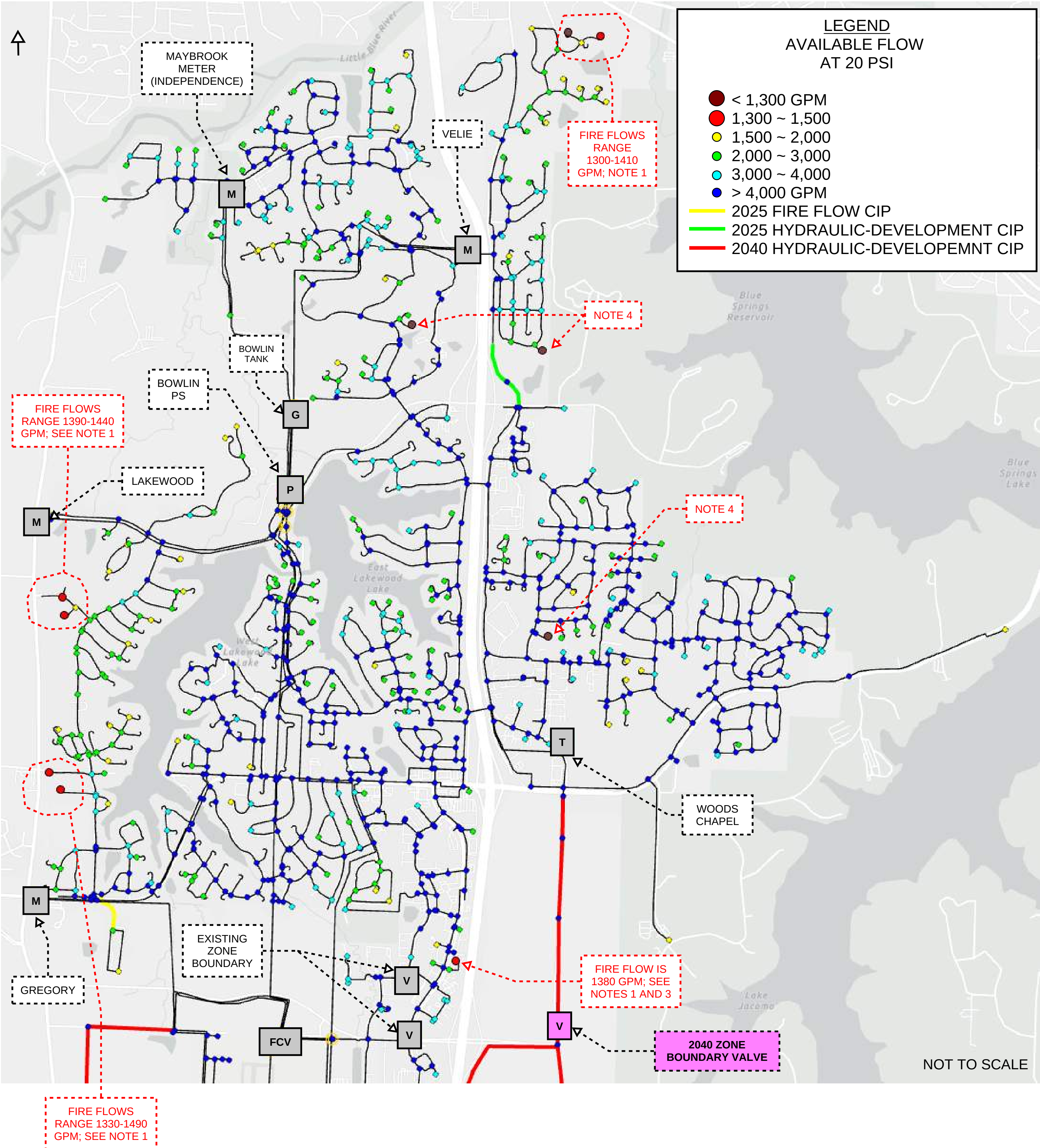


FIGURE 8-16

SOUTH PRESSURE ZONE AVAILABLE FIRE FLOW 2025 MAX DAY



NOTES:
1. CONDUCT FIRE HYDRANT TESTING TO CONFIRM AVAILABLE FLOW AND NEED FOR CAPITAL IMPROVEMENT.
2. CONDUCT FIRE HYDRANT TESTING TO CONFIRM AVAILABLE FLOW.
3. CONFIRM HYDRANT OWNERSHIP.
4. 4-INCH DEAD END SMALL MAIN REPLACEMENT CIP.

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FIGURE 8-17

NORTH PRESSURE ZONE AVAILABLE FIRE FLOW 2040 MAX DAY

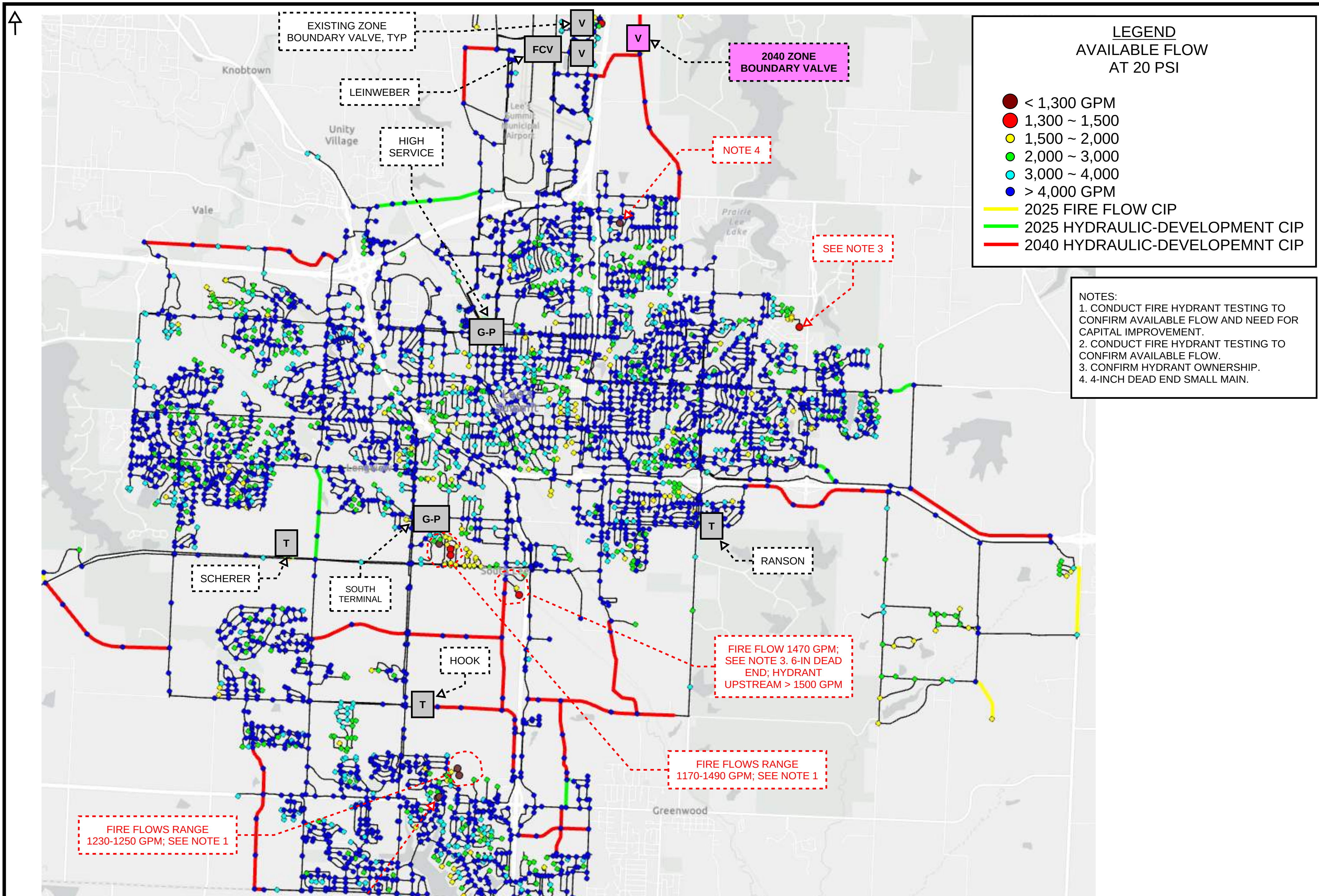

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FIGURE 8-18

SOUTH PRESSURE ZONE AVAILABLE FIRE FLOW 2040 MAX DAY

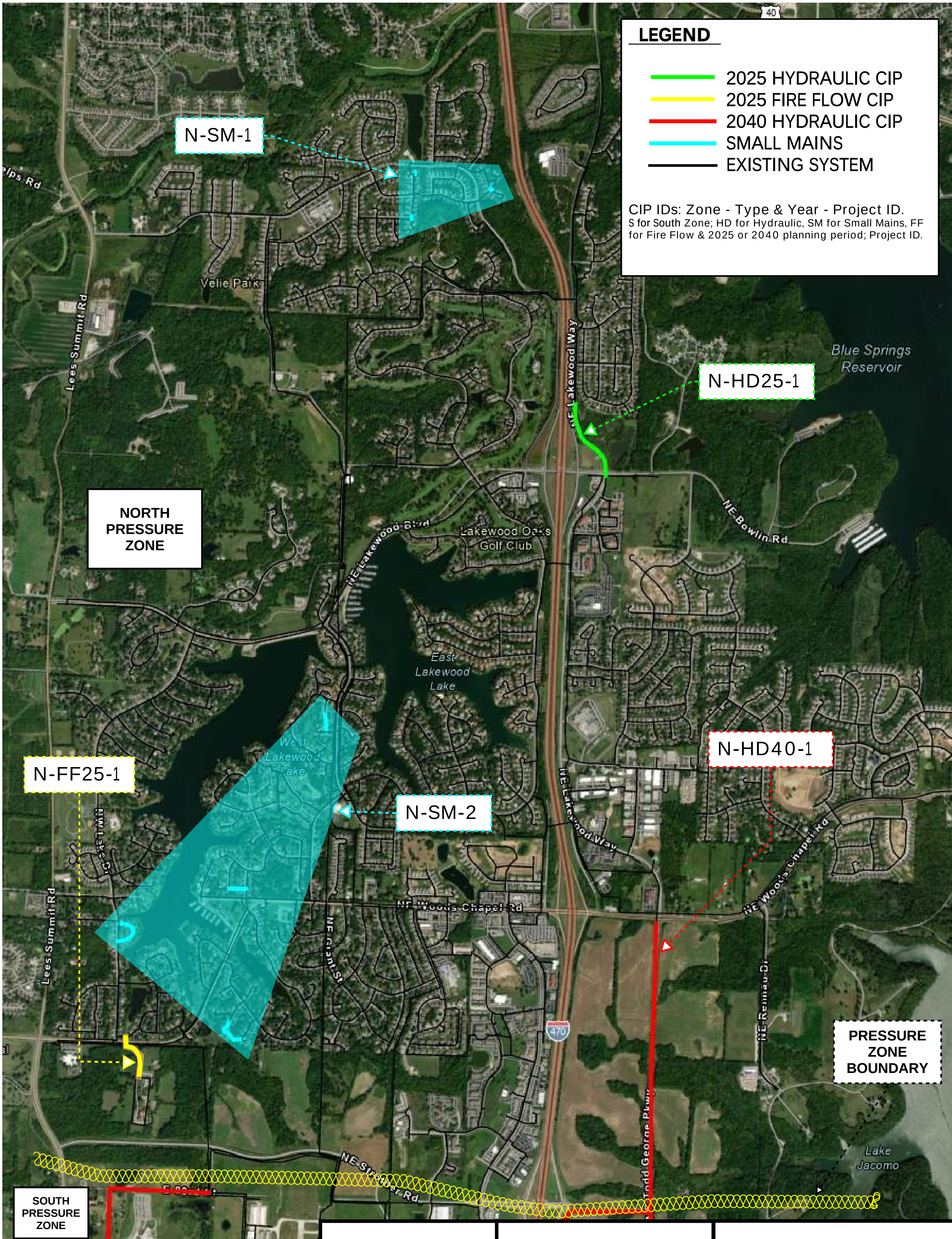

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FIGURE 8-19

NORTH ZONE CIP SUMMARY

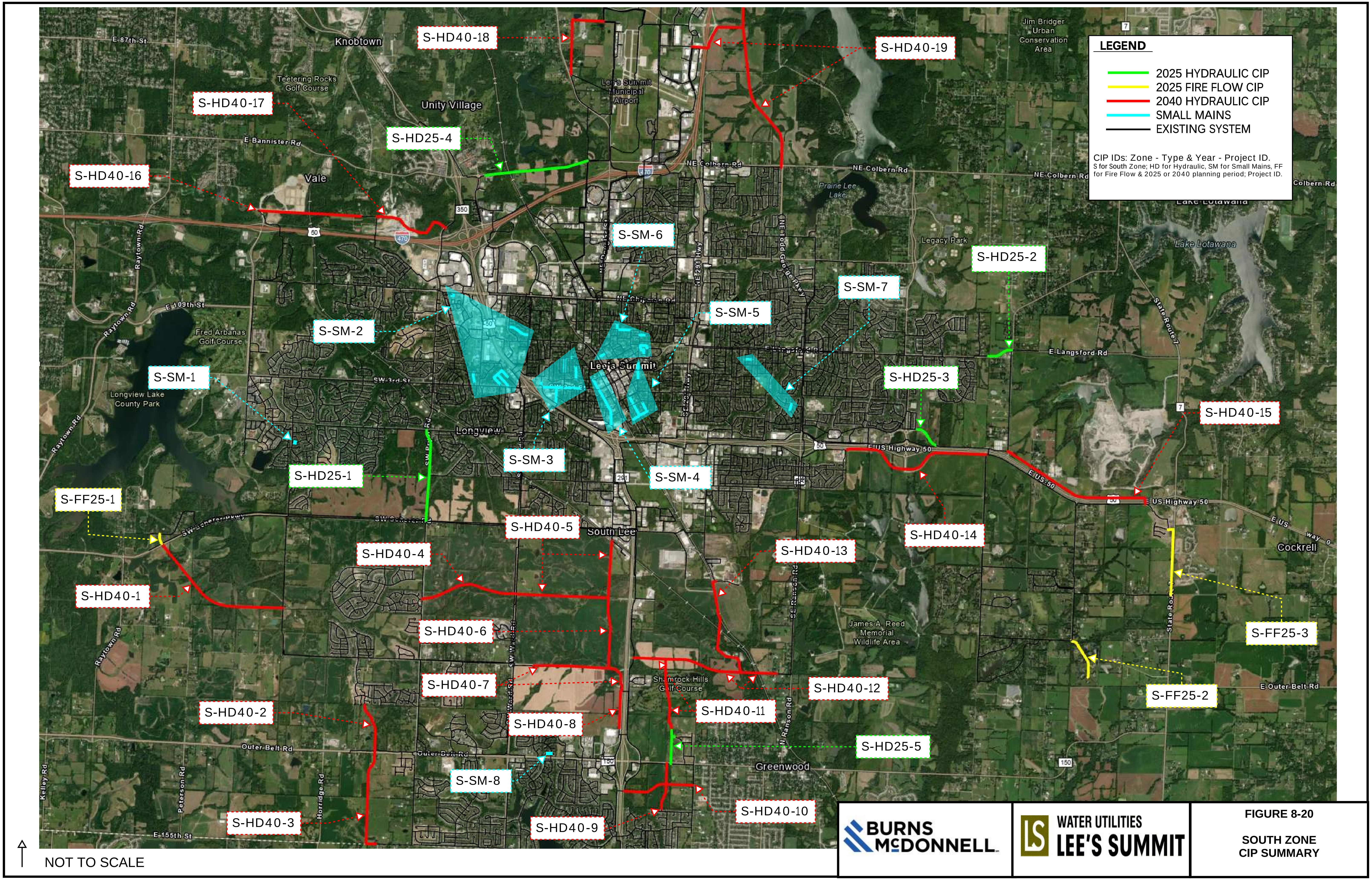

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FIGURE 8-20

SOUTH ZONE CIP SUMMARY

9.0 Distribution System Capital Improvements Plan

Opinions of probable cost for the recommended improvements identified with the hydraulic model are included in this section of the report. Triggers for capital improvements include fire flow, hydraulic-development for future growth, and small main replacements. Unit costs are developed for linear improvements based on recent water main projects in Kansas City.

9.1 Cost Opinions

The order-of-magnitude cost opinions prepared by Burns & McDonnell relating to costs, quantities, demand, or pricing (including, but not limited to, property costs, construction, operations or maintenance costs, and/or energy or commodity demand and pricing), are opinions based on Burns & McDonnell's experience, qualifications, judgment, and information from vendors and published sources such as Means. Burns & McDonnell has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's means and methods, unavoidable delays, construction contractor's method of pricing, demand or usage, population demographics, market conditions, changes in technology, government regulations and laws, and other economic or political factors affecting such opinions. The City of Lee's Summit, Missouri acknowledges that actual results may vary significantly from the representations and opinions herein, and nothing herein shall be construed as a guarantee or warranty of conclusions, results, or cost opinions. Burns & McDonnell makes no guarantee or warranty (actual or implied) that actual rates, demand, pricing, costs, performance, schedules, quantities, technology, and related items will not vary from the opinions contained in the estimates, projections, results, or other statements or opinions prepared by Burns & McDonnell. The construction cost index for Kansas City in November 2022 is 13293.26.

9.2 Unit Cost Development for Linear Improvements

Unit cost information for linear capital improvements is based on recent water main projects in the Kansas City metropolitan area. Unit costs for 8-inch through 20-inch diameter water mains are PVC (AWWA C900) and 30-inch is ductile iron pipe and do not include rock removal. Typical water main construction items used in the unit cost development are detailed in Table 9-1, below.

Table 9-1: Water Main Construction Items

Basic Water Main Components	Pavement Replacement	Miscellaneous	Other Potential Items (where applicable)
Pipe	Pavement Repair	Service Connects	Vaults
Valves	Curb and Gutter	Service Lines	Boring
Fittings	Driveway	Pressure Testing	Casing Pipe
Fire Hydrants	Traffic Control	Disinfection	Directional Drilling
Excavation	Demolition	Seeding	Tree Removal
Blow Off Assemblies	Haul Off	Erosion Control	
		Site Restoration	

Capital improvements include contingency at 20 percent of the construction cost and engineering at 15 percent of the subtotal cost for construction and contingency. The total opinion of probable construction cost for each capital improvement project is in todays' dollars and includes construction, contingency, and engineering. Please note that cost opinions can increase for individual linear improvements, or portions thereof in terms of length, if rock excavation is required which can be highly variable.

9.3 20-Year Distribution System Improvements

A summary of the opinions of probable construction cost for 2025 fire flow projects, 2025 development-hydraulic projects, 2040 development-hydraulic projects, and recommendations for small main replacement projects are listed in Table 9-2.

Table 9-2: Opinion of Probable Construction Cost Summary

Year	CIP Trigger	Implementation Recommendation	Opinion of Probable Cost	Subtotal
2025	hydraulic-development	priority projects	$ 5,152,000	$ 7,149,000
	fire flow	as funding is available	$ 1,997,000	
2040	hydraulic-development	as development occurs and/or with Thoroughfare Master Plan	$ 33,208,000	$ 33,208,000
NA	small mains	as funding is available and or with road improvement projects	$ 5,880,000	$ 5,880,000
Total				$ 46,237,000

A comprehensive list of individual capital improvement projects (CIPs) is included in Tables 9-3 through 9-6. Individual CIP sheets are detailed further in the package listing below:

- Table 9-3 and Package A: 2025 Hydraulic-Development CIPs
- Table 9-4 and Package B: 2025 Fire Flow CIPs
- Table 9-5 and Package C: 2040 Hydraulic-Development CIPs
- Table 9-6 and Package D: Small Main Replacement CIPs

CIP ID	Type	Priority	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
						Construction	Contingency	Engineering	Total
S-HD25-1	Hydraulic	1	SW Pryor Rd between SW Longview Rd and SW Scherer Rd.	5,227	20	$ 1,255,000	$ 252,000	$ 225,000	$ 1,732,000
N-HD25-1	Hydraulic	2	NE Lakewood Way between NE Bowlin Rd and NE Rainbow Dr.	1,501	12	$ 270,000	$ 54,000	$ 49,000	$ 373,000
S-HD25-2	Hydraulic	3	E Langsford Dr between Milton Thompson Rd and Wildflower Dr.	1,410	12	$ 254,000	$ 51,000	$ 46,000	$ 351,000
S-HD25-3	Hydraulic	4	SE Blue Pkwy from SE Joel Ave east to highway feeder.	1,441	12	$ 259,000	$ 52,000	$ 47,000	$ 358,000
S-HD25-4	Hydraulic	5	NW Colbern Rd between Unity Way and NE Douglas St, to intersection of future commercial/industrial collector. (RRX)	5,916	12	$ 1,065,000	$ 213,000	$ 192,000	$ 1,818,000
S-HD25-5	Hydraulic	6	From SE MO-150 north through development parallel with future commercial/industrial collector.	2,092	12	$ 376,000	$ 76,000	$ 68,000	$ 520,000
Total									$ 5,152,000

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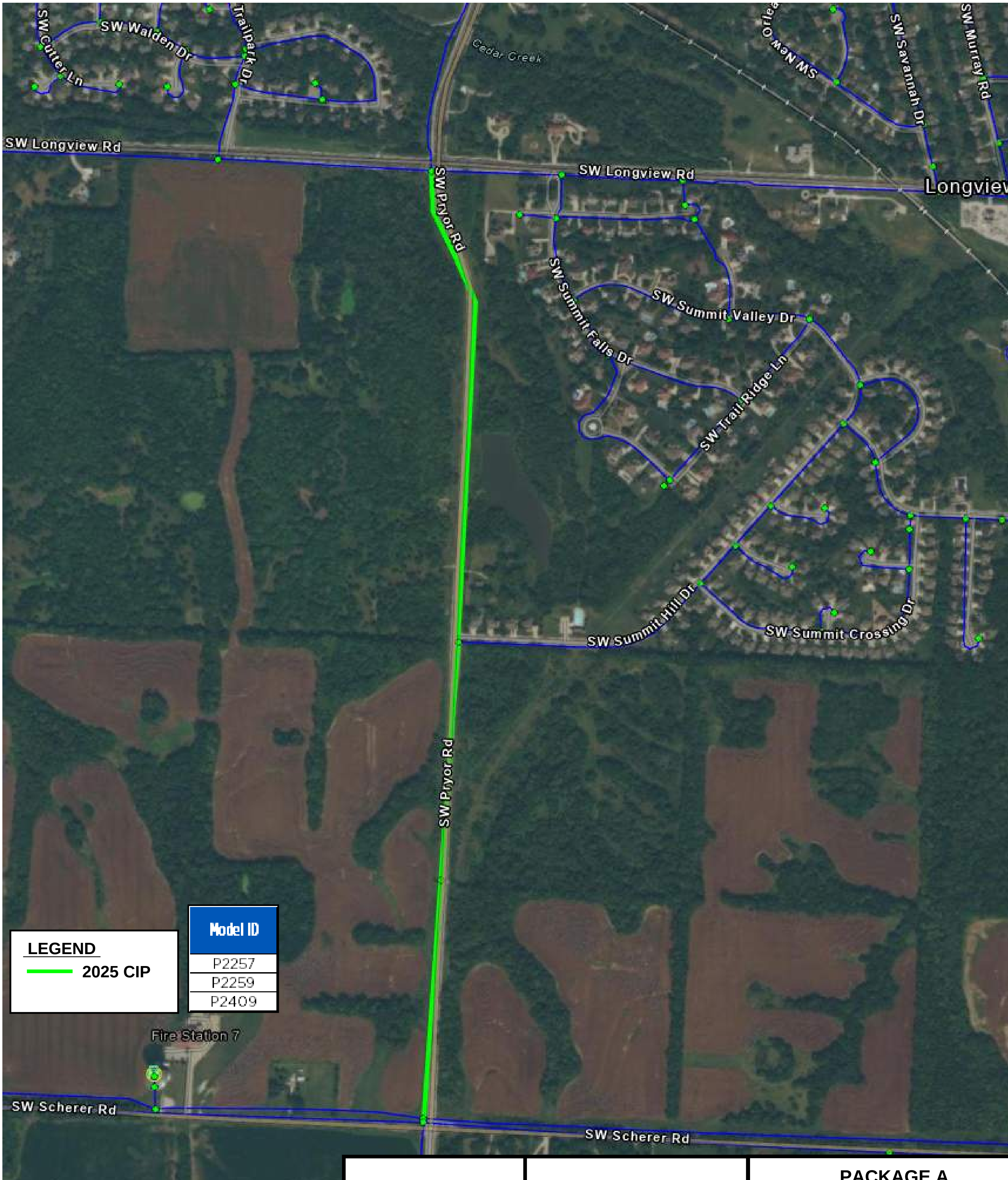
TABLE 9-3

2025 HYDRAULIC-DEVELOPMENT CIPs

CIP ID	Type	Priority	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
						Construction	Contingency	Engineering	Total
S-HD25-1	Hydraulic	1	SW Pryor Rd between SW Longview Rd and SW Scherer Rd.	5,227	20	$ 1,255,000	$ 252,000	$ 225,000	$ 1,732,000



Model ID
P2257
P2259
P2409

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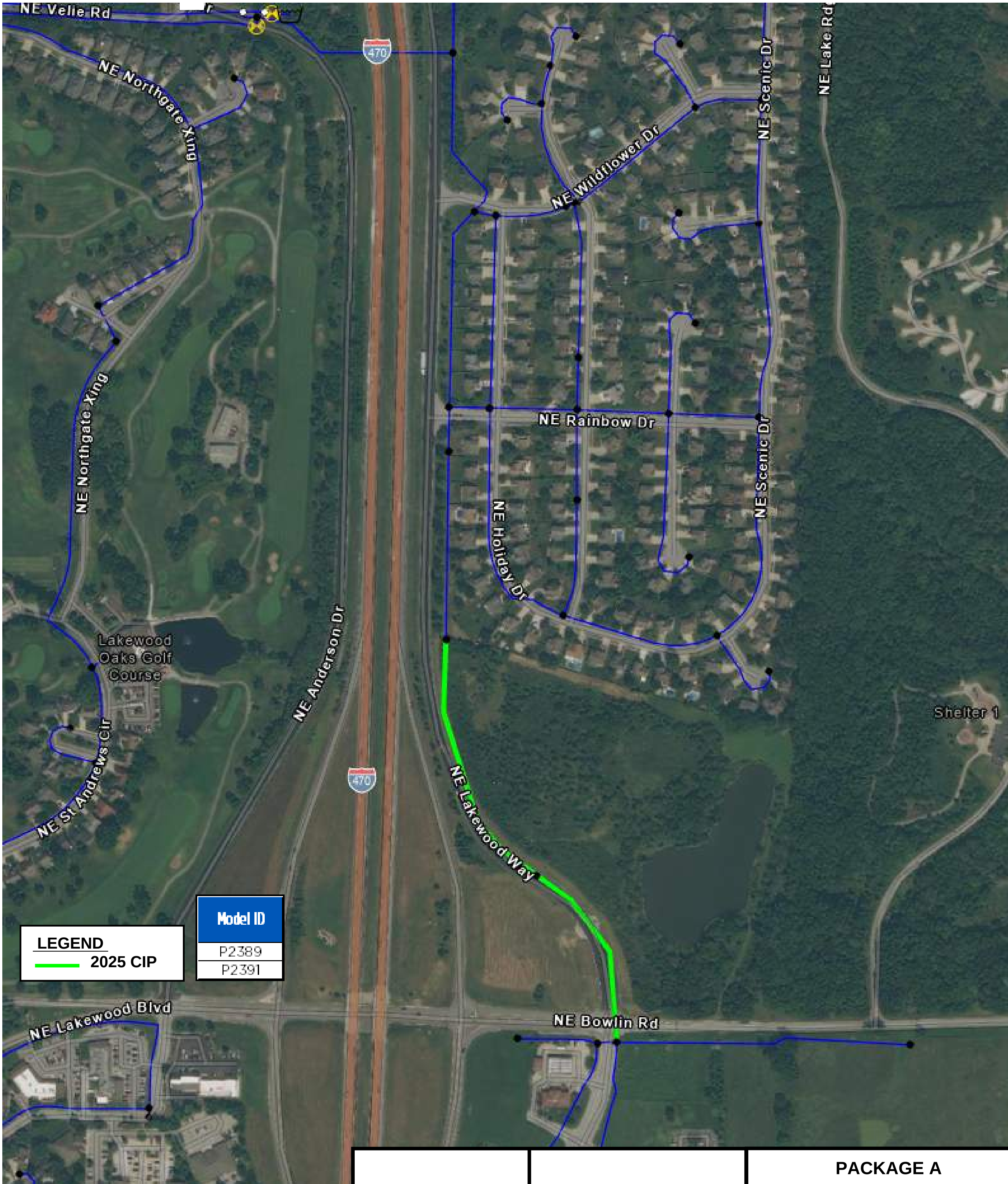
PACKAGE A

CIP: S-HD25-1

SOUTH PRESSURE ZONE

CIP ID	Type	Priority	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
						Construction	Contingency	Engineering	Total
N-HD25-1	Hydraulic	2	NE Lakewood Way between NE Bowlin Rd and NE Rainbow Dr.	1,501	12	$ 270,000	$ 54,000	$ 49,000	$ 373,000



Model ID
P2389
P2391

NOT TO SCALE

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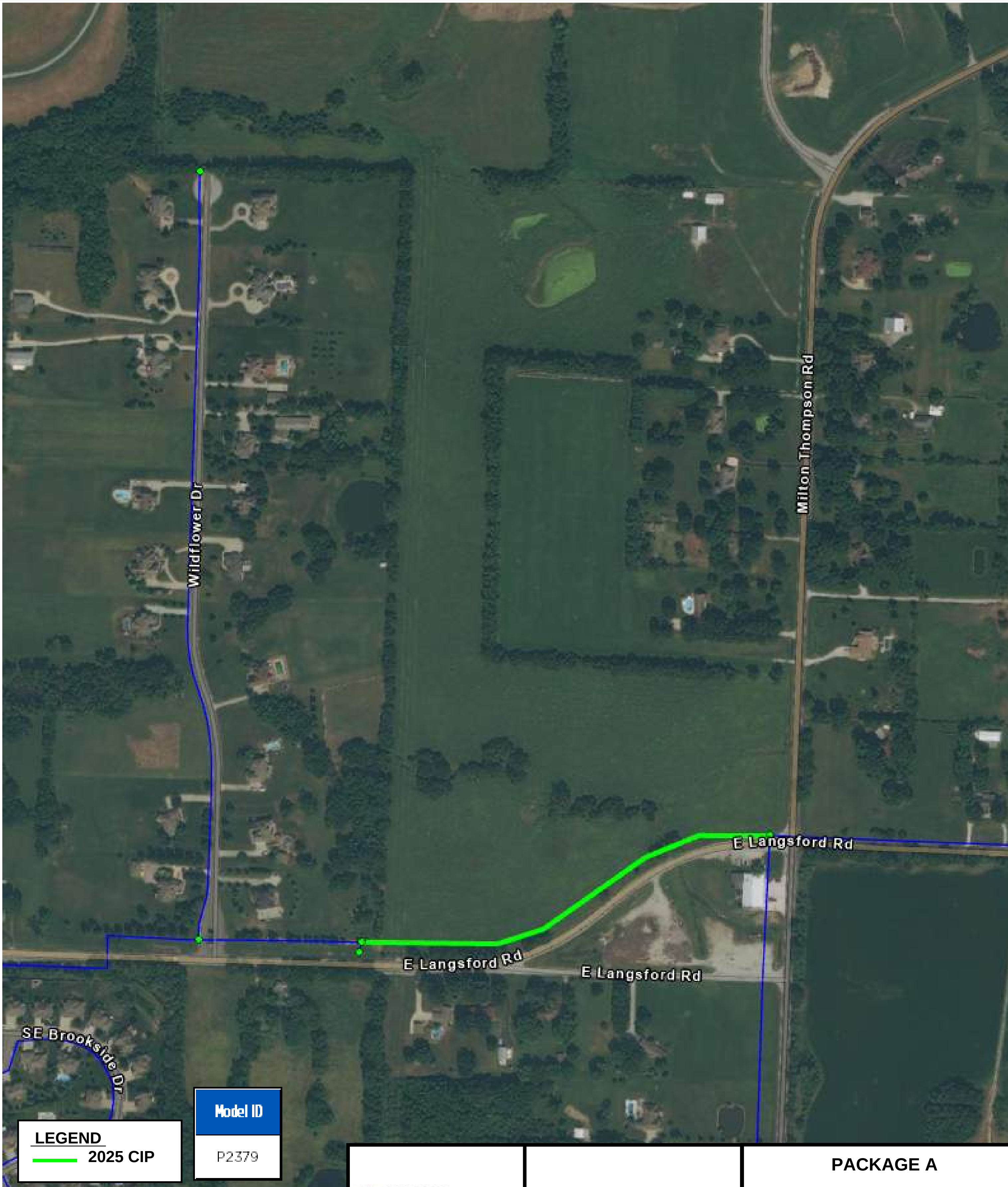
PACKAGE A

CIP: N-HD25-1

NORTH PRESSURE ZONE

CIP ID	Type	Priority	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
						Construction	Contingency	Engineering	Total
S-HD25-2	Hydraulic	3	E Langsford Dr between Milton Thompson Rd and Wildflower Dr.	1,410	12	$ 254,000	$ 51,000	$ 46,000	$ 351,000



LEGEND
2025 CIP

Model ID
P2379

NOT TO SCALE

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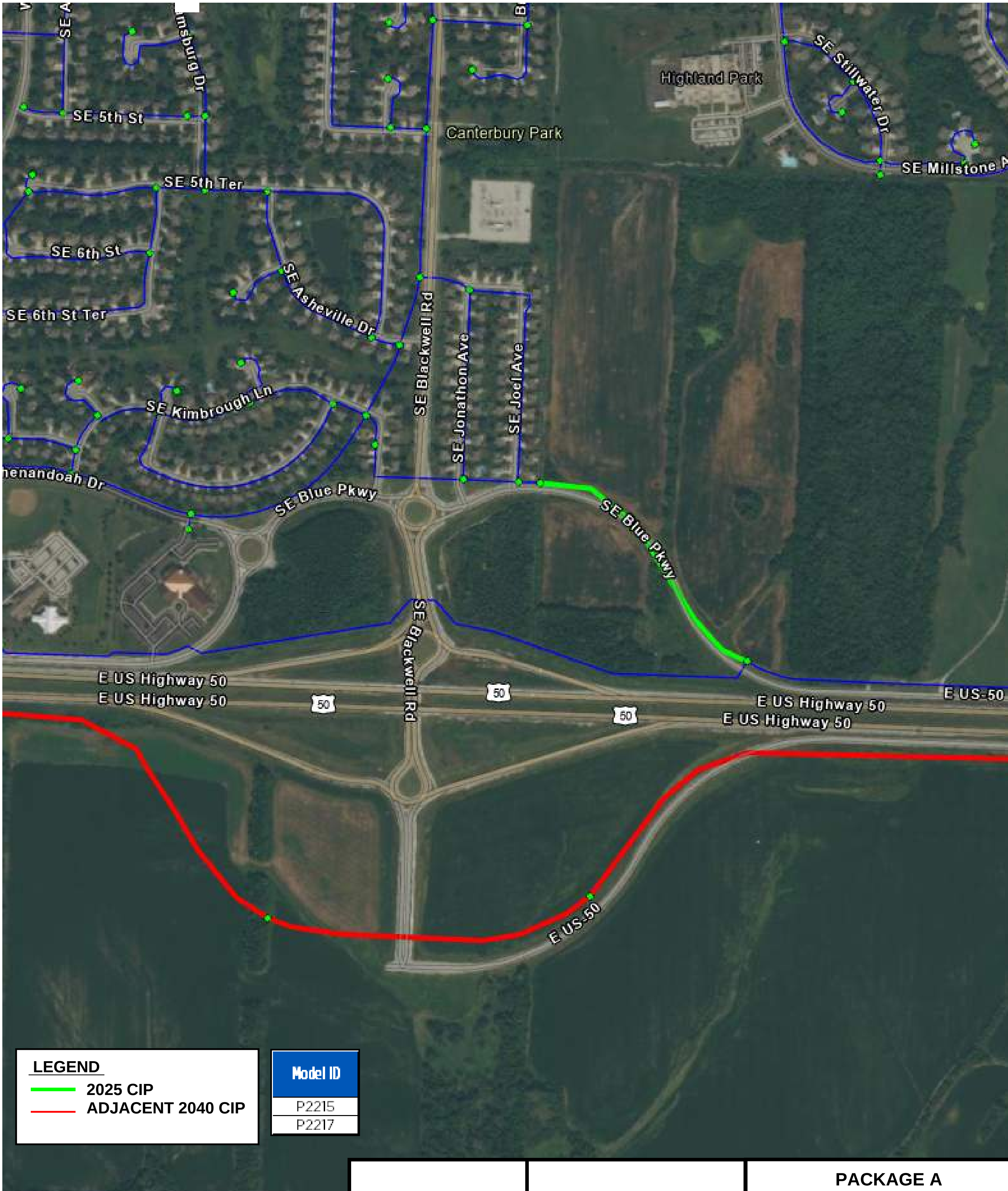
PACKAGE A

CIP: S-HD25-2

SOUTH PRESSURE ZONE

CIP ID	Type	Priority	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost Construction	Contingency	Engineering	Total
S-HD25-3	Hydraulic	4	SE Blue Pkwy from SE Joel Ave east to highway feeder.	1,441	12	$ 259,000	$ 52,000	$ 47,000	$ 358,000



LEGEND

- 2025 CIP
- ADJACENT 2040 CIP

Model ID
P2215
P2217

NOT TO SCALE

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PACKAGE A

CIP: S-HD25-3

SOUTH PRESSURE ZONE

CIP ID	Type	Priority	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
						Construction	Contingency	Engineering	Total
S-HD25-4	Hydraulic	5	NW Colbern Rd between Unity Way and NE Douglas St, to intersection of future commercial/industrial collector. (RRX)	5,916	12	$ 1,065,000	$ 213,000	$ 192,000	$ 1,818,000

Model ID
P2255
P2267
P2277
P2273

LEGEND
2025 CIP

NOT TO SCALE

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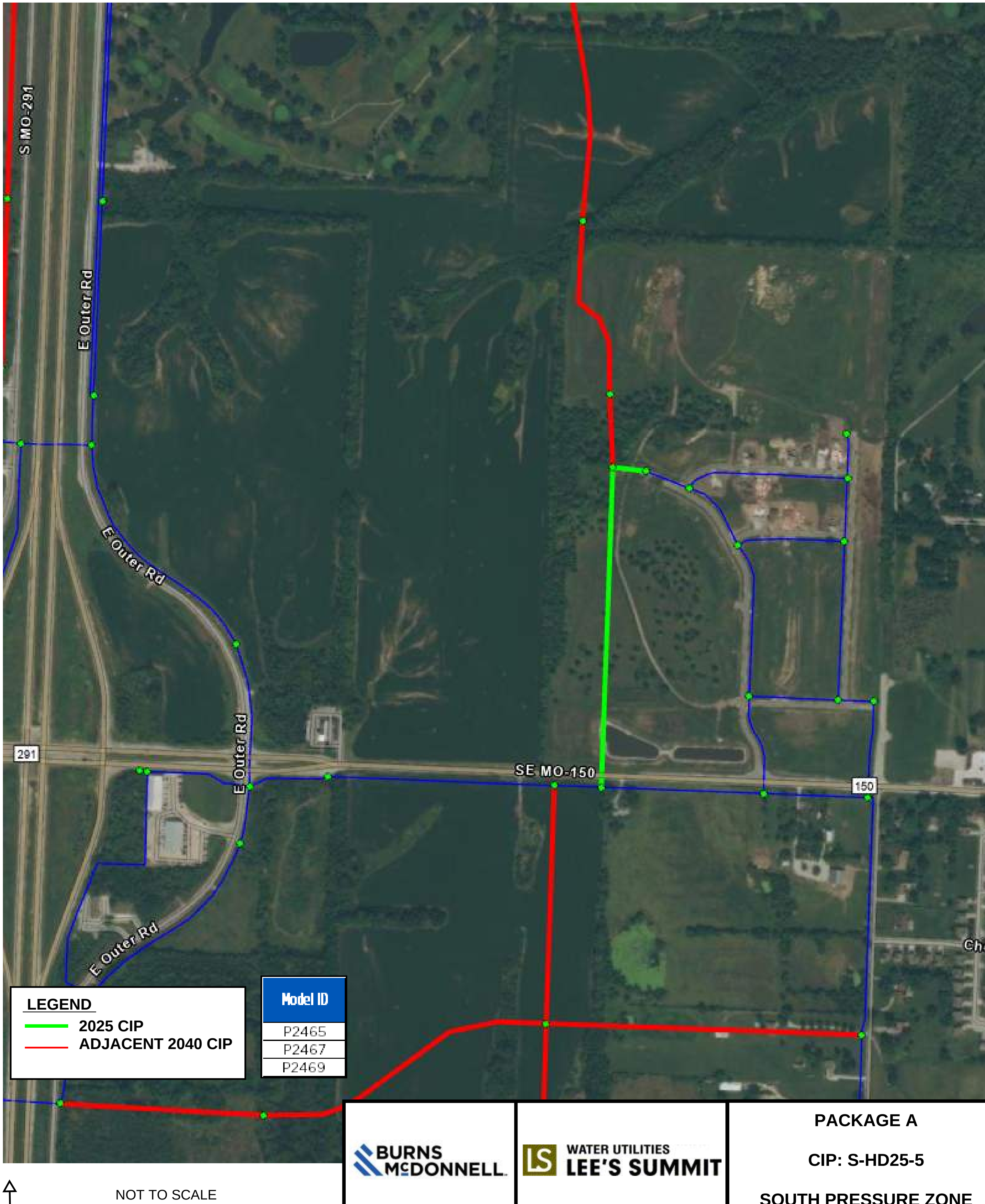
PACKAGE A

CIP: S-HD25-4

SOUTH PRESSURE ZONE

CIP ID	Type	Priority	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
						Construction	Contingency	Engineering	Total
S-HD25-5	Hydraulic	6	From SE MO-150 north through development parallel with future commercial/industrial collector.	2,092	12	$ 376,000	$ 76,000	$ 68,000	$ 520,000



BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE A

CIP: S-HD25-5

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-FF25-1	Fire Flow	On SW Scherer Ln between SW Scherer Rd and SW Scherer Pkwy, looping SW Scherer Rd; new water main	590	12	$ 106,000	$ 21,000	$ 19,000	$ 146,000
S-FF25-2	Fire Flow	On Pebblebrook Dr off of the corner of S Harris Rd and Haines Rd.	2,489	8	$ 448,000	$ 90,000	$ 81,000	$ 619,000
S-FF25-3	Fire Flow	On State Route 7 between Herring Rd and Outer Rd E. Looping Outer Rd E and Herring Rd.	4,074	12	$ 733,000	$ 147,000	$132,000	$ 1,012,000
N-FF25-1	Fire Flow	Drive bound by NW Gregory Blvd, NE Strother Rd and Lees Summit Rd.	884	8	$ 159,000	$ 32,000	$29,000	$ 220,000
Total								$1,997,000

BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

TABLE 9-4

2025 FIRE FLOW CIPs

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-FF25-1	Fire Flow	On SW Scherer Ln between SW Scherer Rd and SW Scherer Pkwy, looping SW Scherer Rd.	590	12	$ 106,000	$ 21,000	$ 19,000	$ 146,000

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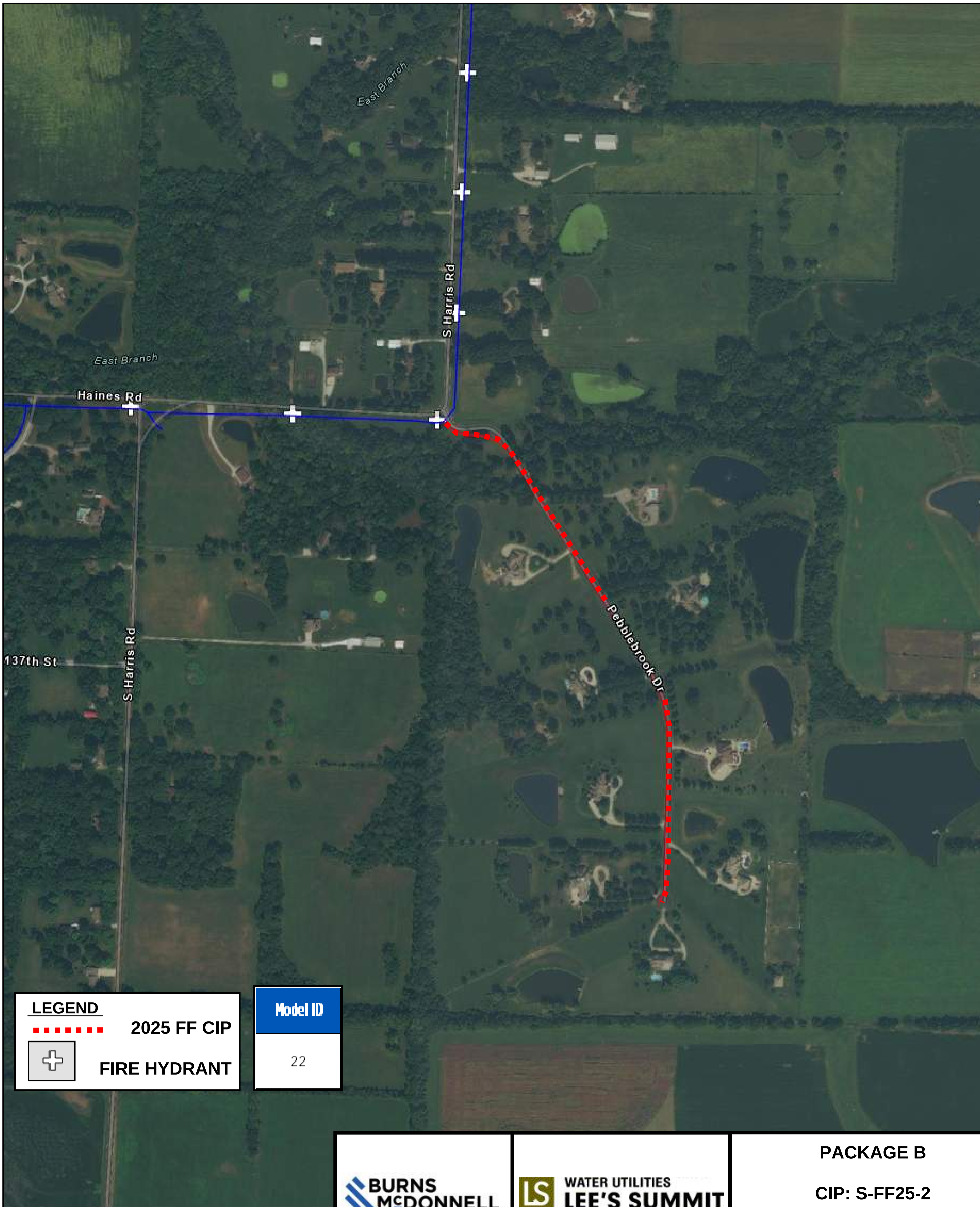
WATER UTILITIES LEE'S SUMMIT

PACKAGE B

CIP: S-FF25-1

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-FF25-2	Fire Flow	On Pebblebrook Dr off of the corner of S Harris Rd and Haines Rd.	2,489	8	$ 448,000	$ 90,000	$ 81,000	$ 619,000



LEGEND

2025 FF CIP

FIRE HYDRANT

Model ID
22

NOT TO SCALE

BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE B

CIP: S-FF25-2

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-FF25-3	Fire Flow	On State Route 7 between Herring Rd and Outer Rd E. Looping Outer Rd E and Herring Rd.	4,074	12	$ 733,000	$ 147,000	$132,000	$ 1,012,000

LEGEND

2025 FF CIP

FIRE HYDRANT

Model ID
P2483

NOT TO SCALE

BURNS McDONNELL

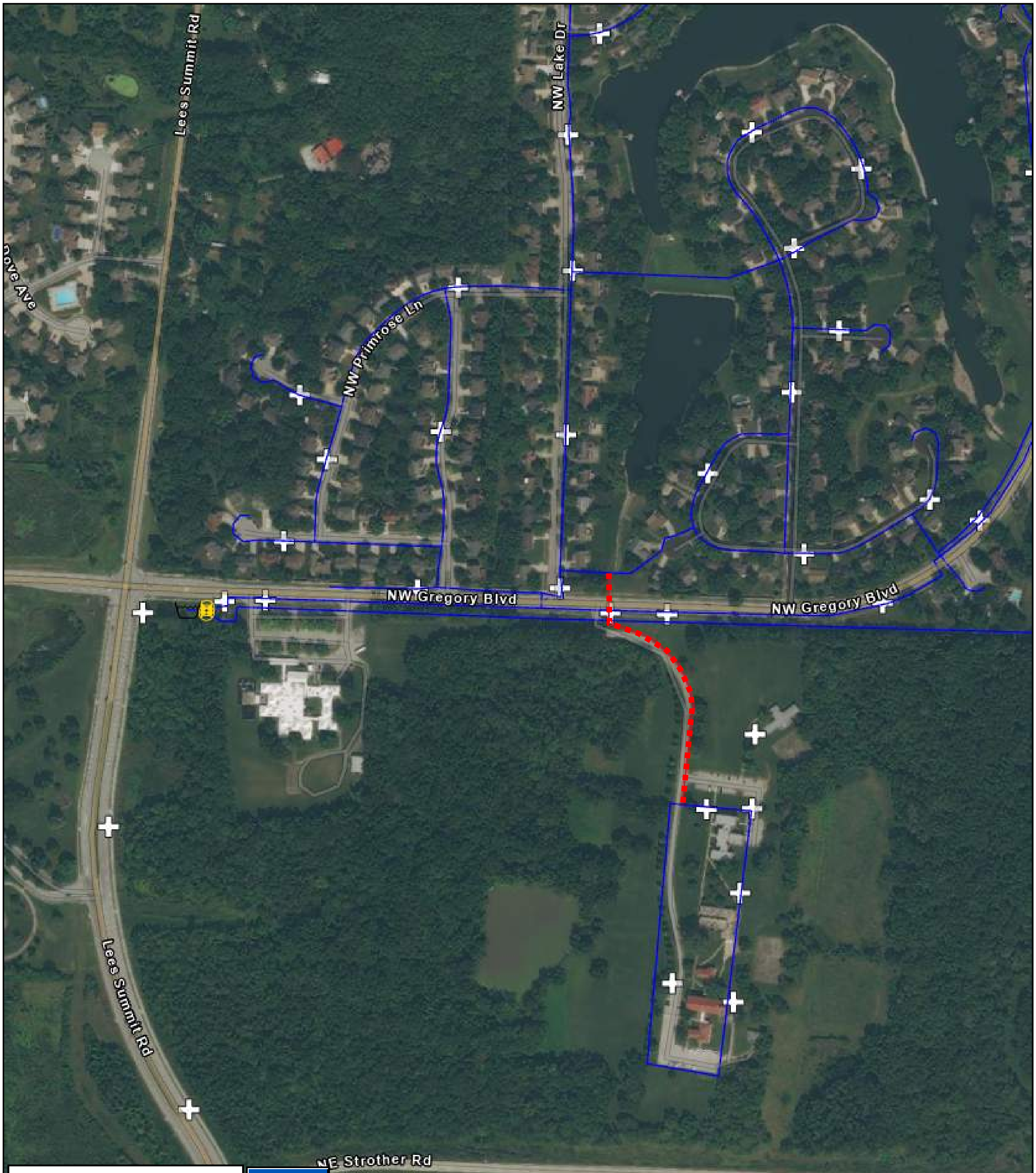
WATER UTILITIES LEE'S SUMMIT

PACKAGE B

CIP: S-FF25-3

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
N-FF25-1	Fire Flow	Drive bound by NW Gregory Blvd, NE Strother Rd and Lees Summit Rd.	884	8	$ 159,000	$ 32,000	$29,000	$ 220,000



LEGEND

2025 FF CIP

FIRE HYDRANT

Model ID
2184

NOT TO SCALE

BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE B

CIP: N-FF25-1

NORTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-1	Hydraulic	Between SW Scherer Pkwy and SW Sampson Rd along future residential collector.	8,480	12	$ 1,526,000	$ 306,000	$ 275,000	$ 2,107,000
S-HD40-2	Hydraulic	Between Outer Belt Rd and SW Kline Ave along future residential collector.	2,774	12	$ 499,000	$ 100,000	$ 90,000	$ 689,000
S-HD40-3	Hydraulic	Between Outer Belt Rd and 155th St along future residential collector; and On 155th St from Meadow Brook Ct west to future residential collector.	5,964	12	$ 1,074,000	$ 216,000	$ 193,000	$ 1,483,000
S-HD40-4	Hydraulic	Between SW Pryor Rd and SW Ward Rd along future minor arterial road.	5,508	12	$ 992,000	$ 198,000	$ 179,000	$ 1,369,000
S-HD40-5	Hydraulic	SW Stuart Rd between SW Ward Rd and SW Jefferson St; north on SW Jefferson St between SW Stuart Rd and railway. (no RRX)	8,501	12	1,529,000	306,000	275,000	2,110,000
S-HD40-6	Hydraulic	Between SW Hook Rd and SW Stuart Rd along future commercial/industrial collector.	4,049	12	$ 729,000	$ 146,000	$ 131,000	$ 1,006,000
S-HD40-7	Hydraulic	On SW Hook Rd between elevated tank and Highway 291 and along S MO-291 near SW Market St. (HWX)	6,121 1,356 484	24 16 12	$ 2,413,000	$ 483,000	$ 435,000	$ 3,331,000
S-HD40-8	Hydraulic	On S MO-291 from SW Market St north towards SW Hook Rd to Highway crossing.	2,098	12	$ 377,000	$ 76,000	$ 68,000	$ 521,000
S-HD40-9	Hydraulic	Between SE MO-150 and SE Hackamore Dr along future commercial/industrial and residential collector.	2,632	12	$ 474,000	$ 95,000	$ 85,000	$ 654,000
S-HD40-10	Hydraulic	Between E Outer Rd and SE Doc Henry Rd along future commercial/industrial collector.	4,066	12	$ 732,000	$ 147,000	$ 131,000	$ 1,010,000
S-HD40-11	Hydraulic	Between SE MO-150 north then east to E Outer Rd/S MO-291 along future commercial/industrial collector.	6,341	12	$ 1,142,000	$ 229,000	$ 207,000	$ 1,578,000
S-HD40-12	Hydraulic	Bewteen S MO-291 and N/SE Ranson Rd in line with Browing Rd along future major arterial road (RRX).	6,468	12	$ 1,165,000	$ 233,000	$ 210,000	$ 2,303,000
S-HD40-13	Hydraulic	SE Hamblen Rd between Resource Recovery Park to Hamblen Rd/intersection of future major arterial road (RRX).	5,511 681	12 16	$ 1,121,000	$ 224,000	$ 202,000	$ 1,756,000
S-HD40-14	Hydraulic	On SE Oldham Pkwy from SE Princeton Dr and on E US-50 to Smart Rd, connected by future commercial industrial collector.	8,803	12	$ 1,584,000	$ 316,000	$ 285,000	$ 2,185,000
S-HD40-15	Hydraulic	On E US-50 northside feeder from Milton Thompson Rd to highway crossing of E US Highway 50 near State Route 7 (HWX).	8,957	12	$ 1,612,000	$ 322,000	$ 290,000	$ 2,628,000
S-HD40-16	Hydraulic	On NW Clifford Rd between View High Dr and Noland Rd (RRX).	5,841	12	$ 1,051,000	$ 211,000	$ 189,000	$ 1,451,000
S-HD40-17	Hydraulic	On NW Quarry Park Rd between NW Pryor Rd and Noland Rd.	4,689	12	$ 844,000	$ 168,000	$ 151,000	$ 1,163,000
S-HD40-18	Hydraulic	On E 83rd St to Lee's Summit Rd.	4,913	12	$ 884,000	$ 177,000	$ 159,000	$ 1,220,000
S-HD40-19	Hydraulic	NE Strother Rd between NE Independence Ave and NE Todd George Pkwy. Under Highway 470 (HWX); And on NE Todd George Pkwy from NE Strother Rd to NE Colbern Rd.	12,402	12	$ 2,232,000	$ 446,000	$ 402,000	$ 3,363,000
N-HD40-1	Hydraulic	NE Todd George Pkwy NE Strother Rd to NE Woods Chapel Rd.	5,162	12	$ 929,000	$ 185,000	$ 167,000	$ 1,281,000
Total								$33,208,000

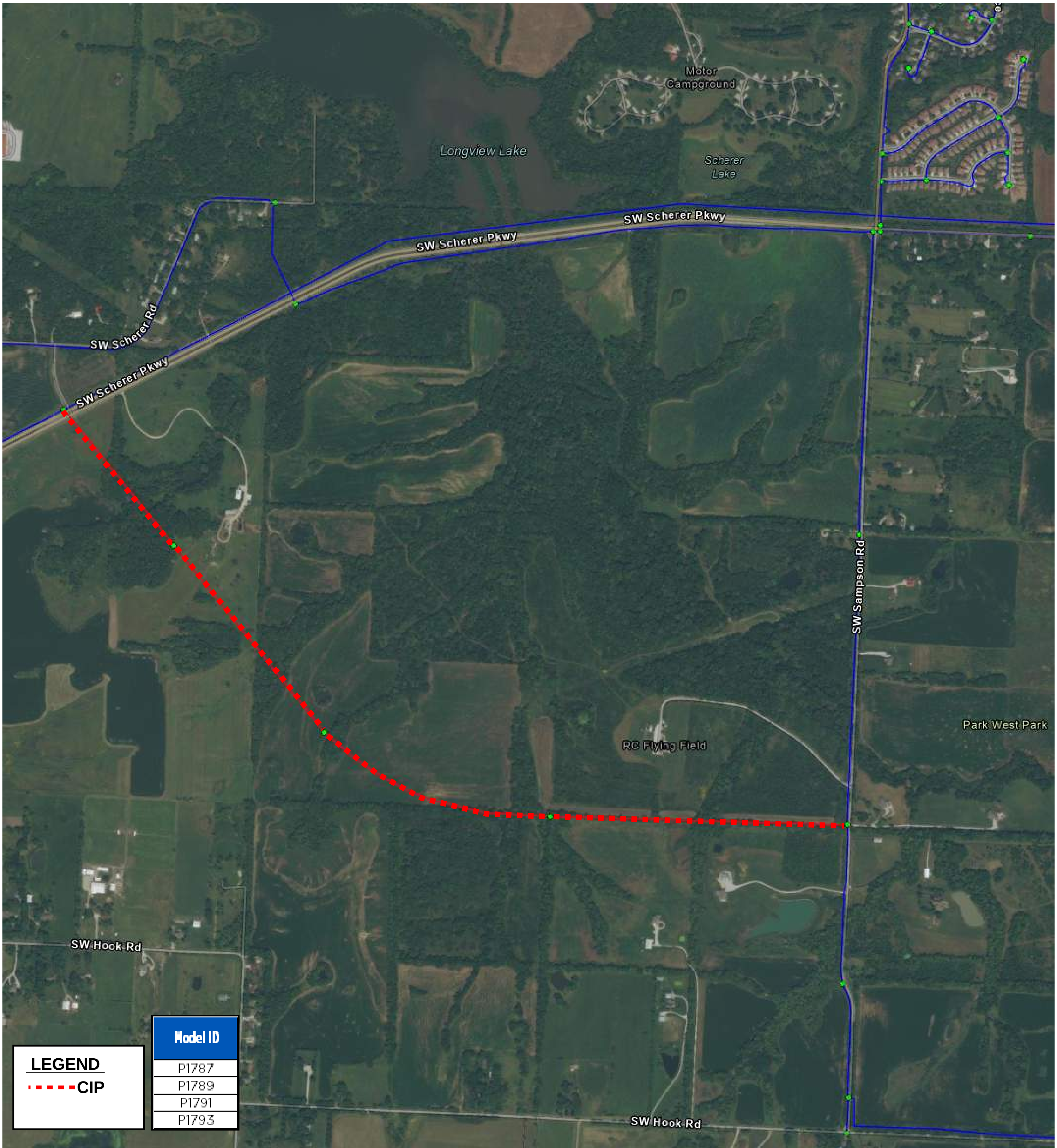
BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

TABLE 9-5

2040 HYDRAULIC-DEVELOPMENT CIPs

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-1	Hydraulic	Between SW Scherer Pkwy and SW Sampson Rd along future residential collector.	8,480	12	$ 1,526,000	$ 306,000	$ 275,000	$ 2,107,000



Model ID
P1787
P1789
P1791
P1793

LEGEND

CIP

NOT TO SCALE

BURNS McDONNELL

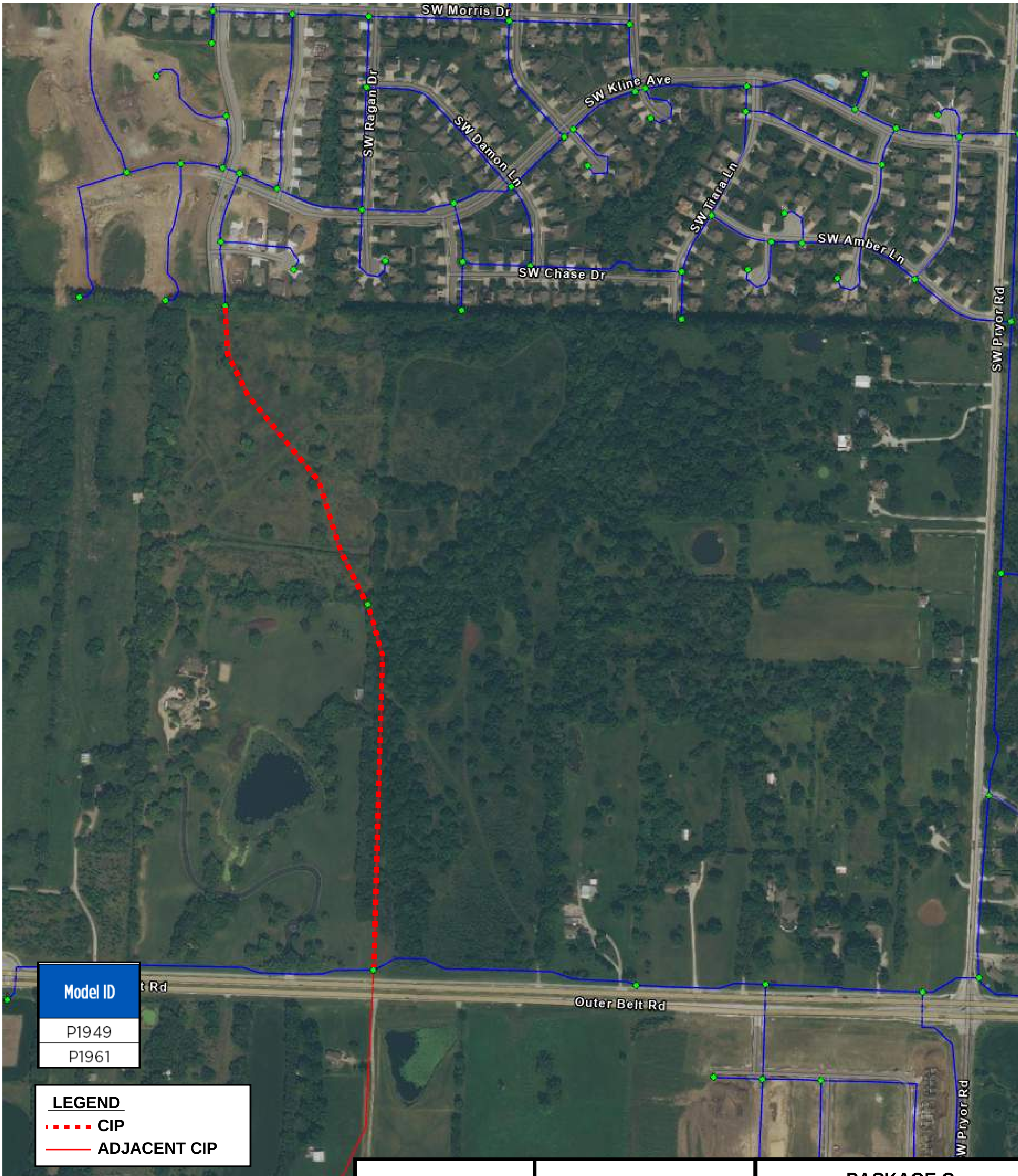
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-1

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-2	Hydraulic	Between Outer Belt Rd and SW Kline Ave along future residential collector.	2,774	12	$ 499,000	$ 100,000	$ 90,000	$ 689,000



Model ID
P1949
P1961

LEGEND
- CIP
- ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

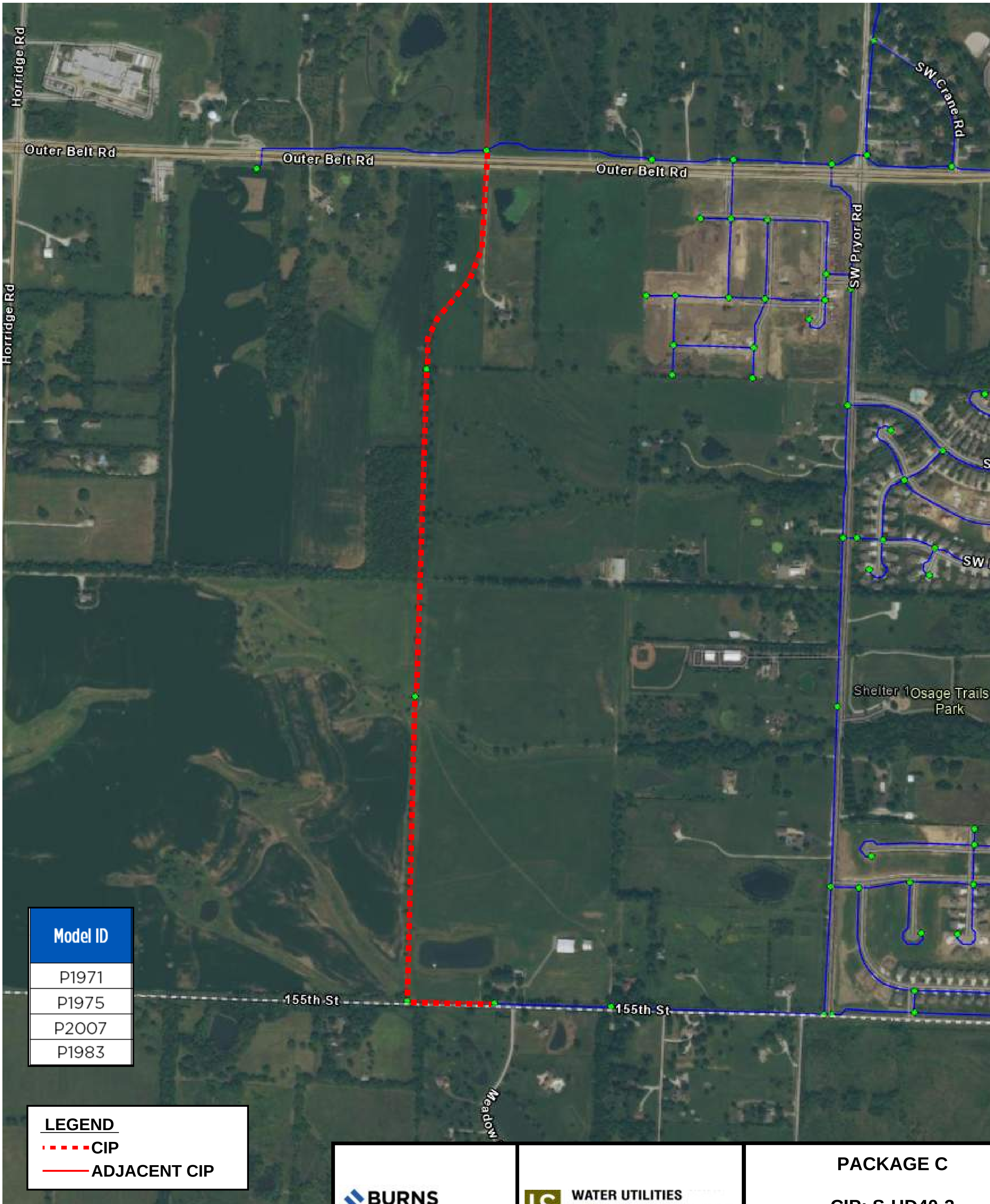
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-2

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-3	Hydraulic	Between Outer Belt Rd and 155th St along future residential collector; and On 155th St from Meadow Brook Ct west to future residential collector.	5,964	12	$ 1,074,000	$ 216,000	$ 193,000	$ 1,483,000



