BURNS McDONNELL

CITY OF LAWRENCE, KANSAS

2024 Water Master Plan

Final Report

PROJECT NO. 164957

JUNE 13, 2025

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Index and Certification

City of Lawrence, Kansas
2024 Water Master Plan
Project No. 164957

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Certification

I hereby certify, as a Professional Engineer in the state of Kansas, 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 Lawrence, Kansas or others without specific verification or adaptation by the Engineer.

Ryan Scott, P.E. Kansas License 20658

Date: June 13, 2025

Executive Summary

The City's water distribution system spans approximately 30 square miles and includes the West Hills and Central service pressure zones, approximately 463 miles of pipe ranging from 4-inch to 36-inch diameter, 19 high service pumps, six storage sites, and two interzonal BPS that pump ground storage from Central Service to West Hills while also floating with and supplying water to Central Service. The other towers in the distribution system are elevated and primarily serve their respective pressure zone.

A calibrated hydraulic model of the distribution system includes the service levels and associated facilities discussed above with a geospatial water demand allocation representing the City's retail and wholesale customer base. Water demand projections are integrated into the hydraulic model to evaluate capital improvements based on City-selected level of service for pressure, pumping, pipeline hydraulics, storage, and fire flow and future growth areas. Capital improvements are planning-level recommendations of a conceptual nature and not intended to be used for final design and/or construction. Associated opinions of probable construction cost are developed to maintain the level of service throughout the planning periods evaluated in this Water Master Plan. The model should be updated as distribution system improvements are implemented and/or as water demands change by amount and/or by location, beyond those indicated herein, as development continues and in advance of demand triggers for capital improvements to confirm sizing recommendations.

ES.1 Water Demand Projections

Water demand projections are based on historical meter demographics, water sales, and water treatment plant (WTP) production data to as the basis for the 2030 and 2040 planning period. A meter-based water demand projection methodology is applied in the water demand projections. Other factors in the water demand evaluation include a traditional representation of the City's nonrevenue water standing with a 12-month rolling average, mass-balance diurnal analyses for West Hills and Central service, a dry-year water demand review as it relates to seasonal demand patterns and historical climate data (temperature and precipitation), and review of historical maximum day demand ratios relative to annual average day demands. The average day and maximum day demand projections applied in the hydraulic analyses is listed below:

- Existing System:
  - Average day at 12.6 MGD
  - Maximum day at 24.6 MGD
- 2030 Planning Period:
  - Average day at 13.3 MGD
  - Maximum day at 26.9 MGD
- 2040 Planning Period:
  - Average day at 13.6 MGD
  - Maximum day at 29.4 MGD

ES.2 Net Water Needs Analysis

The City has surplus capacity through the 2040 planning period in all net water need areas evaluated including water rights, raw water diversion, and water treatment. The City's raw water and water treatment systems generally rely on the redundancy of the two independent water sources and WTPs. Areas of this

current redundancy begin to decrease (as expected) as water demand projections increase through the 2040 planning period:

- The average day and maximum day demand projections begin to exceed the ability of either the Clinton Lake or Kansas River water rights to independently satisfy the demands; for clarity, this is not a water service goal for the City.
- The maximum day demand projections begin to exceed the ability of either the Clinton Lake or Kansas River diversions to independently satisfy the demands; for clarity, this is not a water service goal for the City.
- The maximum day demand projections exceed the ability of either WTP to fully supply the demand independently; for clarity, this is not a water service goal of the City.

The City is well positioned over the planning period with sufficient water and infrastructure from a capacity perspective to supply the projected demands. The condition of raw water diversion assets and water treatment facilities should also be considered in long-term facility planning.

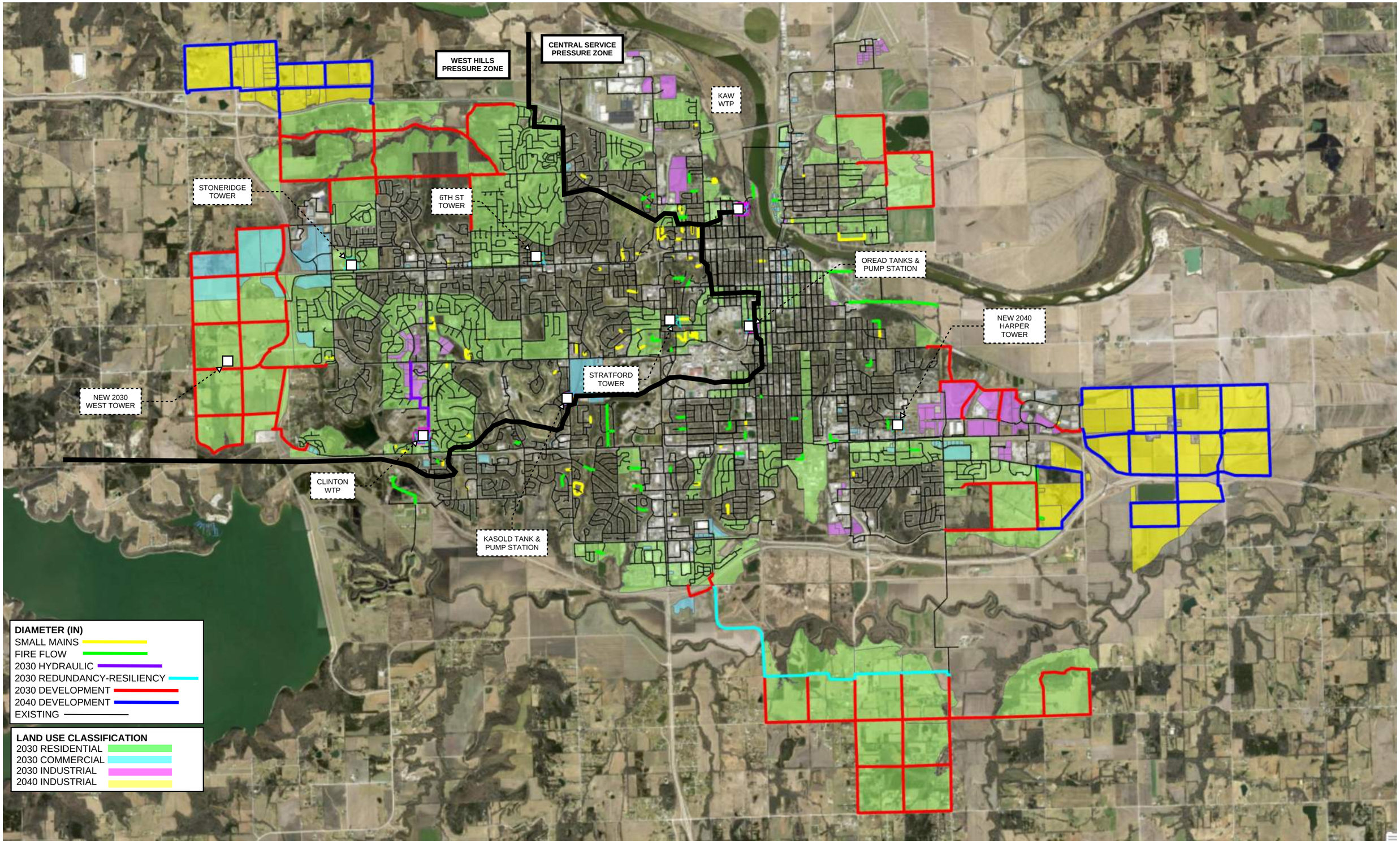
- The City should continue to track annual average day and annual maximum day demands against the respective demand projections prepared in this Water Master Plan.
- The City should evaluate the process piping restriction at the Kaw WTP to restore its 17.5 MGD capacity.
- The City should conduct a condition assessment of the 36-inch raw water transmission main from Clinton Lake to Clinton WTP to determine its remaining useful life. Given the length of this transmission main at approximately 2 miles, the City should stock pipeline repair appurtenances in this size and assess the cost-benefit for a redundant transmission main including nonmonetary factors.

ES.3 Water Master Planning & Capital Improvements

The water distribution system master planning effort includes future development areas, timing for future growth, and the geospatial allocation of projected water demands based on anticipated land use classifications. The proposed land use classifications for development areas in the 2030 and 2040 planning periods were provided by the City to align with Southwest Conveyance Corridor Study (by others) for the wastewater utility. Capital improvements were identified for each planning period based on the water demands projections and City-selected level of service for the water distribution system. A summary of the water master planning growth areas by land use classification and capital improvements is illustrated in Figure ES-1 (standalone).

ES.4 Opinions of Probable Construction Cost

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



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

NOT TO SCALE

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FIGURE ES-1
2030 & 2040 GROWTH AREAS AND CAPITAL IMPROVEMENTS

of Lawrence, Kansas 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.

A summary of the opinions of probable construction cost (OPCC) for the 2030 and 2040 planning period capital improvements is listed in Table ES-1. Costs for linear improvements include contingency at 20 percent and engineering at 15 percent. Costs for facility improvements include contingency at 20 percent and engineering at 20 percent. Facility costs represent elevated storage for the 2030 West Tower, conditional 2030 West pressure zone BPS, and 2040 Harper Tower Replacement. All OPCC for capital improvements are in today's dollars.

Table ES-1: Opinion of Probable Construction Cost Summary

Planning Period	Capital Improvement	Priority	Type	Service	Trigger	OPCC[3]
Available Funding	Small Mains	Lower	Linear	Distribution	Condition	$ 6,211,000
	Fire Flow	Moderate			Level of Service	$ 6,733,000
					Subtotal	**$ 12,944,000**
2030	Hydraulic	Higher	Linear	Transmission	Level of Service	$ 3,286,000
	R-R[1]	Moderate		Looping	Development	$ 10,633,000
	Growth	Note 2		Distribution		$ 45,259,000
	West Tower	Higher	Facility	1.0 MG Elevated Storage	Demand & Development	$ 14,826,000
					2030 Subtotal	**$ 60,085,000**
2040	Growth	Note 2	Linear	Distribution	Development	$ 21,697,000
	Harper Tower Replacement	Higher	Facility	1.0 MG Elevated Storage	Demand & Development	$ 14,400,000
					2040 Subtotal	**$ 36,097,000**
					Total (all projects)	**$ 109,130,000**

Notes:

1. R-R: Redundancy-Resiliency.
2. Development-driven capital improvement priority is as development occurs.
3. OPCC: Opinion of Probable Construction Cost.

1.0 Project Overview

This report on the City of Lawrence, Kansas 2024 Water Master Plan is prepared by Burns & McDonnell in addition to project support from George Butler Associates, Inc, and KLM Engineering, Inc. The water master plan maps out capital improvement projects for the 2030 and 2040 planning periods needed to support the water demand projections and future development areas identified by the City. Services performed on behalf of this team include the following:

- Hydraulic Modelling Software Selection Workshop.
- Field testing post-processing; for clarity, the field testing efforts were completed under a separate contract by Burns & McDonnell.
- GIS-based hydraulic model development and calibration.
- Level of service review.
- Diurnal analyses.
- Water demand projections.
- Water distribution system master planning.
- Water distribution system hydraulic modelling.
- Storage and high service pumping evaluations.
- Net water needs analysis.
- Condition assessment of select storage tanks.
- Capital improvement projects and opinions of probable construction cost.
- Digital storyboard for select water master planning content.

2.0 Existing Water Distribution System

The distribution system spans approximately 30 square miles and includes the West Hills and Central Service pressure zones, approximately 463 miles of pipe ranging from 4-inch to 36-inch diameter, 19 high service pumps, six storage sites, and two interzonal BPS that pump ground storage from Central Service to West Hills while also floating with and supplying water to Central Service. The other towers in the distribution system are elevated and dedicated to respective pressure zones. Central Service ranges in elevation from 814 feet to 978 ft, while the WH pressure zone ranges from 837 ft to 1,066 ft.

2.1 High Service Pumps

Kaw and Clinton WTPs can pump to both the Central Service and West Hills as listed in Table 2-1. Review of the table indicates Kaw and Clinton WTPs can deliver a firm capacity of 23.0 MGD into West Hills and a firm capacity of 19.6 MGD into Central Service. The firm capacity definition for each pressure zone is calculated with the largest pump out of service in each WTP.

Table 2-1: High Service Pumping Summary

Pressure Zone	Pump No.	Year Installed	WTP	Drive	Flow		Head (ft)	Motor	
					(gpm)	(MGD)		(Hp)	(rpm)
West Hills	1	2008	Kaw - 2nd Floor	Constant	1,050	1.5	350	125	1,785
	2	2004	Kaw - 2nd Floor	Constant	1,050	1.5	350	125	1,785
	3	2008	Kaw - 2nd Floor	Constant	1,050	1.5	350	125	1,785
	1	2001[1]	Clinton - HSPS 1	Constant	3,500	5.0	245	300	1,800
	2	2001[1]	Clinton - HSPS 1	Constant	3,500	5.0	245	300	1,800
	3	1997	Clinton - HSPS 1	VFD	3,500	5.0	245	300	1,785
	4	2008	Clinton - HSPS 2	VFD	3,500	5.0	245	300	1,785
	5	2008	Clinton - HSPS 2	VFD	3,500	5.0	245	300	1,785
				West Hills Firm Capacity		23.0			
Central Service	1	2008	Kaw - 2nd Floor	Constant	2,100	3.0	220	150	1,780
	2	2008	Kaw - 2nd Floor	Constant	2,100	3.0	220	150	1,780
	3	2008	Kaw - 2nd Floor	Constant	2,100	3.0	220	150	1,780
	4	2008	Kaw - 2nd Floor	Constant	2,100	3.0	220	150	1,780
	1	2008	Clinton - HSPS 1	Constant	1,900	2.8	80	50	1,750
	2	1978[5]	Clinton - HSPS 1	Constant	1,900	2.8	80	50	1,750
	3	1997	Clinton - HSPS 1	VFD	3,500	5.0	80	100	1,180
	4	2008	Clinton - HSPS 2	VFD	3,500	5.0	80	100	1,785
				Central Service Firm Capacity		19.6			

Notes:
1. New motors installed in 2008.
2. Motor was new in 2008.
3. Motor was new in 1954; pump was either new or rehabbed in 2002.
4. Motor was new in 2011; pump was either new or rehabbed in 2011.
5. New motor installed in 1978; pump and motor serviced in 2008.

2.2 Storage and Booster Pump Stations

The water distribution system includes 6 tank sites with a total capacity of 6.25 MG. Tank data is summarized in Table 2-2 and lists the tank location, capacity and elevation data. The Oread storage facility includes two above-grade ground storage tanks. The distribution system also includes two BPSs and is

summarized in Table 2-3. The firm capacity of Oread BPS is 1.8 MGD and the firm capacity of Kasold BPS is 1.9 MGD.

Table 2-2: Distribution System Storage Summary

Pressure Zone	Name	Year Installed	Type	Volume (MG)	Overflow Elevation (ft)	Bottom Elevation (ft)	Base Elevation (ft)	Head Range (ft)
West Hills	Stoneridge	2008	Elevated	1.50	1,174.0	1,134.0	1,066.0	40.0
	6th Street	1967	Elevated	0.50	1,170.0	1,132.5	1,024.5	37.5
	Stratford	2024	Elevated	0.50	1,174.0	1,144.0	1,045.0	30.0
	West Hills Total =			2.50				
Central Service	Harper	1967	Elevated	0.50	1,015.0	977.5	920.0	37.5
	Kasold	1969	Standpipe	1.50	1,019.0	960.0	960.0	59.0
	Oread	2017	Ground	1.75	1,019.0	989.0	989.0	30.0
	Central Service Total =			3.75				

Table 2-3: Booster Pump Station Summary

Tank	Pump No.	Year Installed	Pressure Zone	Flow		Head (ft)	Motor	
				(gpm)	(MGD)		(Hp)	(rpm)
Kasold	1	2017	West Hills	1,600	2.3	215	125	1,780
	2	2017	West Hills	1,600	2.3	215	125	1,780
Oread	1	2017	West Hills	1,200	1.7	215	125	1,780
	2	2017	West Hills	1,200	1.7	215	125	1,780

2.3 Distribution System Piping

The distribution system includes approximately 463 miles of 4-inch through 36-inch pipe included in the hydraulic model which is a skeletonized version of the City's water system GIS as provided in 2024. A distribution system schematic of the water treatment facilities, storage, interzonal pump stations, and pressure zone arrangement is illustrated in Figure 2-1.

Figure 2-1: Distribution System Schematic (standalone)

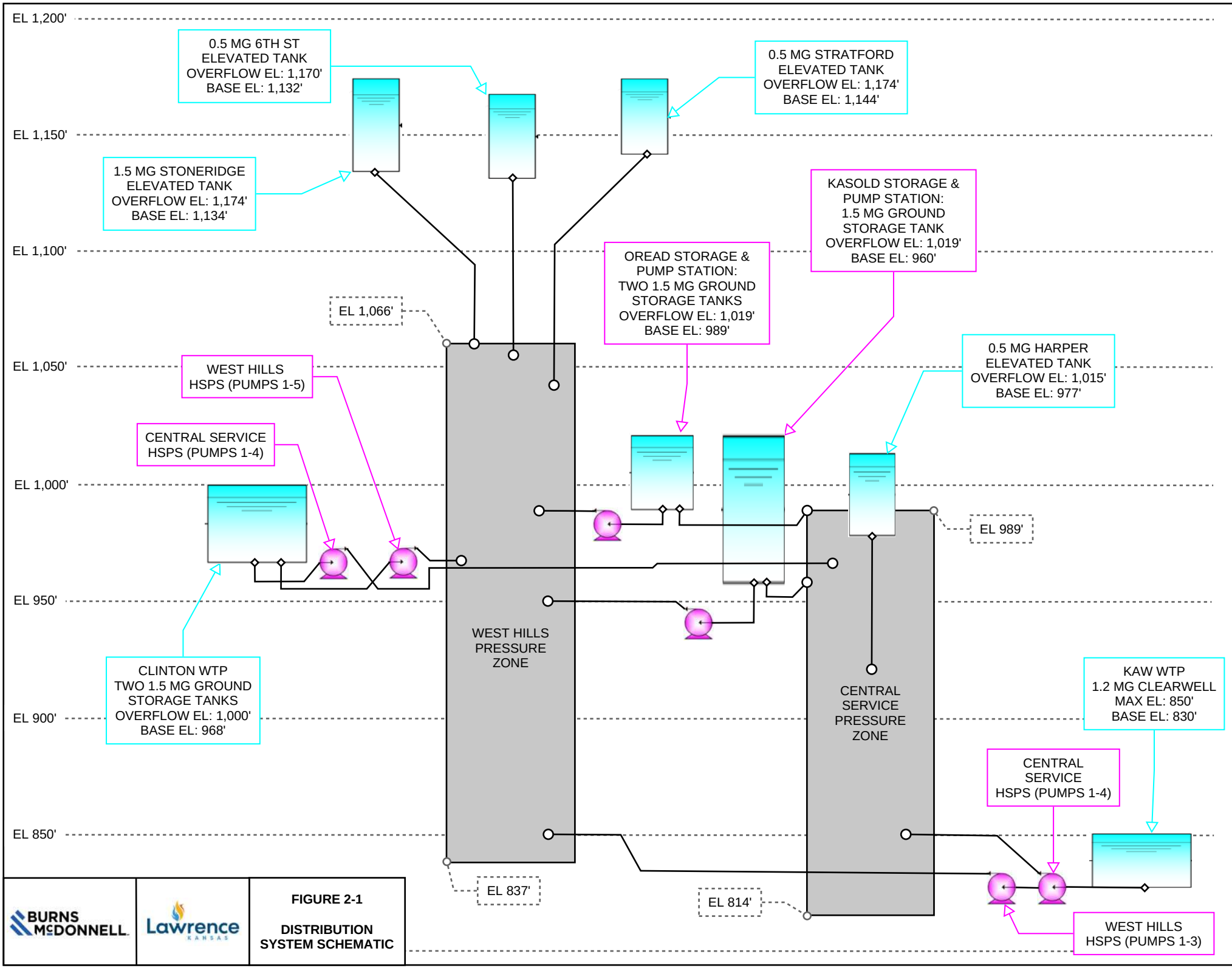

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FIGURE 2-1

DISTRIBUTION SYSTEM SCHEMATIC

3.0 Water Demand Projections

This section of the report evaluates historical meter demographics, water sales, and water treatment plant (WTP) production data to as the basis for the 2030 and 2040 planning period water demand projections. A meter-based water demand projection methodology is applied in the water demand projections. This methodology characterizes water usage, in terms of gallons per meter-day (gpmd), based on meter demographics and water demand for each customer class. Nonrevenue water is included in the water usage metric proportionally by water sales. By this definition, water sales represent metered water consumption at the customer service connection and water demand represents treated water production from both WTPs via high service pump station (HSPS) metering. Water usage is applied to the meter projections which results in water demand projections at the customer class level.

Other factors in the water demand evaluation include a traditional representation of the City's nonrevenue water standing with a 12-month rolling average, mass-balance diurnal analyses for West Hills and Central service, a dry-year water demand review as it relates to seasonal demand patterns and historical climate data (temperature and precipitation), and review of historical maximum day demand ratios relative to annual average day demands.

3.1 Meter Demographics

The City delivers water through a distribution system network (4-inch through 36-inch) spanning approximately 463 miles to approximately 35,000 customer meters. For clarity, this meter estimation represents the number of active accounts and in instances where one account has more than one physical meter, the larger meter size is accounted for. The customer classifications represented by this meter population is listed in Table 3-1 and include residential, multi-family, commercial, industrial, city meters, Kansas University (KU), and wholesale.

Table 3-1: Meter Demographics by Customer Class

Year	Residential	Multi-Family	Commercial	Industrial	City	KU	Wholesale	Total
2000	25,037	687	1,686	74	145	31	11	27,671
2001	25,660	688	1,706	78	144	32	11	28,319
2002	26,306	700	1,732	74	151	34	11	29,008
2003	26,831	713	1,759	73	163	34	10	29,583
2004	27,468	714	1,779	74	145	32	11	30,223
2005	27,988	715	1,782	76	158	34	10	30,763
2006	28,443	712	1,793	74	166	34	10	31,232
2007	28,665	710	1,788	74	192	32	10	31,471
2008	28,952	707	1,781	75	183	34	10	31,742
2009	29,086	747	1,787	78	179	35	10	31,922
2010	29,138	741	1,798	78	185	35	10	31,985
2011	29,439	756	1,843	79	199	36	9	32,361
2012	29,739	771	1,888	80	214	37	9	32,737
2013	30,040	786	1,932	81	228	38	9	33,114
2014	30,340	801	1,977	81	242	38	9	33,488
2015	29,988	798	1,995	82	245	35	9	33,152
2016	30,029	848	2,001	82	250	37	9	33,256
2017	30,477	677	2,024	68	253	39	9	33,547
2018	30,851	632	2,058	33	252	39	9	33,874
2019	31,110	656	2,061	31	245	39	9	34,151
2020	31,275	661	2,051	32	252	57	9	34,337
2021	31,565	659	2,250	38	279	63	9	34,863
2022	31,621	679	2,249	36	284	64	9	34,942
2023	31,730	682	2,248	38	284	64	9	35,055

The mix of historical meter populations amongst all customer class has been very consistent since 2000. Over time, some customer classes were further defined for a better accounting system of the residential, multi-family, industrial and KU meter populations; shifts in these customer class assignments were provided by utility billing staff from the City's Finance Department and are summarized below:

- Multi-Family
  - Reduction of 216 meters from 2016 to 2018.
  - There were inconsistencies in what was classified as multi-family vs residential prior to 2016; therefore, residential is now defined as 2 units or less and multi-family is 3 units or more.
  - With that clarification utility accounts were updated to assign to the correct class based on the number of units.
- Industrial
  - Reduction of 49 meters from 2016 to 2018.
  - There were inconsistencies in what was classified as industrial prior to 2016; therefore, industrial is now defined that as "Entities engaged primarily in the manufacturing, fabrication or assembly of products that consume approximately 3 million gallons or more of water annually" per the Finance Department.
  - With that clarification utility accounts were updated to assign to the correct class based on their annual usage.
- Kansas University
  - Increase of 14 meters from 2018 to 2021.
  - Corrections were made to bring all KU accounts into that classification during this period.

3.2 Meter Projections

Meter projection sensitivities for low, moderate, and high growth scenarios for each customer class were developed from historical trends and is summarized in Table 3-2. The selected meter projection for the 2030 and 2040 planning periods aligns with the development planning utilized in the City's Southwest Conveyance Corridor study (prepared by others) and is summarized in Table 3-3. Both meter history and the selected meter projections for each customer class listed in Table 3-3 are illustrated in Figures 3-1, 3-2, 3-3, and 3-4 for residential with multi-family, commercial with industrial, City with KU, and total meters respectively.

Table 3-2: Meter Projection Sensitivity by Customer Class

Planning Period	Residential	Multi-Family	Commercial	Industrial	City	KU	Wholesale	Total
Low Growth Meter Projection								
Rate (meters/yr)	73	3	3	0.25	0.25	0.25	0	79
2024	31,730	682	2,248	38	284	64	9	35,055
2030	32,165	700	2,266	40	286	66	9	35,531
2040	32,890	730	2,296	42	288	68	9	36,323
Moderate Growth Meter Projection								
Rate (meters/yr)	279	10	23	1.0	0.5	0.5	0	315
2024	31,730	682	2,248	38	284	64	9	35,055
2030	33,407	743	2,387	44	287	67	9	36,943
2040	36,201	844	2,618	54	292	72	9	40,091
High Growth Meter Projection								
Rate (meters/yr)	608	19	45	2.0	0.75	0.75	0	675
2024	31,730	682	2,248	38	284	64	9	35,055
2030	35,377	798	2,517	50	289	69	9	39,107
2040	41,454	990	2,964	70	296	76	9	45,859

Table 3-3: Selected Meter Projections by Customer Class

Planning Period	Residential	Multi-Family	Commercial	Industrial	City	KU	Wholesale	Total
Meters/Year	279	19	23	1.0	0.25	0.5	0	324
2024	32,009	701	2,271	39	284	65	9	35,379
2030	33,686	817	2,410	45	286	68	9	37,320
2040	36,481	1,009	2,641	55	288	73	9	40,556

Figure 3-1: Residential & Multi-Family Meter Projections

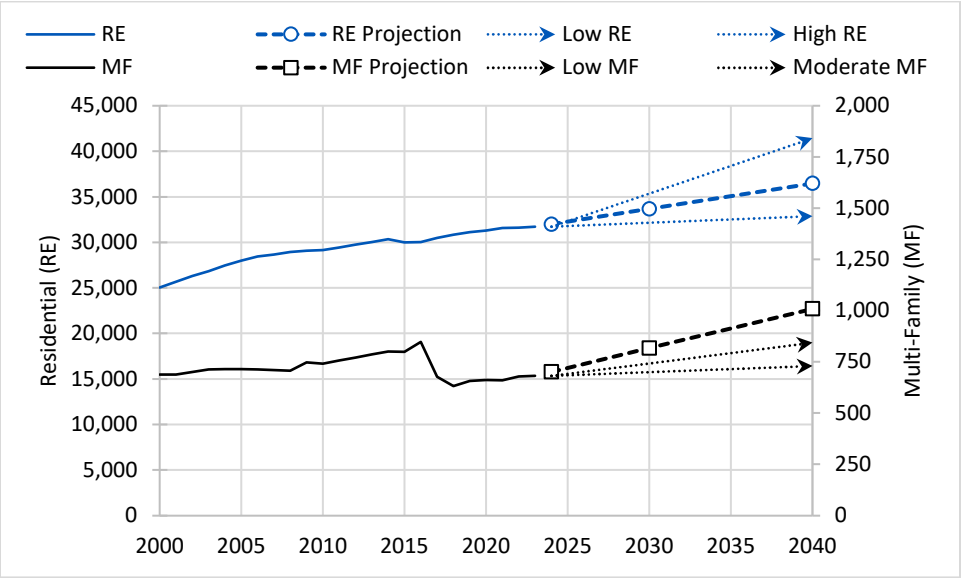


Figure 3-2: Commercial & Industrial Meter Projections

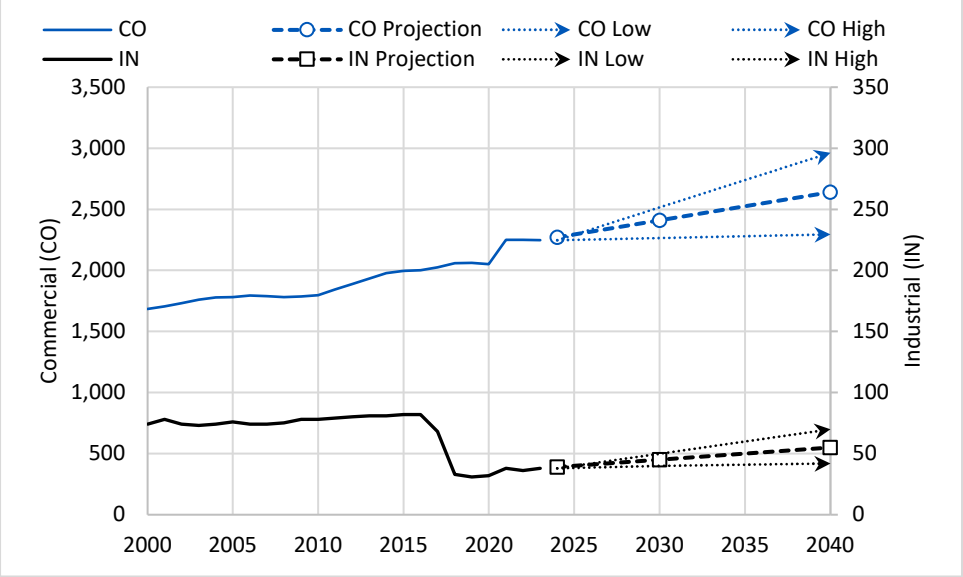


Figure 3-3: City & KU Meter Projections

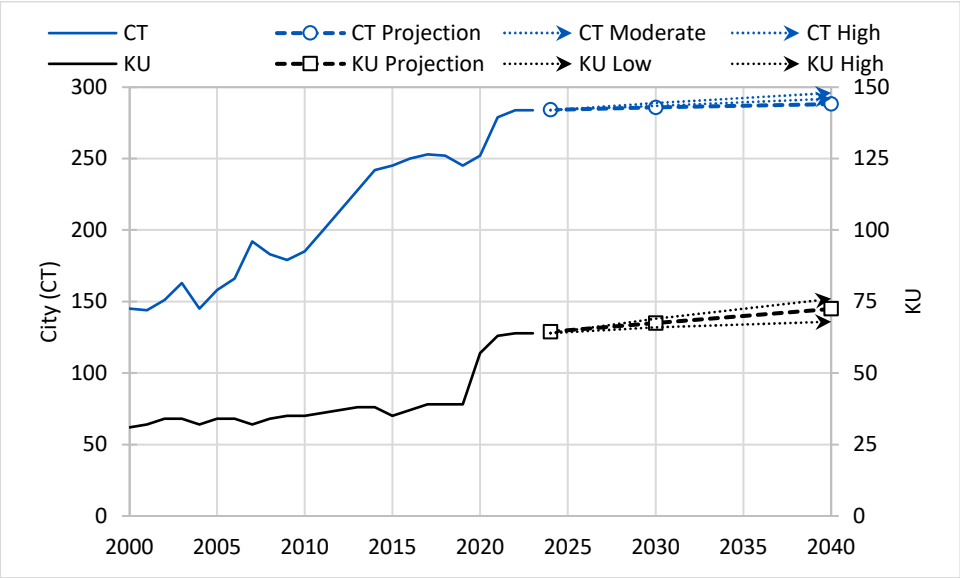
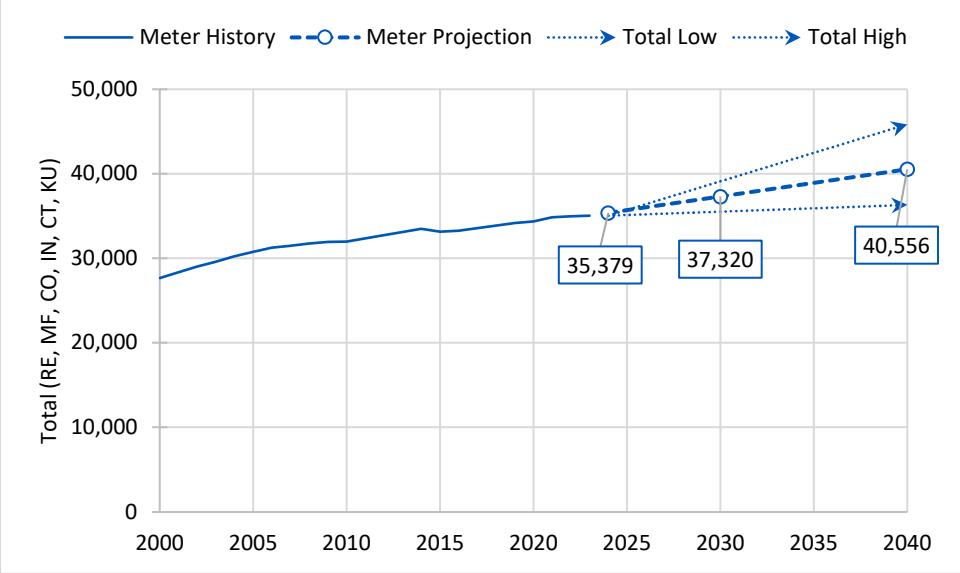


Figure 3-4: Total Meter Projections (all classes)



3.3 Water Sales and Water Demand

Historical water sales since 2000 are listed in Table 3-4 and associated distributions are listed in Table 3-5. Review of Table 3-5 indicates very consistent water sales since 2000 amongst all classes. Acknowledging the changes in customer class designations, as discussed in Section 3.1, between 2016 and 2021, the most recent 5-year averages (2019-2023) by sales distribution (percent) were also observed between 2000 and 2005, hence characterizing water sales as very consistent. Since 2000 residential, including multi-family, and commercial water sales ranged between 69 percent and 78 percent, with an average of 75 percent, of all water sales in the City. These customer classes have the largest influence on the water demand projections.

Table 3-4: Historical Water Sales by Customer Class (MGD)

Year	Residential	Multi-Family	Commercial	Industrial	City	KU	Wholesale	Total
2000	5.22	0.93	2.51	1.00	0.32	0.74	1.30	12.0
2001	4.81	0.97	2.10	0.99	0.24	0.67	1.60	11.4
2002	5.40	0.91	2.43	0.94	0.29	0.70	1.16	11.8
2003	5.45	0.91	2.38	0.56	0.29	0.67	1.30	11.6
2004	4.62	0.88	2.01	0.46	0.21	0.58	1.30	10.1
2005	5.20	0.88	2.21	0.53	0.28	0.66	1.23	11.0
2006	5.59	0.90	2.51	0.53	0.37	0.69	1.34	11.9
2007	5.18	0.90	2.10	0.48	0.33	0.66	1.25	10.9
2008	4.70	0.86	1.87	0.51	0.22	0.56	1.16	9.9
2009	4.34	0.85	1.72	0.43	0.20	0.55	1.00	9.1
2010	4.80	0.88	1.90	0.42	0.21	0.58	1.00	9.8
2011	5.30	0.90	2.03	0.41	0.21	0.54	1.13	10.5
2012	5.97	0.91	2.42	0.47	0.47	0.56	1.27	12.1
2013	4.86	0.89	1.92	0.43	0.74	0.49	1.01	10.3
2014	4.76	0.89	2.00	0.44	0.26	0.71	0.91	10.0
2015	4.51	0.91	1.97	0.43	0.25	0.50	0.92	9.5
2016	4.80	0.97	2.05	0.39	0.29	0.58	0.97	10.0
2017	4.51	0.97	1.71	0.53	0.34	0.60	0.96	9.6
2018	5.07	1.00	1.83	0.52	0.35	0.70	1.12	10.6
2019	4.24	1.00	1.53	0.49	0.38	0.56	0.98	9.2
2020	4.78	1.01	1.44	0.45	0.58	0.47	1.06	9.8
2021	4.65	1.04	1.56	0.53	0.57	0.58	0.91	9.8
2022	4.65	1.12	1.66	0.59	0.60	0.63	0.89	10.1
2023	4.76	1.12	1.69	0.58	0.58	0.66	1.01	10.4

Table 3-5: Historical Sales Distribution

Year	Residential	Multi-Family	Commercial	Industrial	City	KU	Wholesale	Total
2000	43%	8%	21%	8%	3%	6%	11%	100%
2001	42%	9%	18%	9%	2%	6%	14%	100%
2002	46%	8%	21%	8%	2%	6%	10%	100%
2003	47%	8%	21%	5%	3%	6%	11%	100%
2004	46%	9%	20%	5%	2%	6%	13%	100%
2005	47%	8%	20%	5%	3%	6%	11%	100%
2006	47%	8%	21%	4%	3%	6%	11%	100%
2007	48%	8%	19%	4%	3%	6%	11%	100%
2008	48%	9%	19%	5%	2%	6%	12%	100%
2009	48%	9%	19%	5%	2%	6%	11%	100%
2010	49%	9%	19%	4%	2%	6%	10%	100%
2011	50%	9%	19%	4%	2%	5%	11%	100%
2012	49%	8%	20%	4%	4%	5%	11%	100%
2013	47%	9%	19%	4%	7%	5%	10%	100%
2014	48%	9%	20%	4%	3%	7%	9%	100%
2015	48%	10%	21%	4%	3%	5%	10%	100%
2016	48%	10%	20%	4%	3%	6%	10%	100%
2017	47%	10%	18%	6%	4%	6%	10%	100%
2018	48%	9%	17%	5%	3%	7%	11%	100%
2019	46%	11%	17%	5%	4%	6%	11%	100%
2020	49%	10%	15%	5%	6%	5%	11%	100%
2021	47%	11%	16%	5%	6%	6%	9%	100%
2022	46%	11%	16%	6%	6%	6%	9%	100%
2023	46%	11%	16%	6%	6%	6%	10%	100%
Statistics								
Average	47%	9%	19%	5%	3%	6%	11%	NA
Minimum	42%	8%	15%	4%	2%	5%	9%	
Maximum	50%	11%	21%	9%	7%	7%	14%	
5-year Average								
2019-2023	47%	11%	16%	5%	5%	6%	10%	NA

By applying the water sales distribution (by percentage) by customer class to the average day demand, as measured by Clinton and Kaw WTP production, nonrevenue water is accounted for on a customer class basis and is listed in Table 3-6. For clarity, the transcription from water sales to water demand is only intended to develop the water usage metrics to account for nonrevenue water based on historical trends so the water demand projections include the degree of apparent losses and physical losses that occurred and will continue to occur in the water distribution system. Apparent losses and physical losses reference those definitions included in AWWA M36 Water Audits and Loss Control Programs, the industry leading source for technical guidance on nonrevenue water.