Model ID
P1971
P1975
P2007
P1983

LEGEND
- CIP
- ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

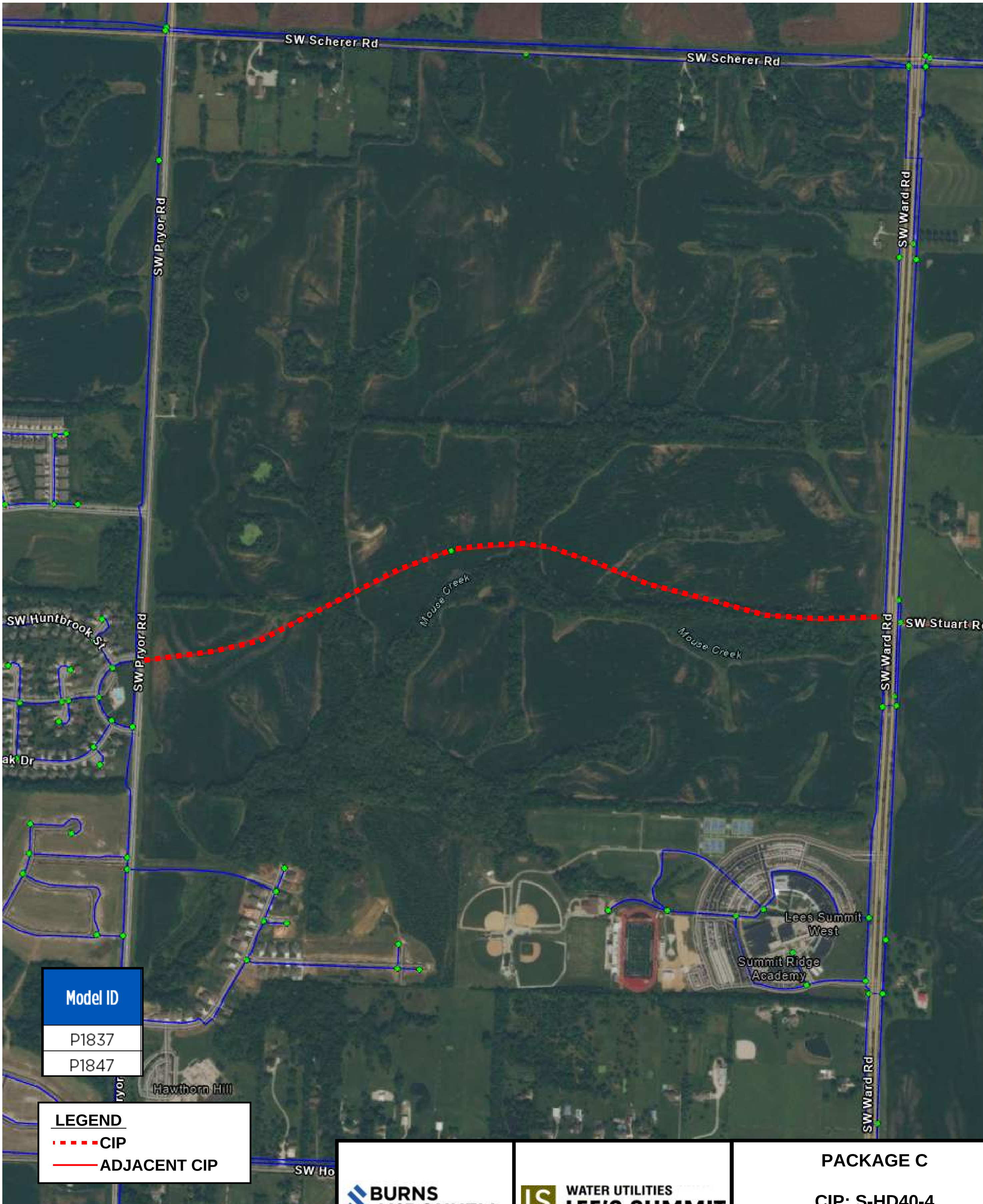
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-3

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-4	Hydraulic	Between SW Pryor Rd and SW Ward Rd along future minor arterial road.	5,508	12	$ 992,000	$ 198,000	$ 179,000	$ 1,369,000



Model ID
P1837
P1847

LEGEND
- CIP
- ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

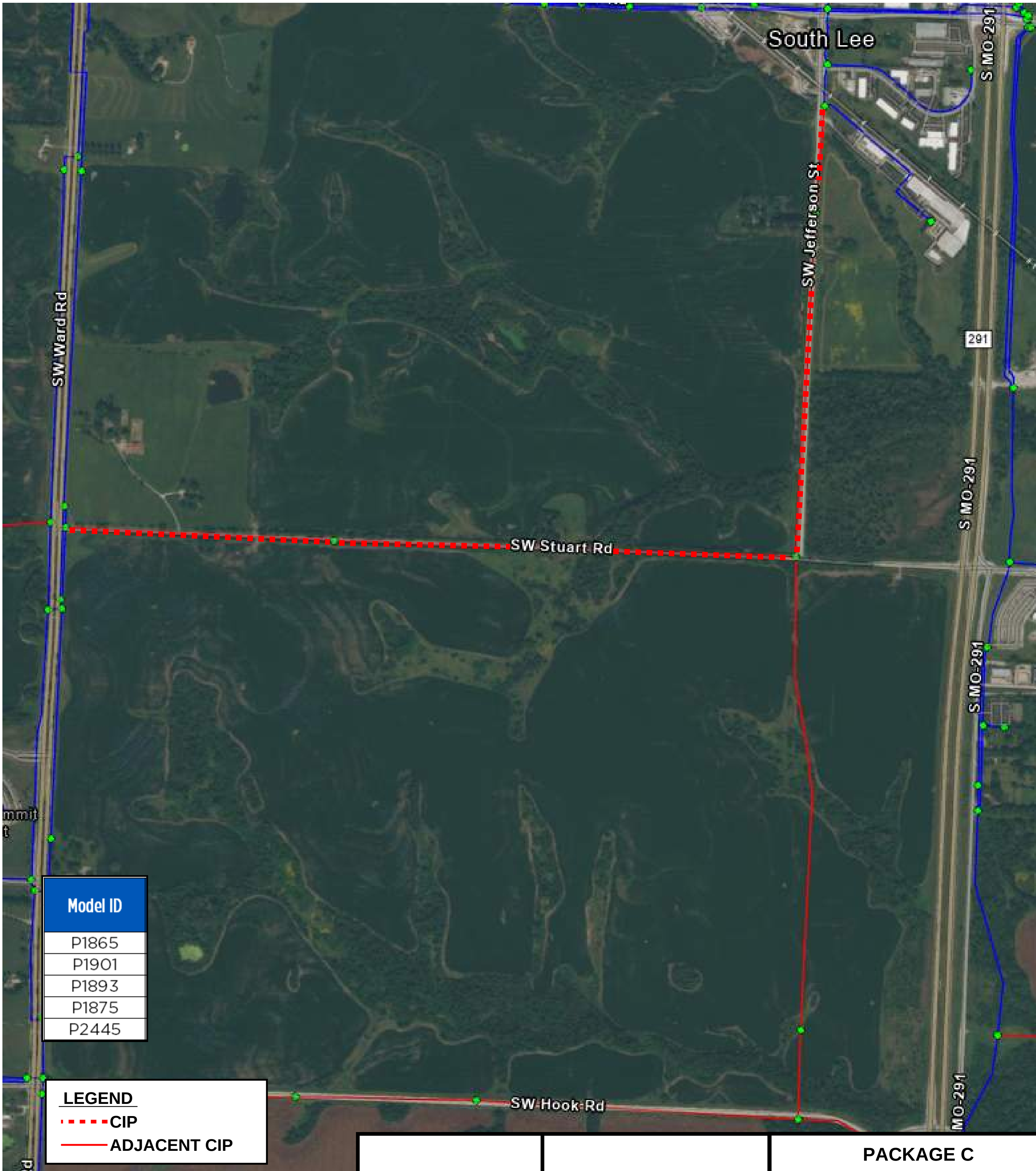
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-4

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-5	Hydraulic	SW Stuart Rd between SW Ward Rd and SW Jefferson St; north on SW Jefferson St between SW Stuart Rd and railway. (no RRX)	8,501	12	1,529,000	306,000	275,000	2,110,000



Model ID
P1865
P1901
P1893
P1875
P2445

LEGEND
- CIP
- ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

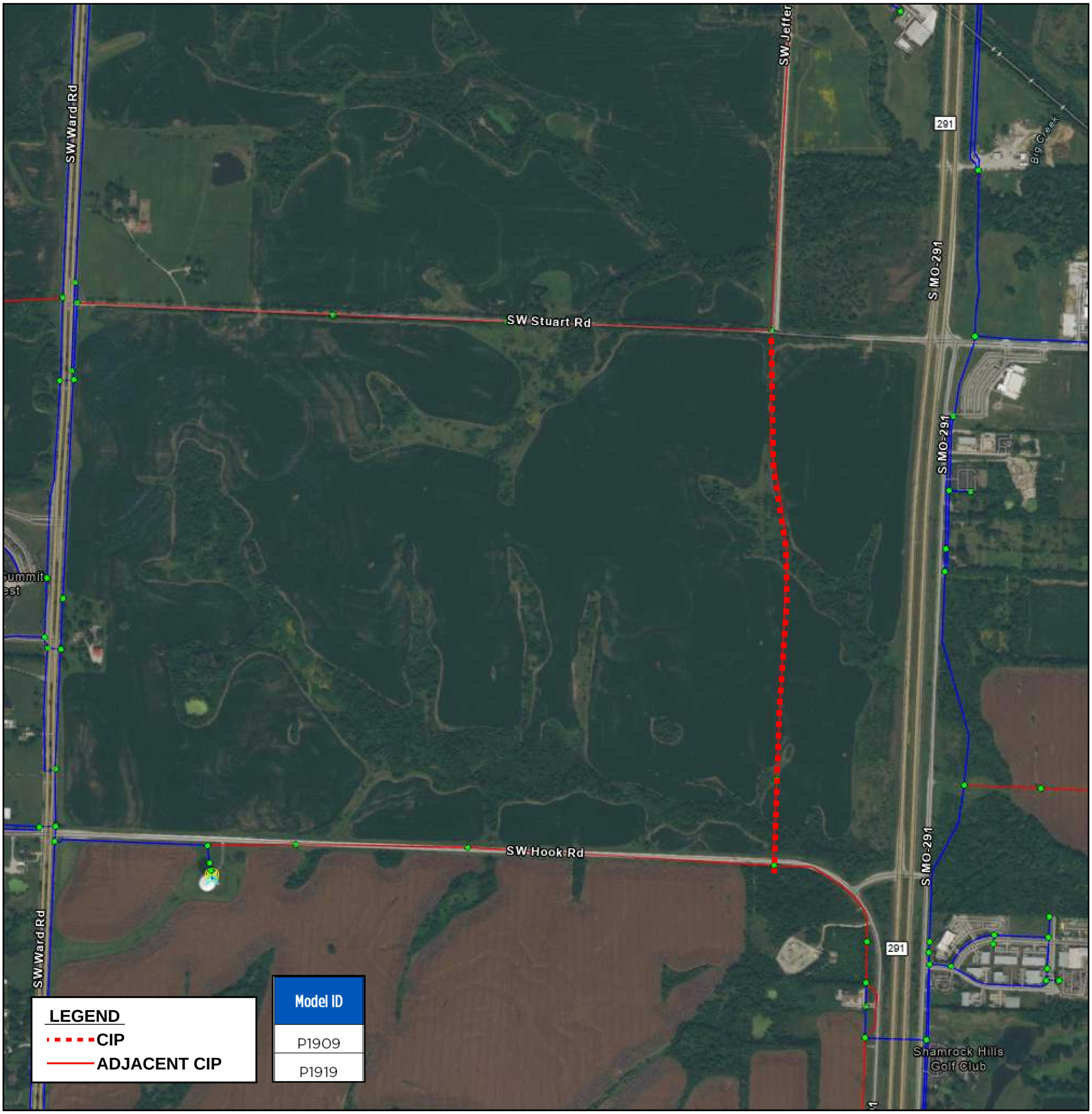
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-5

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-6	Hydraulic	Between SW Hook Rd and SW Stuart Rd along future commercial/industrial collector.	4,049	12	$ 729,000	$ 146,000	$ 131,000	$ 1,006,000



Model ID
P1909
P1919

NOT TO SCALE

BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-6

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-7	Hydraulic	On SW Hook Rd between elevated tank and Highway 291 and along S MO-291 near SW Market St. (HWX)	6,121	24	$ 2,413,000	$ 483,000	$ 435,000	$ 3,331,000
			1,356	16				
			484	12				

NOT TO SCALE

BURNS McDONNELL

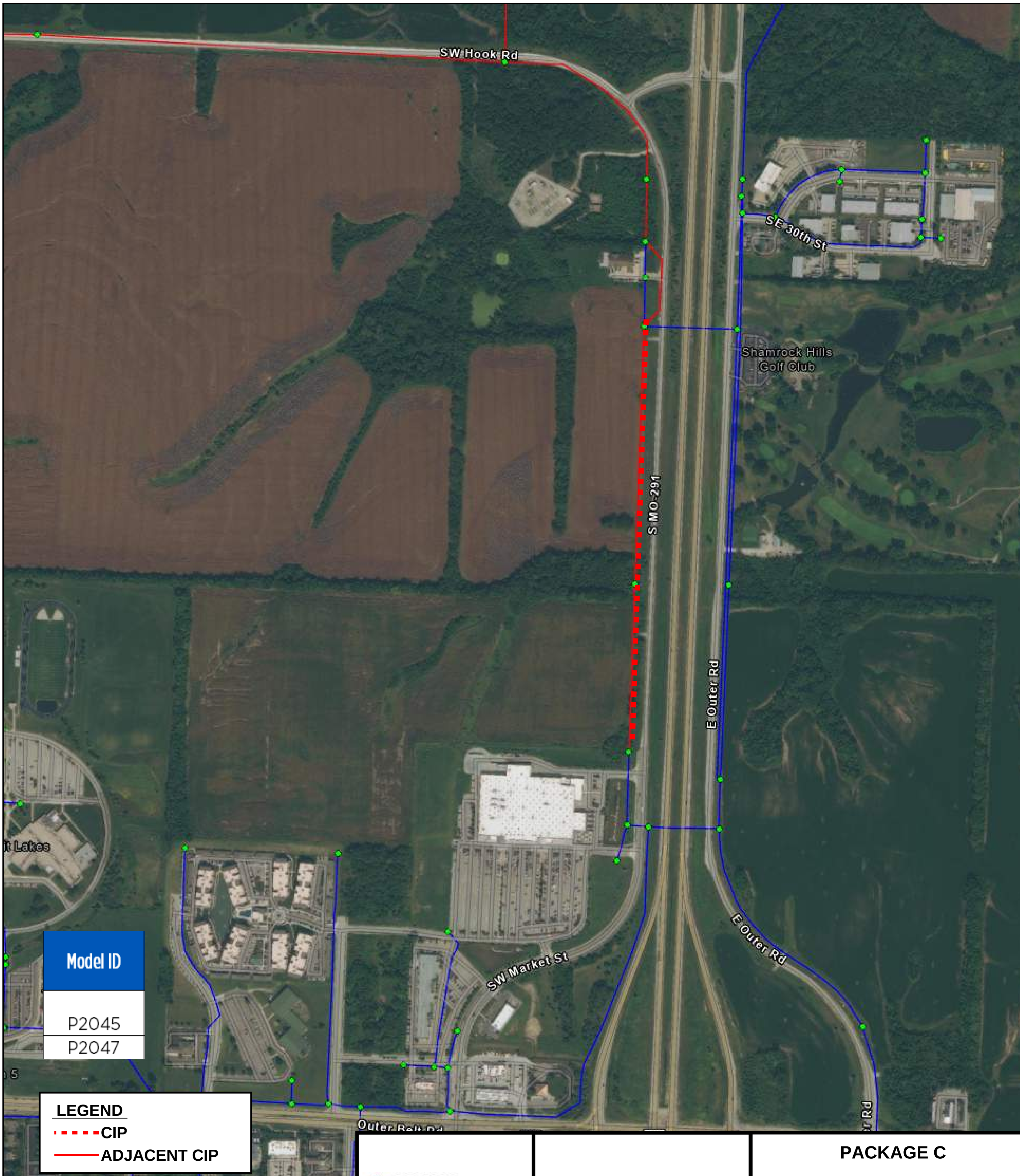
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-7

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-8	Hydraulic	On S MO-291 from SW Market St north towards SW Hook Rd to Highway crossing.	2,098	12	$ 377,000	$ 76,000	$ 68,000	$ 521,000



NOT TO SCALE

BURNS McDONNELL

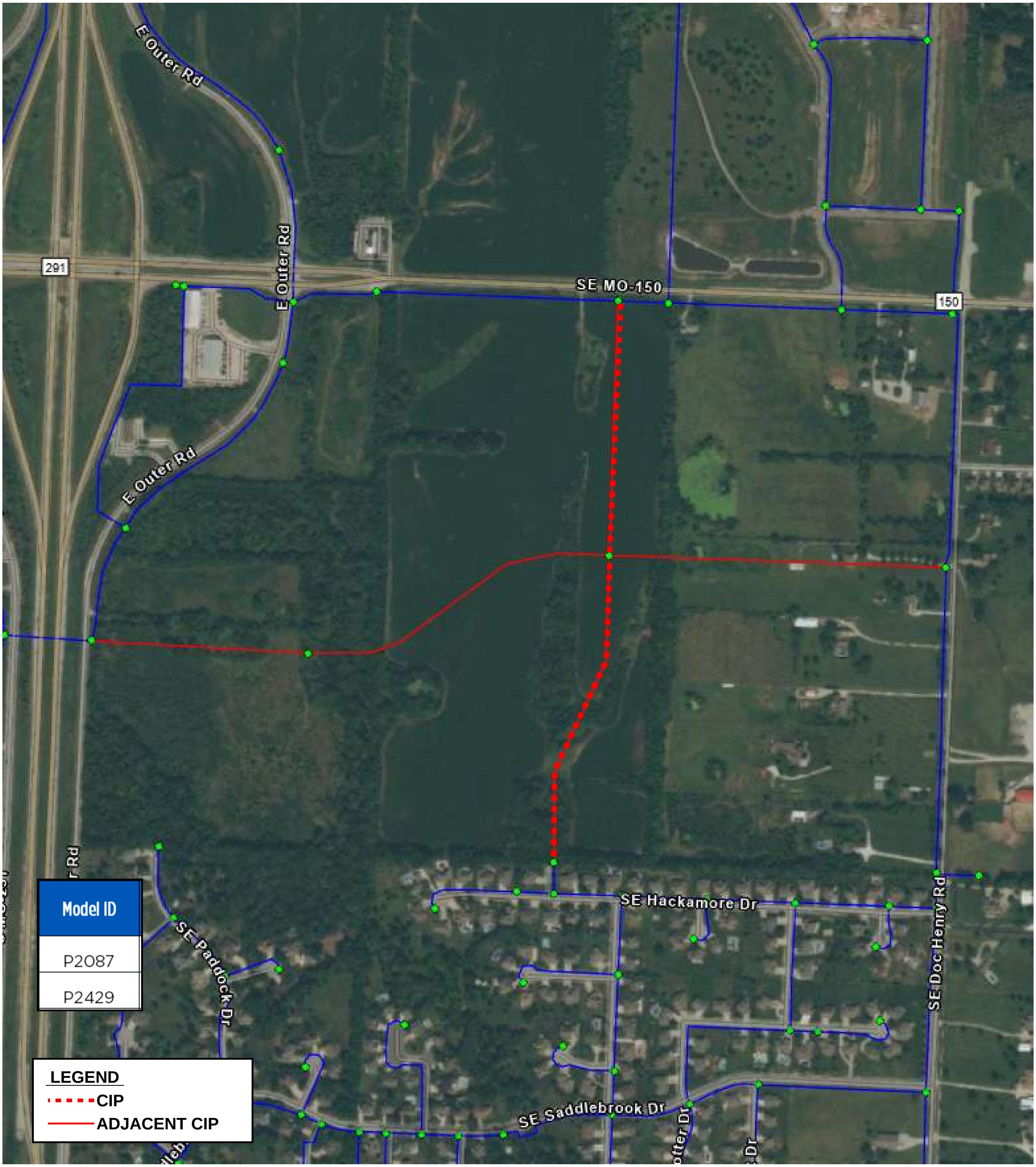
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-8

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-9	Hydraulic	Between SE MO-150 and SE Hackamore Dr along future commercial/industrial and residential collector.	2,632	12	$ 474,000	$ 95,000	$ 85,000	$ 654,000



NOT TO SCALE

BURNS McDONNELL

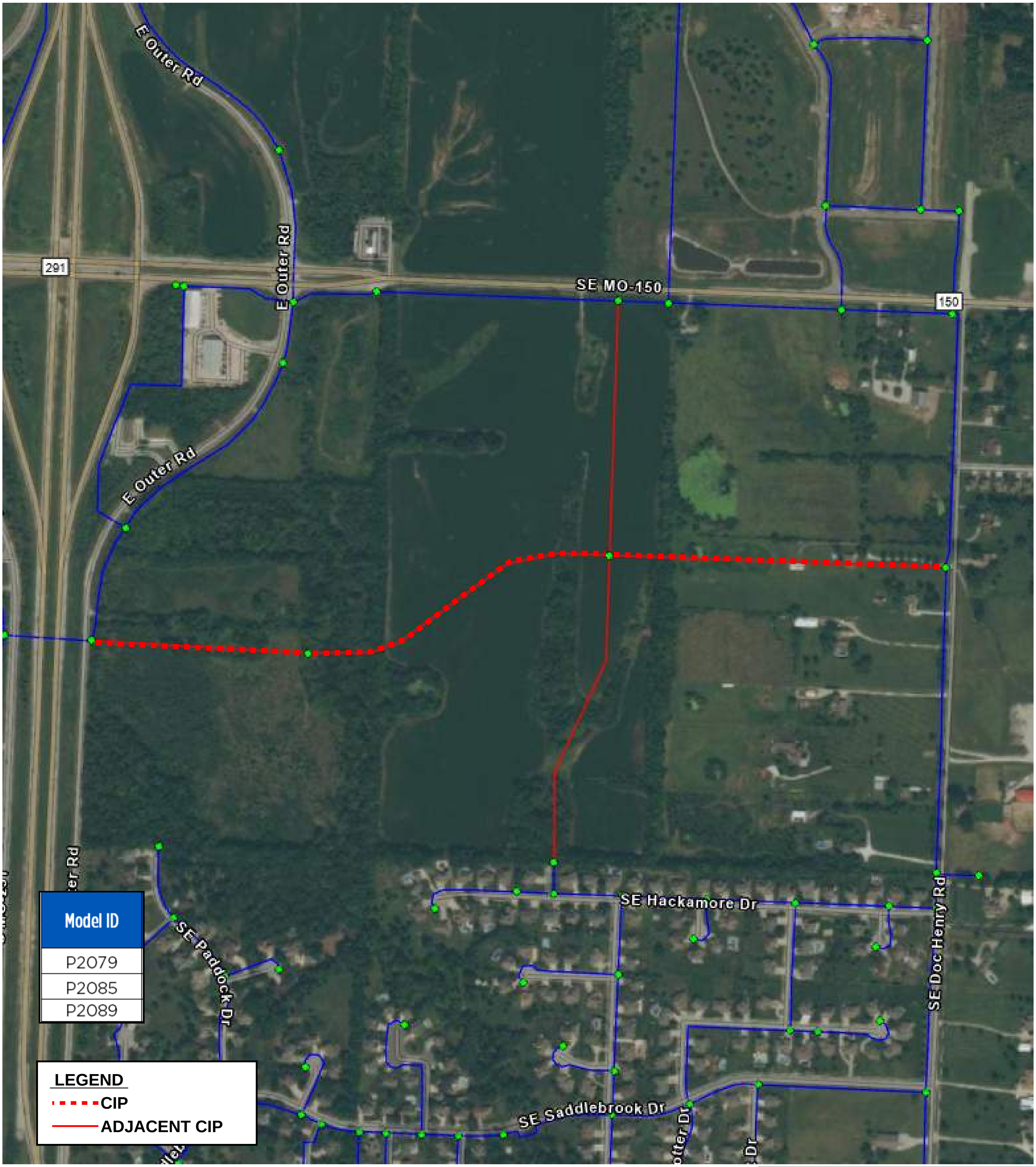
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-9

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-10	Hydraulic	Between E Outer Rd and SE Doc Henry Rd along future commercial/industrial collector.	4,066	12	$ 732,000	$ 147,000	$ 131,000	$ 1,010,000



Model ID
P2079
P2085
P2089

LEGEND
CIP
ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

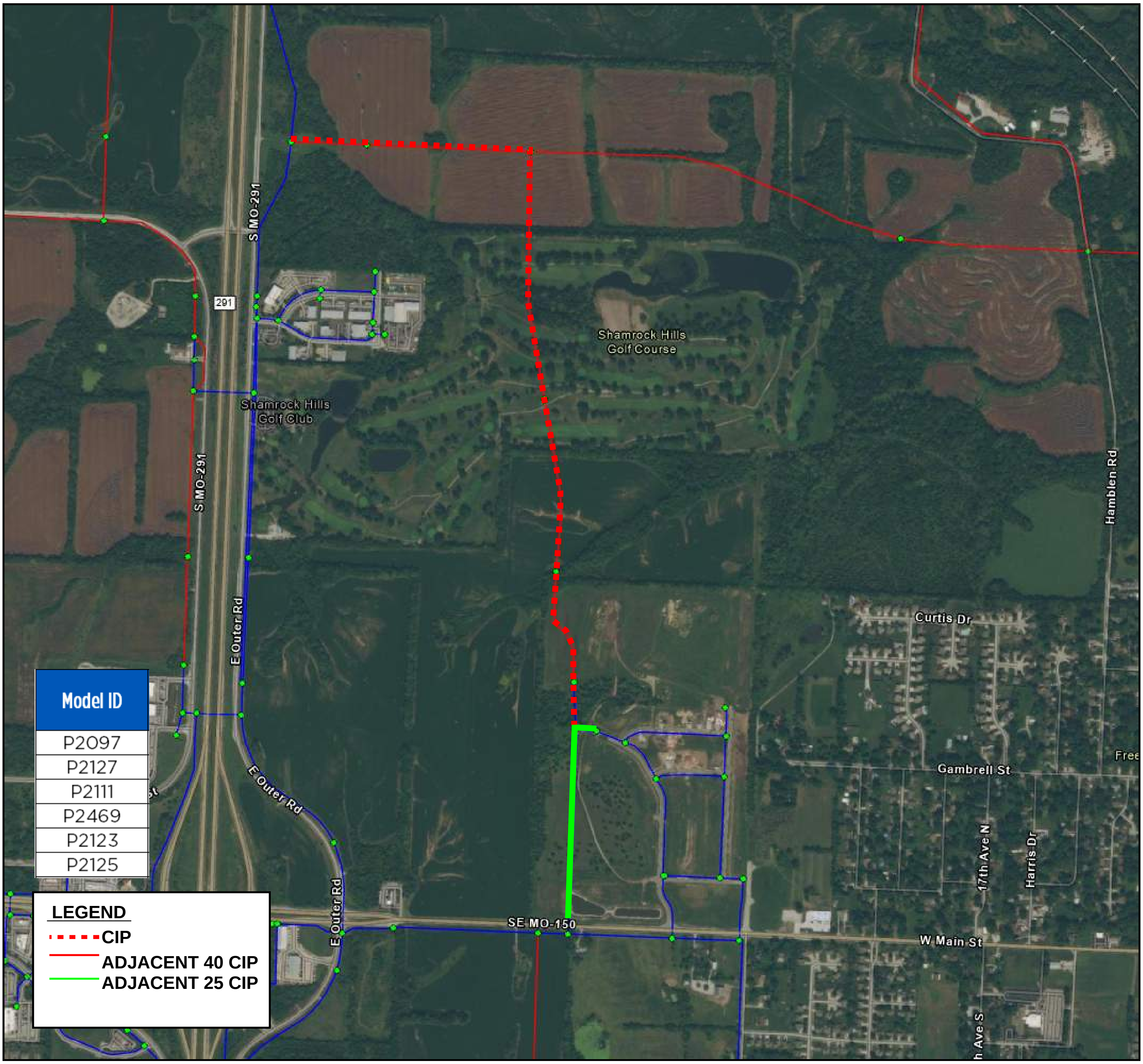
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-10

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-11	Hydraulic	Between SE MO-150 north then east to E Outer Rd/S MO-291 along future commercial/industrial collector.	6,341	12	$ 1,142,000	$ 229,000	$ 207,000	$ 1,578,000



Model ID
P2097
P2127
P2111
P2469
P2123
P2125

LEGEND

- CIP
- ADJACENT 40 CIP
- ADJACENT 25 CIP

NOT TO SCALE

BURNS McDONNELL

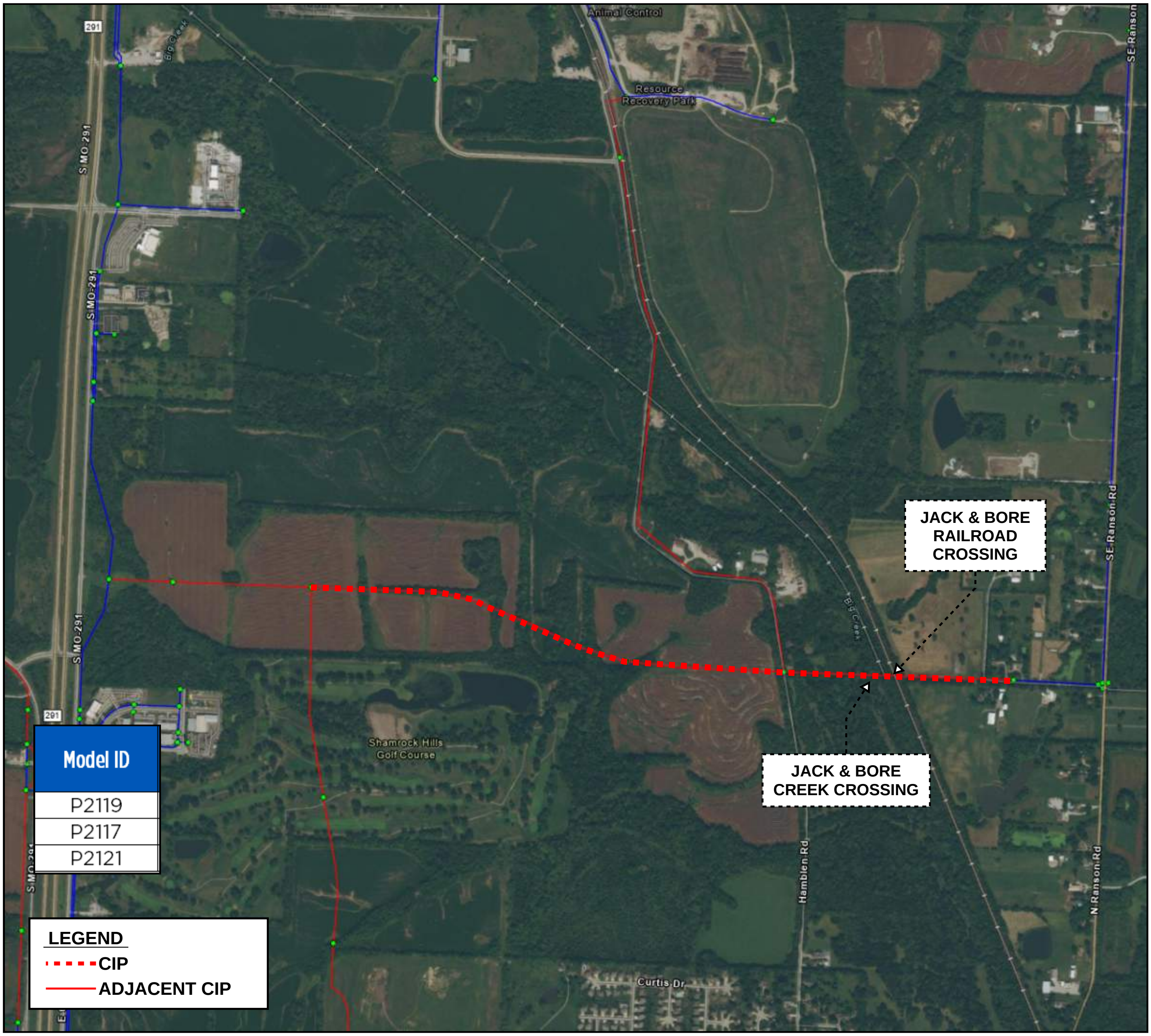
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-11

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-12	Hydraulic	Bewteen S MO-291 and N/SE Ranson Rd in line with Browing Rd along future major arterial road (RRX).	6,468	12	$ 1,165,000	$ 233,000	$ 210,000	$ 2,303,000



NOT TO SCALE

BURNS McDONNELL

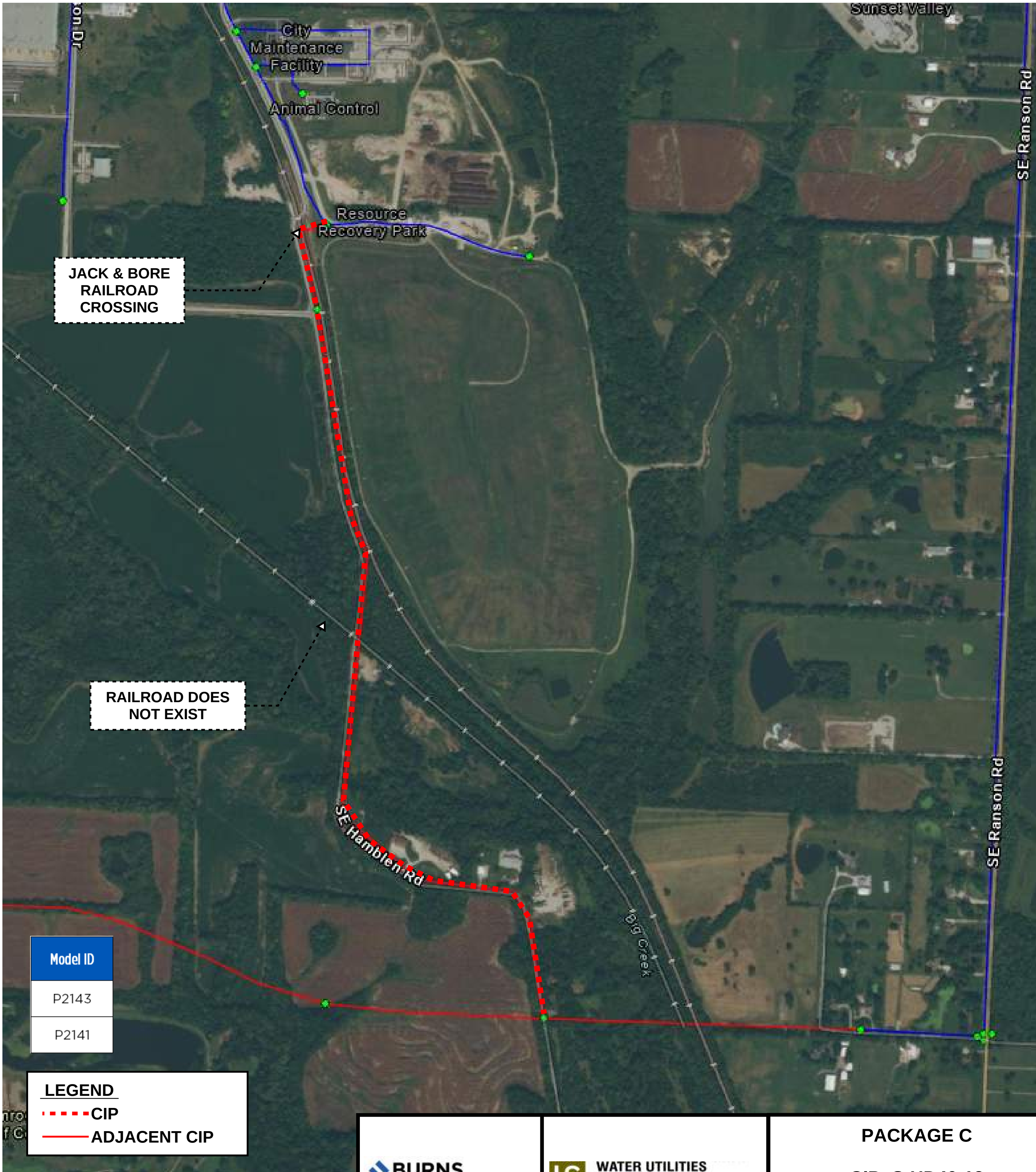
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-12

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-13	Hydraulic	SE Hamblen Rd between Resource Recovery Park to Hamblen Rd/intersection of future major arterial road (RRX).	5,511	12	$ 1,121,000	$ 224,000	$ 202,000	$ 1,756,000
			681	16				



NOT TO SCALE

BURNS McDONNELL

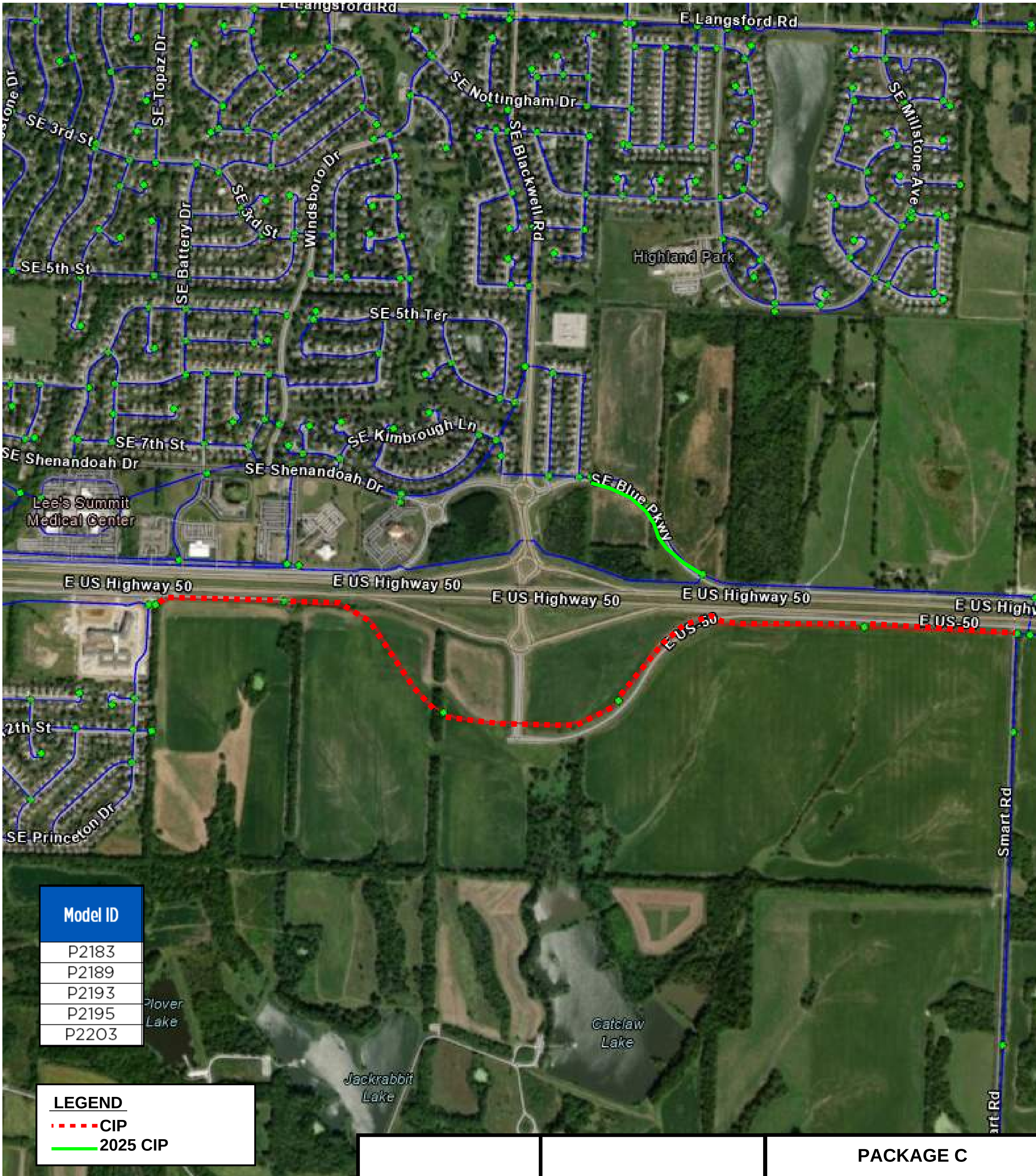
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-13

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost Construction	Contingency	Engineering	Total
S-HD40-14	Hydraulic	On SE Oldham Pkwy from SE Princeton Dr and on E US-50 to Smart Rd, connected by future commercial industrial collector.	8,803	12	$ 1,584,000	$ 316,000	$ 285,000	$ 2,185,000



Model ID
P2183
P2189
P2193
P2195
P2203

LEGEND

- CIP
- 2025 CIP

NOT TO SCALE

BURNS McDONNELL

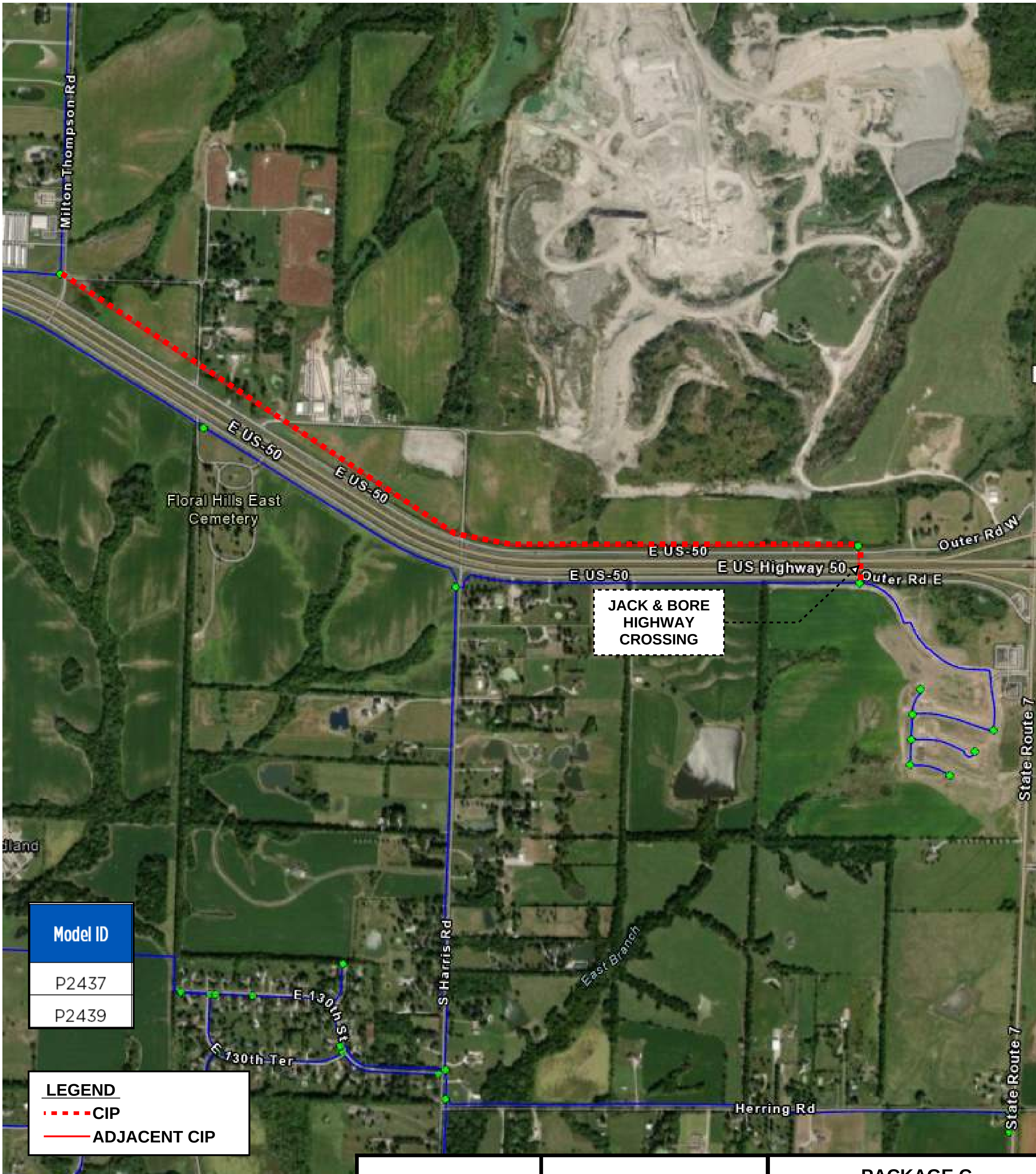
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-14

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-15	Hydraulic	On E US-50 northside feeder from Milton Thompson Rd to highway crossing of E US Highway 50 near State Route 7 (HWX).	8,957	12	$ 1,612,000	$ 322,000	$ 290,000	$ 2,628,000



Model ID
P2437
P2439

LEGEND

- CIP
- ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

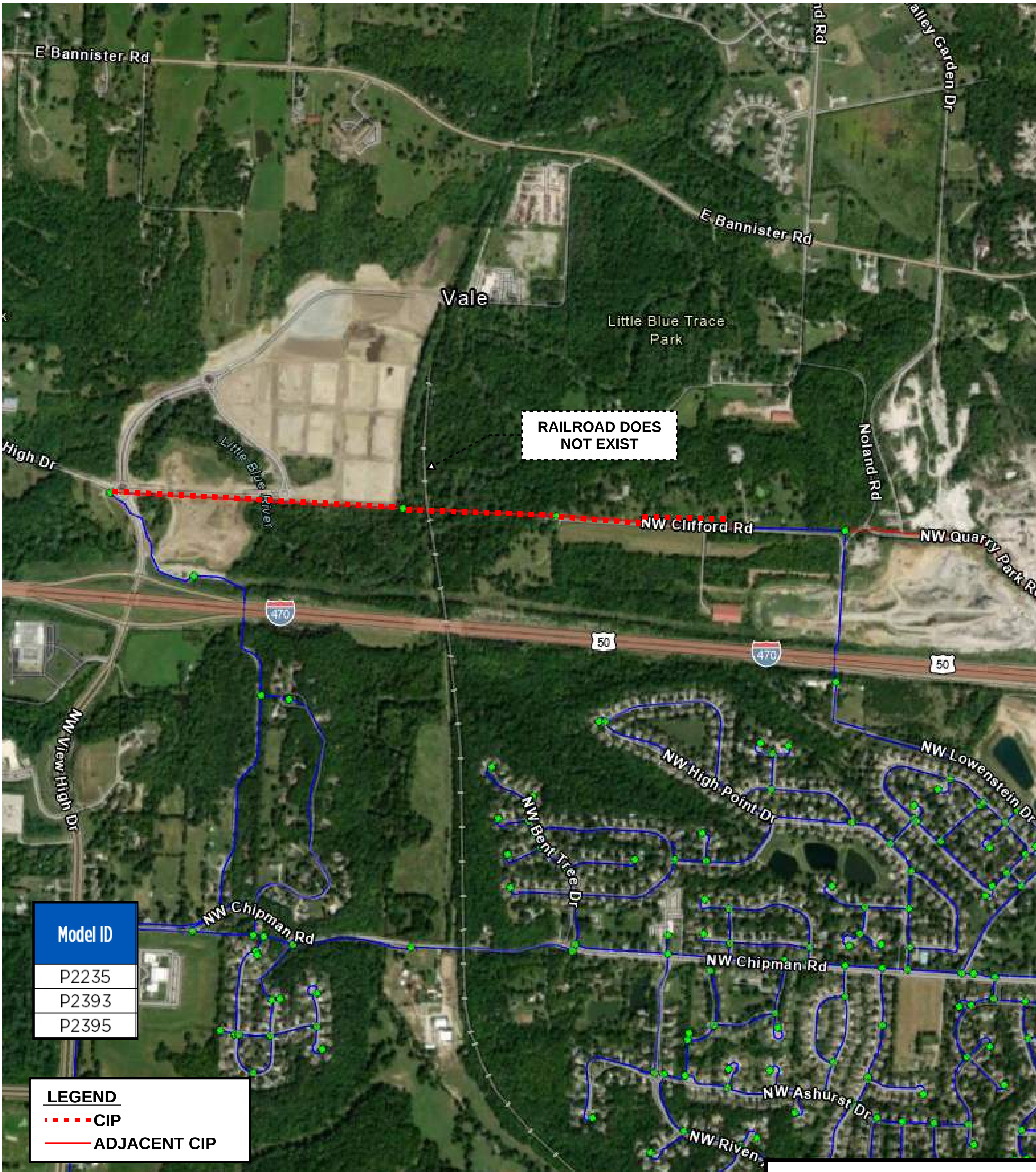
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-15

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-16	Hydraulic	On NW Clifford Rd between View High Dr and Noland Rd (RRX).	5,841	12	$ 1,051,000	$ 211,000	$ 189,000	$ 1,451,000



NOT TO SCALE

BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-16

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-17	Hydraulic	On NW Quarry Park Rd between NW Pryor Rd and Noland Rd.	4,689	12	$ 844,000	$ 168,000	$ 151,000	$ 1,163,000

Model ID
P2265
P2405
P2457

LEGEND
- CIP
- ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

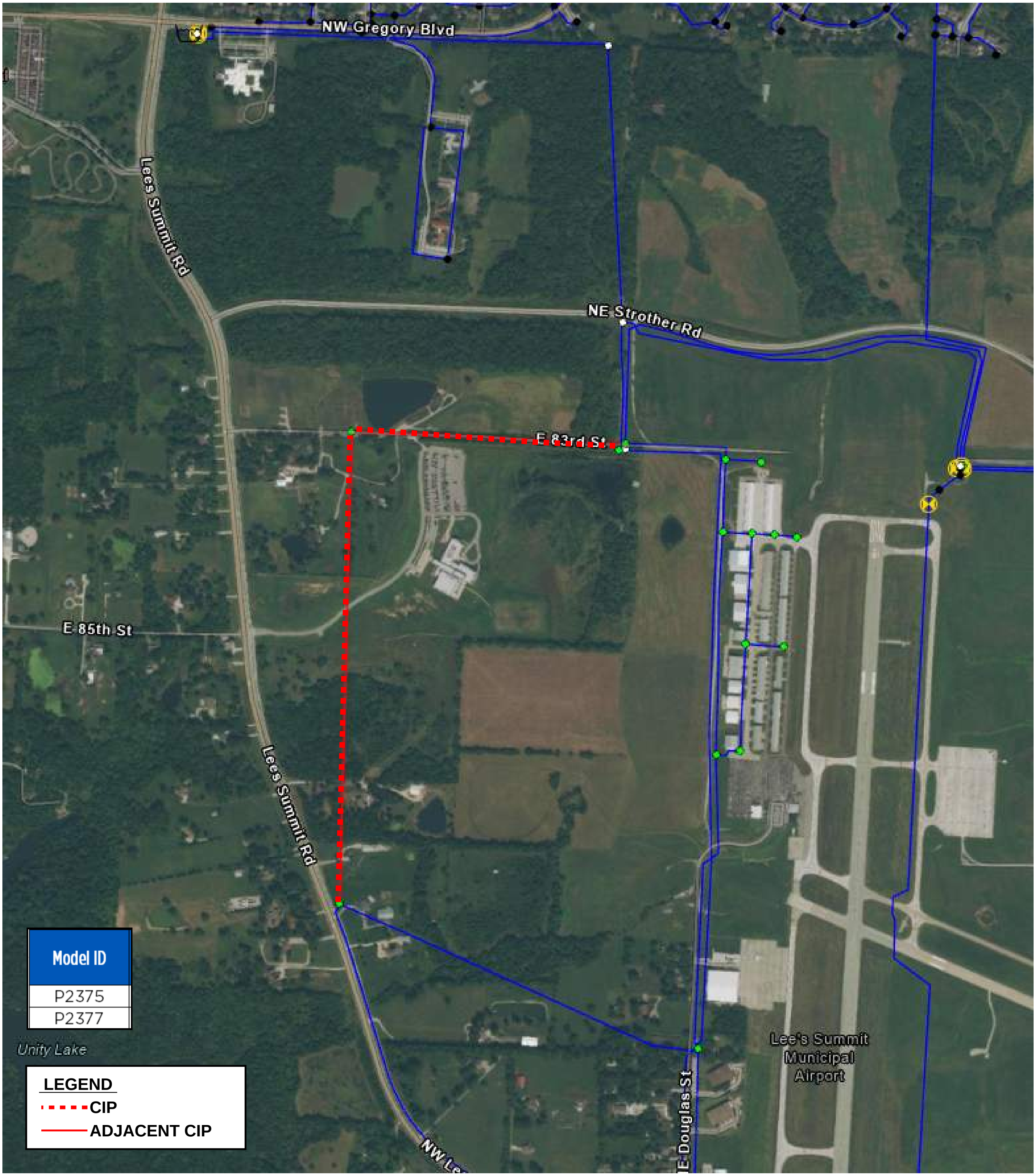
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-17

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-18	Hydraulic	On E 83rd St to Lee's Summit Rd.	4,913	12	$ 884,000	$ 177,000	$ 159,000	$ 1,220,000



Model ID
P2375
P2377

LEGEND
- CIP
- ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

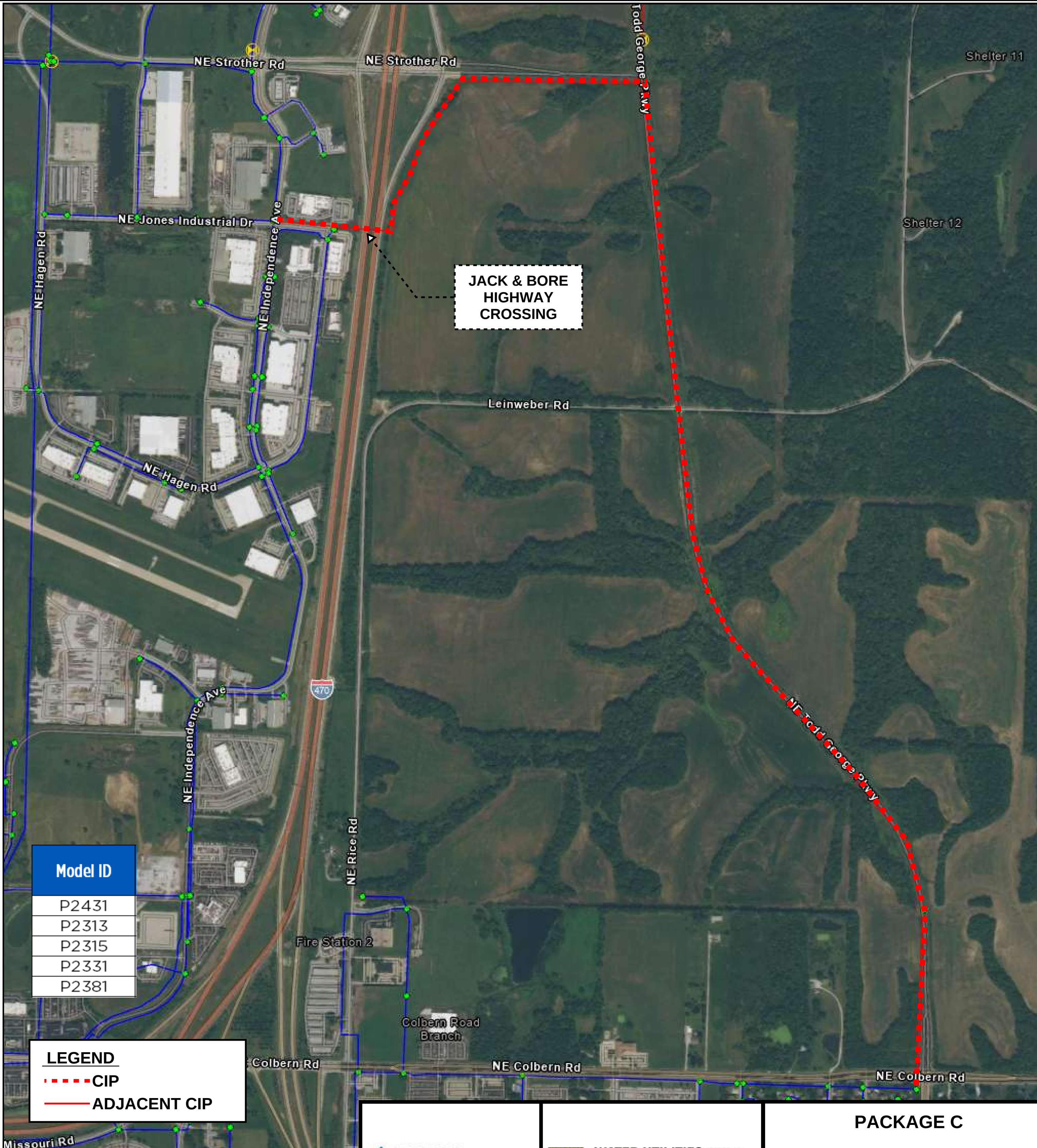
WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-18

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
S-HD40-19	Hydraulic	NE Strother Rd between NE Independence Ave and NE Todd George Pkwy. Under Highway 470 (HWX); And on NE Todd George Pkwy from NE Strother Rd to NE Colbern Rd.	12,402	12	$ 2,232,000	$ 446,000	$ 402,000	$ 3,363,000



Model ID
P2431
P2313
P2315
P2331
P2381

LEGEND
CIP
ADJACENT CIP

NOT TO SCALE

BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: S-HD40-19

SOUTH PRESSURE ZONE

CIP ID	Type	Project Description	Length Total (ft)	Diameter (in)	Opinion of Probable Cost			
					Construction	Contingency	Engineering	Total
N-HD40-1	Hydraulic	NE Todd George Pkwy NE Strother Rd to NE Woods Chapel Rd.	5,162	12	$ 929,000	$ 185,000	$ 167,000	$ 1,281,000

Model ID
P2433
P2385
P2387
P2383

NOT TO SCALE

BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE C

CIP: N-HD40-1

NORTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
N-SM-1	6125	56	8	$ 10,000	$ 2,000	$ 2,000	$ 14,000
	P811	42	8	$ 7,000	$ 1,000	$ 1,000	$ 9,000
	229	401	8	$ 72,000	$ 14,000	$ 13,000	$ 99,000
N-SM-2	199	356	8	$ 64,000	$ 13,000	$ 12,000	$ 89,000
	P775	315	8	$ 57,000	$ 11,000	$ 10,000	$ 78,000
	165	352	8	$ 63,000	$ 13,000	$ 11,000	$ 87,000
	P781	334	8	$ 60,000	$ 12,000	$ 11,000	$ 83,000
	153	620	8	$ 112,000	$ 22,000	$ 20,000	$ 154,000
S-SM-1	39	128	8	$ 23,000	$ 5,000	$ 4,000	$ 32,000
S-SM-2	135	214	8	$ 38,000	$ 8,000	$ 7,000	$ 53,000
	92	569	8	$ 102,000	$ 20,000	$ 18,000	$ 140,000
	128	1249	8	$ 225,000	$ 45,000	$ 41,000	$ 311,000
	P1021	487	8	$ 88,000	$ 18,000	$ 16,000	$ 122,000
	102	946	8	$ 170,000	$ 34,000	$ 31,000	$ 235,000
	97	554	8	$ 100,000	$ 20,000	$ 18,000	$ 138,000
	98	318	8	$ 57,000	$ 11,000	$ 10,000	$ 78,000
	101	286	8	$ 51,000	$ 10,000	$ 9,000	$ 70,000
S-SM-3	112	124	8	$ 22,000	$ 4,000	$ 4,000	$ 30,000
	111	870	8	$ 157,000	$ 31,000	$ 28,000	$ 216,000
	94	726	8	$ 131,000	$ 26,000	$ 24,000	$ 181,000
	91	228	8	$ 41,000	$ 8,000	$ 7,000	$ 56,000
	87	802	8	$ 144,000	$ 29,000	$ 26,000	$ 199,000
	86	414	8	$ 75,000	$ 15,000	$ 14,000	$ 104,000
	84	588	8	$ 106,000	$ 21,000	$ 19,000	$ 146,000
	P1091	326	8	$ 59,000	$ 12,000	$ 11,000	$ 82,000
	85	402	8	$ 72,000	$ 14,000	$ 13,000	$ 99,000
	P1089	96	8	$ 17,000	$ 3,000	$ 3,000	$ 23,000
	79	403	8	$ 73,000	$ 15,000	$ 13,000	$ 101,000
S-SM-4	100	114	8	$ 21,000	$ 4,000	$ 4,000	$ 29,000
	P167	644	8	$ 116,000	$ 23,000	$ 21,000	$ 160,000
	73	304	8	$ 55,000	$ 11,000	$ 10,000	$ 76,000
	P169	304	8	$ 55,000	$ 11,000	$ 10,000	$ 76,000
	72	32	8	$ 6,000	$ 1,000	$ 1,000	$ 8,000
	P1085	613	8	$ 110,000	$ 22,000	$ 20,000	$ 152,000
	P1083	532	8	$ 96,000	$ 19,000	$ 17,000	$ 132,000
	43	509	8	$ 92,000	$ 18,000	$ 17,000	$ 127,000
	50	86	4	Existing Railroad Crossing			
S-SM-5	108	498	8	$ 90,000	$ 18,000	$ 16,000	$ 124,000
	105	525	8	$ 95,000	$ 19,000	$ 17,000	$ 131,000
	62	544	8	$ 98,000	$ 20,000	$ 18,000	$ 136,000
	76	497	8	$ 89,000	$ 18,000	$ 16,000	$ 123,000
	P277	702	8	$ 126,000	$ 25,000	$ 23,000	$ 174,000
	5476	44	8	$ 8,000	$ 2,000	$ 2,000	$ 12,000
	48	371	8	$ 67,000	$ 13,000	$ 12,000	$ 92,000
	P279	511	8	$ 92,000	$ 18,000	$ 17,000	$ 127,000
S-SM-6	118	423	8	$ 76,000	$ 15,000	$ 14,000	$ 105,000
	131	334	8	$ 60,000	$ 12,000	$ 11,000	$ 83,000
	127	762	8	$ 137,000	$ 27,000	$ 25,000	$ 189,000
	5554	279	8	$ 50,000	$ 10,000	$ 9,000	$ 69,000
	5557	602	8	$ 108,000	$ 22,000	$ 20,000	$ 150,000
	5556	361	8	$ 65,000	$ 13,000	$ 12,000	$ 90,000
	115	271	8	$ 49,000	$ 10,000	$ 9,000	$ 68,000
	116	650	8	$ 117,000	$ 23,000	$ 21,000	$ 161,000
S-SM-7	109	411	8	$ 74,000	$ 15,000	$ 13,000	$ 102,000
	5667	348	8	$ 63,000	$ 13,000	$ 11,000	$ 87,000
S-SM-8	16	274	8	$ 49,000	$ 10,000	$ 9,000	$ 68,000
Total							$ 5,880,000

Notes
1. Small main replacement represent looped 4-inch diameter pipes in the distribution system with an 8-inch pipe.