Table 3-6: Historical Water Demand by Water Sales Distribution (MGD)

Year	Residential	Multi-Family	Commercial	Industrial	City	KU	Wholesale	Total WTP Production
2000	5.56	0.99	2.67	1.07	0.34	0.79	1.38	12.8
2001	5.16	1.04	2.26	1.06	0.26	0.72	1.72	12.2
2002	5.81	0.98	2.61	1.01	0.31	0.75	1.25	12.7
2003	5.90	0.98	2.58	0.61	0.32	0.73	1.41	12.5
2004	5.00	0.95	2.18	0.50	0.23	0.63	1.41	10.9
2005	5.50	0.93	2.34	0.56	0.29	0.70	1.30	11.6
2006	5.71	0.92	2.56	0.54	0.38	0.70	1.37	12.2
2007	5.41	0.94	2.19	0.50	0.34	0.69	1.30	11.4
2008	4.93	0.90	1.96	0.54	0.23	0.59	1.22	10.4
2009	4.53	0.89	1.80	0.45	0.21	0.57	1.05	9.5
2010	4.85	0.89	1.92	0.42	0.21	0.59	1.01	9.9
2011	5.39	0.92	2.07	0.42	0.21	0.55	1.15	10.7
2012	6.03	0.92	2.45	0.48	0.48	0.56	1.28	12.2
2013	4.94	0.90	1.95	0.44	0.76	0.49	1.02	10.5
2014	4.87	0.91	2.05	0.45	0.27	0.72	0.93	10.2
2015	4.80	0.97	2.10	0.45	0.26	0.53	0.98	10.1
2016	5.07	1.02	2.17	0.41	0.30	0.61	1.02	10.6
2017	4.88	1.05	1.85	0.57	0.37	0.64	1.04	10.4
2018	5.41	1.07	1.95	0.56	0.37	0.75	1.20	11.3
2019	4.57	1.07	1.65	0.53	0.41	0.61	1.06	9.9
2020	5.08	1.07	1.53	0.48	0.61	0.50	1.13	10.4
2021	4.92	1.10	1.65	0.56	0.60	0.61	0.96	10.4
2022	4.86	1.17	1.74	0.62	0.62	0.66	0.93	10.6
2023	5.03	1.19	1.79	0.61	0.61	0.70	1.07	11.0

3.4 Water Usage

The consistent growth rate of historical meter populations and highly consistent water sales history amongst all customer classes in the last 5 years yields consistent water usage metrics. As indicated previously, water usage with nonrevenue water is characterized in terms of gallons per meter-day (gpmd) and based on the historical meter populations listed in Table 3-1 and the associated water demand by listed Table 3-6. Historical water usage for each customer class is listed in Table 3-7.

Table 3-7: Historical Water Usage by Customer Class (gpmd)

Year	Residential	Multi-Family	Commercial	Industrial	City	KU	Wholesale
2000	222	1,442	1,583	14,396	2,329	25,442	125,900
2001	201	1,514	1,322	13,630	1,790	22,533	156,203
2002	221	1,397	1,506	13,650	2,061	22,037	113,431
2003	220	1,381	1,466	8,302	1,958	21,407	140,697
2004	182	1,326	1,224	6,712	1,565	19,625	127,745
2005	197	1,302	1,311	7,376	1,852	20,533	130,096
2006	201	1,287	1,428	7,311	2,290	20,716	136,772
2007	189	1,329	1,224	6,765	1,772	21,511	130,379
2008	170	1,280	1,101	7,134	1,257	17,280	122,109
2009	156	1,186	1,005	5,745	1,146	16,375	104,651
2010	167	1,201	1,069	5,445	1,148	16,758	101,124
2011	183	1,212	1,121	5,258	1,062	15,184	128,132
2012	203	1,192	1,296	5,988	2,230	15,215	142,379
2013	164	1,146	1,010	5,438	3,316	12,981	113,707
2014	160	1,141	1,035	5,514	1,100	19,030	103,874
2015	160	1,217	1,054	5,538	1,069	15,073	109,396
2016	169	1,204	1,083	5,043	1,204	16,451	113,710
2017	160	1,551	912	8,414	1,444	16,517	115,518
2018	175	1,688	947	16,892	789	19,119	133,108
2019	147	1,637	802	17,017	976	15,546	117,627
2020	162	1,623	744	15,021	1,751	8,841	125,207
2021	156	1,665	732	14,741	1,544	9,753	107,006
2022	154	1,724	772	17,271	1,601	10,366	102,782
2023	159	1,739	796	16,177	1,547	10,978	118,801
Statistics							
Average	176	1,403	1,079	9,902	1,593	16,680	121,498
Minimum	147	1,141	732	5,043	789	8,841	101,124
Maximum	221	1,739	1,506	17,271	3,316	22,533	156,203
5-year Average							
2019 - 2023	161	1,698	798	16,096	1,639	11,287	113,449
Water Usage Applied in Demand Projections (existing and future planning periods)							
Selection	175	1,739	947	17,271	1,751	16,500	142,379

Notes:
1. Dry years shown in bold.
2. Water usage projection for RE, MF, CO and IN is the 6-year maximum.
3. Water usage from 2018-2023 for City deducts 118 gpm which is the 2023 annual water sales for Eagle Bend Golf Course, Clinton Lake Youth Sports Complex, and Lawrence Rotary Club. These customers will transition their irrigation water consumption to raw water in the future.
4. Water usage projection for KU is based on recent 4-year escalation.

3.5 Water Demand Assessment

The water demand assessment reviews the City's nonrevenue water standing, diurnal analyses for West Hills and Central Service, dry-year water review, and the maximum day demand ratio. The nonrevenue water standing and diurnal analyses are components of the City's water demand profile and are indirectly applied in the water demand projections. The dry-year water demand review characterizes seasonal demand patterns to sequester months with highest water consumption for comparative analysis with historical climate data to determine if water usage during dry years should be accounted for, in some capacity, with the

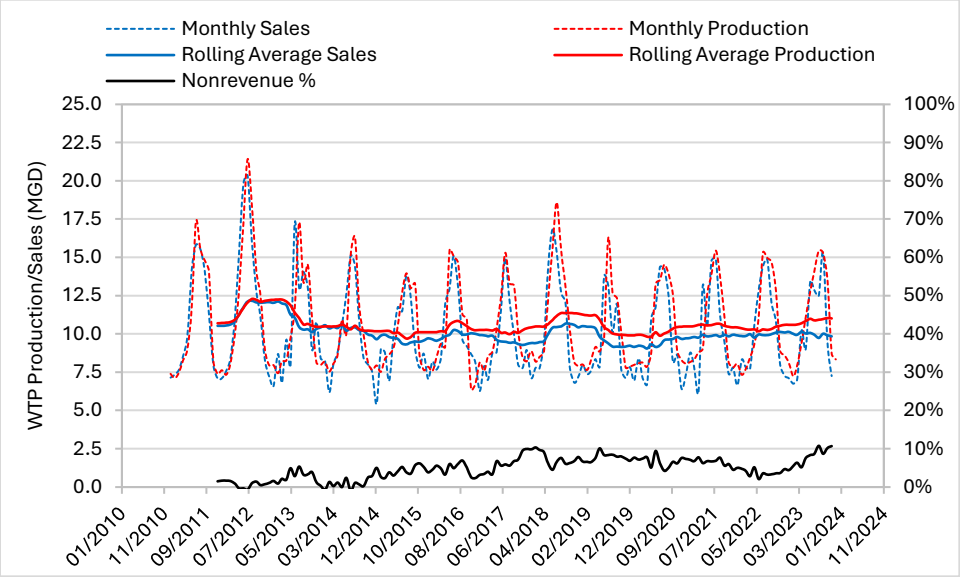
water demand projections. The maximum day demand ratio reviews historical ratios to select an appropriate ratio for the water demand projections.

3.5.1 Nonrevenue Water

As indicated previously in this section, the water usage selected for the demand projections includes nonrevenue water. Therefore, a direct nonrevenue water adjustment, or adder, is not required. However, trending nonrevenue water is important to characterize within the City's water demand profile. For the purposes of this discussion, nonrevenue water is defined as the difference between the annual average water treatment production from Clinton and Kaw WTPs and water sales from the customer billing system on a 12-month rolling average.

The 12-month rolling average for nonrevenue water from 2019 to 2023 ranges between 2 percent and 7 percent and average approximately 7 percent. By this definition the City is considered best-in-class with respect to nonrevenue water standing; though care should be taken using these statistics as a benchmark against other utilities, as each utility is unique and may assess nonrevenue water differently. Water treatment production (water demand) and water sales by month and the corresponding 12-month rolling nonrevenue water average is illustrated in Figure 3-5.

Figure 3-5: Nonrevenue Water Standing



3.5.2 Diurnal Analysis

Diurnal patterns represent changes in water demand over a 24-hour period, reflecting times when customers are using more water or less water than what is pumped into the distribution system from Clinton and Kaw WTPs in addition to Oread and Kasold BPSs. The average demand over the 24-hour period is 100 percent on the diurnal pattern. The equalization storage, peak hour, and minimum hour factors are results of the diurnal evaluation which is based on a mass-balance of flow pumped into the distribution system and tank/tower level changes in distribution system storage. The equalization storage factor refers to the amount of storage needed for daily peaking when the system demand exceeds the 24-hour average. Results of the diurnal analysis are listed in Table 3-8 for West Hills and Central Service. The diurnal patterns for West Hills and

Central Service (weekday and weekend) are illustrated in Figures 3-6, 3-7, and 3-8 respectively. A discernable difference in weekday and weekend diurnal patterns of Central Service was noticed; therefore, these patterns are presented separately.

Table 3-8: Durnal Analysis Results

Pressure Zone	Date	Day	Demand (MGD)	Equalization Storage	Minimum Hour Factor	Peak Hour Factor
West Hills	8/29/2023	weekday	12.1	10%	0.67	1.77
	8/30/2023		12.9	12%	0.53	1.92
	8/31/2023		12.0	10%	0.66	1.77
	9/1/2023		14.1	12%	0.68	1.97
	9/2/2023	weekend	14.4	8%	0.74	1.52
	9/3/2023		13.2	10%	0.74	1.60
	9/4/2023	weekday	14.0	12%	0.46	2.05
	9/5/2023		12.4	10%	0.50	1.78
Central Service	8/29/2023	weekday	4.9	9%	0.58	1.64
	8/30/2023		5.4	13%	0.45	1.55
	8/31/2023		4.4	9%	0.58	1.34
	9/1/2023		4.4	11%	0.26	1.76
	9/2/2023	weekend	4.7	7%	0.46	1.54
	9/3/2023		4.2	8%	0.57	1.38
	9/4/2023	weekday	5.3	9%	0.50	1.48
	9/5/2023		5.2	13%	0.41	1.48

Figure 3-6: West Hills Diurnal Patterns

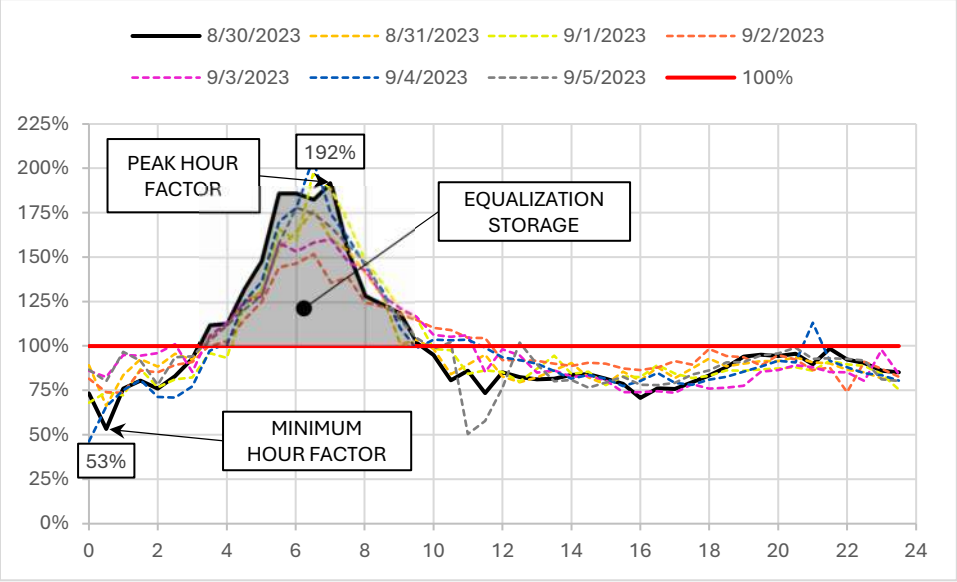


Figure 3-7: Central Service Weekday Diurnal Patterns

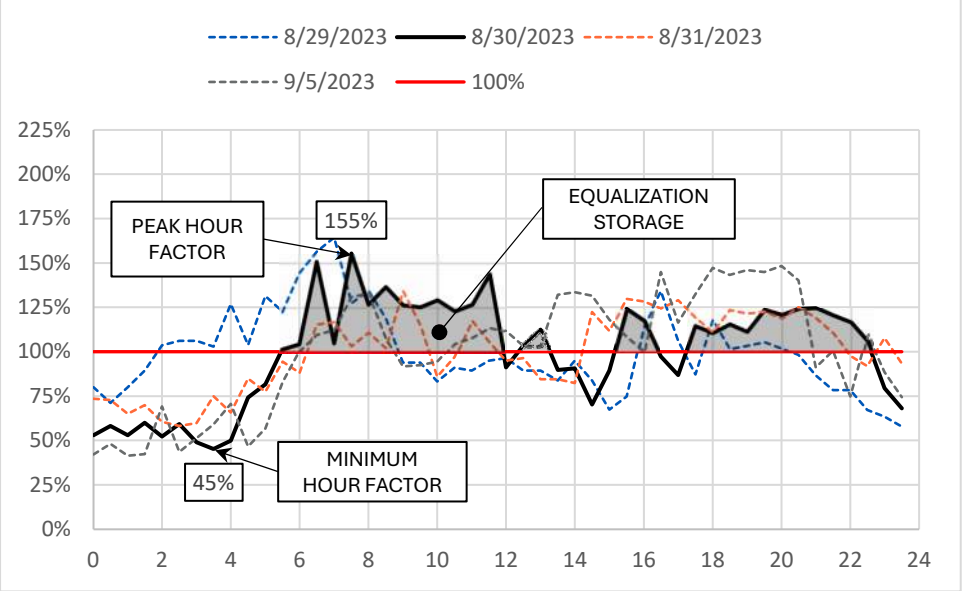
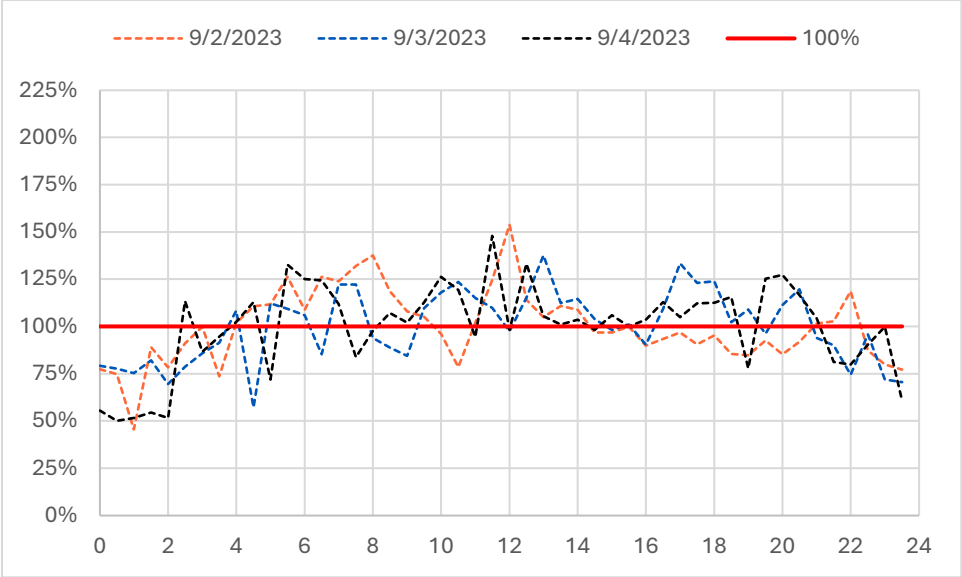


Figure 3-8: Central Service Weekend Diurnal Patterns



The EPS scenarios (existing and future) in the hydraulic model include West Hills and Central Service diurnal patterns. The City's automated metering infrastructure (AMI) system provides hourly flow data resolution for large users in the distribution system by which diurnal patterns are developed and applied in the hydraulic model as well. Representative diurnal patterns, by flow, for large water users are illustrated in Figures 3-9 and 3-10 and are included in the EPS scenarios (existing and future) in the hydraulic model.

The Parks & Rec large user meter is located near the Clinton Lake Youth Sports Complex (grass fields), Lawrence Rotary Arboretum, and Clinton Lake Softball Complex (grass fields); these large users, in addition to Eagle Bend Golf Course (also located near the Parks & Rec meter), are tentatively planned to transition to

non-potable water service in the future, but their water demand is maintained in the model as a conservative approach if water service changes back to potable. The associated account numbers are 248333, 261811, and 251201. The irrigation water service component of their respective water usage (gpmd) is removed in the demand projections to align with the tentative transition plan to non-potable service and more accurately project water demand for future City customer class meter projections. For clarity, the domestic water service component (i.e. bathrooms, sinks, fountains, etc.) of their respective water usage is maintained in both the demand projections and in the model.

Figure 3-9: Group 1: Large User Diurnal Pattern (by flow)

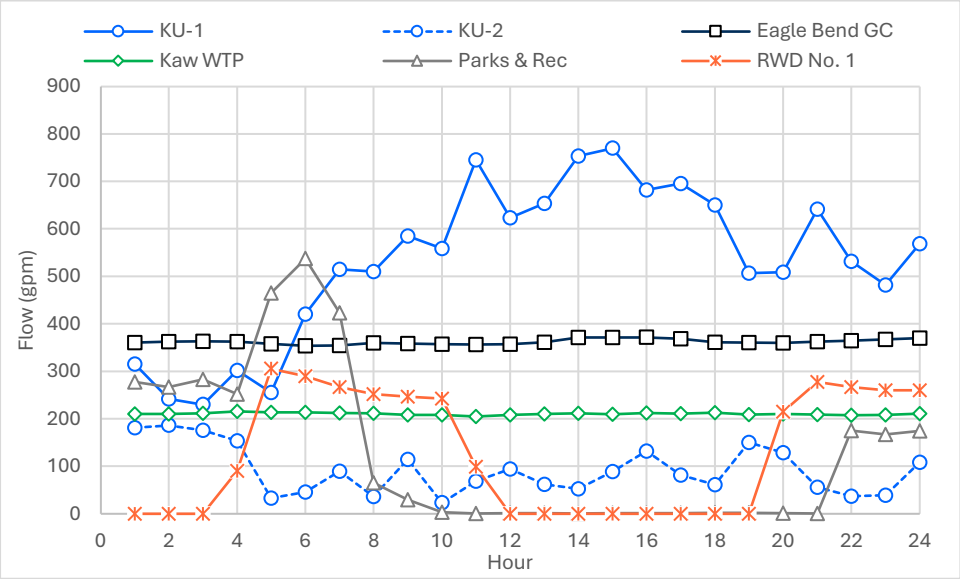
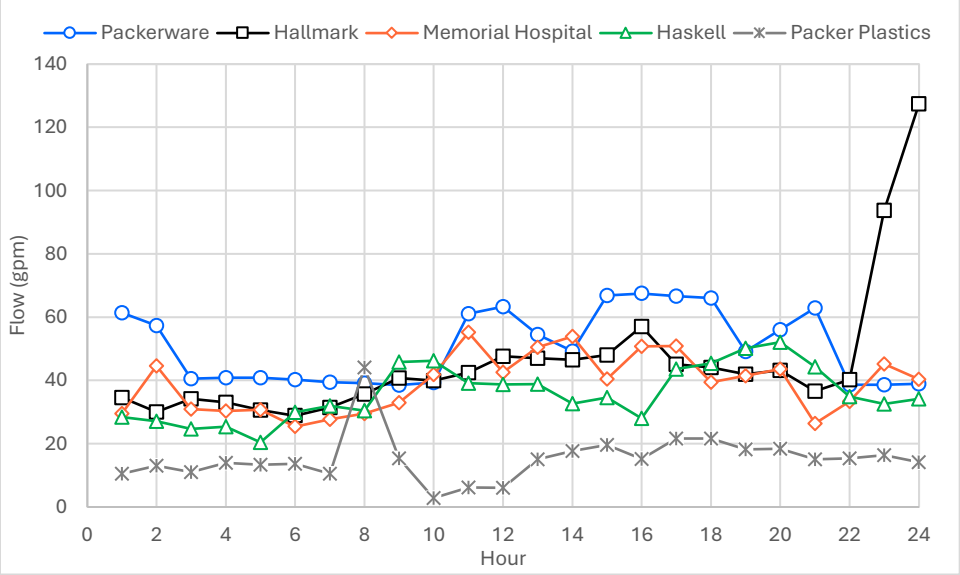


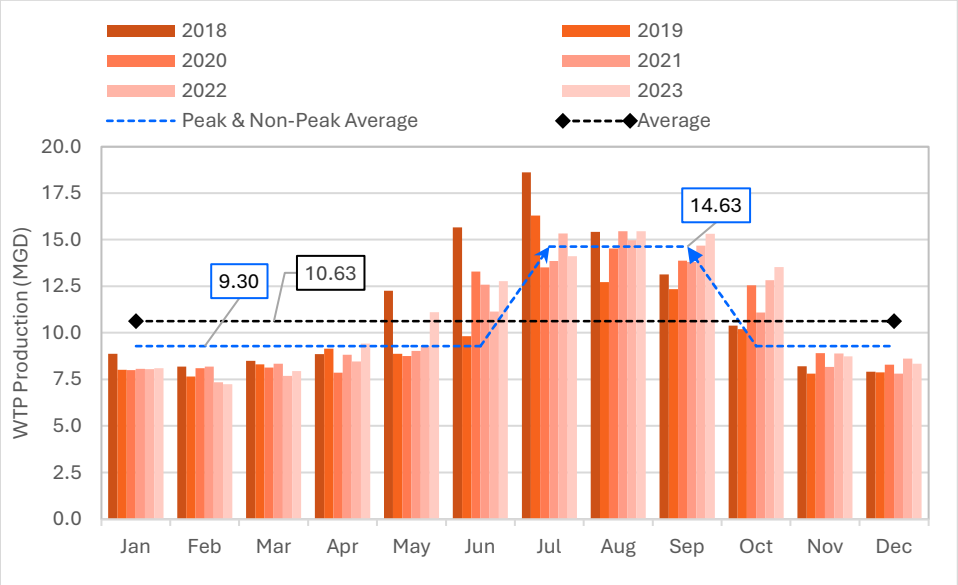
Figure 3-10: Group 2: Large User Diurnal Pattern (by flow)



3.5.3 Dry-Year Water Usage Evaluation

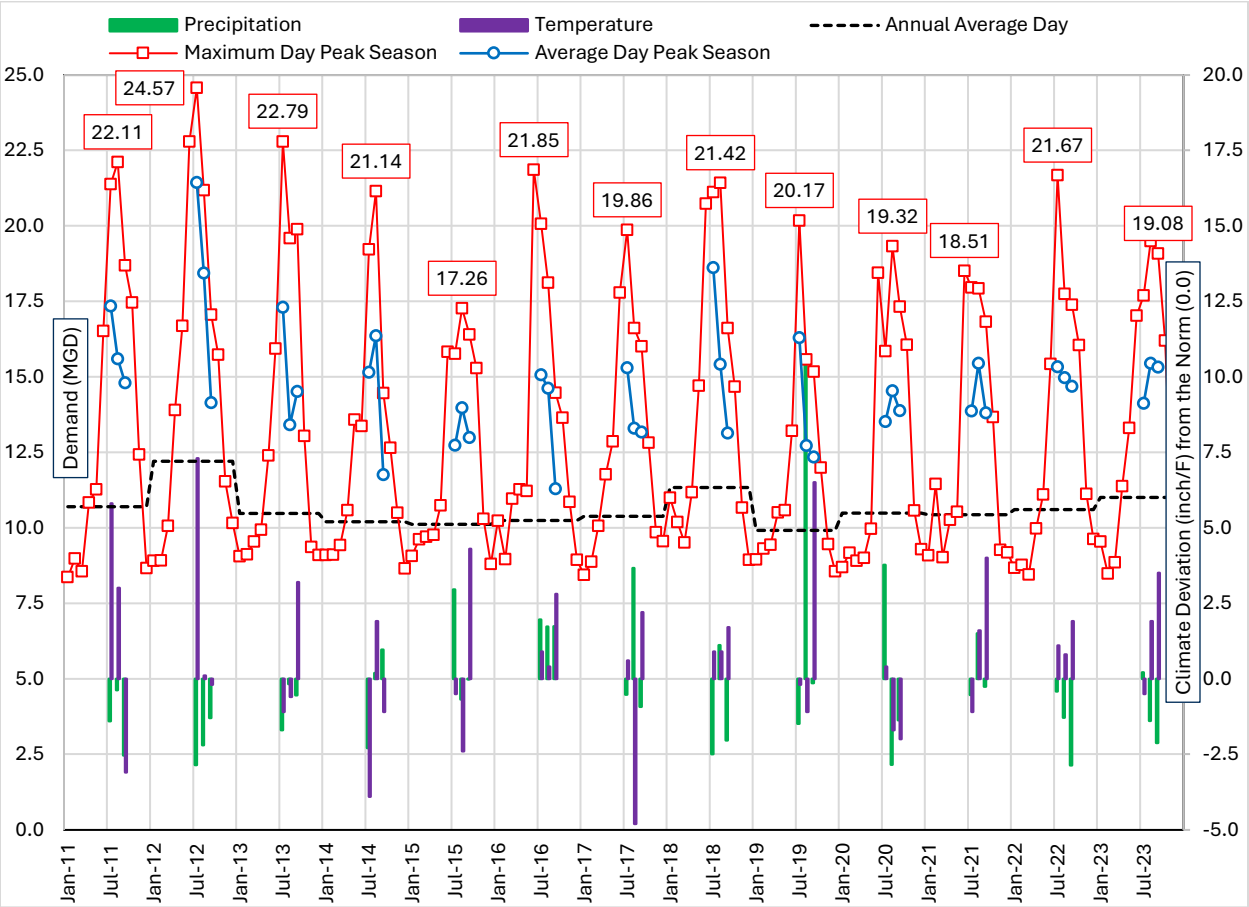
The approach for evaluating dry-year water usage includes a seasonal water demand profile for comparative analysis with climate data to determine if average day demands appear to be influenced by temperature and precipitation during peak demand months. The seasonal demand characterization is based on the last 6 years of monthly WTP production data to identify the peak demand months. The peak demand months have occurred in July, August and September since 2018 and is illustrated in Figure 3-11.

Figure 3-11: Seasonal Water Demand Profile



Dry year conditions, relative to water demand trending, can occur when both temperature and precipitation deviate from their respective norms during the peak demand season. Comparative analysis of average day demands during the peak seasonal demand months of July, August, and September since 2011 indicate observable inflections in 2012 and 2018. Similarly, observable inflections in annual average day demands are also shown in 2012 and 2018. Based on the results of this dry-year water usage evaluation, the residential and commercial water usage in 2018, that have a combined 5-year average water sales is approximately 63 percent, is selected for application in the water demand projections. The water usage selected for multi-family, industrial, City, and KU is based on the 5-year maximum amount.

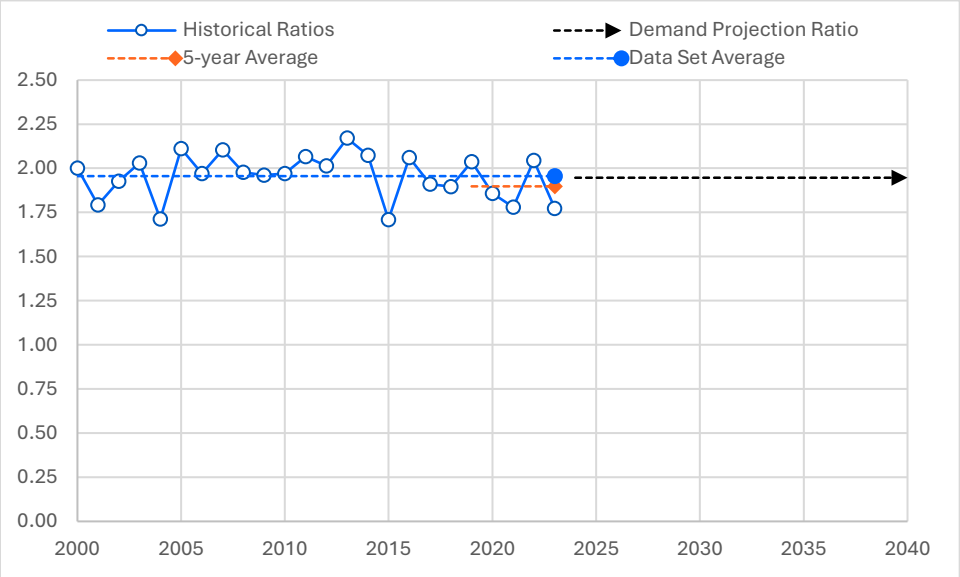
Figure 3-12: Comparative Analysis of Peak Seasonal Demands & Climate



3.5.4 Maximum Day to Average Day Demand Ratio

A maximum day demand ratio is applied to the average day demand projections based on a review of historical ratios during dry years, peak ratio, and 5-year trending. For clarity, the City's wholesale customers are evaluated with contract limits, therefore a maximum day ratio is not applied to this customer class in the demand projections. Historical maximum day ratios since 2000 are illustrated in Figure 3-13. The maximum day ratios during the dry-years of 2012 and 2018 were 2.01 and 1.90 respectively.

Figure 3-13: Historical Maximum Day Ratio

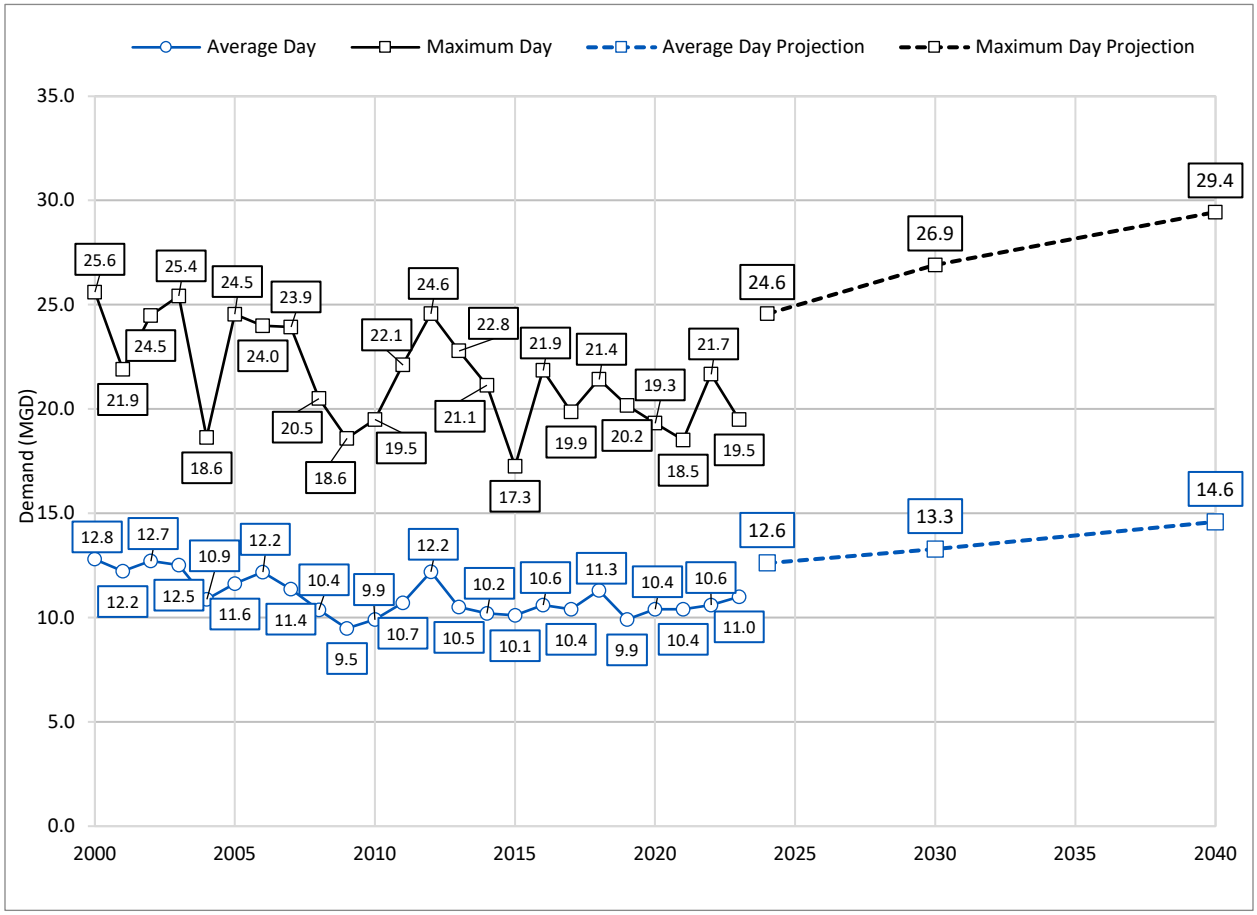


The peak maximum day ratio of 2.17 occurred in 2013 and the 5-year average of maximum day ratios is 1.90. Given the conservative approach of utilizing the dry-year water usage for residential and commercial classes, recent historical water usage highs for the remaining classes, and relatively consistent historical maximum day ratio trending, a maximum day ratio of 1.95 is applied in the water demand projections. Applying dry-year water usage and a peak historical maximum day ratio can result in high to excessive water demand projections which can, effectively, oversize capital improvements or accelerate their implementation long before they are required. Furthermore, maximum day ratios experienced during dry years typically are not relatively high or relatively low, as the annual average day demand is usually higher in cities like Lawrence with dominant residential (with multi-family) and commercial water sales. As indicated previously, residential, multi-family, and commercial water sales averaged 75 percent of all water sales since 2000.

3.6 Water Demand Projections

The average day and maximum day demand projections applied in the hydraulic analyses for the existing system (2024) and the 2030 and 2040 planning periods is based on the information presented in this section of the report and is illustrated in Figure 3-14.

Figure 3-14: Water Demand Projections



4.0 Net Water Needs Analysis

The City's net water needs with respect to water rights, water supply, and water treatment capacity is evaluated in this section of the report. This analysis compares average day and maximum day demand projections with the existing diversion water rights, diversion capacity, and water treatment capacity to assess the net water needs of the system and timing of projected deficits.

The City has a mix of surface and groundwater supplies. Surface water supplies include the Kansas River, Clinton Lake, and Wakarusa River. Groundwater supply comes from the alluvium adjacent to the Kansas River. Clinton Lake and the Wakarusa River supply Clinton WTP and the Kansas River sources, including the alluvium, supply Kaw WTP.

Clinton Lake is operated by the U.S. Army Corps of Engineers and is the sole supply for Clinton Water Treatment Plant. The lake is also used for flood control, recreation, industrial supply, fish & wildlife, and maintaining minimum stream flow conditions on the Wakarusa and Kansas rivers. The Kansas River surface water supply is managed through the Kansas River Water Assurance District. The Kansas River Water Assurance District coordinates the storage and releases of member water stored in Milford, Tuttle Creek and Perry Lakes. The Kansas River alluvium groundwater supply consists of 6 shallow vertical wells in the vicinity of Kaw WTP.

4.1 Water Rights

4.1.1 Clinton Lake

The City is permitted to divert up to 4,988 million gallons (MG) of water annually from Clinton Lake. This equates to an average day rate of 13.6 MGD with a maximum daily diversion rate of 30.0 MGD not to be exceeded. The current water contract between the City and the State of Kansas, represented by the Kansas Water Office, is in place for a period of 40 years starting December 30, 2019. This contract represents a consolidation of the City's wholesale customers' water rights which were allowed to expire in conjunction with the execution of this contract term. The wholesale customers supplied through this contract include the City of Baldwin, Kansas; Douglas County Rural Water District (RWD) No.1, Douglas County RWD No.2, and Douglas County RWD No.4.

4.1.2 Wakarusa River

In 2022 Douglas County RWD No.1 deeded it's Wakarusa River water rights to the City. This followed wholesale contract changes with the City where RWD No.1 began purchasing raw water from the City and, as a result, did not renew its Water Marketing Contract with the Kansas Water Office. These water rights amount to an average day of 0.019 MGD and a maximum daily rate of 0.108 MGD.

4.1.3 Kansas River and Wells

The City maintains water rights for surface and ground water associated with the Kansas River. These water rights amount to an average day of 22.3 MGD and a maximum daily rate of 46.7 MGD.

4.1.4 Water Rights Assessment

The City has adequate total water rights to satisfy the demand projections through the 2040 planning period. However, as shown in Figure 4-1, the projected maximum day demand begins to exceed the ability Clinton Lake water rights to independently satisfy the demand. Tables 4-1 and 4-2 show the net water needs difference between the projected maximum day and average day demands and the City's available water rights.

Figure 4-1: Water Rights vs Demand (standalone)

Table 4-1: Maximum Day Water Rights Needs Assessment

Water Needs Component	Year 2024 (MGD)	Year 2030 (MGD)	Year 2040 (MGD)
Maximum Day Demand Projection[1]	27.4	29.9	32.6
Maximum Day Water Right Diversion	75.0	75.0	75.0
Net Water Rights Status: Surplus	47.6	45.1	42.4

Notes:
1. Includes 8 percent water loss for treatment through WTP and select large user City accounts with irrigation service to be transitioned to non-potable demand as indicated in Section 3.5.2.

Table 4-2: Average Day Water Rights Assessment

Water Needs Component	Year 2024 (MGD)	Year 2030 (MGD)	Year 2040 (MGD)
Average Day Demand Projection[1]	14.1	14.8	16.2
Average Day Water Right Diversion	36.0	36.0	36.0
Net Water Rights Status: Surplus	22.0	21.2	19.8

Notes:
1. Includes 8 percent water loss for treatment through WTP and select large user City accounts with irrigation service to be transitioned to non-potable demand as indicated in Section 3.5.2.

4.2 Raw Water Diversion Capacity

Since the 2012 Water Master Plan, prepared by Burns & McDonnell, the Clinton Lake Raw Water Pump Station (2016 by others) has increased the firm capacity to 25 MGD and a second operational intake and associated piping has been constructed on the Kansas River (2014) increasing the total diversion capacity of the two sources to 47.3 MGD. Clinton Lake supplies 25 MGD, the Kansas River supplies 20.6 MGD and is based on the firm capacity of Low Service Pump Station (LSPS) No. 2, and the Kansas River Wellfield supplies and additional 1.9 MGD. Additional items of note are listed below:

- Even with the noted capacity improvements the Clinton Lake Raw Water Pump Station relies on a single 36-inch transmission main to convey raw water approximately 2 miles to Clinton WTP.
- The City indicated that the Kansas River LSPS No.1 at Kaw WTP is not operational and there are no current plans to rehabilitate or replace it in the future.

The City has sufficient raw water diversion capacity in total to satisfy the demand projections through the 2040 planning period. However, as shown in Figure 4-3, the maximum day demand projection begins to exceed the ability of either the Clinton Lake or Kansas River diversions to independently satisfy the demands.

Figure 4-1: Water Rigths vs Demand

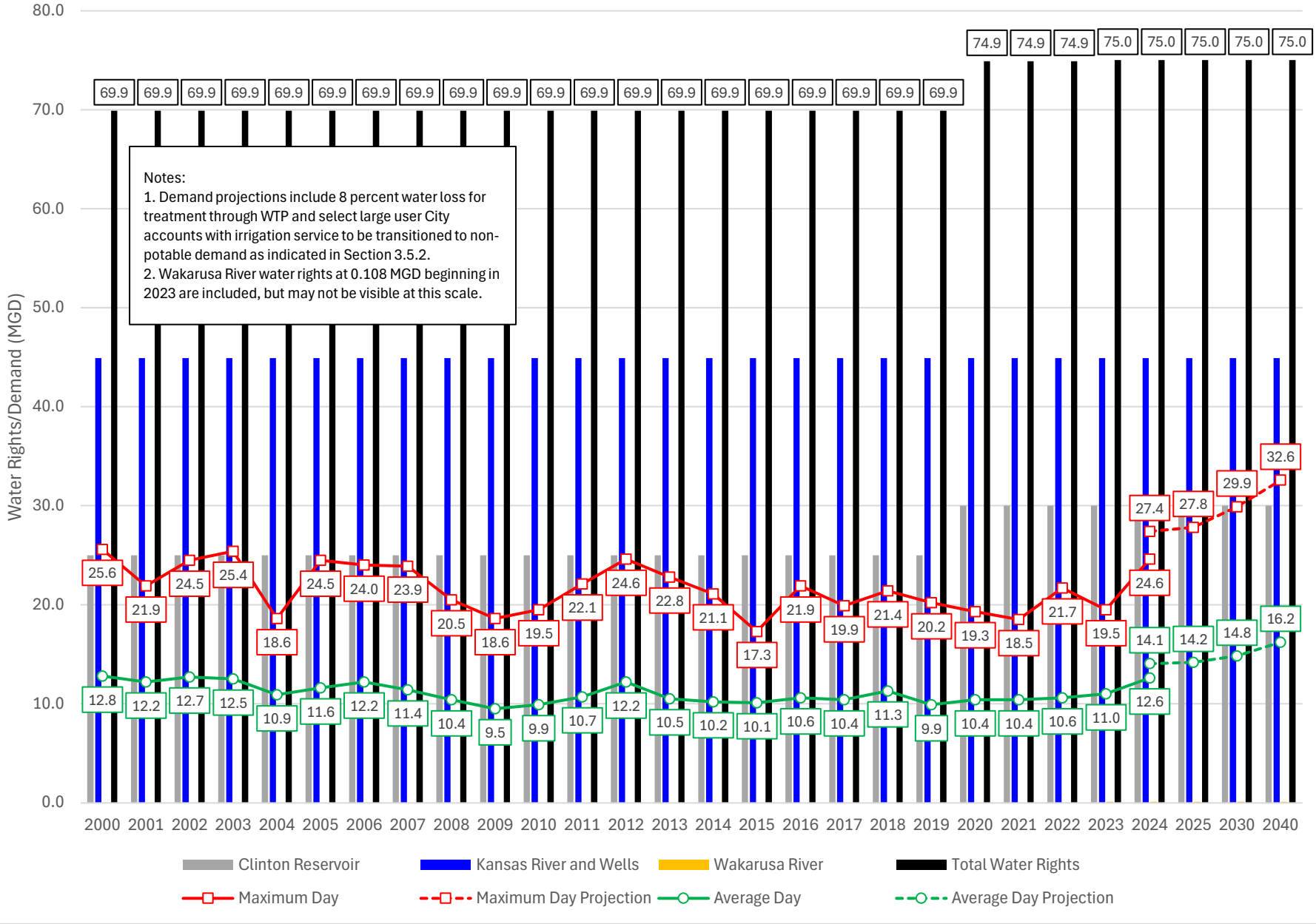


Table 4-3 shows the net water diversion capacity difference between the maximum day demand projections and the available combined diversion capacity of Clinton and Kaw WTPs.

Figure 4-2: Diversion Capacity vs Demand (standalone)

Table 4-3: Diversion Capacity Assessment

Water Needs Component	Year 2024 MGD	Year 2030 MGD	Year 2040 MGD
Required Diversion Capacity[1]	27.4	29.9	32.6
Current Diversion Capacity	47.3	47.3	47.3
Net Diversion Status: Surplus	19.9	17.4	14.7

Notes:
1. Includes 8 percent water loss for treatment through WTP and select large user City accounts with irrigation service to be transitioned to non-potable demand as indicated in Section 3.5.2.

4.3 Water Treatment Capacity

The current total treatment capacity is 41.4 MGD. Clinton WTP can treat 25.0 MGD and Kaw WTP can treat 16.4 MGD. City staff indicated Kaw WTP has a process piping restriction between the carbon contact basin and the primary basin splitter box lowering the capacity from 17.5 MGD to 16.4 MGD.

The City has adequate total treatment capacity to satisfy the demand projections through the 2040 planning period. As seen in Figure 4-4, the average day demand projections through the 2040 planning period can be supplied by either WTP. However, the maximum day demand projections exceed the ability of either WTP to fully treat/supply the system demand independently.

Figure 4-3: Water Treatment Capacity vs Demand (standalone)

Table 4-4: Water Treatment Capacity Assessment

Water Needs Component	Year 2024 MGD	Year 2030 MGD	Year 2040 MGD
Required Treatment Capacity[1]	26.6	29.1	31.8
Current Total Treatment Capacity	41.4	41.4	41.4
1. Kaw WTP Capacity	16.4	16.4	16.4
2. Clinton WTP Capacity	25.0	25.0	25.0
Net Treatment Status: Surplus	14.8	12.3	9.6

Notes:
1. Represents maximum day demand projections plus 8 percent water loss for treatment through WTPs.

4.4 Net Water Needs Summary

The City has surplus capacity through the 2040 planning period in all net water need areas evaluated including water rights, raw water diversion, and water treatment. The City's raw water and water treatment systems generally rely on the redundancy of the two independent water sources and WTPs. Areas of this current redundancy begin to decrease (as expected) as water demand projections increase through the 2040 planning period:

Figure 4-2: Diversion Capacity vs Demand

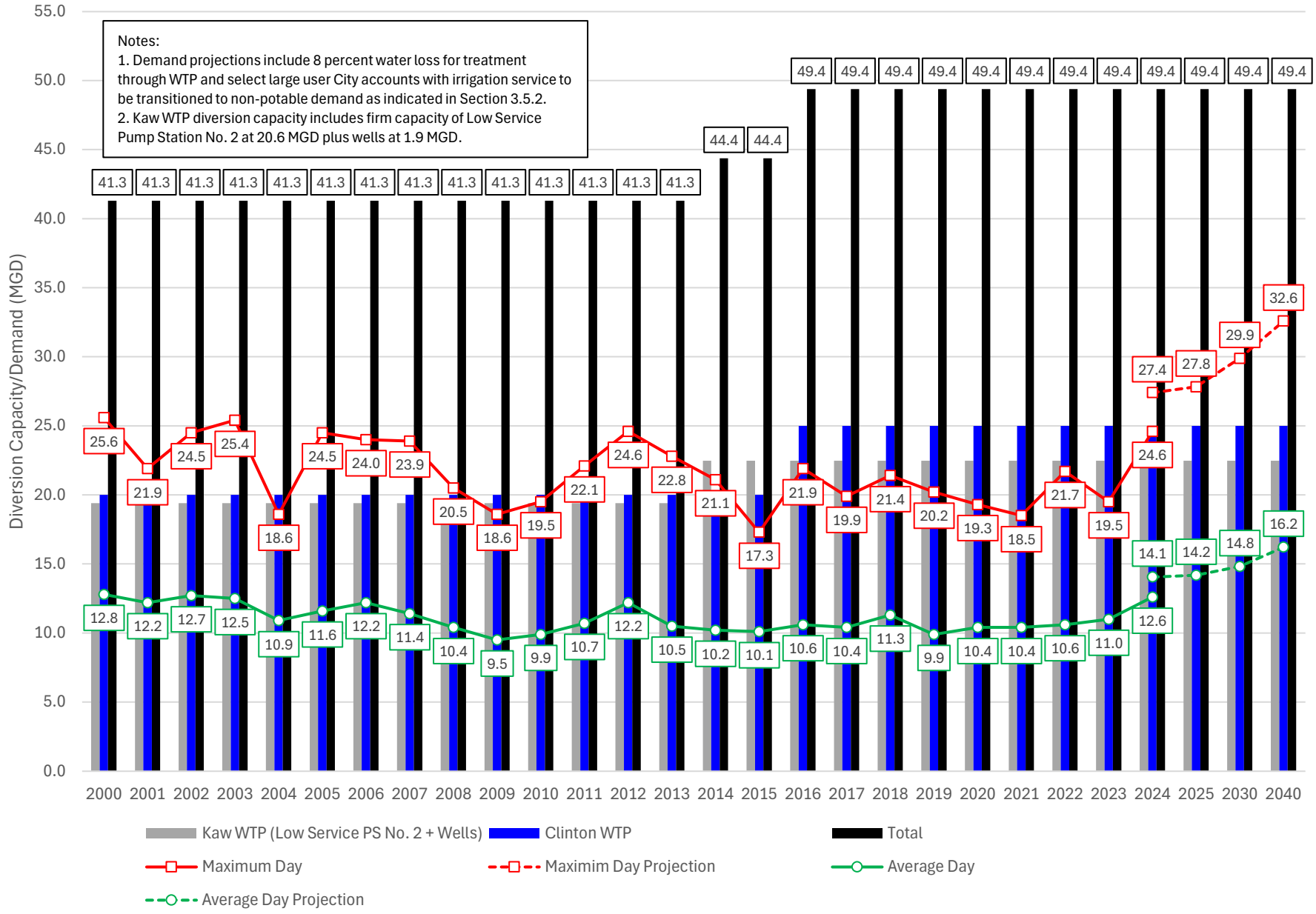
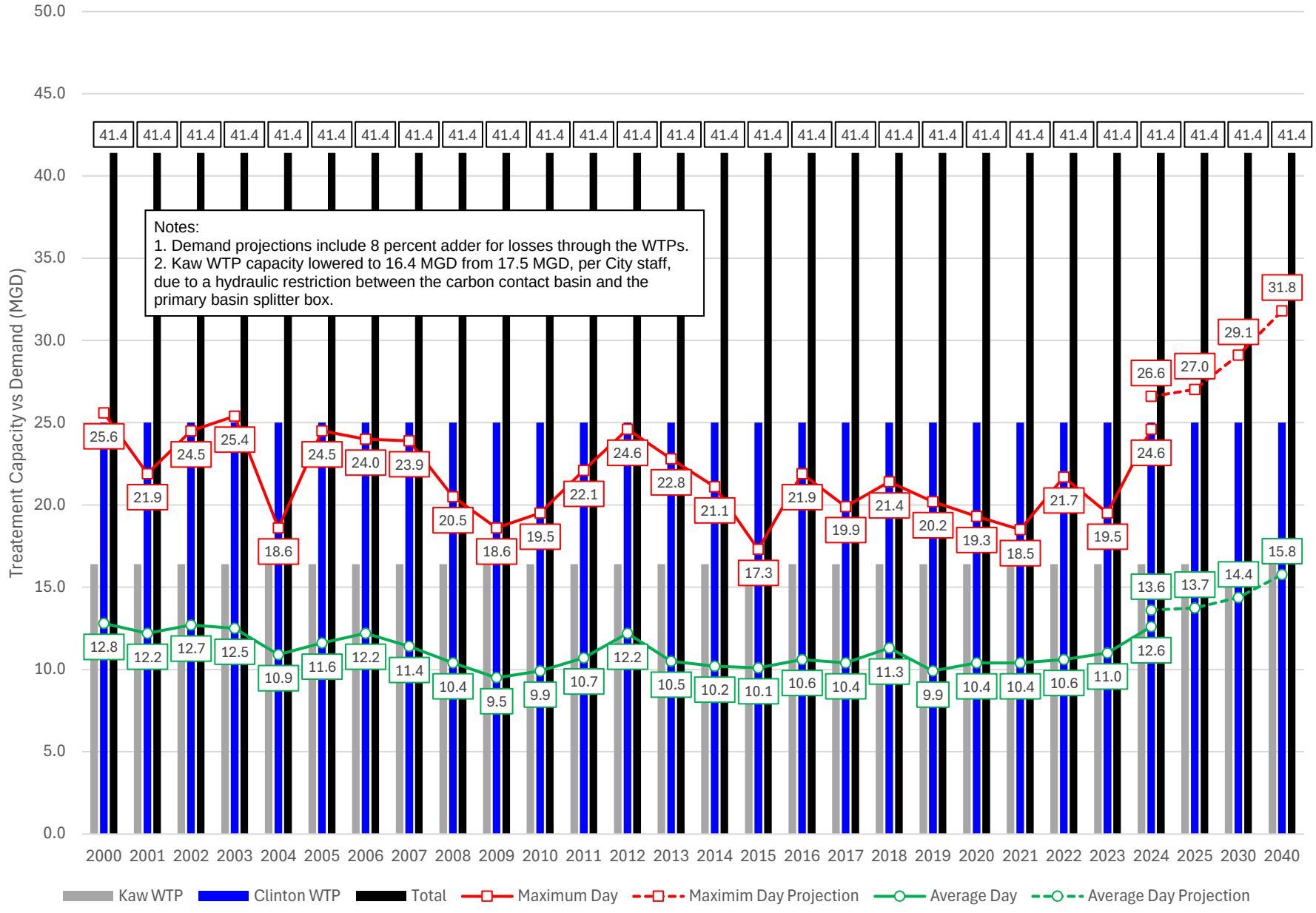


Figure 4-3: Water Treatment Capacity vs Demand



- The maximum day demand projection begins to exceed the ability of Clinton Lake water rights to independently satisfy the demands; for clarity, this is not a water service goal for the City.
- The maximum day demand projection begins to exceed the ability of either the Clinton Lake or Kansas River diversions to independently satisfy the demands; for clarity, this is not a water service goal for the City.
- The maximum day demand projection begins to exceed the ability of either WTP to fully supply the demand independently; for clarity, this is not a water service goal of the City.

4.5 Conclusions & Recommendations

The City is well positioned over the planning period with sufficient water and infrastructure from a capacity perspective to supply the projected demands. The condition of raw water diversion assets and water treatment facilities should also be considered in long-term facility planning.

- The City should continue to track annual average day and annual maximum day demands against the respective demand projections prepared in this Water Master Plan.
- The City should evaluate the process piping restriction at the Kaw WTP to restore its 17.5 MGD capacity.
- The City should conduct a condition assessment of the 36-inch raw water transmission main from Clinton Lake to Clinton WTP to determine its remaining useful life. Given the length of this transmission main at approximately 2 miles, the City should stock pipeline repair appurtenances in this size and assess the cost-benefit for a redundant transmission main including nonmonetary factors.

5.0 Water Distribution Master Planning

This section of the report discusses the level of service conditions for hydraulic analysis, fire flow requirements associated with distribution system storage, and modelling ecology used for water master planning of the distribution system. Model results are evaluated against the level of service conditions to determine if a capital improvement is needed for compliance. The water distribution system master planning effort includes future growth area limits, timing for future growth, and the geospatial allocation of projected water demands based on anticipated land use classifications provided by the City.

5.1 Level of Service

The level of service coverage applied in this water master plan includes limits for distribution system pressure, high service pumping capacity, distribution system hydraulics (velocity and headloss), distribution system storage, and fire flow. The level of service range includes City specific options from minimum performance requirements to mid-level goals to best practices. Ultimately, one level of service is selected for each of the coverage areas and is the basis for capital improvement recommendations. The level of service criteria evaluated in the model and selected for application in this Water Master Plan is listed in Table 5-1.

Table 5-1: Level of Service

Feature	Criterion	Minimum Performance	Mid-Level Goal	Best Practice
Pressure	Minimum	> 20 psi for all conditions	**> 40 psi for normal conditions**	> 50 psi for normal conditions
			> 20 psi for fire flow	> 25 psi for fire flow
	Maximum	**< 150 psi**	Lesser of 100 psi or water main break HGL	
High Service Pumping	Capacity	**Total firm capacity >= pressure zone maximum day**		Firm Capacity each HSPS > system maximum day
Distribution Hydraulics	Velocity	**< 5 fps under peak hour on the maximum day demand**		
	Headloss	**< 6 ft/1,000 ft under peak hour on the maximum day**		
Storage (per pressure zone)	Equalization	**Volumetric demand > the 24-hour average (maximum day x equalization factor)**		
	Fire	Maximum fire flow requirement = 3,000 gpm for 3 hours = 0.54 MG		**Maximum fire flow = 3,500 gpm for 3 hours = 0.63 MG**
	Emergency	**Portion of 1.0 MG Surplus (each pressure zone)**		
	Total (Effective)	Fire + Equalization		**Fire + Equalization + 1.0 MG Surplus (each pressure zone)**
Fire Service	Flow & Pressure	>1,000 gpm at 20 psi minimum	**>1,500 gpm at 20 psi minimum**	>1,500 gpm at 25 psi minimum

Notes:

1. Level of service selected by City and applied in the Water Master Plan indicated in bold.

5.2 Fire Flow

Distribution system storage for the fire reserve includes water that must always be available to fight the most severe fires. The fire storage requirement in the distribution system is 3,500 gpm for 3 hours, or the equivalent to 0.63 MG and is referenced in the City's 2022 Insurance Services Office report included in Appendix A. Fire flow improvements are sized to deliver 1,500 gpm at a minimum residual of 20 psi in the distribution system to meet the level of service.

5.3 Model Ecology

Hydraulic analyses, both static and extend period simulations (EPS) are conducted with the model to evaluate the ability of the distribution system to convey equalization storage (or peaking flows from storage), pump the projected water demands, and identify deficiencies with respect to capacity (velocity and headloss gradient), pressure, and fire flow. The model ecology prepared for these analyses is described below:

- Existing System:
  - EPS with maximum day demands for hydraulic analysis.
  - EPS with maximum day demands for water age analysis.
  - EPS with average day demands for water age analysis.
  - All EPS scenarios include pressure zone specific diurnal patterns for West Hills and Central Service in addition to unique diurnal patterns for the large users discussed in Section 3.0.
  - Static simulation with maximum day demands for available fire flow analysis.
- 2030 and 2040 Planning Periods:
  - EPS with maximum day demands for hydraulic analysis.
  - All EPS scenarios include pressure zone specific diurnal patterns for West Hills and Central Service in addition to unique diurnal patterns for the large users discussed in Section 3.0.
  - Static simulation with maximum day demands for available fire flow analysis.

5.4 Water Master Planning

The water distribution system master planning effort includes future development areas, timing for future growth, and the geospatial allocation of projected water demands based on anticipated land use classifications. The proposed land use classifications for development areas in the 2030 and 2040 planning periods were provided by the City to align with Southwest Conveyance Corridor Study (by others) for the wastewater utility and is illustrated in Figure 5-1. The geospatial allocation for the 2030 and 2040 water demand projections are applied to these development areas are described below:

1. KU development – demand projection is point-loaded:
   a. 2030: one meter at the KU West Campus, one meter at Memorial Stadium, and one meter at the KU-owned parcel in Venture Park.
   b. 2040: three meters at the Crossing and two meters at KU Campus Central Service connection.
2. City development – demand projection is point-loaded:
   a. 2030: one meter just north of Venture Park in City-owned development area and 1 meter in City-owned parcels in Venture Park.
   b. 2040: one meter near North Lawrence Riverfront Site and one meter south of Venture Park at a Future Park by PS49.
3. Industrial development – demand projection is weighted by parcel area.
   a. 2030: inside City limits.
   b. 2040: outside City limits.
4. Commercial development – demand projection weighted by parcel area.
   a. 2030 growth area = 2040 growth area
5. Residential and multi-family development – demand projection weighted by dispersion model population delta:
   a. 2030: service area as indicated in Figure 5-1.
   b. 2040: service area includes 2030 service area + expansion in NW Lawrence (south of -70).

Figure 5-1: Future Development for Water Master Planning (standalone)

City-owned property with industrial zone classification; half of this parcel has been developed via the Transit Facility (red box); make additive to industrial development on lot adjacent to the Transit Facility.

Airport Sites: industrial zone; maintain as industrial development.

North Lawrence Riverfront Site: 8 City-owned parcels with "CD-PD" Downtown Commercial District - Planned Development zoning; maintain commercial development status.

Parking Lot - 402 N 2ND ST, maintain as industrial development.

Downtown Parking Lots: originally included as "Commercial" development area because of expectation that someday they may be developed with underground parking; maintain commercial development opportunity here.

Venture Park / East Hills BP - Recommend still including City/KU owned industrial zoned parcels as part of industrial growth area; maintain as 2030 industrial development.

KU West Campus Parcel - Included as "Commercial" in Southwest Corridor WW Planning (by others) because of concern that some growth should be accounted for here; adopt a commercial demand for this KU polygon. The pink polygon is Evergy substation and is not included as a development area.

Future Park by PS49 - included as part of "Site 5" of the "Potential Industrial Sites Map" provided by City; maintain as industrial 2030 industrial development.

0 0.25 0.5 1 1.5 2 Miles

N

Legend

- City Limits
- City or KU Owned Parcel
- 100-yr Flood Zone (A, AE, or AH)
- Industrial Growth Area, 2030, Within City Limits
- Industrial Growth Area, 2040, Outside City Limits
- Commercial Growth Area
- Residential TAZ-Based Polygons, 100-yr Floodplain & City/KU Parcels Removed

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FIGURE 5-1

FUTURE DEVELOPMENT FOR WATER MASTER PLANNING

6.0 Model Development & Calibration

This section of the report discusses model development, field testing efforts, and model calibration with static and extended period simulations. Pressure in the distribution system is recorded during field testing and is used to calibrate the model. The calibration status reflects the ability of the model to simulate hydraulic behavior in the distribution system; this includes integrating operational controls and system demands into the model as well.

6.1 Model Development

The pipe network included in the model is skeletonized from the City's water system GIS and creates a unique ID 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. Additional hydraulic asset information for pumps, storage tanks, and supply sources such as pump curves, tank head range tank, tank overflow elevation, tank diameter and fixed-head supply sources for Clinton and Kaw WTPs 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 from the 2023 customer billing data set is geocoded by meter address to model junctions. This process includes quality control checks and results in a model with an accurate representation, in terms of quantity and geospatial placement of water demand in the distribution system.

6.2 Field Testing

Field testing was conducted in late September 2023 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-inch 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; localized static and residual pressures at the fire hydrant test are also recorded. SCADA historian information is also collected from the City's system at the time of each fire hydrant test (i.e. WTP flow with suction and discharge pressure, distribution system storage levels, and flow/pressure at Oread and Kasold BPSs).

Fire hydrant testing includes opening a hydrant, termed the "flowing" hydrant (FH A), to measure residual pressure (while open) and measure pressure at an adjacent hydrant, termed the "gauge" hydrant (FH C). The gauge hydrant is typically the nearest one upstream or downstream of the flowing hydrant and connected to the same water main. Flow from the open hydrant is calculated based on the residual pressure. The fire hydrant tests and data logger locations in West Hills and Central Service are illustrated in Figure 6-1. Field test forms are included in Appendix B. The hydrant testing data and SCADA data are used to develop steady-state, or static, calibration scenarios within the model.

Figure 6-1: Field Testing Plan: Data Logger Deployment & Fire Hydrant Tests (standalone)

6.3 Model Calibration

Static simulations include steady state system conditions for each fire hydrant test and are developed in the model to calibrate the water mains in the distribution system. An extended period simulation (EPS) is developed in the model to assess facility performance at pump stations and distribution system storage with

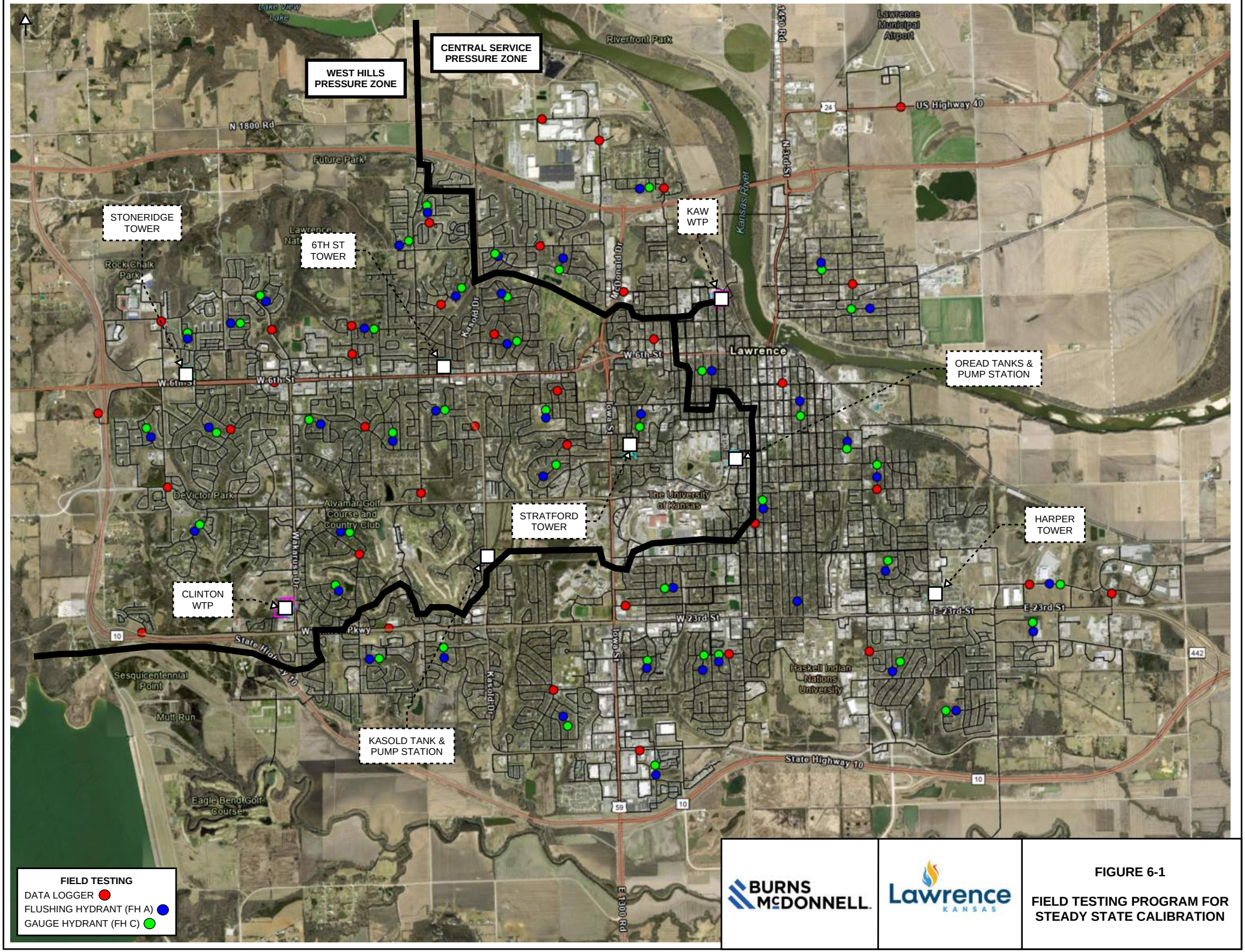

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FIGURE 6-1

FIELD TESTING PROGRAM FOR STEADY STATE CALIBRATION

SCADA data (i.e., pump station flow, suction pressure, discharge pressure, and tank level) based on the distribution system calibration effort. An EPS is effectively a series of steady-state time steps with simple and/or logic controls for facilities such as pump on/off time setting, tank inlet valve open/close based on tank level, and pump VFD settings for flow/pressure control. Model input data for steady-state and EPS simulations include system demand, diurnal patterns (EPS only) tank level, and pump status (on/off and speed), and fire hydrant test flow data to (steady-state only). The model calculates frictional headloss based on the Hazen-Williams coefficient, or C-values, assigned to each pipe and produces results for flow, velocity, headloss, pressure, and hydraulic gradient in the distribution system. Tank filling/drafting status and pump flow-head results are also produced at distribution system facilities.

6.3.1 Steady State Calibration

The C-value of a pipe represents the relative internal roughness and its modelling application represents an indication of the degree of roughness within a pipe. Pipes with high C-values convey water with less frictional headloss and C-values generally decrease with age. Pipe material can also influence the C-value. Pipes with low C-values can also be indicative of partially closed valves in the distribution system, distribution system scaling, tuberculation, or other water quality issues. When C-values degrade beyond a certain point, pipe replacement should be considered. C-value degradation alone should not be the only factor for water main replacement, a pipe's age, material, installation, and break history should also be considered.

The steady-state calibration is performed by adjusting the C-values until the pressure at each fire hydrant test and data logger in the model is aligned with the field measurements under static and residual test conditions. The C-values are adjusted to yield model pressure results within five psi of the field test results. The steady state and EPS model calibration results are included in Appendix C. The C-values applied in the model calibration effort adequately represent the field testing conditions for the system demands experienced at the time of each test. The initial C-value of existing pipes in the model adopted those that were in place during the 2012 Water Master Plan, also completed by Burns & McDonnell, as an extensive field testing and model calibration effort was also conducted for that project. New pipes installed since the previous Water Master Plan are assigned an initial C-value of 130 to account for some degree of past and future deterioration and is a conservative approach; these initial C-values are then adjusted, where needed, for model calibration.

6.3.2 EPS Calibration of Facility Control Schemes

The EPS calibration validates, to the degree that it can be with the available system information, static calibration efforts for pipe C-values in the distribution system and is intended to confirm facility control schemes for pumping and tank operations. The EPS calibration scenario includes a 1-hour timestep for the 48-hour period on August 29-30, 2023 and includes pump on/off status and VFD setting at Clinton and Kaw HSPSs, distribution system storage controls at Harper, Kasold, 6th St, and Stoneridge towers, and BPS service at Oread and Kasold. The EPS results for pump stations (flow, suction pressure, and discharge pressure) and distribution system storage (tank levels) are compared with SCADA trending and are included in Appendix C. Based on the comparative analysis with SCADA trending, the EPS calibration effort adequately reflects the facility control schemes employed by WTP operators.

7.0 Existing System Hydraulic Analysis

This section of the report summarizes the hydraulic analysis and model results for the existing water distribution system under average day and maximum day demands of 12.6 MGD and 24.6 MGD respectively. Maximum day demands in the West Hills and Central Service pressure zones are 15.8 MGD and 8.7 MGD respectively. High service pumping capacity, pressure, storage, and fire flow in the distribution system are evaluated under maximum day demands, including minimum hour and peak hour, because it is the governing condition for the City with respect to capacity-based analyses and water distribution system master planning. Water age is evaluated with average day demands as it reflects periods when disinfectant residuals are lower due to lower velocity profiles through the distribution system that result in higher travel times. In general, these analyses are intended to characterize strengths and weaknesses of the existing distribution system relative to the level of service conditions detailed in Section 5.0.

7.1 Pumping & Pressure

The average pressure in West Hills under the maximum day demand ranges between 46 psi and 141 psi with an average of approximately 83 psi. The pressure range is wide in West Hills and largely attributed to topography where grade elevations range from 837 ft to 1,066 ft, which is equivalent to a static head of 229 ft or 99 psi. Higher pressures, greater than 100 psi in West Hills, occur in areas with grade elevations ranging between 858 ft and 959 ft. The lower end of these elevations in West Hills effectively delineates the topographical pressure zone boundary with Central Service.

The average pressure in Central Service under the maximum day demand ranges between 40 psi and 90 psi with an average of approximately 67 psi. Similarly, the pressure range in Central Service is largely attributed to topography where grade elevations range from 814 ft to 978 ft, which is equivalent to a static elevation head of 164 ft or 71 psi. For clarity, references to static head in this paragraph do not include the overflow elevation of any storage tank in the distribution system (either pressure zone) or low operating clearwell elevations at Clinton and Kaw WTPs from which respective high service pumps draw suction. Distribution system pressure is illustrated in Figure 7-1 and indicates compliance with the level of service for minimum pressure under normal operating conditions of 40 psi.

Figure 7-1: Existing System Pressure (standalone)

The firm pumping capacity for West Hills and Central Service exceeds the 2024 demand projection as illustrated in Figure 7-2 and 7-3 respectively. As all high service pumps at Kaw WTP supplying West Hills and Central Service are constant speed vertical turbine pumps, if intermittent flows are needed then variable frequency drives could be considered that either deliver a consistent pressure with varying rates of flow or deliver fixed flow with varying pressure. A review of the motor windings/insulation, harmonic impacts, and HVAC requirements should be evaluated for VFD application viability; the control relationship for high service pumping between Clinton and Kaw WTP should be evaluated if VFDs are implemented at Kaw WTP.