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WATER UTILITIES LEE'S SUMMIT

TABLE 9-6

SMALL MAIN REPLACEMENT CIPs

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
N-SM-1	6125	56	8	$ 10,000	$ 2,000	$ 2,000	$ 14,000
	P811	42	8	$ 7,000	$ 1,000	$ 1,000	$ 9,000
	229	401	8	$ 72,000	$ 14,000	$ 13,000	$ 99,000

BURNS McDONNELL

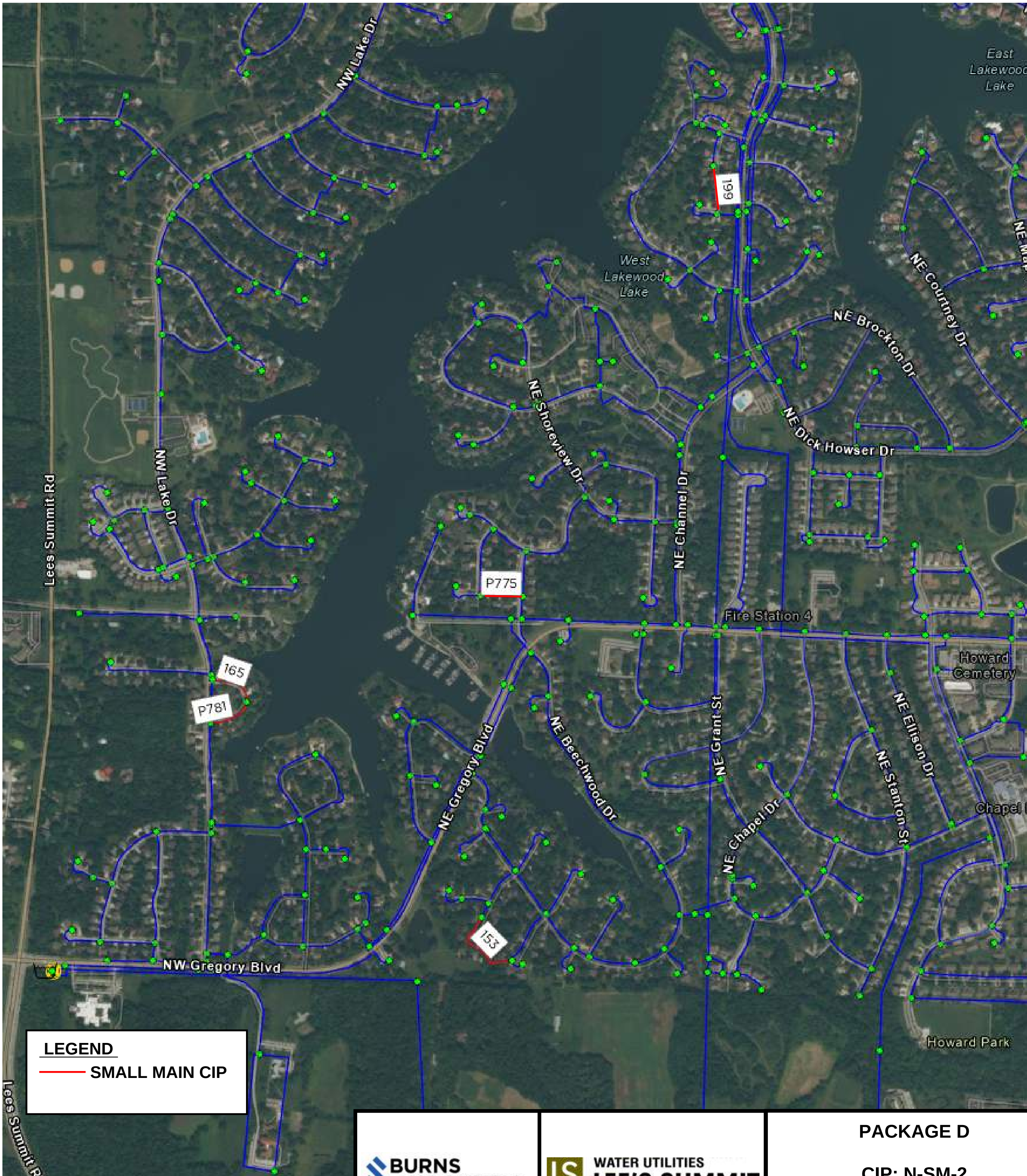
WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: N-SM-1

NORTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
N-SM-2	199	356	8	$ 64,000	$ 13,000	$ 12,000	$ 89,000
	P775	315	8	$ 57,000	$ 11,000	$ 10,000	$ 78,000
	165	352	8	$ 63,000	$ 13,000	$ 11,000	$ 87,000
	P781	334	8	$ 60,000	$ 12,000	$ 11,000	$ 83,000
	153	620	8	$ 112,000	$ 22,000	$ 20,000	$ 154,000



NOT TO SCALE

BURNS McDONNELL

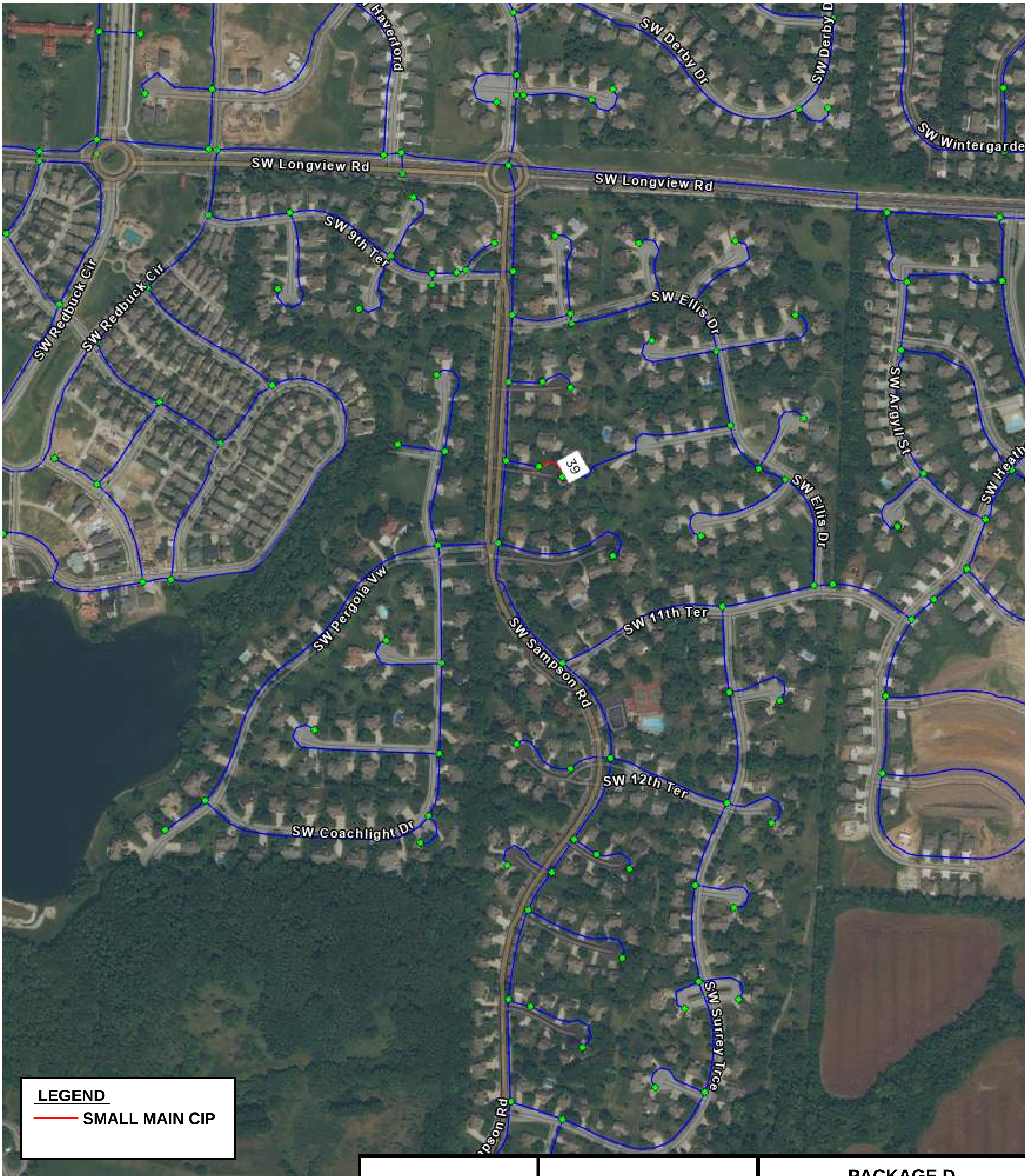
WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: N-SM-2

NORTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-1	39	128	8	$ 23,000	$ 5,000	$ 4,000	$ 32,000



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WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: S-SM-1

SOUTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-2	135	214	8	$ 38,000	$ 8,000	$ 7,000	$ 53,000
	92	569	8	$ 102,000	$ 20,000	$ 18,000	$ 140,000
	128	1249	8	$ 225,000	$ 45,000	$ 41,000	$ 311,000
	P1021	487	8	$ 88,000	$ 18,000	$ 16,000	$ 122,000
	102	946	8	$ 170,000	$ 34,000	$ 31,000	$ 235,000
	97	554	8	$ 100,000	$ 20,000	$ 18,000	$ 138,000
	98	318	8	$ 57,000	$ 11,000	$ 10,000	$ 78,000
	101	286	8	$ 51,000	$ 10,000	$ 9,000	$ 70,000

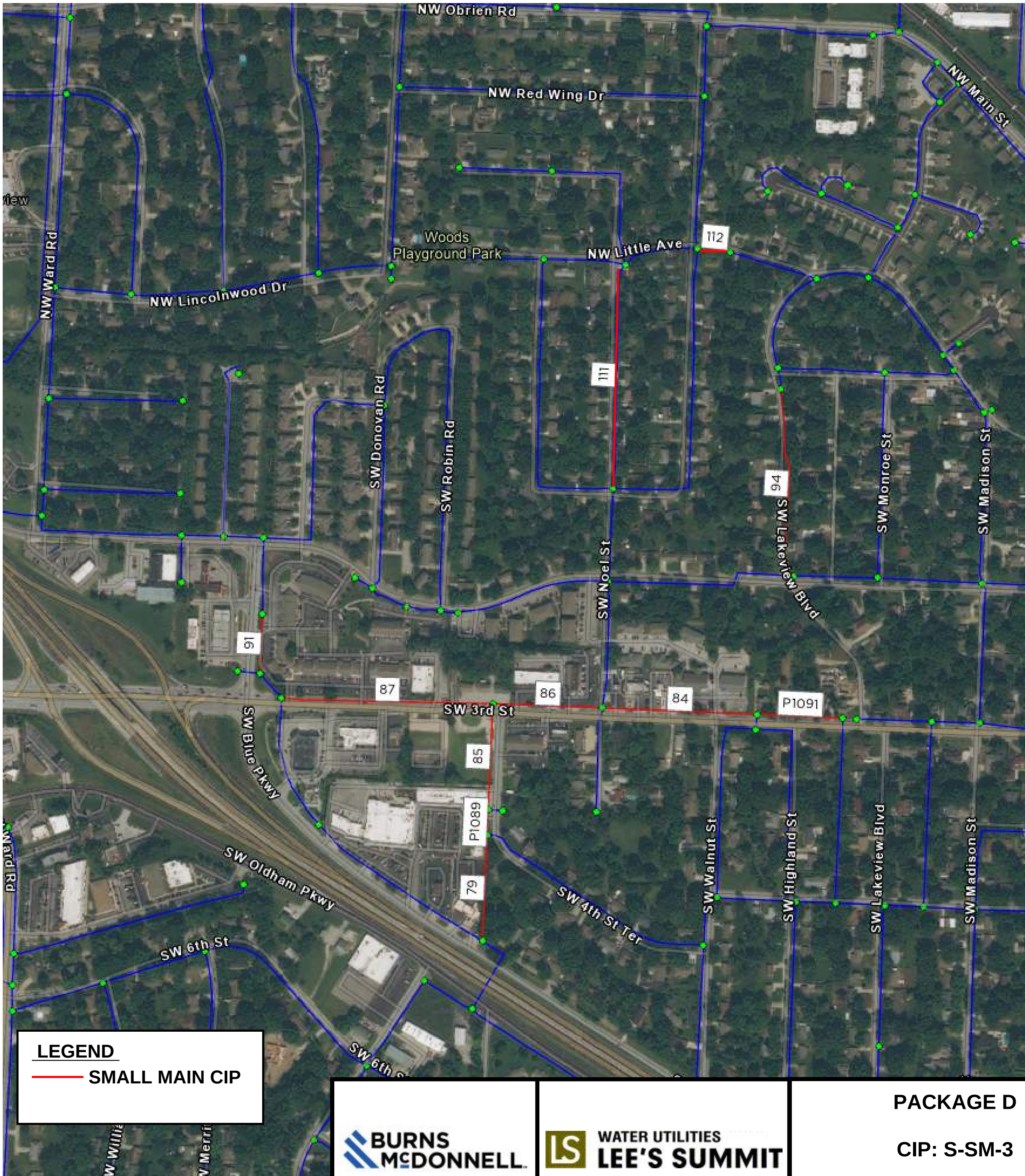
NOT TO SCALE

PACKAGE D

CIP: S-SM-2

SOUTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-3	112	124	8	$ 22,000	$ 4,000	$ 4,000	$ 30,000
	111	870	8	$ 157,000	$ 31,000	$ 28,000	$ 216,000
	94	726	8	$ 131,000	$ 26,000	$ 24,000	$ 181,000
	91	228	8	$ 41,000	$ 8,000	$ 7,000	$ 56,000
	87	802	8	$ 144,000	$ 29,000	$ 26,000	$ 199,000
	86	414	8	$ 75,000	$ 15,000	$ 14,000	$ 104,000
	84	588	8	$ 106,000	$ 21,000	$ 19,000	$ 146,000
	P1091	326	8	$ 59,000	$ 12,000	$ 11,000	$ 82,000
	85	402	8	$ 72,000	$ 14,000	$ 13,000	$ 99,000
	P1089	96	8	$ 17,000	$ 3,000	$ 3,000	$ 23,000
	79	403	8	$ 73,000	$ 15,000	$ 13,000	$ 101,000



NOT TO SCALE

BURNS McDONNELL

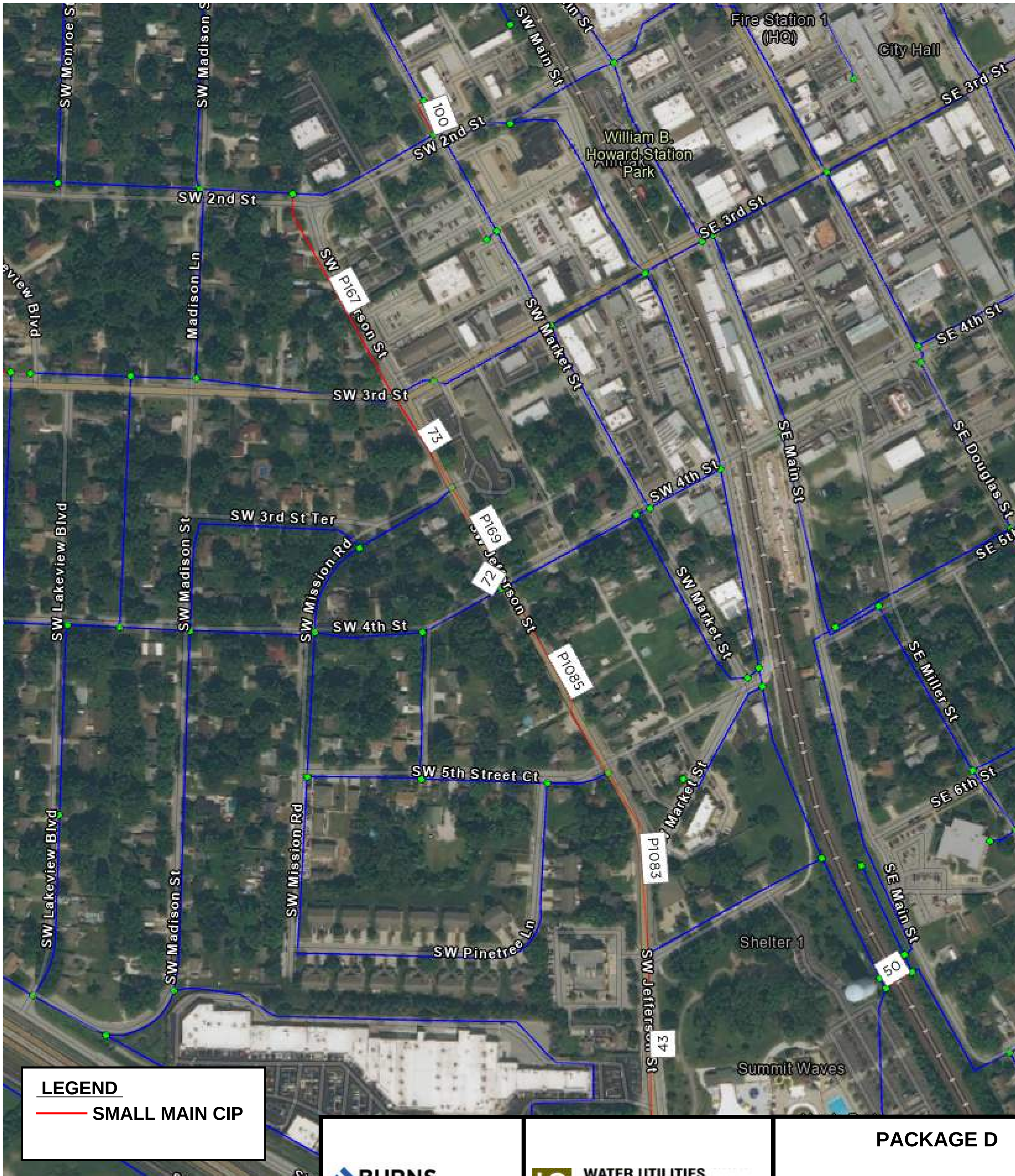
WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: S-SM-3

SOUTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-4	100	114	8	$ 21,000	$ 4,000	$ 4,000	$ 29,000
	P167	644	8	$ 116,000	$ 23,000	$ 21,000	$ 160,000
	73	304	8	$ 55,000	$ 11,000	$ 10,000	$ 76,000
	P169	304	8	$ 55,000	$ 11,000	$ 10,000	$ 76,000
	72	32	8	$ 6,000	$ 1,000	$ 1,000	$ 8,000
	P1085	613	8	$ 110,000	$ 22,000	$ 20,000	$ 152,000
	P1083	532	8	$ 96,000	$ 19,000	$ 17,000	$ 132,000
	43	509	8	$ 92,000	$ 18,000	$ 17,000	$ 127,000
	50	86	4	Existing Railroad Crossing.			



NOT TO SCALE

BURNS McDONNELL

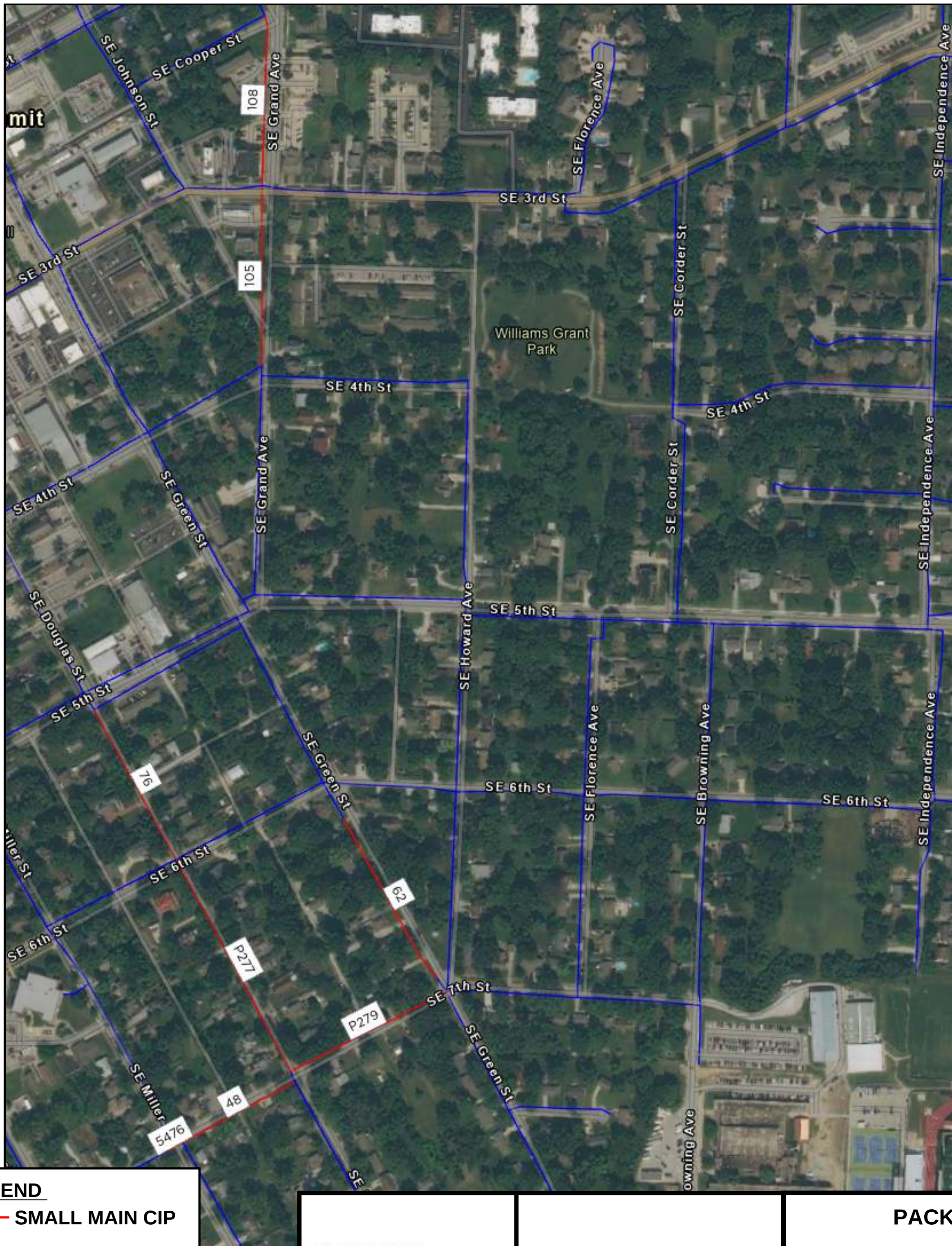
WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: S-SM-4

SOUTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-5	108	498	8	$ 90,000	$ 18,000	$ 16,000	$ 124,000
	105	525	8	$ 95,000	$ 19,000	$ 17,000	$ 131,000
	62	544	8	$ 98,000	$ 20,000	$ 18,000	$ 136,000
	76	497	8	$ 89,000	$ 18,000	$ 16,000	$ 123,000
	P277	702	8	$ 126,000	$ 25,000	$ 23,000	$ 174,000
	5476	44	8	$ 8,000	$ 2,000	$ 2,000	$ 12,000
	48	371	8	$ 67,000	$ 13,000	$ 12,000	$ 92,000
	P279	511	8	$ 92,000	$ 18,000	$ 17,000	$ 127,000



LEGEND

SMALL MAIN CIP

NOT TO SCALE

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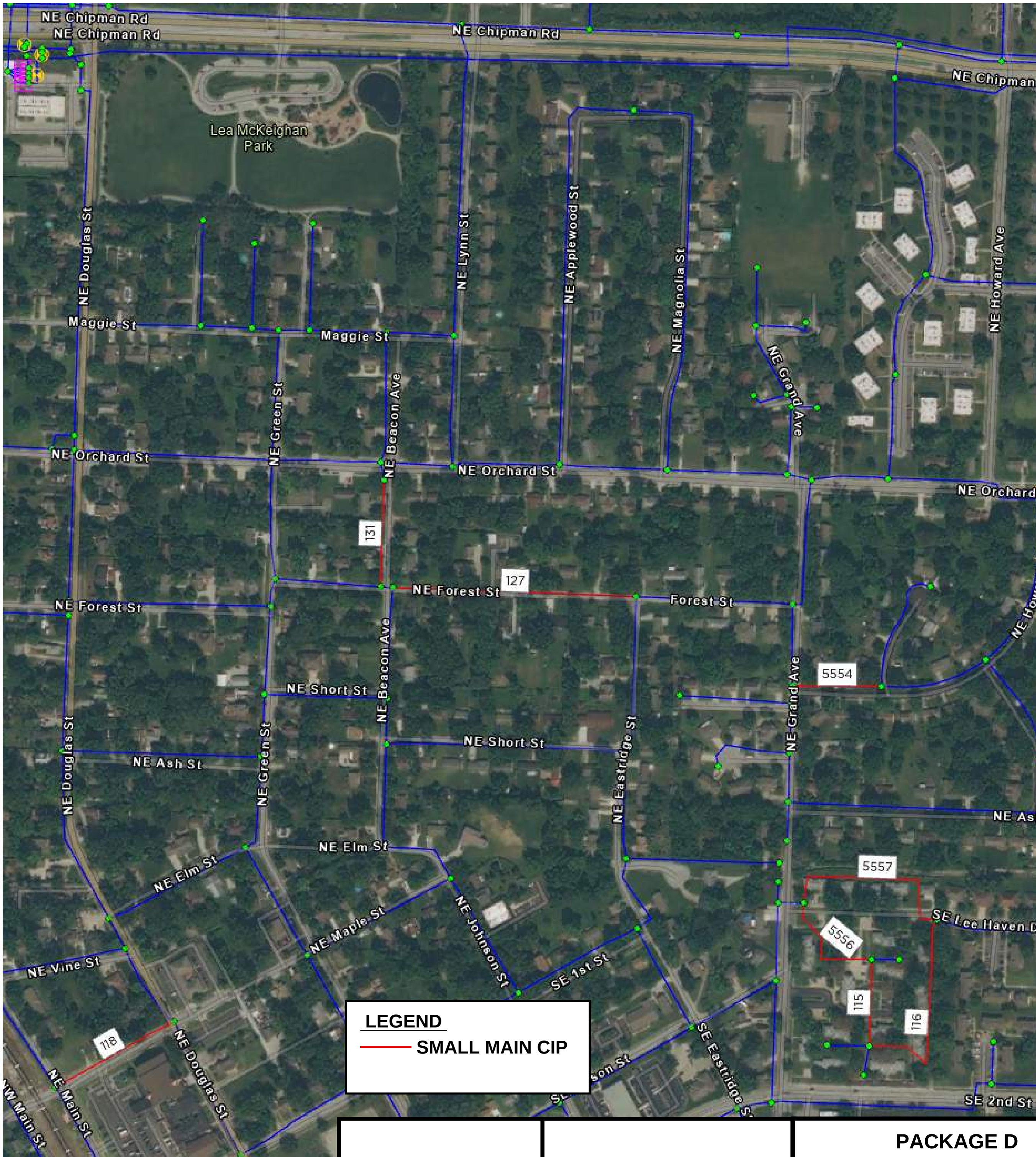
WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: S-SM-5

SOUTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-6	118	423	8	$ 76,000	$ 15,000	$ 14,000	$ 105,000
	131	334	8	$ 60,000	$ 12,000	$ 11,000	$ 83,000
	127	762	8	$ 137,000	$ 27,000	$ 25,000	$ 189,000
	5554	279	8	$ 50,000	$ 10,000	$ 9,000	$ 69,000
	5557	602	8	$ 108,000	$ 22,000	$ 20,000	$ 150,000
	5556	361	8	$ 65,000	$ 13,000	$ 12,000	$ 90,000
	115	271	8	$ 49,000	$ 10,000	$ 9,000	$ 68,000
	116	650	8	$ 117,000	$ 23,000	$ 21,000	$ 161,000



NOT TO SCALE

BURNS McDONNELL

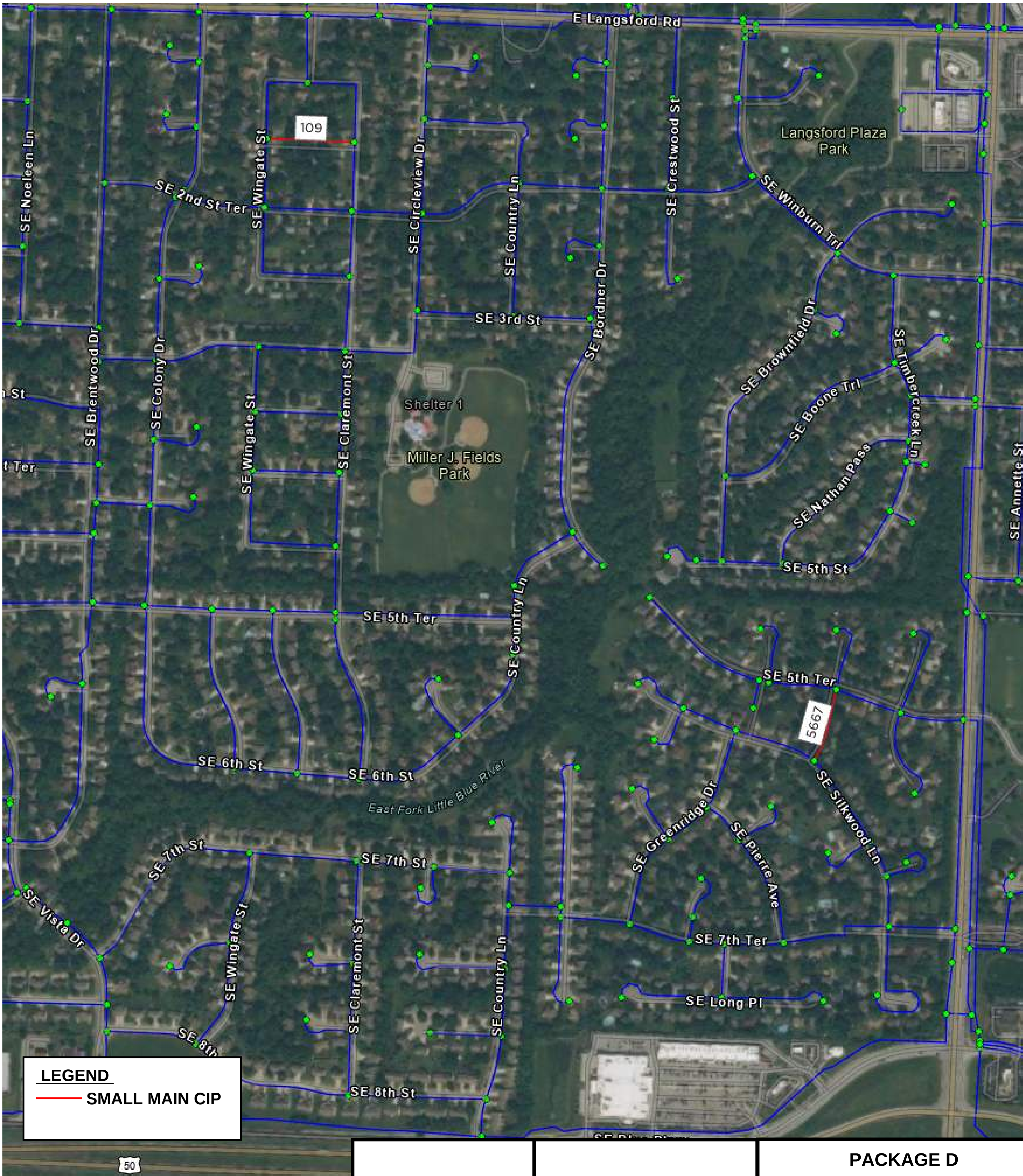
WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: S-SM-6

SOUTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-7	109	411	8	$ 74,000	$ 15,000	$ 13,000	$ 102,000
	5667	348	8	$ 63,000	$ 13,000	$ 11,000	$ 87,000



LEGEND

SMALL MAIN CIP

NOT TO SCALE

BURNS McDONNELL

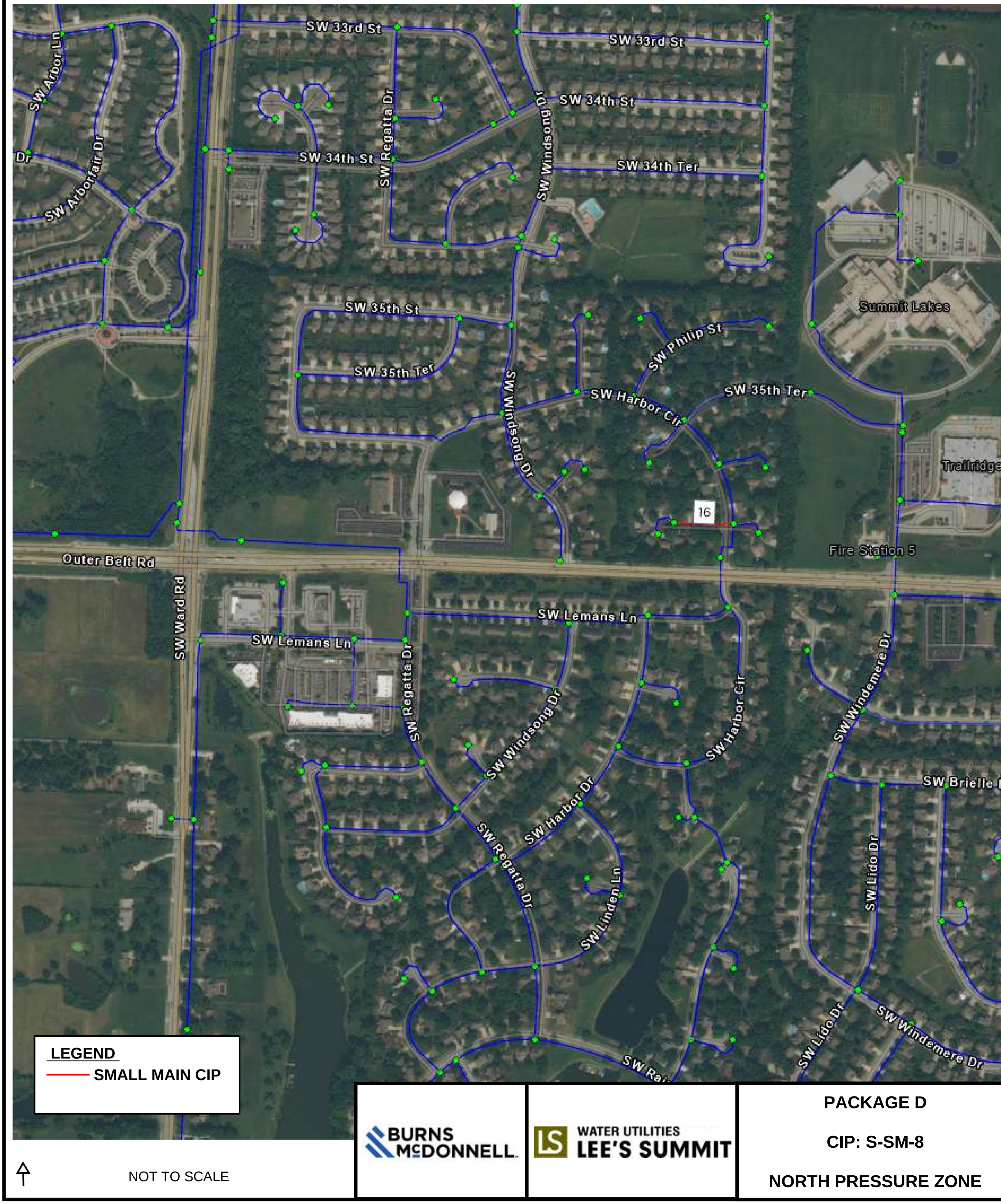
WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: S-SM-7

NORTH PRESSURE ZONE

CIP ID	Model ID	Length (ft)	Diameter (in)	Opinion of Probable Cost			
				Construction	Contingency	Engineering	Total
S-SM-8	16	274	8	$ 49,000	$ 10,000	$ 9,000	$ 68,000



BURNS McDONNELL

WATER UTILITIES LEE'S SUMMIT

PACKAGE D

CIP: S-SM-8

NORTH PRESSURE ZONE

APPENDIX A FACILITY CONTROL SCHEME

BOWLIN PUMP STATION

7/15/22 TS

You must be logged on to SCADA (top right tab) to make any Changes.

Automation: *Communication is needed at; Woods Chapel, Leinweber, Lakewood and this site.*

- *<u>See Water Pump Control section.</u>*
- *<u>See Tower / Reservoir level section for reservoir level override instruction.</u>*
- *<u>See valve section for valve operation instruction.</u>*
- *<u>See Set Point Modification section.</u>*
- *<u>Pump 1 and 2 VFD min / max frequency settings are 25 hz min and 60 hz max.</u>*

You must close any popup windows before moving to a different SCADA screen.

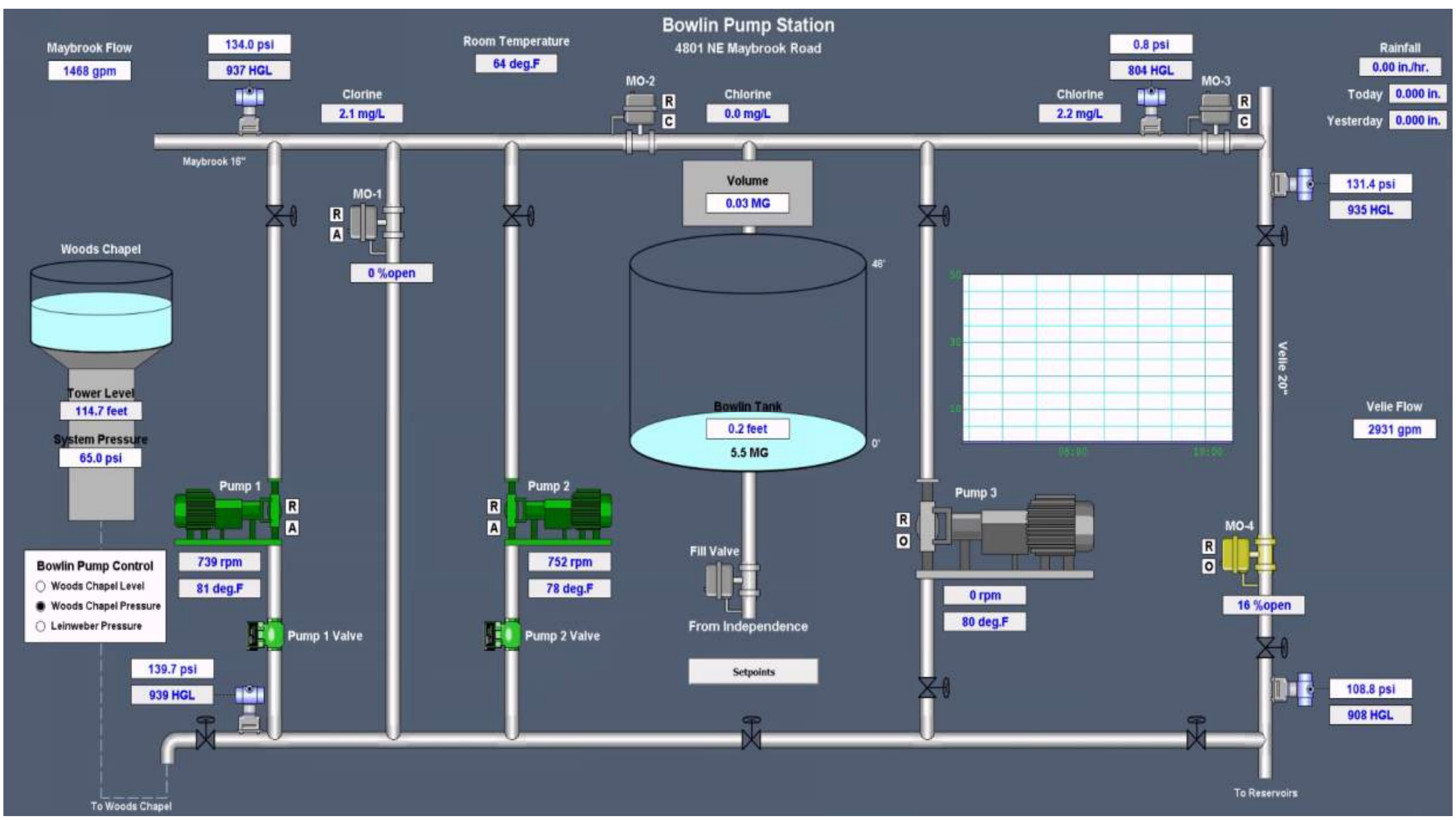
All set point values can be changed. The following set points referenced are used for ease of explanation.

Bowlin Pump Station pumps water to Woods Chapel and the North and South system. Depending on Gregory Blvd configuration, *(See Gregory Blvd)* Woods Chapel can deliver water to the 4 and 5.5 MG reservoirs.

Lee's Summit needs to pull a daily average of 7.5 MG through this pumping station.

1. The 16" Maybrook water main can provide water through MO-1, Pumps 1, and 2, which fills Woods Chapel tower.
   a. 2.5 MGD is needed thru the Maybrook line to ensure LS water meets their contractual agreement with Independence water.
2. Velie 20" line – provides water to the 4 and 5.5 MG reservoirs through MO-4 and also is utilized to fill Bowlin tank, if needed.
   a. 5 MGD is needed thru MO-4 to ensure LS water meets their contractual agreement with Independence water.

Example 1



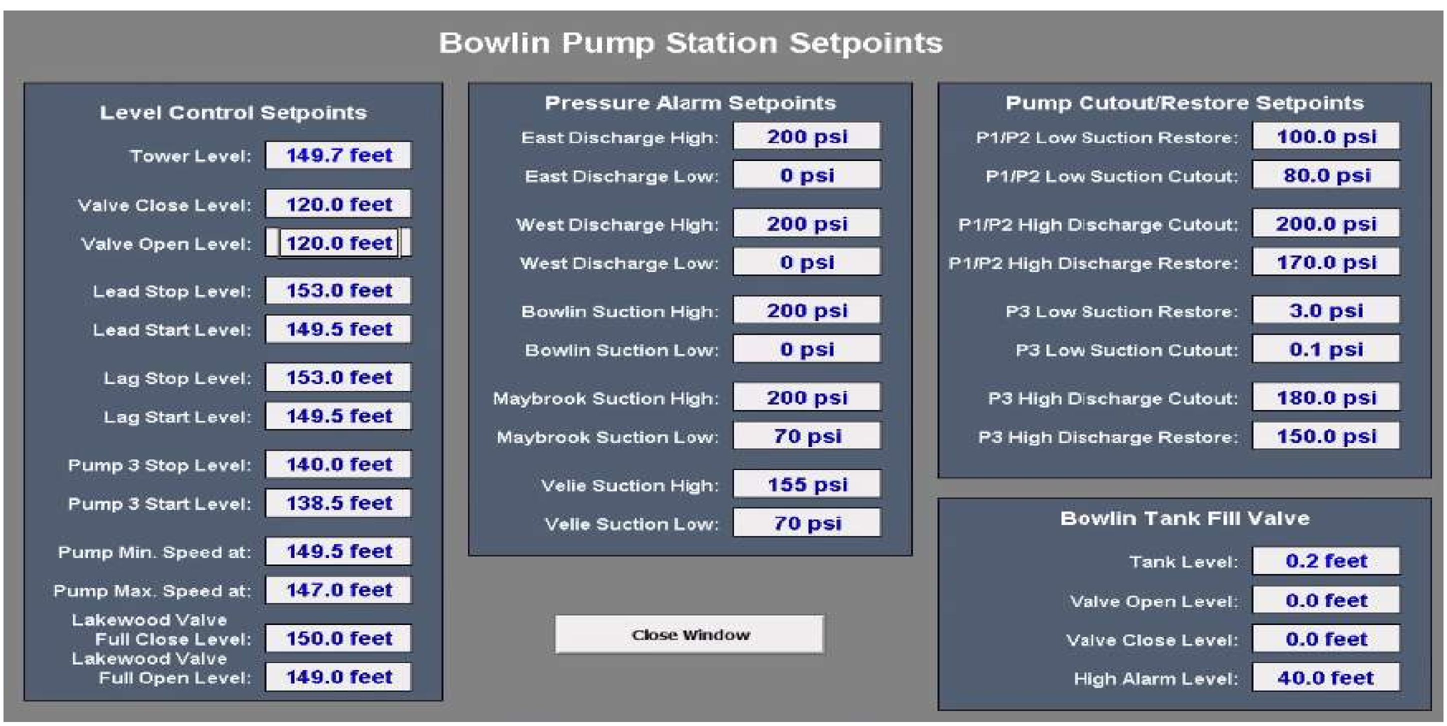
BOWLIN PUMP STATION

7/15/22 TS

Example 1 - displays the following:

1. Woods Chapel Tower level and pressure.
2. Bowlin Pump Control Window
    a. **Woods Chapel Level** – allows the north system operate from Woods Chapel levels.
    b. **Woods Chapel Pressure** - allows the North system to operate from Woods Chapel pressure gauge.
    c. **Leinweber Pressure** – allows the North system to operate from Leinweber pressure gauge.
3. 3 chlorine analyzers.
    a. The left chlorine analyzer monitors Independence water from the Maybrook water main.
    b. The middle chlorine analyzer monitors water from Bowlin Tank if used.
    c. The right chlorine analyzer monitors Independence water from the Velie water main.
4. The graph displays past 4 hours tank level when in use.
5. If *MO-1* is used ensure the valve is in remote **(R)** auto **(A)** settings. MO-1 will modulate between 0 and 100 % within the Valve Open/Close Level setpoints if needed. *(example 1)* [currently not utilized per settings in *example 2]*
6. *Pump 1 and 2* are in remote **(R)** auto **(A)** setting and are green because they are running. They operate within the lead and lag Level Control Setpoints. *(example 1 & 2)*
    a. Pump 1 and 2 valves are in the open position (green), because the pumps are running.
7. *Pump 3* is in the remote **(R)** and off **(O)** setting because is currently not needed.
    a. *Pump 3* is grey because it is not running.
    b. If water is in Bowlin Tank and pump 3 is needed, the pump in the remote **(R)** auto **(A)** setting will operate within the Pump 3 Start/Stop level setpoints. *(example 2)*
8. *Valves MO-2 and 3* are in remote **(R)** and closed **(C)**. (Normal settings)
9. *Valve MO-4* will be in remote **(R)** and open **(O)** setting. The open command position will be set around 24% open to ensure a 5 MGD draw from Independence, and will be adjusted by hand if needed.

Example 2

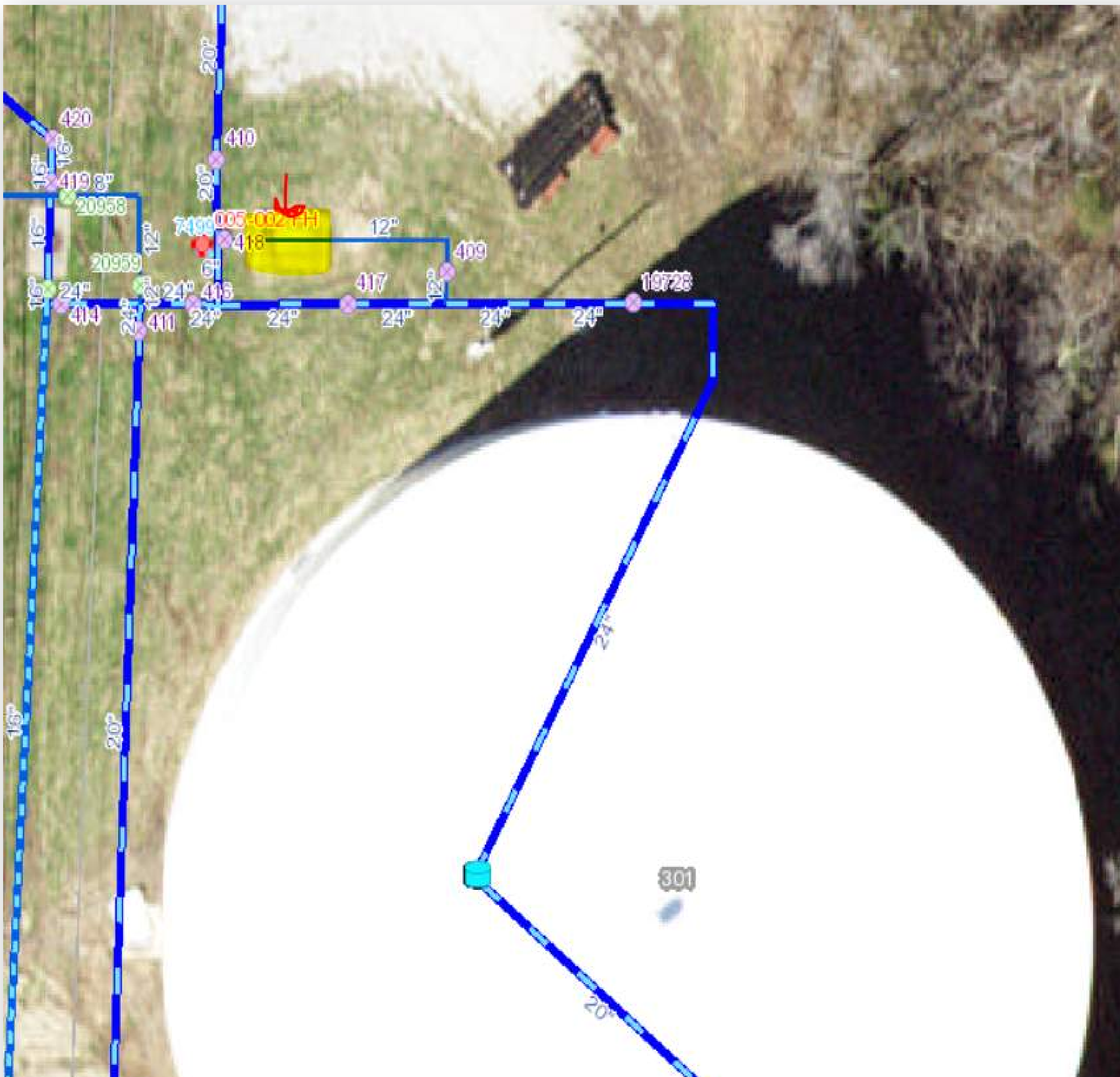


Example 2 - displays the set points window when Setpoints box is clicked.

Bowlin Fill Tank valve operation.

1. The tank fill valve is an Altitude valve located in the Bowlin tank yard vault on the North / North West side of the tank, highlighted in (*example 3)*

Example 3



2. Bowlin Tank valve operates within the parameters set in SCADA under "Bowlin Tank Fill Valve" open and close levels. *(example 2)*
    a. When Bowlin Tank is not in use.
        i. Bowlin Tank is empty.
        ii. Power for Pump 3 VFD is turned off.
        iii. Bowlin Tank fill valve Open/Close levels are set to 0 ft. *(example 2)*
        iv. Facility valve 409 is **closed**. This valve is in the yard next to fill valve vault. *(example 3)*

b. When Bowlin Tank is utilized.

i. Facility valve 409 is **open**. This facility valve is in the yard next to fill valve vault. *(example 3)*

ii. Bowlin Tank fill valve Open/Close levels are set in the Bowlin Tank Fill Valve settings. (30 ft. open and 45 ft. close) The altitude valve will operate within these levels to maintain water levels in Bowlin tank. *(example 2)*

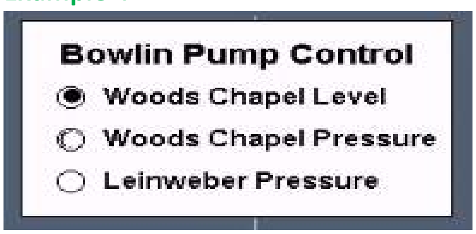
- Water in this tank is fed from the Velie water main.

iii. Power for Pump 3 VFD is turned on.

Woods Chapel Level Mode

1. Lakewood, Leinweber valves and Bowlin pumps are in the auto (**A**) remote (**R**) setting.
2. The valve at Woods Chapel must be open.
3. "Bowlin Pump Control" will display the "**Woods Chapel Level**". *(example 4)*

Example 4



Automation: North System Woods Chapel Level Mode

1. MO-1 will not be used. *(The values are set to 120 ft to inhibit MO-1 operation, if used this valve will modulate within the Valve close and open settings.)*
   a. If MO-1 is used, the pumps will not run if MO-1 is open and modulating.
2. Pumps 1 and 2 will continuously run and modulate within the "Level Control Set Points" settings for lead and lag pumps. *(the lead and lag setpoints are set the same)*

3. Pump 3 - if used, the Bowlin Reservoir must have water for pump operation. *This is a definition of pump operation.*

   a. "Start /Stop Levels will control the operation of this pump. *(example 2)*
   b. Pump 3 must be in remote **(R)** auto (**A**) setting.
   c. Pump 3 will operate with in the pump 3 start/stop parameters.
   d. When pump 3 stop parameter is obtained, then pumps 1 and 2 will start and operate within the "Lead/Lag Start/Stop parameters *(example 2)*
4. **High-water demand** -pumps 1 and 2 will being running at max rpm, Leinweber will be closed, Lakewood valve will modulate within the *Lakewood Valve, Full open/close, level setpoints.* *(example 2)*
   a. Lakewood valve will automatically open and close 10% per minute.
5. **Low water demand** - pumps 1 and 2 will be running at minimum speed, Lakewood valve will be closed and Leinweber valve will modulate to maintain a level in Woods Chapel of within the set parameter.

BOWLIN PUMP STATION

7/15/22 TS

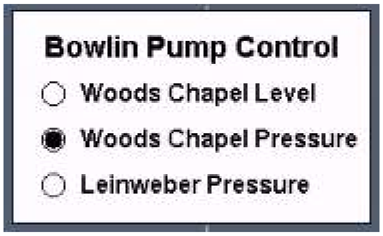
Woods Chapel or Leinweber Pressure mode

DO NOT change to PSI mode until you have completed the Adjustments Needed section of this procedure!

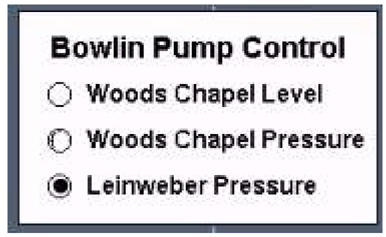
Communication must to be available to; Woods Chapel Tower, Leinweber, Lakewood and this site.

In the Bowlin Pump Control window "***Woods Chapel Pressure*** or Leinweber Pressure" circle will be selected after adjustments have been made. (***example 5*** *or 5/A)*

Example 5



Example 5/A



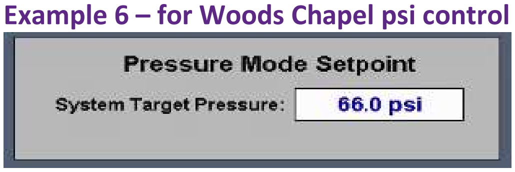
Adjustments Needed:

1. **Lakewood -** valve must be in the remote **(R)** auto **(A)** settings.
2. **Bowlin:**

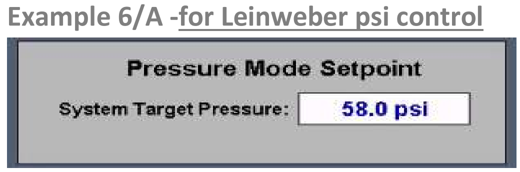
Bowlin pump information		
%	hz	rpm
100	60	1775
75	51.2	1518
50	42.5	1262
25	33.7	1006
0	25	750

   a. VFD's for pump's 1 & 2 must be set for a min/max setting of 25/60 hertz. *(Confirmed on site)*
   b. Pumps 1 and 2 must be in remote **(R)** auto **(A)** settings.
   c. MO-1 Valve open/close level setpoints set to 120 ft. (MO-1 will not be utilized per parameter settings)
   d. Pump 3 VFD must be powered down and will not be used. *(Confirmed on site)*
3. **Woods Chapel** - "System Target Pressure" value is entered in the Pressure Mode Setpoint box. *This value will be changed depending on which site is chosen to operate the North System in pressure mode.*
   a. If **Woods Chapel Pressure** is selected (*example 5)*, the pressure gauge at Woods Chapel is controlling automation for the North System. The System Target value will be 66 psi *(example 6)*
   b. If Leinweber Pressure is selected ***(example 5/A)***, the pressure gauge at Leinweber is controlling automation for the North System. The System Target value will be 58 psi ***(example 6/A)***

Example 6 – for Woods Chapel psi control



Example 6/A -for Leinweber psi control



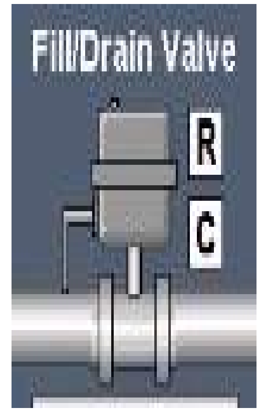
4. **Leinweber** – change the valve command switch to the hand position hand and **SLOWLY** decrease the Open Command value to 8%.
   a. This is the minimum valve setting while operating in ***Woods Chapel Pressure*** *or* ***Leinweber Pressure*** *modes. (example 7)*

Example 7

Example 8

Example 9

Example 9/A



Example 7 - currently displays the valve in auto and the valve position is at 14%. The open command value is at 8%. If the switch were placed in the open position the valve would close to the 8% value.

5. **Bowlin** - Place pump's 1 and 2 in the hand position. *(example 8)*
   a. Change the Hand Speed value % box **<u>slowly</u>** for pumps 1 and 2 simultaneously to match system pressure at **Woods Chapel.** *Allow time between adjustments for the system pressure change to register at **Woods Chapel.***

6. **Woods Chapel** - **SLOWLY** close the Fill/Drain Valve by decreasing the open command values to 0% open. *Use the same procedure and **caution** as used for the Leinweber valve. (example 9)*
   a. Monitor the system pressure at Woods Chapel. You may need to increase or decrease the Hand Speed % at Bowlin to maintain System Target Pressure. (see step 5)
   b. Leave this valve in the closed position. *(example 9/A)*
7. **Leinweber** - place the valve in remote **(R)** and auto **(A)** setting.
8. **Bowlin** - place the pump selector switches for pumps 1 and 2 in the auto **(A)** positions.

(This section left intentionally blank)

SCADA Supervisor and Facility Manager (only)

Preset values for Pressure Mode

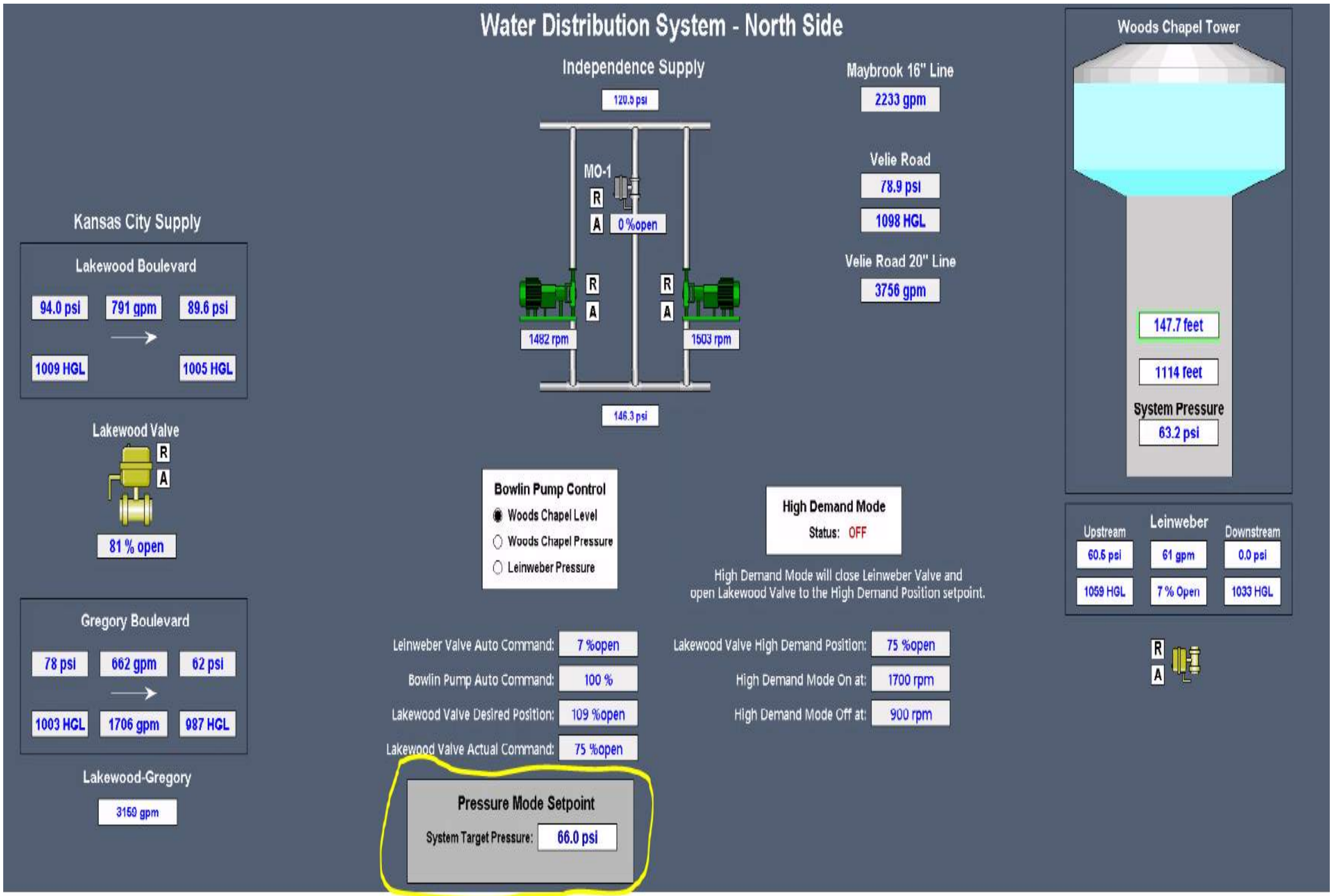
On the SCADA Water Overview page, ***only** the SCADA Supervisor and the Facilities Manager* will have a "**Water Totals** / **North Side Control** and a **South Side Control**" window. *(example 10)*

Click on the North Side Control. This screen allows the Control System Supervisor and the operator the ability to preset SCADA conditions at Bowlin, Leinweber, and Lakewood, before changing the north system to operate in the Woods Chapel or Leinweber pressure mode.

Example 10

When the "North Side Control" box is clicked this SCADA screen will present. *(example 11)*

Example 11



The North System is ready to convert to: Woods Chapel Pressure Mode or Leinweber Pressure Mode at Bowlin.

Automation of the North System Pressure mode

Select the **Woods Chapel** (example 5) or **Leinweber (example 5/A)** **Pressure** circle based on which way the conditions are set in the system.

The **System Target Pressure value will control the automation for the North System**. The "Pressure Mode Setpoint" will be set in the Water Overview / North Side Control window. *(example 6)*

There is a plus and minus 1 psi dead band for the entered System Target Setpoint.

1. When the pressure in the North System is **greater than 1 psi** of "System Target Pressure":
   a. If the synchronized Bowlin pumps 1 and 2 are running above minimum speed, the pumps will modulate down to minimum speed of approximately 750 rpm. (Max rpm is approximately 1775)

   b. When the pumps are running minimum speed, and the system pressure is still too high, then Leinweber valve will modulate open. (This will reduce system pressure to maintain the System Target Pressure)

2. When the pressure in the North System is **less than 1 psi** of the "System Target Pressure", and Leinweber valve is open more than 8%:
   a. Leinweber valve will modulate close to 8% position. (this in the minimum %, in pressure mode, set in SCADA)
   b. After Leinweber valve has modulated to 8% (and the pressure in the North System is still too low) the synchronized pumps 1 and 2 at Bowlin will increase speed modulation to achieve the System Target Pressure.
   c. When the pumps speed reaches 1700 rpm *(example 11- "High Demand Mode On at:" setpoint)* and the North System pressure is still too low the following will happen
      i. Leinweber valve will close to 0%.
      ii. Lakewood valve will open to the "*Lakewood Valve High Demand Position set point"* 75%, 10% every minute (*example 11)*
      iii. When system pressure is being maintained, and the pumps at Bowlin slow to the speed of the "*High Demand Mode Off at:"* 900 rpm *(example 11)* Leinweber valve will open back to the SCADA controlled value of 8% and the Lakewood valve will close Lakewood valve 10% every minute.

Upstream High- and Low-pressure Alarm Setpoints at Leinweber and Lakewood are monitored for North System pressures. SCADA will alarm Win-911 if the North System pressures are out of range for more than 360 seconds. (This will help reduce nuisance alarms) **Be patience with SCADA automation. Watch the psi for 7 minutes or more to see if SCADA automation will correct pressure issues.** The demand will outrun the automation for a little bit.

If power loss occurs at Bowlin, when operating in **Woods Chapel Pressure** or **Leinweber Pressure** mode, SCADA will immediately open Lakewood valve to 30% and modulate to try to maintain the "System Target Pressure" 66psi *(example 11).* This is to prevent a major loss of pressure in the north system.

When the power returns to Bowlin, SCADA will close Lakewood valve 10% every minute as pumps 1 and 2 ramp up to speed.

BOWLIN PUMP STATION

7/15/22 TS

To place the North System back in Woods Chapel Level Mode – Woods Chapel Tower must be storing water!

1. At Woods Chapel - **Slowly** open Woods Chapel valve to 25%.
2. At Leinweber - **Slowly** set the Leinweber valve to 8%.
4. At Woods Chapel – **Slowly** open Woods Chapel valve to 100%
5. At Bowlin - Click the **Woods Chapel Level circle.** *(example 4)*
6. The North system is now being controlled by Woods Chapel Tower level.

LAKEWOOD VALVE OPERATION

7/15/22 TS

The Lakewood valve allows Kansas City water into the Lee's Summit system. It is used in conjunction with the Bowlin Pump Station pumps to supply water to Woods Chapel Tower.

Automation: Communication is needed to; Bowlin, Leinweber, Woods Chapel Tower and this site.

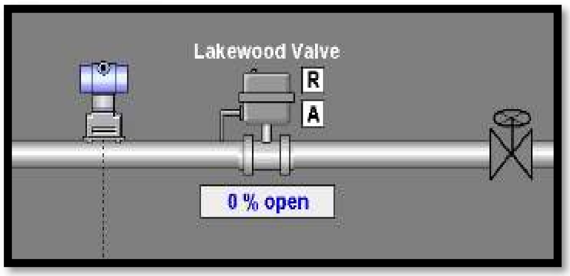
All set point values can be changed. The following set points referenced are used for ease of explanation.

- *See Valve Control page for definitions on valve control and movement.*

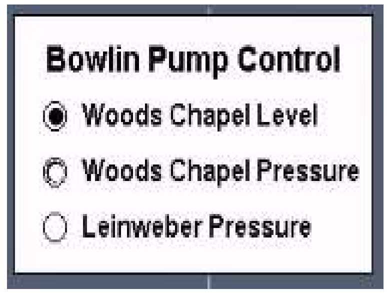
You must close any popup windows before moving to a different SCADA screen.

Automation: Valve must be in the auto (**A**) remote (**R**) settings. *(example 1)*

Example 1



Example 2



Automatic valve operation - **Woods Chapel Level Mode** *(example 2)*

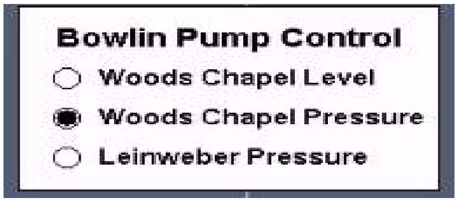
1. SCADA will modulate this valve within the "Lakewood Valve Full Close Level and Full Open Level setpoints at Bowlin. *(example 3)*
   a. This valve will modulate 10% open and close, per minute, as levels change.

Example 3

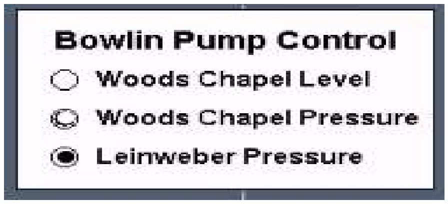
Level Control Setpoints	
Tower Level:	143.9 feet
Valve Close Level:	120.0 feet
Valve Open Level:	120.0 feet
Lead Stop Level:	157.0 feet
Lead Start Level:	151.8 feet
Lag Stop Level:	157.0 feet
Lag Start Level:	151.8 feet
Pump 3 Stop Level:	140.0 feet
Pump 3 Start Level:	138.5 feet
Pump Min. Speed at:	149.5 feet
Pump Max. Speed at:	147.0 feet
Lakewood Valve Full Close Level:	152.4 feet
Lakewood Valve Full Open Level:	150.0 feet

Automatic valve operation - **Woods Chapel Pressure** (*example 4)* or **Leinweber Pressure Mode.** (*example 4/A*)

Example 4



Example 4/A



1. When the pumps at Bowlin reach 1400 rpm SCADA will open the Lakewood valve 10% per minute. This is to help offset low-pressure issues in a high demand occurrence. (*example 5)*
2. The valve will open to the "*Lakewood Valve High Demand Position: set point".*
   - These values are displayed on the main Water Distribution page under North Side Control button. (*example 5)*

Example 5 – (*This page is only accessibly for the Control System Supervisor and Facility Manager on the* ***Water Overview/North Side Control Buttons***)

3. When the pumps at Bowlin slow to 900 rpm SCADA will close the valve 10% per minute. (*example 5)*

If a power failure occurs at Bowlin pump station SCADA will immediately open this valve to 30%. When power has been restored at Bowlin valve will modulate close when the level /or pressure at Woods Chapel Tower has returned to the "Lakewood Valve Close Level / pressure" parameters set in the Bowlin Pump Station setpoint window.

Woods Chapel Tower

7/15/22 TS

Woods Chapel Tower receives water from Independence, thru Bowlin Pump Station, and Kansas City, via Lakewood Valve as needed.

You must be logged on to SCADA to make any Changes.

Automation: *Communication is needed at Bowlin, Leinweber Lakewood and this site.*

All set point values can be changed. The following set points referenced are used for ease of explanation.

You must close any popup windows before moving to a different SCADA screen.

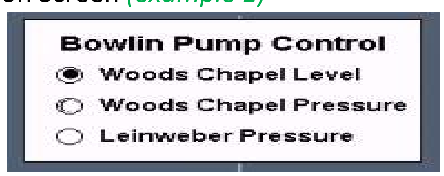
- *See Tower/Reservoir level section for reservoir level override instruction.*
- *See Valve section for valve operation instruction.*
- *See Set Point Modification section.*
- *See Gregory Blvd. section.*
- *See Lakewood Blvd. section.*
- *See Leinweber section.*

This site delivers water to the North System but can also deliver water to the South Systems through valve configuration at Gregory Blvd. vault.

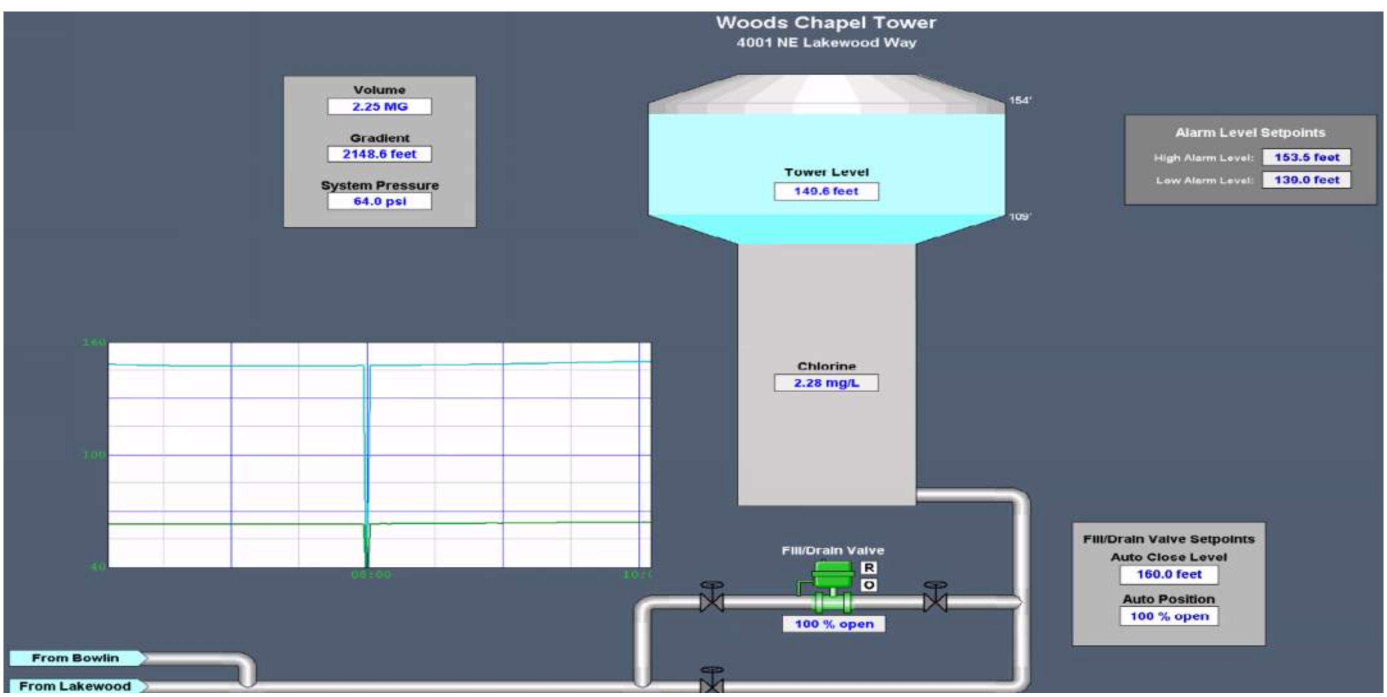
WOODS CHAPEL LEVEL Mode

Woods Chapel Mode - selected at the Bowlin Pump Station Screen *(example 1)*

Example 1 *(control at Bowlin Pump station screen)*



Example 2



Example 2 - displays the following:

1. The Fill/Drain valve 100% open in remote **(R)** and open **(O)** setting. This setting inhibits SCADA automation.
2. The graph on the left displays a 4-hour level and pressure trends.
3. The Chlorine reading of the water in the tower. 2.09 mg/l.
4. High- and low-level alarm set points. 153.5 ft. and 139.0 ft.
5. Auto Close level 160 ft. (this setting prevents closure of valve)
6. Current Auto Command 100% open.

WOODS CHAPEL LEVEL mode

Bowlin pump station: MO-1 valve, all pump start /stop commands and Lakewood and Leinweber valve modulations are controlled from the level in this tower.

The fill/drain valve is programmed to move 10% per minute when it receives a SCADA command to change positions.

1. If the water level in tower raises to 152 ft. Leinweber will modulate to maintain 152 ft. in the tower.
2. If the water level in the tower raises to 153.5 ft Win-911 will send an alarm. Immediate action is required! The following are possibilities for correction
   a. **Call Facilities**
   b. Turn off the pumps at Bowlin.
   c. Ensure the valve at Lakewood is closed.
   d. Open Leinweber valve.
3. When the water in the tower drops below the “Low Alarm Set Point” 139. ft., Win-911 will send an alarm. Immediate action is required! The following are possibilities for correction
   a. **Call Facilities**
   b. Turn on the pumps at Bowlin.
   c. Ensure the valve at Lakewood is open.
   d. Close Leinweber valve.

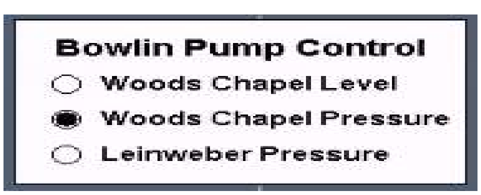
If the tower level drops below 138 ft., residents in the area will not have adequate water pressure in their homes.

WOODS CHAPEL PRESSURE mode

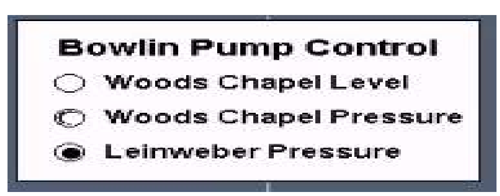
Woods Chapel Pressure mode – selected at the Bowlin Pump Station Screen *(example 3)*

Leinweber Pressure mode - selected at the Bowlin Pump Station Screen *(example 3A)*

Example 3

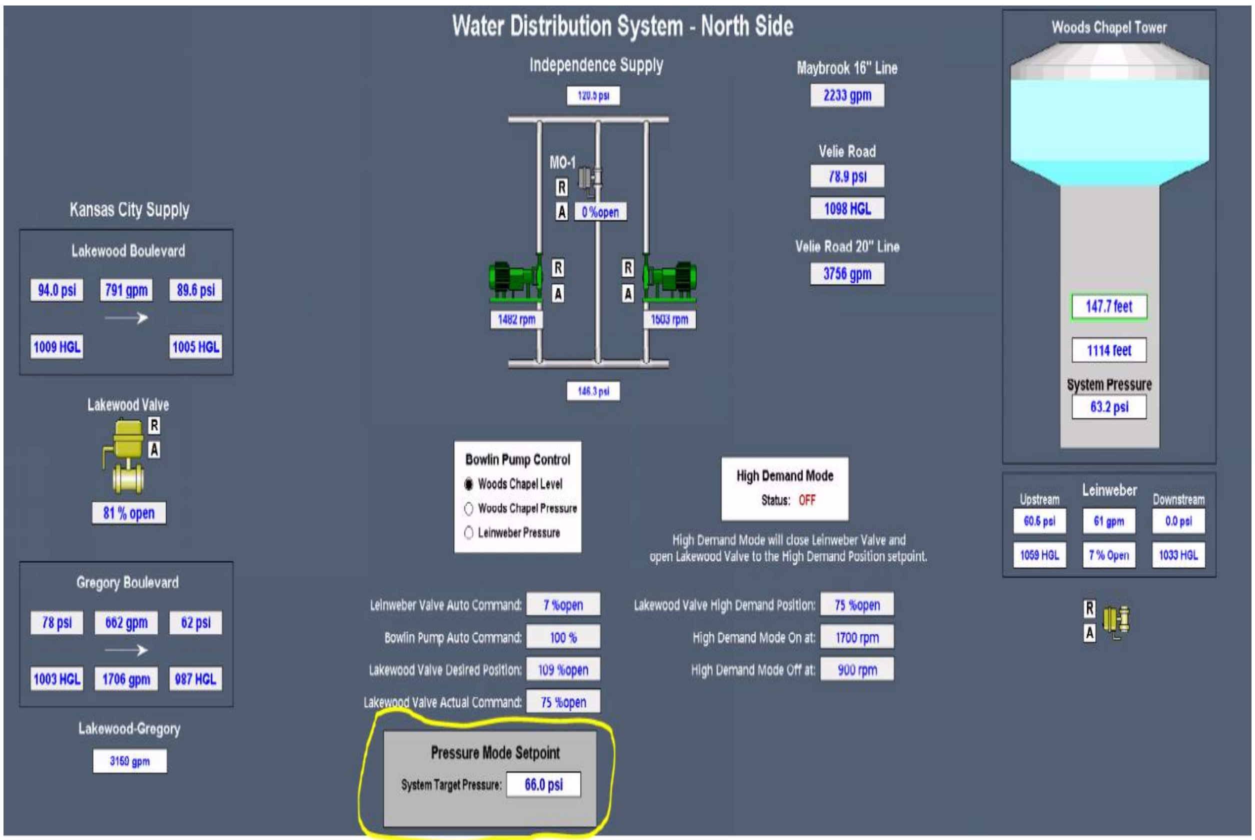


Example 3/A



- When Woods Chapel Tower needs to be serviced, the North System can operate in **Woods Chapel Pressure** or Leinweber Pressure mode. Woods Chapel Fill/Drain will be closed.
- The ability to operate the North system in **Woods Chapel Pressure** *(example 3)* or **Leinweber Pressure *(example 3/A)*** mode with the Fill/Drain valve open is an option, when the tower has water. This option is in lieu of **Woods Chapel Level** mode. However, be cognoscente of the Chlorine residual in the Tower.
- ***See Bowlin Pump Station documentation*** **Woods Chapel Pressure or** Leinweber Pressure mode **pages 5-8 before selecting pressure mode settings.**

Example 4



Example 4 – displays the Facility manager / Control System supervisor control page. This page is accessed from the **Water Overview/North Side Control buttons.**

1. Pressure Mode Setpoint window.
   a. System Target Pressure value controls the North System automation.
      i. If **Woods Chapel Pressure** or Leinweber Pressure mode is selected the System Target Pressure value will be entered here.
   - 66 psi for **Woods Chapel Pressure** mode *(66 x 2.31 + 3 = 155.46 of level in the tower)*
   - 61 psi for Leinweber Pressure mode *(61 x 2.31 + 13.1= 154 ft. in Woods Chapel Tower)*

HIGH SERVICE PUMPING STATION

7/21/22 TS

You must be logged on to SCADA to make any Changes.