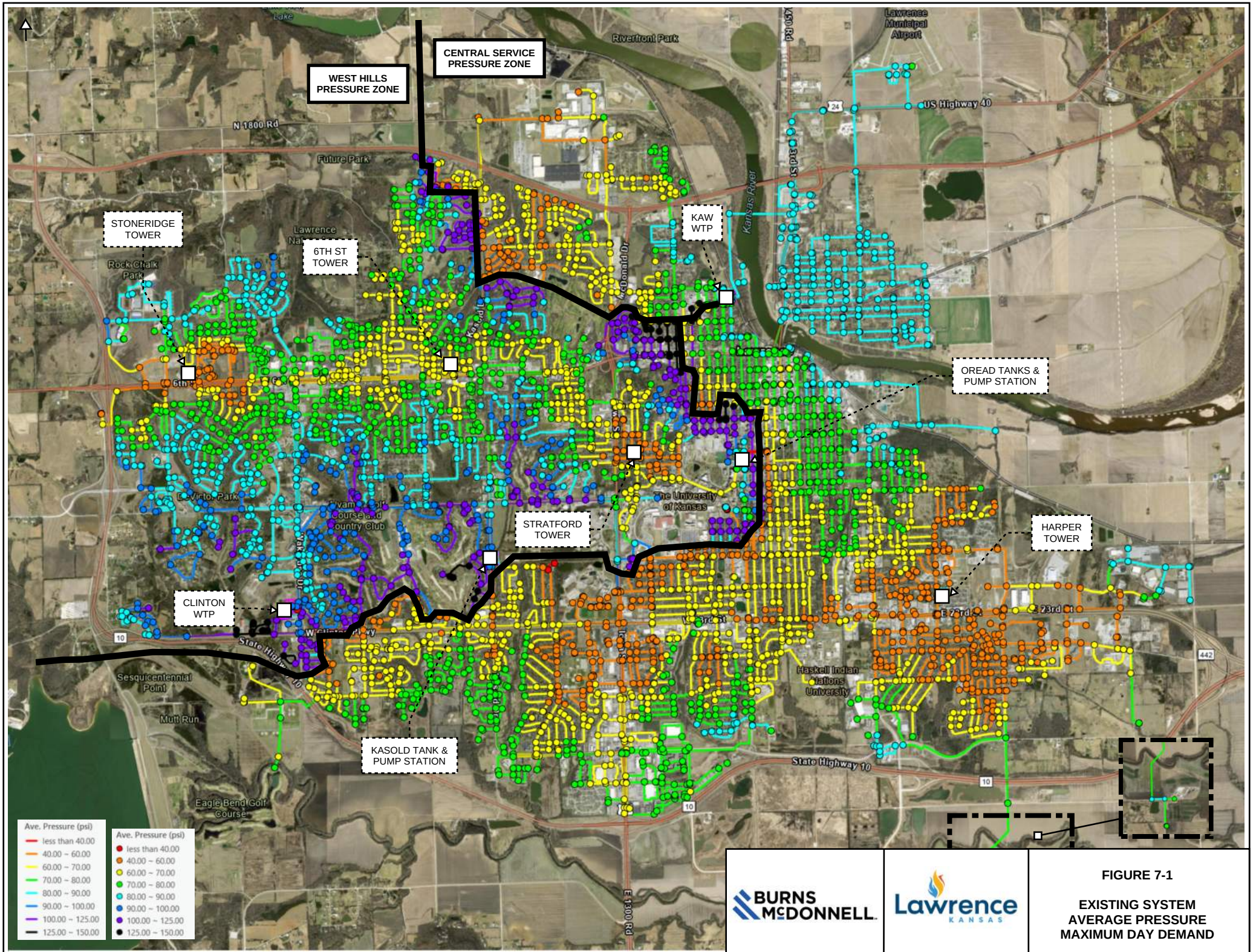

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FIGURE 7-1

EXISTING SYSTEM AVERAGE PRESSURE MAXIMUM DAY DEMAND

Figure 7-2: West Hills Pumping Capacity

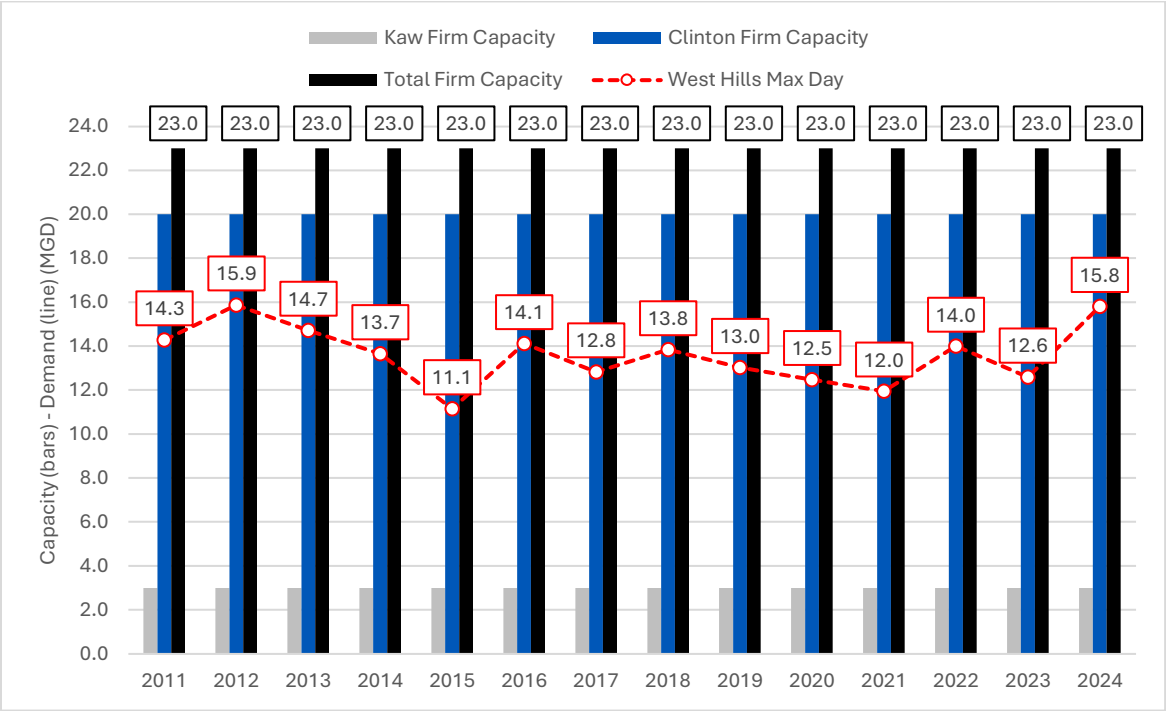
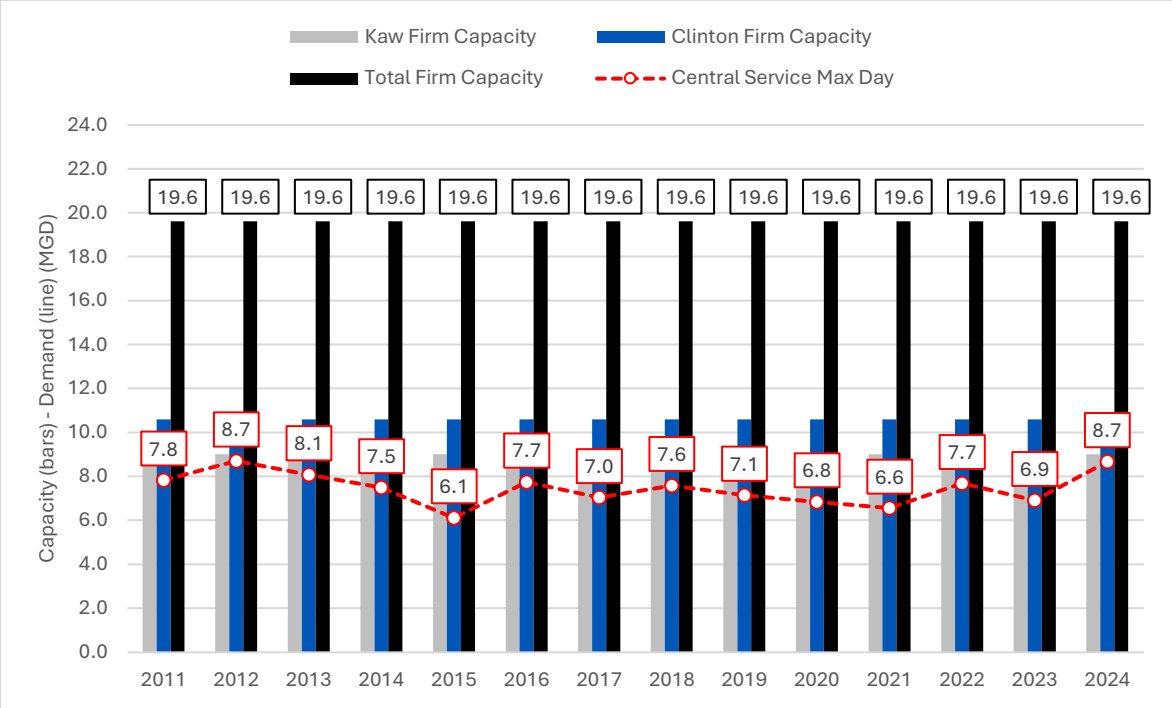


Figure 7-3: Central Service Pumping Capacity



System head curves for West Hills at Clinton and Kaw WTPs are illustrated in Figures 7-4 and 7-5 respectively. System head curves for Central Service at Clinton and Kaw WTPs are illustrated in Figure 7-6

and 7-7 respectively. These curves are representative of higher and lower static head conditions in distribution system storage and fixed static head elevations of 850 ft at Kaw WTP and 995 ft at Clinton WTP. For clarity, the range of system head curves presented for Central Service reflect the effective elevation head range of Oread ground storage (989 ft to 1,019 ft) within Kasold ground storage; this is important to distinguish as the lower volume of Kasold ground storage (960 ft to 989 ft) is reserved as pumped storage for West Hills. As indicated in Section 2.0, the Oread and Kasold tanks are considered high elevation ground storage that float together in Central service and share the same overflow elevation of 1,019 ft; more specifically, Kasold ground storage floats within the operational control scheme of the influent valve that closes when the low-level condition is met for Central Service.

Figure 7-4: West Hills – Kaw HSPS System Head Curves

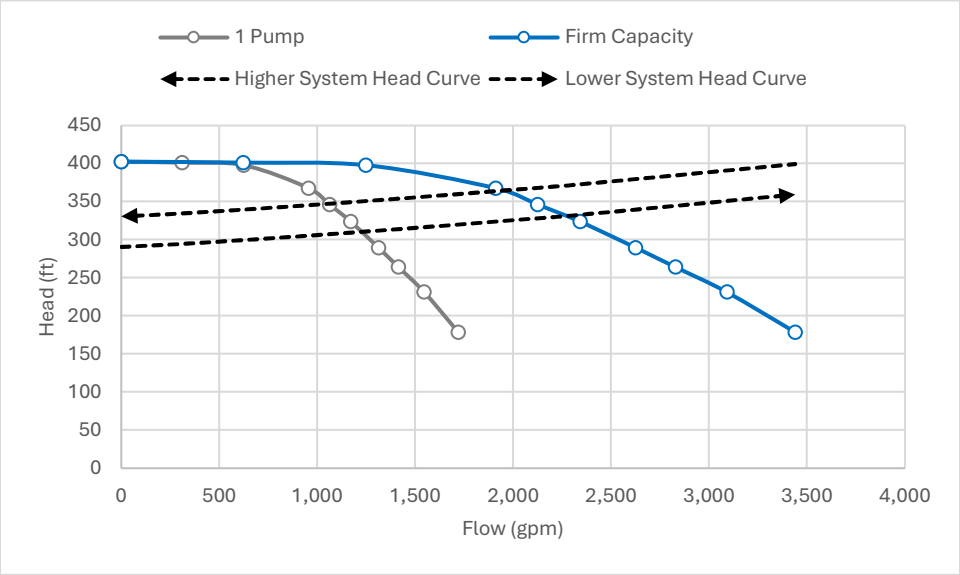


Figure 7-5: West Hills – Clinton HSPS System Head Curves

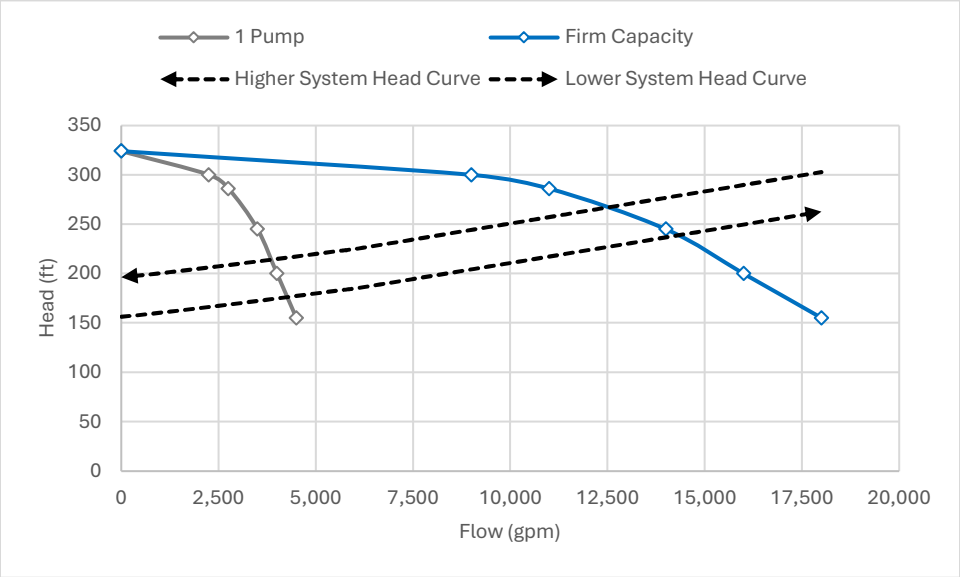


Figure 7-6: Central Service – Kaw HSPS System Head Curves

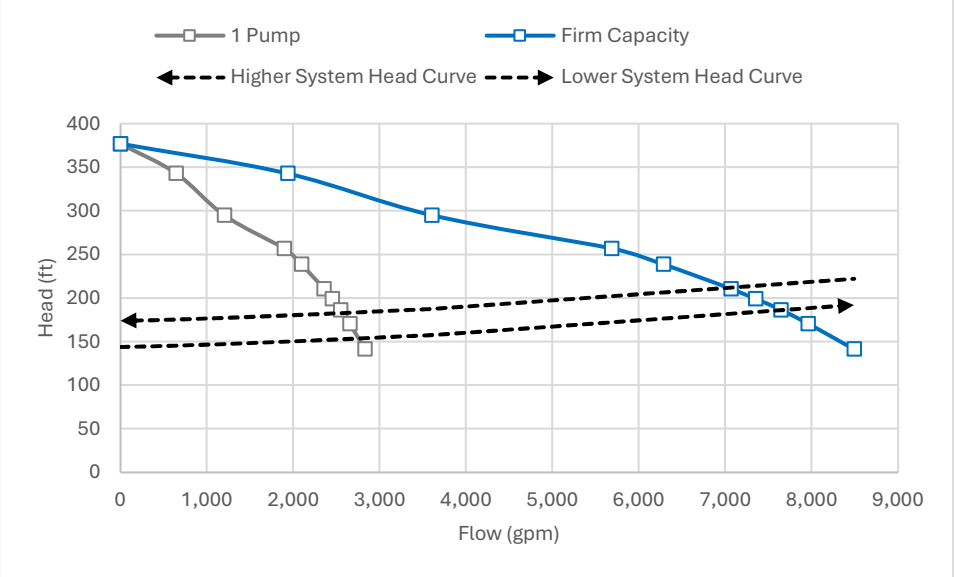
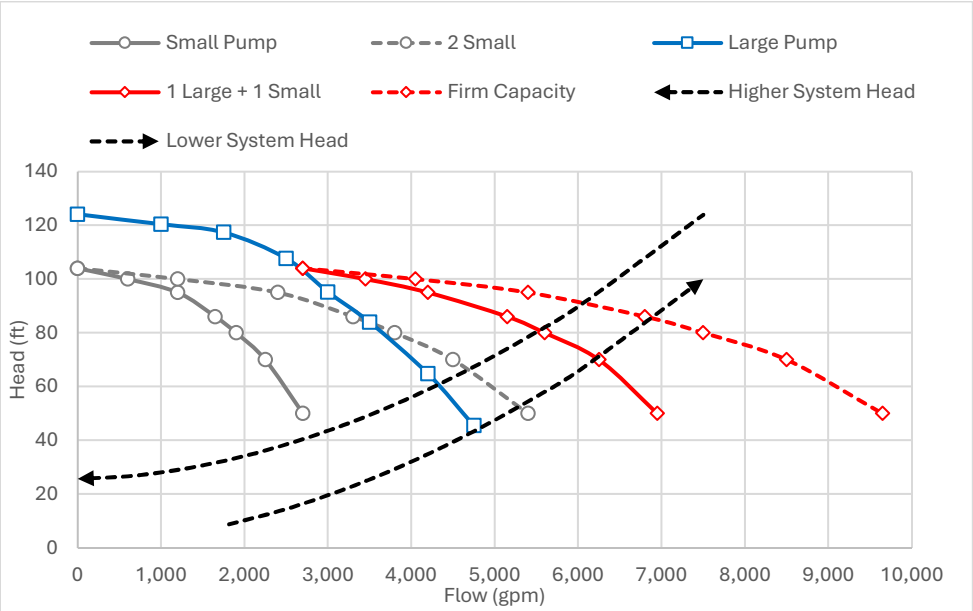


Figure 7-7: Central Service – Clinton HSPS System Head Curves



7.2 Water Distribution Hydraulics

The maximum day demand is evaluated in the EPS scenario to identify high velocity and headloss in the distribution system, confirm the demands can be supplied by the HSPS, and confirm the distribution system storage can be replenished during periods of low demand. The level of service conditions for hydraulic capacity in the distribution system water main is 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 unless tank replenishment during lower daily demand periods is an issue.

The model results indicate higher velocity and headloss conditions in West Hills extending from Clinton WTP to Bob Billings Pkwy in the 24-inch water main. While the velocity and headloss level of service conditions are not exceeded under the current maximum day demand, the demand projections in West Hills will continue increasing with anticipated development and require a parallel water main for additional capacity to maintain the level of service for hydraulic capacity. The average velocity and headloss in the distribution system is illustrated in Figures 7-8 and 7-9 respectively.

Figure 7-8: Existing System Velocity Profile (standalone)

Figure 7-9: Existing System Headloss Gradient Profile (standalone)

7.3 Storage Evaluation

The amount of storage required in distribution systems is contingent on many factors such as diurnal usage, pressure zone arrangement, fire flow level of service, emergency reserve designation, and type of storage such as ground, elevated, or pumped storage. Reserves for equalization, fire, and emergency storage in the distribution system are quantified and compared with the minimum level of service requirement to determine if there is a surplus or deficit. Storage allocations are illustrated in 7-10 and discussed in further detail below.

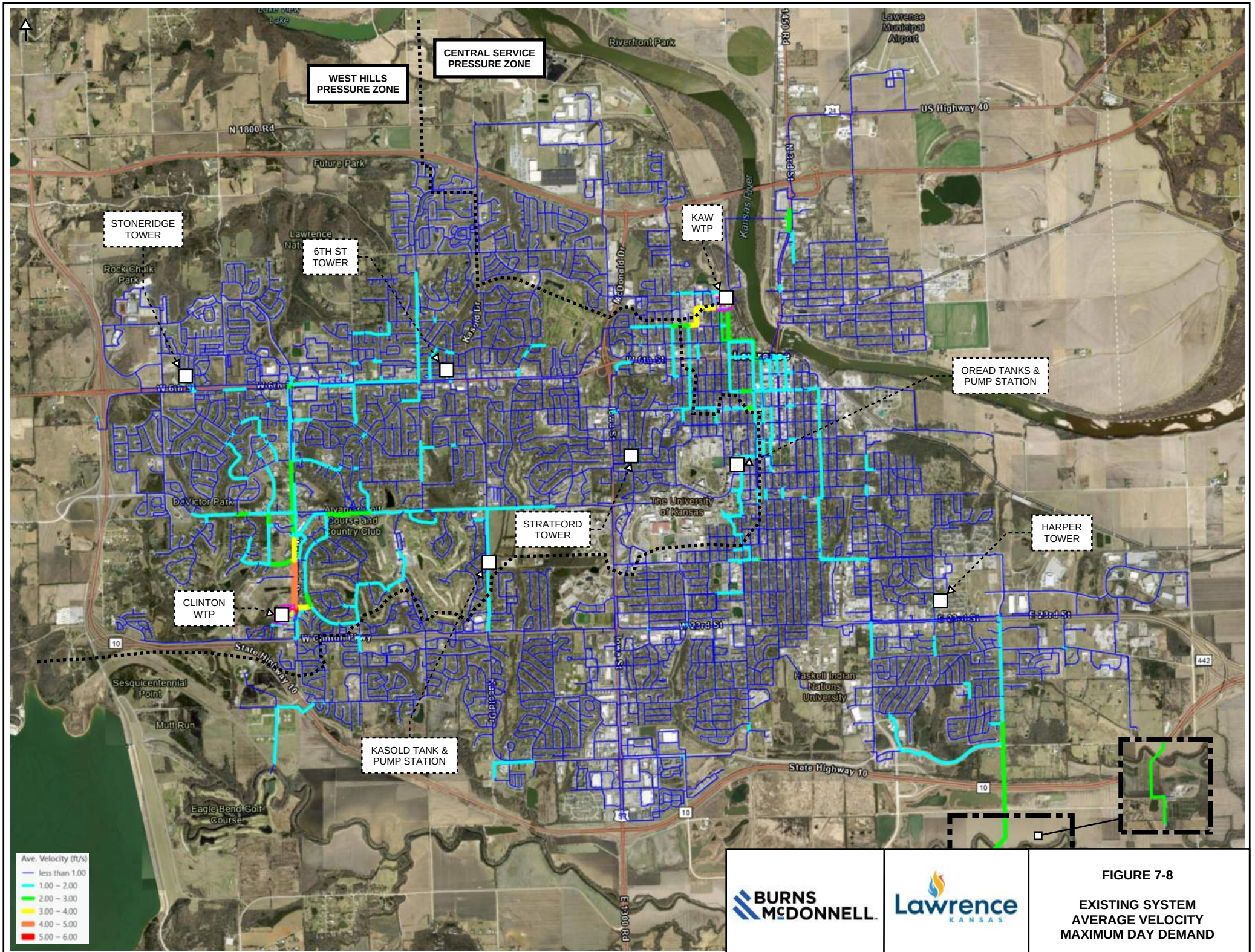


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FIGURE 7-8

EXISTING SYSTEM AVERAGE VELOCITY MAXIMUM DAY DEMAND

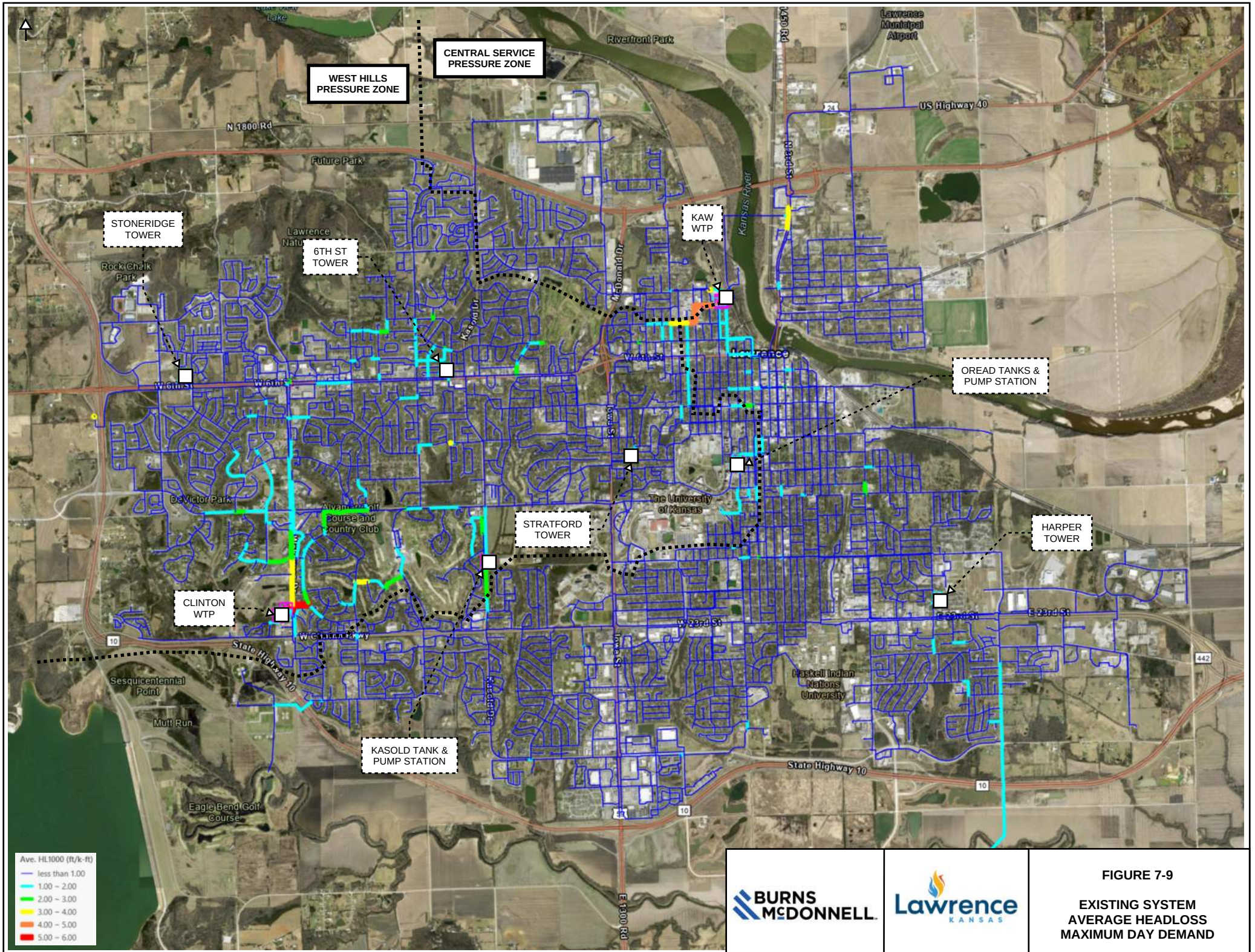

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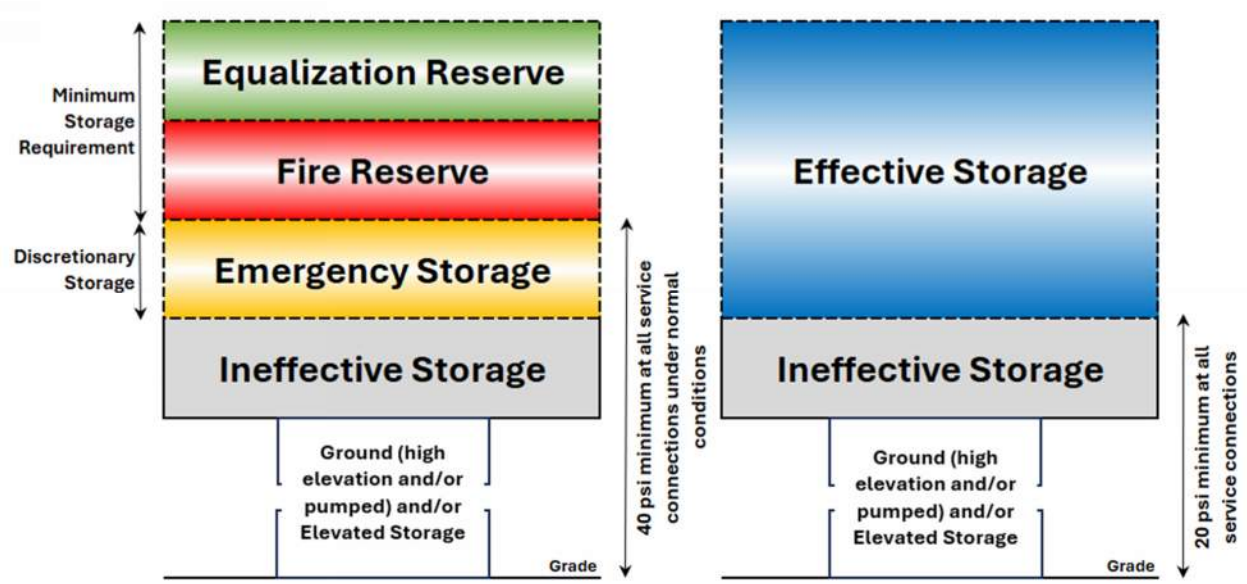
FIGURE 7-9

EXISTING SYSTEM AVERAGE HEADLOSS MAXIMUM DAY DEMAND

Figure 7-10: Storage Allocation



- Equalization reserve includes the difference between volumetric peaking demands greater than the 24-hour average (on the maximum day).
- Fire reserve is informed by the types of customer facilities in the distribution system and typically set by the Insurance Services Office (ISO). The 2023 ISO report indicates a maximum fire flow requirement of 3,500 gpm for three hours should be obtainable and is equivalent to 0.63 MG. Fire flow service for any customers and/or facilities requiring greater than 3,500 gpm is typically the responsibility of the customer.
- Emergency reserve is at the City's discretion and represents storage desired greater than the equalization and fire reserve total. Emergency storage also represents a storage surplus.
- A storage deficit occurs when the minimum storage requirement (equalization plus fire) is less than the effective storage volume.
- Based on the system demands, the interzonal pumped ground storage transfer capability from Central Service to West Hills via Oread and Kasold BPSs, mix of ground and elevated storage, current effective storage in each pressure zone, maintaining a 1.0 MG surplus in each pressure zone is recommended.

Storage can be provided in multiple ways, at multiple locations, and not all system storage can be defined as effective storage. The City has a mix of elevated storage, pumped ground storage, and high elevation ground storage in the distribution system. Effective storage can be held in elevated tanks or pumped from ground storage with certain criteria and is defined below:

- 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 up to the overflow elevation or other elevation in the tank bowl that increases water main break potential.
  - WTP operators routinely fill distribution storage near overflow and the associated hydraulic gradient; this does not currently create concern for water main break potential as indicated by City staff.
  - The overflow elevation at Harper Tower is 1,015 ft which is 4 ft below Oread and Kasold ground storage tanks resulting in a partially submerged condition in Central Service. As the head

range of Harper Tower lies within the head range of Oread and Kasold, by elevation, the entire volume of Harper Tower is considered effected. Operators utilize control valves at Kasold and Harper Towers to effectively turnover tank volumes daily for water quality.

- A similar partially submerged condition exists in the 6th and Kasold Tower; its overflow elevation is 1,170 ft and is 4 ft below Stoneridge and Stratford towers in West Hills. Since the head range of the 6th and Kasold Tower lies within the head range of the other elevated tanks, this storage is considered effected. Operators utilize HSPS control schemes and control valves at Kasold and Harper Towers to effectively turnover tank volumes daily for water quality.

- Pumped ground storage is effective if the BPS has emergency power for firm capacity pumping. Oread and Kasold BPSs meet the criteria for effective pumped ground storage in West Hills; its shared allocation is weighted by the demand in each pressure zone.
- For the purposes of this evaluation, and indicated by the City, the current function (as of the date of this report), as well as in the 2030 and 2040 planning period storage analyses, of storage at Oread is dedicated to Central Service.
- The effective storage determination for the distribution system is listed in Table 7-1.

Table 7-1: Existing System Shared Storage Determination

Storage Facility	Total Available Storage (MG)	Storage (MG)	
		West Hills (MGD) 15.81	Central Service (MGD) 8.67
Stoneridge	1.50	1.50	--
6th St	0.50	0.50	--
Stratford	0.50	0.50	--
Oread	1.75	0.00	1.75
Kasold	1.50	0.97	0.53
Harper	0.50	--	0.50
Total	**6.25**	**3.47**	**2.78**

Results of the storage analysis for West Hills and Central Service are summarized in Tables 7-2 and 7-3 respectively and indicate a storage surplus of approximately 0.78 MG and 0.94 MG respectively. West Hills effective storage and associated surplus fall below the 1.0 MG recommendation; therefore, the 2030 planning period will incorporate additional storage in an amount that meets this level of service. Central Service effective storage and associated surplus is just below the 1.0 MG recommendation; therefore, the 2040 planning period will incorporate additional storage in an amount that meets this level of service.

Table 7-2: Existing System West Hills Storage Evaluation

Storage Factor	Quantity	Comments
Maximum Day Demand (MGD)	15.81	demand projection
Total Storage (MG)	3.47	ground + elevated
Effective Storage (MG)	3.47	all storage
Fire Flow Requirement (MG)	0.63	maximum ISO designation
Equalization Factor	13%	West Hills diurnal analysis
Equalization Requirement (MG)	2.05	equalization × maximum day
Minimum Storage Requirement (MG)	2.68	fire + equalization
Result (MG)	**0.78**	**Storage Surplus**
Emergency Reserve Duration (hrs)	2.3	@ avg day demand (8.2 MGD)
	1.2	@ max day demand (15.8 MGD)

Table 7-3: Existing System Central Service Evaluation

Storage Factor	Quantity	Comments
Maximum Day Demand (MGD)	8.67	demand projection
Total Storage (MG)	2.78	ground + elevated
Effective Storage (MG)	2.78	all storage
Fire Flow Requirement (MG)	0.63	maximum ISO designation
Equalization Factor	14%	Central Service diurnal analysis
Equalization Requirement (MG)	1.21	equalization × maximum day
Minimum Storage Requirement (MG)	1.84	fire + equalization
Result (MG)	**0.94**	**Storage Surplus**
Emergency Reserve Duration (hrs)	5.0	@ avg day demand (4.5 MGD)
	2.6	@ max day demand (8.7 MGD)

7.4 Fire Flow Analysis

A static simulation is used to evaluate available fire flow 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 water main segments in the looped distribution system, fire hydrants, and other intermediate model junctions. Available fire flow on 4-inch diameter water mains without fire hydrants and dead ends without fire hydrants are not included. 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 at 20 psi and is additive to the maximum day demand. Additional field testing is recommended for confirmation of results in instances where available flows range between 1,000 gpm and 1,500 gpm because the simulation takes a conservative approach by setting the initial level of elevated storage near half capacity to the degree where the system demand is supplied mostly by the associated high service pump stations. This is a conservative planning-level recommendation for evaluating available fire flow because it represents a fire occurring on the maximum day demand after equalization reserves in distribution system storage is depleted.

For clarity, the City does not draw down elevated storage to half capacity under normal daily operations. As such, additional fire flow testing in areas that do not meet the level of service for fire flow (1,500 gpm at 20 psi residual) within the low level normal operating range can help inform fire flow improvement prioritization. The available fire flow results in the existing distribution system under the maximum day demands is illustrated in Figure 7-11. Nearly all locations with low fire flow (less than 1,500 gpm at 20 psi residual) are smaller diameter 4-inch and 6-inch dead end water mains.

Figure 7-11: Existing System Available Fire Flow (standalone)

7.5 Water Age Analysis

The water quality analysis evaluates water age in the distribution system to assist in predicting areas with the greatest potential for lower disinfectant residuals. Water age is evaluated with average day and maximum day demands at 12.6 MGD and 24.6 MGD respectively. The EPS water age simulation includes a timestep to capture the longest travel time within the distribution system for a parcel of water to reach its destination; this is referred to as equilibrium or convergence when water age normalizes over a 24-hour period, though varying each hour due to the 24-hour diurnal pattern being applied to system demand. The average day

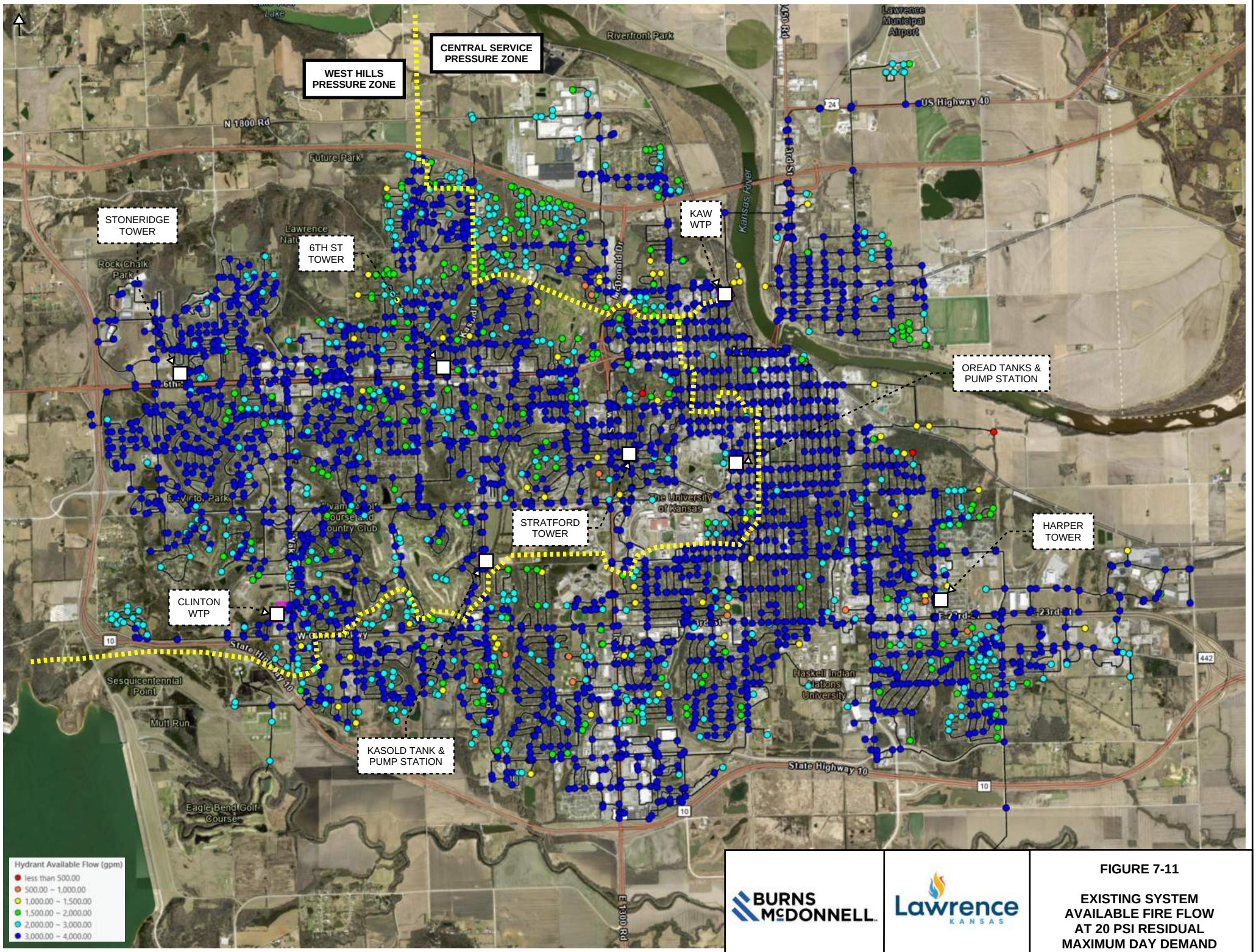


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FIGURE 7-11

EXISTING SYSTEM AVAILABLE FIRE FLOW AT 20 PSI RESIDUAL MAXIMUM DAY DEMAND

demand and/or lower seasonal demands represent the governing condition for evaluating water age; as system demand decreases the water age increases due to the lower velocity profile which increases the travel time for a parcel of water moving through the distribution system.

The average water age in the distribution system is based on the water age of each junction and weighted by the demand of each junction relative to the total system demand. The average water age under average day demands is 25 hours and is illustrated in Figure 7-12. The average water age under the maximum day demands is 20 hours and is illustrated in Figure 7-13. The relatively low water age under average day demands, relative to maximum day demands, is largely influenced by the positioning of water treatment and high service pumping on the periphery and in opposite corners of the distribution system as well as short proximity of Kaw and Clinton HSPS to each pressure zone.

As indicated previously in Section 3.5.2, the Parks & Rec and Eagle Bend Golf Course large user meters (City customer class, account numbers are 248333, 261811, and 251201) are located near the Clinton Lake Youth Sports Complex, Lawrence Rotary Arboretum, and Clinton Lake Softball Complex and are tentatively planned to transition their irrigation service to non-potable water in the future. The City can consider implementing automatic flushing in this area to lower water age and maintain water quality. Average day and maximum day demands are expected to decrease by approximately 315 gpm and 584 gpm respectively when their irrigation water service is removed from the distribution system. Although, of note, the irrigation component of their water service diminishes each year in the low demand season during winter months, so changes in water quality that likely occur every year during winter may likely persist throughout the entire year.

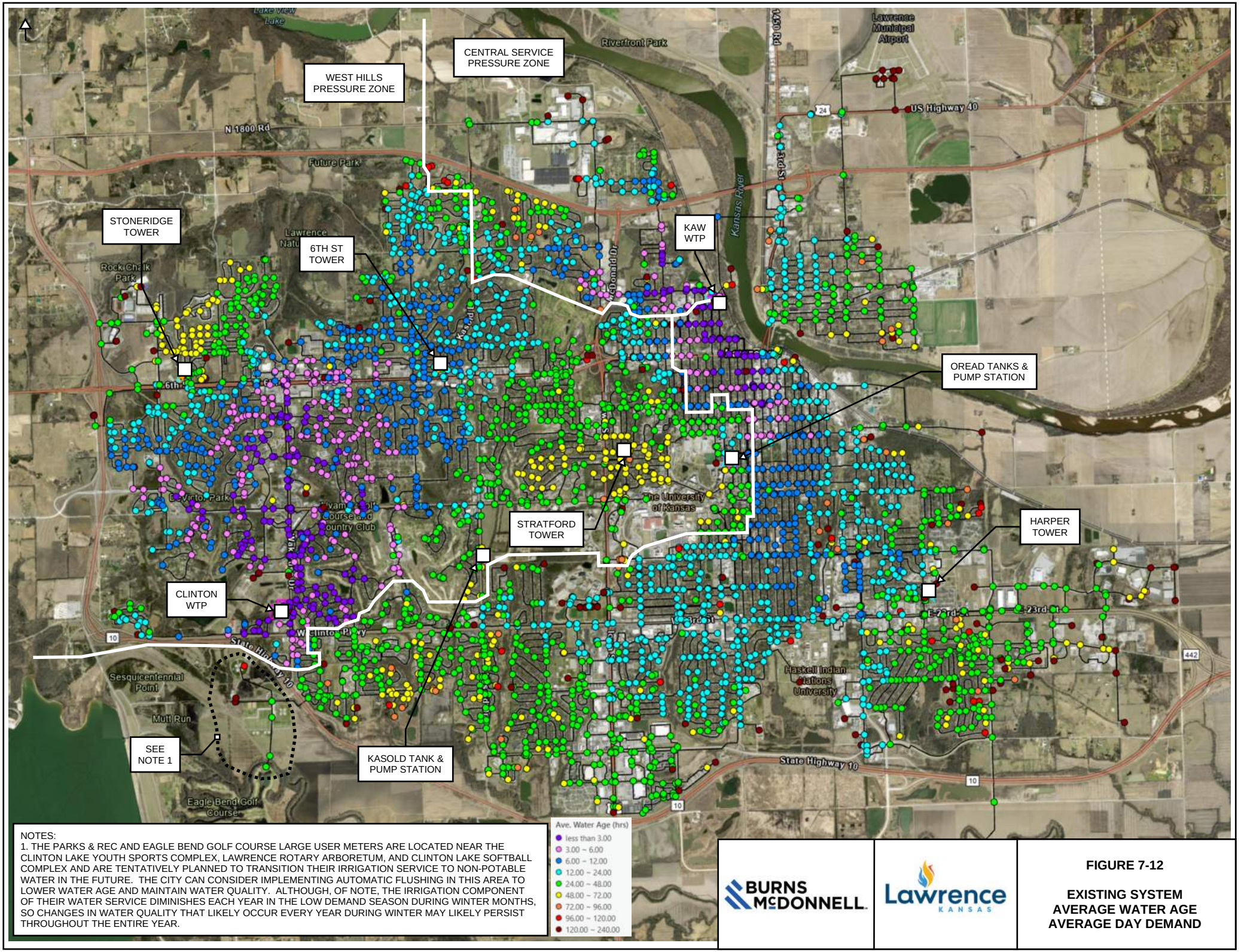
Figure 7-12: Average Water Age – Average Day Demands (standalone)

Figure 7-13: Average Water Age – Maximum Day Demands (standalone)

7.6 Central Service Sensitivity Analysis with Harper Tower Inactive

City staff requested a sensitivity analysis with Harper Tower out of service to determine if the level of service conditions can be maintained in Central Service. Harper Tower is currently inactive, as of the date of this report, due to extensive condition restoration improvements and may continue to be inactive during the peak demand season which generally occurs between June and September. This sensitivity analysis was performed under a system maximum day demand of 24.6 MGD with approximately 8.7 MGD in Central Service.

Comparative analysis of Central Service system pressure with Harper Tower inactive indicates marginal difference and is illustrated in Figure 7-14 (for comparison with Figure 7-1). Locationally, pressure at the base of Harper Tower (upstream of the control valve/check valve arrangement, Central Service side) also indicates marginal difference with Harper Tower active and inactive and is illustrated in Figure 7-15. Pumping impacts at Kaw and Clinton WTP with Harper Tower inactive is also marginal and is illustrated in Figure 7-16. Changes in Central Service storage gradients at Oread and Kasold with Harper Tower inactive indicates some change, but still marginal as illustrated in Figure 7-17. Review of Oread and Kasold flow rates moderately illustrate differences slightly more than differences in hydraulic gradients (at this scale), but effective differences are still marginal as illustrated in Figure 7-18. The available fire flow with Harper Tower inactive is illustrated in Figure 7-19 for comparative analysis with Figure 7-11 and indicates marginal differences in Central Service.



NOTES:
1. THE PARKS & REC AND EAGLE BEND GOLF COURSE LARGE USER METERS ARE LOCATED NEAR THE CLINTON LAKE YOUTH SPORTS COMPLEX, LAWRENCE ROTARY ARBORETUM, AND CLINTON LAKE SOFTBALL COMPLEX AND ARE TENTATIVELY PLANNED TO TRANSITION THEIR IRRIGATION SERVICE TO NON-POTABLE WATER IN THE FUTURE. THE CITY CAN CONSIDER IMPLEMENTING AUTOMATIC FLUSHING IN THIS AREA TO LOWER WATER AGE AND MAINTAIN WATER QUALITY. ALTHOUGH, OF NOTE, THE IRRIGATION COMPONENT OF THEIR WATER SERVICE DIMINISHES EACH YEAR IN THE LOW DEMAND SEASON DURING WINTER MONTHS, SO CHANGES IN WATER QUALITY THAT LIKELY OCCUR EVERY YEAR DURING WINTER MAY LIKELY PERSIST THROUGHOUT THE ENTIRE YEAR.

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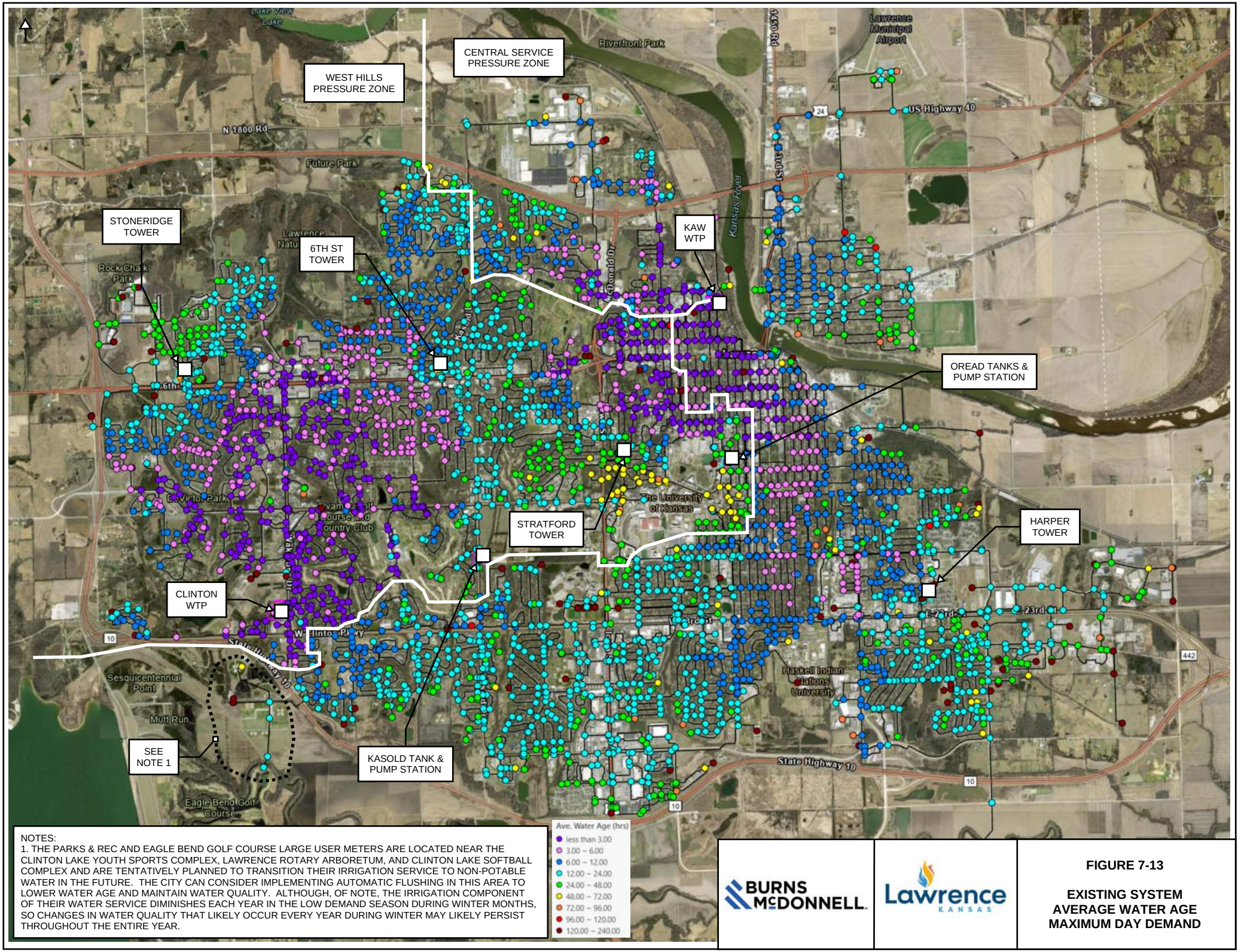
FIGURE 7-12

EXISTING SYSTEM AVERAGE WATER AGE AVERAGE DAY DEMAND



NOTES:
1. THE PARKS & REC AND EAGLE BEND GOLF COURSE LARGE USER METERS ARE LOCATED NEAR THE CLINTON LAKE YOUTH SPORTS COMPLEX, LAWRENCE ROTARY ARBORETUM, AND CLINTON LAKE SOFTBALL COMPLEX AND ARE TENTATIVELY PLANNED TO TRANSITION THEIR IRRIGATION SERVICE TO NON-POTABLE WATER IN THE FUTURE. THE CITY CAN CONSIDER IMPLEMENTING AUTOMATIC FLUSHING IN THIS AREA TO LOWER WATER AGE AND MAINTAIN WATER QUALITY. ALTHOUGH, OF NOTE, THE IRRIGATION COMPONENT OF THEIR WATER SERVICE DIMINISHES EACH YEAR IN THE LOW DEMAND SEASON DURING WINTER MONTHS, SO CHANGES IN WATER QUALITY THAT LIKELY OCCUR EVERY YEAR DURING WINTER MAY LIKELY PERSIST THROUGHOUT THE ENTIRE YEAR.

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FIGURE 7-13

EXISTING SYSTEM AVERAGE WATER AGE MAXIMUM DAY DEMAND

Overall, the differences in model results with Harper Tower inactive are marginal compared to active conditions with respect to Central Service system pressure, locational pressure at Harper Tower, pumping from Kaw and Clinton WTPs, and both hydraulic gradient and flow rate at Oread and Kasold storage tanks. Observable impacts to hydraulic gradients and flow rates are more noticeable at Oread and Kasold with Haper Tower inactive and likely absorb much of the drafting and filling rates experienced at Harper Tower when active. Another factor contributing to the marginal impact on distribution system hydraulics with Harper Tower inactive is its overflow elevation is four ft lower than Oread and Kasold storage tanks which diminishes its effective head range with which it can operate in. Harper Tower's lower overflow elevation also decreases its effective storage volume whose total volume is only 0.5 MG.

Figure 7-14: System Pressure with Harper Tower Inactive (standalone)

Figure 7-15: Central Service Pressure near Harper Tower

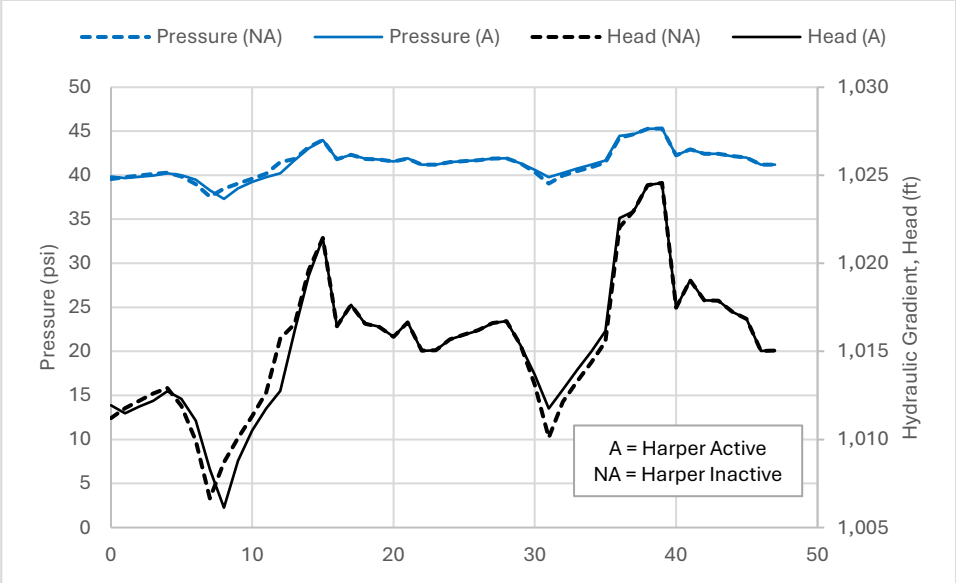
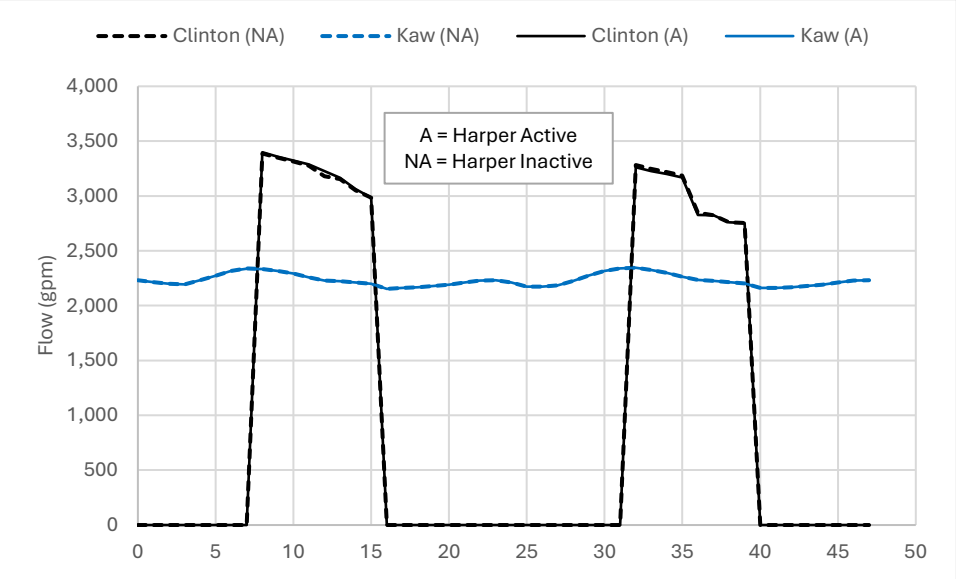


Figure 7-16: Clinton & Kaw WTP Flow (Central Service Supply)



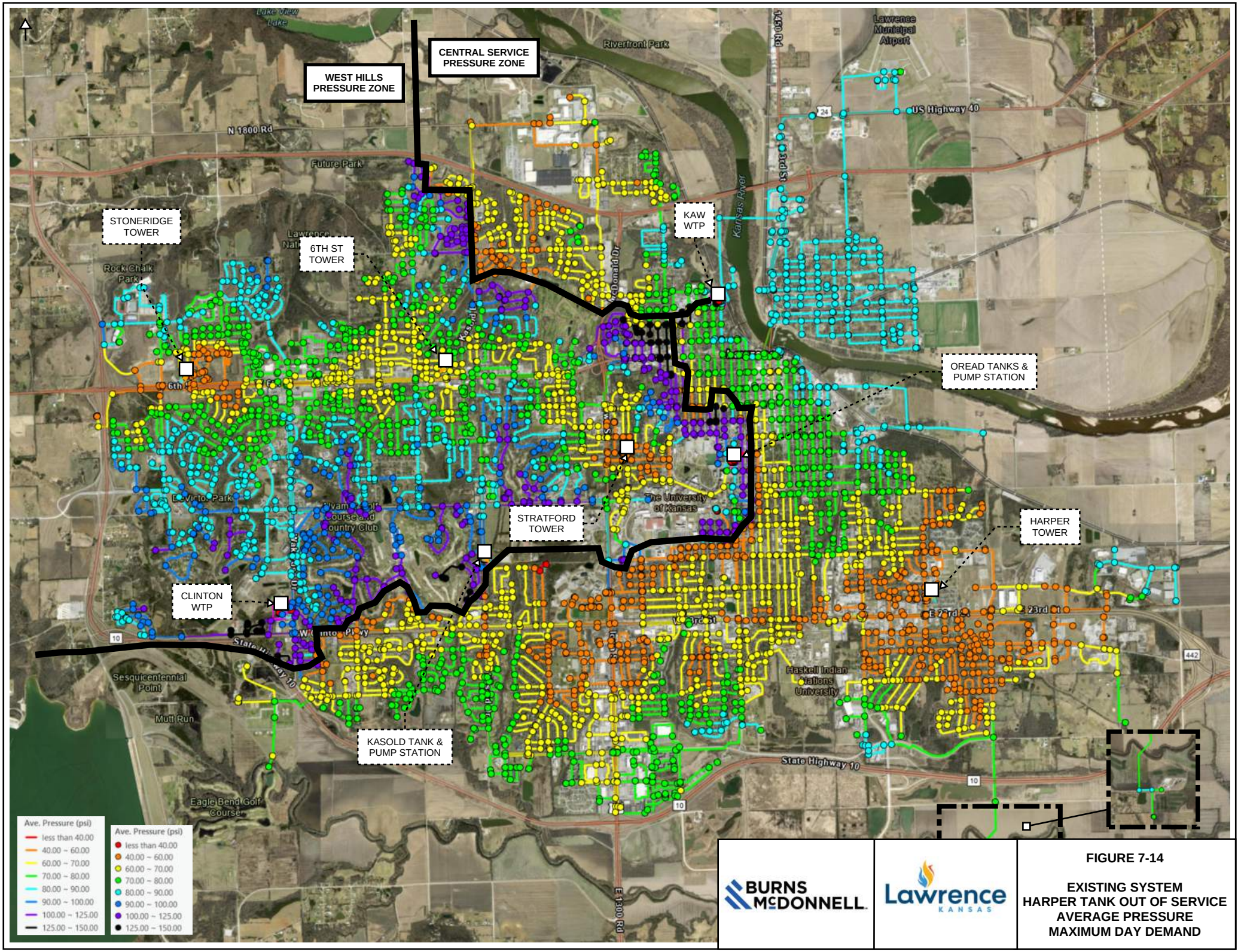


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FIGURE 7-14

EXISTING SYSTEM
HARPER TANK OUT OF SERVICE
AVERAGE PRESSURE
MAXIMUM DAY DEMAND

Figure 7-17: Oread & Kasold Storage Tank Hydraulic Gradient

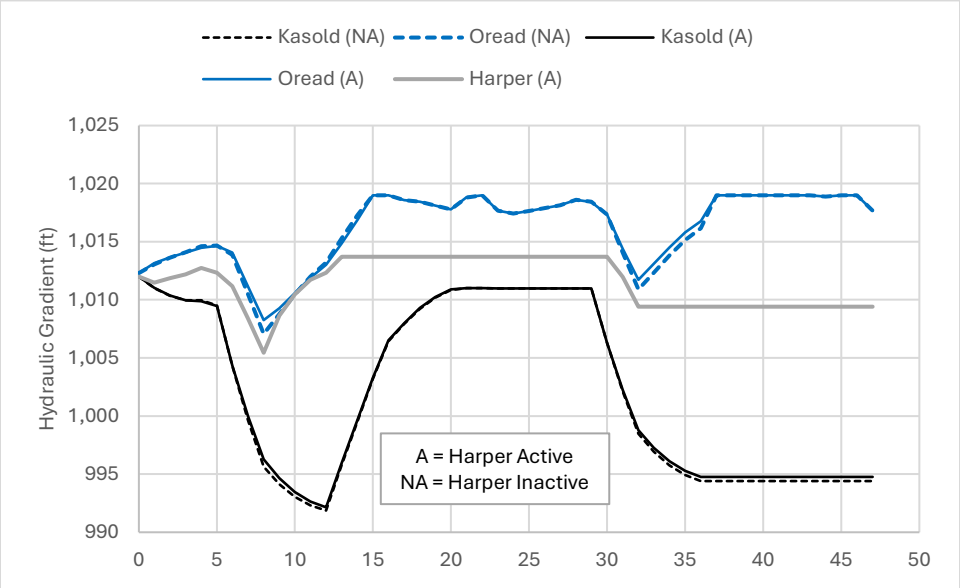

Figure 7-18: Oread & Kasold Flowrate

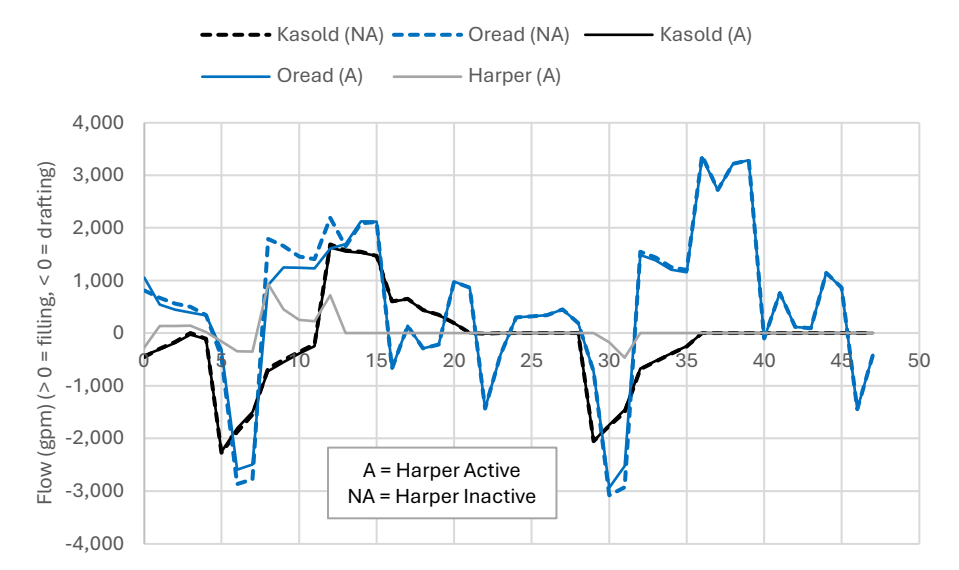

Figure 7-19: Available Fire Flow with Harper Tower Inactive (standalone)

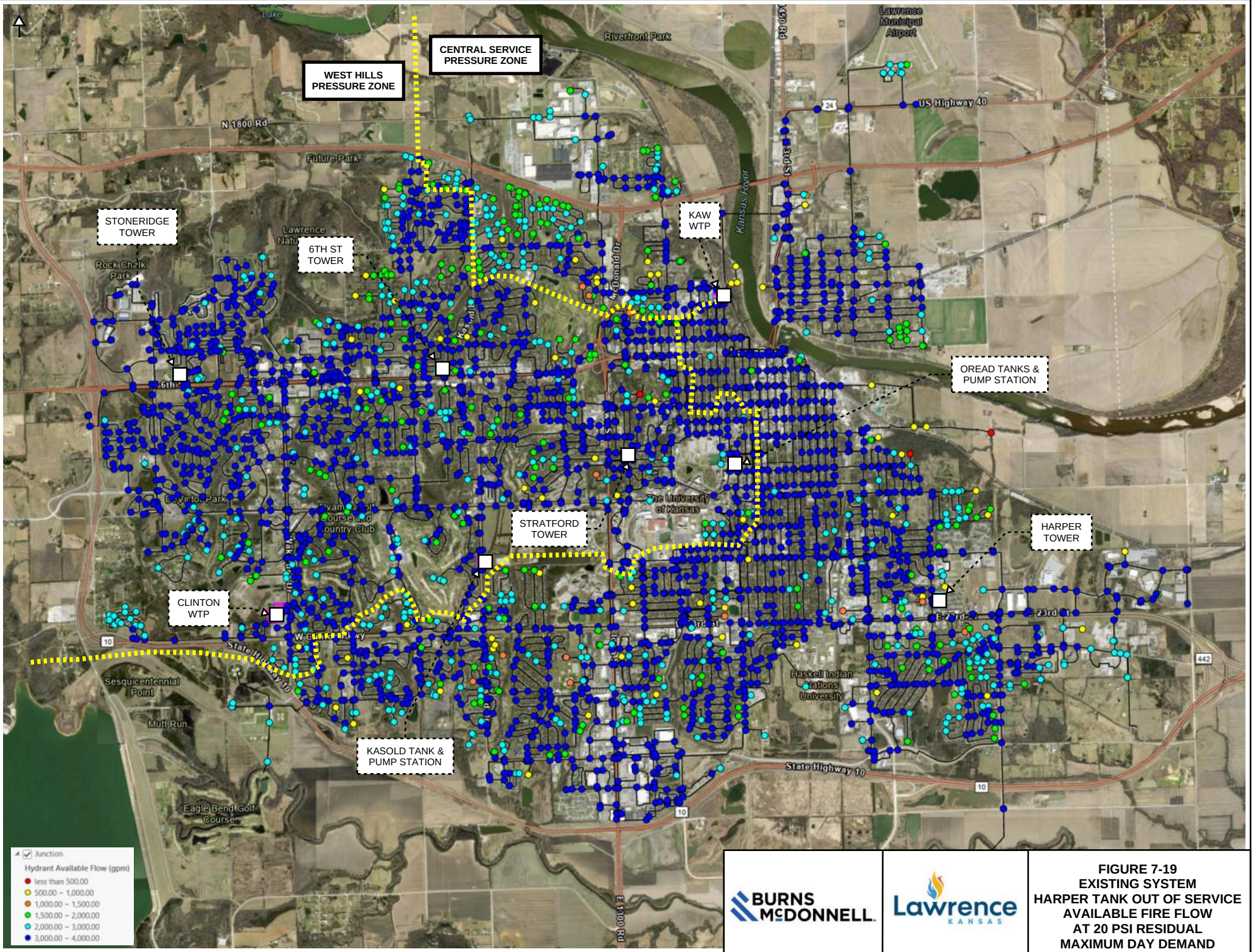

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FIGURE 7-19
EXISTING SYSTEM
HARPER TANK OUT OF SERVICE
AVAILABLE FIRE FLOW
AT 20 PSI RESIDUAL
MAXIMUM DAY DEMAND

8.0 2030 Planning Period Hydraulic Analysis

This section of the report includes the hydraulic analysis of the distribution system for the 2030 planning period with a projected maximum day demand of 26.9 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 development are also included in the 2030 planning period and illustrated in Figure 8-1.

Notable projects include a new 1.0 MG in West Hills to support future growth and associated demand projections. A 24-inch transmission main from Clinton WTP to Bob Billings Pkwy is needed for additional distribution system capacity. Capital improvements in areas of low fire flow that have fire hydrants are included, as well as small main replacement of all 4-inch pipes with 8-inch. A redundancy/resiliency project includes approximately 3.5 miles of 16-inch pipeline from the intersection of Iowa St and K10 to the City's WWTP south of the Wakarusa River near the N 1175 Rd and E 1600 Rd as a redundant supply to the City's WWTP (termed a critical facility by City staff); this project would also support proposed residential development south of the Wakarusa River.

Figure 8-1: 2030 Planning Period Capital Improvements (standalone)

8.1 Pressure & Pumping

The average pressure in West Hills under the maximum day demand ranges between 42 psi and 146 psi with an average of approximately 83 psi. The average pressure in Central Service under the maximum day demand ranges between 40 psi and 88 psi with an average of approximately 66 psi. Distribution system pressure is illustrated in Figure 8-2 and indicates compliance with the level of service for minimum pressure under normal operating conditions of 40 psi.

Figure 8-2: 2030 System Pressure (standalone)

Additional elevated storage, West Tank, is recommended for West Hills and is discussed further in Section 8.3. The West Tank will float with the Stoneridge, 6th and Kasold, and Stratford elevated tanks in West Hills. The overflow elevation and head range can match Stoneridge; final design level modelling should be conducted to confirm elevations based on the proposed tank location. Model results indicate pressures near higher elevation areas west of K10 at approximately 1,073 ft, near the intersection of N 1550 Rd and E 800 Rd, range between 39 psi and 44 psi and average approximately 42 psi under 2030 maximum day demands. Based on the City's growth for water service area expansion west of K10, a new pressure zone is not required as both the pressure and fire flow level of service conditions can be met.

If the growth plan changes and the water service area extends further west, then the potential exists for a new pressure zone delineated by grade elevations ranging between 1,065 ft and 1,070 and should be evaluated in further detail. Domestic water demand of the new West pressure zone could be supplied by a West BPS that pulls directly from the West elevated tank as illustrated in Figure 8-3. Fire flow service for a new West pressure zone could be conveyed through check valves from the West Hills pipe network and/or pumped, via dedicated fire pumps within the West BPS. For clarity, the West Tower would still float in the West Hills pressure zone. The model results presented in this master plan do not reflect alternative growth strategies such as this.

WEST HILLS PRESSURE ZONE

CENTRAL SERVICE PRESSURE ZONE

KAW WTP

STONERIDGE TOWER

6TH ST TOWER

OREAD TANKS & PUMP STATION

HARPER TOWER

STRATFORD TOWER

NEW 2030 WEST TOWER

CLINTON WTP

KASOLD TANK & PUMP STATION

Riverfront Park
Municipal Airport
Linwood Rd
US Highway 40
N 1800 Rd
Future Park
Lawrence Nature Area
Rock Chalk Park
Highway 40
Kanwaka
W 6th St
Lawrence
Kansas River
Iowa St
Kasold Dr
W Donald Dr
N 3rd St
DeVictor Park
Alvamar Golf Course and Country Club
The University of Kansas
Wakarusa Dr
W 23rd St
E 23rd St
Haskell Indian Nations University
State Highway 10
442
10
59
Clinton State Park
Eagle Bend Golf Course
E 1300 Rd
Wakarusa
Sibleyville

DIAMETER (IN)
- SMALL MAINS
- FIRE FLOW
- 2030 HYDRAULIC
- 2030 REDUNDANCY-RESILIENCY
- 2030 DEVELOPMENT
- 2040 DEVELOPMENT
- EXISTING

LAND USE CLASSIFICATION
- 2030 RESIDENTIAL
- 2030 COMMERCIAL
- 2030 INDUSTRIAL
- 2040 INDUSTRIAL

NOT TO SCALE

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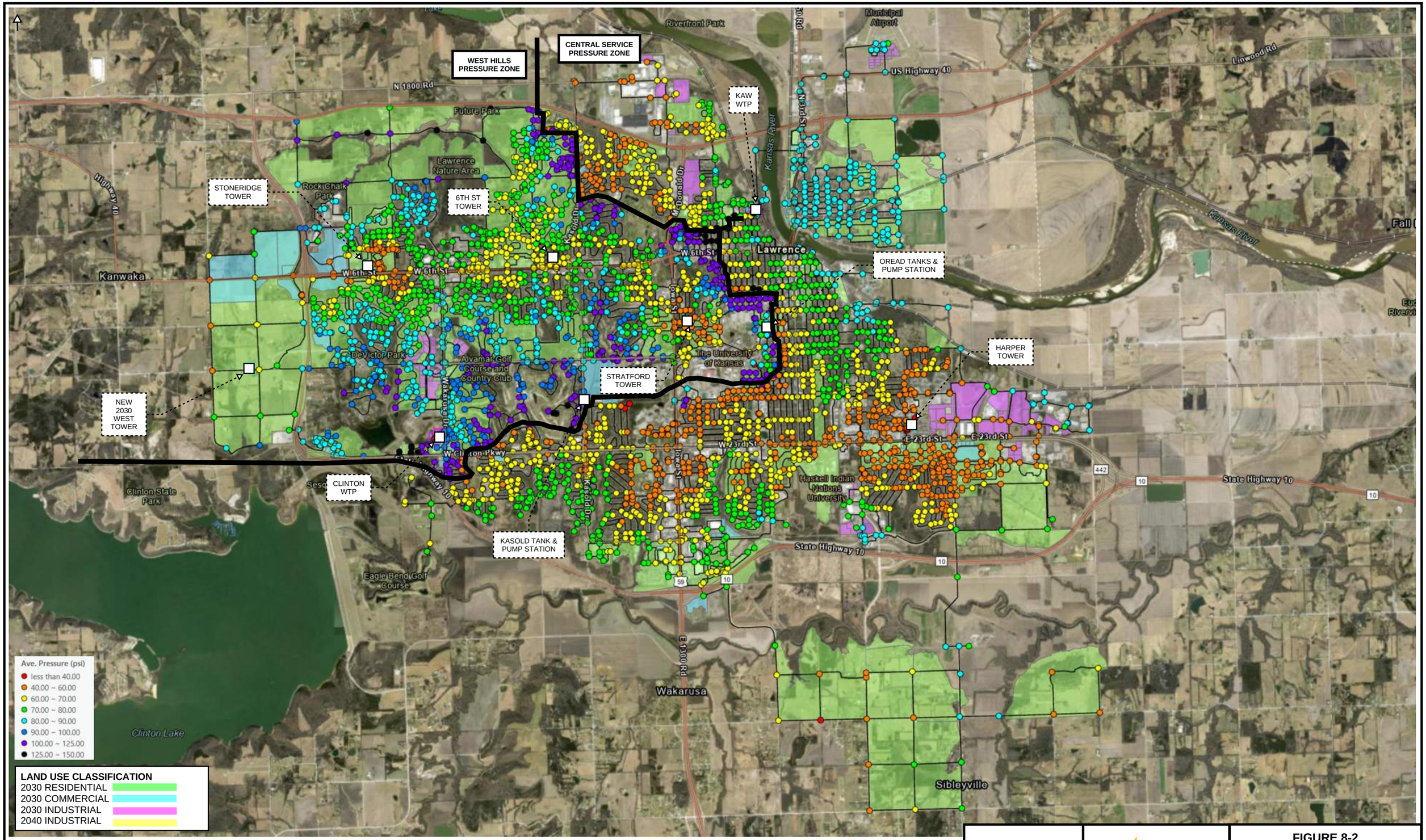
FIGURE 8-1

2030 PLANNING PERIOD GROWTH AREAS AND CAPITAL IMPROVEMENTS



NOTES:
1. ONLY 2030 PLANNING PERIOD GROWTH AREAS (LAND USE CLASSIFICATIONS SHOWN).
2. MODEL RESULTS REFLECT ALL 2030 CAPITAL IMPROVEMENT PROJECTS.

NOT TO SCALE

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FIGURE 8-2

2030 PLANNING PERIOD AVERAGE PRESSURE MAXIMUM DAY DEMAND

Figure 8-3: 2030 Alternative Growth Strategy – West Pressure Zone (standalone)

The firm pumping capacity for West Hills and Central Service exceeds the 2030 maximum day demand projection as illustrated in Figure 8-4 and 8-5 respectively, therefore, no pumping capacity improvements are needed. For clarity, the projected demand between 2024 and 2030 is linear and is not based on any specific growth strategy in these interstitial years.