Automation – Communications are needed to Gregory, Ranson, Harris Park and this site.

All set point values can be changed. The following set points referenced are used for ease of explanation.

- *See Water Pump Control section.*
- *See Tower / Reservoir level section for reservoir level override instruction.*
- *See valve section for valve operation instruction*
- *See Backup Generator section.*
- *See Set Point Modification section.*

You must close any popup windows before moving to a different SCADA screen.

High Service Reservoirs receives water from MO-4 at Bowlin Pump Station and Gregory Blvd. vault.

Levels in the 4 or 5.5 MG reservoirs control valve modulation in Gregory Blvd. vault.

High Service delivers water to the following areas:

1. Ranson Tower
2. Hook Tower
3. Scherer Tower
4. The South System

Pump control hand settings

High Service & South Terminal		
%	hz	rpm
100	60	1800
75	55	1650
50	50	1500
25	45	1350
0	40	1200

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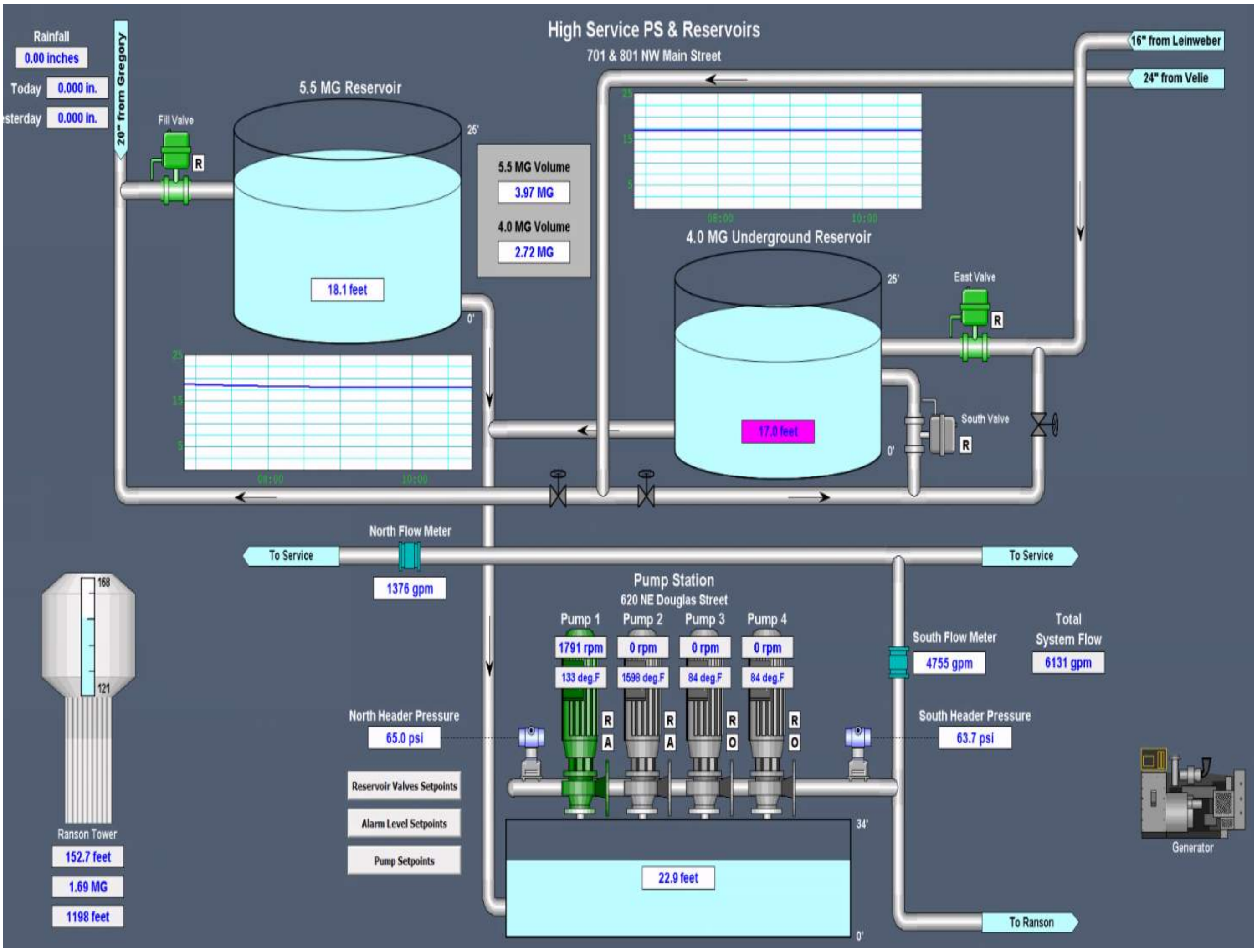
Example 1



Example 1 - displays the follow:

1. The 2 grids display 4-hour level trends for each reservoir.
2. Reservoir levels
3. Clearwell level
4. The backup generator is not running. (grey)
5. Pumps 1 and 2 are in remote (**R**) and auto **(A)**
6. Pumps 3 and 4 are in remote (**R**) and off **(H)**
7. The east valve is 100% open. (green)
8. The south valve is closed. (grey)
9. Displays the volumes for the 4 and 5.5MG reservoirs.
10. Ranson Tower information
11. North, South and total system flow
12. North and South header pressures.

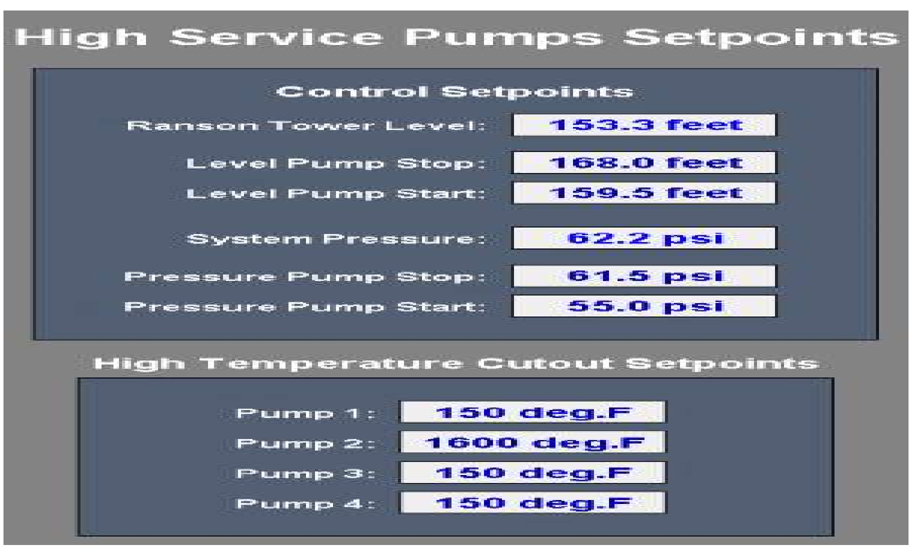
Example 2

Example 2 **-** Reservoir Valve Set Points boxed when clicked.

Example 3

Example 3 - Alarm Level Set Points box when clicked.

Example 4



Example 4 – Pump setpoints and Temperature settings when clicked.

High Service Automation

2 Pumps must be in remote **(R)** and auto **(A)**.

The first pump selected in auto will be the level pump, and the second pump selected in auto will be the pressure pump.

1. **Level Pump** start/stop are controlled by Ranson Tower.

    a. The "**Level Pump** Stop/Start Setpoints "- will ensure the level pump runs within the duration of the pressure pump on/off cycle.

2. The **Pressure Pump** start/stop is controlled by the psi gauge at either Harris Park of Hook tower.

    a. The **Pressure Pump** start setpoint is set to ensure the High Service pressure pump starts after the pressure pump at South Terminal runs. *(example 2)*

    b. The **Pressure Pump** stop setpoint is set to ensure the High Service pressure pump stops before the pressure pump at South Terminal turns off. *(example 2)*

These setpoints will help keep the 4 and 5.5MG reservoirs full.

SOUTH TERMINAL PUMPING STATION

7/21/2022 TS

South Terminal receives water from Kansas City Jackson Cass Water Main and will mainly supply water to Scherer, Hook, Ranson Towers and the South System.

Automation: Communication is needed at Scherer, Harris Park and this site.

- *See the Water Pump Control section.*
- *See Tower/Reservoir level section for reservoir level override instruction.*
- *See Backup Generator section.*
- *See Set Point Modification section.*

All set point values can be changed. The following set points referenced are used for ease of explanation.

For Automation pumps must be in the auto (**A**) and remote (**R**).

2 Pumps must be in remote **(R)** and auto **(A)**.

The first pump selected in auto will be the level pump, and the second pump selected in auto will be the pressure pump.

The level pump start/stop levels are controlled by Scherer Tower.

The pressure pump start/stop is controlled by the psi gauge at either Harris Park of Hook tower.

(setting dependent)

You must close any popup windows by before moving to a different SCADA screen.

Flow meters:

Pump start - 140 second delay before the flow meters will register a reading.
Pump stop - 30 sec delay before the flow meters stop reading.

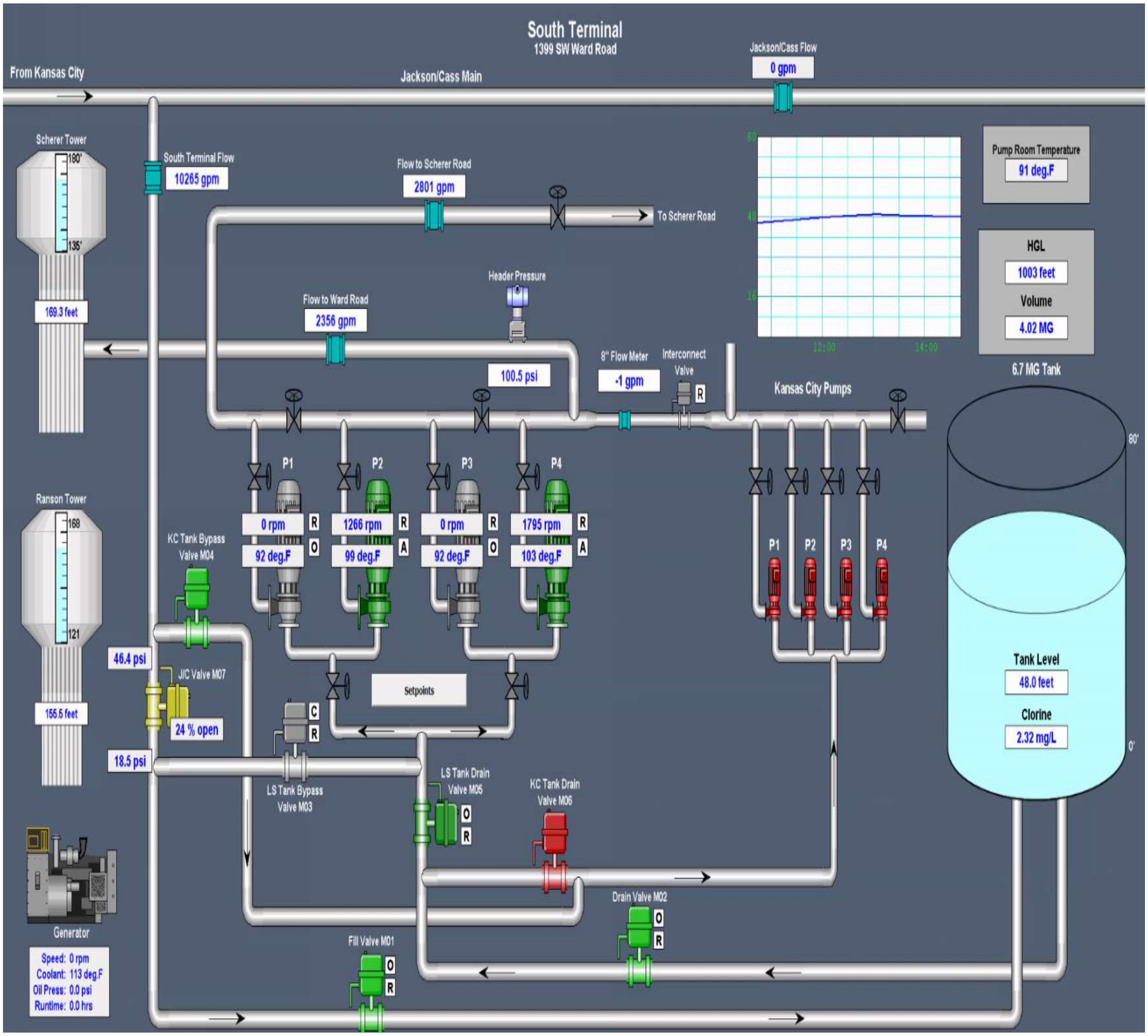
The delays are used for check valves opening and closing and to stop reverse flow through the header causing meter reading accuracy issues.

VFD Settings: The minimum and maximum frequency for all the VFD's need to set at 40 -60 hz. This adjustment will need to be done on site.

Hand speed control for the pumps

High Service & South Terminal		
%	hz	rpm
100	60	1800
75	55	1650
50	50	1500
25	45	1350
0	40	1200

Example 1

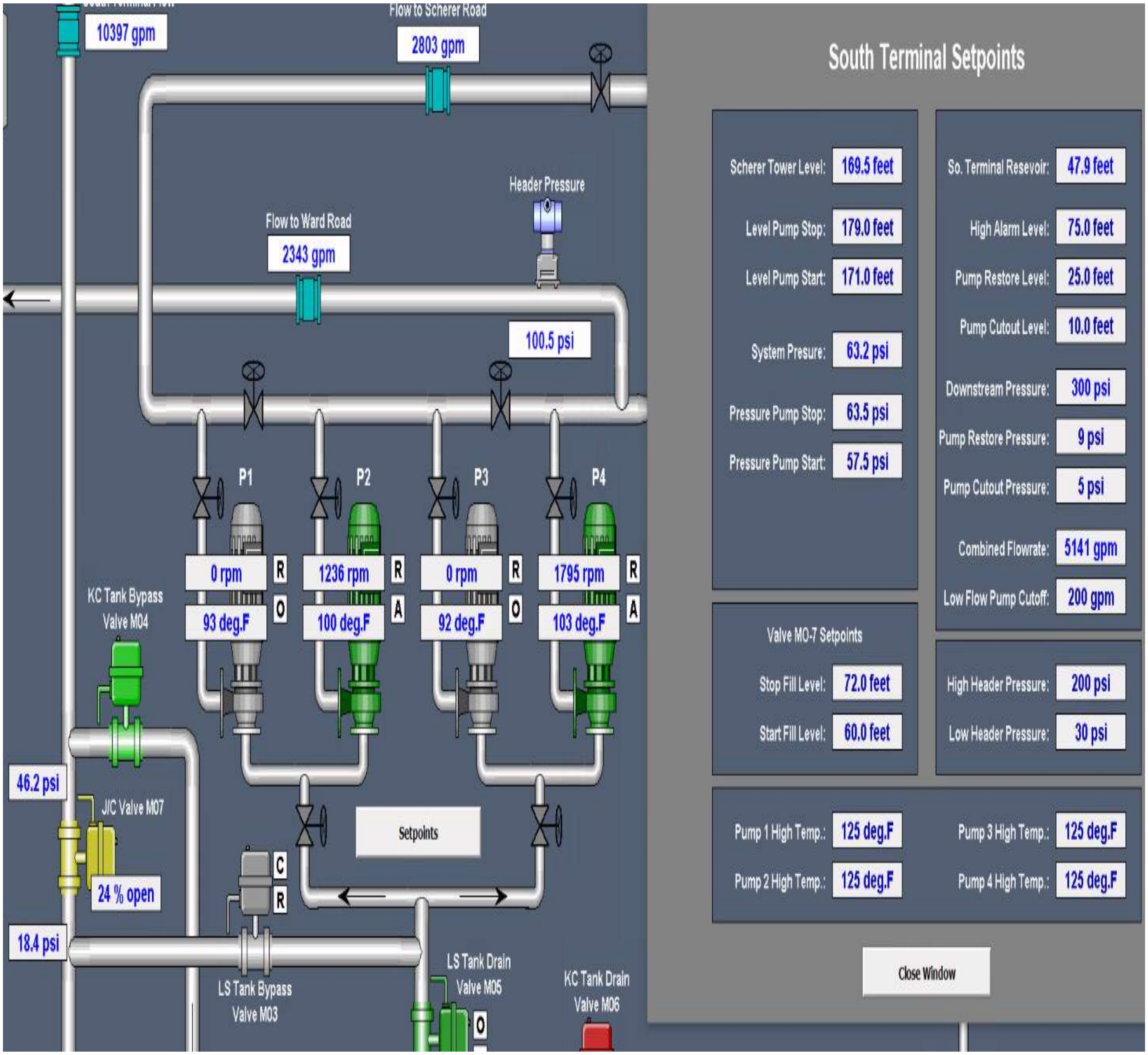


Example 1 - displays the following:

1. The backup generator is not running.
2. Water level in the reservoir. 48 ft.
3. Chlorine residual in the reservoir. 2.32 mg/l
4. The four red pumps display the Kansas City pumps and are shown to be in a fault condition.
5. Lee's Summit pumps 1 and 3 are in remote (**R**) and off **(O)**. (displayed in grey)
6. Lee's Summit pumps 2 and 4 are in remote **(R)** and auto **(A)**.
7. LS Tank Drain valve MO-1,2,4 and 5, are open **(O)** and remote **(R)** (displayed in green)
8. MO-3 is closed **(C)** and remote **(R)** (displayed in grey)
9. The KC Tank Drain valve MO-6 is in the fault or off condition. (displayed in red)

10. MO-7, the J/C valve is partially open, 24%. (displayed in yellow)
11. MO-1 and 2 are in the open (**O**) and remote (**R**) setting, and are 100% open.

Example 2



Example 2 – displays the South Terminal Set Points screen when the Set Points box is clicked.

1 The "Level Pump Stop and Start" set points for level pump off and on control.
2 The "Pressure Pump Stop and Start" set points are for pressure pump off and on control.
3 Valve MO-7 set points are values sent to Kansas City SCADA system, and Kansas City will maintain levels in the South Terminal reservoir. *(example 2)*

South Terminal Automation

The pump start/stop parameters are set to maximize water usage from Kansas City into the South System and ease pump run times at High Service.

1. **Level Pump** start/stop are controlled by Scherer Tower.

   a. The "**Level Pump** Stop/Start Setpoints "- will ensure the level pump runs within the duration of the pressure pump on/off cycle.

2. The **Pressure Pump** start/stop is controlled by the psi gauge at either Harris Park of Hook tower.

(setting dependent)

   a. The **Pressure Pump** start setpoint is set to ensure the South Terminal pressure pump runs before the pressure pump at High Service runs. *(example 2)*

   b. The **Pressure Pump** stop setpoint is set to ensure the South Terminal pressure pump stops after the pressure pump at High Service turns off. *(example 2)*

These setpoints will help keep the 4 and 5.5MG reservoirs full.

Harris Park Stand Pipe

7/15/22 TS

Automation: *Communication is needed at: High Service and South Terminal pump stations and this site.*

Currently the pressure gauge is the only component being utilized. It is controlling the pressure pumps at High Service and South Terminal.

There is a 3-minute averaging for the pressure reading. This is done to smooth the psi signal sent to the pressure pumps at High Service and South Terminal.

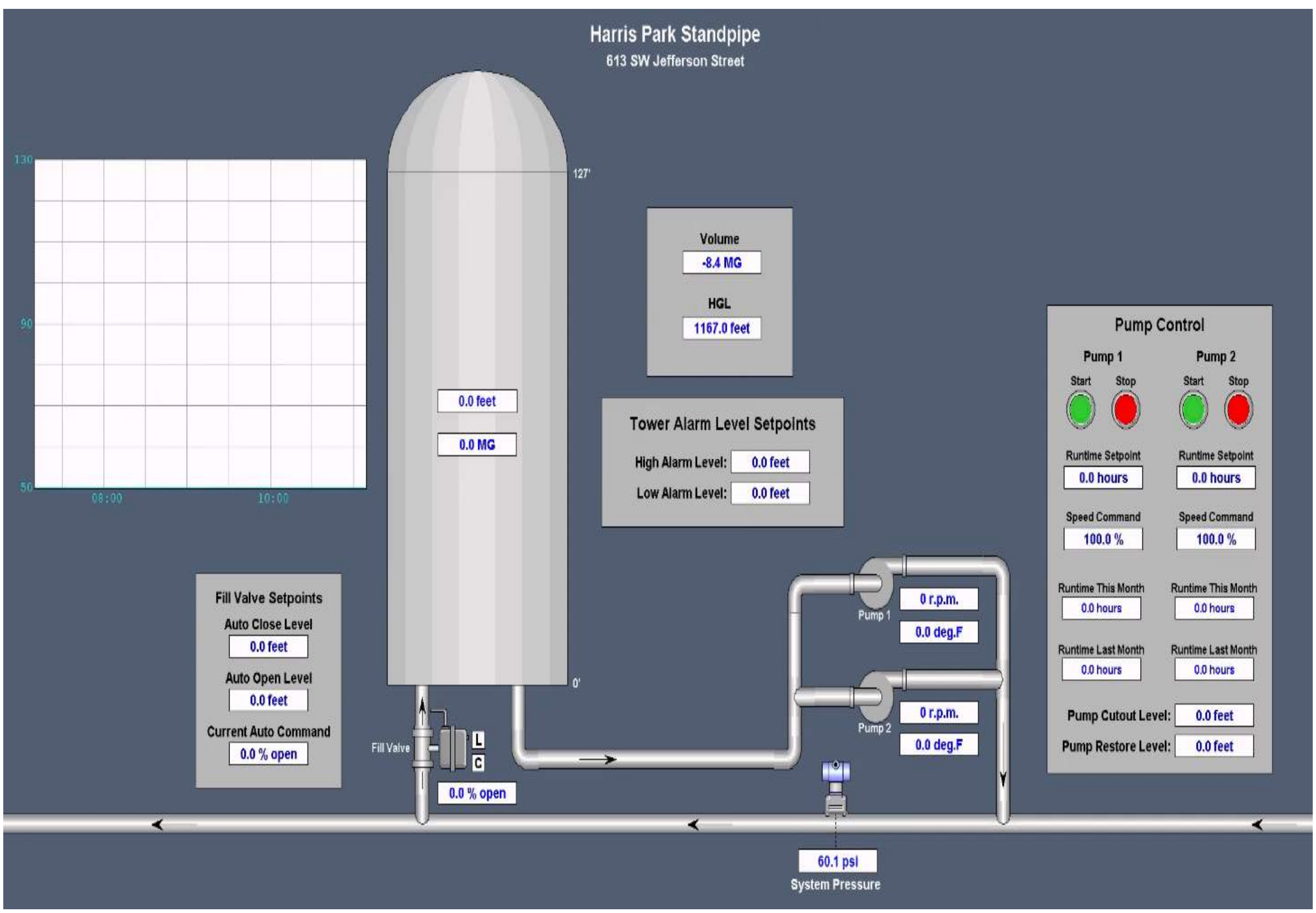
All set point values can be changed. The following set points referenced are used for ease of explanation.

When the Stand Pipe is being filled it utilizes the same water needed to fill Ranson, Hook and Scherer water towers.

- <u>*See Tower/Reservoir level section for reservoir level override instruction.*</u>
- <u>*See Valve section for valve operation instruction*</u>
- <u>*See Set Point Modification section.*</u>
- <u>*See SCADA Communication section.*</u>
- <u>*See Alarm acknowledgement section.*</u>

You must close any popup windows before moving to a different SCADA screen.

Example 1



Harris Park Stand Pipe

7/15/22 TS

Example 1 – displays the following:

1. The graph on the left displays a 4 hour level trend, when in use.
2. Fill Valve set points
    a. Auto Close level 0%
    b. Auto Open Level 0%
    c. Current Auto Command 0%
3. Actual Valve position. (Below the valve) 0.0%
4. The fill valve in local **(L)** and closed (**C**).
    a. The local command inhibits valve automation from SCADA
5. Tower level 0.0 ft.
6. MG (million gallons) 0.0
7. Volume -8.4
8. HGL 1167.0 ft.
9. Tower Alarm Set Points
    a. High Alarm Level 0.0 ft.
    b. Low Alarm Level 0.0 ft.
10. Pump information:
    a. Pump 1 and 2
        i. rpm
        ii. Temperature 0.0 deg. F
    b. Pump Control 1 and 2
        i. Start / Stop buttons
        ii. Runtime Set Points 0.0 hrs.
        iii. Speed Command 100%
        iv. Runtime this month 0.0 hrs.
        v. Runtime last month 0.0 hrs.
        vi. Pump Cutout Level 0.0 ft.
        vii. Pump Restore Level 0.0 ft.
11. System Pressure Gauge 60.1 psi

Operation of the Site

1. The fill valve must be in auto (**A**) and remote (**R**).
2. Set the “Current Auto Command” to 50%.
    a. When the fill valve is called to open, it will open to the 50% value (or the value entered in the “Current Auto Command” setting).
3. Set the “Auto Close Level” to 120 ft.
    a. The fill valve will auto close, and stop filling, when the Stand Pipe has 120 ft. of water.
4. Set the “Auto Open Level” to 15 ft.
    a. The fill valve will auto open, and start filling, when the Stand Pipe has 15 ft. of water.
5. Set the “High Alarm Level” to 125 ft.
6. Set the “Low Alarm Level” to 10 ft.
    a. The Tower Level Set Points are utilized to ensure proper fill valve operation.
7. Set the “Runtime Set Points” for pumps 1 and 2 for 3 for hours.
    a. This the amount time the pumps will run once started.

8. Set “Speed Command” to 100%, the pump will run at max rpm.
    a. 50% is 50 Hz and a reduced rpm
    b. 0% is 40 Hz and the rpm’s will run at the minimum set point in the VFD.
9. Click on the “Start” button to operate the pump of choice.
10. Click the “Stop” button if needing to stop before the 3 hours has expired.
11. Set the “Pump Cutout Level” 1 ft. below the “Auto Open Command Level”. 14 ft.
    a. The “Auto Open Command Level” is set at 15 ft. in this example.
12. Set the “Pump Restore Level” 5 ft. above the “Auto Open Command Level”. 20 ft.
    a. This ensures ample water in the Stand Pipe if the pumps try restart within the 3 hour set point that is used in this example.
13. After the “Pump Runtime” value (3 hrs.) has expired, the pumps will not start again until the SCADA operator clicks the start button.

Leinweber Vault

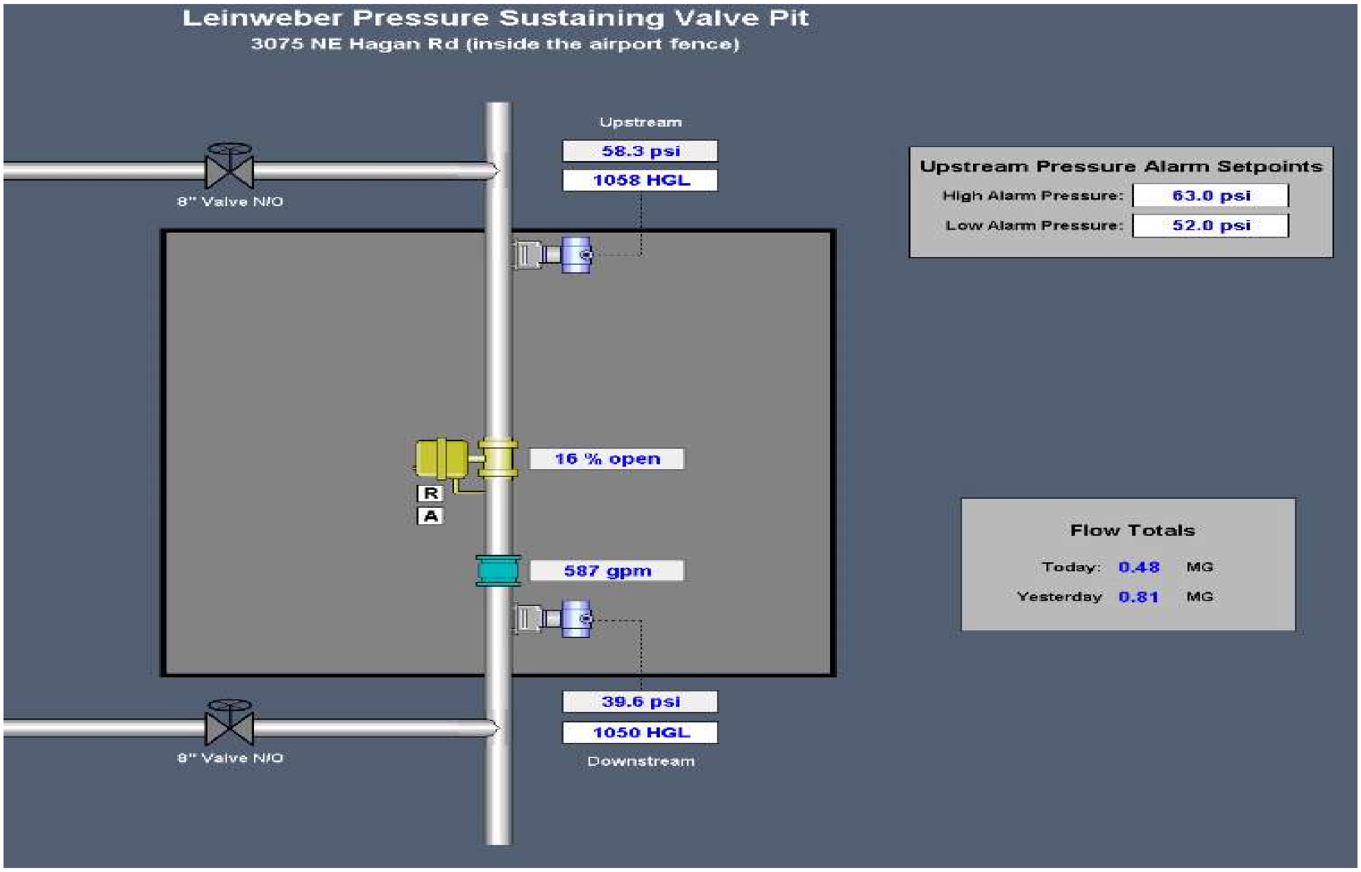
7/15/22 TS

Automation: *Communication is needed at; Bowlin Pump station, Woods Chapel and this site.*

- *See Valve Control page for definitions on valve control and movement*

All set point values can be changed. The following set points referenced are used for ease of explanation.

Example 1



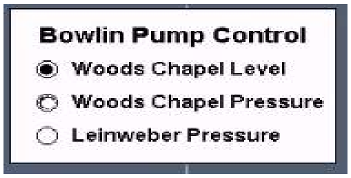
Example 1: displays the following:

1. Upstream psi and HGL
2. Upstream Pressure Alarm Setpoints
   i. High Alarm pressure
   ii. Low Alarm pressure
3. Valve percentage open.
   i. currently displaying 16% open and yellow, partially open state.
      a. A green valve represents 100% open
      b. A grey valve represents closed.
      c. A red valve represents a valve vail to open or close.
4. The flow through the valve.
5. Downstream psi and HGL.
6. Flow totals for today and yesterday.

When Bowlin Pump Control is in **Woods Chapel Level Mode** *(example 2)* the Leinweber valve should be set in remote (**R)** and auto **(A)** setting.

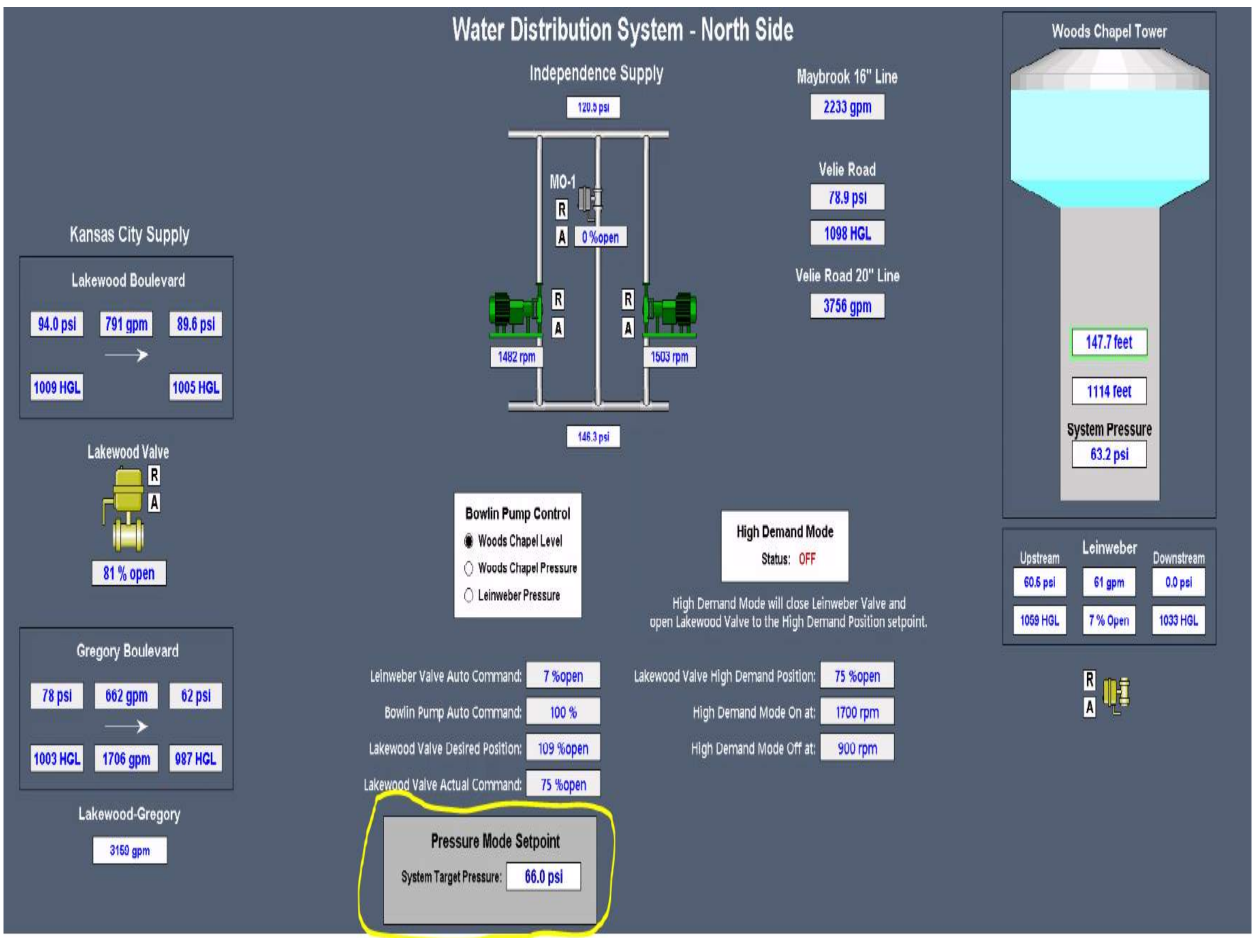
If the pumps at Bowlin are running minimum speed, (approx. 750 rpm) and the level in Woods Chapel is at 152 ft. then Leinweber valve will modulate to maintain a level of 152 ft. or the Woods Chapel

Example 2



When Bowlin Pump Control is in **Woods Chapel Pressure** *(example 4)* or **Leinweber Pressure** ***(example 4A)*** **Mode** the Leinweber valve will be modulated by SCADA to maintain the Pressure Mode Setpoint. *(example 3) This window can be accessed from the Water Overview page and clicking the North System Control Button.*

EXAMPLE 3



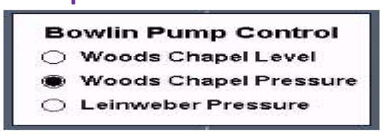
1. **North Side Control** - “System Target Pressure” value is entered in the Pressure Mode Setpoint box. *This value will be changed depending on which site is chosen to operate the North System in pressure mode.*

a. If **Woods Chapel Pressure Mode** is selected (*example 4)*, the pressure gauge at Woods Chapel is controlling automation for the North System. The System Target value will be 66 psi *(66 x 2.3 +3 = 155.5 ft in Woods Chapel Tower) (example 6)*

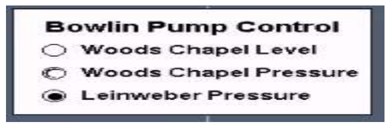
b. If **Leinweber Pressure Mode is** selected ***(example 4 A)***, the pressure gauge at Leinweber is controlling automation for the North System. The System Target value will be 61 psi *(61 x 2.31 + 13.1= 154 ft. in Woods Chapel Tower)* ***(example 4 A)***

- The Leinweber valve should be in remote (**R)** and auto **(A)** position when Bowlin Pump Control is
- in **Woods Chapel Pressure** *(example 4) or* ***Leinweber Pressure (example 4A)*** mode.
- The minimum valve closure will be 8%.
- The maximum valve open will be 50%. These values are set in SCADA.
- There is a 360 sec time delay before a low-pressure alarm will be sent to WIN-911. This is to allow Independence pressure fluctuations and buffer errant alarms.

Example 4



Example 4 A



When Bowlin Pump Control is in **Woods Chapel Pressure** or **Leinweber Pressure** Mode, (at Bowlin Pump station) the following will happen:

1. When the pressure in the North System is **greater than 1 psi** of "System Target Pressure":
   a. If the synchronized pumps 1 and 2 are running above minimum speed, the pumps will modulate down to minimum speed of approximately 750 rpm. (Max rpm is approximately 1775)

   b. If the pumps are running minimum speed, and the system pressure is still too high, then Leinweber valve will modulate open. (This will reduce system pressure to maintain the System Target Pressure)

2. When the pressure in the North System is **less than 1 psi** of the "System Target Pressure", and Leinweber valve is open more than 8%:
   a. Leinweber valve will modulate close to 8% position. (this in the minimum % set in SCADA)
   b. After Leinweber valve has modulated to 8% (and the pressure in the North System is still too low) the synchronized pumps 1 and 2, at Bowlin, will increase speed modulation to achieve the System Target Pressure.
   c. When the pumps reach maximum speed of 1775 rpm and Lake wood valve is 70% open and the North System pressure is still too low **CALL FACILITIES!**

HOOK WATER TOWER

7/21/2022 TS

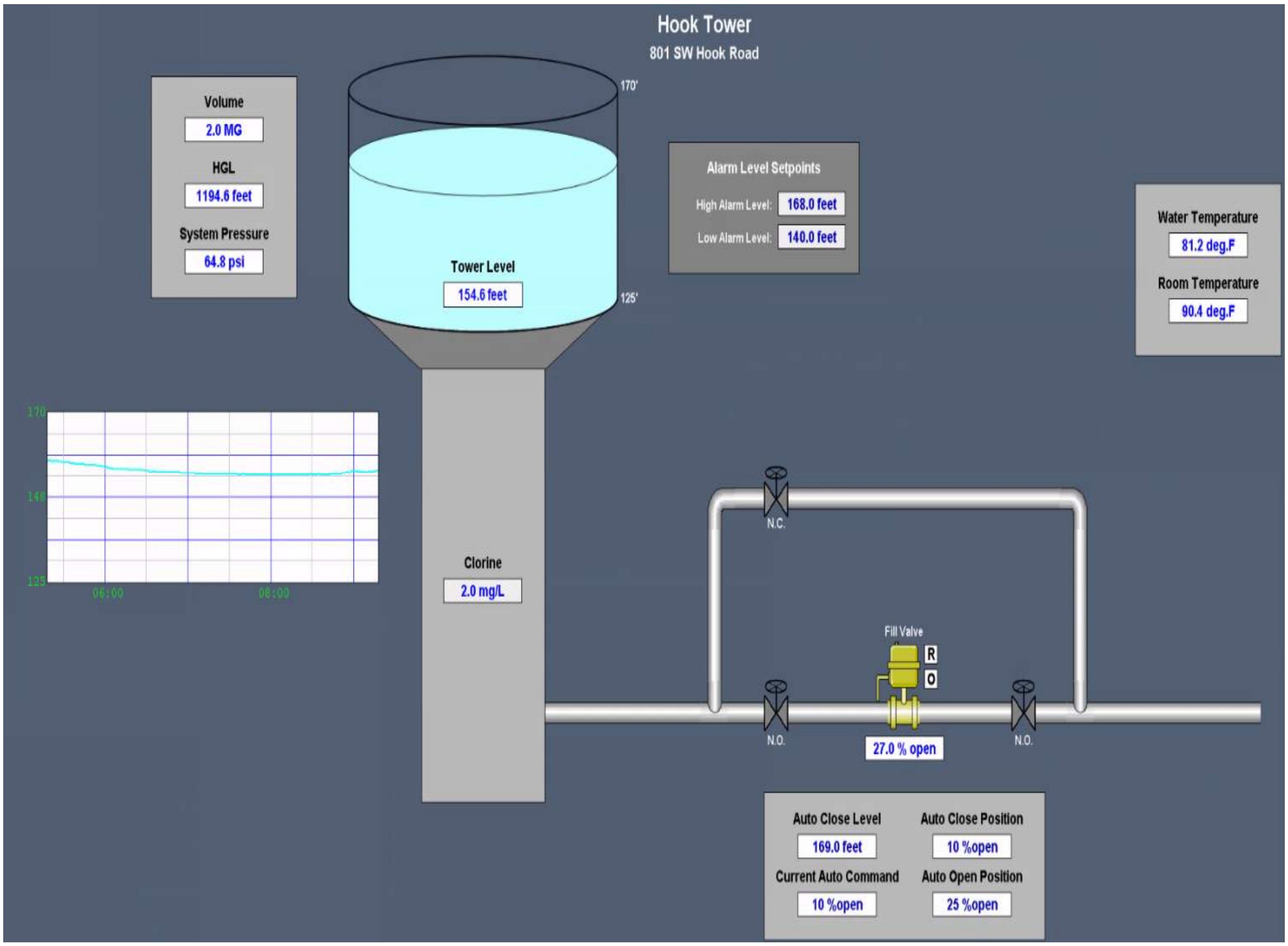
Hook Tower receives water from High Service and/or South Terminal, depending on which pumps are running, and delivers water to the South system.

All set point values can be changed. The following set points referenced are used for ease of explanation.

- *See Tower / Reservoir level section for reservoir level override instruction.*
- *See Valve section for valve operation instruction*
- *See Valve Control section for definitions on valve control and settings.*
- *See Set Point Modification section.*

You must close any popup windows before moving to a different SCADA screen.

Example 1



Example 1

1. Graph on the left displays a 4-hour level trend.
2. CL2 reading of the water in the tower. 2.0mg/l
3. High and low level alarm set points. 168 ft. and 140 ft.
4. Auto Close level 169 ft.

5. Auto Close Position 10%
6. Auto Open Position 25%
7. Current Auto Command 10%
8. Fill valve - remote **(R)** and open (**O**).

Alarm Level Set points

1. **High Alarm** - water level in the tower raises to 168 ft. SCADA will send an alarm to Win-911. *(example 1)* Immediate action is needed!
    a. The SCADA operator must correct the issue
        i. Turn off a pump or pumps in the south system. (South Terminal and/or High Service). Continue to monitor ensure the problem has been corrected.
        ii. Contact Facilities
2. **Low Alarm** - water level in the tower drops to 140 ft. SCADA will send an alarm to Win-911. *(example1)* Immediate action is needed!
    a. The SCADA operator must correct the issue.
        i. Turn on a pump or pumps in the south system. (South Terminal and/or High Service). Continue to monitor to ensure the problem has been corrected.
        ii. Contact Facilities

Fill Valve Control

The fill valve is programmed to move 10% a minute when it receives a command to change positions.

When the fill valve is in remote (**R**) and auto (**A**), the following automation will occur:

1. "Auto Close Level Set Point", (168 ft.)
    a. When the water level in the tower raises to 168 ft. the fill valve, if in auto, will automatically close. Follow **High alarm** instructions above.

RANSON WATER TOWER

7/15/2022 TS

Ranson Tower receives water from High Service and or South Terminal pump stations and deliver's water to the South System and Central Lee's Summit area.

Ranson Tower level only controls the level pump start/stop at High Service

Automation: Communications is needed at High Service, Haris Park and this site.

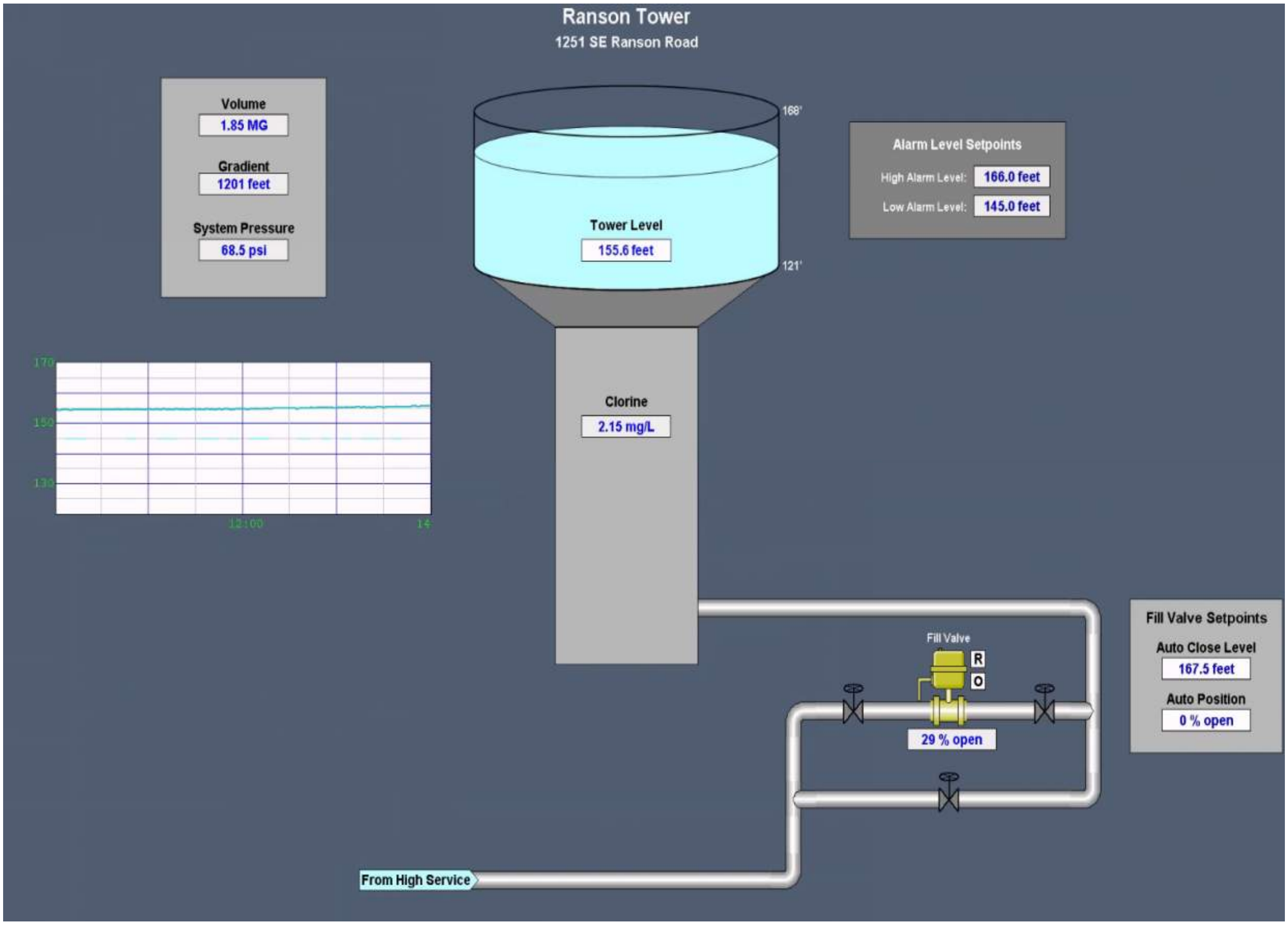
All set point values can be changed. The following set points referenced are used for ease of explanation.

- *See Tower / Reservoir level section for reservoir level override instruction.*
- *See Valve section for valve operation instruction*
- *See Set Point Modification section.*

You must close any popup windows before moving to a different SCADA screen.

Automation: Fill valve must be in the auto (**A**) remote (**R**) setting.

Example 1



Example 1 displays:

RANSON WATER TOWER

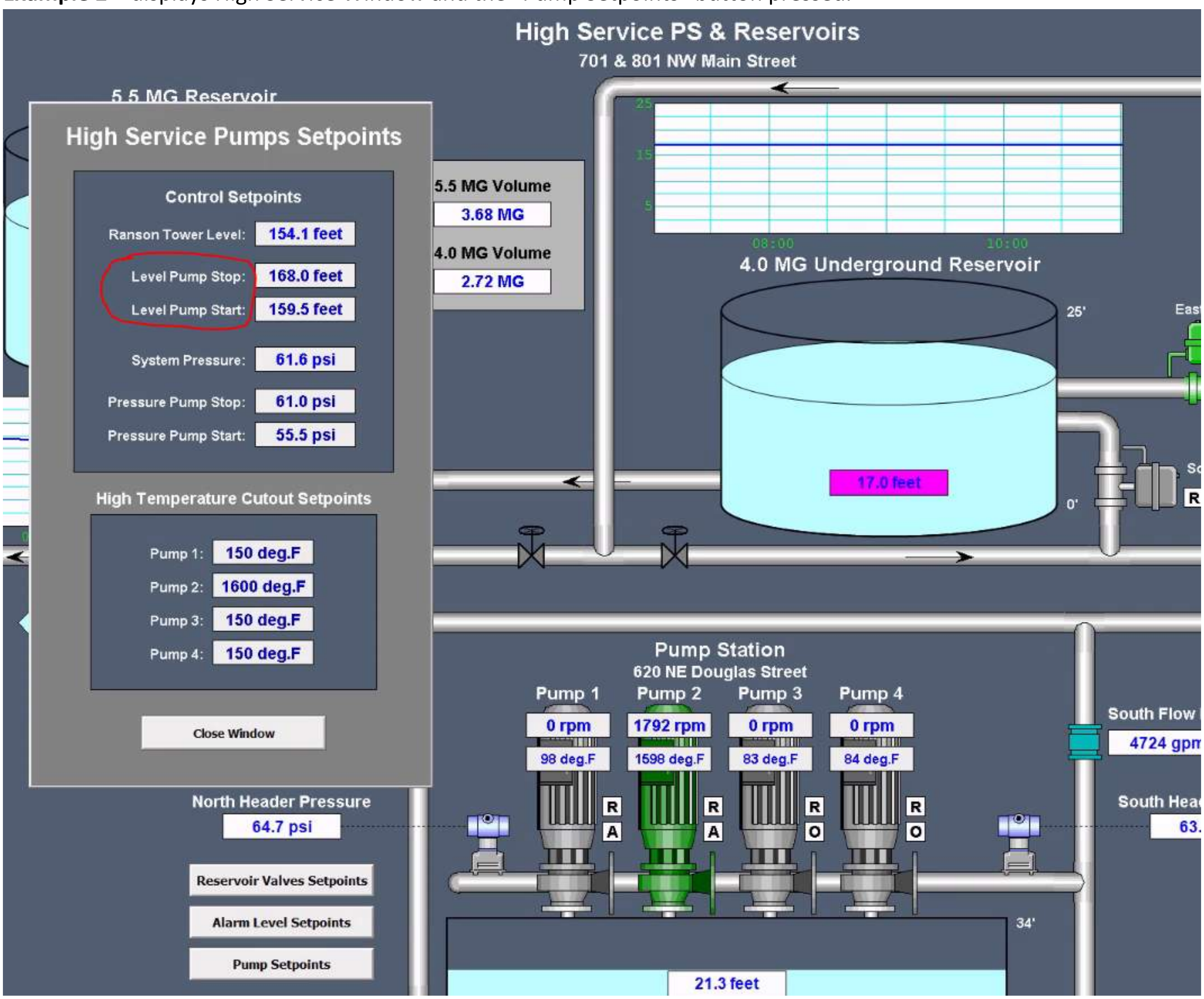
7/15/2022 TS

- The graph on the left displays a 4-hour level trend.
- The CL2 reading of the water in the tower is 2.15 mg/l
- High- and low-level alarm set points. 166 ft. and 145 ft.
- Auto Close level 167.5 ft.
- Current Auto Command 30%. *(valve is shown in yellow because it is only open to 30%)*
- The fill valve is in remote **(R)** and open (**O**).
- Tower level is 155.6

Ranson Tower level only controls:

1. High Service Level pump within the start/stop settings. (*example 2)*
   a. current parameters
      i. Level Pump Stop – 168 ft.
      ii. Level Pump Start – 159.5 ft.

Example 2 – displays High Service Window and the "Pump Setpoints" button pressed.



RANSON WATER TOWER

7/15/2022 TS

Ranson Tower Operation:

1. **High Alarm** - water level in the tower raises to 167.5 ft. SCADA will send an alarm to Win-911. *(example1)* Immediate action is needed!
   a. The SCADA operator must correct the issue
      i. Turn off a pump or pumps in the south system. (South Terminal and/or High Service). Continue to monitor ensure the problem has been corrected.
      ii. Contact Facilities
2. **Low Alarm** - the water level in the tower drops to 100 ft. SCADA will send an alarm to Win-911. *(example1)* Immediate action is needed!
   a. The SCADA operator must correct the issue.
      i. Turn on a pump or pumps in the south system. (South Terminal and/or High Service). Continue to monitor to ensure the problem has been corrected.
      ii. Contact Facilities

The fill valve is programmed to move 10% a minute when it receives a command to change positions.

When the fill valve is in remote (**R**) and auto (**A**), the following will occur:

1. "Auto Close Level Set Point", (167.5 ft.) *(example1)*
   a. When the water level in the tower raises to 167.5 ft. the fill valve, if in auto, will automatically close. Follow **High alarm** instructions above.

SCHERER TOWER

7/15/22 TS

Scherer Tower can receive its water from High Service and or South Terminal, depending on which pumps are running, and delivers water to the south system.

Scherer Tower level only controls the level pump start/stop at South Terminal

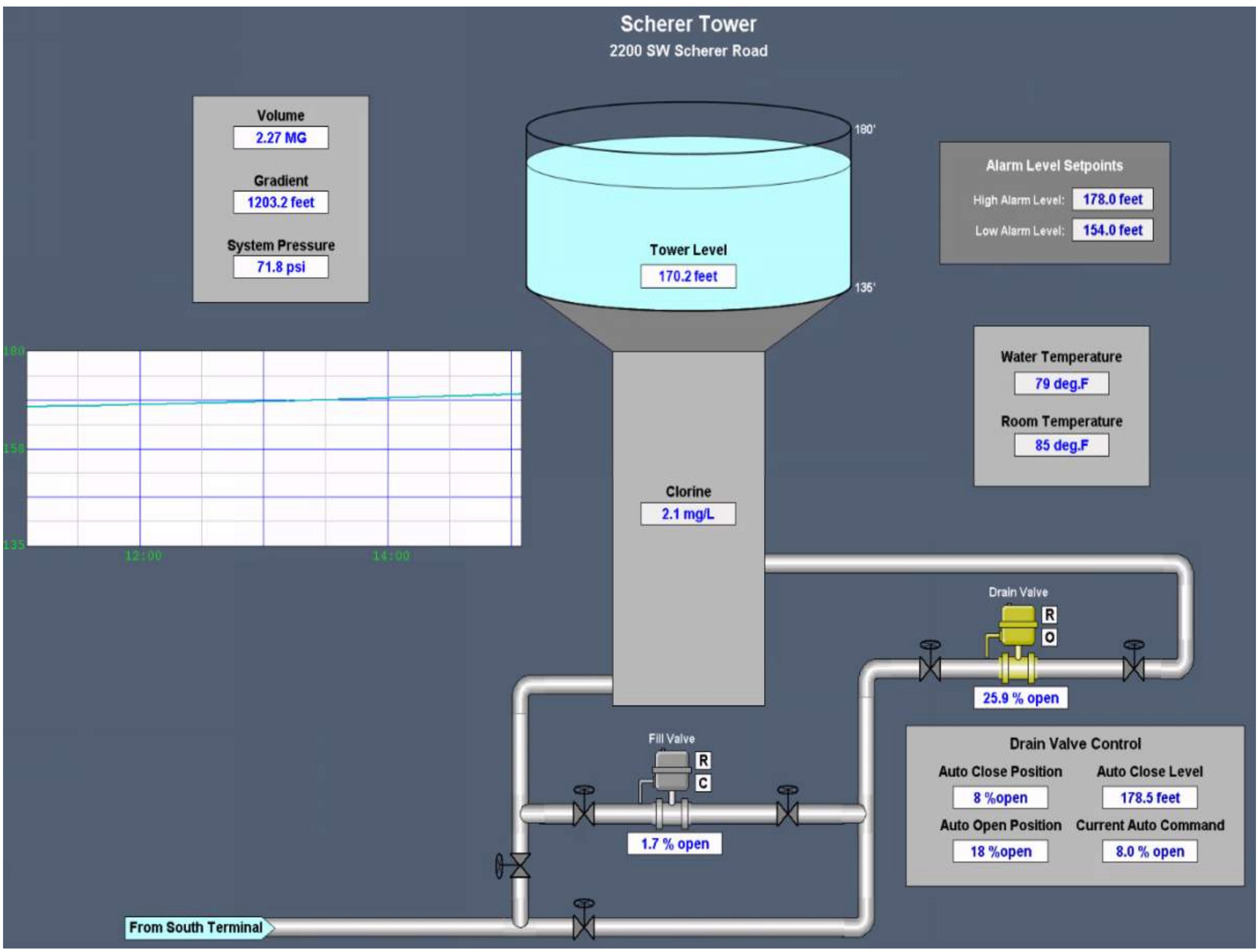
Automation: Communication is needed at South Terminal, Harris Park, and this site.

All set point values can be changed. The following set points referenced are used for ease of explanation.

- *See Tower/Reservoir level section for reservoir level override instruction.*
- *See Valve section for valve operation instruction*
- *See Valve Control section for definitions on valve control and settings.*
- *See Set Point Modification section.*

You must close any popup windows before moving to a different SCADA screen.

Example 1



Example 1 - displays:

SCHERER TOWER

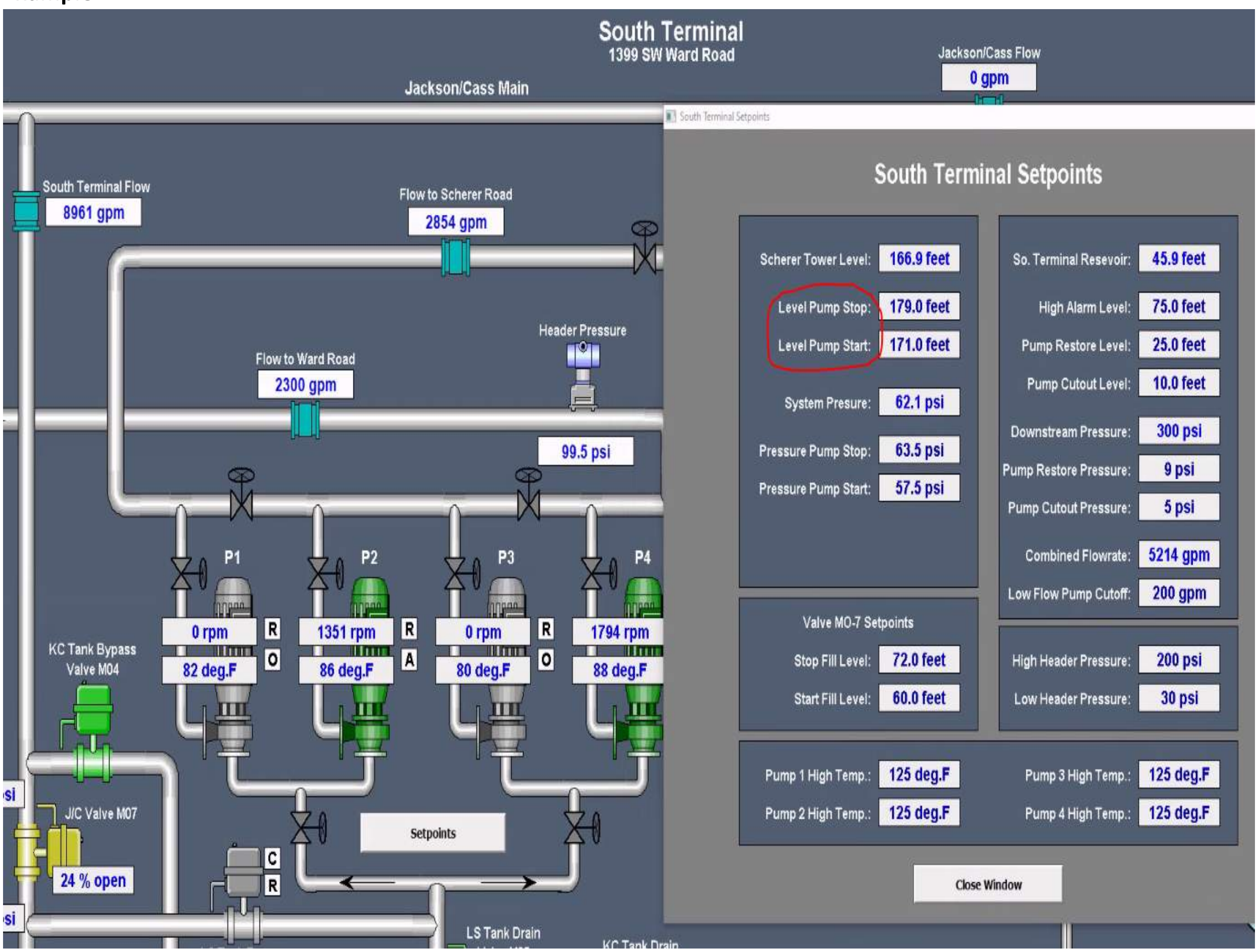
7/15/22 TS

- The graph on the left displays a 4-hour level trend.
- The CL2 reading of the water in the tower. 2.21mg/l
- High- and low-level alarm set points. 178 ft. and 154 ft.
- Auto Close level 178.5 ft.
- Auto Close Position 8%
- Auto Open Position 18%
- Current Auto Command 8%
- The fill valve is in remote (**R**) and closed (**C**). (Fill valve generally not used)

Scherer Tower level only controls:

1. South Terminal Level pump within the start/stop settings. (*example 2)*
   a. current parameters
      i. Level Pump Stop – 179 ft.
      ii. Level Pump Start – 171 ft.

Example 2



Alarm Level Set points

1. **High Alarm** - water level in the tower raises to 178 ft. SCADA will send an alarm to Win-911. *(example 1)* Immediate action is needed!
    a. The SCADA operator must correct the issue
        i. Turn off a pump or pumps in the south system. (South Terminal and/or High Service). Continue to monitor ensure the problem has been corrected.
        ii. Contact Facilities
2. **Low Alarm** - water level in the tower drops to 154 ft. SCADA will send an alarm to Win-911. *(example1)* Immediate action is needed!
    a. The SCADA operator must correct the issue.
        i. Turn on a pump or pumps in the south system. (South Terminal and/or High Service). Continue to monitor to ensure the problem has been corrected.
        ii. Contact Facilities

Drain Valve Control

The fill valve is programmed to move 10% a minute when it receives a command to change positions.

When the fill valve is in remote (**R**) and auto (**A**), the following automation will occur:

1. "Auto Close Level Set Point", (178.5 ft.)
    a. When the water level in the tower raises to 178.5 ft. the fill valve, if in auto, will automatically close. Follow **High alarm** instructions above.

STERLING

Sterling Fluid Systems (USA), Inc / Peerless Pump

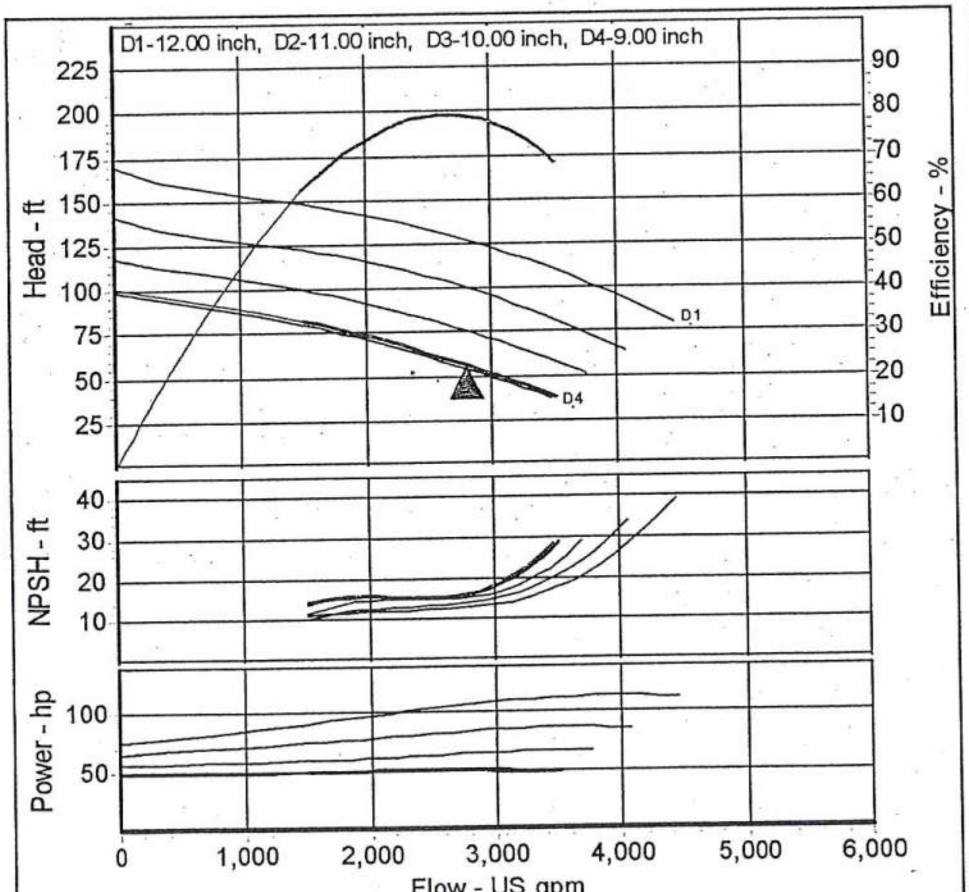
11800 Shawnee Mission Parkway, Shawnee, Kansas 66203
John Michael Titus
Phone : 913-248-PUMP (7867)
Fax : 913-248-0720

Customer : City of Lee's Summit, Mo
Bartlett & West Engineers

Contact : Chad Bachman
Phone : **Fax :**
Date : Thursday, December 26, 2002

Project : Bowlin Road Pump Station
Quote No. : 2SKC0157 **Page No :** 1

Type:	AE - Horizontal Split Case Single Stage	Item :	Independance Supply
Pump Model:	Peerless - 10AE12	Impeller No.:	2694126
Nom. Speed:	1760 RPM, 60 Hz Electric	Fluid:	Water
Impeller Dia.:	9.11 inch	Temperature:	68 °F
Curve No.:	3132111	Viscosity:	1 cSt
Market :	Water	Sp. Gravity:	1
		Your Ref. :	



Duty Flow	2800 US gpm
Duty Head	55 ft
Imp. Dia.	9.11 inch
Power Required	50.69 hp
NPSH Required	16.387 ft
Efficiency	79.2 %
Peak Power	50.77 hp
Closed Valve Head	101.15 ft
Tolerance	Hyd Inst- Peerless Std

Comments

Performance curve represents typical performance. See Standard Hydraulic Performance document in the selective printing area of RAPID for testing tolerances & contractual guarantees.