Figure 8-4: 2030 West Hills Pumping Capacity

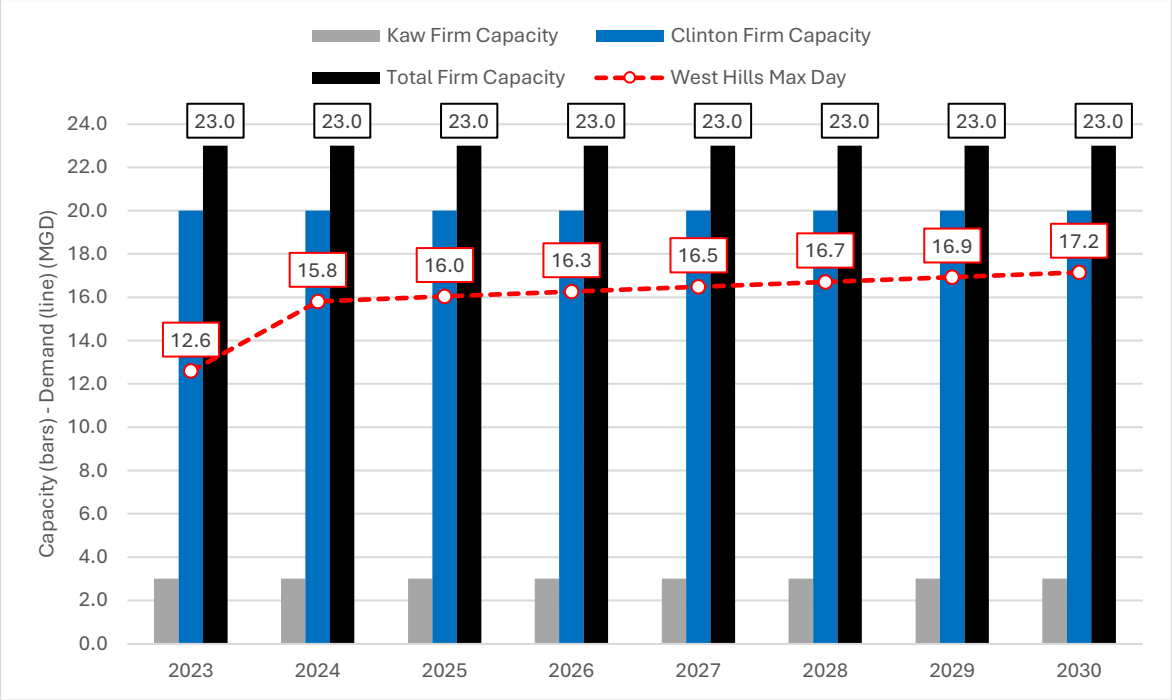
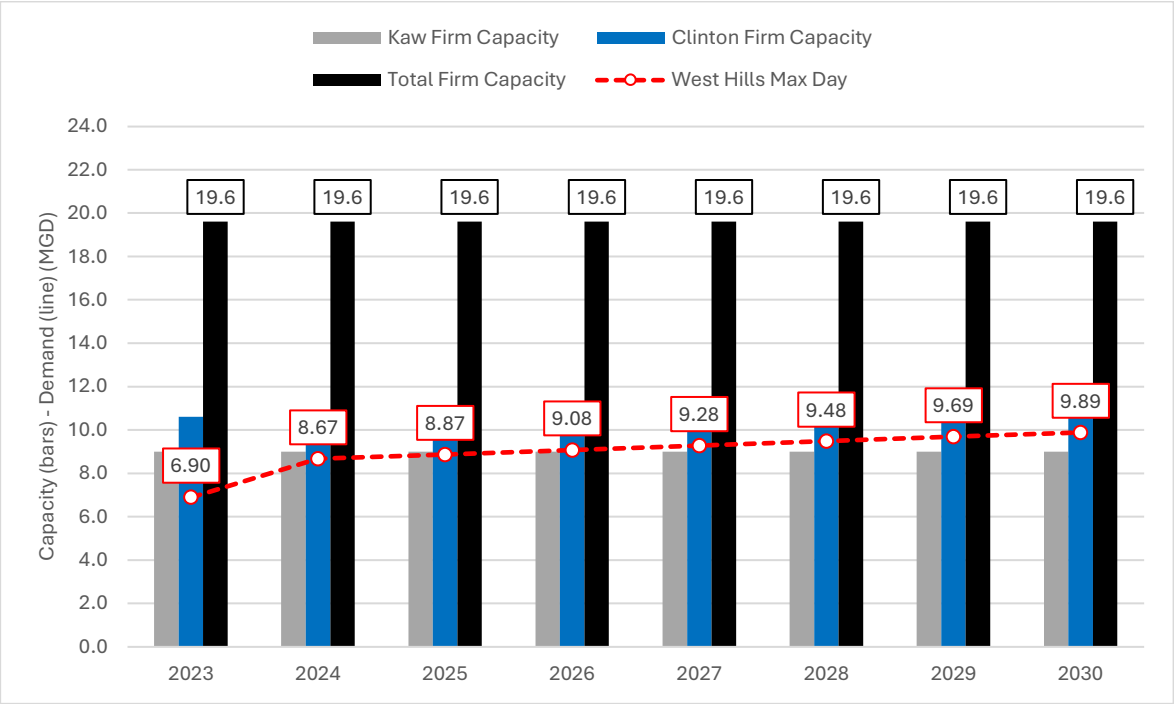


Figure 8-5: 2030 Central Hills Pumping Capacity



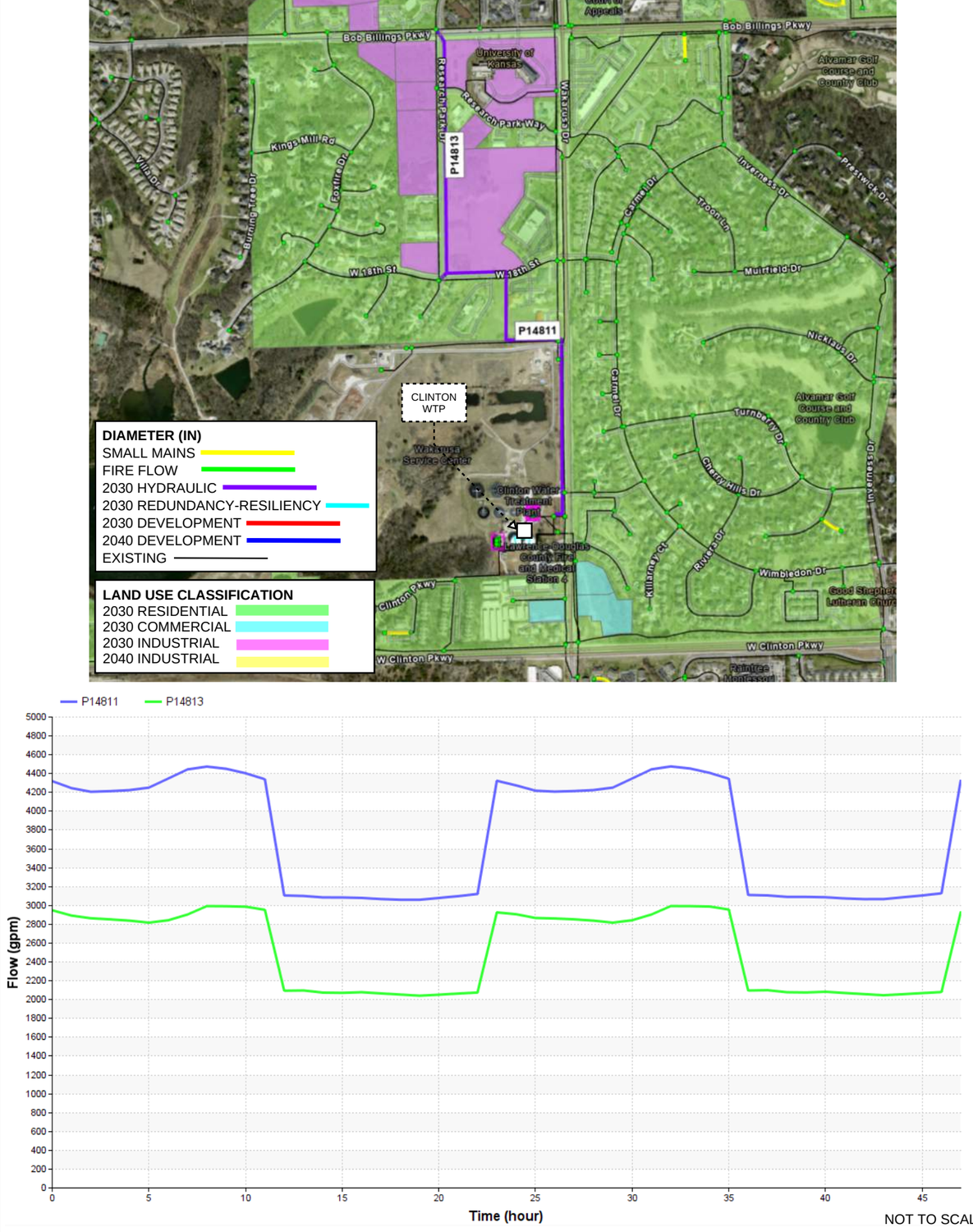
8.2 Water Distribution Hydraulics

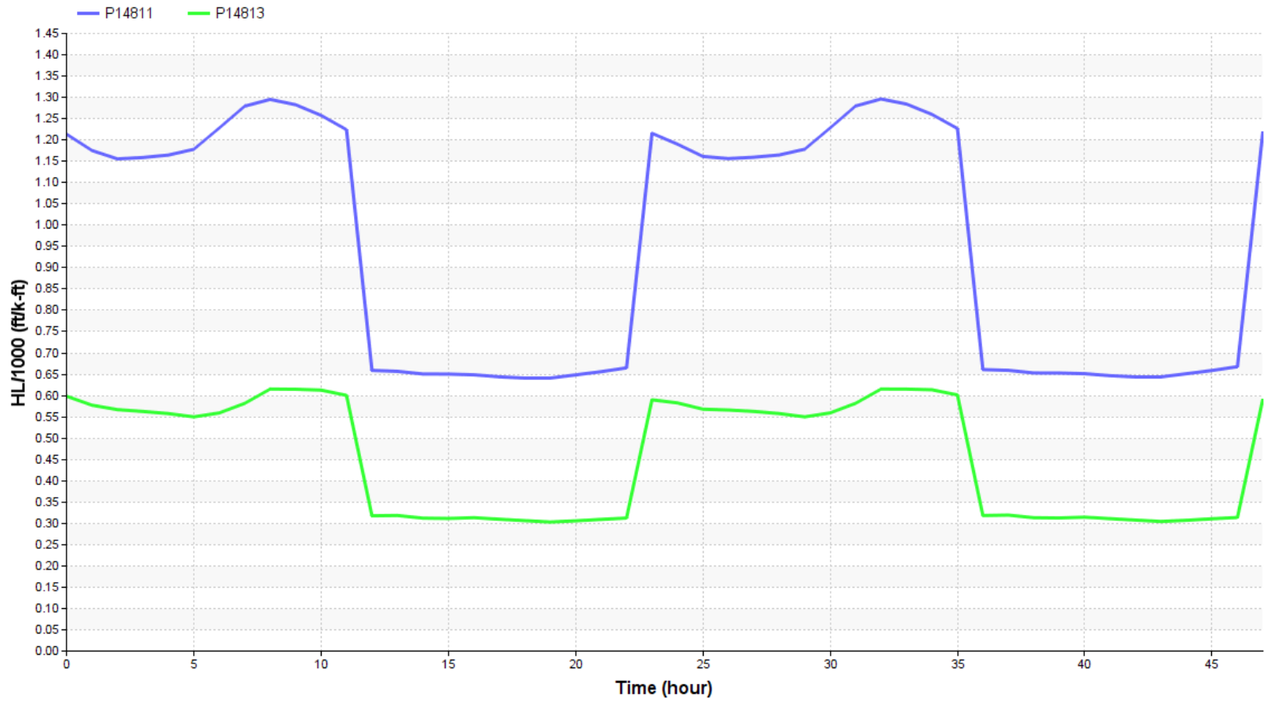
The existing system model results indicate higher velocity and headloss conditions in West Hills extending from Clinton WTP to Bob Billings Pkwy in the 24-inch water main. As maximum day demands in West Hills increase to 17.2 MGD in the 2030 planning period, the existing 24-inch on Wakarusa Dr from Clinton WTP to Bob Billings Pkwy approaches the level of service for velocity and headloss in the distribution system. Therefore, a higher priority hydraulic capital improvement is recommended and includes a 24-inch transmission main from Clinton WTP to the existing 12-inch water main at the intersection of W 18th St and Research Park Dr and extending along Research Park Dr to the existing 12-inch on Bob Billings Pkwy. The flow, velocity, and headloss in this improvement are illustrated in Figure 8-6.

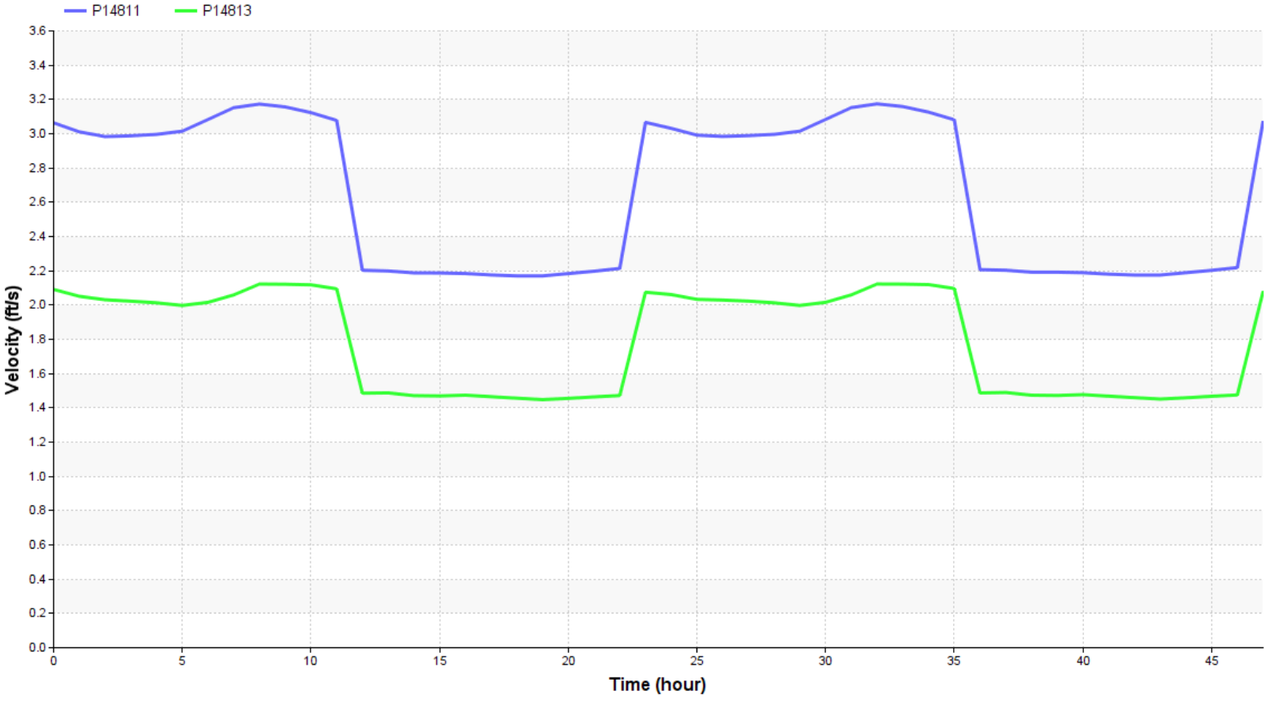
Figure 8-6: 2030 Hydraulic Improvement – Clinton WTP to Bob Billings Pkwy

8.3 Storage Evaluation

The effective storage evaluation for the distribution system and results of the 2030 storage analysis for West Hills and Central Service are summarized in Tables 8-1, 8-2, and 8-3 respectively and indicate a storage surplus of approximately 1.6 MG and 0.8 MG respectively. The 2030 planning period incorporates an additional 1.0 MG of elevated storage in West Hills. This size will meet the storage requirements and 1.0 MG effective storage surplus for West Hills throughout the 2040 planning period. The implementation or demand trigger for the new West Tank is more associated with future development-driven (commercial and residential) demands of approximately 470 gpm (does not include maximum contract amount for RWD No. 1) west of K10 as opposed to total demand in West Hills.







NOT TO SCALE

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FIGURE 8-6

2030 HYDRAULIC IMPROVEMENT - CLINTON WTP TO BOB BILLINGS PKWY

The storage surplus for Central Service falls below the 1.0 MG surplus recommendation and is largely attributed to the proposed residential development areas in south of the Wakarusa River in southeast Lawrence.

Table 8-1: 2030 Shared Storage Evaluation

Storage Facility	Total Available Storage (MG)	Storage (MG)	
		West Hills (MGD) 17.15	Central Service (MGD) 9.89
Stoneridge	1.50	1.50	--
6th St	0.50	0.50	--
Stratford	0.50	0.50	--
New West Tower	1.00	1.00	--
Oread	1.75	0.00	1.75
Kasold	1.50	0.95	0.53
Harper	0.50	--	0.50
Total	**7.25**	**4.45**	**2.78**

Table 8-2: 2030 West Hills Storage Analysis

Storage Factor	Quantity	Comments
Maximum Day Demand (MGD)	17.15	demand projection
Total Storage (MG)	4.45	ground + elevated
Effective Storage (MG)	4.45	all storage
Fire Flow Requirement (MG)	0.63	maximum ISO designation
Equalization Factor	13%	West Hills diurnal analysis
Equalization Requirement (MG)	2.23	equalization × maximum day
Minimum Storage Requirement (MG)	2.86	fire + equalization
Result (MG)	**1.59**	**Storage Surplus**
Emergency Reserve Duration (hrs)	4.45	@ avg day demand (8.6 MGD)
	2.23	@ max day demand (17.2 MGD)

Table 8-3: 2030 Central Service Storage Analysis

Storage Factor	Quantity	Comments
Maximum Day Demand (MGD)	9.89	demand projection
Total Storage (MG)	2.78	ground + elevated
Effective Storage (MG)	2.78	all storage
Fire Flow Requirement (MG)	0.63	maximum ISO designation
Equalization Factor	14%	Central Service diurnal analysis
Equalization Requirement (MG)	1.38	equalization × maximum day
Minimum Storage Requirement (MG)	2.01	fire + equalization
Result (MG)	**0.77**	**Storage Surplus**
Emergency Reserve Duration (hrs)	3.91	@ avg day demand (4.7 MGD)
	1.86	@ max day demand (9.9 MGD)

Given the magnitude of linear improvements needed to expand the Central Service distribution system south of the Wakarusa River (Central Service) for the projected TAZ population, it may require a timeframe beyond the 2030 planning period. Coupled with a desire for additional on-site storage at Kaw WTP, as indicated by City staff, the trigger for additional elevated storage in Central Service is aligned with the industrial development east of E 1750 Rd anticipated in the 2040 planning period, while acknowledging the long-term treatment and facility plan for Kaw WTP. Additional storage at Kaw WTP can impact the sizing (by volume) needed for additional storage in Central Service. As the long-term treatment and facility planning at Kaw

WTP is beyond the scope of this project, increasing the Central Service effective storage surplus above 1.0 MG is incorporated in the 2040 planning period storage analysis to meet the level of service. However, if the 2040 industrial development areas accelerate before 2040, and before a long-term facility plan for Kaw WTP is determined, replacing Harper tank with a 1.0 MG elevated tank may change the planning period for this storage improvement.

8.4 Fire Flow Analysis & Small Mains

The level of service for fire flow is 1,500 gpm at 20 psi and is additive to the 2030 projected maximum day demand. The fire flow results are illustrated in Figure 8-7 and reflect all capital improvements described in Figure 8-1. Fire flow improvements are developed for each water main segment that includes a fire hydrant and is not incompliance with the level of service. In instances where a small main, which is considered any pipe less than or equal to 4-inch diameter, results in a low fire flow the capital improvement is considered a higher priority and termed a fire flow improvement over the lower priority small mains replacement designation.

Figure 8-7: 2030 Available Fire Flow (standalone)

The small mains designation carries no prioritization as these improvements can be implemented with available funding and/or as they align with other utility or road projects. For the purposes of this report, the small mains designation captures all water mains less than or equal to 4-inch and is intended to summarize a total capital cost for City budget planning efforts. Many of these small mains may be old cast iron pipes and in need of replacement due to a low remaining useful life and/or persistence of water main breaks. However, each small main replacement should be considered individually as not all need to be replaced if there are no maintenance issues or concerns with water quality. It should be noted that if any small mains remain in service and a new fire hydrant assembly is installed, then the fire flow analysis should be evaluated again to confirm compliance with the fire flow level of service or if the small main need needs additional capacity.

8.5 Conclusions & Recommendations

In conclusion, the 24-inch hydraulic improvement from Clinton WTP to Bob Billings Pkwy has a higher priority and should be implemented as the maximum day demand in West Hills approaches 15.8 MGD regardless of the status for development-driven residential, commercial, and industrial linear improvements and associated demands. The demand trigger for a new West Hills tank should align with the projected demands and new development areas (all classes) in West Hills, most notably west of K10. If the demand trigger is met, but the development-driven linear improvements are not in place west of K10, then the City should consider delaying implementation of the West Tank to prevent water quality issues and aging of what maybe a potentially under-utilized asset.

The development driven demands west of K10 included in the 2030 planning period are the primary catalyst for new elevated storage in West Hills. Important factors to consider in developing a more defined implementation schedule for the 2030 West Tower are listed below by order of importance as it relates to the 2030 growth plan.

1. Looped Network West of K10
    a. Implementing a looped network west of K10 is important for turnover in the new West Tower. The existing 16-inch highway crossing south of W 6th St should be looped from the south by

WEST HILLS PRESSURE ZONE

CENTRAL SERVICE PRESSURE ZONE

KAW WTP

STONERIDGE TOWER

6TH ST TOWER

OREAD TANKS & PUMP STATION

HARPER TOWER

STRATFORD TOWER

NEW 2030 WEST TOWER

CLINTON WTP

KASOLD TANK & PUMP STATION

Hydrant Available Flow (gpm)
- less than 500.00
- 500.00 ~ 1,000.00
- 1,000.00 ~ 1,500.00
- 1,500.00 ~ 2,000.00
- 2,000.00 ~ 3,000.00
- 3,000.00 ~ 4,000.00

DIAMETER (IN)
- SMALL MAINS
- FIRE FLOW
- 2030 HYDRAULIC
- 2030 REDUNDANCY-RESILIENCY
- 2030 DEVELOPMENT
- 2040 DEVELOPMENT
- EXISTING

LAND USE CLASSIFICATION
- 2030 RESIDENTIAL
- 2030 COMMERCIAL
- 2030 INDUSTRIAL
- 2040 INDUSTRIAL

NOTES:
1. ONLY 2030 PLANNING PERIOD GROWTH AREAS (LAND USE CLASSIFICATIONS SHOWN).
2. MODEL RESULTS REFLECT ALL 2030 CAPITAL IMPROVEMENT PROJECTS.

NOT TO SCALE

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FIGURE 8-7

2030 PLANNING PERIOD AVAILABLE FIRE FLOW MAXIMUM DAY DEMAND

either of the Lake Estates Dr/N 1500 Rd (CIP ID P14519) highway crossing or the southern-most highway crossing just north of Clinton Pkwy. This looping provides for delivering more flow from Clinton HSPS (path of least resistance).

2. Stoneridge Tower Cycling and Pumping Frequency of Kasold Ground Storage
   a. As average day demands increase in West Hills and, as a result, Stoneridge Tower cycling increases coupled with more reliance from pumped ground storage at Kasold are indicators for implementing the West Tower; it may be more observable under maximum day demands where longer run times from Kasold pumps (and associated longer tank replenishment of Kasold Tower from Central Service) are observed.
   b. One factor that may contribute to increased tower cycling and pumping frequency mentioned above is the partial submergence of the 6th and Kasold Tower whose overflow elevation is 4 ft below Stoneridge and Stratford Towers. Albeit a smaller storage volume of 0.5 MG, the 6th and Kasold Tower will not support West Hills demands when the hydraulic gradient is above its overflow elevation of 1,170 ft.
3. Temporary Single Point of Entry and Rate of development vs Actual Demand
   a. A common progression for residential development in green areas with peripheral water service area expansion, and even those more specifically with in-situ barriers like railroads, rivers, and/or highways (i.e. K10), is that the residential development rate (new construction and population growth) starts slower and increases over time in terms of water demand escalations. The slower periods of residential development result in equally lower water demands that are delivered through capital improvements sized for a larger long-term 20-year projection and/or buildout of the development area.
   b. Therefore, the City could consider, as long as a looped network is in place as described above, creating a single point of entry for water supply west of K10 by utilizing the southern-most highway crossing (either of the two mentioned above) and temporarily closing the existing 16-inch highway crossing. This will remove a portion of the water demand burden west of K10 from Stoneridge Tower and shift it to Clinton HSPS. This will also promote more turnover in the West Tower. As actual demands approach the 2030 demand projections west of K10 the 16-inch highway crossing can be opened.

Linear development-driven improvements for residential, commercial, and industrial areas can be implemented as development occurs and are illustrated in Figures 8-8, 8-9, 8-10, 8-11, and 8-12 for southeast, east, northeast, northwest, and west Lawrence respectively.

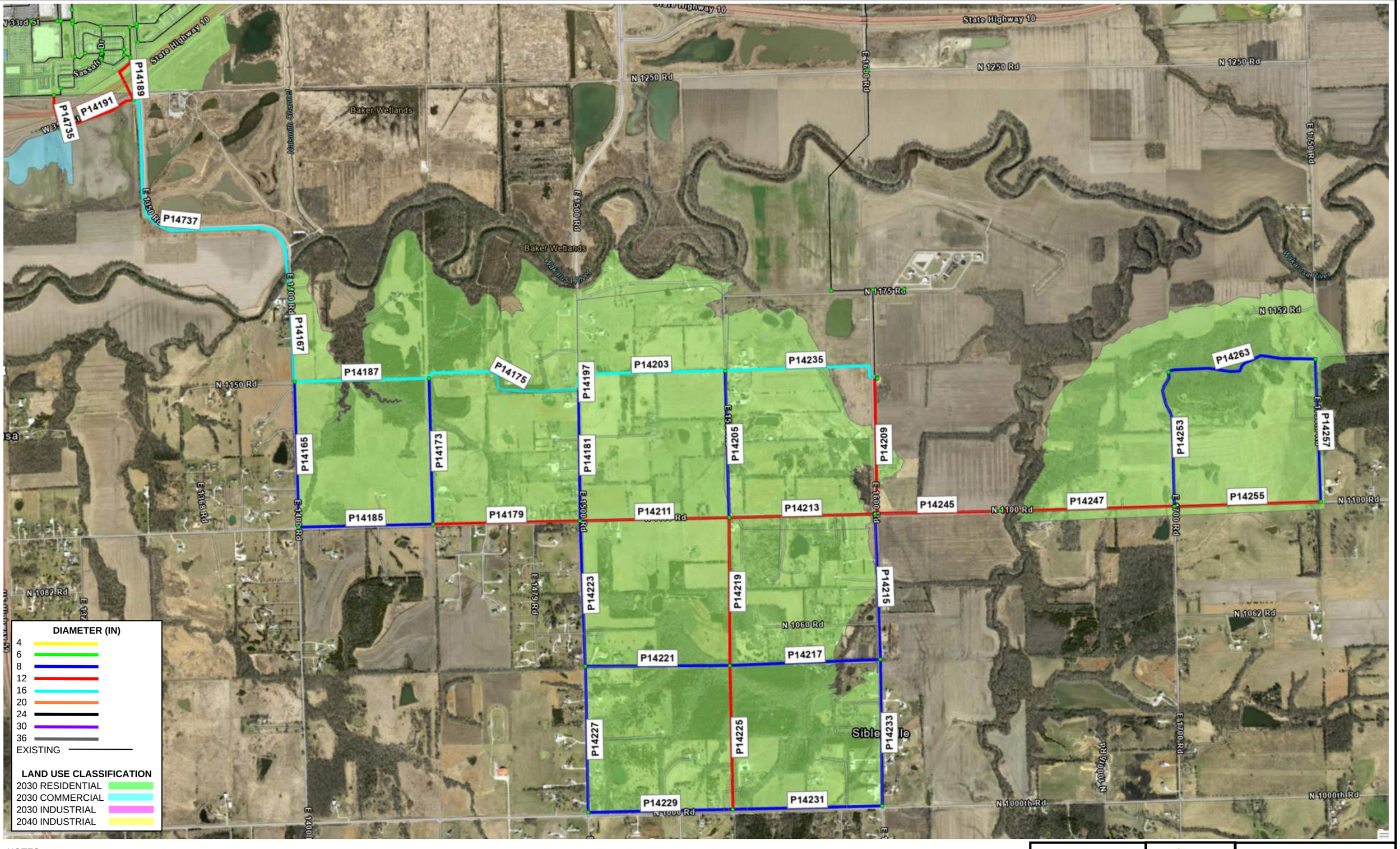
Figure 8-8: 2030 Southeast Lawrence Capital Improvements (standalone)

Figure 8-9: 2030 East Lawrence Capital Improvements (standalone)

Figure 8-10: 2030 Northeast Lawrence Capital Improvements (standalone)

Figure 8-11: 2030 Northwest Lawrence Capital Improvements (standalone)

Figure 8-12: 2030 West Lawrence Capital Improvements (standalone)



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND AND CIP ID ILLUSTRATED IN FIGURE.

NOT TO SCALE

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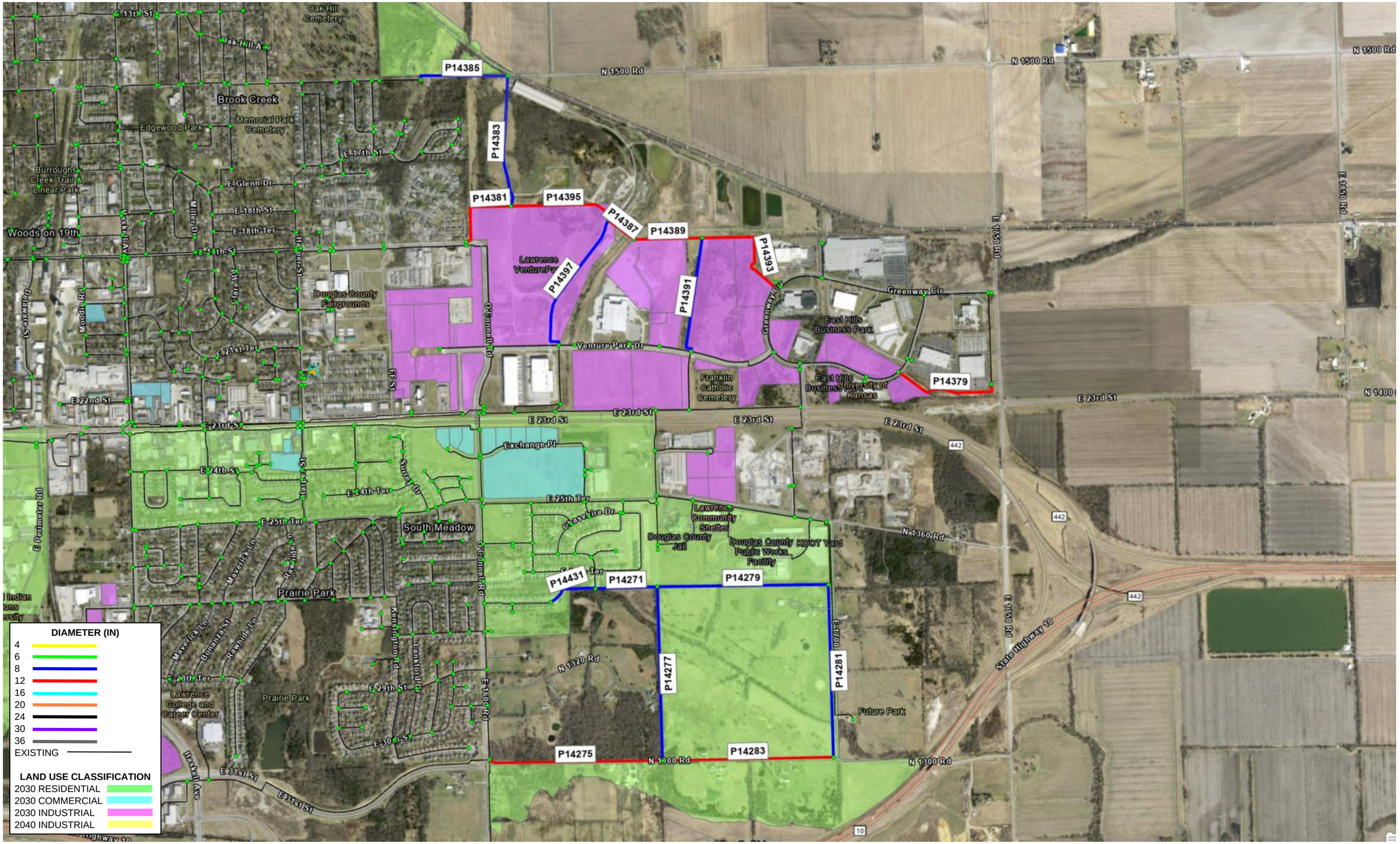
FIGURE 8-8
SOUTHEAST LAWRENCE
2030 CAPITAL IMPROVEMENTS



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

NOT TO SCALE

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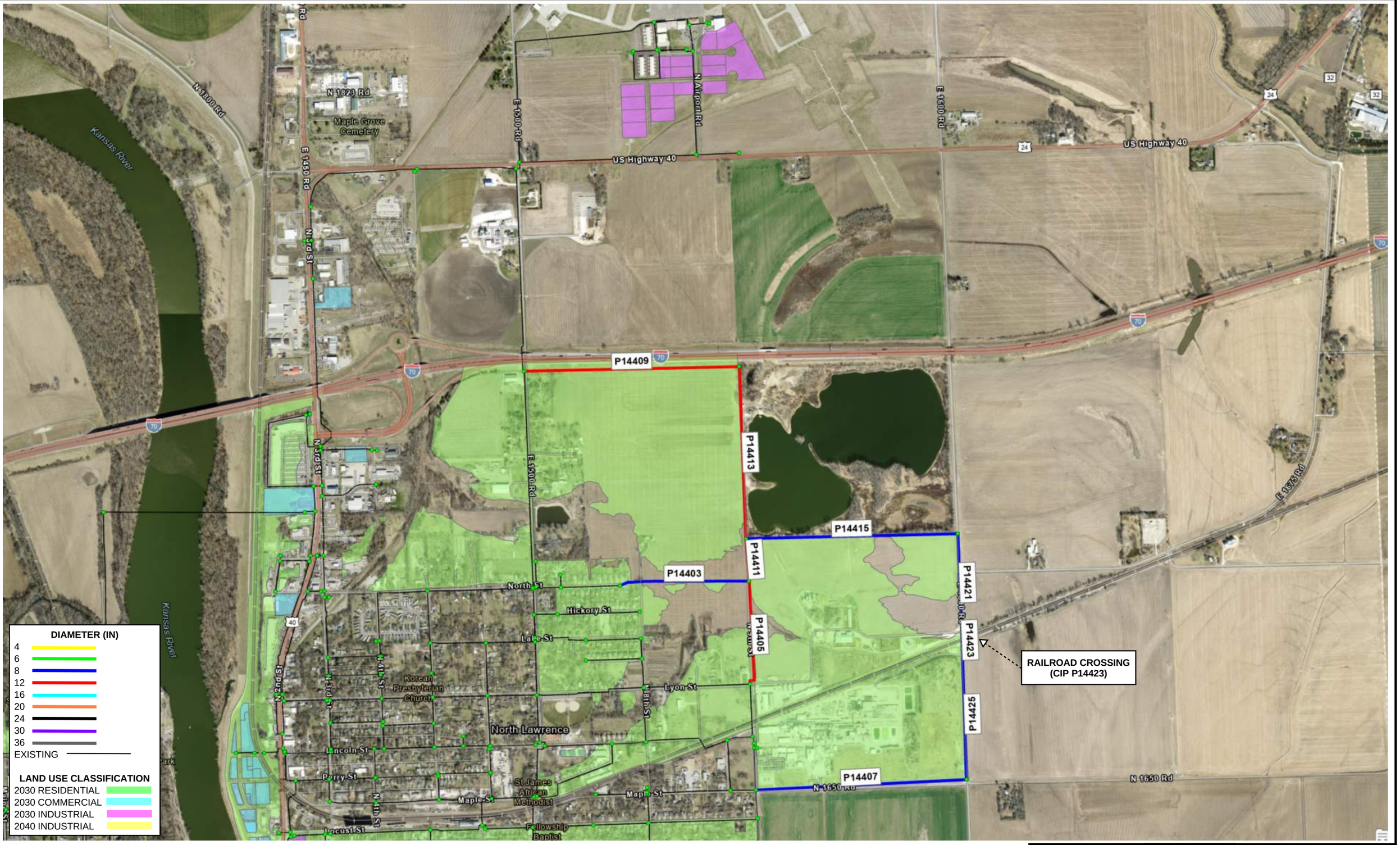
FIGURE 8-9
EAST LAWRENCE
2030 CAPITAL IMPROVEMENTS



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

NOT TO SCALE

N

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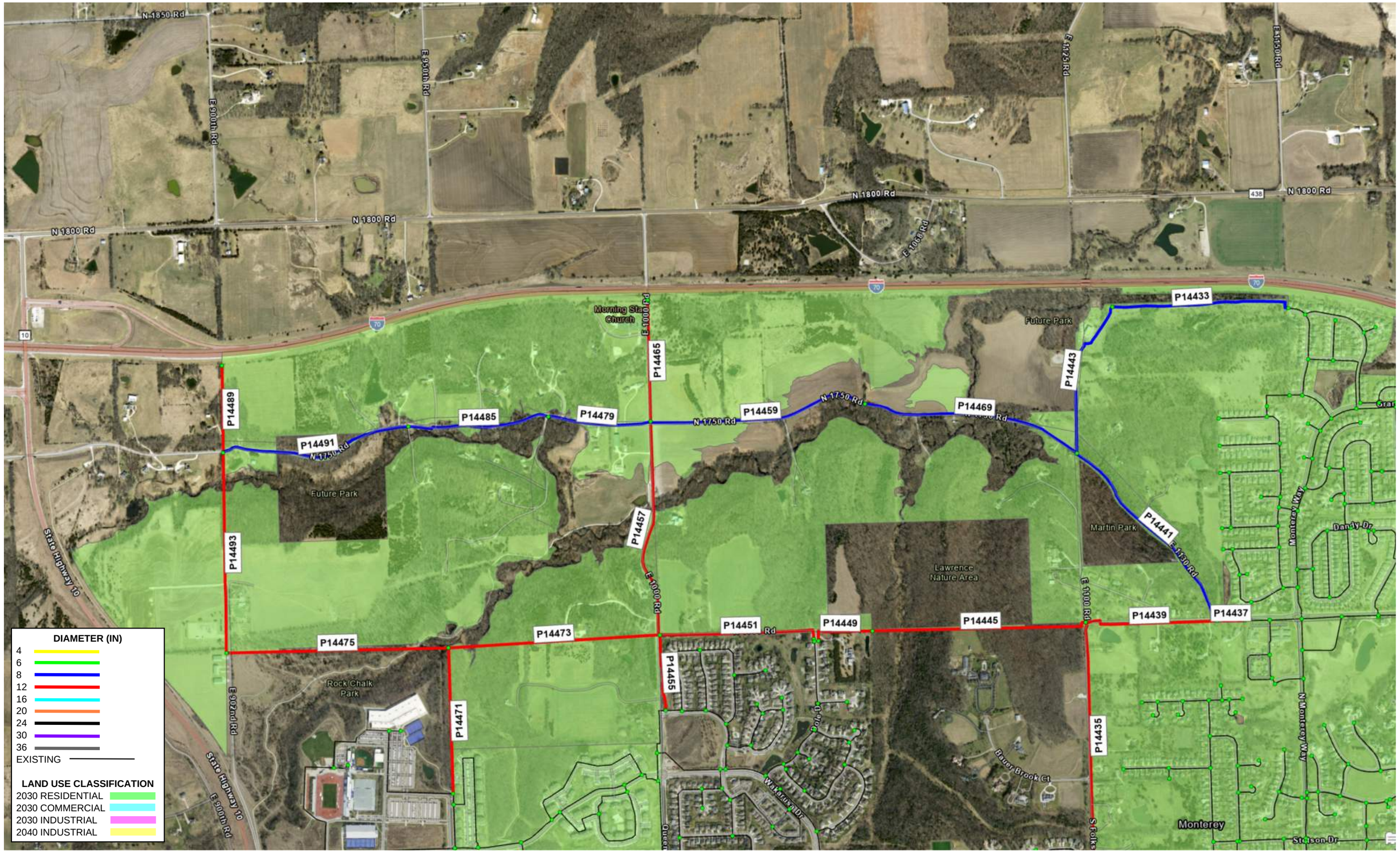
FIGURE 8-10
NORTHEAST LAWRENCE
2030 CAPITAL IMPROVEMENTS



DIAMETER (IN)

- 4
- 6
- 8
- 12
- 16
- 20
- 24
- 30
- 36
- EXISTING

LAND USE CLASSIFICATION

- 2030 RESIDENTIAL
- 2030 COMMERCIAL
- 2030 INDUSTRIAL
- 2040 INDUSTRIAL

NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

NOT TO SCALE

N

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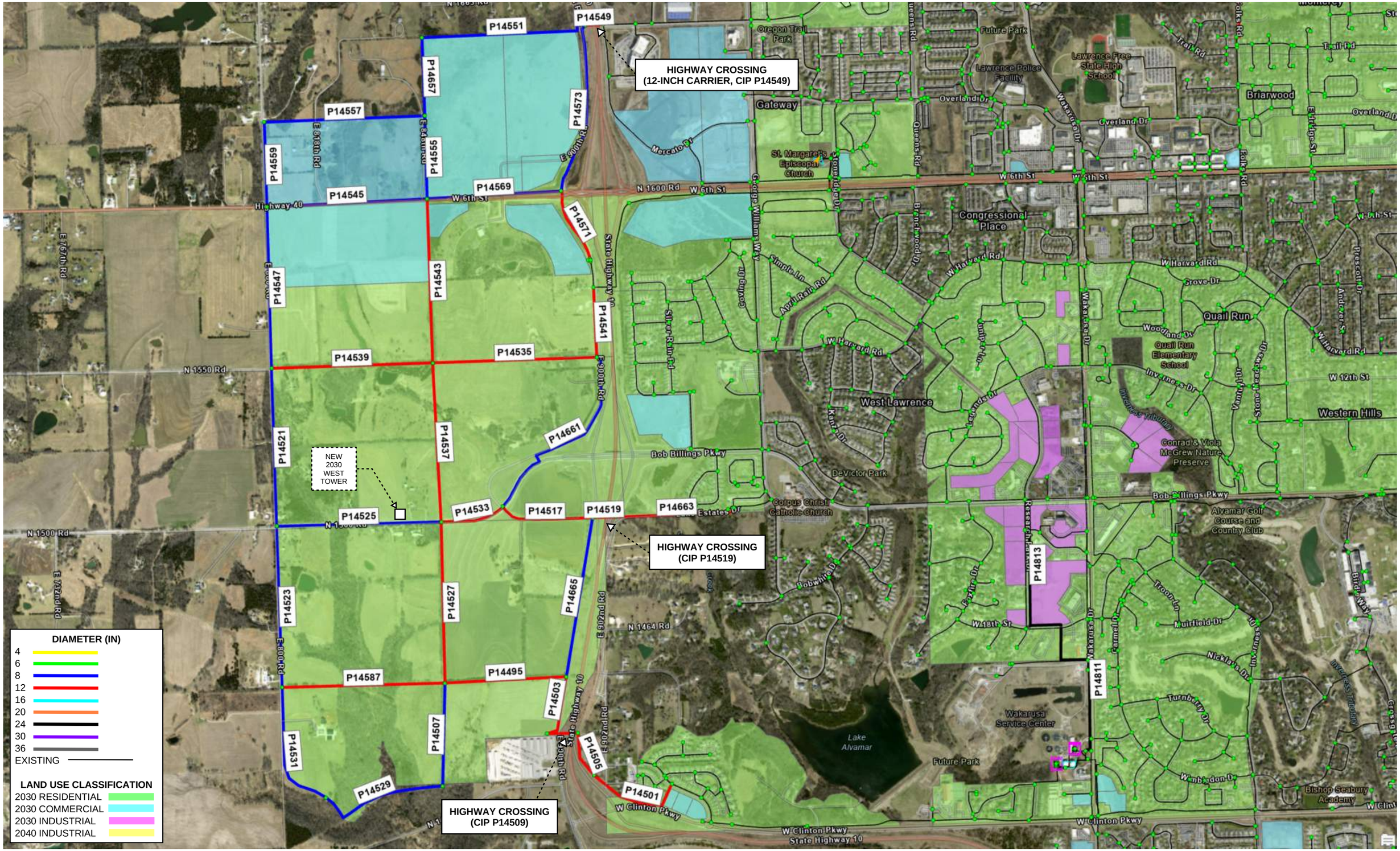
FIGURE 8-11
NORTHWEST LAWRENCE
2030 CAPITAL IMPROVEMENTS



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

NOT TO SCALE

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FIGURE 8-12
WEST LAWRENCE
2030 CAPITAL IMPROVEMENTS

9.0 2040 Planning Period Hydraulic Analysis

This section of the report includes the hydraulic analysis of the distribution system for the 2040 planning period with a projected maximum day demand of 29.6 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. The 2030 planning period capital improvements, including fire flow and small mains, are included in the 2040 planning period scenario, and associated model results, and illustrated in Figure 9-1.