Flow (US gpm)	Head (ft)	Pump Efficiency (%)	Power Required (hp)	NPSH Required (ft)
0.0	101.15	0.0	49.31	
1490.0	82.34	62.4	49.65	
1776.7	77.62	69.6	50.06	15.59
2063.5	72.37	74.7	50.45	15.78
2350.3	66.62	78.0	50.71	15.51
2637.0	60.40	79.2	50.76	15.71
2923.8	53.70	78.4	50.58	17.32
3210.6	46.53	75.1	50.25	21.30
3497.3	38.81	68.6	49.99	28.64

Customer : City of Lee's Summit, Mo
Bartlett & West Engineers

STERLING

Sterling Fluid Systems (USA), Inc / Peerless Pump

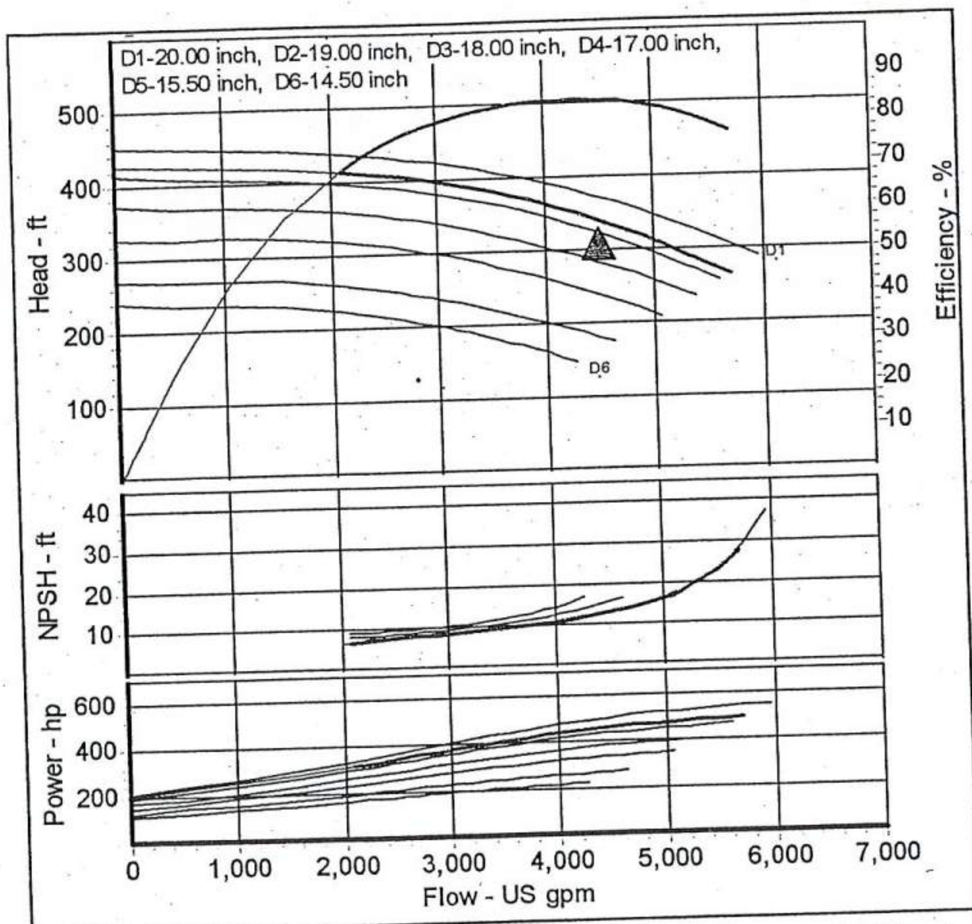
11800 Shawnee Mission Parkway, Shawnee, Kansas 66203
John Michael Titus
Phone : 913-248-PUMP (7867)
Fax : 913-248-0720

Contact : Chad Bachman
Phone :
Fax :
Date : Thursday, December 26, 2002

Project : Bowlin Road Pump Station
Quote No. : 2SKC0157
Page No : 1

Type: **AE - Horizontal Split Case Single Stage**
Pump Model: **Peerless - 10AE20**
Nom. Speed: **1775 RPM, 60 Hz Electric**
Impeller Dia.: **19.41** inch
Curve No.: **3132078**
Market : **Water**

Item : **Bowlin Supply**
Impeller No.: 2693541
Fluid: **Water**
Temperature: **68** °F
Viscosity: **1.007** cSt
Sp. Gravity: **1**
Your Ref. :



Duty Flow	**4500** US gpm
Duty Head	**330** ft
Imp. Dia.	**19.41** inch
Power Required	**460.33** hp
NPSH Required	**13.012** ft
Efficiency	**84.1** %
Peak Power	**496.04** hp
Closed Valve Head	**427.822** ft
Tolerance	**Hyd Inst-Peerless Std**

Comments

Performance curve represents typical performance. See Standard Hydraulic Performance document in the selective printing area of RAPID for testing tolerances & contractual guarantees.

Flow (US gpm)	Head (ft)	Pump Efficiency (%)	Power Required (hp)	NPSH Required (ft)
0.0	427.82	0.0	199.40	
2069.5	413.56	69.0	313.23	6.93
2586.6	406.24	76.1	348.65	7.90
3103.6	394.96	80.5	384.42	8.77
3620.6	378.96	83.0	417.43	9.98
4137.7	357.82	84.0	444.99	11.55
4654.7	331.49	83.6	465.90	13.82
5171.7	300.34	81.5	481.38	18.13
5688.7	265.16	76.8	496.04	27.48

11211

Fairbanks Morse Pump
Submittal Data For
Lee's Summit Pump Station Upgrade
Lee's Summit, MO

RECEIVED
OCT 26 1999

Supplier:	Sanders Company
Manufacturer: Pump	Fairbanks Morse Pump Corporation 3601 Fairbanks Ave. Kansas City, Kansas 66106-0906 (913) 371-5000
Fairbanks Morse Project Number:	062903
Service:	High Service Pumps – P-1, P-2, P-3, and P-4
Quantity:	4
Pump Size & Model:	19C 7100AW,
Motor:	U S Electrical Motors P. O. Box 2345 St. Louis, MO 66112 (913) 894-8736

SANDERS CO., PLUMBING AND HEATING, INC.
5201 BLUE PARKWAY
KANSAS CITY, MO 64130
THIS SUBMITTAL HAS BEEN CHECKED AS FOLLOWS:
☐ APPROVED ☐ APPROVED AS NOTED
☐ REVISE & RESUBMIT ☐ REJECTED
BY [signature]
SUBMITTAL NUMBER 332.609

APPROVED [ ]
APPROVED AS CORRECTED [X]
REVISE AND RESUBMIT [ ]
NOT APPROVED [ ]

Approval is only for conformance with the design concept of the project and compliance with the information given in the Contract Documents. Contractor is responsible for dimensions to be confirmed and correlated at the job site; for information that pertains solely to the fabrication processes or to techniques or construction; and for coordination of the work of all trades.

BARTLETT & WEST ENGINEERS INC.
Nov 8/99
Date
[signature]

GUARENTEED VALUES @ MAXIMUM RPM (1770)

PUMP CAPACITY (GPM)	TOTAL HEAD (FT)	MIN PUMP EFFICIENCIES (%)
3000	280	63 %
4000	250	75 %
5000	220	81 %
6000	180	81 %
7000	135	72%

Fairbanks Morse Pump
A Member of Pentair Pump Group

See Previous Page For Guaranteed Values!

SUBMITTAL CURVE

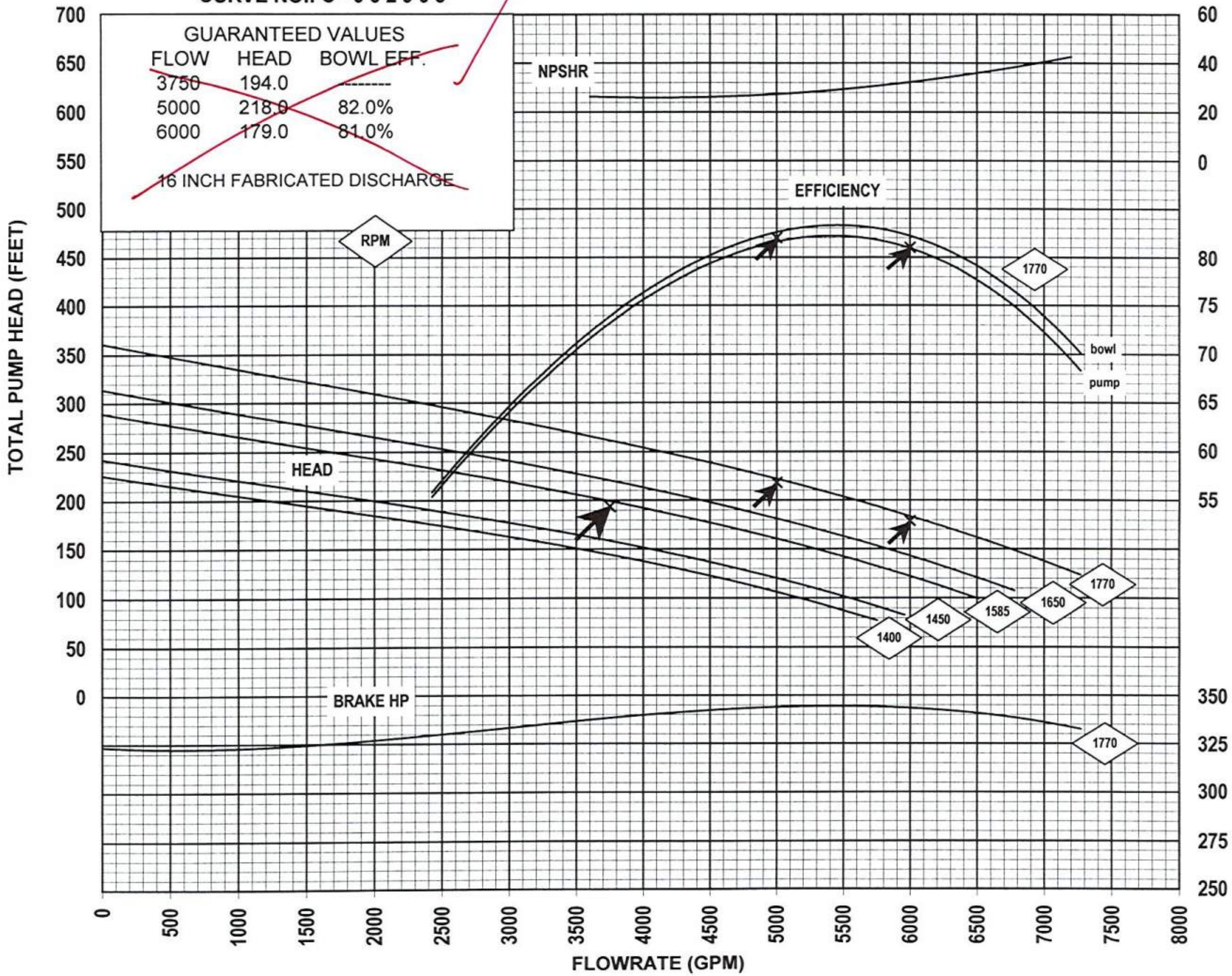
THIS CURVE IS BASED ON ACTUAL TEST PERFORMANCE OF A SIMILAR PUMP. ONLY THOSE CONDITIONS MARKED BY A SOLID ARROW ARE GUARANTEED

CURVE NO.: C - 0 6 2 9 0 3

GUARANTEED VALUES

FLOW	HEAD	BOWL EFF.
3750	194.0	--------
5000	218.0	82.0%
6000	179.0	81.0%

16 INCH FABRICATED DISCHARGE



DRIVER:
350 HP
w/ VFD

MODEL:
19C - 7100AW

IMPELLER:
A & B

STAGES:
TWO

SPEED:
1770 RPM

DIAMETER:
13.30" / 13.85"
(R2)

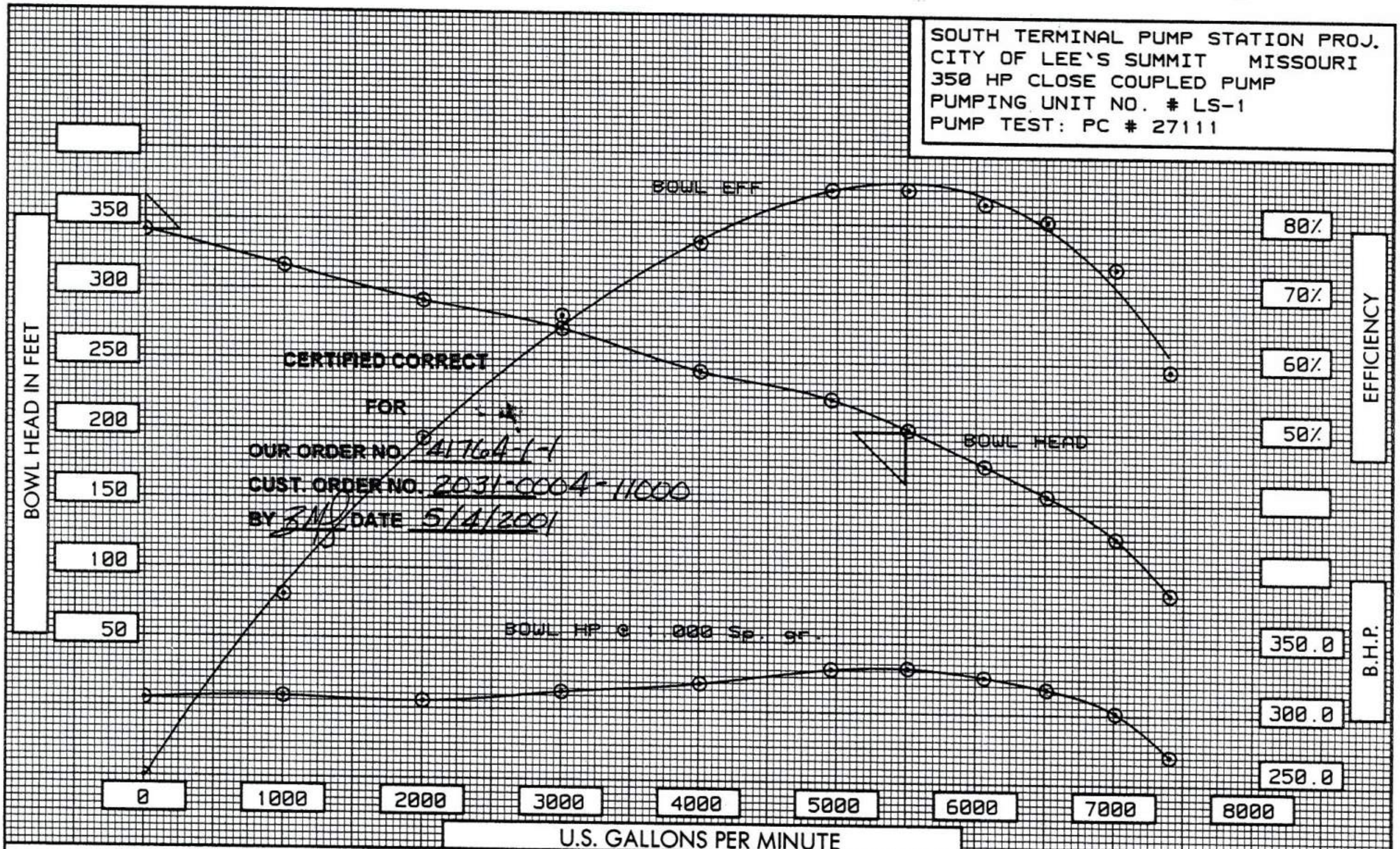
COLUMN:
16" x 31.25'

DATE:
22-OCT-99

PLOTTED BY:
M R N

REFERENCE:
ASCU

SOUTH TERMINAL PUMP STATION PROJ.
CITY OF LEE'S SUMMIT MISSOURI
350 HP CLOSE COUPLED PUMP
PUMPING UNIT NO. # LS-1
PUMP TEST: PC # 27111



FOLEY COMPANY
7501 FRONT STREET
KANSAS CITY MO 64120

DWG. NO. 41764-1-1-T1

FLOWAY PUMPS
FRESNO, CALIFORNIA
A WEIR COMPANY

TYPE 19 FKM
NO. OF STAGES 2
R.P.M. 1785
PUMP SERIAL NO. 41764-1-1

DWN. BY B.M.S. DATE 05/04/2001

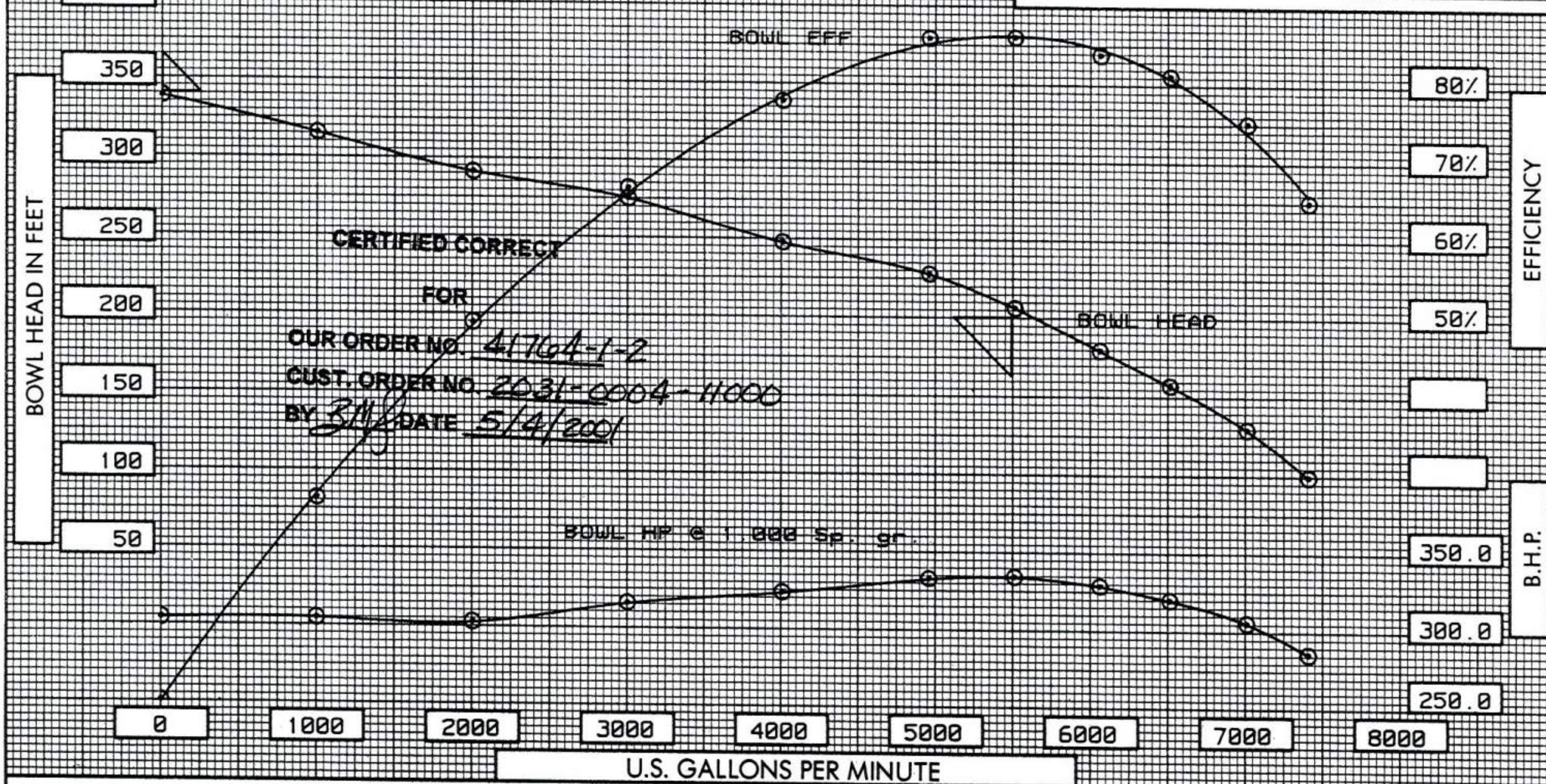
PF-614

TEST NUMBER PC#: 27111 S.O. # : 41764-1-1 DATE: 05/04/2001
CONDITION POINT: GPM= 5500 TDH= 200 RPM =1785
CALCULATED BY: B.M.S. DRAWING No. = 41764-1-1-T1
PUMP TYPE (Bb$): 19 FKM
[illegible]OMETER CONSTANT (Mc) = 1.0060 IMPELLER TRIM DIA. = 11.300 inch
GAGE HEIGHT (Ght) = 5.060 IMPELLER FINAL DIA. = 11.300 inch
NUMBER OF STAGES(Stages) = 2 NUMBER OF STAGES TESTED (Ds) = 2
SPECIFIC GRAVITY (SPG) = 1.0000
WATER TEMPERATURE = 65 DEGREES (F) SPECIFIC WEIGHT = 62.324 Lbs/Cu Ft.
COLUMN SIZE = 16
MOTOR NUMBER (Mno) = 13

RUN	RPM	GPM	PRESS	GA COR	S LOSS	C-LOS	DH-LOS	VEL HD	HP RDG.	B LOS
1	1789	0.0	145.80	0.00	0.00	0.00	0.00	0.00	328.80	0.00
2	1789	1000.0	134.90	0.00	0.00	0.00	0.00	0.05	330.90	0.00
3	1789	2000.0	124.20	0.00	0.00	0.00	0.00	0.19	328.00	0.00
4	1789	3000.0	115.70	0.00	0.00	0.00	0.00	0.44	335.80	0.00
5	1788	4000.0	102.60	-0.13	0.00	0.00	0.00	0.78	342.40	0.00
6	1788	4950.0	94.10	-0.26	0.00	0.00	0.00	1.19	354.10	0.00
7	1788	5500.0	84.90	-0.45	0.00	0.00	0.00	1.47	355.20	0.00
8	1788	6050.0	73.30	-0.10	0.00	0.00	0.00	1.78	348.80	0.00
9	1788	6500.0	64.00	-0.10	0.00	0.00	0.00	2.05	340.10	0.00
10	1789	7000.0	50.90	-0.01	0.00	0.00	0.00	2.38	323.40	0.00
11	1791	7400.0	33.60	-0.06	0.00	0.00	0.00	2.66	291.70	0.00

I	RPM	GPM	TDH	TDH/STAGE	BHP	BHP/STAGE	EFF	MTR EFF
1	1785	0.0	340.40	170.20	305.32	152.66	0.00	0.9348
[illegible]	1785	1003.8	315.38	157.69	307.31	153.66	26.01	0.9350
[illegible]	1785	2007.5	290.91	145.46	304.56	152.28	48.42	0.9348
4	1785	3011.3	271.60	135.80	311.96	155.98	66.20	0.9353
5	1785	4017.2	241.78	120.89	318.76	159.38	76.95	0.9357
6	1785	4971.3	222.32	111.16	329.89	164.95	84.60	0.9363
7	1785	5523.7	200.98	100.49	330.94	165.47	84.71	0.9364
8	1785	6076.1	175.38	87.69	324.85	162.42	82.84	0.9360
9	1785	6528.0	154.24	77.12	316.57	158.29	80.32	0.9355
10	1785	7026.3	124.46	62.23	300.20	150.10	73.56	0.9345
11	1785	7419.5	84.64	42.32	269.33	134.66	58.88	0.9326

SOUTH TERMINAL PUMP STATION PROJ.
CITY OF LEE'S SUMMIT MISSOURI
350 HP CLOSE COUPLED PUMP
PUMPING UNIT NO. # LS-2
PUMP TEST: PC # 27118



FOLEY COMPANY
7501 FRONT STREET
KANSAS CITY MO 64120

DWG. NO. 41764-1-2-T1

FLOWAY PUMPS
FRESNO, CALIFORNIA
A WEIR COMPANY

TYPE 19 FKM
NO. OF STAGES 2
R.P.M. 1785
PUMP SERIAL NO. 41764-1-2

DWN. BY B.M.S. DATE 05/04/2001

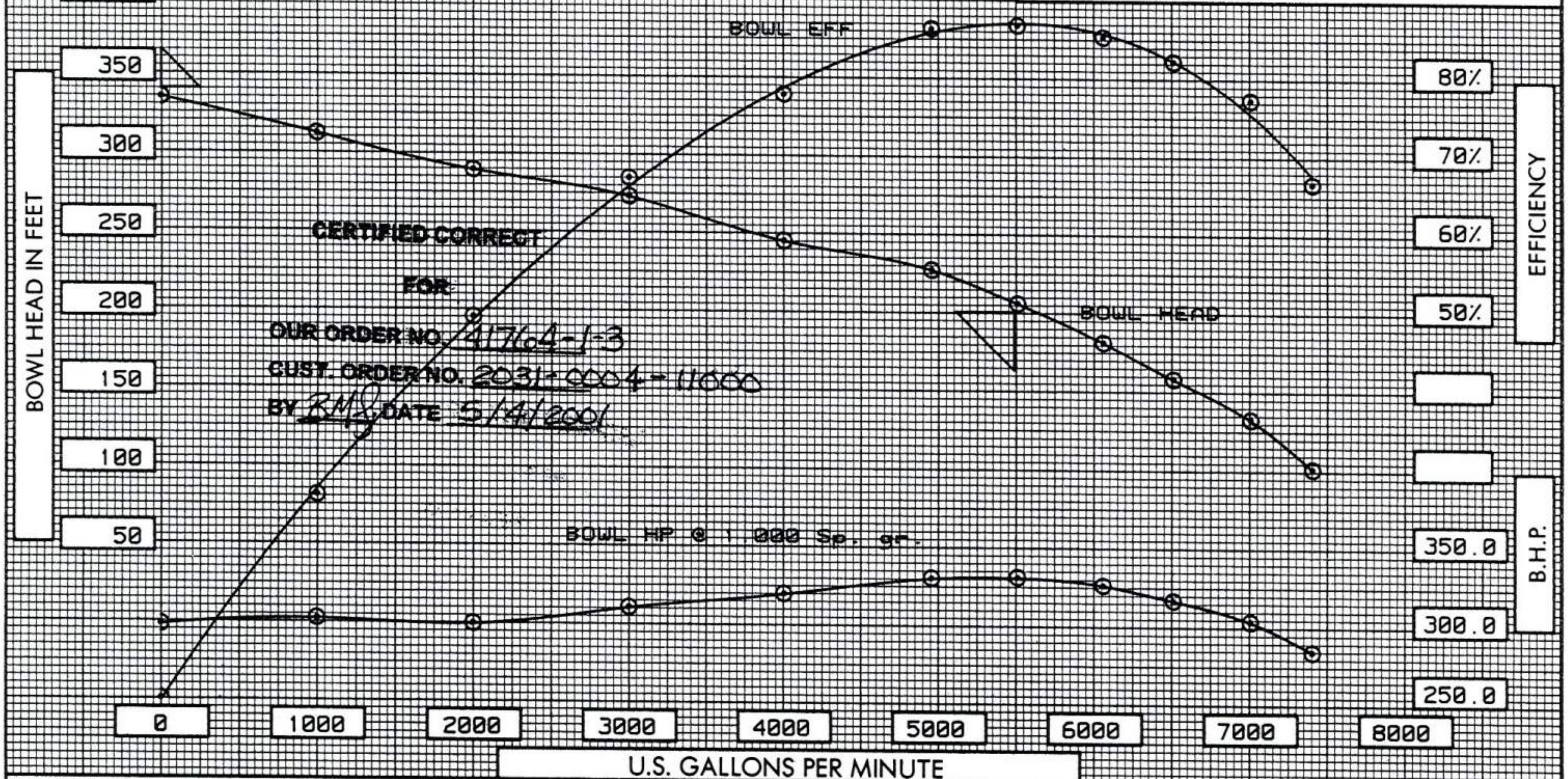
PF-614

TEST NUMBER PC#: 27118 S.O. # : 41764-1-2 DATE: 05/04/2001
CONDITION POINT: GPM= 5500 TDH= 200 RPM =1785
CALCULATED BY: B.M.S. DRAWING No. = 41764-1-2-T1
PUMP TYPE (Bb$): 19 FKM
[illegible]OMETER CONSTANT (Mc) = 1.0060 IMPELLER TRIM DIA. = 11.300 inch
GAGE HEIGHT (Ght) = 5.110 IMPELLER FINAL DIA. = 11.300 inch
NUMBER OF STAGES(Stages) = 2 NUMBER OF STAGES TESTED (Ds) = 2
SPECIFIC GRAVITY (SPG) = 1.0000
WATER TEMPERATURE = 65 DEGREES (F) SPECIFIC WEIGHT = 62.324 Lbs/Cu Ft.
COLUMN SIZE = 16
MOTOR NUMBER (Mno) = 13

RUN	RPM	GPM	PRESS	GA COR	S LOSS	C-LOS	DH-LOS	VEL HD	HP RDG.	B LOS
1	1789	0.0	144.60	0.00	0.00	0.00	0.00	0.00	326.70	0.00
2	1789	1000.0	134.50	0.00	0.00	0.00	0.00	0.05	327.30	0.00
3	1789	2000.0	123.90	0.00	0.00	0.00	0.00	0.19	325.20	0.00
4	1789	3000.0	116.80	0.00	0.00	0.00	0.00	0.44	339.00	0.00
5	1788	4000.0	104.70	-0.10	0.00	0.00	0.00	0.78	346.60	0.00
6	1788	4950.0	96.00	-0.23	0.00	0.00	0.00	1.19	356.70	0.00
7	1788	5500.0	86.80	-0.41	0.00	0.00	0.00	1.47	358.20	0.00
8	1788	6050.0	74.80	-0.10	0.00	0.00	0.00	1.78	352.20	0.00
9	1788	6500.0	65.10	-0.10	0.00	0.00	0.00	2.05	342.80	0.00
10	1789	7000.0	52.80	-0.03	0.00	0.00	0.00	2.38	328.40	0.00
11	1790	7400.0	39.60	0.00	0.00	0.00	0.00	2.66	308.10	0.00

I	RPM	GPM	TDH	TDH/STAGE	BHP	BHP/STAGE	EFF	MTR EFF
1	1785	0.0	337.69	168.85	303.33	151.67	0.00	0.9347
[illegible]	1785	1003.8	314.51	157.26	303.90	151.95	26.23	0.9348
[illegible]	1785	2007.5	290.27	145.14	301.91	150.95	48.74	0.9346
4	1785	3011.3	274.18	137.09	315.00	157.50	66.19	0.9355
5	1785	4017.2	246.74	123.37	322.75	161.38	77.55	0.9359
6	1785	4971.3	226.81	113.41	332.37	166.19	85.67	0.9365
7	1785	5523.7	205.49	102.75	333.80	166.90	85.87	0.9366
8	1785	6076.1	178.88	89.44	328.08	164.04	83.66	0.9362
9	1785	6528.0	156.82	78.41	319.14	159.57	81.00	0.9357
10	1785	7026.3	128.84	64.42	304.94	152.47	74.96	0.9348
11	1785	7423.6	98.71	49.36	285.24	142.62	64.87	0.9336

SOUTH TERMINAL PUMP STATION PROJ.
CITY OF LEE'S SUMMIT MISSOURI
350 HP CLOSE COUPLED PUMP
PUMPING UNIT NO. # LS-3
PUMP TEST: PC # 27120



FOLEY COMPANY
7501 FRONT STREET
KANSAS CITY MO 64120

DWG. NO. 41764-1-3-T1

FLOWAY PUMPS
FRESNO, CALIFORNIA
A WEIR COMPANY

TYPE 19 FKM
NO. OF STAGES 2
R.P.M. 1785
PUMP SERIAL NO. 41764-1-3

DWN. BY B.M.S. DATE 05/04/2001

PF-614

TEST NUMBER PC#: 27120 S.O. # : 41764-1-3 DATE: 05/04/2001
CONDITION POINT: GPM= 5500 TDH= 200 RPM =1785
CALCULATED BY: B.M.S. DRAWING No. = 41764-1-3-T1
PUMP TYPE (Bb$): 19 FKM
[illegible]OMETER CONSTANT (Mc) = 1.0060
[illegible]GE HEIGHT (Ght) = 5.110
NUMBER OF STAGES(Stages) = 2
SPECIFIC GRAVITY (SPG) = 1.0000
WATER TEMPERATURE = 65 DEGREES (F)
COLUMN SIZE = 16
MOTOR NUMBER (Mno) = 13

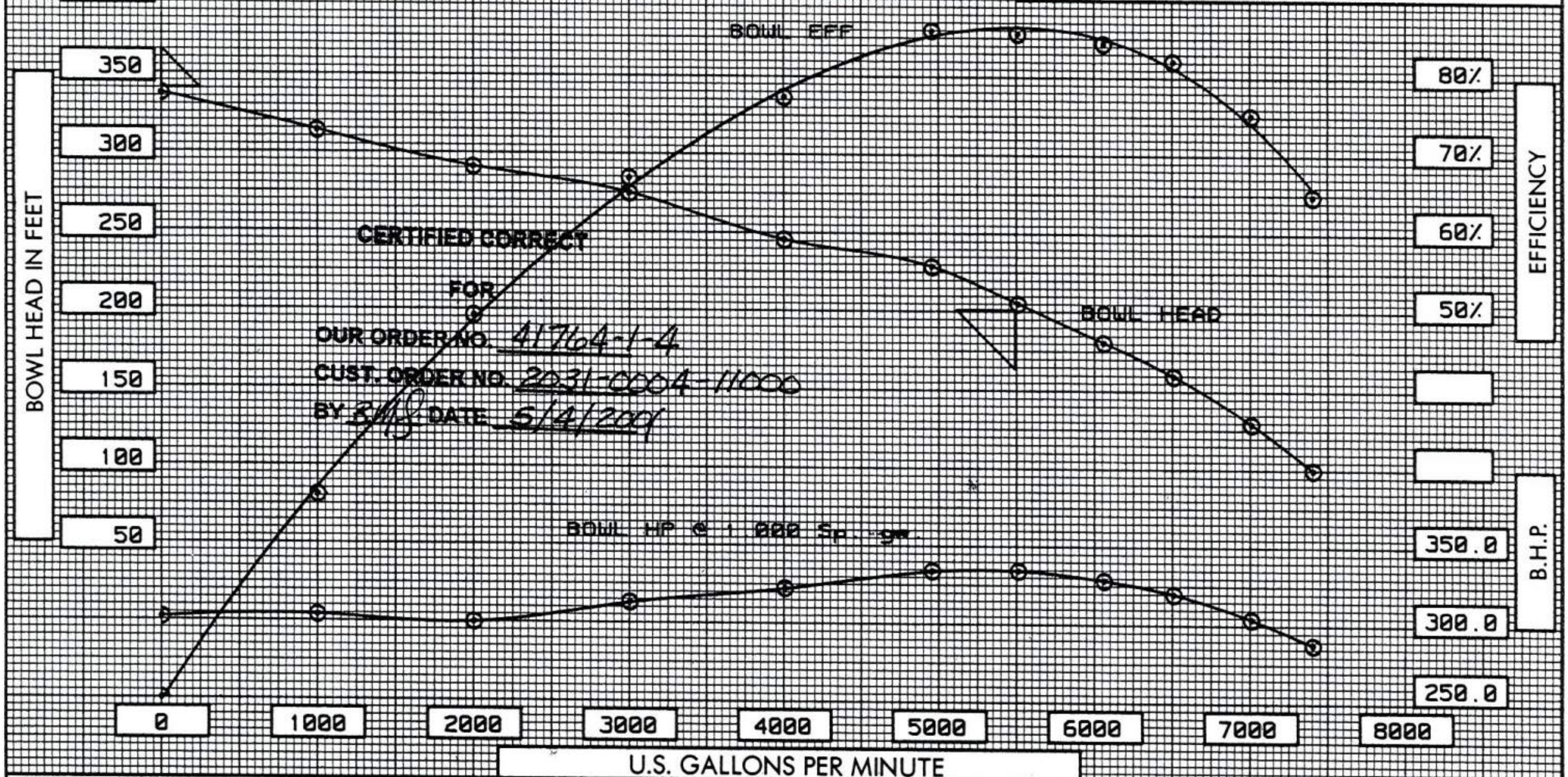
IMPELLER TRIM DIA. = 11.300 inch
IMPELLER FINAL DIA. = 11.300 inch
NUMBER OF STAGES TESTED (Ds) = 2

SPECIFIC WEIGHT = 62.324 Lbs/Cu Ft.

RUN	RPM	GPM	PRESS	GA COR	S LOSS	C-LOS	DH-LOS	VEL HD	HP RDG.	B LOS
1	1790	0.0	143.20	0.00	0.00	0.00	0.00	0.00	321.30	0.00
2	1790	1000.0	133.20	0.00	0.00	0.00	0.00	0.05	325.70	0.00
3	1790	2000.0	123.30	0.00	0.00	0.00	0.00	0.19	322.60	0.00
4	1789	3000.0	115.90	0.00	0.00	0.00	0.00	0.44	333.50	0.00
5	1789	4000.0	103.70	-0.11	0.00	0.00	0.00	0.78	343.30	0.00
6	1788	4950.0	95.70	-0.24	0.00	0.00	0.00	1.19	353.80	0.00
7	1788	5500.0	86.60	-0.42	0.00	0.00	0.00	1.47	354.60	0.00
8	1788	6050.0	75.50	-0.10	0.00	0.00	0.00	1.78	349.40	0.00
9	1788	6500.0	65.20	-0.10	0.00	0.00	0.00	2.05	339.30	0.00
10	1789	7000.0	53.90	-0.04	0.00	0.00	0.00	2.38	325.80	0.00
11	1790	7400.0	40.30	0.00	0.00	0.00	0.00	2.66	306.10	0.00

I	RPM	GPM	TDH	TDH/STAGE	BHP	BHP/STAGE	EFF	MTR EFF
1	1785	0.0	334.10	167.05	297.71	148.86	0.00	0.9344
2	1785	1003.2	311.17	155.59	301.88	150.94	26.11	0.9347
[illegible]	1785	2006.4	288.57	144.29	298.94	149.47	48.91	0.9345
4	1785	3011.3	272.11	136.06	309.78	154.89	66.80	0.9351
5	1785	4015.0	244.14	122.07	319.08	159.54	77.58	0.9357
6	1785	4971.3	226.10	113.05	329.61	164.80	86.12	0.9363
7	1785	5523.7	205.01	102.50	330.37	165.19	86.56	0.9364
8	1785	6076.1	180.49	90.25	325.42	162.71	85.10	0.9361
9	1785	6528.0	157.05	78.52	315.81	157.90	81.98	0.9355
10	1785	7026.3	131.35	65.67	302.48	151.24	77.05	0.9347
11	1785	7423.6	100.32	50.16	283.36	141.68	66.37	0.9335

SOUTH TERMINAL PUMP STATION PROJ.
CITY OF LEE'S SUMMIT MISSOURI
350 HP CLOSE COUPLED PUMP
PUMPING UNIT NO. # LS-4
PUMP TEST: PC # 27121



FOLEY COMPANY
7501 FRONT STREET
KANSAS CITY MO 64120

DWG. NO. 41764-1-4-T1

FLOWAY PUMPS
FRESNO, CALIFORNIA
A WEIR COMPANY

TYPE 19 FKM
NO. OF STAGES 2
R.P.M. 1785
PUMP SERIAL NO. 41764-1-4

DWN. BY B.M.S. DATE 05/04/2001

PF-614

TEST NUMBER PC#: 27121 S.O. # : 41764-1-4 DATE: 05/04/2001
CONDITION POINT: GPM= 5500 TDH= 200 RPM =1785
CALCULATED BY: B.M.S. DRAWING No. = 41764-1-4-T1
PUMP TYPE (Bb$): 19 FKM
[illegible]OMETER CONSTANT (Mc) = 1.0060 IMPELLER TRIM DIA. = 11.300 inch
GAGE HEIGHT (Ght) = 5.110 IMPELLER FINAL DIA. = 11.300 inch
NUMBER OF STAGES(Stages) = 2 NUMBER OF STAGES TESTED (Ds) = 2
SPECIFIC GRAVITY (SPG) = 1.0000
WATER TEMPERATURE = 65 DEGREES (F) SPECIFIC WEIGHT = 62.324 Lbs/Cu Ft.
COLUMN SIZE = 16
MOTOR NUMBER (Mno) = 13

RUN	RPM	GPM	PRESS	GA COR	S LOSS	C-LOS	DH-LOS	VEL HD	HP RDG.	B LOS
1	1790	0.0	144.30	0.00	0.00	0.00	0.00	0.00	325.50	0.00
2	1790	1000.0	134.00	0.00	0.00	0.00	0.00	0.05	327.30	0.00
3	1790	2000.0	124.00	0.00	0.00	0.00	0.00	0.19	322.90	0.00
4	1789	3000.0	116.60	0.00	0.00	0.00	0.00	0.44	336.10	0.00
5	1789	4000.0	103.90	-0.11	0.00	0.00	0.00	0.78	345.90	0.00
6	1788	4950.0	96.20	-0.22	0.00	0.00	0.00	1.19	357.40	0.00
7	1788	5500.0	86.10	-0.42	0.00	0.00	0.00	1.47	357.70	0.00
8	1788	6050.0	75.00	-0.10	0.00	0.00	0.00	1.78	351.30	0.00
9	1789	6500.0	65.80	-0.10	0.00	0.00	0.00	2.05	342.80	0.00
10	1789	7000.0	52.30	-0.02	0.00	0.00	0.00	2.38	325.90	0.00
11	1790	7400.0	39.50	-0.01	0.00	0.00	0.00	2.66	309.10	0.00

I	RPM	GPM	TDH	TDH/STAGE	BHP	BHP/STAGE	EFF	MTR EFF
1	1785	0.0	336.63	168.31	301.69	150.84	0.00	0.9347
[illegible]	1785	1003.2	313.01	156.51	303.39	151.69	26.14	0.9348
[illegible]	1785	2006.4	290.18	145.09	299.23	149.61	49.13	0.9345
4	1785	3011.3	273.72	136.86	312.24	156.12	66.66	0.9353
5	1785	4015.0	244.60	122.30	321.55	160.77	77.13	0.9359
6	1785	4971.3	227.30	113.65	333.04	166.52	85.68	0.9365
7	1785	5523.7	203.86	101.93	333.32	166.66	85.31	0.9366
8	1785	6076.1	179.34	89.67	327.23	163.61	84.09	0.9362
9	1785	6524.4	158.25	79.13	318.60	159.30	81.84	0.9357
10	1785	7026.3	127.71	63.86	302.57	151.29	74.89	0.9347
11	1785	7423.6	98.46	49.23	286.19	143.09	64.50	0.9337

APPENDIX B ISO REPORT

ISO
1000 Bishops Gate Blvd. Ste 300
Mt. Laurel, NJ 08054-5404

t1.800.444.4554 Opt.2
f1.800.777.3929

February 27, 2017

Mr. Randy Rhoads, Mayor
Lees Summit FPSA
220 SE Green St
Lee's Summit, Missouri, 64063

RE: Lees Summit Fpsa, Cass, Jackson Counties, Missouri
Public Protection Classification: 02/2X
Effective Date: June 01, 2017

Dear Mr. Randy Rhoads,

We wish to thank you Mr. Mark Schaufler and Chief Rick Poeschl for your cooperation during our recent Public Protection Classification (PPC) survey. ISO has completed its analysis of the structural fire suppression delivery system provided in your community. The resulting classification is indicated above.

If you would like to know more about your community's PPC classification, or if you would like to learn about the potential effect of proposed changes to your fire suppression delivery system, please call us at the phone number listed below.

ISO's Public Protection Classification Program (PPC) plays an important role in the underwriting process at insurance companies. In fact, most U.S. insurers – including the largest ones – use PPC information as part of their decision- making when deciding what business to write, coverage's to offer or prices to charge for personal or commercial property insurance.

Each insurance company independently determines the premiums it charges its policyholders. The way an insurer uses ISO's information on public fire protection may depend on several things – the company's fire-loss experience, ratemaking methodology, underwriting guidelines, and its marketing strategy.

Through ongoing research and loss experience analysis, we identified additional differentiation in fire loss experience within our PPC program, which resulted in the revised classifications. We based the differing fire loss experience on the fire suppression capabilities of each community. The new classifications will improve the predictive value for insurers while benefiting both commercial and residential property owners. We've published the new classifications as "X" and "Y" — formerly the "9" and "8B" portion of the split classification, respectively. For example:

- A community currently graded as a split 6/9 classification will now be a split 6/6X classification; with the "6X" denoting what was formerly classified as "9."
- Similarly, a community currently graded as a split 6/8B classification will now be a split 6/6Y classification, the "6Y" denoting what was formerly classified as "8B."

- Communities graded with single "9" or "8B" classifications will remain intact.
- Properties over 5 road miles from a recognized fire station would receive a class 10.

PPC is important to communities and fire departments as well. Communities whose PPC improves may get lower insurance prices. PPC also provides fire departments with a valuable benchmark, and is used by many departments as a valuable tool when planning, budgeting and justifying fire protection improvements.

ISO appreciates the high level of cooperation extended by local officials during the entire PPC survey process. The community protection baseline information gathered by ISO is an essential foundation upon which determination of the relative level of fire protection is made using the Fire Suppression Rating Schedule.

The classification is a direct result of the information gathered, and is dependent on the resource levels devoted to fire protection in existence at the time of survey. Material changes in those resources that occur after the survey is completed may affect the classification. Although ISO maintains a pro-active process to keep baseline information as current as possible, in the event of changes please call us at 1-800-444-4554, option 2 to expedite the update activity.

ISO is the leading supplier of data and analytics for the property/casualty insurance industry. Most insurers use PPC classifications for underwriting and calculating premiums for residential, commercial and industrial properties. The PPC program is not intended to analyze all aspects of a comprehensive structural fire suppression delivery system program. It is not for purposes of determining compliance with any state or local law, nor is it for making loss prevention or life safety recommendations.

If you have any questions about your classification, please let us know.

Sincerely,

Dominic Santanna

Dominic Santanna
Manager -National Processing Center

cc: Ms. Vickie McLaughlin, Manager, Jackson County PWSD 12
Mr. Mark Schaufler, Director, Lees Summit Water Dept
Mr. John Johnson, Manager, Unity Village Water Department
Ms. Kim Harris, Communications Supervisor, Lees Summit Fire Dispatch
Chief Rick Poeschl, Chief, Lees Summit Fire Department
Chief Jim Eden, Assistant Chief, Lees Summit Fire Department

Public Protection Classification

(PPC™)

Summary Report

Lees Summit FPSA

MISSOURI

Prepared by

Insurance Services Office, Inc.
1000 Bishops Gate Blvd., Ste. 300
P.O. Box 5404
Mt. Laurel, New Jersey 08054-5404
1-800-444-4554

Report Created February 2017

Effective June 1, 2017

Background Information

Introduction

ISO collects and evaluates information from communities in the United States on their structure fire suppression capabilities. The data is analyzed using our Fire Suppression Rating Schedule (FSRS) and then a Public Protection Classification (PPC™) grade is assigned to the community. The surveys are conducted whenever it appears that there is a possibility of a PPC change. As such, the PPC program provides important, up-to-date information about fire protection services throughout the country.

The FSRS recognizes fire protection features only as they relate to suppression of first alarm structure fires. In many communities, fire suppression may be only a small part of the fire department's overall responsibility. ISO recognizes the dynamic and comprehensive duties of a community's fire service, and understands the complex decisions a community must make in planning and delivering emergency services. However, in developing a community's PPC grade, only features related to reducing property losses from structural fires are evaluated. Multiple alarms, simultaneous incidents and life safety are not considered in this evaluation. The PPC program evaluates the fire protection for small to average size buildings. Specific properties with a Needed Fire Flow in excess of 3,500 gpm are evaluated separately and assigned an individual PPC grade.

A community's investment in fire mitigation is a proven and reliable predictor of future fire losses. Statistical data on insurance losses bears out the relationship between excellent fire protection – as measured by the PPC program – and low fire losses. So, insurance companies use PPC information for marketing, underwriting, and to help establish fair premiums for homeowners and commercial fire insurance. In general, the price of fire insurance in a community with a good PPC grade is substantially lower than in a community with a poor PPC grade, assuming all other factors are equal.

ISO is an independent company that serves insurance companies, communities, fire departments, insurance regulators, and others by providing information about risk. ISO's expert staff collects information about municipal fire suppression efforts in communities throughout the United States. In each of those communities, ISO analyzes the relevant data and assigns a PPC grade – a number from 1 to 10. Class 1 represents an exemplary fire suppression program, and Class 10 indicates that the area's fire suppression program does not meet ISO's minimum criteria.

ISO's PPC program evaluates communities according to a uniform set of criteria, incorporating nationally recognized standards developed by the National Fire Protection Association and the American Water Works Association. A community's PPC grade depends on:

- **Needed Fire Flows**, which are representative building locations used to determine the theoretical amount of water necessary for fire suppression purposes.
- **Emergency Communications**, including emergency reporting, telecommunicators, and dispatching systems.
- **Fire Department**, including equipment, staffing, training, geographic distribution of fire companies, operational considerations, and community risk reduction.
- **Water Supply**, including inspection and flow testing of hydrants, alternative water supply operations, and a careful evaluation of the amount of available water compared with the amount needed to suppress fires up to 3,500 gpm.

Data Collection and Analysis

ISO has evaluated and classified over 48,000 fire protection areas across the United States using its FSRS. A combination of meetings between trained ISO field representatives and the dispatch center coordinator, community fire official, and water superintendent is used in conjunction with a comprehensive questionnaire to collect the data necessary to determine the PPC grade. In order for a community to obtain a grade better than a Class 9, three elements of fire suppression features are reviewed. These three elements are Emergency Communications, Fire Department, and Water Supply.

A review of the **Emergency Communications** accounts for 10% of the total classification. This section is weighted at **10 points,** as follows:

- Emergency Reporting 3 points
- Telecommunicators 4 points
- Dispatch Circuits 3 points

A review of the **Fire Department** accounts for 50% of the total classification. ISO focuses on a fire department's first alarm response and initial attack to minimize potential loss. The fire department section is weighted at **50 points,** as follows:

- Engine Companies 6 points
- Reserve Pumpers 0.5 points
- Pump Capacity 3 points
- Ladder/Service Companies 4 points
- Reserve Ladder/Service Trucks 0.5 points
- Deployment Analysis 10 points
- Company Personnel 15 points
- Training 9 points
- Operational considerations 2 points
- Community Risk Reduction 5.5 points (in addition to the 50 points above)

A review of the **Water Supply** system accounts for 40% of the total classification. ISO reviews the water supply a community uses to determine the adequacy for fire suppression purposes. The water supply system is weighted at **40 points,** as follows:

- Credit for Supply System 30 points
- Hydrant Size, Type & Installation 3 points
- Inspection & Flow Testing of Hydrants 7 points

There is one additional factor considered in calculating the final score – **Divergence**.

Even the best fire department will be less than fully effective if it has an inadequate water supply. Similarly, even a superior water supply will be less than fully effective if the fire department lacks the equipment or personnel to use the water. The FSRS score is subject to modification by a divergence factor, which recognizes disparity between the effectiveness of the fire department and the water supply.

The Divergence factor mathematically reduces the score based upon the relative difference between the fire department and water supply scores. The factor is introduced in the final equation.

PPC Grade

The PPC grade assigned to the community will depend on the community's score on a 100-point scale:

PPC	Points
1	90.00 or more
2	80.00 to 89.99
3	70.00 to 79.99
4	60.00 to 69.99
5	50.00 to 59.99
6	40.00 to 49.99
7	30.00 to 39.99
8	20.00 to 29.99
9	10.00 to 19.99
10	0.00 to 9.99

The classification numbers are interpreted as follows:

- Class 1 through (and including) Class 8 represents a fire suppression system that includes an FSRS creditable dispatch center, fire department, and water supply.
- Class 8B is a special classification that recognizes a superior level of fire protection in otherwise Class 9 areas. It is designed to represent a fire protection delivery system that is superior except for a lack of a water supply system capable of the minimum FSRS fire flow criteria of 250 gpm for 2 hours.
- Class 9 is a fire suppression system that includes a creditable dispatch center, fire department but no FSRS creditable water supply.
- Class 10 does not meet minimum FSRS criteria for recognition, including areas that are beyond five road miles of a recognized fire station.

New PPC program changes effective July 1, 2014

We have revised the PPC program to capture the effects of enhanced fire protection capabilities that reduce fire loss and fire severity in Split Class 9 and Split Class 8B areas (as outlined below). This new structure benefits the fire service, community, and property owner.

New classifications

Through ongoing research and loss experience analysis, we identified additional differentiation in fire loss experience within our PPC program, which resulted in the revised classifications. We based the differing fire loss experience on the fire suppression capabilities of each community. The new PPC classes will improve the predictive value for insurers while benefiting both commercial and residential property owners. Here are the new classifications and what they mean.

Split classifications

When we develop a split classification for a community — for example 5/9 — the first number is the class that applies to properties within 5 road miles of the responding fire station and 1,000 feet of a creditable water supply, such as a fire hydrant, suction point, or dry hydrant. The second number is the class that applies to properties within 5 road miles of a fire station but beyond 1,000 feet of a creditable water supply. We have revised the classification to reflect more precisely the risk of loss in a community, replacing Class 9 and 8B in the second part of a split classification with revised designations.

What's changed with the new classifications?

We've published the new classifications as "X" and "Y" — formerly the "9" and "8B" portion of the split classification, respectively. For example:

- A community currently displayed as a split 6/9 classification will now be a split 6/6X classification; with the "6X" denoting what was formerly classified as "9".
- Similarly, a community currently graded as a split 6/8B classification will now be a split 6/6Y classification, the "6Y" denoting what was formerly classified as "8B".
- Communities graded with single "9" or "8B" classifications will remain intact.

Prior Classification	New Classification
1/9	1/1X
2/9	2/2X
3/9	3/3X
4/9	4/4X
5/9	5/5X
6/9	6/6X
7/9	7/7X
8/9	8/8X
9	9

Prior Classification	New Classification
1/8B	1/1Y
2/8B	2/2Y
3/8B	3/3Y
4/8B	4/4Y
5/8B	5/5Y
6/8B	6/6Y
7/8B	7/7Y
8/8B	8/8Y
8B	8B

What's changed?
As you can see, we're still maintaining split classes, but it's how we represent them to insurers that's changed. The new designations reflect a reduction in fire severity and loss and have the potential to reduce property insurance premiums.

Benefits of the revised split class designations

- To the fire service, the revised designations identify enhanced fire suppression capabilities used throughout the fire protection area
- To the community, the new classes reward a community's fire suppression efforts by showing a more reflective designation
- To the individual property owner, the revisions offer the potential for decreased property insurance premiums

New water class
Our data also shows that risks located more than 5 but less than 7 road miles from a responding fire station with a creditable water source within 1,000 feet had better loss experience than those farther than 5 road miles from a responding fire station with no creditable water source. We've introduced a new classification —10W — to recognize the reduced loss potential of such properties.

What's changed with Class 10W?
Class 10W is property-specific. Not all properties in the 5-to-7-mile area around the responding fire station will qualify. The difference between Class 10 and 10W is that the 10W-graded risk or property is within 1,000 feet of a creditable water supply. Creditable water supplies include fire protection systems using hauled water in any of the split classification areas.

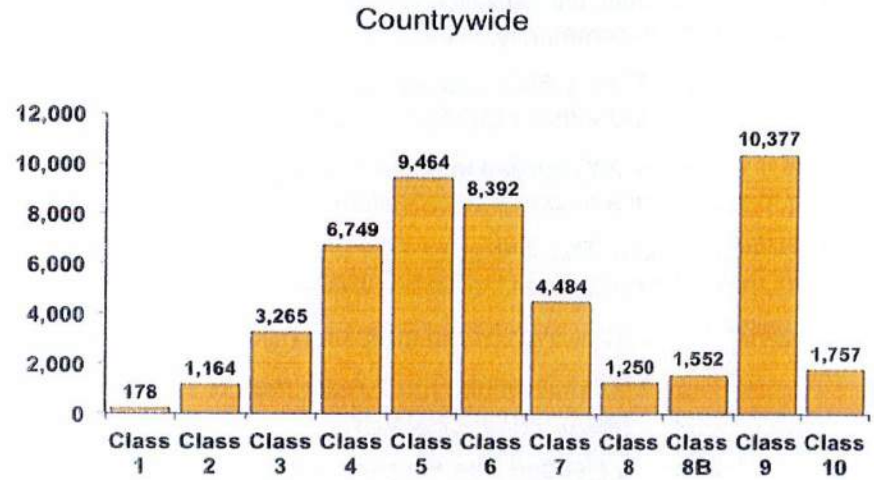
What's the benefit of Class 10W?
10W gives credit to risks within 5 to 7 road miles of the responding fire station and within 1,000 feet of a creditable water supply. That's reflective of the potential for reduced property insurance premiums.

What does the fire chief have to do?
Fire chiefs don't have to do anything at all. The revised classifications went in place automatically effective July 1, 2014 (July 1, 2015 for Texas).

What if I have additional questions?
Feel free to contact ISO at 800.444.4554 or email us at PPC-Cust-Serv@iso.com.

Distribution of PPC Grades

The 2016 published countrywide distribution of communities by the PPC grade is as follows:



Assistance

The PPC program offers help to communities, fire departments, and other public officials as they plan for, budget, and justify improvements. ISO is also available to assist in the understanding of the details of this evaluation.

The PPC program representatives can be reached by telephone at (800) 444-4554. The technical specialists at this telephone number have access to the details of this evaluation and can effectively speak with you about your questions regarding the PPC program. What's more, we can be reached via the internet at www.isomitigation.com/talk/.

We also have a website dedicated to our Community Hazard Mitigation Classification programs at www.isomitigation.com. Here, fire chiefs, building code officials, community leaders and other interested citizens can access a wealth of data describing the criteria used in evaluating how cities and towns are protecting residents from fire and other natural hazards. This website will allow you to learn more about the PPC program. The website provides important background information, insights about the PPC grading processes and technical documents. ISO is also pleased to offer Fire Chiefs Online — a special, secured website with information and features that can help improve your PPC grade, including a list of the Needed Fire Flows for all the commercial occupancies ISO has on file for your community. Visitors to the site can download information, see statistical results and also contact ISO for assistance.

In addition, on-line access to the FSRS and its commentaries is available to registered customers for a fee. However, fire chiefs and community chief administrative officials are given access privileges to this information without charge.

To become a registered fire chief or community chief administrative official, register at www.isomitigation.com.

PPC Review

ISO concluded its review of the fire suppression features being provided for Lees Summit FPSA. The resulting community classification is **Class 02/2X**.

If the classification is a single class, the classification applies to properties with a Needed Fire Flow of 3,500 gpm or less in the community. If the classification is a split class (e.g., 6/XX):

- The first class (e.g., "6" in a 6/XX) applies to properties within 5 road miles of a recognized fire station and within 1,000 feet of a fire hydrant or alternate water supply.
- The second class (XX or XY) applies to properties beyond 1,000 feet of a fire hydrant but within 5 road miles of a recognized fire station.
- Alternative Water Supply: The first class (e.g., "6" in a 6/10) applies to properties within 5 road miles of a recognized fire station with no hydrant distance requirement.
- Class 10 applies to properties over 5 road miles of a recognized fire station.
- Class 10W applies to properties within 5 to 7 road miles of a recognized fire station with a recognized water supply within 1,000 feet.
- Specific properties with a Needed Fire Flow in excess of 3,500 gpm are evaluated separately and assigned an individual classification.

FSRS Feature	Earned Credit	Credit Available
Emergency Communications		
414. Credit for Emergency Reporting	2.40	3
422. Credit for Telecommunicators	4.00	4
432. Credit for Dispatch Circuits	3.00	3
440. Credit for Emergency Communications	9.40	10
Fire Department		
513. Credit for Engine Companies	5.94	6
523. Credit for Reserve Pumpers	0.49	0.50
532. Credit for Pump Capacity	3.00	3
549. Credit for Ladder Service	0.86	4
553. Credit for Reserve Ladder and Service Trucks	0.17	0.50
561. Credit for Deployment Analysis	3.83	10
571. Credit for Company Personnel	9.56	15
581. Credit for Training	8.00	9
730. Credit for Operational Considerations	2.00	2
590. Credit for Fire Department	33.85	50
Water Supply		
616. Credit for Supply System	29.34	30
621. Credit for Hydrants	2.87	3
631. Credit for Inspection and Flow Testing	6.39	7
640. Credit for Water Supply	38.60	40
Divergence	-5.76	--
1050. Community Risk Reduction	4.45	5.50
Total Credit	80.54	105.50

Emergency Communications

Ten percent of a community's overall score is based on how well the communications center receives and dispatches fire alarms. Our field representative evaluated:

- Communications facilities provided for the general public to report structure fires
- Enhanced 9-1-1 Telephone Service including wireless
- Computer-aided dispatch (CAD) facilities
- Alarm receipt and processing at the communication center
- Training and certification of telecommunicators
- Facilities used to dispatch fire department companies to reported structure fires

	Earned Credit	Credit Available
414. Credit Emergency Reporting	2.40	3
422. Credit for Telecommunicators	4.00	4
432. Credit for Dispatch Circuits	3.00	3
Item 440. Credit for Emergency Communications:	9.40	10

Item 414 - Credit for Emergency Reporting (3 points)

The first item reviewed is Item 414 "Credit for Emergency Reporting (CER)". This item reviews the emergency communication center facilities provided for the public to report fires including 911 systems (Basic or Enhanced), Wireless Phase I and Phase II, Voice over Internet Protocol, Computer Aided Dispatch and Geographic Information Systems for automatic vehicle location. ISO uses National Fire Protection Association (NFPA) 1221, *Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems* as the reference for this section.

Item 410. Emergency Reporting (CER)	Earned Credit	Credit Available
A./B. Basic 9-1-1, Enhanced 9-1-1 or No 9-1-1 For maximum credit, there should be an Enhanced 9-1-1 system, Basic 9-1-1 and No 9-1-1 will receive partial credit.	20.00	20
1. E9-1-1 Wireless Wireless Phase I using Static ALI (automatic location identification) Functionality (10 points); Wireless Phase II using Dynamic ALI Functionality (15 points); Both available will be 25 points	25.00	25
2. E9-1-1 Voice over Internet Protocol (VoIP) Static VoIP using Static ALI Functionality (10 points); Nomadic VoIP using Dynamic ALI Functionality (15 points); Both available will be 25 points	25.00	25
3. Computer Aided Dispatch Basic CAD (5 points); CAD with Management Information System (5 points); CAD with Interoperability (5 points)	10.00	15
4. Geographic Information System (GIS/AVL) The PSAP uses a fully integrated CAD/GIS management system with automatic vehicle location (AVL) integrated with a CAD system providing dispatch assignments. * The individual fire departments being dispatched do not need GIS/AVL capability to obtain this credit.	0.00	15
Review of Emergency Reporting total:	80.00	100

Item 422- Credit for Telecommunicators (4 points)

The second item reviewed is Item 422 "Credit for Telecommunicators (TC)". This item reviews the number of Telecommunicators on duty at the center to handle fire calls and other emergencies. All emergency calls including those calls that do not require fire department action are reviewed to determine the proper staffing to answer emergency calls and dispatch the appropriate emergency response. NFPA 1221, *Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems,* recommends that ninety-five percent of emergency calls shall be answered within 15 seconds and ninety-nine percent of emergency calls shall be answered within 40 seconds. In addition, NFPA recommends that ninety percent of emergency alarm processing shall be completed within 60 seconds and ninety-nine percent of alarm processing shall be completed within 90 seconds of answering the call.

To receive full credit for operators on duty, ISO must review documentation to show that the communication center meets NFPA 1221 call answering and dispatch time performance measurement standards. This documentation may be in the form of performance statistics or other performance measurements compiled by the 9-1-1 software or other software programs that are currently in use such as Computer Aided Dispatch (CAD) or Management Information System (MIS).

Item 420. Telecommunicators (CTC)	**Earned Credit**	**Credit Available**
A1. Alarm Receipt (AR) Receipt of alarms shall meet the requirements in accordance with the criteria of NFPA 1221	**20.00**	**20**
A2. Alarm Processing (AP) Processing of alarms shall meet the requirements in accordance with the criteria of NFPA 1221	**20.00**	**20**
B. Emergency Dispatch Protocols (EDP) Telecommunicators have emergency dispatch protocols (EDP) containing questions and a decision-support process to facilitate correct call categorization and prioritization.	**20.00**	**20**
C. Telecommunicator Training and Certification (TTC) Telecommunicators meet the qualification requirements referenced in NFPA 1061, *Standard for Professional Qualifications for Public Safety Telecommunicator,* and/or the Association of Public-Safety Communications Officials - International (APCO) *Project 33.* Telecommunicators are certified in the knowledge, skills, and abilities corresponding to their job functions.	**20.00**	**20**
D. Telecommunicator Continuing Education and Quality Assurance (TQA) Telecommunicators participate in continuing education and/or in-service training and quality-assurance programs as appropriate for their positions	**20.00**	**20**
Review of Telecommunicators total:	**100.00**	**100**

Item 432 - Credit for Dispatch Circuits (3 points)

The third item reviewed is Item 432 "Credit for Dispatch Circuits (CDC)". This item reviews the dispatch circuit facilities used to transmit alarms to fire department members. A "Dispatch Circuit" is defined in NFPA 1221 as "A circuit over which an alarm is transmitted from the communications center to an emergency response facility (ERF) or emergency response units (ERUs) to notify ERUs to respond to an emergency". All fire departments (except single fire station departments with full-time firefighter personnel receiving alarms directly at the fire station) need adequate means of notifying all firefighter personnel of the location of reported structure fires. The dispatch circuit facilities should be in accordance with the general criteria of NFPA 1221. "Alarms" are defined in this Standard as "A signal or message from a person or device indicating the existence of an emergency or other situation that requires action by an emergency response agency".

There are two different levels of dispatch circuit facilities provided for in the Standard – a primary dispatch circuit and a secondary dispatch circuit. In jurisdictions that receive 730 alarms or more per year (average of two alarms per 24-hour period), two separate and dedicated dispatch circuits, a primary and a secondary, are needed. In jurisdictions receiving fewer than 730 alarms per year, a second dedicated dispatch circuit is not needed. Dispatch circuit facilities installed but not used or tested (in accordance with the NFPA Standard) receive no credit.

The score for Credit for Dispatch Circuits (CDC) is influenced by monitoring for integrity of the primary dispatch circuit. There are up to 0.90 points available for this Item. Monitoring for integrity involves installing automatic systems that will detect faults and failures and send visual and audible indications to appropriate communications center (or dispatch center) personnel. ISO uses NFPA 1221 to guide the evaluation of this item. ISO's evaluation also includes a review of the communication system's emergency power supplies.

Item 432 "Credit for Dispatch Circuits (CDC)" = 3.00 points

Fire Department

Fifty percent of a community's overall score is based upon the fire department's structure fire suppression system. ISO's field representative evaluated:

- Engine and ladder/service vehicles including reserve apparatus
- Equipment carried
- Response to reported structure fires
- Deployment analysis of companies
- Available and/or responding firefighters
- Training

	Earned Credit	Credit Available
513. Credit for Engine Companies	**5.94**	6
523. Credit for Reserve Pumpers	**0.49**	0.5
532. Credit for Pumper Capacity	**3.00**	3
549. Credit for Ladder Service	**0.86**	4
553. Credit for Reserve Ladder and Service Trucks	**0.17**	0.5
561. Credit for Deployment Analysis	**3.83**	10
571. Credit for Company Personnel	**9.56**	15
581. Credit for Training	**8.00**	9
730. Credit for Operational Considerations	**2.00**	2
Item 590. Credit for Fire Department:	**33.85**	**50**

Basic Fire Flow

The Basic Fire Flow for the community is determined by the review of the Needed Fire Flows for selected buildings in the community. The fifth largest Needed Fire Flow is determined to be the Basic Fire Flow. The Basic Fire Flow has been determined to be 3500 gpm.

Item 513 - Credit for Engine Companies (6 points)

The first item reviewed is Item 513 "Credit for Engine Companies (CEC)". This item reviews the number of engine companies, their pump capacity, hose testing, pump testing and the equipment carried on the in-service pumpers. To be recognized, pumper apparatus must meet the general criteria of NFPA 1901, *Standard for Automotive Fire Apparatus* which include a minimum 250 gpm pump, an emergency warning system, a 300 gallon water tank, and hose. At least 1 apparatus must have a permanently mounted pump rated at 750 gpm or more at 150 psi.

The review of the number of needed pumpers considers the response distance to built-upon areas; the Basic Fire Flow; and the method of operation. Multiple alarms, simultaneous incidents, and life safety are not considered.

The greatest value of A, B, or C below is needed in the fire district to suppress fires in structures with a Needed Fire Flow of 3,500 gpm or less: **7 engine companies**

a) **7 engine companies** to provide fire suppression services to areas to meet NFPA 1710 criteria or within 1½ miles.

b) **3 engine companies** to support a Basic Fire Flow of 3500 gpm.

c) **3 engine companies** based upon the fire department's method of operation to provide a minimum two engine response to all first alarm structure fires.

The FSRS recognizes that there are **7 engine companies** in service.

The FSRS also reviews Automatic Aid. Automatic Aid is considered in the review as assistance dispatched automatically by contractual agreement between two communities or fire districts. That differs from mutual aid or assistance arranged case by case. ISO will recognize an Automatic Aid plan under the following conditions:

- It must be prearranged for first alarm response according to a definite plan. It is preferable to have a written agreement, but ISO may recognize demonstrated performance.
- The aid must be dispatched to all reported structure fires on the initial alarm.
- The aid must be provided 24 hours a day, 365 days a year.

FSRS Item 512.D "Automatic Aid Engine Companies" responding on first alarm and meeting the needs of the city for basic fire flow and/or distribution of companies are factored based upon the value of the Automatic Aid plan (up to 1.00 can be used as the factor). The Automatic Aid factor is determined by a review of the Automatic Aid provider's communication facilities, how they receive alarms from the graded area, inter-department training between fire departments, and the fire ground communications capability between departments.

For each engine company, the credited Pump Capacity (PC), the Hose Carried (HC), the Equipment Carried (EC) all contribute to the calculation for the percent of credit the FSRS provides to that engine company.

Item 513 "Credit for Engine Companies (CEC)" = 5.94 points

Item 523 - Credit for Reserve Pumpers (0.50 points)

The item is Item 523 "Credit for Reserve Pumpers (CRP)". This item reviews the number and adequacy of the pumpers and their equipment. The number of needed reserve pumpers is 1 for each 8 needed engine companies determined in Item 513, or any fraction thereof.