Figure 9-1: 2030 & 2040 Planning Period Capital Improvements

Notable projects include replacing the existing 0.5 MG Harper Tower with new 1.0 MG nearby (same site, Central Service) to support future growth and associated demand projections primarily for the 2040 industrial growth in east Lawrence (east of existing industrial park) and the 2030 residential development south of the Wakarusa River. The fire flow improvements and small main replacements identified in the 2030 planning period scenario are sized for the 2040 projected demands; therefore, no additional fire flow improvements are needed in the 2040 planning period. The linear improvements identified for the 2040 planning period are associated with the proposed industrial areas in northwest (north of I-70) and east (as indicated above) Lawrence.

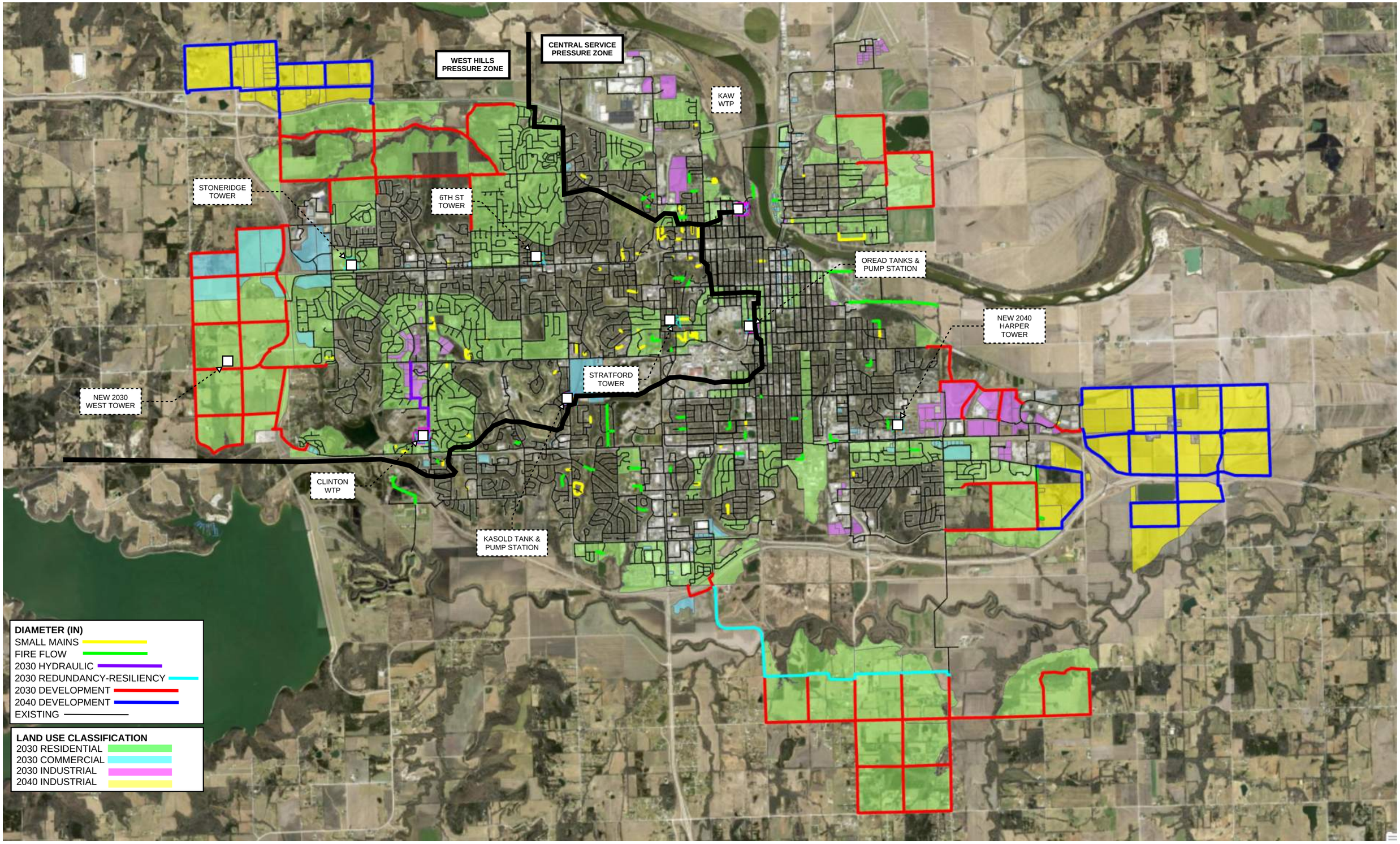
9.1 Pressure & Pumping

The average pressure in West Hills under the maximum day demand ranges between 41 psi and 150 psi with an average of approximately 84 psi. The average pressure in Central Service under the maximum day demand ranges between 40 psi and 90 psi with an average of approximately 67 psi. Distribution system pressure is illustrated in Figure 9-2 and indicates compliance with the level of service for minimum pressure under normal operating conditions of 40 psi.

Figure 9-2: 2040 System Pressure

Additional elevated storage, Harper Tower replacement, is recommended for Central Service and is discussed further in Section 9.3. The Harper Tower replacement will float on the Central Service pressure plane with the same overflow elevation as Oread ground storage tanks; final design level modelling should be conducted to confirm elevations based on the proposed tank location. The proposed overflow elevation of the new Harper Tower is approximately 4 ft higher than the existing tower and will increase localized pressure approximately 1-2 psi higher when full. Raising the proposed overflow elevation any higher than the Oread tank overflow elevation would increase localized pressure around Harper Tower even further, as this has historically been a lower pressure area (but still greater than 40 psi, bound by E 23rd St, O'Connell Rd, E 27 St, and Haskell Ave) but would submerge that volume over an elevation of 1,019 ft at Oread and Kasold. Therefore, it is recommended that the Harper Tower overflow elevation and head range match Oread and Kasold ground storage.

The firm pumping capacity for West Hills and Central Service exceeds the 2040 maximum day demand projection as illustrated in Figure 9-3 and 9-4 respectively, therefore, no pumping capacity improvements are needed. For clarity, the projected demand between 2024 and 2040 is linear and is not based on any specific growth strategy during these interstitial years.



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

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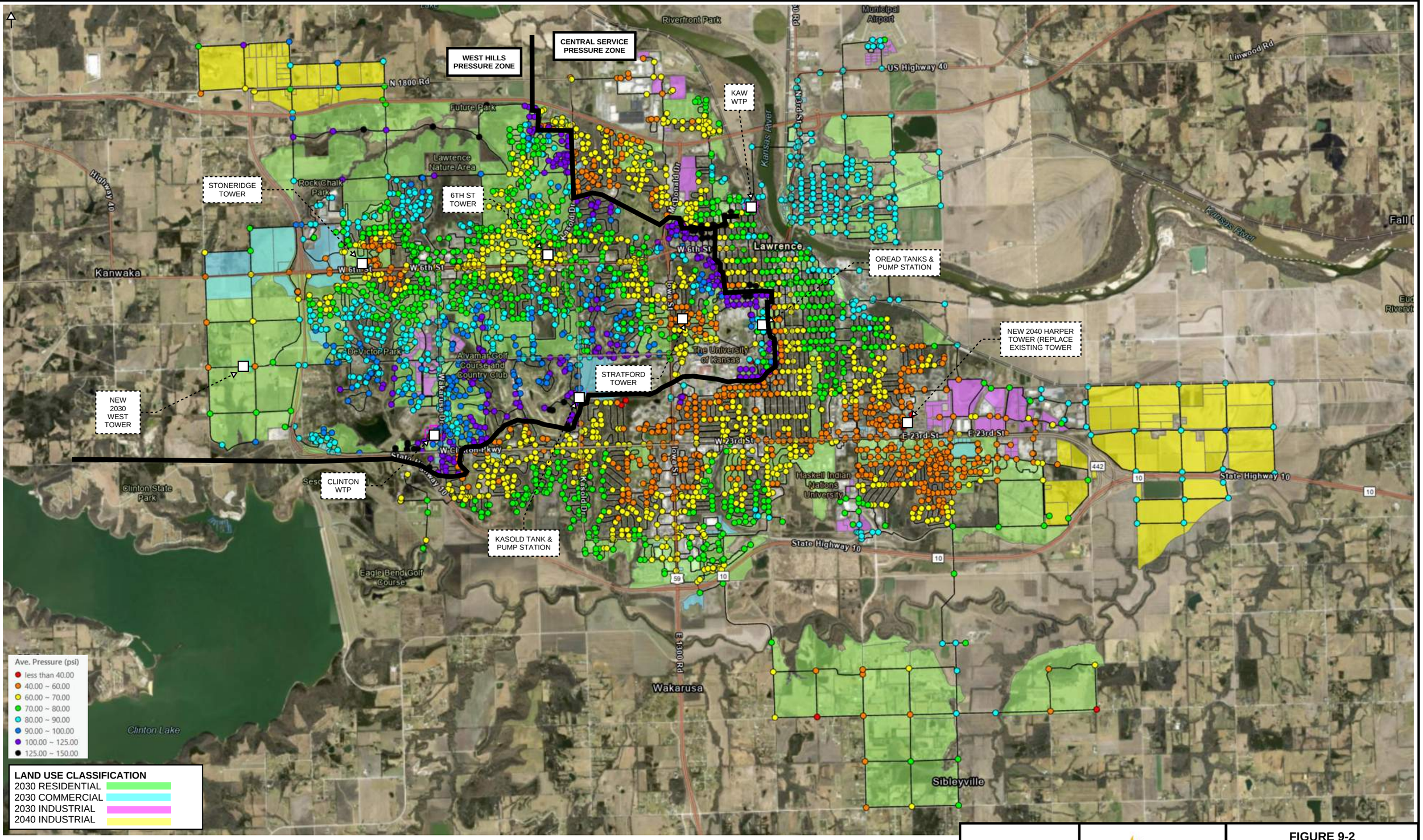
FIGURE 9-1
2030 & 2040 CAPITAL IMPROVEMENTS



NOTES:
1. THE 2030 AND 2040 PLANNING PERIOD GROWTH AREAS (LAND USE CLASSIFICATIONS SHOWN).
2. MODEL RESULTS REFLECT ALL 2030 AND 2040 CAPITAL IMPROVEMENT PROJECTS.

NOT TO SCALE

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FIGURE 9-2

2040 PLANNING PERIOD AVERAGE PRESSURE MAXIMUM DAY DEMAND

Figure 9-3: 2040 West Hills Pumping Capacity

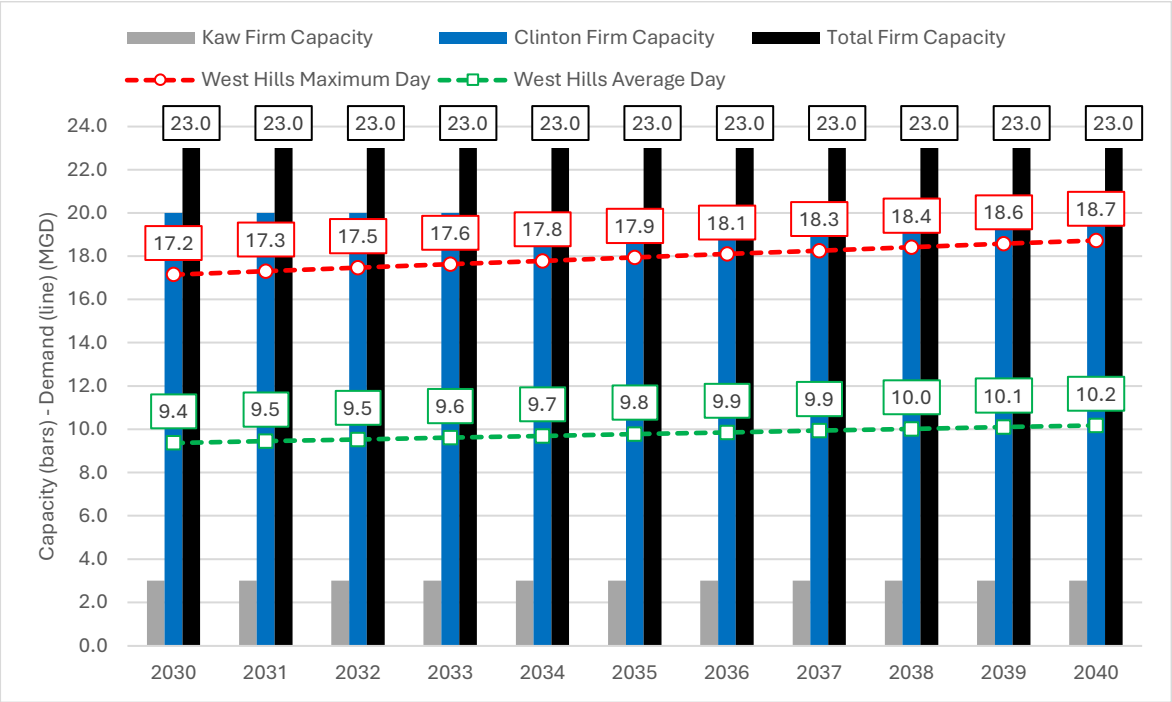
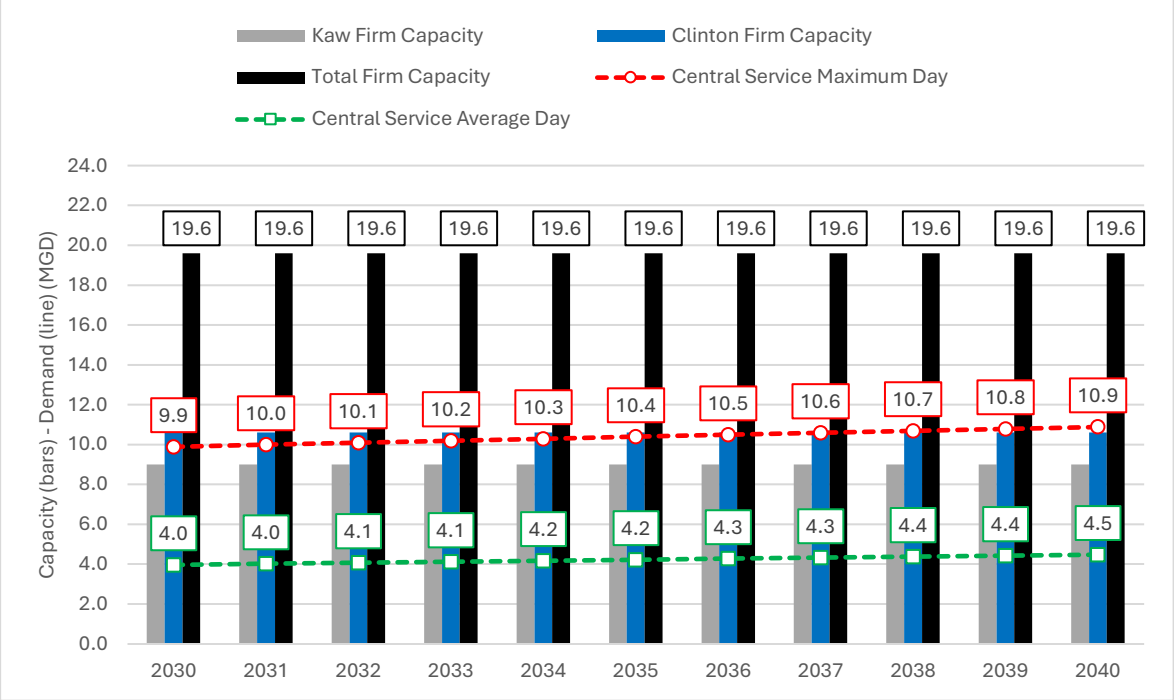


Figure 9-4: 2040 Central Service Pumping Capacity



9.2 Water Distribution Hydraulics

The level of service conditions for hydraulic capacity in the distribution system hydraulics is velocity less than 5.0 fps and headloss less than 6 ft per 1,000 ft of pipe each (24-hr average). There are no high priority

hydraulic capacity improvements required in the distribution system. The existing distribution system, 2030 linear capital improvements, and proposed 2040 linear capital improvements (all development-driven) are adequately sized for the projected 2040 maximum day demands.

9.3 Storage Evaluation

The effective storage evaluation for the distribution system and results of the 2040 storage analysis for West Hills and Central Service are summarized in Tables 9-1, 9-2, and 9-3 respectively and indicate a storage surplus of approximately 1.4 MG and 1.1 MG respectively. The 2040 planning period incorporates an additional 1.0 MG of elevated storage in West Hills (carried forward as indicated the 2030 planning period recommendation) and Harper Tower replacement at 1.0 MG in Central Service.

Table 9-1: 2040 Share Storage Evaluation

Storage Facility	Total Available Storage (MG)	Storage (MG)	
		West Hills (MGD) 18.73	Central Service (MGD) 10.89
Stoneridge	1.50	1.50	--
6th St	0.50	0.50	--
Stratford	0.50	0.50	--
New West Tower	1.00	1.00	--
Oread	1.75	0.00	1.75
Kasold	1.50	0.95	0.53
New Harper	1.00	--	1.00
Total	**7.75**	**4.45**	**3.28**

Table 9-2: 2040 West Hills Storage Analysis

Storage Factor	Quantity	Comments
Maximum Day Demand (MGD)	18.73	demand projection
Total Storage (MG)	4.45	ground + elevated
Effective Storage (MG)	4.45	all storage
Fire Flow Requirement (MG)	0.63	maximum ISO designation
Equalization Factor	13%	West Hills diurnal analysis
Equalization Requirement (MG)	2.43	equalization × maximum day
Minimum Storage Requirement (MG)	3.06	fire + equalization
Result (MG)	**1.38**	**Storage Surplus**
Emergency Reserve Duration (hrs)	3.52	@ avg day demand (9.4 MGD)
	1.77	@ max day demand (18.7 MGD)

Table 9-3: 2040 Central Service Storage Analysis

Storage Factor	Quantity	Comments
Maximum Day Demand (MGD)	10.89	demand projection
Total Storage (MG)	3.28	ground + elevated
Effective Storage (MG)	3.28	all storage
Fire Flow Requirement (MG)	0.63	maximum ISO designation
Equalization Factor	14%	Central Service diurnal analysis
Equalization Requirement (MG)	1.52	equalization × maximum day
Minimum Storage Requirement (MG)	2.15	fire + equalization
Result (MG)	**1.13**	**Storage Surplus**
Emergency Reserve Duration (hrs)	5.23	@ avg day demand (5.2 MGD)
	2.48	@ max day demand (10.9 MGD)

As indicated previously in Section 8.3, additional storage at Kaw WTP can impact the volume needed for additional storage in Central Service. As the long-term treatment and facility planning at Kaw WTP is defined, the volume for the Harper Tower replacement should be re-evaluated at that time. However, if the 2030 and 2040 industrial growth occurs as planned and before long-term planning at Kaw WTP is further defined, then Harper Tower should be replaced with a new 1.0 MG elevated storage tank with an overflow elevation and head range equivalent to Oread ground storage tanks. For clarity, this overflow elevation also matches the Kasold ground storage tank; collectively all three tanks will float in the Central Service pressure plane.

Like the demand trigger for the 2030 West Tank being more contingent on growth west of K10, the demand trigger for the Harper Tower replacement is largely influenced by industrial development in east Lawrance of approximately 300 gpm and residential development south of the Wakarusa River of approximately 390 gpm (this does not include WWTP demand or maximum contract amounts for Baldwin City and RWD No. 4). However, if these development areas do not align with the 2040 planning period, it is more likely that the existing Harper Tower will be closer to the end of its useful remaining life and continued maintenance investments are not recommended. In which case, the condition of the existing Harper Tower may be the governing factor for replacement as opposed to the industrial and residential development demands.

Another factor that can accelerate Harper Tower replacement is if the City elects to change the Oread ground storage service function (normal condition) from Central Service only to Central Service and West Hills service. This will impact the storage analysis, as more effective storage in Oread Tanks is allocated to West Hills the effective storage will decrease in Central Service; this will increase the size, by volume, needed to maintain a 1.0 MG surplus in Central Service.

9.4 Fire Flow Analysis

The level of service for fire flow is 1,500 gpm at 20 psi and is additive to the 2030 projected maximum day demand. The fire flow results are illustrated in Figure 8-7 and reflect all capital improvements included in Figure 9-1. Fire flow improvements are developed for each water main segment that includes a fire hydrant and is not incompliance with the level of service. In instances where a small main, which is considered any pipe less than or equal to 4-inch diameter, results in a low fire flow the capital improvement is considered a higher priority and termed a fire flow improvement over the lower priority small mains replacement designation.

Figure 9-5: 2040 Available Fire Flow (standalone)

9.5 Conclusions & Recommendations

In conclusion, Harper Tower replacement with a 1.0 MG elevated storage tank is the only high priority capital improvement based on the 2040 water demand projection. Important factors to consider when determining the implementation of the Harper Tower Replacement are listed below by importance.

1. Central Service Long-Term Facility Planning at Kaw WTP:
   a. City staff indicated a need/preference for more potable water storage and if there is emergency power capable of pumping firm capacity (to either pressure zone), then a portion of this on-site storage could be allocated to Central Service. This allocation can impact the sizing recommendation for Harper Tower replacement.
2. Condition and Remaining Useful Life

WEST HILLS PRESSURE ZONE

CENTRAL SERVICE PRESSURE ZONE

KAW WTP

STONERIDGE TOWER

6TH ST TOWER

OREAD TANKS & PUMP STATION

NEW 2040 HARPER TOWER REPLACEMENT

STRATFORD TOWER

NEW 2030 WEST TOWER

CLINTON WTP

KASOLD TANK & PUMP STATION

Hydrant Available Flow (gpm)
- less than 500.00
- 500.00 ~ 1,000.00
- 1,000.00 ~ 1,500.00
- 1,500.00 ~ 2,000.00
- 2,000.00 ~ 3,000.00
- 3,000.00 ~ 4,000.00

DIAMETER (IN)
- SMALL MAINS
- FIRE FLOW
- 2030 HYDRAULIC
- 2030 REDUNDANCY-RESILIENCY
- 2030 DEVELOPMENT
- 2040 DEVELOPMENT
- EXISTING

LAND USE CLASSIFICATION
- 2030 RESIDENTIAL
- 2030 COMMERCIAL
- 2030 INDUSTRIAL
- 2040 INDUSTRIAL

NOTES:
1. ONLY 2030 PLANNING PERIOD GROWTH AREAS (LAND USE CLASSIFICATIONS SHOWN).
2. MODEL RESULTS REFLECT ALL 2030 CAPITAL IMPROVEMENT PROJECTS.

NOT TO SCALE

BURNS McDONNELL

Lawrence KANSAS

FIGURE 9-5

2040 PLANNING PERIOD AVAILABLE FIRE FLOW MAXIMUM DAY DEMAND

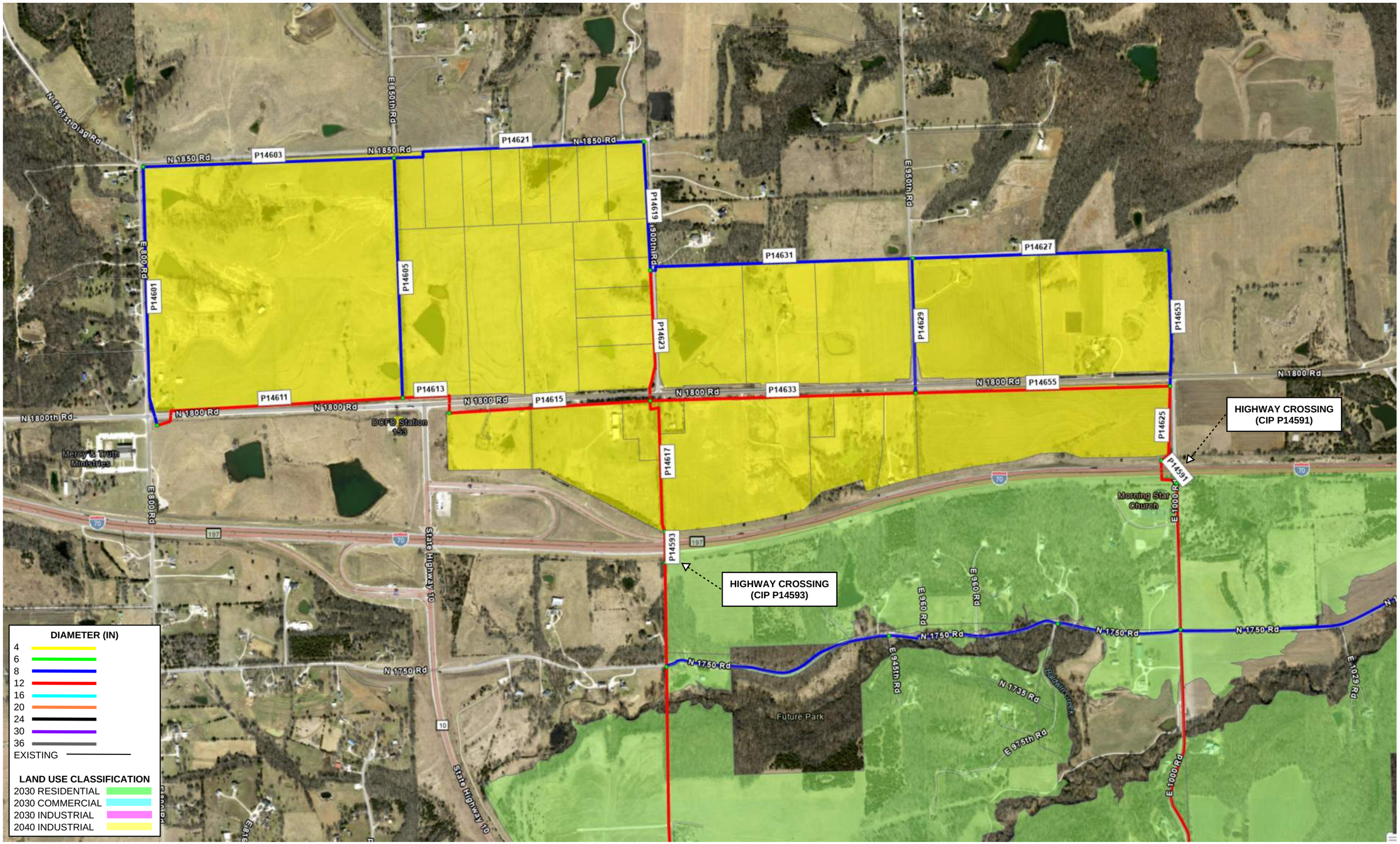
a. If the long-term facility planning for Kaw WTP, discussed above, is not defined with respect to additional on-site storage, then the existing remaining useful life of Harper Tower should be considered in determining the replacement vs maintenance investment over the next 20 years. This factor has greater importance than the demand projections discussed below.

3. Submergence and Tank Location vs Demand Projections
   a. The demand projections associated with industrial development in East Lawrence and residential development in Southeast Lawrence (south of the Wakarusa River) support the recommendation for additional storage in Central Service.
   b. More importantly, the recommended location is at or near the existing Harper Tower because of its higher elevation, proximity to adequately sized water mains, and it is well positioned amongst Oread and Kasold storage within Central Service. The current location also resides within a demand center of the existing Central Service network, and it is submerged when the hydraulic gradient exceeds its overflow elevation; these factors are of greater importance than the demand projections that align with the 2040 growth plan in Central Service. The location within the existing network is an important distinction, comparatively speaking, to the proposed 2030 West Tower whose implementation is directly tied to development/demands west of K10 where there is currently little demand and/or minimal infrastructure.
      i. Other areas in Central Service with a robust network of at least 12-inch diameter water mains can also be considered and validated with additional model, such as Venture Park, and/or other areas of higher elevation. Venture Park could be viable given its proximity to larger capacity water mains and future growth demand centers, however, grade elevation ranges between 815 ft and 915 ft compared to grade elevated of 920 ft at Harper Tower; lower elevations require a taller tank. Higher elevation areas in Venture Park are generally west of O'Connell Rd.

All other improvements are linear and are development-driven, whose priority is as development occurs. The small mains replacement and fire flow improvements identified in the 2030 planning period are adequately sized for the 2040 water demand projection; therefore, no additional fire flow improvements are identified in the 2040 planning period. Linear development-driven improvements for the 2040 industrial areas are illustrated in Figures 9-6 and 9-7 for northwest and east Lawrence respectively.

Figure 9-6: 2040 Northwest Lawrence Capital Improvements

Figure 9-7: 2040 East Lawrence Capital Improvement



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

NOT TO SCALE

N

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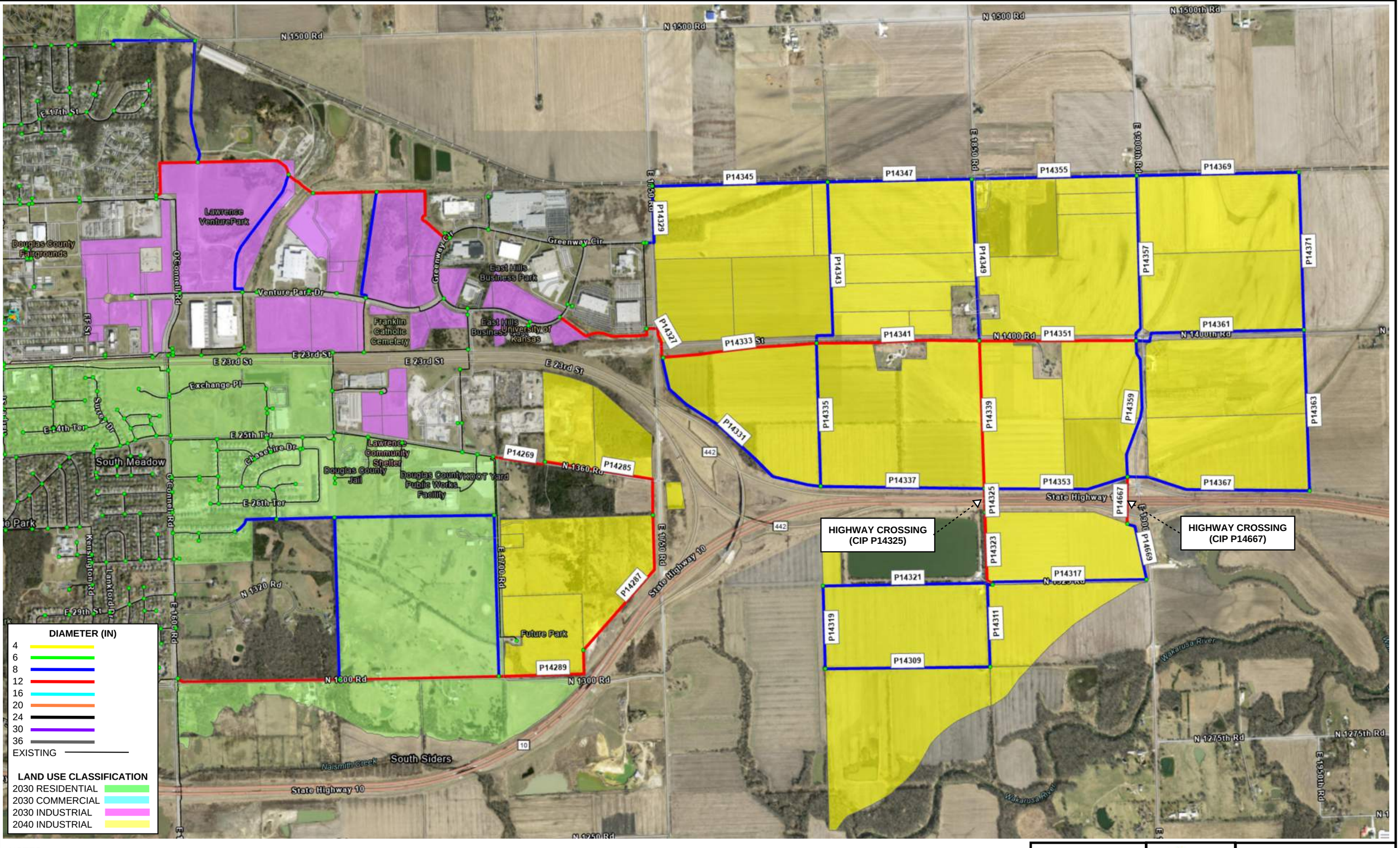
FIGURE 9-6
NORTHWEST LAWRENCE
2040 CAPITAL IMPROVEMENTS



NOTES:
1. EXISTING DISTRIBUTION SYSTEM WATER MAINS IN BLACK; CAPITAL IMPROVEMENT COLOR CODED VIA LEGEND.

NOT TO SCALE

N

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FIGURE 9-7
EAST LAWRENCE
2040 CAPITAL IMPROVEMENTS

10.0 Capital Improvement Planning

Unit cost development and opinions of probable construction cost for the recommended capital improvement projects are included in this section of the report. Triggers for capital improvements include fire flow, development for future growth, storage, redundancy-resiliency, and small main replacements. Unit costs are developed for linear improvements based on recent water main construction projects.

10.1 Opinions of Probable Construction Cost

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 Lawrence, Kansas 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 ENR 20-city average construction cost index in January 2025 is 13632.41.

10.2 Cost Development

Unit cost information for linear capital improvements is based on the standard for a Class 5 cost estimate per the Association for Advancement of Cost Engineering (AACE) Recommended Practices 17R-97, 56R-08, other applicable AACE Recommended Practices, and recent water main projects. Typical water main construction items used in the unit cost development are listed in Table 10-1. Unit costs for water main installation in the City (pavement removal/replacement) vs undeveloped areas is considered for applicable diameter.

Table 10-1: Water Main Construction Cost Variables

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

10.3 Capital Improvement Projects

A summary of the opinions of probable construction cost (OPCC) for the 2030 and 2040 planning period capital improvements is listed in Table 10-2. Costs for linear improvements include contingency at 20 percent and engineering at 15 percent. Costs for facility improvements include contingency at 20 percent and engineering at 20 percent. Facility costs represent elevated storage for the 2030 West Tower, conditional 2030 West pressure zone BPS, and 2040 Harper Tower Replacement. All OPCC for capital improvements are in today's dollars.

Table 10-2: Opinion of Probable Construction Cost Summary

Planning Period	Capital Improvement	Priority	Type	Service	Trigger	OPCC[3]
Available Funding	Small Mains	Lower	Linear	Distribution	Condition	$ 6,211,000
	Fire Flow	Moderate			Level of Service	$ 6,733,000
					Subtotal	**$ 12,944,000**
2030	Hydraulic	Higher	Linear	Transmission	Level of Service	$ 3,286,000
	R-R[1]	Moderate		Looping	Development	$ 10,633,000
	Growth	Note 2		Distribution		$ 45,259,000
	West Tower	Higher	Facility	1.0 MG Elevated Storage	Demand & Development	$ 14,826,000
					2030 Subtotal	**$ 60,085,000**
2040	Growth	Note 2	Linear	Distribution	Development	$ 21,697,000
	Harper Tower Replacement	Higher	Facility	1.0 MG Elevated Storage	Demand & Development	$ 14,400,000
					2040 Subtotal	**$ 36,097,000**
					Total (all projects)	**$ 109,130,000**

Notes:
1. R-R: Redundancy-Resiliency.
2. Development-driven capital improvement priority is as development occurs.
3. OPCC: Opinion of Probable Construction Cost.