Item 523 "Credit for Reserve Pumpers (CRP)" = 0.49 points

Item 532 – Credit for Pumper Capacity (3 points)

The next item reviewed is Item 532 "Credit for Pumper Capacity (CPC)". The total pump capacity available should be sufficient for the Basic Fire Flow of 3500 gpm. The maximum needed pump capacity credited is the Basic Fire Flow of the community.

Item 532 "Credit for Pumper Capacity (CPC)" = 3.00 points

Item 549 – Credit for Ladder Service (4 points)

The next item reviewed is Item 549 "Credit for Ladder Service (CLS)". This item reviews the number of response areas within the city with 5 buildings that are 3 or more stories or 35 feet or more in height, or with 5 buildings that have a Needed Fire Flow greater than 3,500 gpm, or any combination of these criteria. The height of all buildings in the city, including those protected by automatic sprinklers, is considered when determining the number of needed ladder companies. Response areas not needing a ladder company should have a service company. Ladders, tools and equipment normally carried on ladder trucks are needed not only for ladder operations but also for forcible entry, ventilation, salvage, overhaul, lighting and utility control.

The number of ladder or service companies, the height of the aerial ladder, aerial ladder testing and the equipment carried on the in-service ladder trucks and service trucks is compared with the number of needed ladder trucks and service trucks and an FSRS equipment list. Ladder trucks must meet the general criteria of NFPA 1901, *Standard for Automotive Fire Apparatus* to be recognized.

The number of needed ladder-service trucks is dependent upon the number of buildings 3 stories or 35 feet or more in height, buildings with a Needed Fire Flow greater than 3,500 gpm, and the method of operation.

The FSRS recognizes that there are **2 ladder companies** in service. These companies are needed to provide fire suppression services to areas to meet NFPA 1710 criteria or within 2½ miles and the number of buildings with a Needed Fire Flow over 3,500 gpm or 3 stories or more in height, or the method of operation.

The FSRS recognizes that there are **0 service companies** in service.

Item 549 "Credit for Ladder Service (CLS)" = 0.86 points

Item 553 – Credit for Reserve Ladder and Service Trucks (0.50 points)

The next item reviewed is Item 553 "Credit for Reserve Ladder and Service Trucks (CRLS)". This item considers the adequacy of ladder and service apparatus when one (or more in larger communities) of these apparatus are out of service. The number of needed reserve ladder and service trucks is 1 for each 8 needed ladder and service companies that were determined to be needed in Item 540, or any fraction thereof.

Item 553 "Credit for Reserve Ladder and Service Trucks (CRLS)" = 0.17 points

Item 561 – Deployment Analysis (10 points)

Next, Item 561 "Deployment Analysis (DA)" is reviewed. This Item examines the number and adequacy of existing engine and ladder-service companies to cover built-upon areas of the city.

To determine the Credit for Distribution, first the Existing Engine Company (EC) points and the Existing Engine Companies (EE) determined in Item 513 are considered along with Ladder Company Equipment (LCE) points, Service Company Equipment (SCE) points, Engine-Ladder Company Equipment (ELCE) points, and Engine-Service Company Equipment (ESCE) points determined in Item 549.

Secondly, as an alternative to determining the number of needed engine and ladder/service companies through the road-mile analysis, a fire protection area may use the results of a systematic performance evaluation. This type of evaluation analyzes computer-aided dispatch (CAD) history to demonstrate that, with its current deployment of companies, the fire department meets the time constraints for initial arriving engine and initial full alarm assignment in accordance with the general criteria of in NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments.*

A determination is made of the percentage of built upon area within 1½ miles of a first-due engine company and within 2½ miles of a first-due ladder-service company.

Item 561 "Credit Deployment Analysis (DA)" = 3.83 points

Item 571 – Credit for Company Personnel (15 points)

Item 571 "Credit for Company Personnel (CCP)" reviews the average number of existing firefighters and company officers available to respond to reported first alarm structure fires in the city.

The on-duty strength is determined by the yearly average of total firefighters and company officers on-duty considering vacations, sick leave, holidays, "Kelley" days and other absences. When a fire department operates under a minimum staffing policy, this may be used in lieu of determining the yearly average of on-duty company personnel.

Firefighters on apparatus not credited under Items 513 and 549 that regularly respond to reported first alarms to aid engine, ladder, and service companies are included in this item as increasing the total company strength.

Firefighters staffing ambulances or other units serving the general public are credited if they participate in fire-fighting operations, the number depending upon the extent to which they are available and are used for response to first alarms of fire.

On-Call members are credited on the basis of the average number staffing apparatus on first alarms. Off-shift career firefighters and company officers responding on first alarms are considered on the same basis as on-call personnel. For personnel not normally at the fire station, the number of responding firefighters and company officers is divided by 3 to reflect the time needed to assemble at the fire scene and the reduced ability to act as a team due to the various arrival times at the fire location when compared to the personnel on-duty at the fire station during the receipt of an alarm.

The number of Public Safety Officers who are positioned in emergency vehicles within the jurisdiction boundaries may be credited based on availability to respond to first alarm structure fires. In recognition of this increased response capability the number of responding Public Safety Officers is divided by 2.

The average number of firefighters and company officers responding with those companies credited as Automatic Aid under Items 513 and 549 are considered for either on-duty or on-call company personnel as is appropriate. The actual number is calculated as the average number of company personnel responding multiplied by the value of AA Plan determined in Item 512.D.

The maximum creditable response of on-duty and on-call firefighters is 12, including company officers, for each existing engine and ladder company and 6 for each existing service company.

Chief Officers are not creditable except when more than one chief officer responds to alarms; then extra chief officers may be credited as firefighters if they perform company duties.

The FSRS recognizes **34.43 on-duty personnel** and an average of **0.00 on-call personnel** responding on first alarm structure fires.

Item 571 "Credit for Company Personnel (CCP)" = 9.56 points

Summary of PPC Review

for

Lees Summit FPSA

FSRS Item	Earned Credit	Credit Available
Emergency Communications		
414. Credit for Emergency Reporting	2.40	3
422. Credit for Telecommunicators	4.00	4
432. Credit for Dispatch Circuits	3.00	3
440. Credit for Emergency Communications	9.40	10
Fire Department		
513. Credit for Engine Companies	5.94	6
523. Credit for Reserve Pumpers	0.49	0.5
532. Credit for Pumper Capacity	3.00	3
549. Credit for Ladder Service	0.86	4
553. Credit for Reserve Ladder and Service Trucks	0.17	0.5
561. Credit for Deployment Analysis	3.83	10
571. Credit for Company Personnel	9.56	15
581. Credit for Training	8.00	9
730. Credit for Operational Considerations	2.00	2
590. Credit for Fire Department	33.85	50
Water Supply		
616. Credit for Supply System	29.34	30
621. Credit for Hydrants	2.87	3
631. Credit for Inspection and Flow Testing	6.39	7
640. Credit for Water Supply	38.60	40
Divergence	-5.76	--
1050. Community Risk Reduction	4.45	5.50
Total Credit	80.54	105.5

Final Community Classification = 02/2X

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Lees Summit Fpsa

County Cass,Jackson State MISSOURI (24) Witnessed by: Insurance Services Office Date: Jan 3, 2017

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM $Q=(29.83(C(d^2)p^{0.5}))$ INDIVIDUAL HYDRANTS			TOTAL	PRESSURE PSI STATIC	RESID.	FLOW -AT 20 PSI NEEDED **	AVAIL.	REMARKS***	MODEL TYPE
1		Hamblen & Fleetway	Lees Summit Water Dept, Lees Summit	2710	0	0	12760	0	0	5000	10050		CNMP
10		Front of High School	Lees Summit Water Dept, Lees Summit	1190	1190	0	8380	0	0	5000	6000		CNMP
10A		Front of High School	Lees Summit Water Dept, Lees Summit	1190	1190	0	8380	0	0	4000	6000		CNMP
10B		Front of High School	Lees Summit Water Dept, Lees Summit	1190	1190	0	8380	0	0	3000	6000		CNMP
11		Chipman & Rice	Lees Summit Water Dept, Lees Summit	2590	0	0	9340	0	0	4500	6750		CNMP
11A		Chipman & Rice	Lees Summit Water Dept, Lees Summit	2590	0	0	9340	0	0	3500	6750		CNMP
12		North East Douglas Street & Maple	Lees Summit Water Dept, Lees Summit	1430	0	0	3180	0	0	2250	1750		CNMP
13		NW O'Brien & Killarney Ln	Lees Summit Water Dept, Lees Summit	2740	0	0	7040	0	0	8000	4300		CNMP
13A		NW O'Brien & Killarney Ln	Lees Summit Water Dept, Lees Summit	2740	0	0	7040	0	0	5500	4300		CNMP
13B		NW O'Brien & Killarney Ln	Lees Summit Water Dept, Lees Summit	2740	0	0	7040	0	0	2000	4300		CNMP
14		Pryor & Chipman	Lees Summit Water Dept, Lees Summit	3060	0	0	8260	0	0	5000	5200		CNMP
14A		Pryor & Chipman	Lees Summit Water Dept, Lees Summit	3060	0	0	8260	0	0	5000	5200		CNMP
14B		Pryor & Chipman	Lees Summit Water Dept, Lees Summit	3060	0	0	8260	0	0	4500	5200		CNMP
14C		Pryor & Chipman	Lees Summit Water Dept, Lees Summit	3060	0	0	8260	0	0	3500	5200		CNMP
15		Ashurst & Ashurst Pl.	Lees Summit Water Dept, Lees Summit	1910	0	0	4510	0	0	750	2600		CNMP
16		Longview Rd, at arena north hydrant	Lees Summit Water Dept, Lees Summit	1690	0	0	6040	0	0	5500	4350		CNMP

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR PROPERTY INSURANCE PREMIUM CALCULATIONS ONLY AND ARE *NOT* INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION.

THE AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire Suppression Rating Schedule.

*** (A)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Lees Summit Fpsa

County Cass,Jackson State MISSOURI (24) Witnessed by: Insurance Services Office Date: Jan 3, 2017

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM INDIVIDUAL HYDRANTS			FLOW - GPM TOTAL	PRESSURE PSI STATIC	PRESSURE PSI RESID.	FLOW - AT 20 PSI NEEDED **	FLOW - AT 20 PSI AVAIL.	REMARKS***	MODEL TYPE
16A		Longview Rd, at arena north hydrant	Lees Summit Water Dept, Lees Summit	1690	0	0	6040	0	0	4500	4350		CNMP
16B		Longivew Rd, at arena north hydrant	Lees Summit Water Dept, Lees Summit	1690	0	0	6040	0	0	1500	4350		CNMP
17		Eagleview	Lees Summit Water Dept, Lees Summit	2780	0	0	2780	98	58	750	4000		
18		South West Market Street & Hwy 150	Lees Summit Water Dept, Lees Summit	1750	0	0	6350	0	0	4500	4600		CNMP
18A		South West Market St & Hwy 150	Lees Summit Water Dept, Lees Summit	1750	0	0	6350	0	0	3500	4600		CNMP
19		Huntington Dr & Allendale Lake Rd	Jackson County PWSD 12, RWD #12	1860	0	0	1860	100	42	750	2200		
1A		Hamblen & Fleetway	Lees Summit Water Dept, Lees Summit	2710	0	0	12760	0	0	5000	10050		CNMP
1B		Hamblen & Fleetway	Lees Summit Water Dept, Lees Summit	2710	0	0	12760	0	0	5000	10050		CNMP
1C		Hamblen & Fleetway	Lees Summit Water Dept, Lees Summit	2710	0	0	12760	0	0	4500	10050		CNMP
1D		Hamblen & Fleetway	Lees Summit Water Dept, Lees Summit	2710	0	0	12760	0	0	2250	10050		CNMP
2		Prarieview Elementary	Lees Summit Water Dept, Lees Summit	1430	0	0	11030	0	0	4500	9600		CNMP
20		West Main Street & Harris	Jackson County PWSD 12, RWD #12	2020	0	0	2020	106	42	3000	2400		
21		Jefferson at Community school	Lees Summit Water Dept, Lees Summit	2160	0	0	7310	0	0	4000	5150		CNMP
21A		Jefferson at Community school	Lees Summit Water Dept, Lees Summit	2160	0	0	7310	0	0	2000	5150		CNMP
22		Ward & 3rd (behind S/C)	Lees Summit Water Dept, Lees Summit	2260	0	0	2260	94	70	3500	4200		
2A		Prairieview Elementary	Lees Summit Water Dept, Lees Summit	1430	0	0	11030	0	0	1000	9600		CNMP

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*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire Suppression Rating Schedule.

*** (A)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City: Lees Summit Fpsa

County: Cass,Jackson State: MISSOURI (24) Witnessed by: Insurance Services Office Date: Jan 3, 2017

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM				PRESSURE PSI		FLOW -AT 20 PSI		REMARKS***	MODEL TYPE
				INDIVIDUAL HYDRANTS			TOTAL	STATIC	RESID.	NEEDED **	AVAIL.		
3		Bristol & Bridgeport	Lees Summit Water Dept, Lees Summit	2850	0	0	8000	0	0	750	5150		CNMP
4		NE Colbern & Ball	Lees Summit Water Dept, Lees Summit	2470	0	0	6620	0	0	4500	4150		CNMP
4a		Ne Colbern & Ball	Lees Summit Water Dept, Lees Summit	2470	0	0	6620	0	0	3000	4150		CNMP
5		Lakewood Blvd & Anderson	Lees Summit Water Dept, Lees Summit	2430	0	0	13280	0	0	3500	10850		CNMP
6		Dick Howser & Brockton	Lees Summit Water Dept, Lees Summit	2390	0	0	8890	0	0	750	6500		CNMP
7		Hagen & Independence	Lees Summit Water Dept, Lees Summit	2630	0	0	11030	0	0	3500	8400		CNMP
8		Rte 350 (Unity Village)	Unity Village Water Department, Main	2990	0	0	2990	100	68	2250	4900		
9		Missouri & Douglas	Lees Summit Water Dept, Lees Summit	2430	0	0	6230	0	0	3000	3800		CNMP

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR PROPERTY INSURANCE PREMIUM CALCULATIONS ONLY AND ARE *NOT* INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION.

THE AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire Suppression Rating Schedule.

*** (A)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

APPENDIX C PWSD12 & PWSD13 MEMORANDUM

Memorandum

BURNS & McDONNELL

Date: January 21, 2022

To: Jeff Thorn, P.E.
City of Lee's Summit, Missouri
Deputy Director of Water Utilities

From: Ryan Scott, P.E.
Project Manager

Subject: 2021 Water Master Plan
Burns & McDonnell Project No. 136566
PWSD 12 & 13 Service Opportunities & Options

1. Separate meetings held with City and PWSD12 and with City and PWSD13.
    a. Requests for planning and water demand projections made; no information provided from either PWSD.
    b. Meetings included discussion on potential water service/water supply opportunities. While neither PWSD12 or PWSD13 indicated a need for additional service beyond emergency connections, the conversation was opened and can remain open in the future.
    c. PWSD13 indicated that they prefer to maintain PWSD13 water service customers within Lee's Summit city limits.
    d. PWSD12 and PWSD13 indicated current supply from TWA and/or KC Water has met and is meeting their respective system needs.
2. KCMO wholesale supply amounts
    a. PWSD 12 @ 1.5 MGD
        i. Tri-County supply @ 50 percent of KCMO supply; noted supply limitations/service issues from Tri-County
    b. PWSD 13 @ 1.4 MGD
3. Neighboring service provider opportunities:
    a. For now, just interested in water service for emergency only.
4. Conclusion
    a. Minimal contribution to City's short and long term supply needs;
    b. Continue open dialogue in future

RS

cc: Mark Schaufler (City)
Kevin York, P.E. (City)
Brent Boice (City)

APPENDIX D FIELD TEST FORMS

System: Lee's Summit, Missouri | **Data Logger Installation Form**

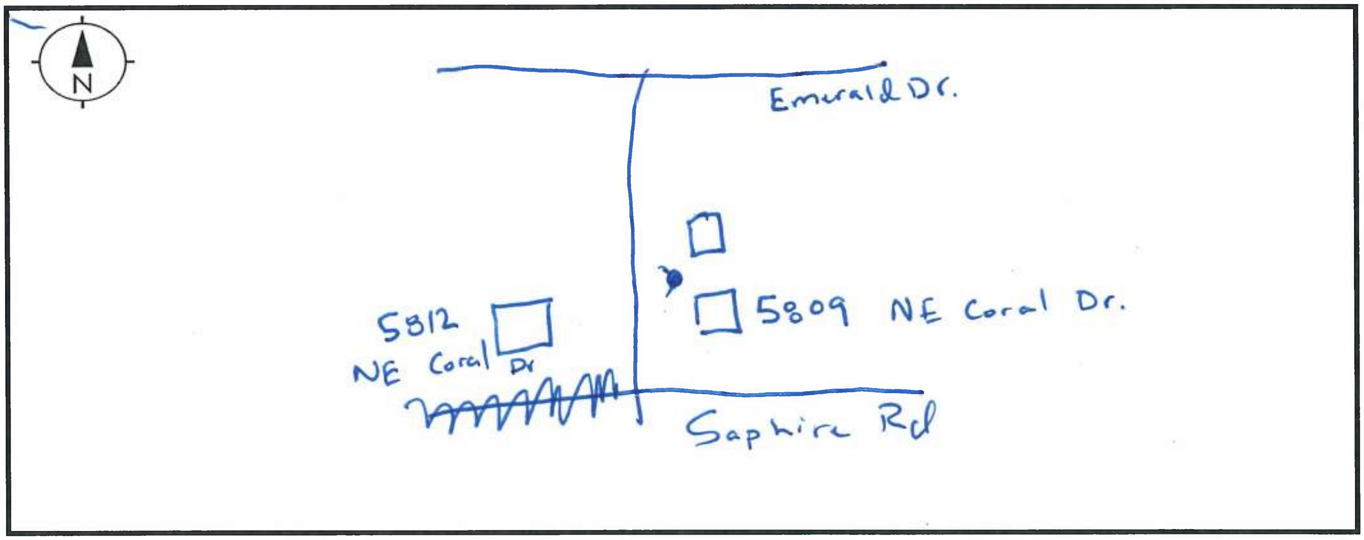
BMcD Telog Serial No.:	76151	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	10:05 AM
Removed:		4/14/2022	12:24 pm

Location: Saphire Rd

Pressure Zone: North

Sketch:



Photos:

System: Lee's Summit, Missouri **Data Logger Installation Form**

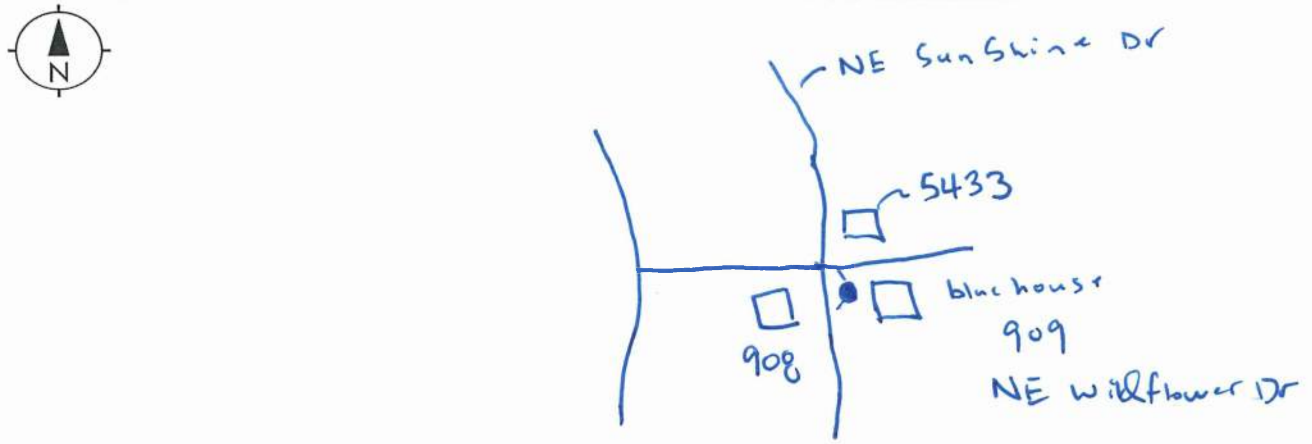
BMcD Telog Serial No.:	Main Size:	Fire Hydrant Nozzle Diameter:
76161		2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	10:25
Removed:		4/14/2022	11:27

Location: NE Wildflower Dr

Pressure Zone: North

Sketch:



Photos:

(3)

System: Lee's Summit, Missouri | **Data Logger Installation Form**

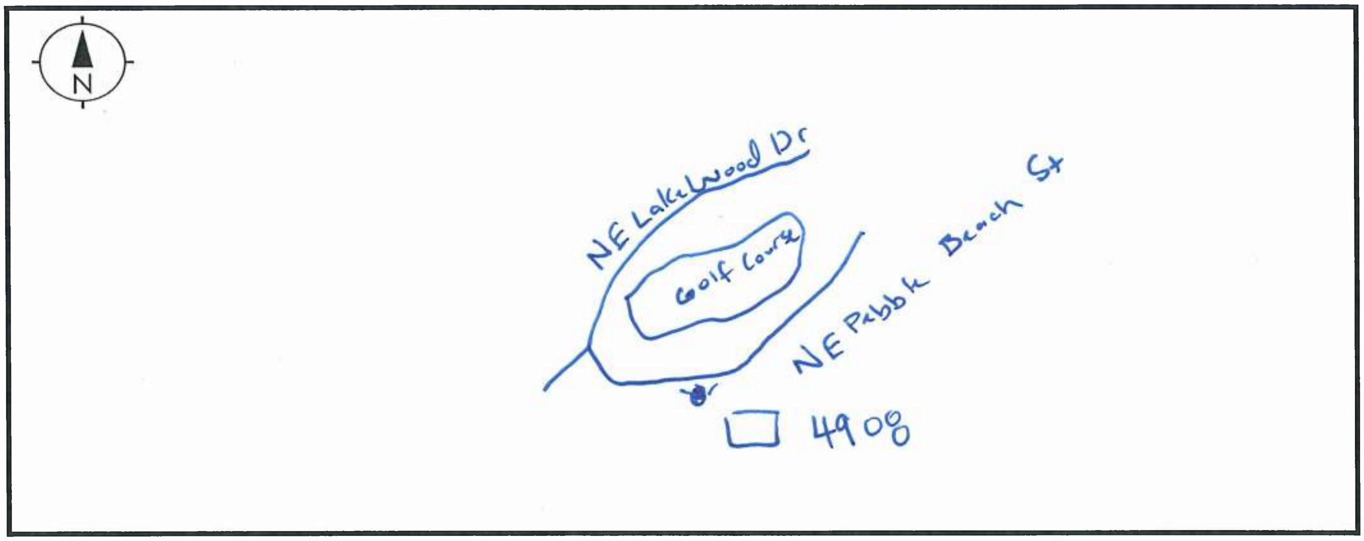
BMcD Telog Serial No.:	76157	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	10:45 AM
Removed:		4/14/2022	12:17 pm

Location: NE Lakewood Dr

Pressure Zone: North

Sketch:



Photos:

4

System: Lee's Summit, Missouri **Data Logger Installation Form**

BMcD Telog Serial No.:	76153	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	10:58 AM
Removed:		4/14/2022	12:31 pm

Location: NE Fairway Homes Dr

Pressure Zone: North

Sketch:

Photos:

5

System: Lee's Summit, Missouri | Data Logger Installation Form

BMcD Telog Serial No.: 76155

Main Size:

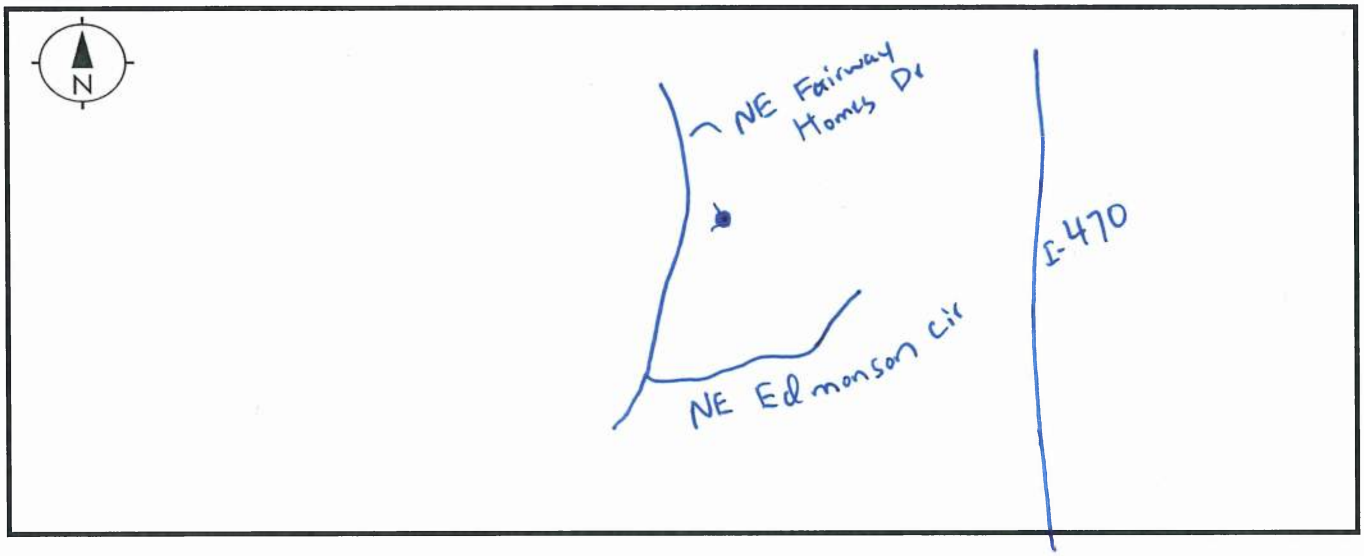
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	11:17 AM
Removed:		4/14/2022	12:35 pm

Location: NE Edmonson Cir

Pressure Zone: North

Sketch:



Photos:

6

System: Lee's Summit, Missouri — **Data Logger Installation Form**

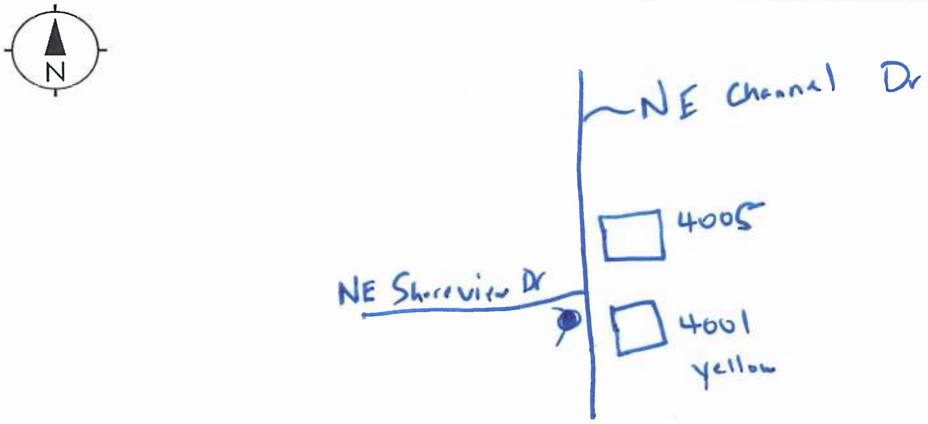
BMcD Telog Serial No.:	76152	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	11:40 AM
Removed:		4/14/2022	12:04 PM

Location: NE Chanel Dr

Pressure Zone: North

Sketch:



Photos:

7

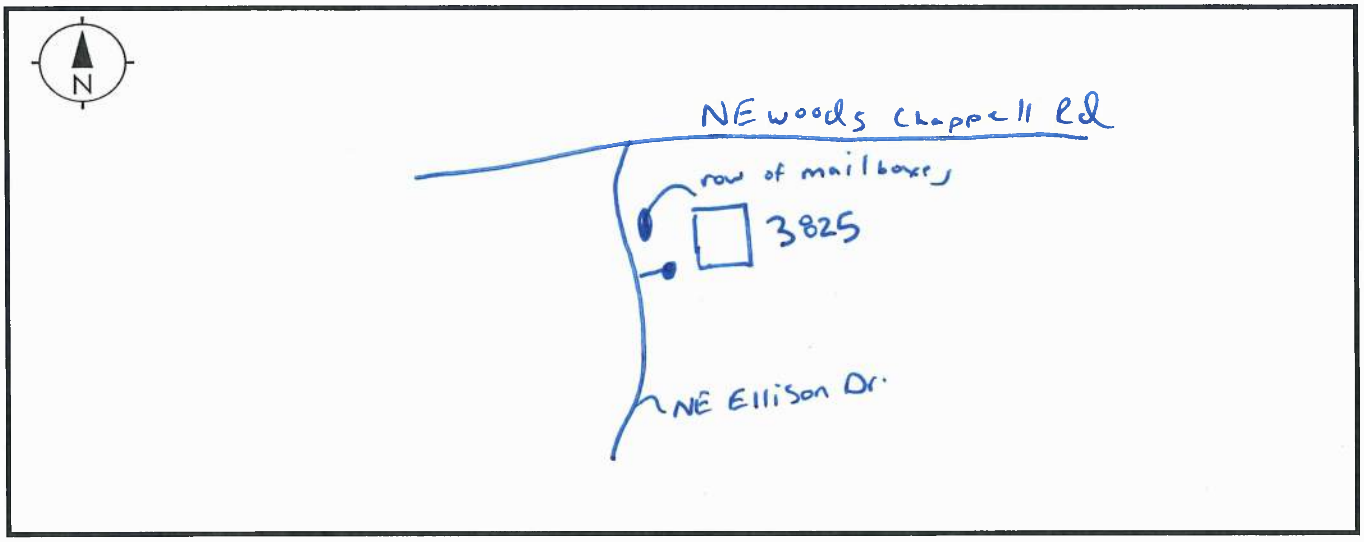
BMcD Telog Serial No.:	206384	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	11:56 AM
Removed:		4/14/2022	11:55 Am

Location: NE Woods Chappell Rd

Pressure Zone: North

Sketch:



Photos:

8

System: Lee's Summit, Missouri | **Data Logger Installation Form**

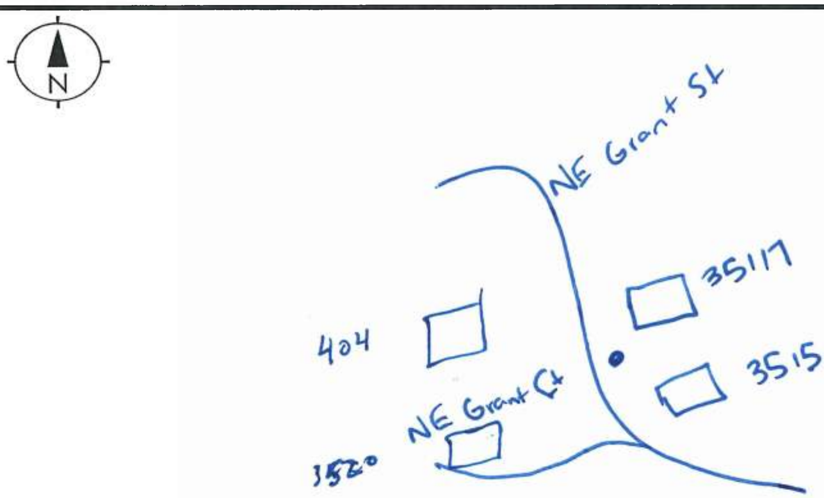
BMcD Telog Serial No.:	206386	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	12:09 pm
Removed:		4/14/2022	11:59

Location: NE Grant St

Pressure Zone: North

Sketch:



Photos:

System: Lee's Summit, Missouri | **Data Logger Installation Form**

BMcD Telog Serial No.: 76156

Main Size:

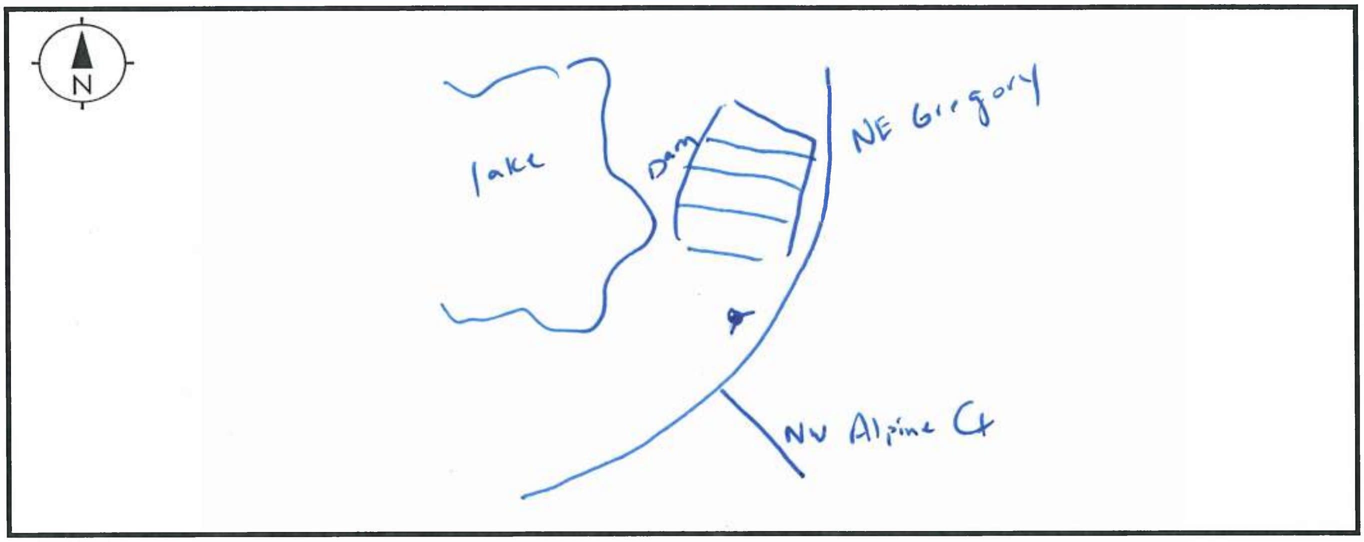
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	12:24 PM
Removed:		4/14/2022	12:07 PM

Location: NE Gregory

Pressure Zone: North

Sketch:



Photos:

10

System: Lee's Summit, Missouri | **Data Logger Installation Form**

BMcD Telog Serial No.: 206385

Main Size:

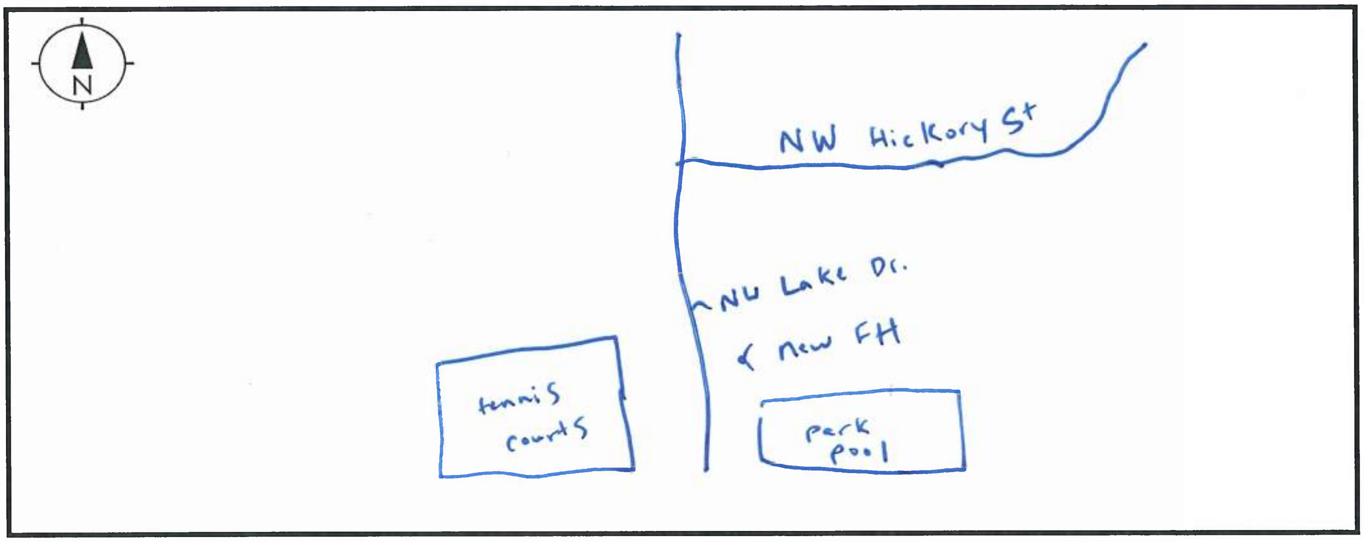
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	12:36 PM
Removed:		4/14/2022	12:12 pm

Location: NW Hickory St

Pressure Zone: North

Sketch:



Photos:

System: Lee's Summit, Missouri | **Data Logger Installation Form**

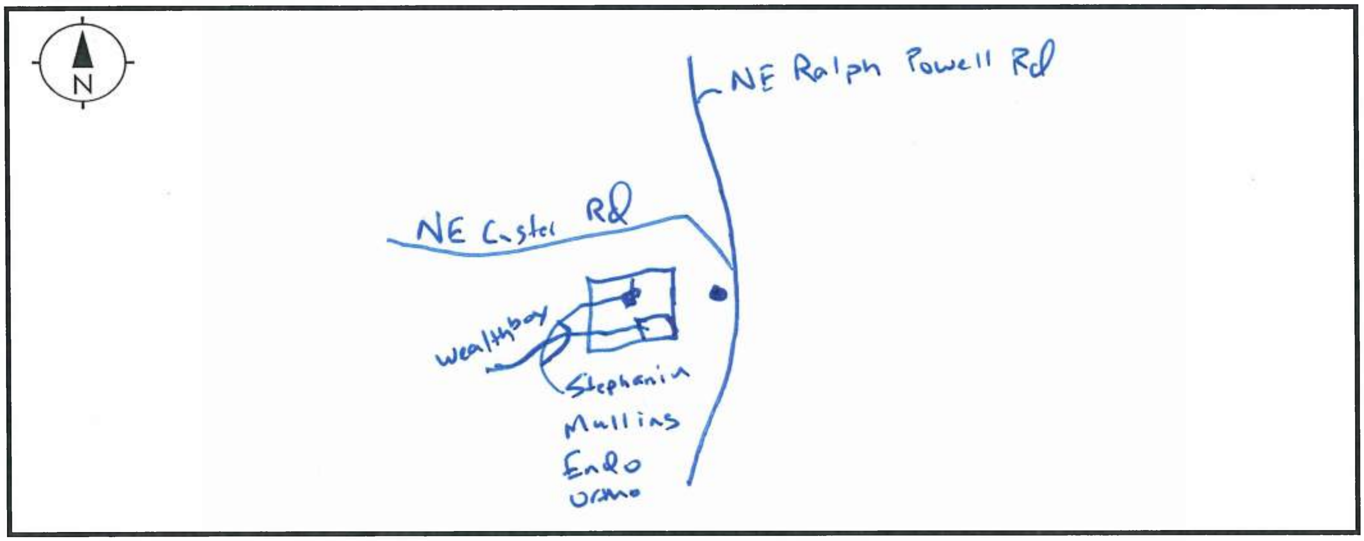
BMcD Telog Serial No.:	206383	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	1:33 PM
Removed:		4/14/2022	11:49 AM

Location: NE Ralph Powell Rd

Pressure Zone: North

Sketch:



Photos:

System: Lee's Summit, Missouri | **Data Logger Installation Form**

BMcD Telog Serial No.: 76159

Main Size:

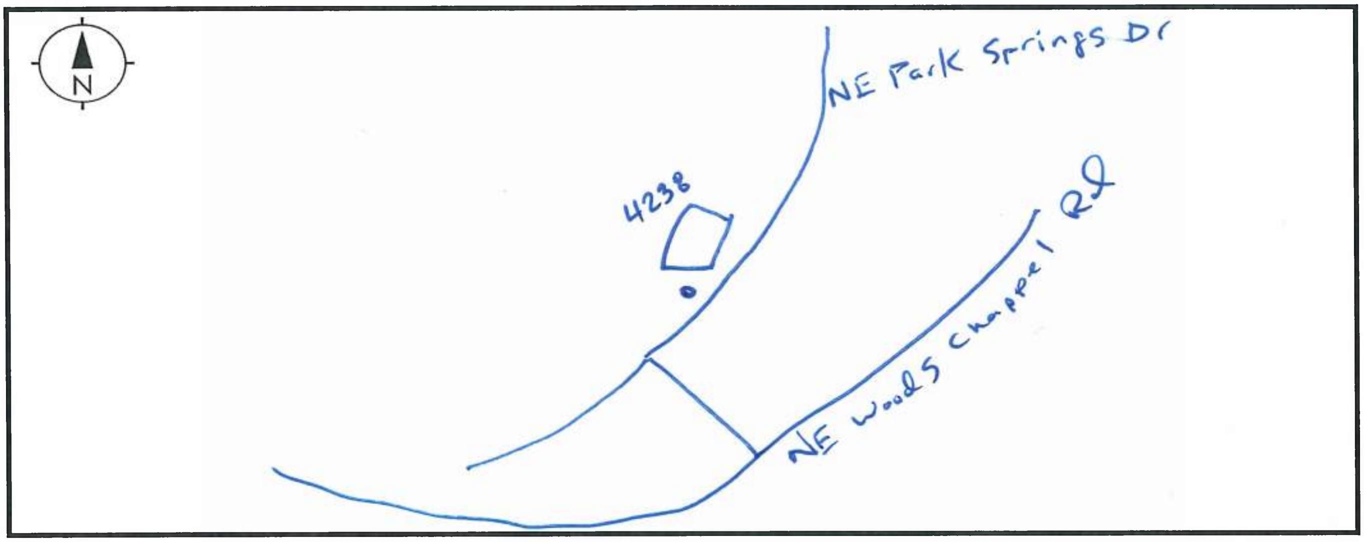
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	1:49 pm
Removed:		4/14/2022	11:40 Am

Location: NE Park Springs Dr

Pressure Zone: North

Sketch:



Photos:

(13)

System: Lee's Summit, Missouri **Data Logger Installation Form**

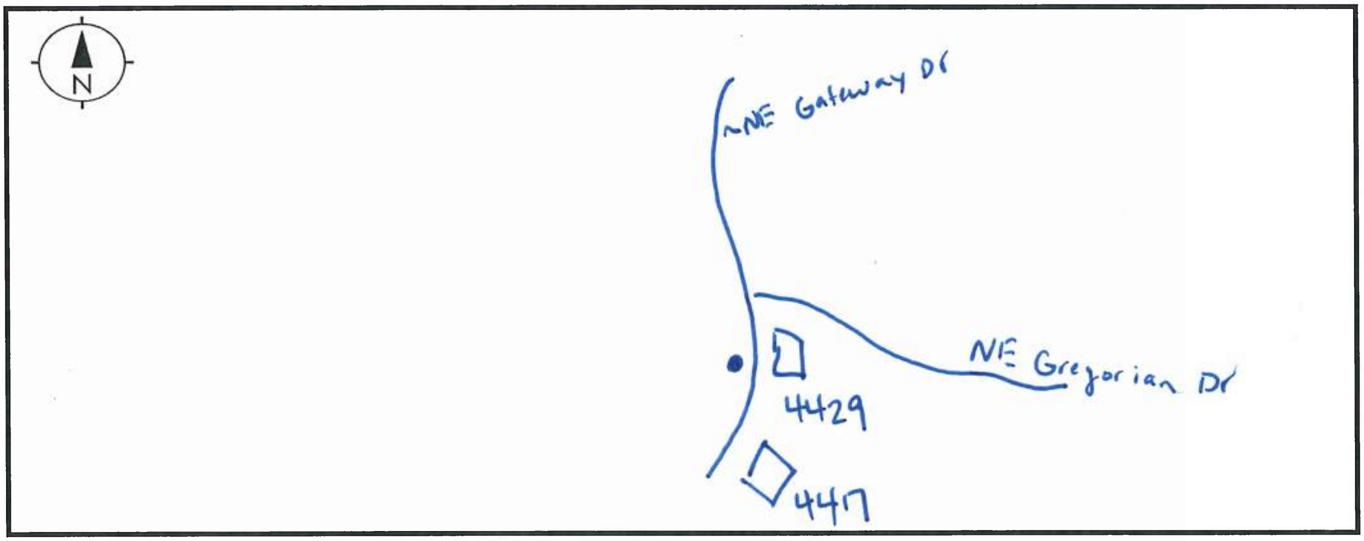
BMcD Telog Serial No.:	76160 x symbol	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		4/11/2022	2:00 pm
Removed:		4/14/2022	11:36 AM

Location: NE Gateway Dr

Pressure Zone: North

Sketch:



Photos:

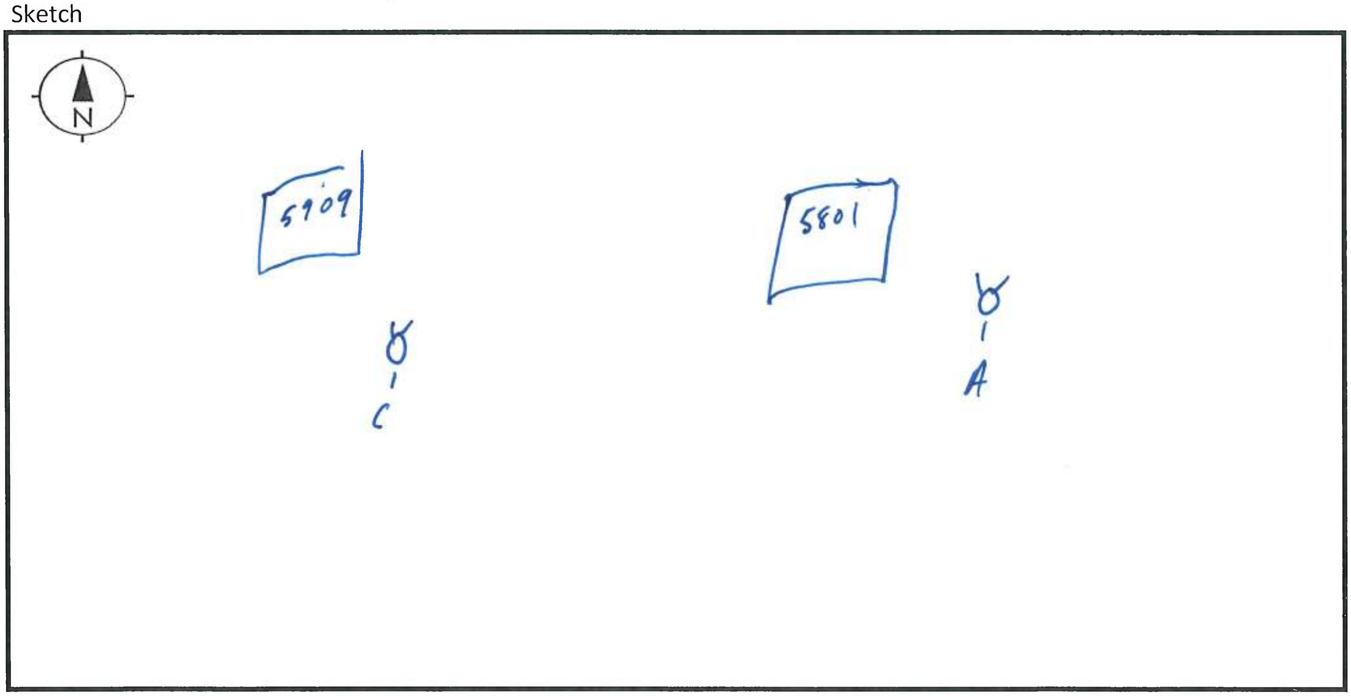
Date:	4/13	Time:	11:55
Main Size (in):	6 in.	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	136	85	1547
Hydrant C:	148	119	FLOWING GAUGE 4 lbs lower

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: Pearl Ct ; Sapphire

Sketch



Date: 4/13

Time: 12:14

Main Size (in): 8

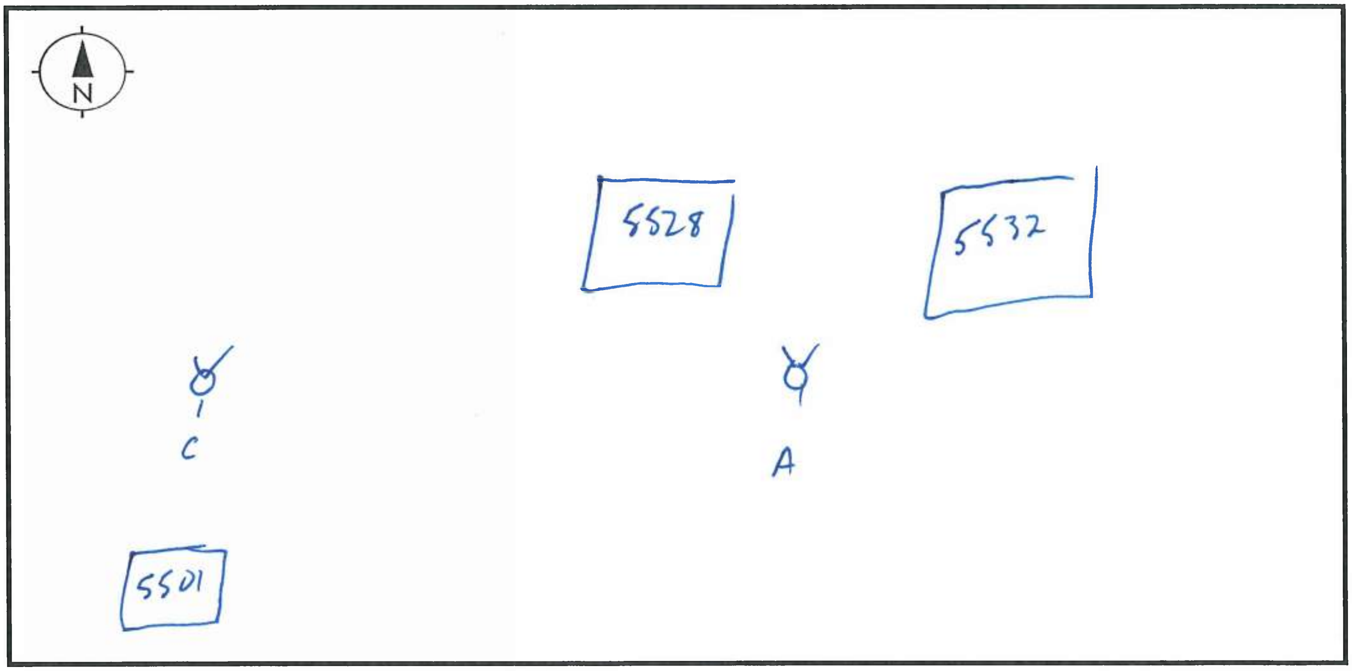
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	92	50	1186
Hydrant C:	90	70	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NorthGate Drive

Sketch



Date: 4/13

Time: 12:36

Main Size (in): 6in

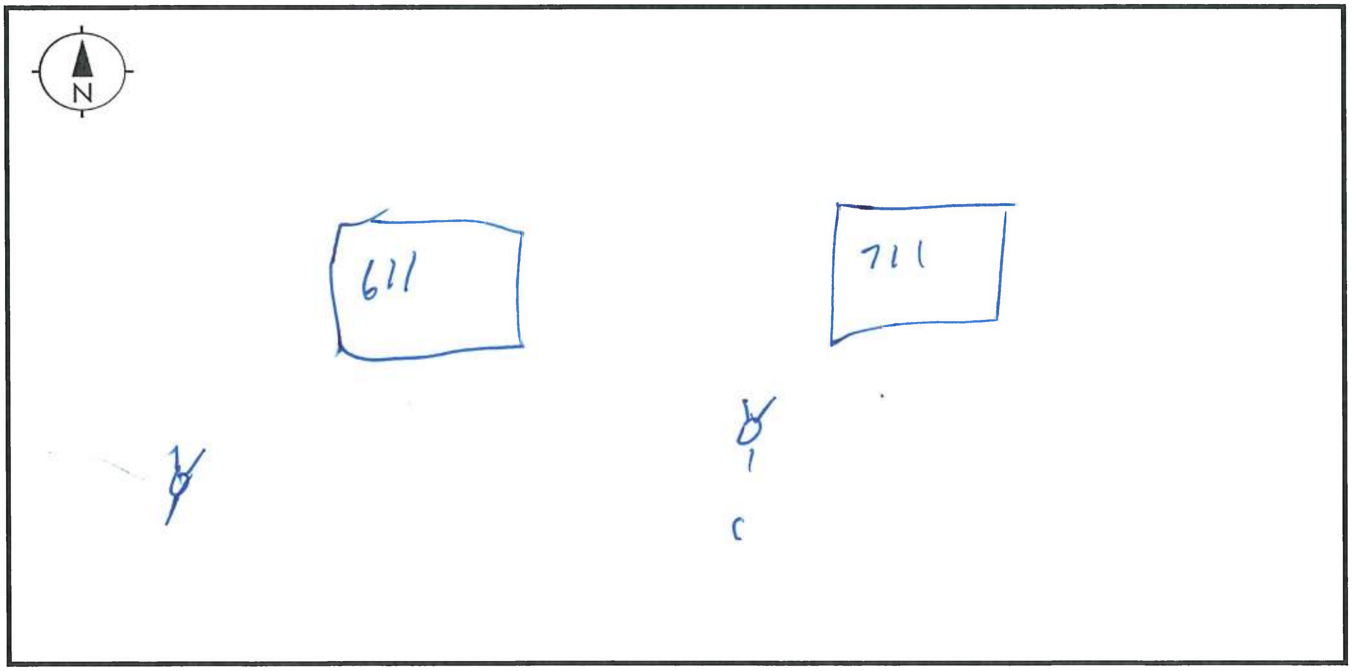
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	94	62	1321
Hydrant C:	98	86	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: Pebble Beach & Burning Tree

Sketch



Date: 4/13 | Time: 12:52

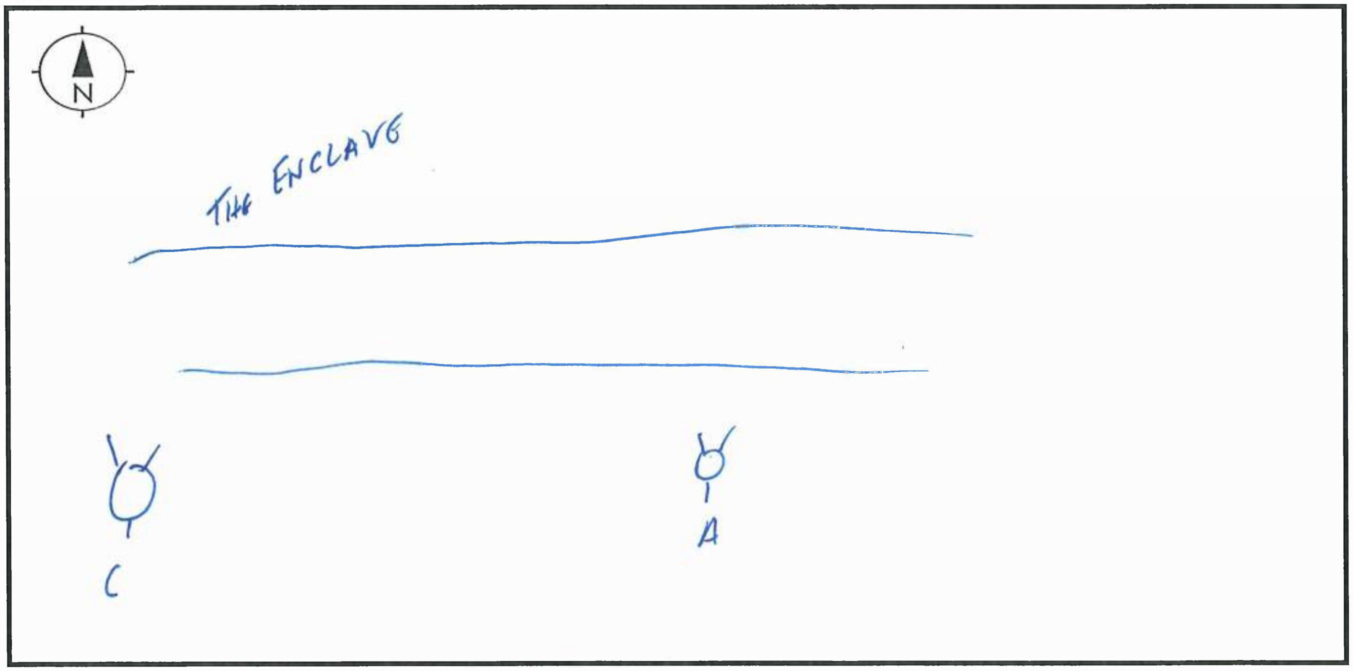
Main Size (in): 8in | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	92	84	1538
Hydrant C:	100	99	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: DEL LAGO

Sketch



Date: 4/13

Time: 1:06

Main Size (in):

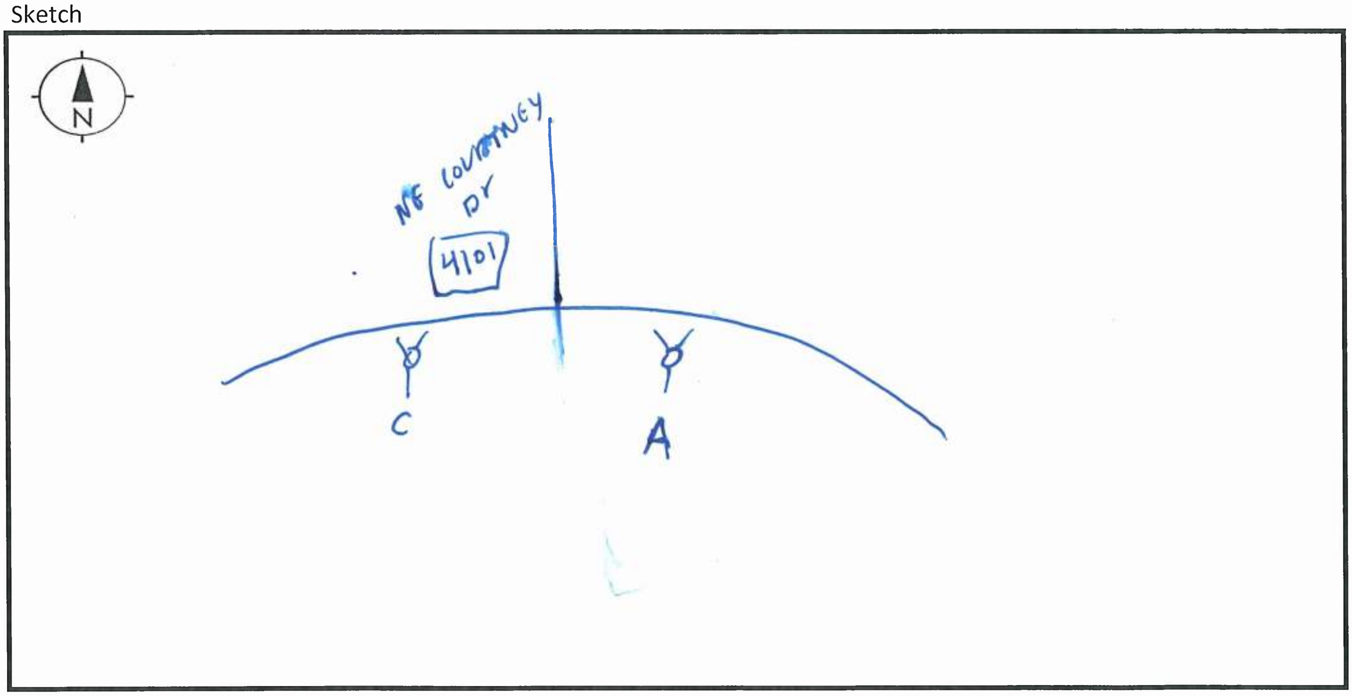
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	88	76	1463
Hydrant C:	90	89	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: DICK HOWSER Dr

Sketch



Date: 4/13

Time: 2:08

Main Size (in): 8

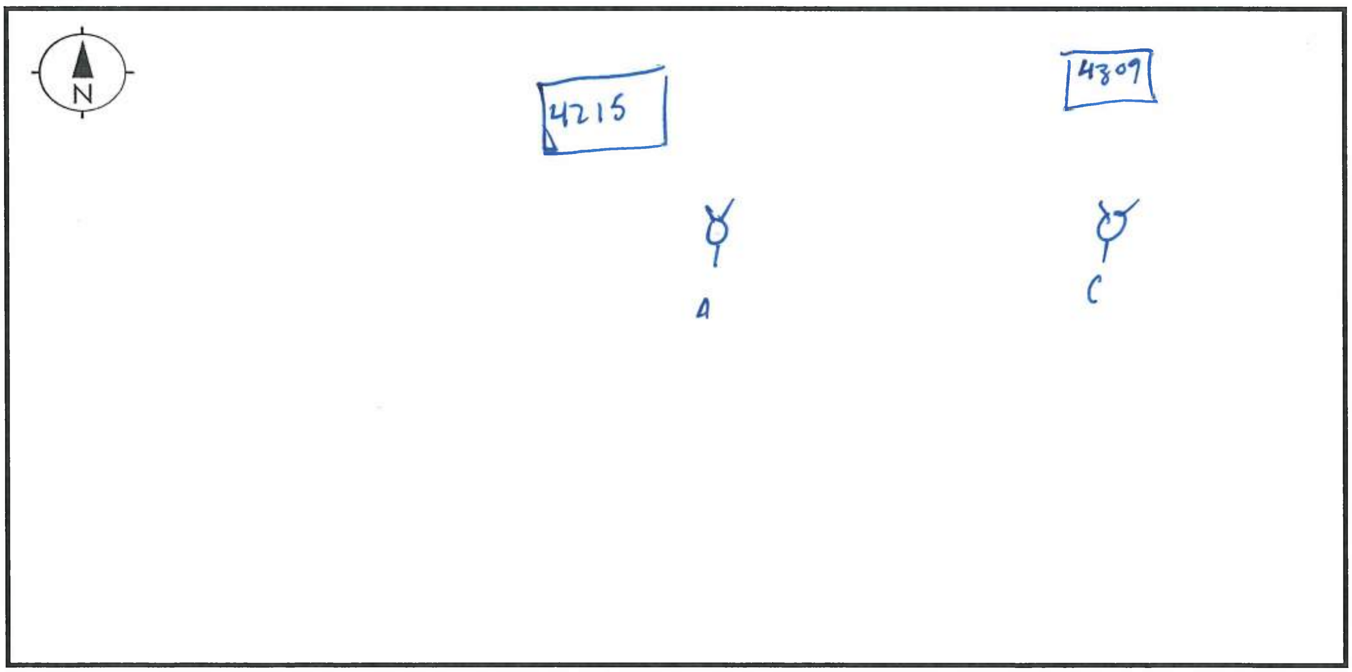
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	86	66	1300
Hydrant C:	84	69	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: Locust

Sketch



Date: 4/13

Time: 2:33

Main Size (in): 6

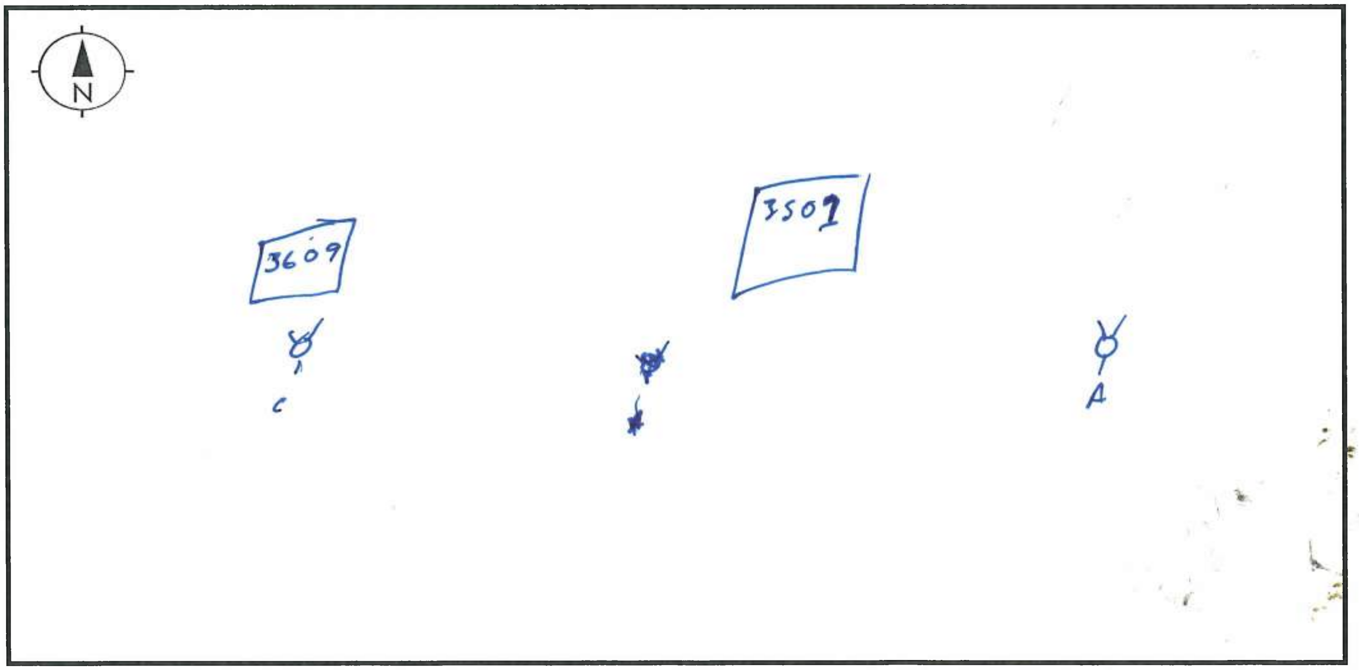
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	88	71	1414
Hydrant C:	94	85	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NW Lake Dr. ; Gregory Blvd

Sketch



Date: 4/13

Time: 3:02

Main Size (in): 8

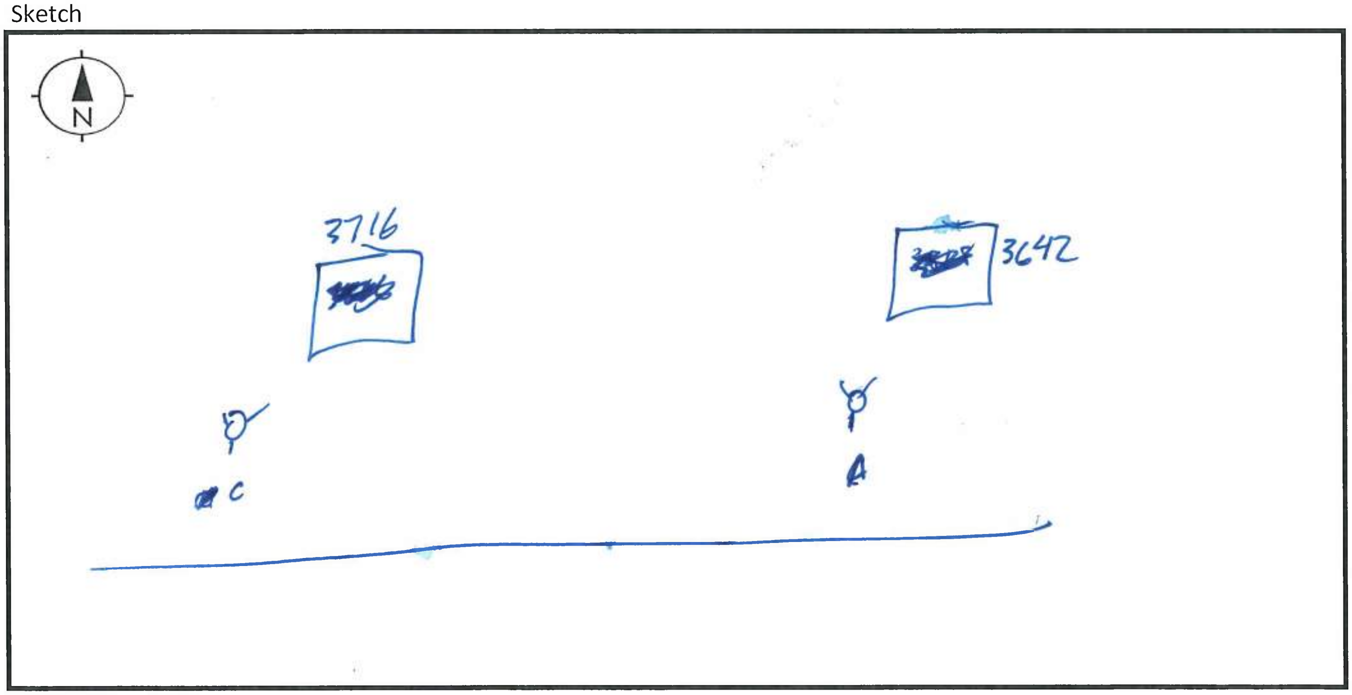
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	87	70	1404
Hydrant C:	88	64	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: BEACHWOOD Dr. ; ROSEWOOD Dr.

Sketch



Date: 4/14

Time: 9:41

Main Size (in):

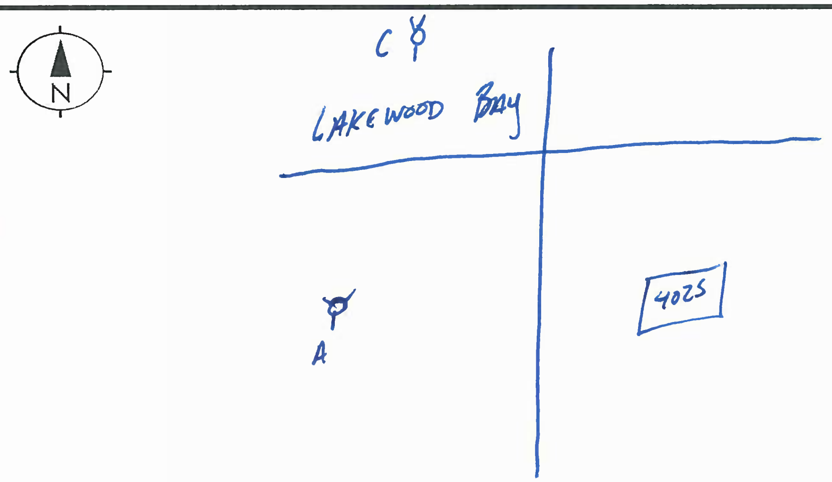
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	87	75	1453
Hydrant C:	93	81	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: BAY VIEW & CHANNEL

Sketch



Date: 4/14 | Time: 9:57

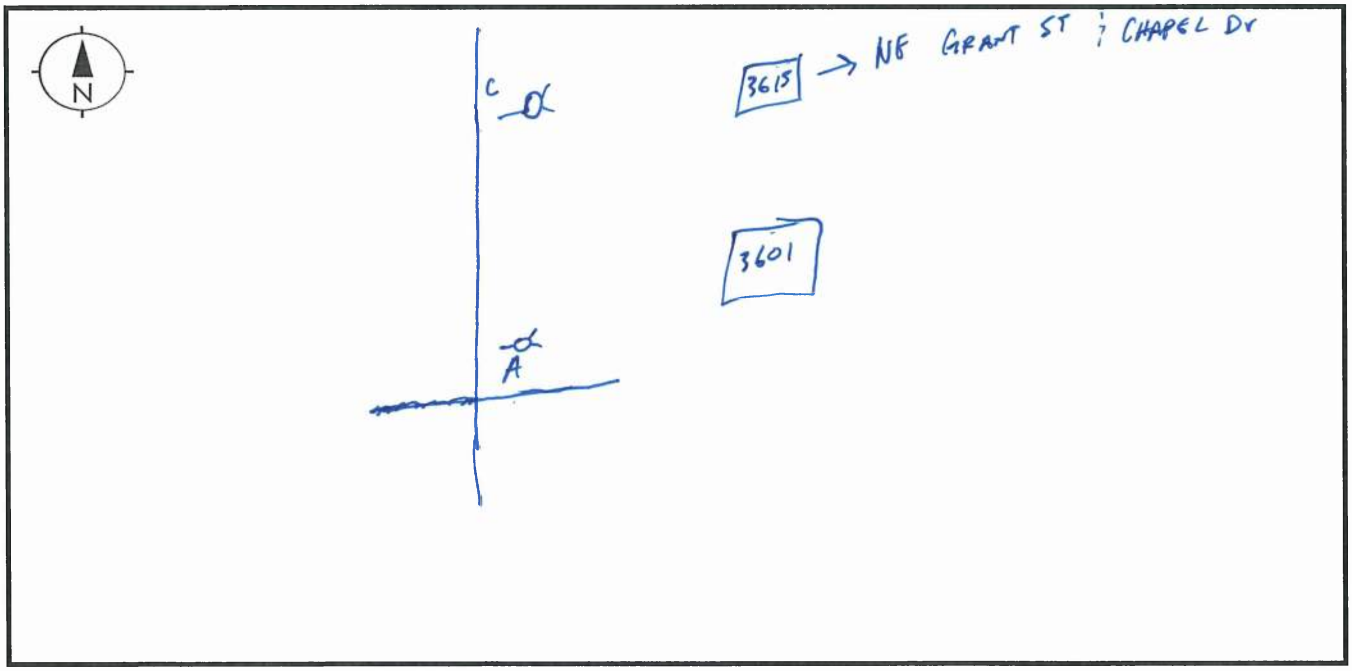
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	93	76	1463
Hydrant C:	84	82	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE CHAPEL DR ; CHAPEL CT

Sketch



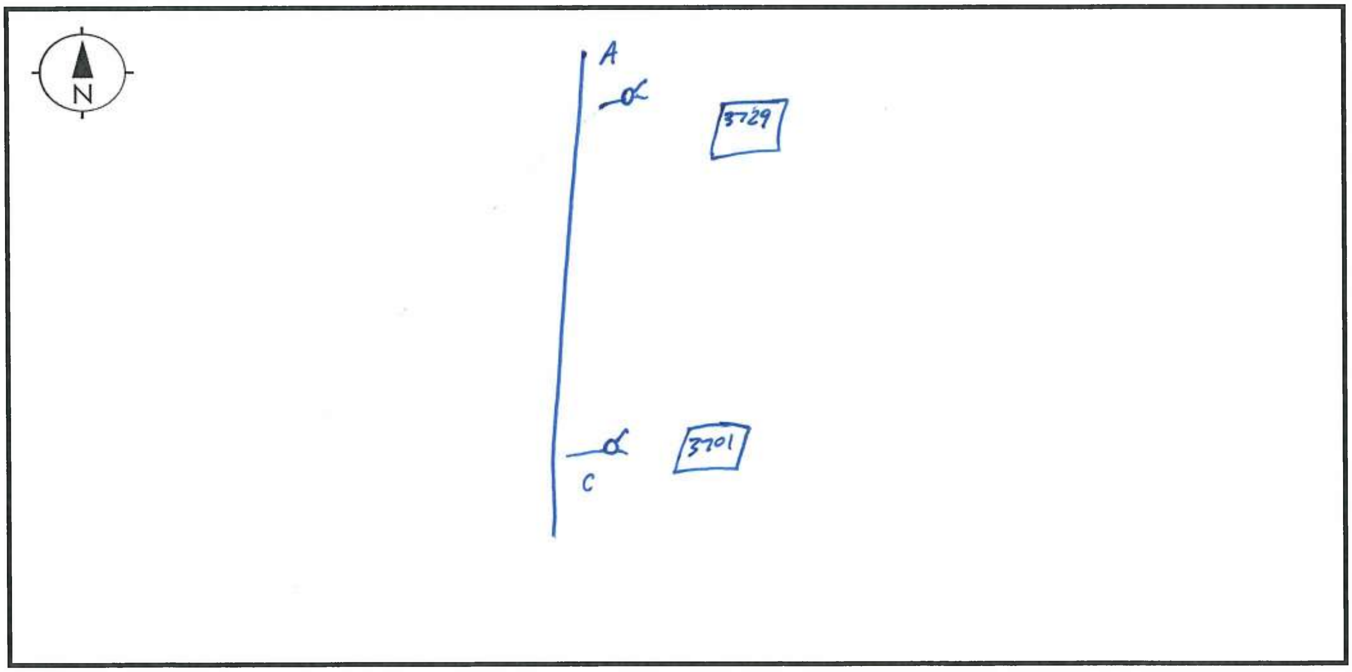
Date:	4/14	Time:	10:13
Main Size (in):		FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	68	46	1139
Hydrant C:	66	61	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Ellison Dr.

Sketch



Date: 4/14 | Time: 10:26

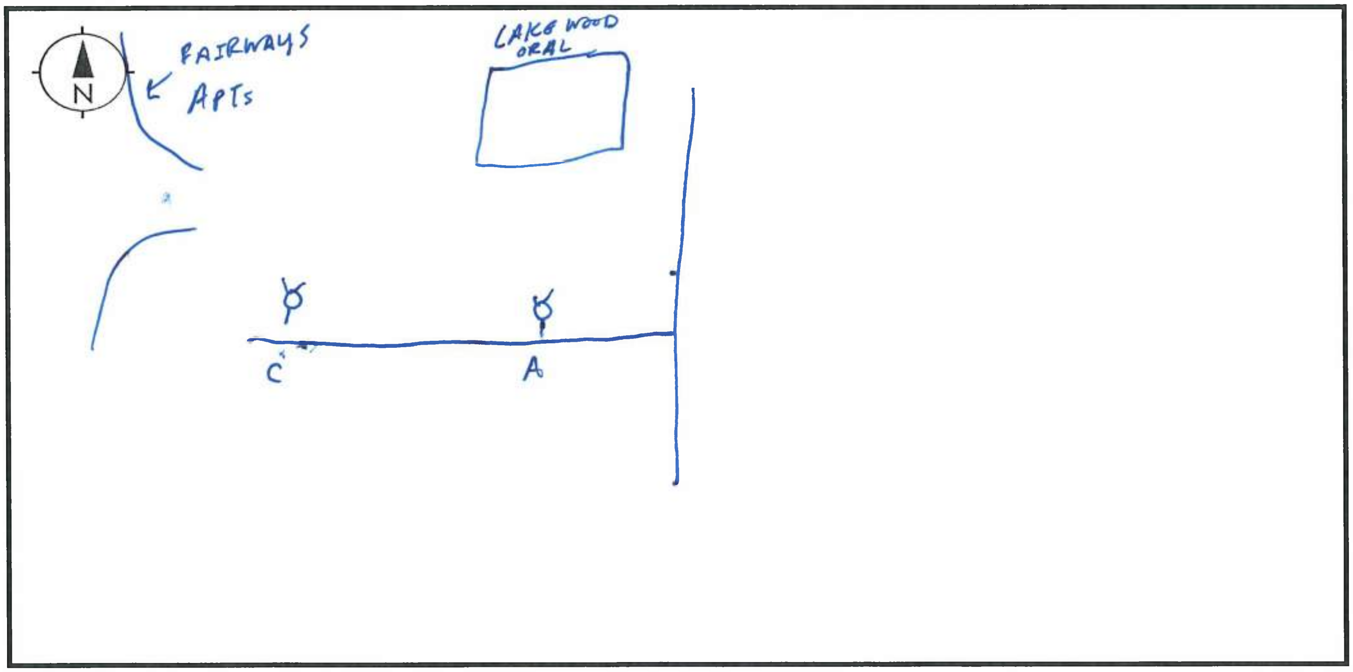
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	66	60	1300
Hydrant C:	71	68	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Ralph Powell Rd.

Sketch



Date: 4/14 | Time: 10:43

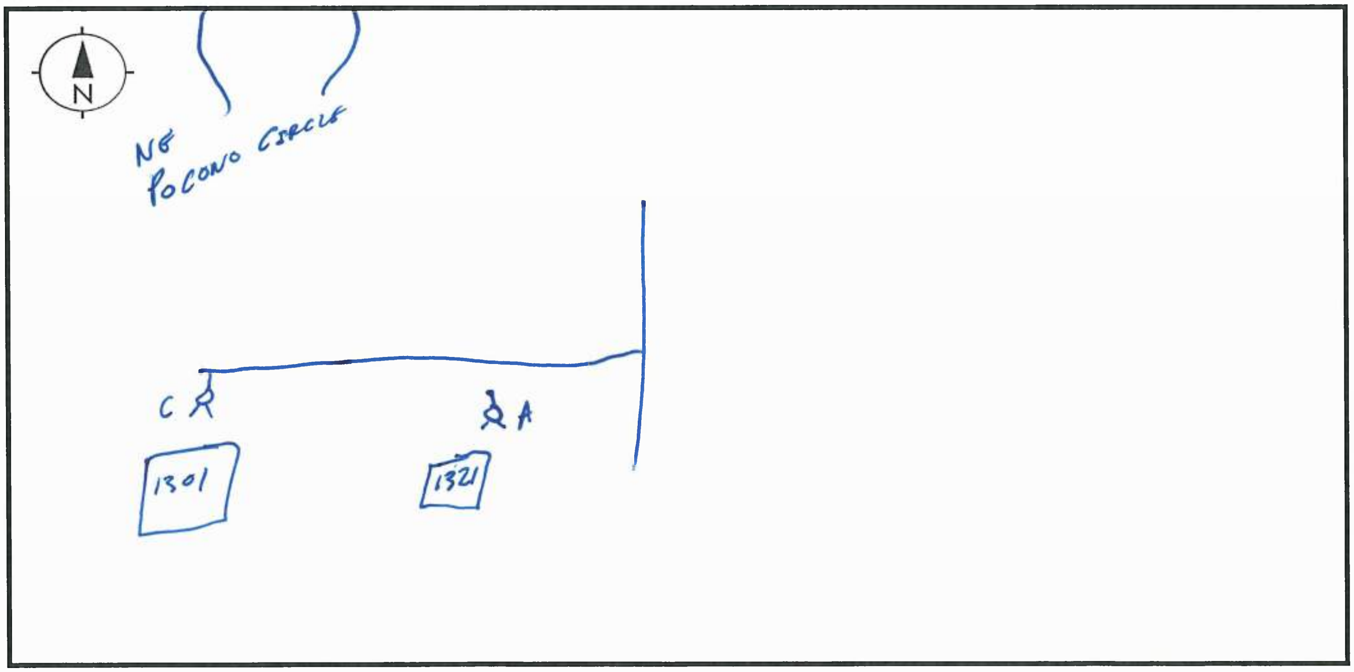
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	82	61	1311
Hydrant C:	77	63	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Gateway Dr. & Goshen Dr.

Sketch



Date: 4/14 | Time: 11:15

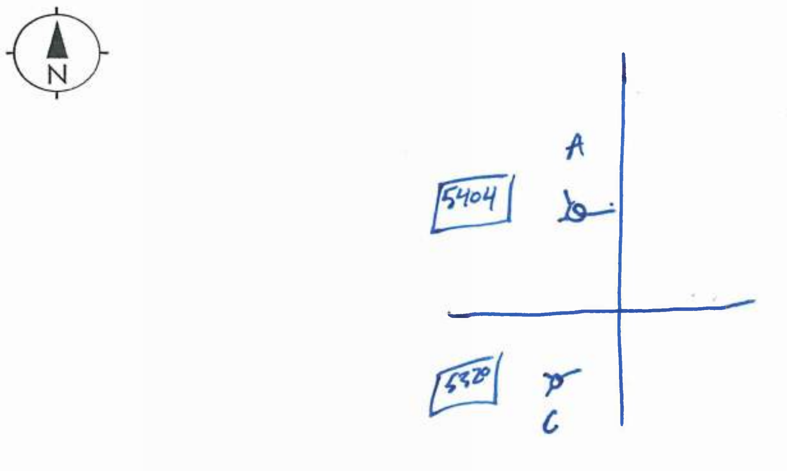
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	88	55	1244
Hydrant C:	90	64	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Sunshine Dr & Rainbow

Sketch



Date: 4/14

Time: 12:58

Main Size (in):

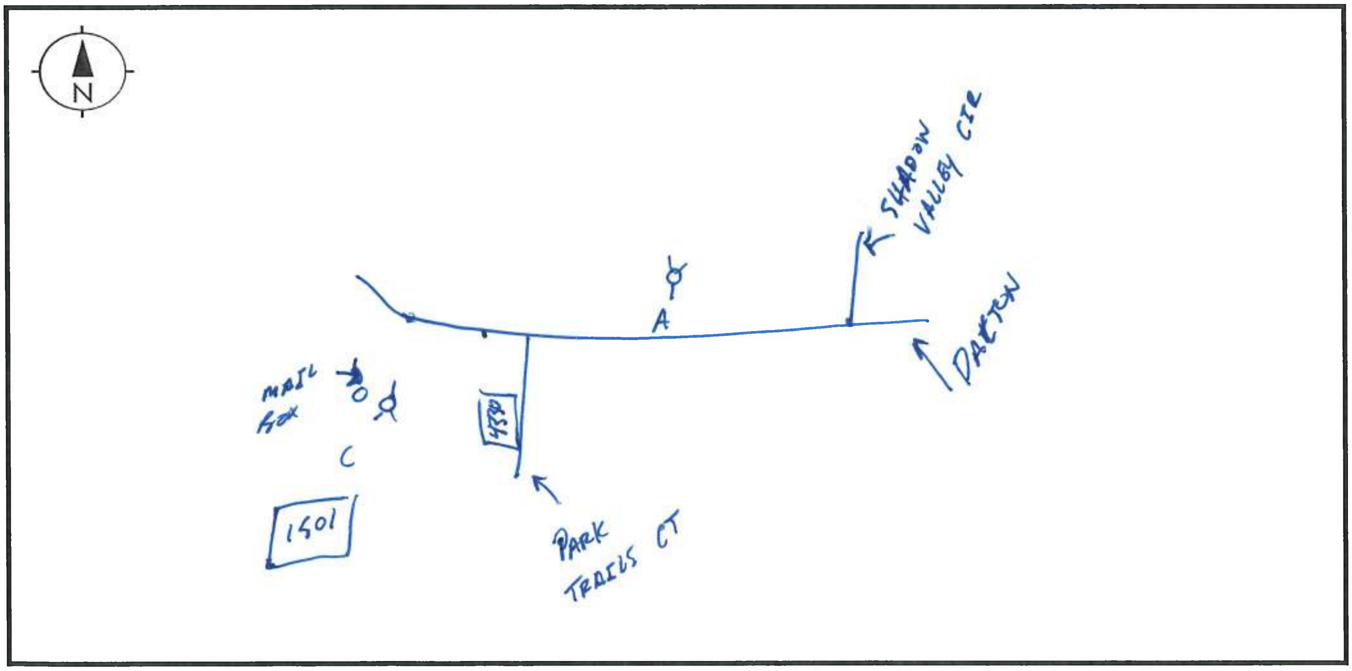
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	86	65	1353
Hydrant C:	80	78	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Park Trails Ct Dalton Ridge Dr.

Sketch



BMcD Telog Serial No.: 76155

Main Size:

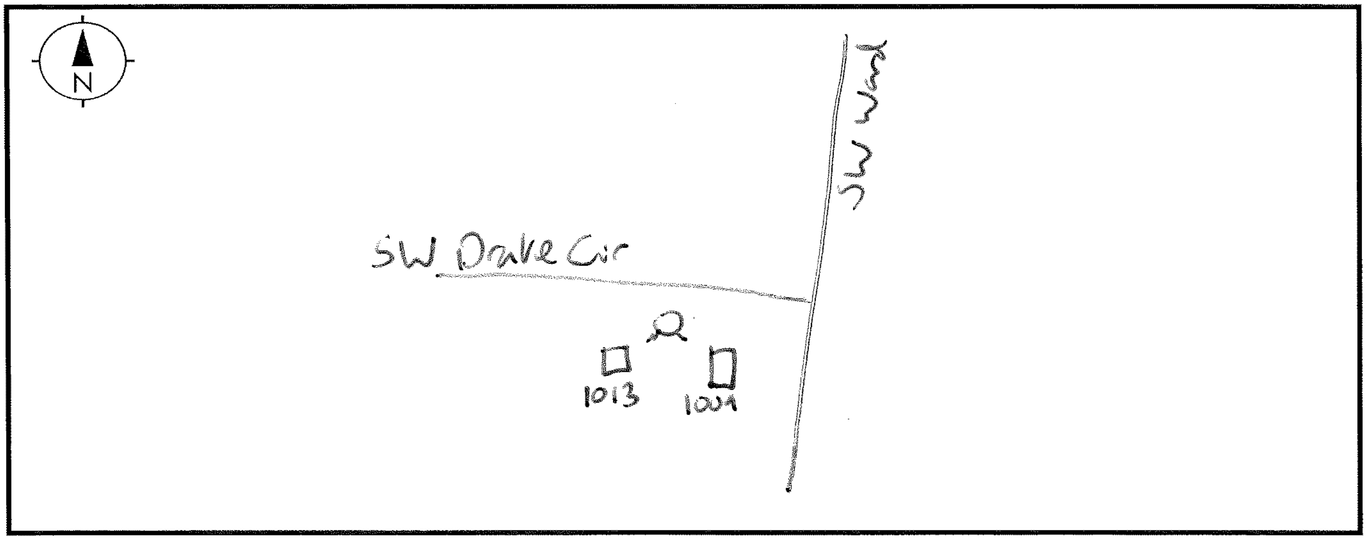
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	11:00AM
Removed:		May 19	~~[illegible]~~ 12:15

Location: SW Ward

Pressure Zone: South

Sketch:



Photos:

(2)

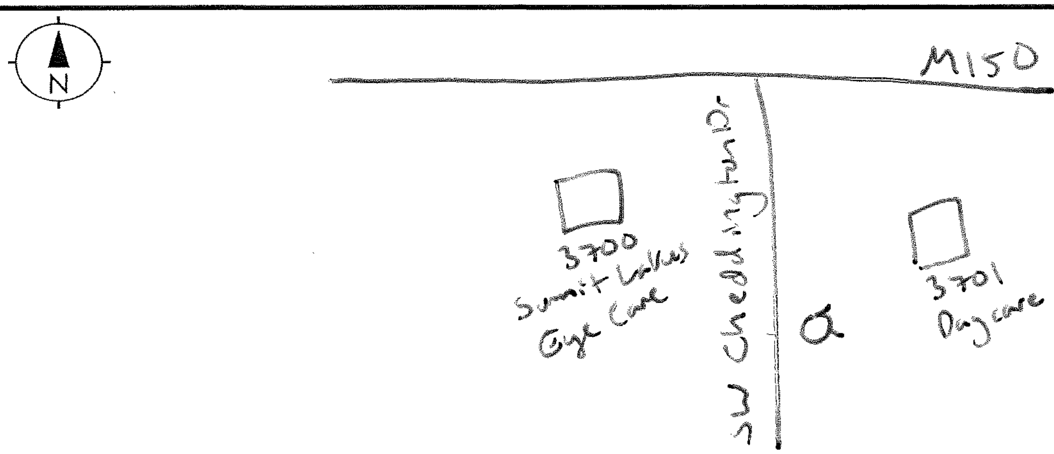
BMcD Telog Serial No.:	76159	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	11:18
Removed:		5/19	12:23

Location: SW Cheddington Dr

Pressure Zone: South

Sketch:



Photos:

System: Lee's Summit, Missouri | **Data Logger Installation Form**

BMcD Telog Serial No.: 76161

Main Size:

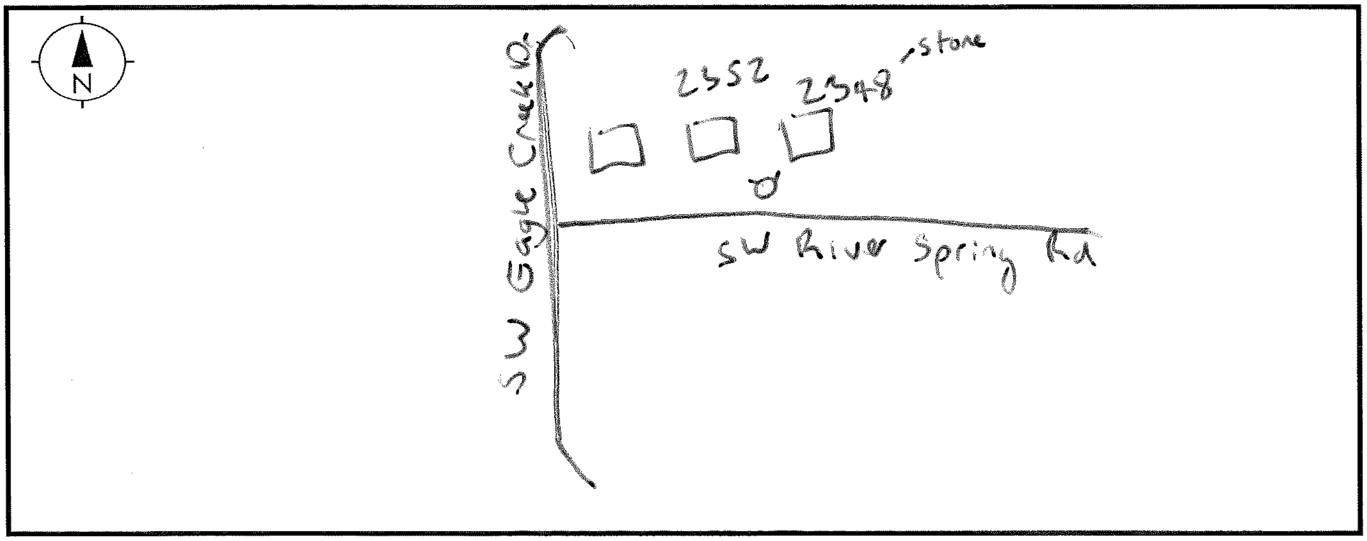
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 7	11:43
Removed:		5/[illegible] 19	12:50

Location: SW River Spring Rd

Pressure Zone: South

Sketch:



Photos:

BMcD Telog Serial No.: 76160

Main Size:

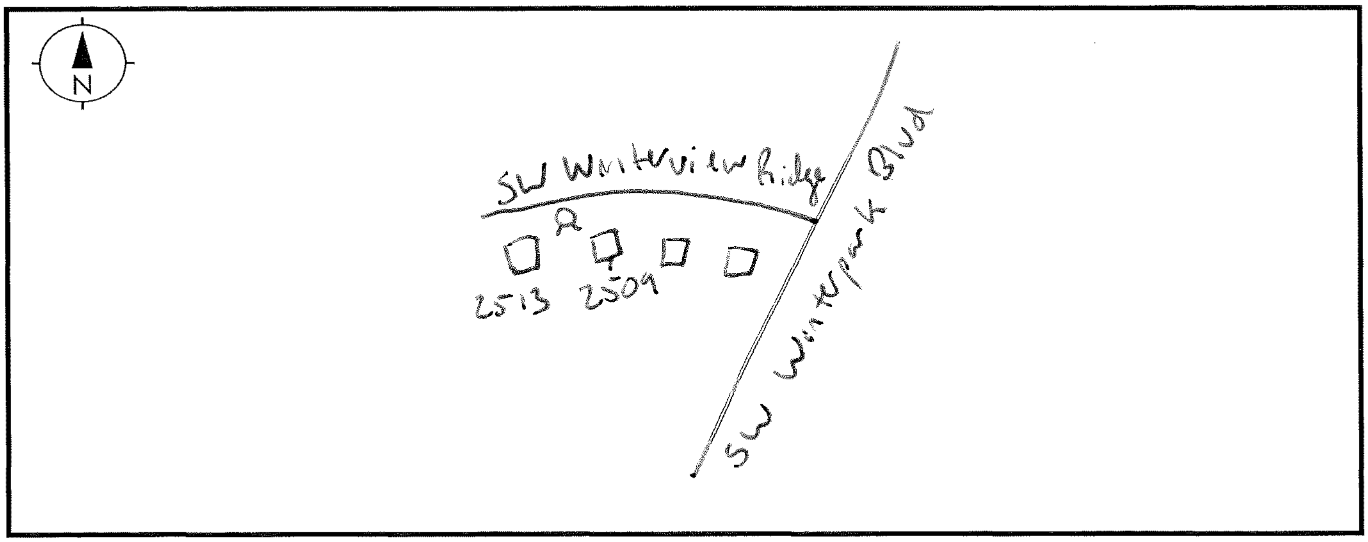
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	12:02
Removed:		5/19	1:03

Location: SW Winterpark Blvd

Pressure Zone: South

Sketch:



Photos:

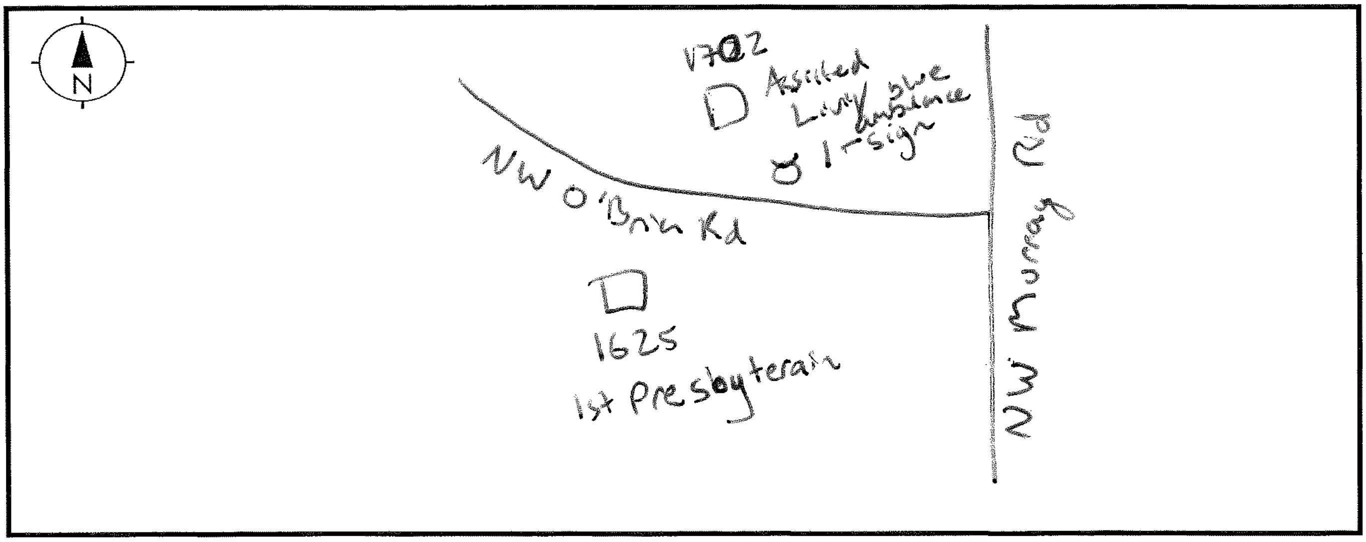
BMcD Telog Serial No.:	76153	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	12:15
Removed:		5/19	1:14

Location: NW Murray Rd

Pressure Zone: South

Sketch:



Photos:

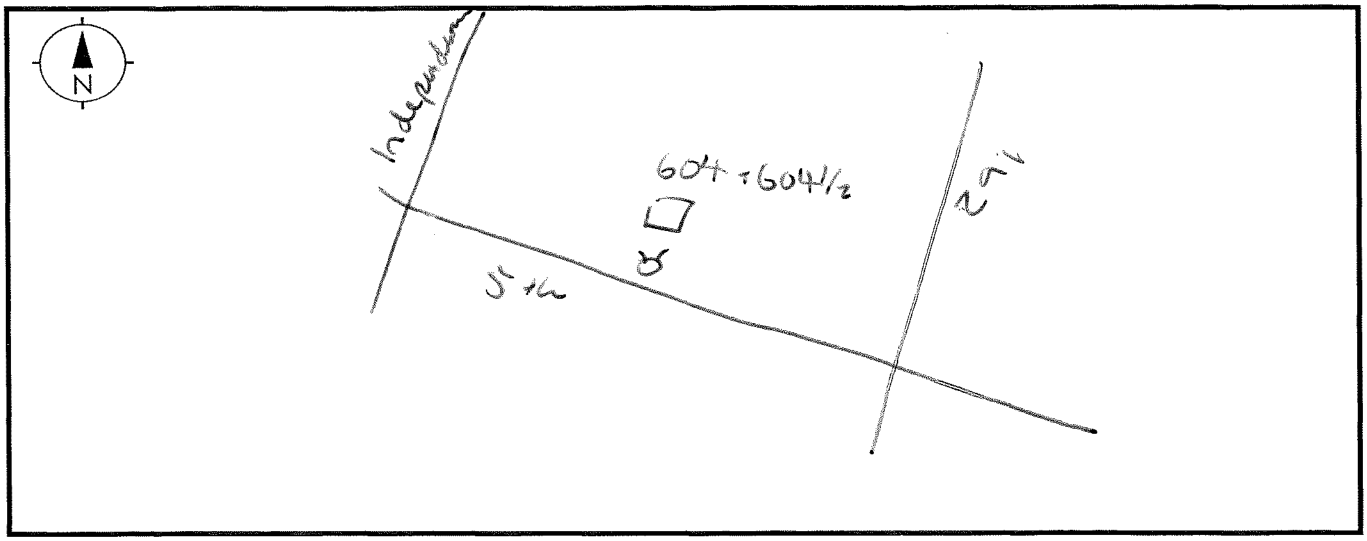
BMcD Telog Serial No.:	76152	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 27	12:37
Removed:		19	10:55

Location: 5th St

Pressure Zone: South

Sketch:



Photos:

7

BMcD Telog Serial No.: 206386

Main Size:

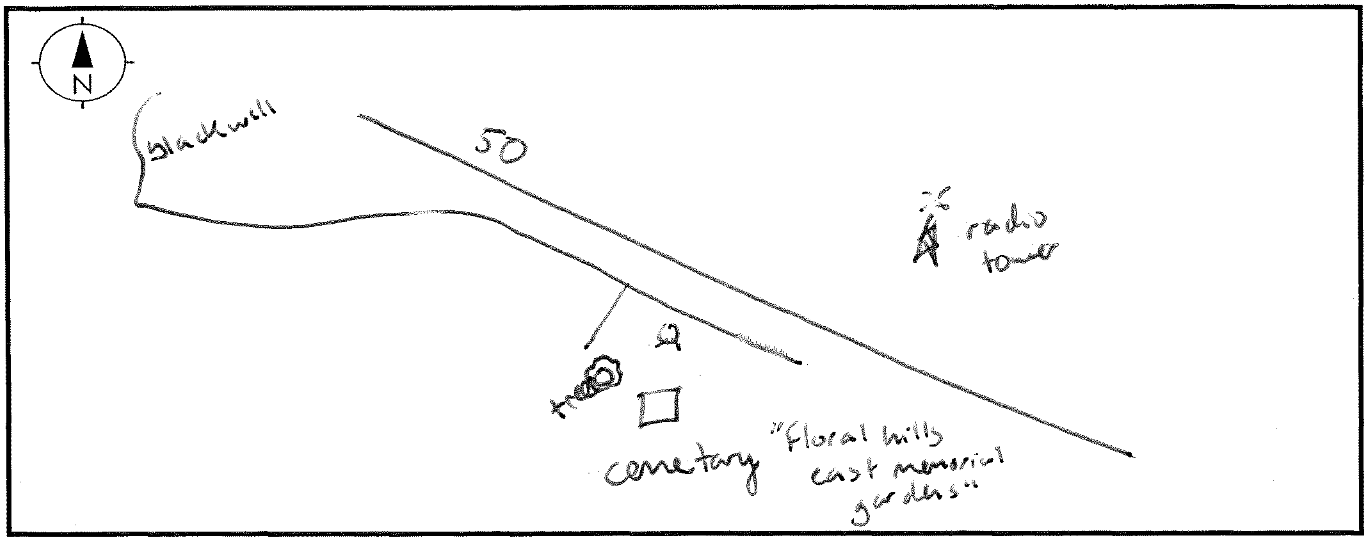
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	12:57
Removed:		May 19	10:23

Location: Floral Hills East Memorial Gardens

Pressure Zone: South

Sketch:



Photos:

System: Lee's Summit, Missouri | **Data Logger Installation Form**

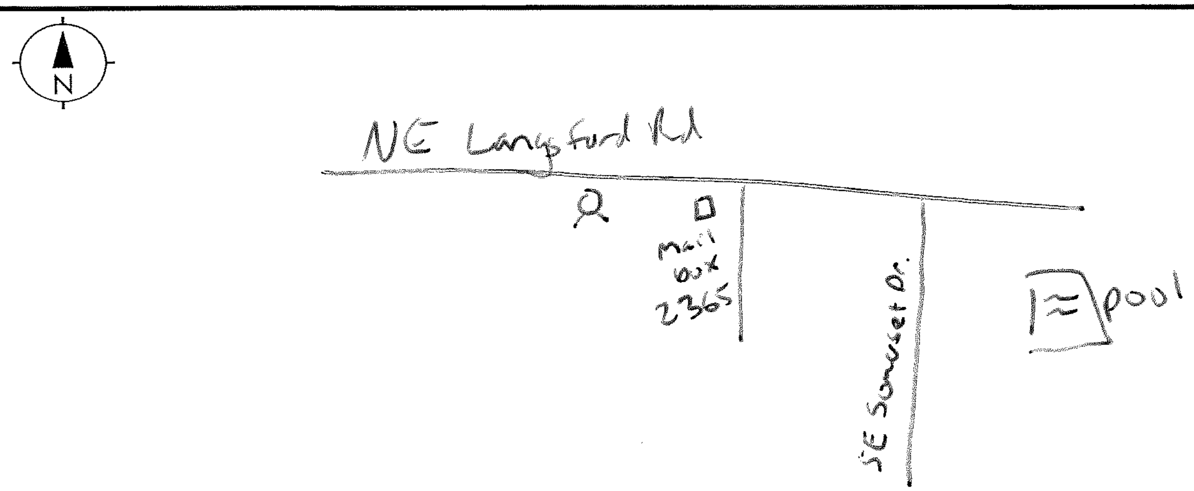
BMcD Telog Serial No.:	206385	Main Size:		Fire Hydrant Nozzle Diameter:	2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	1:57
Removed:		May 19	10:41

Location: NE Langsford Rd

Pressure Zone: South

Sketch:



Photos:

System: Lee's Summit, Missouri | **Data Logger Installation Form**

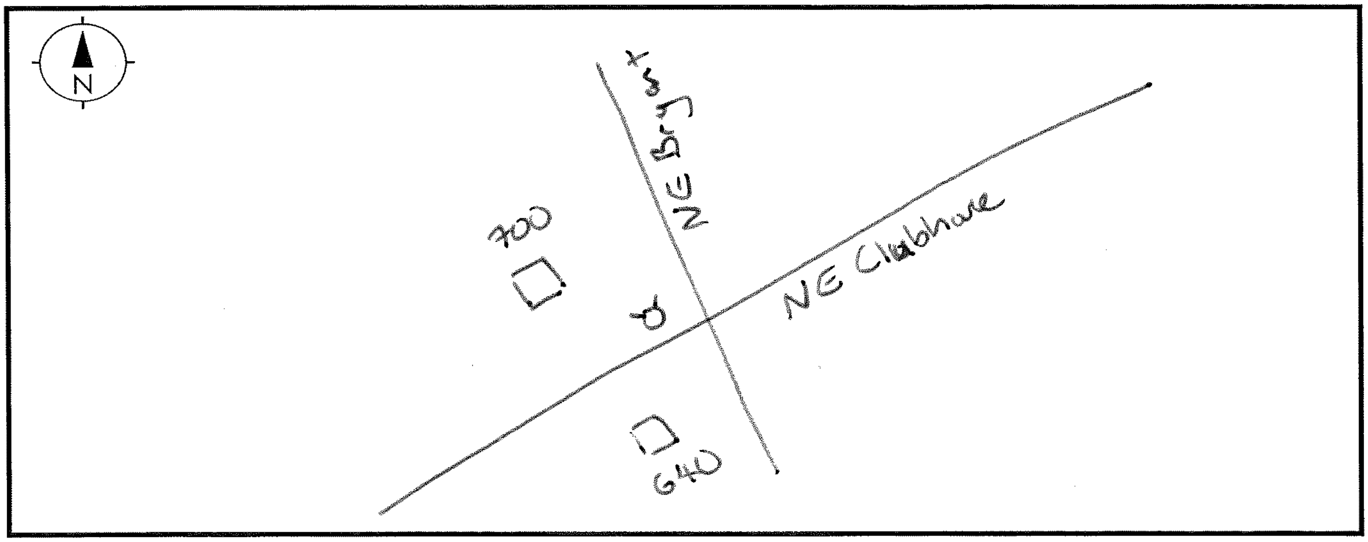
BMcD Telog Serial No.:	76151	Main Size:	
Fire Hydrant Nozzle Diameter:	2.5-inch		

	Pressure (psi)	Date	Time
Installed:		May 17	2:11
Removed:		May 19	10:39

Location: NE Bryont

Pressure Zone: South

Sketch:



Photos:

BMcD Telog Serial No.: 76156

Main Size:

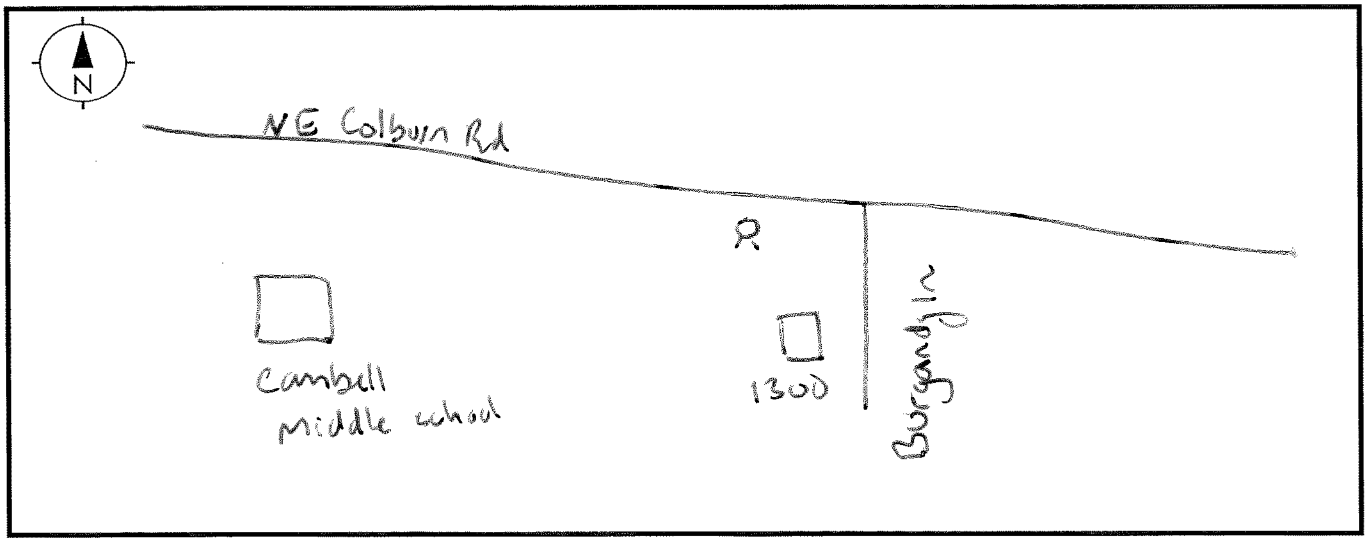
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	2:25
Removed:		May 19	9:54

Location: NE Colburn Rd

Pressure Zone: South

Sketch:



Photos:

BMcD Telog Serial No.: 76514
76154

Main Size:

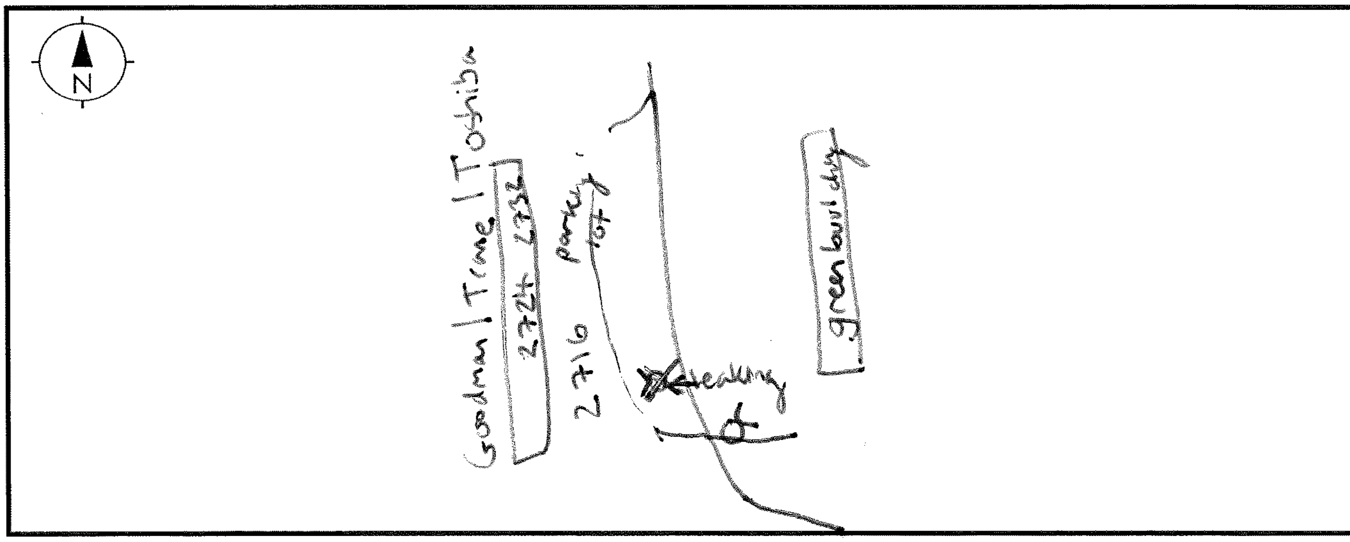
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	2:41
Removed:		May 19	9:40

Location: Goodman

Pressure Zone: South

Sketch:



Photos:

BMcD Telog Serial No.: 76157

Main Size:

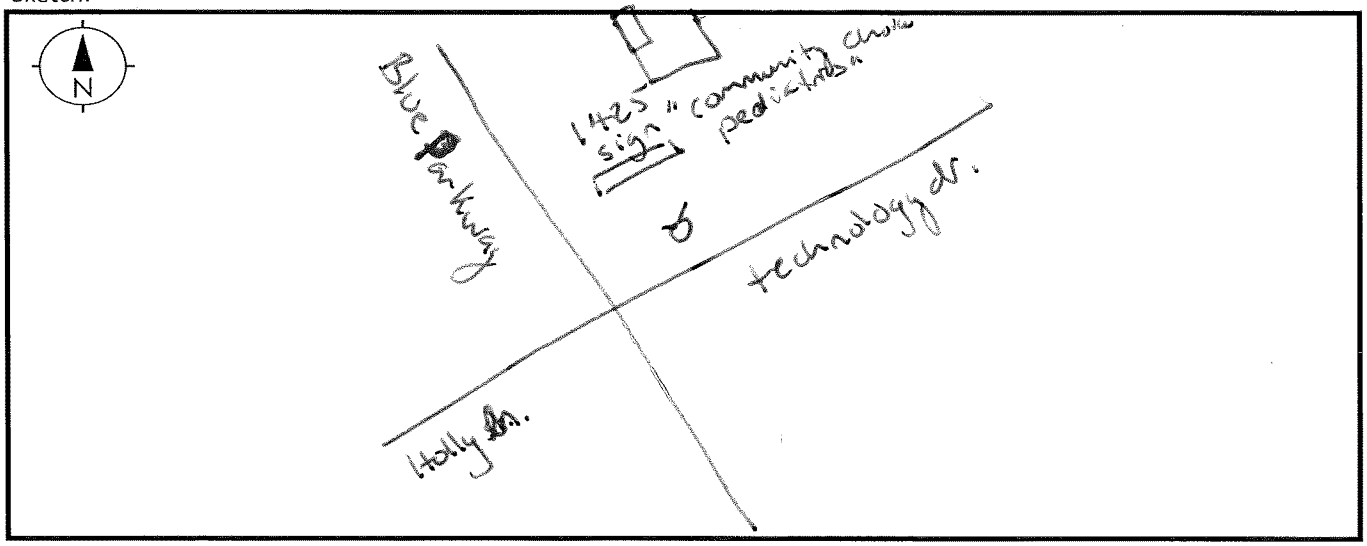
Fire Hydrant Nozzle Diameter: 2.5-inch

	Pressure (psi)	Date	Time
Installed:		May 17	3:03
Removed:		5/18	1:25

Location: Technology Drive

Pressure Zone: South

Sketch:



Photos:

Date: May 18

Time: 8:15 AM

Main Size (in):

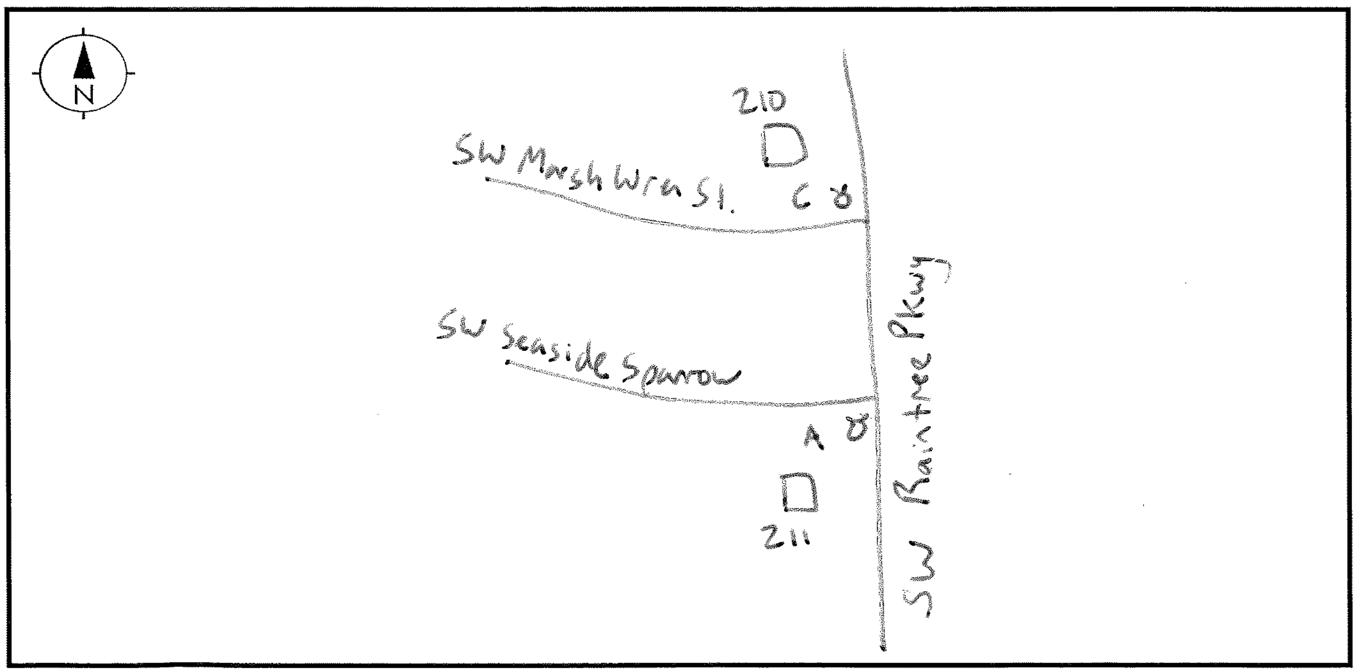
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	96	70	1404
Hydrant C:	99	81	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^{2}*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SW Raintree Pkwy

Sketch



Date: May 18

Time: 8:39

Main Size (in):

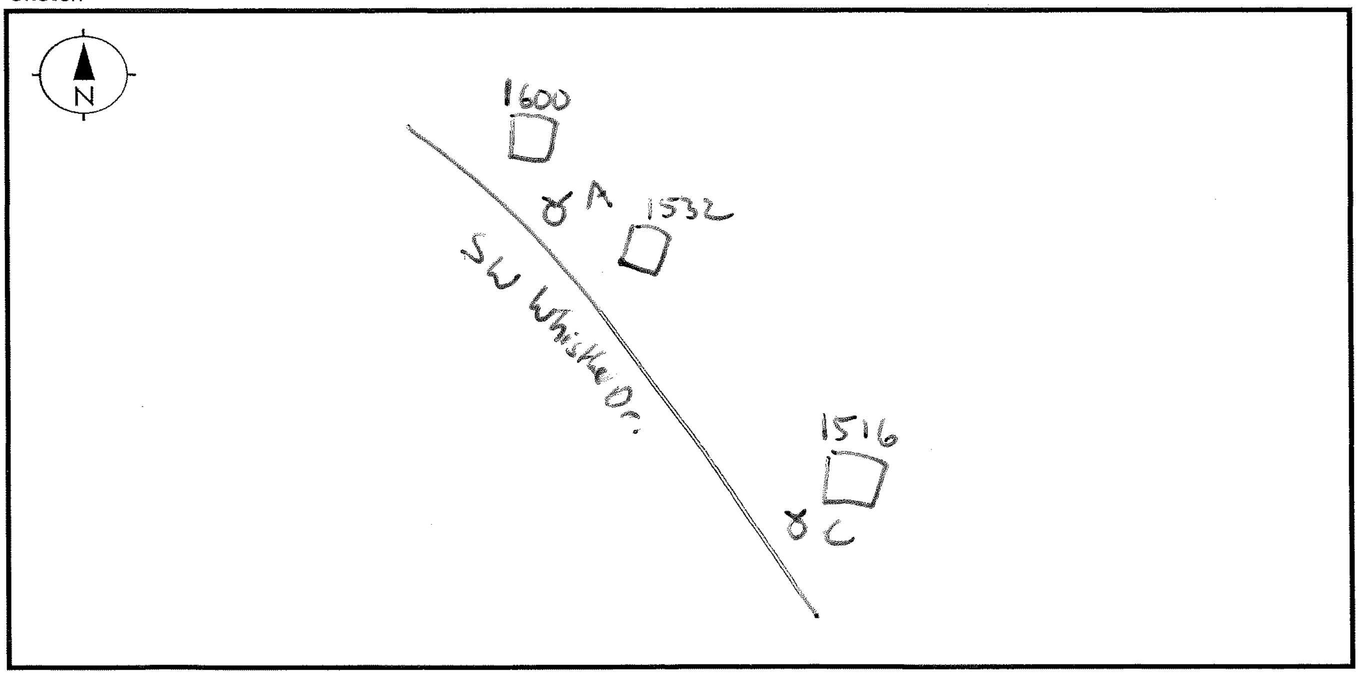
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	78	68	1348
Hydrant C:	86	81	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SW Whistle Dr.

Sketch



TJK Updated FH Tests
5_20_22 Map
Confirmed

Date: May 18

Time: 8:58

Main Size (in):

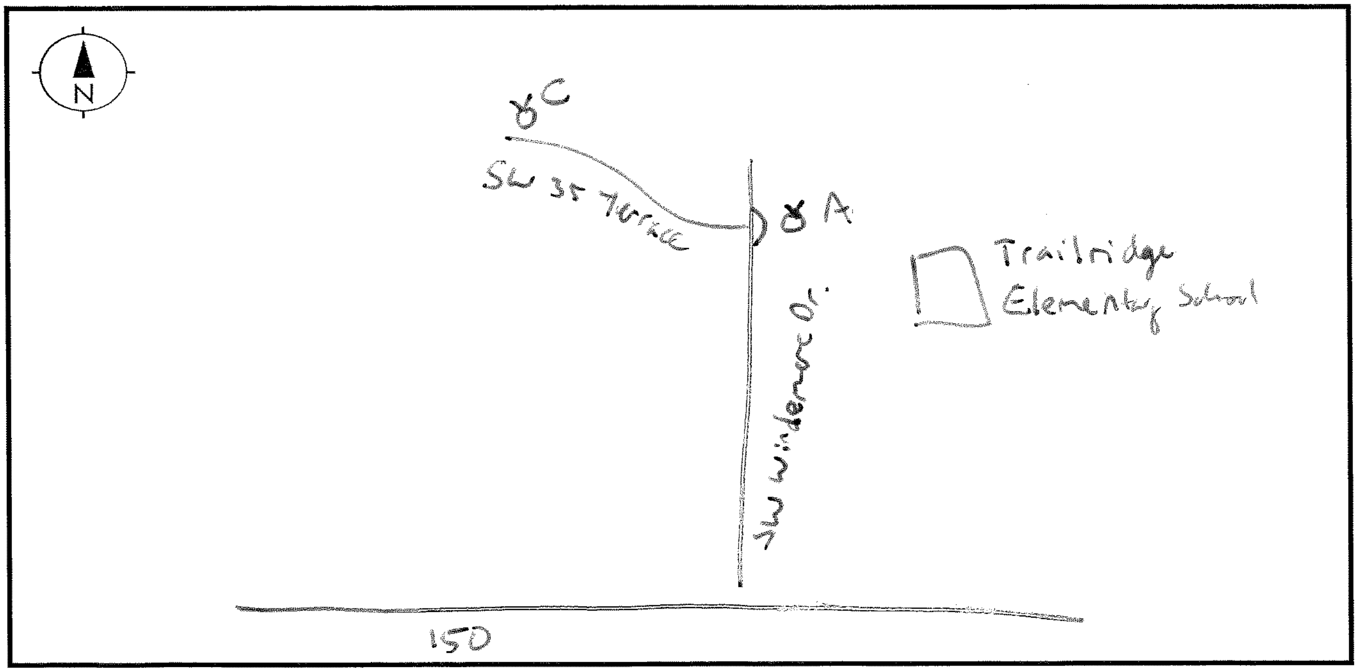
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	90	68	1348
Hydrant C:	88	76	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: Trailridge Elementary School

Sketch



Date: May 18

Time: 9:29

Main Size (in):

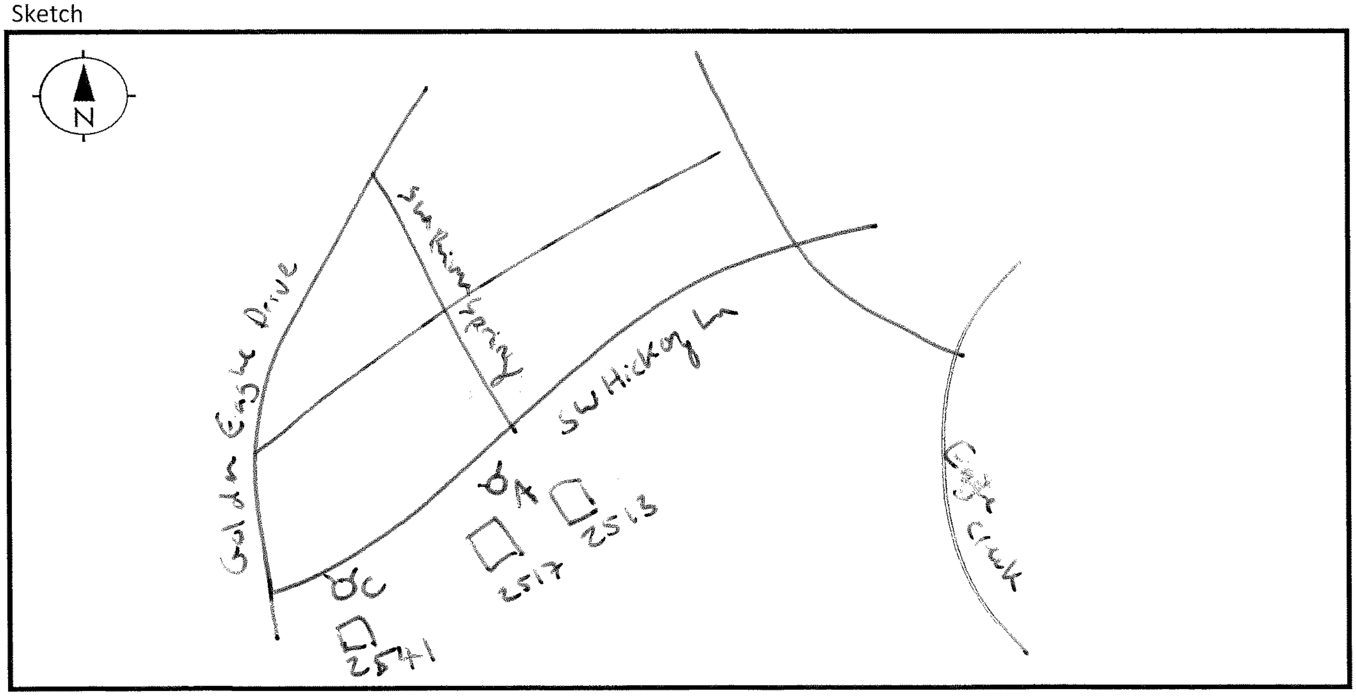
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	114	100	1678
Hydrant C:	118	107	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SW Hickory Ln

Sketch



5

Date: May 18 | Time: 9:53

Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	94	84	1538
Hydrant C:	107	88	

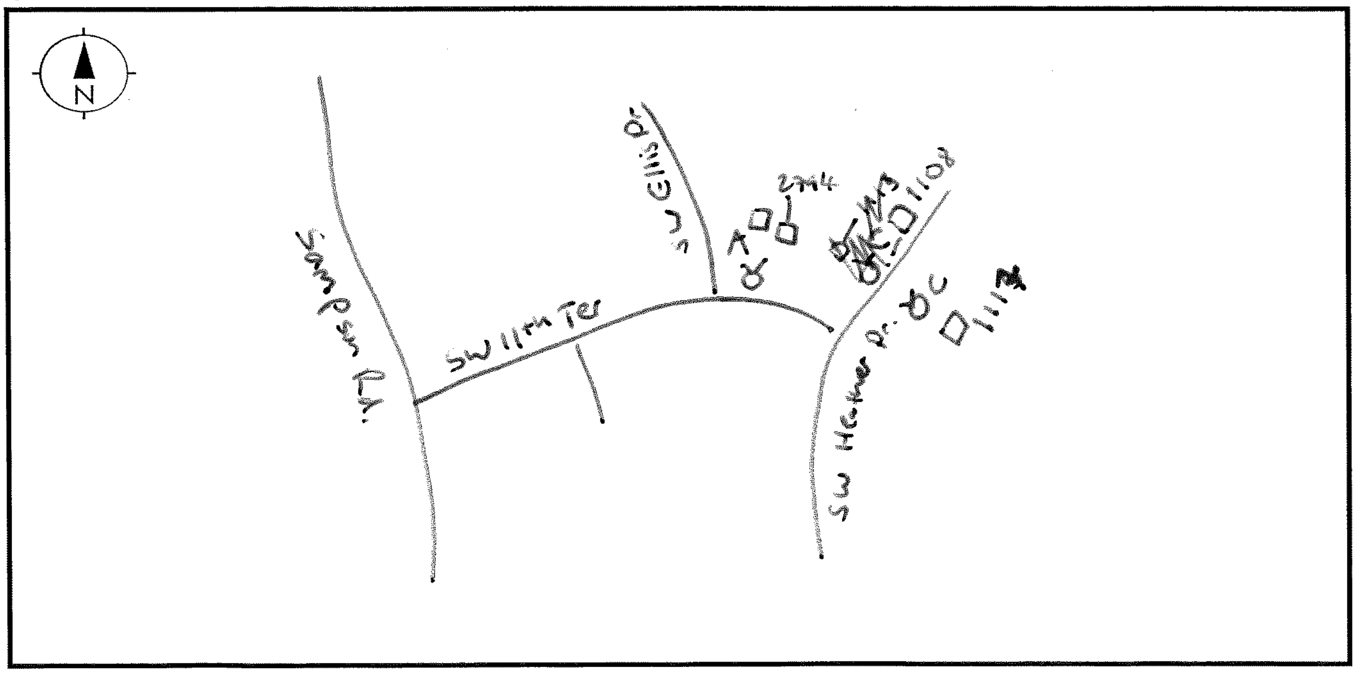
88 or 98?

--it is 88

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SW 11th Terrace

Sketch



Date: May 18

Time: 10:12

Main Size (in):

FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	120	104	1686
Hydrant C:	109	104	

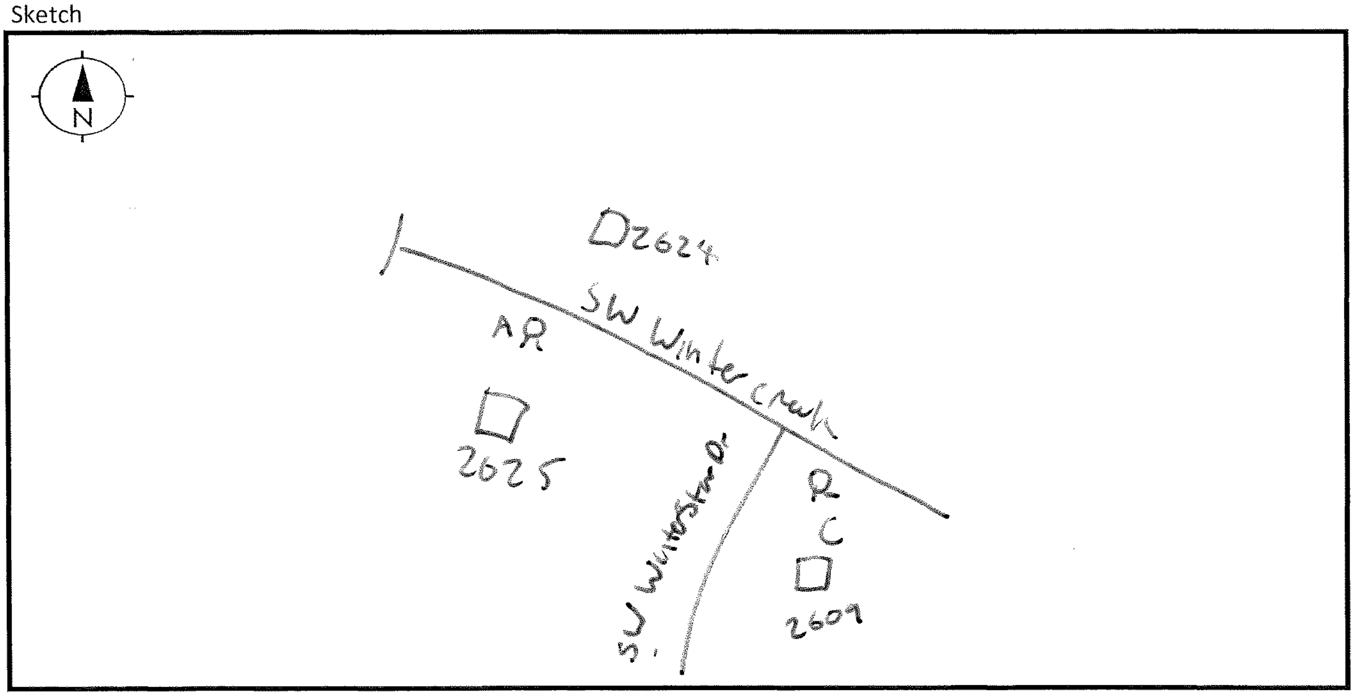
101 or 104?

--it is 101

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SW Winter Creek

Sketch



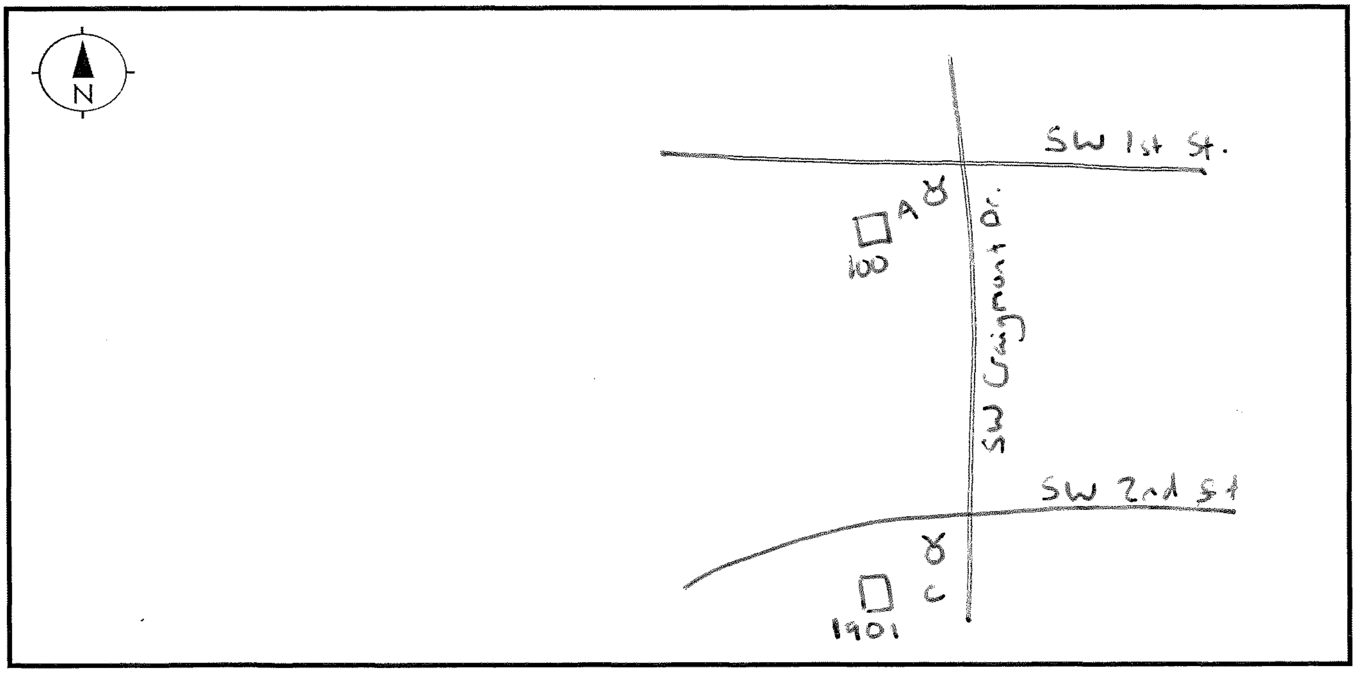
Date:	May 18	Time:	10:36
Main Size (in):		FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	92	62	1321
Hydrant C:	94	90	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SW Craigmont Drive

Sketch



Date: May 18

Time: 11:01

Main Size (in):

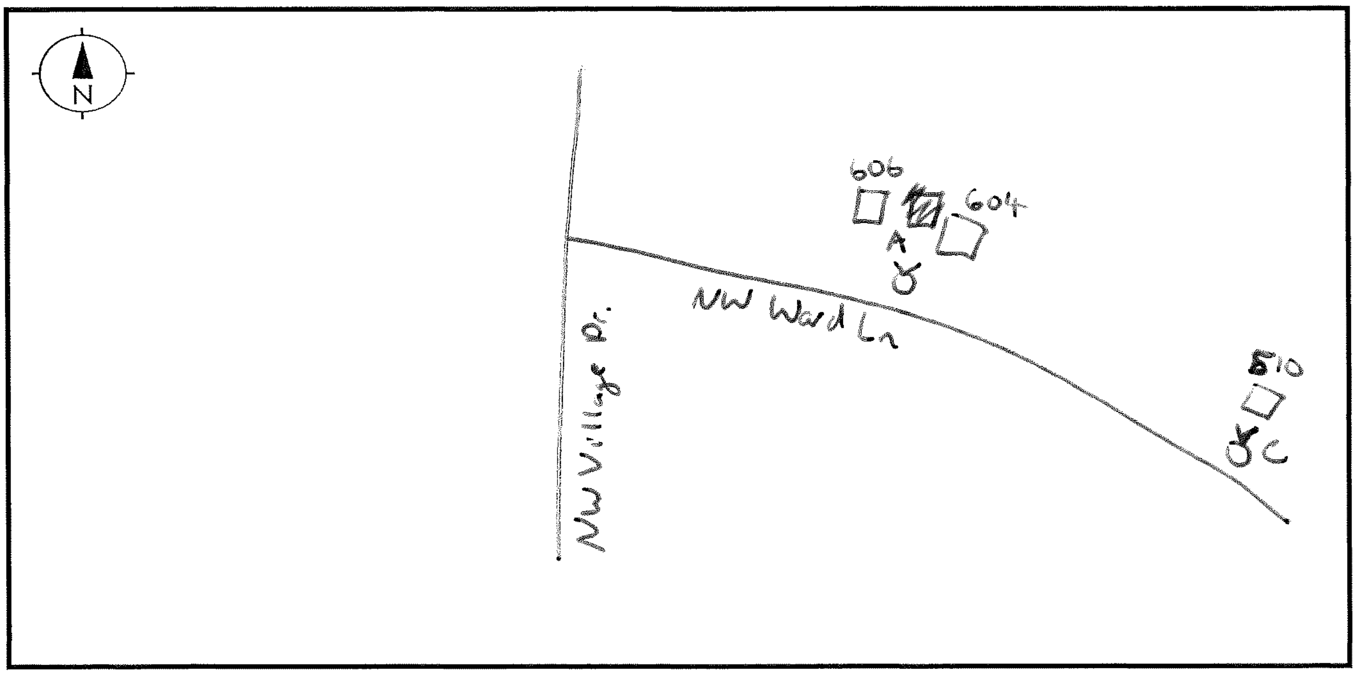
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	98	82	1519
Hydrant C:	95	86	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NW Ward Lane

Sketch



Date: May 18 | Time: 11:19

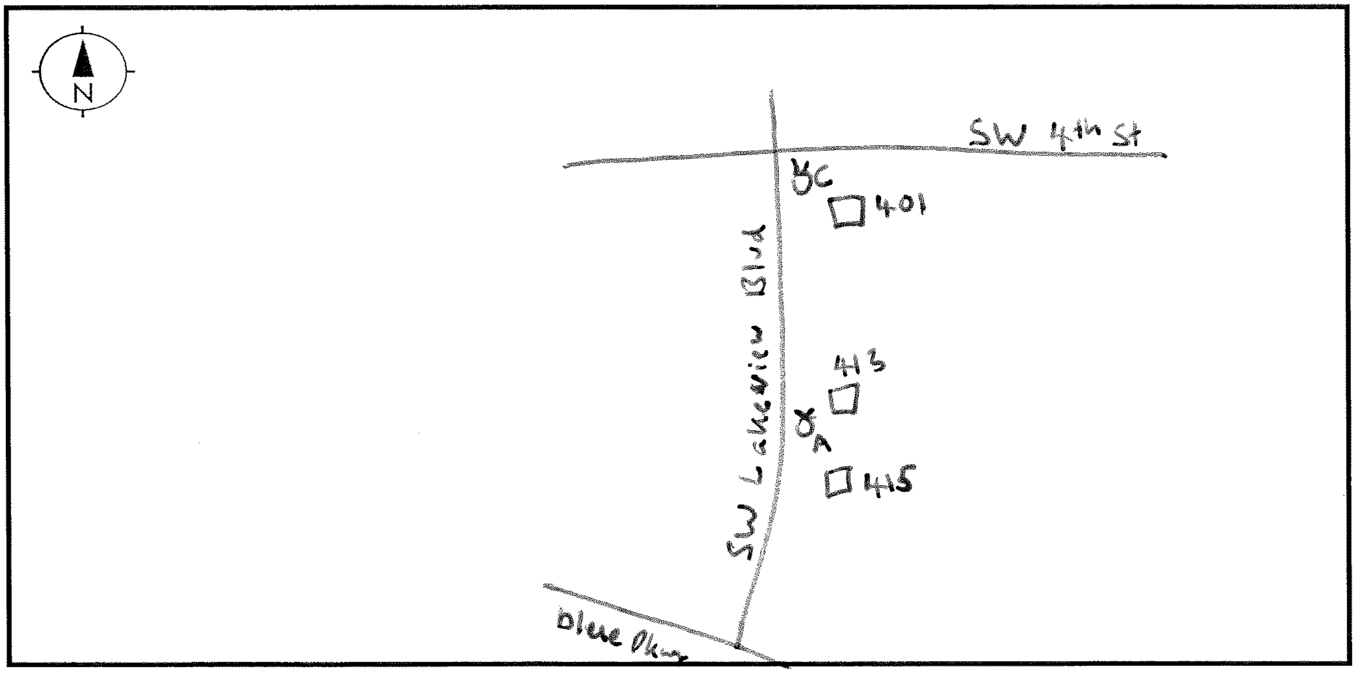
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	72	54	1233
Hydrant C:	67	62	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SW Lakeview Blvd

Sketch



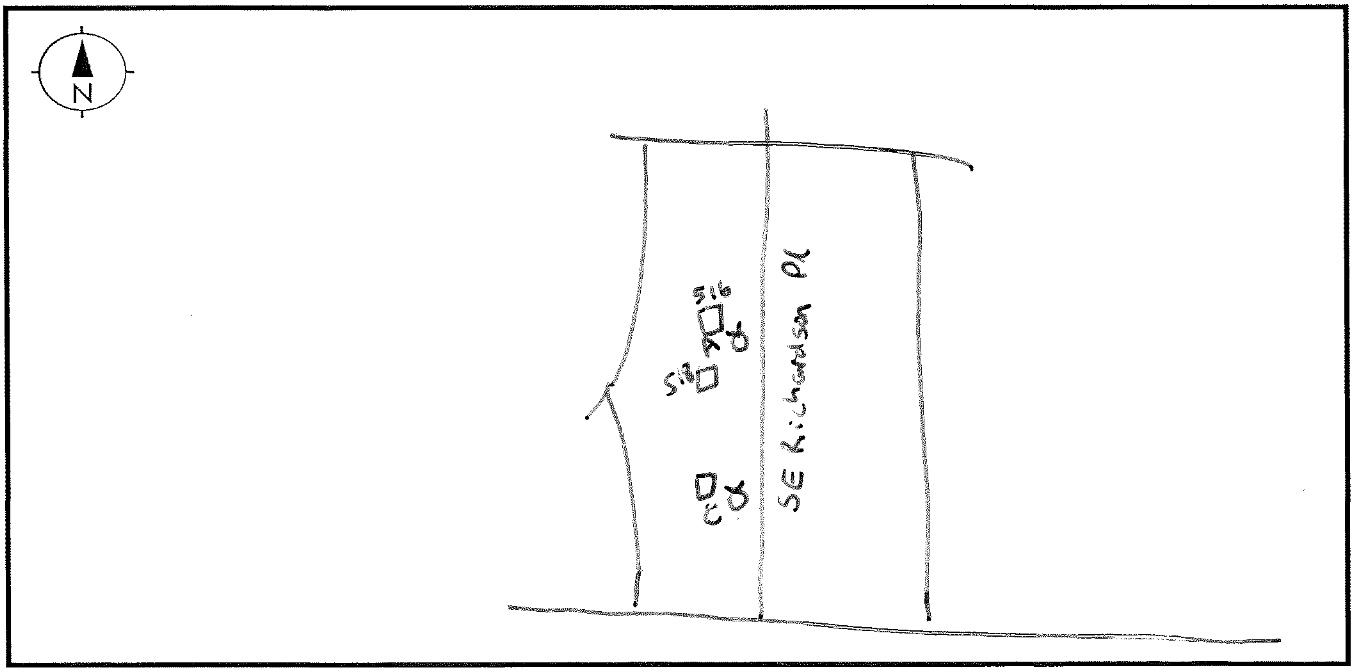
Date:	May 18	Time:	11:37
Main Size (in):		FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	82	48	1163
Hydrant C:	81	78	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SE Richardson Place

Sketch



Date: May 18

Time: 12:01

Main Size (in):

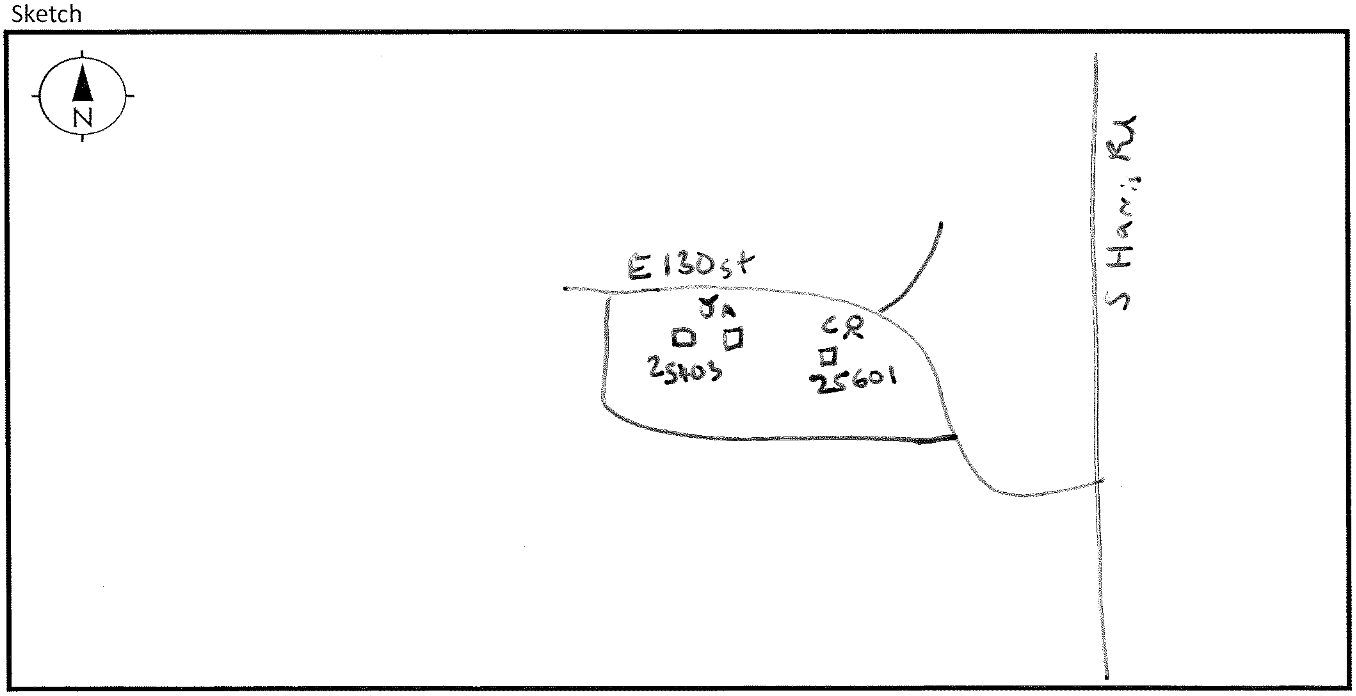
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	90	52	1210
Hydrant C:	82	56	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: E 130 St

Sketch



Date: May 18

Time: 1:01

Main Size (in):

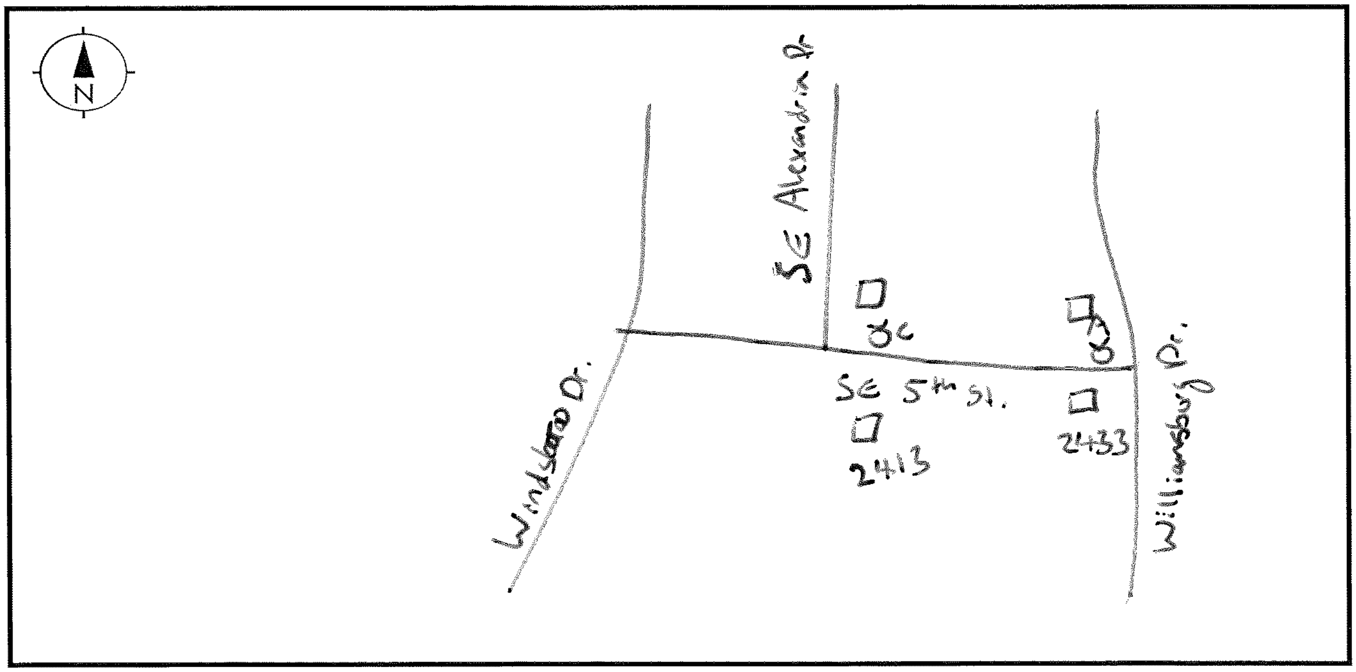
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	96	85	1547
Hydrant C:	90	84	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SE 5th Street

Sketch



Date: May 18 | Time: 1:19

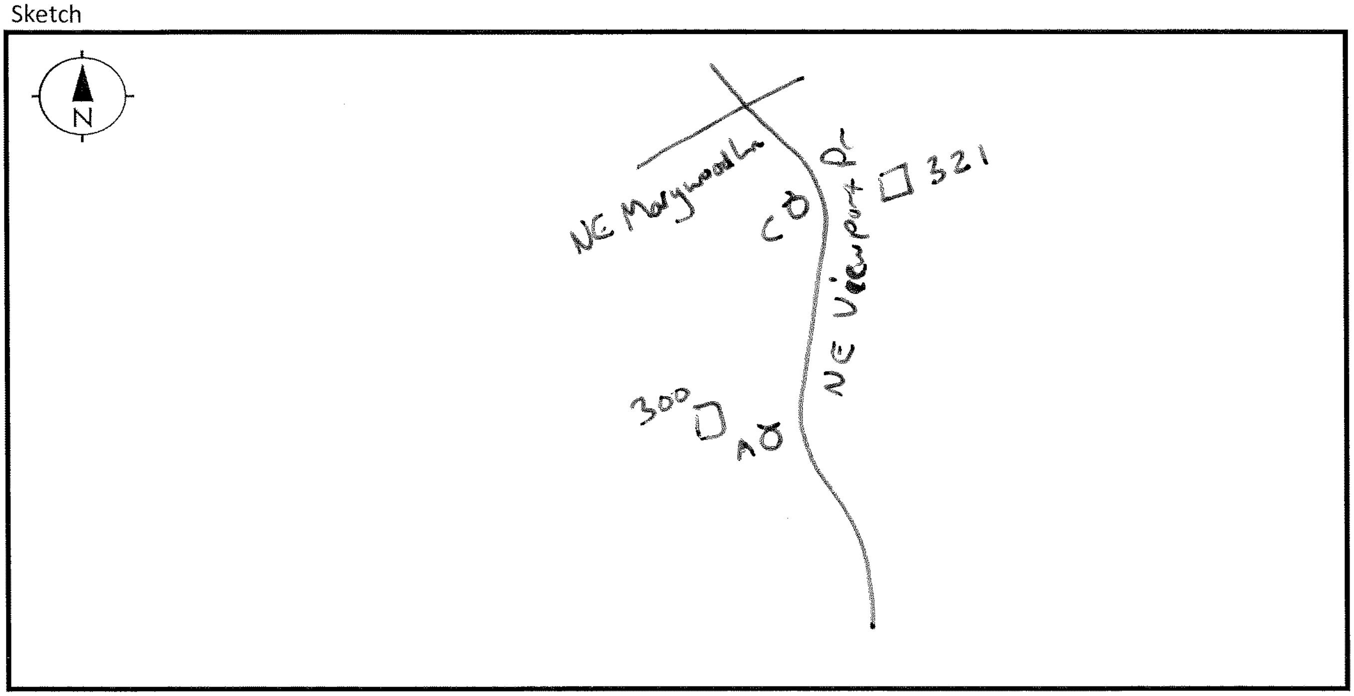
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	~~108~~ 107	92	1609
Hydrant C:	107	101	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Viewport Drive

Sketch



Date: May 18

Time: 1:34

Main Size (in):

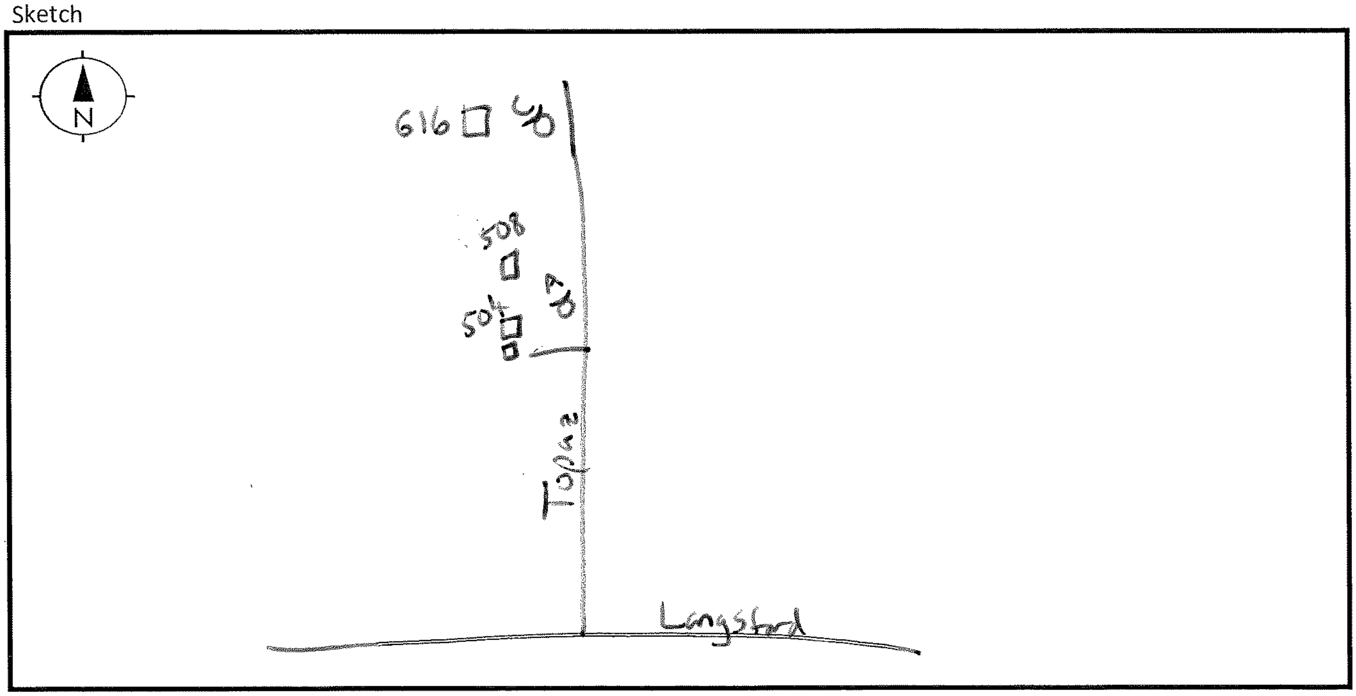
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	113	100	1678
Hydrant C:	~~101~~ 122	116	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Topaz Drive

Sketch



Date: May 18

Time: 1:50

Main Size (in):

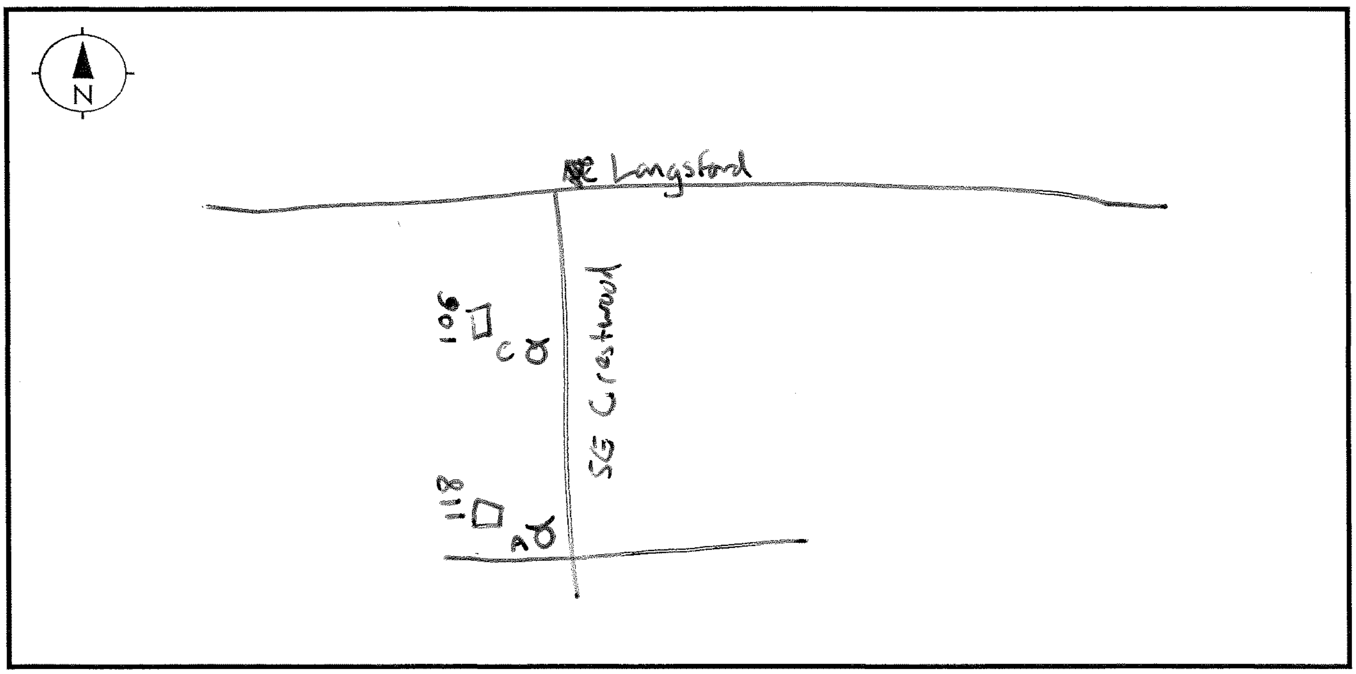
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	105	76	1463
Hydrant C:	104	99	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: SE Crestwood Street

Sketch



Date: May 18

Time: 2108

Main Size (in):

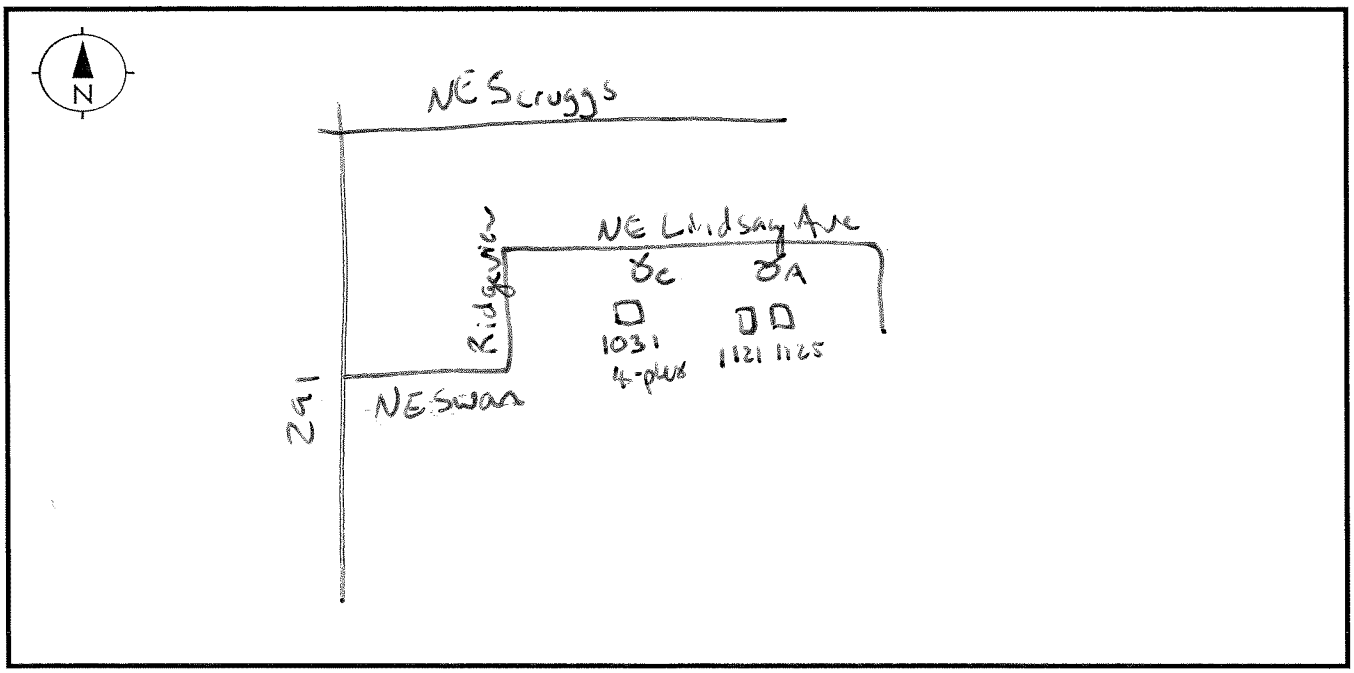
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	93	66	1363
Hydrant C:	98	84	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Lindsay Ave

Sketch



Date: May 18

Time: 2:26

Main Size (in):

FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	100	86	1556
Hydrant C:	103	96	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Mulberry St

Sketch

Date: May 19 | Time: 7:26 AM

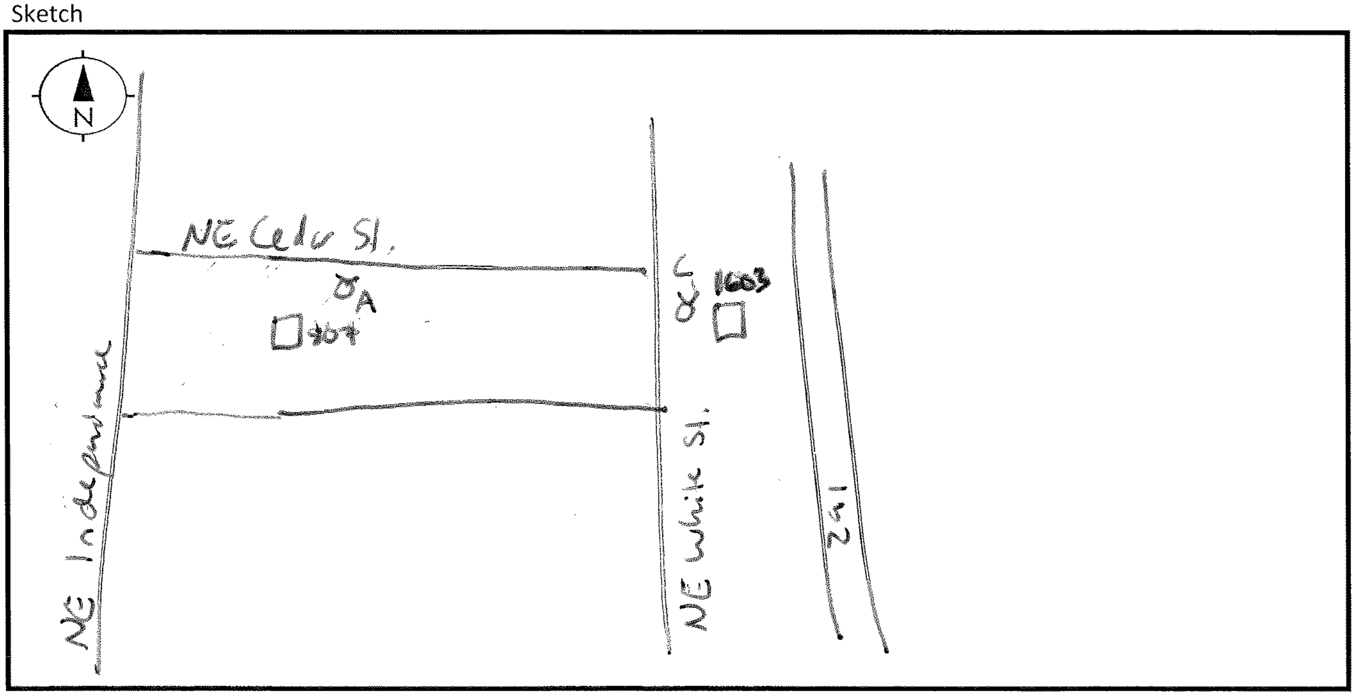
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	104	76	1463
Hydrant C:	107	101	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Cedar Street

Sketch



Date: May 19 | Time: 7:39

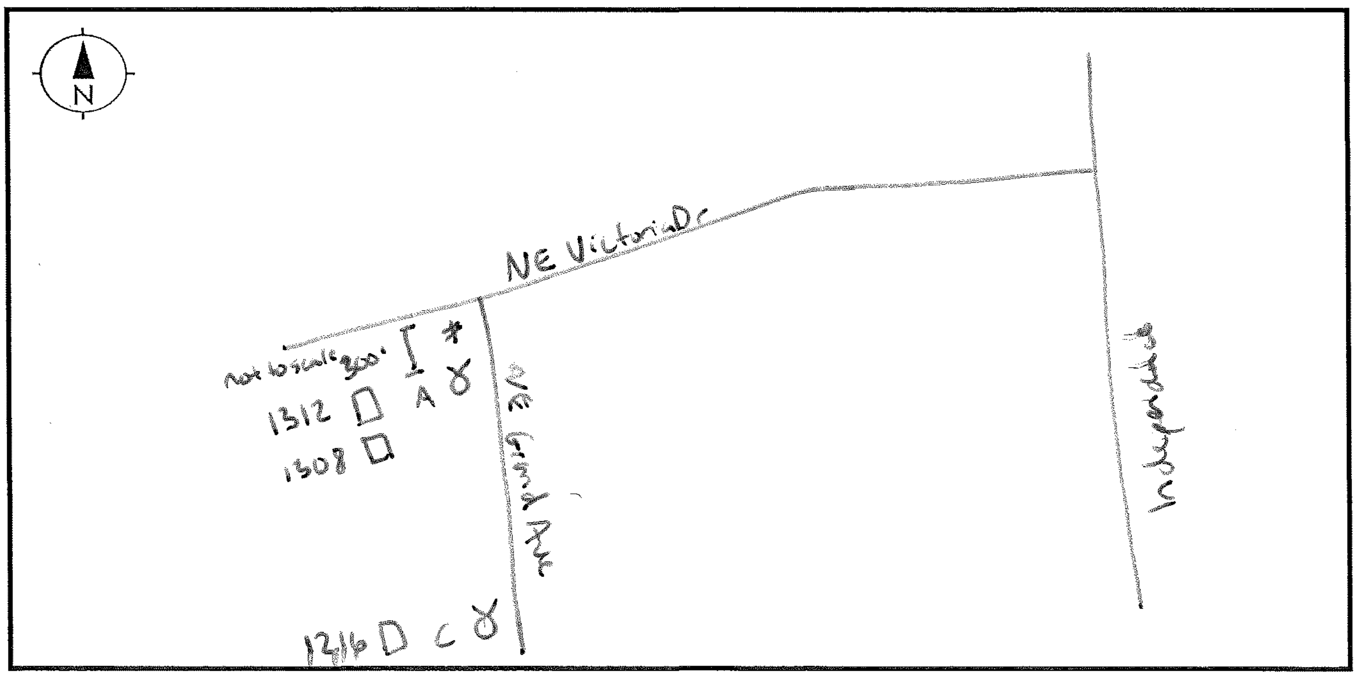
Main Size (in): | FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	79	62	1321
Hydrant C:	86	78	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Grand Avenue

Sketch



System: Lee's Summit, Missouri - South Pressure Zone **Hydrant Test Form**

Date: May 19 Time: 8:17

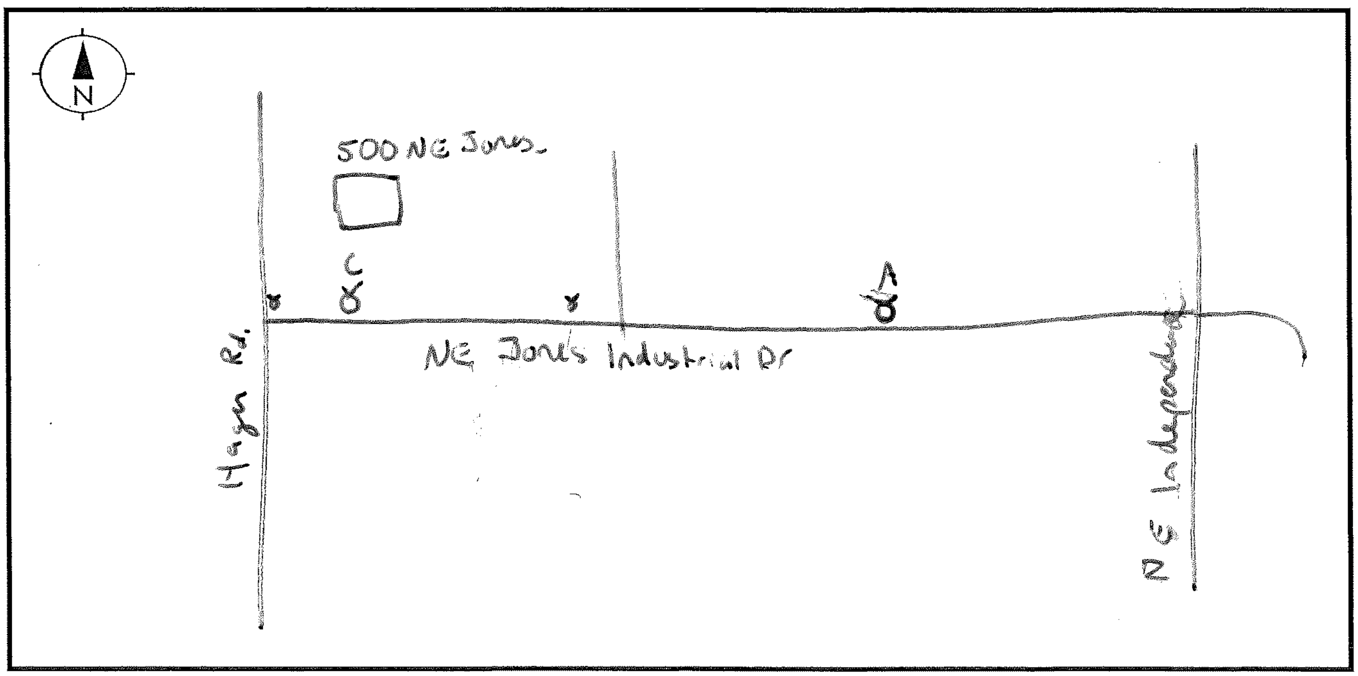
Main Size (in): FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	103	92	1609
Hydrant C:	109	104	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NE Jones Industrial Drive

Sketch



System: Lee's Summit, Missouri - South Pressure Zone **Hydrant Test Form**

Date: May 19 Time: 8:51 AM

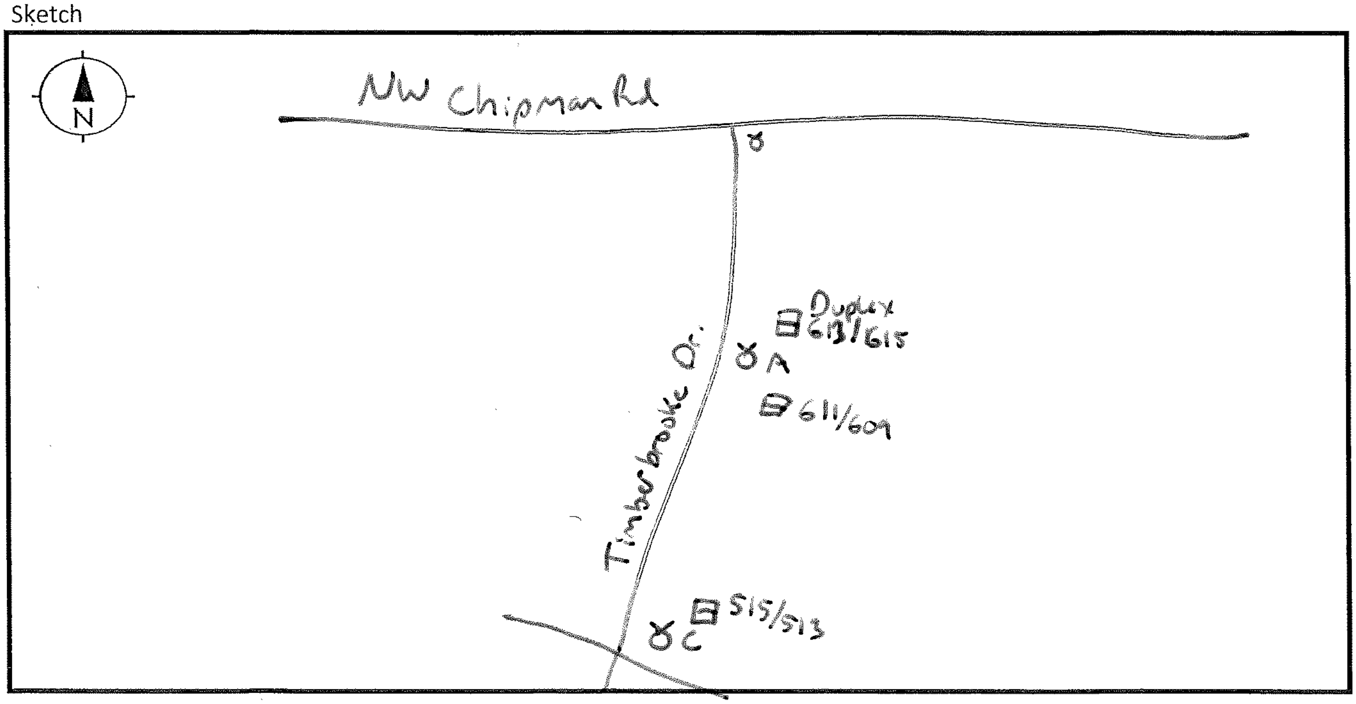
Main Size (in): FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	109	88	1574
Hydrant C:	115	104	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: ~~Fest~~ Timberman Dr.

Sketch



Date: May 19

Time: 9:09 AM

Main Size (in):

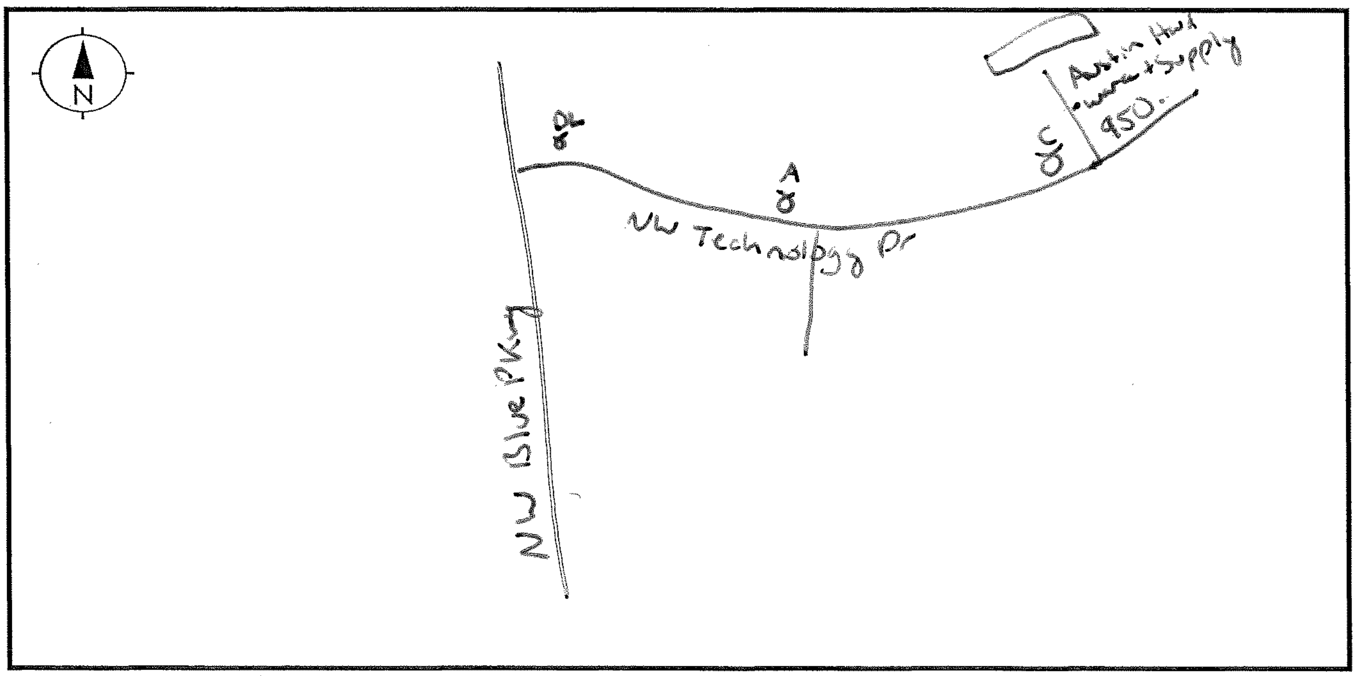
FH Nozzle Size (in): 2.5

	Static Pressure (psi)	Flowing Pressure (psi)	Flow[1] (gpm)
Hydrant A:	108	98	1661
Hydrant C:	110	108	

Notes: 1. Flow = 29.83*(discharge coefficient)*(FH nozzle size)^2*(Hydrant A, LG Flowing)$^{0.5}$
Discharge coefficient = 0.9

Location: NW Technology Drive

Sketch



APPENDIX E MODEL CALIBRATION RESULTS

Appendix E

South Pressure Zone Model Calibration

		6:15:00 AM	IND Direct												lvl	gpm	eff. Dia	lvl	gpm	eff. Dia	lvl	gpm	eff. Dia
															162.4	100	113.0	151.40	-567	113.0	151.50	-557	103
			Demand	South Terminal Pumping Station (KCMO Supply)					High Service Pump Station						Elevated Storage								
			South	Shared	South	South	Metered to	Metered to	South	South	South			South	South			South			South		
			5838.92	GST			Ward Rd	Scherer Rd	GST1 (5.5 MG)	GST2 (4.0 MG)					Scherer Tower			Hook Tower			Ranson Tower		
Fire Hydrant Test Location	Date	Time	Calculated	Level	Discharge Pressure	Pumps 1, 2, 3, 4 ON/OFF Status	Flow	Flow	Level	Level	Discharge Pressure	North Flow	South Flow	Pumps 1, 2, 3, 4 ON/OFF Status	Tower Level (measured from Datum)	Tower Level (measured from BCL)	System Pressure	Tower Level (measured from Datum)	Tower Level (measured from BCL)	System Pressure	Tower Level (measured from Datum)	Tower Level (measured from BCL)	System Pressure
			(gpm)	(ft)	(psi)	(Pumps Active)	(gpm)	(gpm)	(ft)	(ft)	(psi)	(gpm)	(gpm)	(Pumps Active)	(ft)	(ft)	(psi)	(ft)	(ft)	(psi)	(ft)	(ft)	(psi)
SW Raintree Pkwy	Δt (min)	9	0.717			OFF								P4 ON	-140.0	**134**		-130.0	**-567**		-128.0	**-538**	
Field Data (SCADA)	5/18/2022	8:14 AM	4,186	50.6	94.9		0	0	14.9	14.2	62	4,082	1,077	SETTING: 0.94	162.3	22.3	68.5	151.9	21.9	63.5	152.1	24.1	66.0
Model Results		Test 1									60	1,075	4,517				70.4			65.7			65.9
SW Whistle Drive	Δt (min)	23	0.874			OFF								P4 ON		**39**			**-127**			**171**	
Field Data	5/18/2022	8:38 AM	5,106	50.7	95.5		0	0	14.9	14.2	61	4,068	955	SETTING: 0.94	162.2	22.2	68.6	152.2	22.2	63.7	151.6	23.6	66.0
Model Results		Test 2									60	1,090	4,531				70.0			65.2			65.7
Trailridge Elementary School	Δt (min)	20	0.888			OFF								P4 ON		**60**			**103**			**-113**	
Field Data	5/18/2022	8:58 AM	5,184	50.7	96.8		0	0	14.9	14.2	62	4,059	1,074	SETTING: 0.94	162.1	22.1	68.5	152.0	22.0	63.6	151.9	23.9	66.0
Model Results		Test 3									62	1,087	4,427				70.9			66.3			66.0
SW Hickory Lane	Δt (min)	31	0.912			OFF								P4 ON		**32**			**96**			**108**	
Field Data	5/18/2022	9:28 AM	5,324	50.8	96.0		0	0	14.9	14.2	62	4,079	1,009	SETTING: 0.94	162.0	22.0	68.5	151.7	21.7	63.5	151.5	23.5	65.8
Model Results		Test 4									59	1,100	4,539				69.4			64.9			65.6
SW 11th Terrace	Δt (min)	25	0.890			OFF								P4 ON		**40**			**0**			**0**	
Field Data	5/18/2022	9:53 AM	5,199	50.8	96.0		0	0	14.9	14.2	63	4,006	1,153	SETTING: 0.94	161.9	21.9	68.3	151.7	21.7	63.5	151.5	23.5	65.9
Model Results		Test 5									59	1,120	4,530				70.1			65.6			65.6
SW Winter Creek	Δt (min)	17	0.884			OFF								P4 ON		**59**			**0**			**-49**	
Field Data	5/18/2022	10:10 AM	5,164	50.9	95.4		0	0	14.9	14.2	62	4,030	1,124	SETTING: 0.94	161.8	21.8	68.4	151.7	21.7	63.5	151.6	23.6	65.8
Model Results		Test 6									59	1,083	4,525				70.1			65.6			65.7
SW Craigmont Drive	Δt (min)	26	0.885			OFF								P4 ON		**0**			**0**			**0**	
Field Data	5/18/2022	10:36 AM	5,166	51.0	95.2		0	0	14.9	14.2	61	4,090	1,076	SETTING: 0.94	161.8	21.8	68.4	151.7	21.7	63.6	151.6	23.6	65.9
Model Results		Test 7									59	1,103	4,534				70.1			65.7			65.7
NW Ward Lane	Δt (min)	25	0.879			OFF								P4 ON		**48**			**-160**			**70**	
Field Data	5/18/2022	11:01 AM	5,134	51.1	95.6		0	0	14.9	14.2	62	4,120	1,056	SETTING: 0.94	161.7	21.7	68.3	152.1	22.1	63.7	151.4	23.4	68.3
Model Results		Test 8									59	1,113	4,537				70.1			65.8			65.6
SW Lakeview Blvd	Δt (min)	17	0.946			OFF								P4 ON		**-12**			**347**			**26**	
Field Data	5/18/2022	11:18 AM	5,521	51.1	95.6		0	0	14.9	14.2	62	4,138	1,021	SETTING: 0.94	161.7	21.7	63.4	151.5	21.5	63.4	151.3	23.3	65.7
Model Results		Test 9									59	1,099	4,545				70.1			65.6			65.6
SE Richardson Place	Δt (min)	18	0.874			OFF								P4 ON		**28**			**-58**			**-35**	
Field Data	5/18/2022	11:36 AM	5,105	51.1	95.6		0	0	14.9	14.2	62	4,083	1,087	SETTING: 0.94	161.7	21.7	68.3	151.6	21.6	63.5	151.4	23.4	65.6
Model Results		Test 10									59	1,083	4,550				70.3			65.9			65.5
E 130 Street	Δt (min)	24	0.923			OFF								P4 ON		**21**			**90**			**74**	
Field Data	5/18/2022	12:00 AM	5,392	51.1	95.9		0	0	14.9	14.2	62	4,193	1,014	SETTING: 0.94	161.6	21.6	68.3	151.4	21.4	63.4	151.2	23.2	65.6
Model Results		Test 11									59	1,088	4,547				70.3			65.8			65.5
SE 5th Street	Δt (min)	63	0.884			OFF								P4 ON		**0**			**11**			**93**	
Field Data	5/18/2022	1:03 PM	5,160	51.4	95.2		0	0	14.9	14.2	62	4,099	957	SETTING: 0.94	161.6	21.6	68.3	151.3	21.3	63.3	150.5	22.5	65.7
Model Results		Test 12									59	1,083	4,564				70.2			65.7			65.2
NE Viewport Drive	Δt (min)	15	0.853			OFF								P4 ON		**80**			**-47**			**-223**	
Field Data	5/18/2022	1:18 PM	4,983	51.4	95.5		0	0	14.9	14.2	63	4,126	1,046	SETTING: 0.94	161.5	21.5	68.2	151.4	21.4	63.4	150.9	22.9	65.6
Model Results		Test 13									59	1,080	4,561				70.3			65.8			65.4
NE Topaz Drive	Δt (min)	16	0.874			OFF								P4 ON		**50**			**0**			**0**	
Field Data	5/18/2022	1:34 PM	5,104	51.4	96.2		0	0	14.9	14.2	62	4,061	993	SETTING: 0.94	161.4	21.4	68.3	151.4	21.4	63.2	150.9	22.9	65.6
Model Results		Test 14									59	1,082	4,565				70.2			65.8			65.4
SE Crestwood Street	Δt (min)	14	0.901			OFF								P4 ON		**0**			**72**			**0**	
Field Data	5/18/2022	1:48 PM	5,262	51.4	95.7		0	0	14.9	14.2	62	4,151	1,039	SETTING: 0.94	161.4	21.4	68.2	151.3	21.3	63.3	150.9	22.9	65.6
Model Results		Test 15									59	1,082	4,568				70.1			65.7			65.4
NE Lindsay Ave	Δt (min)	18	0.922			OFF								P4 ON		**56**			**0**			**139**	
Field Data	5/18/2022	2:07 PM	5,386	51.5	95.9		0	0	14.9	14.2	61	4,245	945	SETTING: 0.94	161.3	21.3	68.3	151.3	21.3	63.3	150.6	22.6	65.5
Model Results		Test 16									59	1,120	4,549				70.0			65.6			65.3
NE Mulberry St	Δt (min)	18	0.863			OFF								P4 ON		**0**			**-57**			**-107**	
Field Data	5/18/2022	2:25 PM	5,038	51.5	95.6		0	0	14.9	14.2	64	4,142	1,060	SETTING: 0.94	161.3	21.3	68.2	151.4	21.4	63.4	150.8	22.8	65.1
Model Results		Test 17									59	1,176	4,492				70.0			65.6			65.3
NE Cedar Street	Δt (min)	1022	0.907			OFF								P4 ON		**-31**			**-19**			**-25**	
Field Data	5/19/2022	7:26 AM	5,295	46.9	96.4		0	0	14.9	14.1	62	4,277	1,093	SETTING: 0.94	164.5	24.5	69.1	153.3	23.3	64.0	153.9	25.9	66.8
Model Results		Test 18									60	1,190	4,412				71.3			66.7			66.7
NE Grand Avenue	Δt (min)	13	0.901			OFF								P4 ON		**77**			**-77**			**-64**	
Field Data	5/19/2022	7:39 AM	5,264	46.9	96.0		0	0	14.9	14.1	63	4,265	1,063	SETTING: 0.94	164.4	24.4	69.3	153.4	23.4	64.2	154.0	26.0	66.8
Model Results		Test 19									60	1,191	4,405				71.3			66.7			66.7
NE Jones Industrial Drive	Δt (min)	36	0.925			OFF								P4 ON		**84**			**18**			**46**	
Field Data	5/19/2022	8:15 AM	5,402	47.0	96.4		0	0	14.9	14.1	62	4,180	1,074	SETTING: 0.94	164.1	24.1	69.3	153.3	23.3	64.3	153.8	25.8	66.7
Model Results		Test 20									59	1,218	4,397				71.1			66.6			66.6
Timberman Drive	Δt (min)	35	0.954			OFF								P4 ON		**86**			**39**			**143**	
Field Data	5/19/2022	8:50 AM	5,571	47.1	96.8		0	0	14.8	14.1	63	4,261	1,043	SETTING: 0.94	163.8	23.8	69.2	153.2	23.2	64.1	153.2	25.2	66.6
Model Results		Test 21									60	1,112	4,503				70.8			66.3			66.4
NW Technology Drive	Δt (min)	18	0.909			OFF								P4 ON		**0**			**0**			**-46**	
Field Data	5/19/2022	9:08 AM	5,307	47.2	96.3		0	0	14.8	14.1	63	4,311	1,042	SETTING: 0.94	163.8	23.8	69.2	153.2	23.2	64.2	153.3	25.3	66.6
Model Results		Test 22									59	1,153	4,463				70.7			66.2			66.4
	Δt (min)																						
Field Data	5/19/2022																						
Model Results																							
	Δt (min)																						
Field Data	5/18/2022																						
Model Results																							

Notes:

1. FH-A represents the flowing hydrant and FH-C represents the nearest adjacent hydrant; static readings are measure before the hydrant test is conducted.

6:15:00 AM | * Nearest DL | FH-A Flowing Hydrant | - = Modeled value lower than observed

Fire Hydrant Test Location	Date	Time	Data Loggers: Hook EST 206383 South (psi)	Scherer EST 206384 South (psi)	206385 South (psi)	206386 South (psi)	76151 South (psi)	76152 South (psi)	76153 South (psi)	76154 South (psi)	76155 South (psi)	76156 South (psi)	76157 South (psi)	76159 South (psi)	76160 South (psi)	76161 South (psi)	Hydrant Test[1] FH-A Flow (gpm)	Hydrant Test[1] FH-A Pressure (psi)	Hydrant Test[1] FH-C Pressure (psi)	Static Reading[1] FH-A Pressure (psi)	Static Reading[1] FH-C Pressure (psi)	Flowing FH-A Pressure (psi)	Flowing FH-C Pressure (psi)	Static FH-A Pressure (psi)	Static FH-C Pressure (psi)
SW Raintree Pkwy	Δt (min)	9									*			*											
Field Data (SCADA)	5/18/2022	8:14 AM	64	70	97	66	91	84	91	93	92	97	97	78	108	94	1,404	70	81	96	99	12	2	0	-3
Model Results		Test 1	66	70	98	68	92	85	92	95	94	98	98	82	110	93		82	83	96	96				
SW Whistle Drive	Δt (min)	23									**			*											
Field Data	5/18/2022	8:38 AM	65	70	97	67	91	84	91	94	91	96	98	83	108	95	1,348	68	81	78	86	4	-4	-1	-4
Model Results		Test 2	65	70	98	68	92	85	91	94	93	97	98	82	109	93		72	77	77	82				
Trailridge Elementary School	Δt (min)	20									*			**											
Field Data	5/18/2022	8:58 AM	65	70	97	66	91	85	92	94	93	97	97	78	109	94	1,348	68	76	90	88	12	1	0	-4
Model Results		Test 3	66	71	100	70	94	87	93	96	96	99	99	81	110	94		80	77	90	84				
SW Hickory Lane	Δt (min)	31														**									
Field Data	5/18/2022	9:28 AM	65	70	97	66	91	85	92	93	95	97	97	82	109	83	1,678	100	107	114	118	-7	-9	-6	-7
Model Results		Test 4	65	69	98	68	91	85	91	94	94	97	98	82	109	85		93	98	108	111				
SW 11th Terrace	Δt (min)	25													**										
Field Data	5/18/2022	9:53 AM	65	70	97	67	91	84	90	91	94	95	96	82	106	94	1,538	84	88	94	107	-1	-2	-4	-16
Model Results		Test 5	66	70	98	68	92	85	91	95	95	98	98	82	106	93		83	86	90	91				
SW Winter Creek	Δt (min)	17													**										
Field Data	5/18/2022	10:10 AM	65	70	97	66	92	83	89	96	95	97	97	80	102	94	1,686	101	104	120	109	9	-3	-2	-2
Model Results		Test 6	66	70	98	68	92	85	90	95	95	98	98	82	105	93		110	101	118	107				
SW Craigmont Drive	Δt (min)	26							**						*										
Field Data	5/18/2022	10:36 AM	65	70	97	65	90	83	88	93	94	97	96	81	105	94	1,321	62	90	92	94	22	1	-1	0
Model Results		Test 7	66	70	98	68	91	85	90	94	95	97	97	82	108	93		84	91	91	94				
NW Ward Lane	Δt (min)	25							**																
Field Data	5/18/2022	11:01 AM	65	70	97	67	92	83	91	94	95	96	97	81	106	94	1,519	82	86	98	95	-5	-4	-3	-3
Model Results		Test 8	66	70	98	68	92	85	91	94	95	97	98	82	109	93		77	82	95	92				
SW Lakeview Blvd	Δt (min)	17						*																	
Field Data	5/18/2022	11:18 AM	65	70	98	67	91	83	91	95	94	97	98	82	107	94	1,233	54	62	72	67	9	3	0	1
Model Results		Test 9	65	70	98	68	91	84	91	94	95	97	98	82	109	93		63	65	72	68				
SE Richardson Place	Δt (min)	18						**																	
Field Data	5/18/2022	11:36 AM	65	70	97	67	91	82	91	94	94	97	97	82	108	95	1,163	48	78	82	81	24	-2	-1	0
Model Results		Test 10	66	70	98	68	91	84	92	94	95	97	98	82	109	93		72	76	81	81				
E 130 Street	Δt (min)	24				*																			
Field Data	5/18/2022	12:00 AM	65	70	97	60	90	85	93	92	95	96	97	82	109	94	1,210	52	56	90	82	5	3	-7	-2
Model Results		Test 11	66	70	97	62	91	85	91	94	95	97	98	82	109	93		57	59	83	80				
SE 5th Street	Δt (min)	63			*																				
Field Data	5/18/2022	1:03 PM	65	70	92	64	91	84	93	94	95	96	98	82	108	94	1,547	85	84	96	90	3	-1	-3	-3
Model Results		Test 12	66	70	97	67	91	85	92	95	95	97	98	82	109	93		88	83	93	87				
NE Viewport Drive	Δt (min)	15			*																				
Field Data	5/18/2022	1:18 PM	65	70	93	64	90	85	93	91	95	97	96	82	108	94	1,609	92	101	107	107	7	-2	0	-2
Model Results		Test 13	66	70	96	67	91	84	91	94	95	97	98	82	109	93		99	99	107	105				
NE Topaz Drive	Δt (min)	16			**																				
Field Data	5/18/2022	1:34 PM	65	70	95	68	91	83	92	93	95	97	97	81	107	95	1,678	100	116	113	122	3	-3	-3	-3
Model Results		Test 14	66	70	96	67	91	84	91	94	95	97	98	82	109	93		103	113	110	119				
SE Crestwood Street	Δt (min)	14			*		*																		
Field Data	5/18/2022	1:48 PM	65	70	94	65	90	84	92	93	94	95	97	82	108	95	1,463	76	99	105	104	23	-1	-1	-3
Model Results		Test 15	66	70	97	67	91	84	91	94	95	97	98	82	109	93		99	98	104	101				
NE Lindsay Ave	Δt (min)	18					*																		
Field Data	5/18/2022	2:07 PM	65	70	96	64	89	84	92	90	94	95	94	82	108	95	1,363	66	84	93	98	9	1	-1	-3
Model Results		Test 16	65	70	97	67	91	84	91	93	95	96	97	82	109	93		75	85	92	95				
NE Mulberry St	Δt (min)	18										*													
Field Data	5/18/2022	2:25 PM	65	70	97	64	89	84	93	89	94	92	94	81	108	95	1,556	86	96	100	103	3	-2	-1	-3
Model Results		Test 17	66	70	97	67	91	84	91	92	95	92	97	82	109	93		89	94	99	100				
NE Cedar Street	Δt (min)	1022										*													
Field Data	5/19/2022	7:26 AM	65	71	97	66	91	85	93	92	95	94	97	82	110	95	1,463	76	101	104	107	13	-1	-4	-2
Model Results		Test 18	67	71	98	69	92	85	92	93	96	96	98	83	110	94		89	100	100	105				
NE Grand Avenue	Δt (min)	13										*													
Field Data	5/19/2022	7:39 AM	65	71	97	67	92	85	93	92	95	96	97	82	108	95	1,321	62	78	79	86	5	0	0	-1
Model Results		Test 19	67	71	99	69	92	86	93	95	96	98	99	83	110	94		67	78	79	85				
NE Jones Industrial Drive	Δt (min)	36								**															
Field Data	5/19/2022	8:15 AM	65	71	98	66	89	84	92	89	96	95	94	82	109	96	1,609	92	104	103	109	10	-3	4	0
Model Results		Test 20	66	71	98	68	92	85	92	90	96	96	98	83	110	94		102	101	107	109				

6:15:00 AM | * Nearest DL | FH-A Flowing Hydrant

Fire Hydrant Test Location	Date	Time	Data Loggers														Hydrant Test[1]			Static Reading[1]	
			Hook EST	Scherer EST																	
			206383	206384	206385	206386	76151	76152	76153	76154	76155	76156	76157	76159	76160	76161	FH-A		FH-C	FH-A	FH-C
			South	South	South	South	South	South	South	South	South	South	South	South	South	South	Flow	Pressure	Pressure	Pressure	Pressure
			(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(gpm)	(psi)	(psi)	(psi)	(psi)
Timberman Drive	Δt (min)	35							*												
Field Data	5/19/2022	8:50 AM	65	71	98	67	92	84	87	94	94	97	97	83	105	96	1,574	88	104	109	115
Model Results		Test 21	66	71	98	69	92	86	90	95	96	98	98	83	108	94		95	102	105	110
NW Technology Drive	Δt (min)	18											**								
Field Data	5/19/2022	9:08 AM	65	71	98	66	90	85	90	92	95	97	91	82	109	96	1,661	98	108	108	110
Model Results		Test 22	66	71	98	68	92	85	91	94	96	97	94	83	109	94		100	103	105	108
	Δt (min)																				
Field Data	5/19/2022																				
Model Results																					
	Δt (min)																				
Field Data	5/18/2022																				
Model Results																					

- = Modeled value lower than observed

Flowing		Static	
FH-A	FH-C	FH-A	FH-C
Pressure	Pressure	Pressure	Pressure
(psi)	(psi)	(psi)	(psi)
7	-2	-4	-5
2	-5	-3	-2
0	0	0	0
0	0	0	0

North Pressure Zone Model Calibration

97.20

FH-A Flowing Hydrant

Fire Hydrant Test Location	Date	Time	North Base 2151.4 DMD	Maybrook (IND)	Bowlin Pump Station		Leinweber	Elevated Storage			Data Loggers														Hydrant Test[1]			Static Reading[1]	
				North	North		North	North																					
				Meter	Booster Pumps 1 + 2			Woods Chapel			206383	206384	206385	206386	76151	76152	76153	76154	76155	76156	76157	76159	76160	76161	FH-A		FH-C	FH-A	FH-C
				Flow	Maybrook Suction Pressure	Maybrook Discharge Pressure	Upstream Pressure	Tower Level (measured from datum)	Level (Measured from BCL)	Tower Pressure	North	North	North	North	North	North	North	North	North	North	North	North	North	North (E of I470)	Flow	Pressure	Pressure	Pressure	Pressure
				(gpm)	(psi)	(psi)	(psi)	(ft)	(ft)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(psi)	(gpm)	(psi)	(psi)	(psi)	(psi)
Pearl Ct. & Sapphire					HGL = 1120'				-108.75						*									*					
Field Data	4/13/2022	12:03 PM	1084	1,102	136	135	55	143.9	35.2	62	58	71	84	88	116	81	96	84	93	92	96	72	85	51	1,547	85	119	136	148
Model Results		Run1	0.504	1,406	135	135	55		35	62	58	71	85	88	117	80	95	84	94	91	98	71	85	54		95	118	134	144
Northgate Drive	Δt (min)	19							**14.4**						*									*					
Field Data	4/13/2022	12:21 PM	1116	1,102	136	134	56	144.0	35.2	62	59	71	84	88	123	80	96	83	93	92	94	72	84	56	1,186	50	70	92	90
Model Results		Run3	0.519	1,408	135	134	55		35	62	58	71	85	88	127	80	95	84	94	92	99	72	85	62		74	74	89	88
Pebble Beach & Burning Tree	Δt (min)	22							**0.7**								*				*								
Field Data	4/13/2022	12:37 PM	1102	1,102	137	136	54	144.0	35.2	62	58	71	83	86	144	80	91	85	93	92	100	72	85	77	1,321	62	86	94	98
Model Results		Run5	0.512	1,408	135	135	56		35	62	58	71	85	88	141	80	95	84	94	92	96	72	85	75		79	87	92	94
Del Lago	Δt (min)	16							**-27.3**								*		*										
Field Data	4/13/2022	12:52 PM	1044	1,071	136	134	58	143.9	35.2	62	58	71	83	88	144	80	95	85	92	92	100	72	85	77	1,538	84	99	92	100
Model Results		Run7	0.485	1,404	135	135	56		35	62	58	71	85	88	142	80	95	84	94	92	99	72	85	76		90	96	92	98
Dick Howser Dr.	Δt (min)	14							**-42.2**										*										
Field Data	4/13/2022	1:06 PM	1006	1,048	134	133	54	143.8	35.1	62	58	71	84	88	143	80	95	85	93	92	101	72	85	76	1,463	76	89	88	90
Model Results		Run9	0.467	1,408	135	134	55		35	62	58	71	85	88	143	80	96	85	94	91	100	72	85	77		86	87	87	88
Locust	Δt (min)	62							**11.2**				*																
Field Data	4/13/2022	2:11 PM	1021	1,010	135	134	58	143.9	35.2	62	58	68	69	87	144	80	95	85	93	91	100	72	85	77	1,300	60	69	86	84
Model Results		Run11	0.475	1,402	135	135	55		35	62	58	71	72	87	143	80	96	85	94	90	100	72	85	77		71	68	86	81
NW Lake R. & Gregory Blvd	Δt (min)	25							**-14.5**				*							*									
Field Data	4/13/2022	2:35 PM	1026	1,041	137	136	53	143.9	35.1	62	59	71	79	87	143	80	95	85	94	88	100	72	85	76	1,414	71	85	88	94
Model Results		Run13	0.477	1,410	134	134	55		35	62	58	71	82	87	143	80	96	85	94	88	100	72	85	77		81	85	88	90
Beachwood Dr & Rosewood Dr.	Δt (min)	29							**16.5**											*									
Field Data	4/13/2022	3:05 PM	1027	1,010	137	135	54	143.9	35.2	62	60	69	83	87	144	80	95	85	93	87	100	72	85	77	1,404	70	84	87	88
Model Results		Run15	0.477	1,403	135	135	56		35	62	58	71	84	87	143	80	96	85	94	89	100	72	85	77		78	82	85	85
Bayview & Channel	Δt (min)	399							**-8.1**					*															
Field Data	4/14/2022	9:44 AM	1094	1,102	137	136	54	143.5	34.8	61	58	70	83	87	144	80	94	84	93	91	100	72	85	77	1,453	75	81	87	83
Model Results		Run17	0.508	1,407	134	134	55		35	62	58	71	85	87	142	79	96	85	94	91	100	72	85	77		83	82	85	83
NE Chapel Dr & Chapel Ct	Δt (min)	16							**50.2**			*																	
Field Data	4/14/2022	10:01 AM	1157	1,107	137	136	56	143.6	34.9	61	58	70	83	90	144	80	95	84	93	91	100	72	85	76	1,463	76	82	93	84
Model Results		Run19	0.538	1,433	134	134	54		35	62	57	70	85	86	142	80	96	85	94	91	100	72	85	77		84	79	90	82
NE Ellison Dr.	Δt (min)	16							**-83.8**		*																		
Field Data	4/14/2022	10:13 AM	1079	1,163	136	135	58	143.4	34.7	62	57	71	84	87	142	80	96	85	93	91	100	72	85	76	1,139	46	61	68	66
Model Results		Run21	0.502	1,443	134	134	56		35	62	58	68	85	87	142	80	96	85	94	91	100	72	85	77		58	60	67	63
NE Ralph Powell Rd.	Δt (min)	13							**-30.7**		*																		
Field Data	4/14/2022	10:07 AM	1102	1,132	136	134	57	143.4	34.6	61	55	70	83	88	144	79	96	85	93	92	100	72	85	76	1,300	60	68	66	71
Model Results		Run23	0.512	1,507	134	134	55		35	62	55	70	85	87	142	80	95	85	94	91	99	72	85	77		57	64	62	67
NE Gateway Dr. & Goshen Dr.	Δt (min)	17							**14.2**														*						~30 higher E
Field Data	4/14/2022	10:50 AM	1177	1,163	136	135	55	143.4	34.7	61	58	70	84	87	144	80	95	82	93	91	100	72	83	76	1,311	61	63	82	77
Model Results		Run25	0.547	1,462	134	134	55		35	62	58	71	85	88	142	80	95	84	94	91	99	71	84	76		79	66	84	70
NE Sunshine Dr & Rainbow	Δt (min)	32																						*					
Field Data	4/14/2022	11:22 AM	1132	1,132	136	135	55	143.3	34.6	61	58	71	83	87	124	79	95	83	93	92	94	72	85	52	1,244	55	64	88	90
Model Results		Run27	0.526	1,459	134	134	55		35	62	58	71	85	87	126	80	95	84	94	91	98	71	85	55		59	63	86	87
NE Park Trails Ct. & Dalton Ridge	Δt (min)																				*								
Field Data	4/14/2022	11:08 AM	1163	1,163	136	135	56	143.4	34.6	62	59	71	84	87	143	79	95	84	93	91	100	69	85	78	1,353	65	78	86	80
Model Results		Run29	0.540	1461	134	134	55		35	62	58	71	85	88	142	80	95	84	94	91	99	69	83	76		82	75	86	78
Field Data																													
Model Results																													

Notes:

1. FH-A represents the flowing hydrant and FH-C represents the nearest adjacent hydrant; static readings are measure before the hydrant test is conducted.
2. NA represents not applicable

* siginfies the nearest data logger to the fire flow event

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