The OPCCs for the West Tower and Harper Tower Replacement reflect the higher end of probable construction costs as indicated by a tank manufacturer. The OPCC range for these towers is listed below in addition to the West BPS conditional improvement, and a new Kaw WTP washwater tank. For clarity, the conditional West pressure zone BPS and Kaw Washwater Tank are not included in Table 10-2 because the BPS implementation is based on an alternative growth strategy and the Kaw Washwater Tank implementation should be considered in the long-term facility planning needs at Kaw WTP, both of which are beyond the scope of this project.

- 2030 West Tower: $9.6 million to $14.8 million
- 2040 Harper Tower Replacement: $9.4 million to $14.4 million
- Conditional West Pressure Zone BPS: $1.2 million
  - Needed if the growth plan expands beyond the development boundary west of E 800 Rd delineated by a grade elevation area greater than 1,065 ft. Factors affecting the BPS OPCC include fire service and pump sizing for alternative demand projections.
- Alternative Northeast Lawrence 12-inch upsizing: $713,000
  - This includes replacement of just over 3,000 linear ft of existing 8-inch water main with 12-inch from the intersection of N 3rd St and Hwy 40 to the intersection (northeast corner) of E 1500 Rd

and Hwy 40 near the airport. For clarity, this improvement aligns with an alternative growth strategy near the airport that is not fully defined as of the date of this report.

- Kaw Washwater Tank: $3.5 million(+), though constructability may impact the total project cost due to site limitations and unknown variables; demolition of the existing tank is not included as no information is provided on location of the new tank within the site or if the WTP can temporarily operate without the existing tank in service if the new tank were constructed in the current location. This OPCC should be updated as more information is available to the degree that a range of OPCC can be provided.

Itemized OPCC for individual linear capital projects are listed in Tables 10-3, 10-4, 10-5, and 10-6 for small main improvements, fire flow improvements, 2030 planning period improvements, and 2040 planning period improvements respectively. The CIP ID references in these tables correspond with the following CIP figures:

- Section 8.0: Figures 8-8 through 8-12 (2030 planning period)
- Section 9.0: Figures 9-6 and 9-7 (2040 planning period)
- Small mains: refer to digital storyboard
- Fire flow: refer to digital storyboard

Table 10-3: OPCC Small Mains Replacement (standalone)

Table 10-4: OPCC Fire Flow Capital Improvements (standalone)

Table 10-5: OPCC 2030 Capital Improvements (standalone)

Table 10-6: OPCC 2040 Capital Improvements (standalone)

Table 10-3
Opinion of Probable Construction Costs - Small Mains Capital Improvements

CIP ID	Improvement Type	Planning Period	Length (ft)	Diameter (in)	Unit Cost ($/LF)	Construction	Contingency	Engineering	Total OPCC
P43	Small Mains	Available Funding	42	8	$ 194	$ 8,000	$ 2,000	$ 2,000	$ 12,000
P187	Small Mains	Available Funding	287	8	$ 194	$ 56,000	$ 11,000	$ 10,000	$ 77,000
P281	Small Mains	Available Funding	25	8	$ 194	$ 5,000	$ 1,000	$ 1,000	$ 7,000
P323	Small Mains	Available Funding	513	8	$ 194	$ 99,000	$ 20,000	$ 18,000	$ 137,000
P337	Small Mains	Available Funding	693	8	$ 194	$ 134,000	$ 27,000	$ 24,000	$ 185,000
P347	Small Mains	Available Funding	190	8	$ 194	$ 37,000	$ 7,000	$ 7,000	$ 51,000
P859	Small Mains	Available Funding	63	8	$ 194	$ 12,000	$ 2,000	$ 2,000	$ 16,000
P981	Small Mains	Available Funding	689	8	$ 194	$ 134,000	$ 27,000	$ 24,000	$ 185,000
P983	Small Mains	Available Funding	154	8	$ 194	$ 30,000	$ 6,000	$ 5,000	$ 41,000
P989	Small Mains	Available Funding	457	8	$ 194	$ 89,000	$ 18,000	$ 16,000	$ 123,000
P1093	Small Mains	Available Funding	341	8	$ 194	$ 66,000	$ 13,000	$ 12,000	$ 91,000
P1123	Small Mains	Available Funding	298	8	$ 194	$ 58,000	$ 12,000	$ 11,000	$ 81,000
P1137	Small Mains	Available Funding	307	8	$ 194	$ 60,000	$ 12,000	$ 11,000	$ 83,000
P1163	Small Mains	Available Funding	350	8	$ 194	$ 68,000	$ 14,000	$ 12,000	$ 94,000
P1173	Small Mains	Available Funding	237	8	$ 194	$ 46,000	$ 9,000	$ 8,000	$ 63,000
P1181	Small Mains	Available Funding	202	8	$ 194	$ 39,000	$ 8,000	$ 7,000	$ 54,000
P1231	Small Mains	Available Funding	47	8	$ 194	$ 9,000	$ 2,000	$ 2,000	$ 13,000
P1285	Small Mains	Available Funding	556	8	$ 194	$ 108,000	$ 22,000	$ 20,000	$ 150,000
P1295	Small Mains	Available Funding	502	8	$ 194	$ 97,000	$ 19,000	$ 17,000	$ 133,000
P1299	Small Mains	Available Funding	623	8	$ 194	$ 121,000	$ 24,000	$ 22,000	$ 167,000
P1383	Small Mains	Available Funding	111	8	$ 194	$ 21,000	$ 4,000	$ 4,000	$ 29,000
P1413	Small Mains	Available Funding	471	8	$ 194	$ 91,000	$ 18,000	$ 16,000	$ 125,000
P1457	Small Mains	Available Funding	515	8	$ 194	$ 100,000	$ 20,000	$ 18,000	$ 138,000
P1479	Small Mains	Available Funding	202	8	$ 194	$ 39,000	$ 8,000	$ 7,000	$ 54,000
P1527	Small Mains	Available Funding	538	8	$ 194	$ 104,000	$ 21,000	$ 19,000	$ 144,000
P1535	Small Mains	Available Funding	106	8	$ 194	$ 21,000	$ 4,000	$ 4,000	$ 29,000
P1559	Small Mains	Available Funding	1,281	8	$ 194	$ 248,000	$ 50,000	$ 45,000	$ 343,000
P1805	Small Mains	Available Funding	647	8	$ 194	$ 126,000	$ 25,000	$ 23,000	$ 174,000
P2069	Small Mains	Available Funding	43	8	$ 194	$ 8,000	$ 2,000	$ 2,000	$ 12,000
P2147	Small Mains	Available Funding	717	8	$ 194	$ 139,000	$ 28,000	$ 25,000	$ 192,000
P2243	Small Mains	Available Funding	323	8	$ 194	$ 63,000	$ 13,000	$ 11,000	$ 87,000
P2303	Small Mains	Available Funding	20	8	$ 194	$ 4,000	$ 1,000	$ 1,000	$ 6,000
P2387	Small Mains	Available Funding	202	8	$ 194	$ 39,000	$ 8,000	$ 7,000	$ 54,000
P2405	Small Mains	Available Funding	220	8	$ 194	$ 43,000	$ 9,000	$ 8,000	$ 60,000
P2455	Small Mains	Available Funding	255	8	$ 194	$ 49,000	$ 10,000	$ 9,000	$ 68,000
P2607	Small Mains	Available Funding	154	8	$ 194	$ 30,000	$ 6,000	$ 5,000	$ 41,000
P2629	Small Mains	Available Funding	191	8	$ 194	$ 37,000	$ 7,000	$ 7,000	$ 51,000
P2761	Small Mains	Available Funding	226	8	$ 194	$ 44,000	$ 9,000	$ 8,000	$ 61,000
P2879	Small Mains	Available Funding	288	8	$ 194	$ 56,000	$ 11,000	$ 10,000	$ 77,000
P2965	Small Mains	Available Funding	420	8	$ 194	$ 82,000	$ 16,000	$ 15,000	$ 113,000
P2975	Small Mains	Available Funding	59	8	$ 194	$ 11,000	$ 2,000	$ 2,000	$ 15,000
P2985	Small Mains	Available Funding	155	8	$ 194	$ 30,000	$ 6,000	$ 5,000	$ 41,000
P3041	Small Mains	Available Funding	162	8	$ 194	$ 32,000	$ 6,000	$ 6,000	$ 44,000
P3359	Small Mains	Available Funding	25	8	$ 194	$ 5,000	$ 1,000	$ 1,000	$ 7,000
P3447	Small Mains	Available Funding	49	8	$ 194	$ 9,000	$ 2,000	$ 2,000	$ 13,000
P3821	Small Mains	Available Funding	25	8	$ 194	$ 5,000	$ 1,000	$ 1,000	$ 7,000
P4233	Small Mains	Available Funding	220	8	$ 194	$ 43,000	$ 9,000	$ 8,000	$ 60,000
P4343	Small Mains	Available Funding	406	8	$ 194	$ 79,000	$ 16,000	$ 14,000	$ 109,000
P4501	Small Mains	Available Funding	217	8	$ 194	$ 42,000	$ 8,000	$ 8,000	$ 58,000
P4519	Small Mains	Available Funding	476	8	$ 194	$ 92,000	$ 18,000	$ 17,000	$ 127,000
P4521	Small Mains	Available Funding	270	8	$ 194	$ 52,000	$ 10,000	$ 9,000	$ 71,000
P4665	Small Mains	Available Funding	20	8	$ 194	$ 4,000	$ 1,000	$ 1,000	$ 6,000
P6857	Small Mains	Available Funding	148	8	$ 194	$ 29,000	$ 6,000	$ 5,000	$ 40,000
P6969	Small Mains	Available Funding	601	8	$ 194	$ 117,000	$ 23,000	$ 21,000	$ 161,000
P7245	Small Mains	Available Funding	229	8	$ 194	$ 44,000	$ 9,000	$ 8,000	$ 61,000
P7575	Small Mains	Available Funding	91	8	$ 194	$ 18,000	$ 4,000	$ 3,000	$ 25,000
P7577	Small Mains	Available Funding	139	8	$ 194	$ 27,000	$ 5,000	$ 5,000	$ 37,000
P7589	Small Mains	Available Funding	213	8	$ 194	$ 41,000	$ 8,000	$ 7,000	$ 56,000
P7647	Small Mains	Available Funding	1,164	8	$ 194	$ 226,000	$ 45,000	$ 41,000	$ 312,000
P7909	Small Mains	Available Funding	63	8	$ 194	$ 12,000	$ 2,000	$ 2,000	$ 16,000
P8207	Small Mains	Available Funding	20	8	$ 194	$ 4,000	$ 1,000	$ 1,000	$ 6,000
P8211	Small Mains	Available Funding	20	8	$ 194	$ 4,000	$ 1,000	$ 1,000	$ 6,000
P8225	Small Mains	Available Funding	145	8	$ 194	$ 28,000	$ 6,000	$ 5,000	$ 39,000
P8227	Small Mains	Available Funding	220	8	$ 194	$ 43,000	$ 9,000	$ 8,000	$ 60,000
P8383	Small Mains	Available Funding	490	8	$ 194	$ 95,000	$ 19,000	$ 17,000	$ 131,000
P8531	Small Mains	Available Funding	54	8	$ 194	$ 10,000	$ 2,000	$ 2,000	$ 14,000
P8581	Small Mains	Available Funding	50	8	$ 194	$ 10,000	$ 2,000	$ 2,000	$ 14,000
P8587	Small Mains	Available Funding	36	8	$ 194	$ 7,000	$ 1,000	$ 1,000	$ 9,000
P8709	Small Mains	Available Funding	713	8	$ 194	$ 138,000	$ 28,000	$ 25,000	$ 191,000
P8843	Small Mains	Available Funding	515	8	$ 194	$ 100,000	$ 20,000	$ 18,000	$ 138,000
P9541	Small Mains	Available Funding	376	8	$ 194	$ 73,000	$ 15,000	$ 13,000	$ 101,000
P10157	Small Mains	Available Funding	32	8	$ 194	$ 6,000	$ 1,000	$ 1,000	$ 8,000
P10593	Small Mains	Available Funding	154	8	$ 194	$ 30,000	$ 6,000	$ 5,000	$ 41,000
P10655	Small Mains	Available Funding	77	8	$ 194	$ 15,000	$ 3,000	$ 3,000	$ 21,000
P10815	Small Mains	Available Funding	43	8	$ 194	$ 8,000	$ 2,000	$ 2,000	$ 12,000
P11823	Small Mains	Available Funding	1,810	8	$ 194	$ 351,000	$ 70,000	$ 63,000	$ 484,000
P12701	Small Mains	Available Funding	101	8	$ 194	$ 20,000	$ 4,000	$ 4,000	$ 28,000
P14001	Small Mains	Available Funding	80	8	$ 194	$ 15,000	$ 3,000	$ 3,000	$ 21,000
								Total	$ 6,211,000

Table 10-4
Opinion of Probable Construction Costs - Fire Flow Capital Improvements

CIP ID	Improvement Type	Planning Period	Length (ft)	Diameter (in)	Unit Cost ($/LF)	Construction	Contingency	Engineering	Total OPCC	Comments
P957	Fire	Available Funding	120	8	$ 590	$ 71,000	$ 14,000	$ 13,000	$ 98,000	Railroad Crossing
P1039	Fire	Available Funding	481	8	$ 194	$ 93,000	$ 19,000	$ 17,000	$ 129,000	
P14839	Fire	Available Funding	369	8	$ 194	$ 72,000	$ 14,000	$ 13,000	$ 99,000	
P14831	Fire	Available Funding	332	8	$ 194	$ 64,000	$ 13,000	$ 12,000	$ 89,000	
P1287	Fire	Available Funding	547	8	$ 194	$ 106,000	$ 21,000	$ 19,000	$ 146,000	
P14841	Fire	Available Funding	61	8	$ 194	$ 12,000	$ 2,000	$ 2,000	$ 16,000	
P14857	Fire	Available Funding	145	8	$ 194	$ 28,000	$ 6,000	$ 5,000	$ 39,000	
P14843	Fire	Available Funding	185	8	$ 194	$ 36,000	$ 7,000	$ 6,000	$ 49,000	
P2085	Fire	Available Funding	724	8	$ 194	$ 140,000	$ 28,000	$ 25,000	$ 193,000	
P1797	Fire	Available Funding	173	8	$ 194	$ 34,000	$ 7,000	$ 6,000	$ 47,000	
P1979	Fire	Available Funding	606	8	$ 194	$ 118,000	$ 24,000	$ 21,000	$ 163,000	
P2025	Fire	Available Funding	427	8	$ 194	$ 83,000	$ 17,000	$ 15,000	$ 115,000	
P2039	Fire	Available Funding	629	8	$ 194	$ 122,000	$ 24,000	$ 22,000	$ 168,000	
P1587	Fire	Available Funding	511	8	$ 194	$ 99,000	$ 20,000	$ 18,000	$ 137,000	
P2135	Fire	Available Funding	128	8	$ 194	$ 25,000	$ 5,000	$ 5,000	$ 35,000	
P2371	Fire	Available Funding	555	8	$ 194	$ 108,000	$ 22,000	$ 20,000	$ 150,000	
P2759	Fire	Available Funding	255	8	$ 194	$ 50,000	$ 10,000	$ 9,000	$ 69,000	
P2853	Fire	Available Funding	221	8	$ 194	$ 43,000	$ 9,000	$ 8,000	$ 60,000	
P2931	Fire	Available Funding	225	8	$ 194	$ 44,000	$ 9,000	$ 8,000	$ 61,000	
P3011	Fire	Available Funding	679	8	$ 194	$ 132,000	$ 26,000	$ 24,000	$ 182,000	
P4627	Fire	Available Funding	499	8	$ 194	$ 97,000	$ 19,000	$ 17,000	$ 133,000	
P1423	Fire	Available Funding	575	8	$ 194	$ 111,000	$ 22,000	$ 20,000	$ 153,000	
P7117	Fire	Available Funding	521	8	$ 194	$ 101,000	$ 20,000	$ 18,000	$ 139,000	
P1339	Fire	Available Funding	317	8	$ 194	$ 62,000	$ 12,000	$ 11,000	$ 85,000	
P13627	Fire	Available Funding	657	8	$ 194	$ 127,000	$ 25,000	$ 23,000	$ 175,000	
P8299	Fire	Available Funding	822	8	$ 194	$ 159,000	$ 32,000	$ 29,000	$ 220,000	
P8303	Fire	Available Funding	53	8	$ 194	$ 10,000	$ 2,000	$ 2,000	$ 14,000	
P8305	Fire	Available Funding	1,501	8	$ 194	$ 291,000	$ 58,000	$ 52,000	$ 401,000	
P8341	Fire	Available Funding	443	8	$ 194	$ 86,000	$ 17,000	$ 15,000	$ 118,000	
P11237	Fire	Available Funding	474	8	$ 194	$ 92,000	$ 18,000	$ 17,000	$ 127,000	
P11367	Fire	Available Funding	1,290	8	$ 194	$ 250,000	$ 50,000	$ 45,000	$ 345,000	
P14767	Fire	Available Funding	145	8	$ 194	$ 28,000	$ 6,000	$ 5,000	$ 39,000	
P14819	Fire	Available Funding	190	8	$ 194	$ 37,000	$ 7,000	$ 7,000	$ 51,000	
P14823	Fire	Available Funding	376	8	$ 194	$ 73,000	$ 15,000	$ 13,000	$ 101,000	
P14825	Fire	Available Funding	327	8	$ 194	$ 63,000	$ 13,000	$ 11,000	$ 87,000	
P14827	Fire	Available Funding	593	8	$ 194	$ 115,000	$ 23,000	$ 21,000	$ 159,000	
P14829	Fire	Available Funding	707	8	$ 194	$ 137,000	$ 27,000	$ 25,000	$ 189,000	
P1225	Fire	Available Funding	2,691	8	$ 194	$ 522,000	$ 104,000	$ 94,000	$ 720,000	
P14835	Fire	Available Funding	324	8	$ 194	$ 63,000	$ 13,000	$ 11,000	$ 87,000	
P14837	Fire	Available Funding	87	8	$ 194	$ 17,000	$ 3,000	$ 3,000	$ 23,000	
P14851	Fire	Available Funding	426	8	$ 194	$ 83,000	$ 17,000	$ 15,000	$ 115,000	
P6919	Fire	Available Funding	522	8	$ 194	$ 101,000	$ 20,000	$ 18,000	$ 139,000	
P14845	Fire	Available Funding	374	8	$ 194	$ 73,000	$ 15,000	$ 13,000	$ 101,000	
P14847	Fire	Available Funding	319	8	$ 194	$ 62,000	$ 12,000	$ 11,000	$ 85,000	
P14849	Fire	Available Funding	569	8	$ 194	$ 110,000	$ 22,000	$ 20,000	$ 152,000	
P937	Fire	Available Funding	517	12	$ 169	$ 87,000	$ 17,000	$ 16,000	$ 120,000	
P1203	Fire	Available Funding	957	12	$ 169	$ 162,000	$ 32,000	$ 29,000	$ 223,000	
P14861	Fire	Available Funding	102	12	$ 590	$ 60,000	$ 12,000	$ 11,000	$ 83,000	Railroad Crossing
P14859	Fire	Available Funding	946	12	$ 169	$ 160,000	$ 32,000	$ 29,000	$ 221,000	
P4335	Fire	Available Funding	237	12	$ 169	$ 40,000	$ 8,000	$ 7,000	$ 55,000	
P991	Fire	Available Funding	119	12	$ 169	$ 20,000	$ 4,000	$ 4,000	$ 28,000	
								Total	$ 6,733,000	

Table 10-5
Opinion of Probable Construction Costs - 2030 Capital Improvements

CIP ID	Location	Improvement Type	Planning Period	Length (ft)	Diameter (in)	Unit Cost ($/LF)	Construction	Contingency	Engineering	Total OPCC	Comments
P14811	Clinton WTP Transmission-1	Hydraulic	2030	3,187	24	$ 445	$ 1,418,000	$ 284,000	$ 255,000	$ 1,957,000	
P14813	Clinton WTP Transmission-2	Hydraulic	2030	2,164	24	$ 445	$ 963,000	$ 193,000	$ 173,000	$ 1,329,000	
P14167	SE Lawrence	Redundancy-Resiliency	2030	1,698	16	$ 385	$ 654,000	$ 131,000	$ 118,000	$ 903,000	
P14175	SE Lawrence	Redundancy-Resiliency	2030	2,976	16	$ 385	$ 1,146,000	$ 229,000	$ 206,000	$ 1,581,000	
P14187	SE Lawrence	Redundancy-Resiliency	2030	2,430	16	$ 385	$ 936,000	$ 187,000	$ 168,000	$ 1,291,000	
P14197	SE Lawrence	Redundancy-Resiliency	2030	276	16	$ 385	$ 106,000	$ 21,000	$ 19,000	$ 146,000	
P14203	SE Lawrence	Redundancy-Resiliency	2030	2,649	16	$ 385	$ 1,020,000	$ 204,000	$ 184,000	$ 1,408,000	
P14235	SE Lawrence	Redundancy-Resiliency	2030	2,946	16	$ 385	$ 1,134,000	$ 227,000	$ 204,000	$ 1,565,000	
P14737	SE Lawrence	Redundancy-Resiliency	2030	5,621	16	$ 385	$ 2,164,000	$ 433,000	$ 390,000	$ 2,987,000	
P14165	SE Lawrence	Development	2030	2,621	8	$ 116	$ 304,000	$ 61,000	$ 55,000	$ 420,000	
P14173	SE Lawrence	Development	2030	2,631	8	$ 116	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14263	SE Lawrence	Development	2030	2,782	8	$ 116	$ 323,000	$ 65,000	$ 58,000	$ 446,000	
P14181	SE Lawrence	Development	2030	2,366	8	$ 116	$ 274,000	$ 55,000	$ 49,000	$ 378,000	
P14185	SE Lawrence	Development	2030	2,417	8	$ 116	$ 280,000	$ 56,000	$ 50,000	$ 386,000	
P14257	SE Lawrence	Development	2030	2,573	8	$ 116	$ 298,000	$ 60,000	$ 54,000	$ 412,000	
P14253	SE Lawrence	Development	2030	2,480	8	$ 116	$ 288,000	$ 58,000	$ 52,000	$ 398,000	
P14205	SE Lawrence	Development	2030	2,648	8	$ 116	$ 307,000	$ 61,000	$ 55,000	$ 423,000	
P14233	SE Lawrence	Development	2030	2,639	8	$ 116	$ 306,000	$ 61,000	$ 55,000	$ 422,000	
P14231	SE Lawrence	Development	2030	2,694	8	$ 116	$ 312,000	$ 62,000	$ 56,000	$ 430,000	
P14229	SE Lawrence	Development	2030	2,613	8	$ 116	$ 303,000	$ 61,000	$ 55,000	$ 419,000	
P14215	SE Lawrence	Development	2030	2,624	8	$ 116	$ 304,000	$ 61,000	$ 55,000	$ 420,000	
P14217	SE Lawrence	Development	2030	2,715	8	$ 116	$ 315,000	$ 63,000	$ 57,000	$ 435,000	
P14227	SE Lawrence	Development	2030	2,627	8	$ 116	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14221	SE Lawrence	Development	2030	2,611	8	$ 116	$ 303,000	$ 61,000	$ 55,000	$ 419,000	
P14223	SE Lawrence	Development	2030	2,622	8	$ 116	$ 304,000	$ 61,000	$ 55,000	$ 420,000	
P14225	SE Lawrence	Development	2030	2,592	12	$ 169	$ 438,000	$ 88,000	$ 79,000	$ 605,000	
P14219	SE Lawrence	Development	2030	2,664	12	$ 169	$ 450,000	$ 90,000	$ 81,000	$ 621,000	
P14213	SE Lawrence	Development	2030	2,636	12	$ 169	$ 446,000	$ 89,000	$ 80,000	$ 615,000	
P14211	SE Lawrence	Development	2030	2,686	12	$ 169	$ 454,000	$ 91,000	$ 82,000	$ 627,000	
P14209	SE Lawrence	Development	2030	2,533	12	$ 169	$ 428,000	$ 86,000	$ 77,000	$ 591,000	
P14245	SE Lawrence	Development	2030	2,261	12	$ 169	$ 382,000	$ 76,000	$ 69,000	$ 527,000	
P14247	SE Lawrence	Development	2030	3,148	12	$ 169	$ 532,000	$ 106,000	$ 96,000	$ 734,000	
P14191	SE Lawrence	Development	2030	1,433	12	$ 169	$ 242,000	$ 48,000	$ 44,000	$ 334,000	
P14255	SE Lawrence	Development	2030	2,643	12	$ 169	$ 447,000	$ 89,000	$ 80,000	$ 616,000	
P14189	SE Lawrence	Redundancy-Resiliency	2030	924	12	$ 590	$ 545,000	$ 109,000	$ 98,000	$ 752,000	Highway Crossing
P14179	SE Lawrence	Development	2030	2,658	12	$ 169	$ 449,000	$ 90,000	$ 81,000	$ 620,000	
P14735	SE Lawrence	Development	2030	631	12	$ 590	$ 372,000	$ 74,000	$ 67,000	$ 513,000	Highway Crossing
P14271	East Lawrence	Development	2030	947	8	$ 116	$ 110,000	$ 22,000	$ 20,000	$ 152,000	
P14397	East Lawrence	Development	2030	2,303	8	$ 116	$ 267,000	$ 53,000	$ 48,000	$ 368,000	
P14277	East Lawrence	Development	2030	2,651	8	$ 116	$ 307,000	$ 61,000	$ 55,000	$ 423,000	
P14279	East Lawrence	Development	2030	2,601	8	$ 116	$ 302,000	$ 60,000	$ 54,000	$ 416,000	
P14281	East Lawrence	Development	2030	2,628	8	$ 116	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14391	East Lawrence	Development	2030	1,814	8	$ 116	$ 210,000	$ 42,000	$ 38,000	$ 290,000	
P14385	East Lawrence	Development	2030	1,387	8	$ 116	$ 161,000	$ 32,000	$ 29,000	$ 222,000	
P14383	East Lawrence	Development	2030	2,007	8	$ 116	$ 233,000	$ 47,000	$ 42,000	$ 322,000	
P14431	East Lawrence	Development	2030	777	8	$ 116	$ 90,000	$ 18,000	$ 16,000	$ 124,000	
P14379	East Lawrence	Development	2030	1,652	12	$ 169	$ 279,000	$ 56,000	$ 50,000	$ 385,000	
P14387	East Lawrence	Development	2030	508	12	$ 169	$ 86,000	$ 17,000	$ 15,000	$ 118,000	
P14389	East Lawrence	Development	2030	1,037	12	$ 169	$ 175,000	$ 35,000	$ 32,000	$ 242,000	
P14283	East Lawrence	Development	2030	2,603	12	$ 169	$ 440,000	$ 88,000	$ 79,000	$ 607,000	
P14393	East Lawrence	Development	2030	1,832	12	$ 169	$ 310,000	$ 62,000	$ 56,000	$ 428,000	
P14395	East Lawrence	Development	2030	1,605	12	$ 169	$ 271,000	$ 54,000	$ 49,000	$ 374,000	
P14275	East Lawrence	Development	2030	2,651	12	$ 169	$ 448,000	$ 90,000	$ 81,000	$ 619,000	
P14381	East Lawrence	Development	2030	1,200	12	$ 169	$ 203,000	$ 41,000	$ 37,000	$ 281,000	
P14403	NE Lawrence	Development	2030	1,630	8	$ 116	$ 189,000	$ 38,000	$ 34,000	$ 261,000	
P14423	NE Lawrence	Development	2030	213	8	$ 590	$ 125,000	$ 25,000	$ 23,000	$ 173,000	Railroad Crossing
P14407	NE Lawrence	Development	2030	2,644	8	$ 116	$ 307,000	$ 61,000	$ 55,000	$ 423,000	
P14421	NE Lawrence	Development	2030	1,228	8	$ 116	$ 142,000	$ 28,000	$ 26,000	$ 196,000	
P14415	NE Lawrence	Development	2030	2,660	8	$ 116	$ 309,000	$ 62,000	$ 56,000	$ 427,000	
P14425	NE Lawrence	Development	2030	1,641	8	$ 116	$ 190,000	$ 38,000	$ 34,000	$ 262,000	
P14409	NE Lawrence	Development	2030	2,698	12	$ 169	$ 456,000	$ 91,000	$ 82,000	$ 629,000	
P14405	NE Lawrence	Development	2030	1,347	12	$ 169	$ 228,000	$ 46,000	$ 41,000	$ 315,000	
P14413	NE Lawrence	Development	2030	2,157	12	$ 169	$ 365,000	$ 73,000	$ 66,000	$ 504,000	
P14411	NE Lawrence	Development	2030	534	12	$ 169	$ 90,000	$ 18,000	$ 16,000	$ 124,000	
P14433	NW Lawrence	Development	2030	2,279	8	$ 116	$ 264,000	$ 53,000	$ 48,000	$ 365,000	
P14491	NW Lawrence	Development	2030	2,428	8	$ 116	$ 282,000	$ 56,000	$ 51,000	$ 389,000	

Table 10-5
Opinion of Probable Construction Costs - 2030 Capital Improvements

CIP ID	Location	Improvement Type	Planning Period	Length (ft)	Diameter (in)	Unit Cost ($/LF)	Construction	Contingency	Engineering	Total OPCC	Comments
P14485	NW Lawrence	Development	2030	1,791	8	$ 116	$ 208,000	$ 42,000	$ 38,000	$ 288,000	
P14479	NW Lawrence	Development	2030	1,289	8	$ 116	$ 150,000	$ 30,000	$ 27,000	$ 207,000	
P14441	NW Lawrence	Development	2030	2,789	8	$ 116	$ 323,000	$ 65,000	$ 58,000	$ 446,000	
P14443	NW Lawrence	Development	2030	2,022	8	$ 116	$ 235,000	$ 47,000	$ 42,000	$ 324,000	
P14469	NW Lawrence	Development	2030	2,787	8	$ 116	$ 323,000	$ 65,000	$ 58,000	$ 446,000	
P14459	NW Lawrence	Development	2030	2,770	8	$ 116	$ 321,000	$ 64,000	$ 58,000	$ 443,000	
P14451	NW Lawrence	Development	2030	2,026	12	$ 169	$ 342,000	$ 68,000	$ 62,000	$ 472,000	
P14455	NW Lawrence	Development	2030	958	12	$ 169	$ 162,000	$ 32,000	$ 29,000	$ 223,000	
P14457	NW Lawrence	Development	2030	2,739	12	$ 169	$ 463,000	$ 93,000	$ 83,000	$ 639,000	
P14449	NW Lawrence	Development	2030	808	12	$ 169	$ 137,000	$ 27,000	$ 25,000	$ 189,000	
P14465	NW Lawrence	Development	2030	1,514	12	$ 169	$ 256,000	$ 51,000	$ 46,000	$ 353,000	
P14445	NW Lawrence	Development	2030	2,706	12	$ 169	$ 457,000	$ 91,000	$ 82,000	$ 630,000	
P14471	NW Lawrence	Development	2030	1,822	12	$ 169	$ 308,000	$ 62,000	$ 56,000	$ 426,000	
P14473	NW Lawrence	Development	2030	2,640	12	$ 169	$ 446,000	$ 89,000	$ 80,000	$ 615,000	
P14475	NW Lawrence	Development	2030	2,776	12	$ 169	$ 469,000	$ 94,000	$ 84,000	$ 647,000	
P14439	NW Lawrence	Development	2030	1,690	12	$ 169	$ 286,000	$ 57,000	$ 51,000	$ 394,000	
P14437	NW Lawrence	Development	2030	345	12	$ 169	$ 58,000	$ 12,000	$ 11,000	$ 81,000	
P14489	NW Lawrence	Development	2030	1,082	12	$ 169	$ 183,000	$ 37,000	$ 33,000	$ 253,000	
P14435	NW Lawrence	Development	2030	3,160	12	$ 169	$ 534,000	$ 107,000	$ 96,000	$ 737,000	
P14493	NW Lawrence	Development	2030	2,504	12	$ 169	$ 423,000	$ 85,000	$ 76,000	$ 584,000	
P14665	West Lawrence	Development	2030	2,630	8	$ 116	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14657	West Lawrence	Development	2030	1,275	8	$ 116	$ 148,000	$ 30,000	$ 27,000	$ 205,000	
P14573	West Lawrence	Development	2030	2,817	8	$ 116	$ 327,000	$ 65,000	$ 59,000	$ 451,000	
P14569	West Lawrence	Development	2030	2,203	8	$ 116	$ 256,000	$ 51,000	$ 46,000	$ 353,000	
P14507	West Lawrence	Development	2030	1,680	8	$ 116	$ 195,000	$ 39,000	$ 35,000	$ 269,000	
P14559	West Lawrence	Development	2030	1,388	8	$ 116	$ 161,000	$ 32,000	$ 29,000	$ 222,000	
P14521	West Lawrence	Development	2030	2,581	8	$ 116	$ 299,000	$ 60,000	$ 54,000	$ 413,000	
P14523	West Lawrence	Development	2030	2,633	8	$ 116	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14525	West Lawrence	Development	2030	2,692	8	$ 116	$ 312,000	$ 62,000	$ 56,000	$ 430,000	
P14557	West Lawrence	Development	2030	2,625	8	$ 116	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14529	West Lawrence	Development	2030	2,183	8	$ 116	$ 253,000	$ 51,000	$ 46,000	$ 350,000	
P14531	West Lawrence	Development	2030	2,183	8	$ 116	$ 253,000	$ 51,000	$ 46,000	$ 350,000	
P14555	West Lawrence	Development	2030	1,357	8	$ 116	$ 157,000	$ 31,000	$ 28,000	$ 216,000	
P14551	West Lawrence	Development	2030	2,772	8	$ 116	$ 322,000	$ 64,000	$ 58,000	$ 444,000	
P14547	West Lawrence	Development	2030	2,634	8	$ 116	$ 306,000	$ 61,000	$ 55,000	$ 422,000	
P14661	West Lawrence	Development	2030	3,348	8	$ 116	$ 388,000	$ 78,000	$ 70,000	$ 536,000	
P14545	West Lawrence	Development	2030	2,622	8	$ 116	$ 304,000	$ 61,000	$ 55,000	$ 420,000	
P14543	West Lawrence	Development	2030	2,680	12	$ 169	$ 453,000	$ 91,000	$ 82,000	$ 626,000	
P14541	West Lawrence	Development	2030	1,143	12	$ 169	$ 193,000	$ 39,000	$ 35,000	$ 267,000	
P14537	West Lawrence	Development	2030	2,601	12	$ 169	$ 440,000	$ 88,000	$ 79,000	$ 607,000	
P14535	West Lawrence	Development	2030	2,684	12	$ 169	$ 454,000	$ 91,000	$ 82,000	$ 627,000	
P14533	West Lawrence	Development	2030	1,072	12	$ 169	$ 181,000	$ 36,000	$ 33,000	$ 250,000	
P14527	West Lawrence	Development	2030	2,634	12	$ 169	$ 445,000	$ 89,000	$ 80,000	$ 614,000	
P14517	West Lawrence	Development	2030	1,545	12	$ 169	$ 261,000	$ 52,000	$ 47,000	$ 360,000	
P14505	West Lawrence	Development	2030	777	12	$ 169	$ 131,000	$ 26,000	$ 24,000	$ 181,000	
P14571	West Lawrence	Development	2030	1,236	12	$ 169	$ 209,000	$ 42,000	$ 38,000	$ 289,000	
P14503	West Lawrence	Development	2030	1,065	12	$ 169	$ 180,000	$ 36,000	$ 32,000	$ 248,000	
P14587	West Lawrence	Development	2030	2,662	12	$ 169	$ 450,000	$ 90,000	$ 81,000	$ 621,000	
P14501	West Lawrence	Development	2030	1,641	12	$ 169	$ 277,000	$ 55,000	$ 50,000	$ 382,000	
P14539	West Lawrence	Development	2030	2,637	12	$ 169	$ 446,000	$ 89,000	$ 80,000	$ 615,000	
P14663	West Lawrence	Development	2030	2,000	12	$ 169	$ 338,000	$ 68,000	$ 61,000	$ 467,000	
P14495	West Lawrence	Development	2030	1,987	12	$ 169	$ 336,000	$ 67,000	$ 60,000	$ 463,000	
P14509	West Lawrence	Development	2030	505	12	$ 605	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14519	West Lawrence	Development	2030	381	12	$ 590	$ 225,000	$ 45,000	$ 41,000	$ 311,000	
P14549	West Lawrence	Development	2030	290	12	$ 590	$ 171,000	$ 34,000	$ 31,000	$ 236,000	
									Total	$ 59,178,000	

Table 10-6
Opinion of Probable Construction Costs - 2040 Capital Improvements

CIP ID	Location	Improvement Type	Planning Period	Length (ft)	Diameter (in)	Unit Cost ($/LF)	Construction	Contingency	Engineering	Total OPCC	Comments
P14669	East Lawrence	Development	2040	1,019	8	$ 116	$ 118,000	$ 24,000	$ 21,000	$ 163,000	
P14369	East Lawrence	Development	2040	2,649	8	$ 116	$ 307,000	$ 61,000	$ 55,000	$ 423,000	
P14367	East Lawrence	Development	2040	3,002	8	$ 116	$ 348,000	$ 70,000	$ 63,000	$ 481,000	
P14363	East Lawrence	Development	2040	2,626	8	$ 116	$ 305,000	$ 61,000	$ 55,000	$ 421,000	
P14309	East Lawrence	Development	2040	2,688	8	$ 116	$ 312,000	$ 62,000	$ 56,000	$ 430,000	
P14311	East Lawrence	Development	2040	1,423	8	$ 116	$ 165,000	$ 33,000	$ 30,000	$ 228,000	
P14317	East Lawrence	Development	2040	2,558	8	$ 116	$ 297,000	$ 59,000	$ 53,000	$ 409,000	
P14319	East Lawrence	Development	2040	1,351	8	$ 116	$ 157,000	$ 31,000	$ 28,000	$ 216,000	
P14321	East Lawrence	Development	2040	2,770	8	$ 116	$ 321,000	$ 64,000	$ 58,000	$ 443,000	
P14361	East Lawrence	Development	2040	2,853	8	$ 116	$ 331,000	$ 66,000	$ 60,000	$ 457,000	
P14359	East Lawrence	Development	2040	2,280	8	$ 116	$ 265,000	$ 53,000	$ 48,000	$ 366,000	
P14329	East Lawrence	Development	2040	1,042	8	$ 116	$ 121,000	$ 24,000	$ 22,000	$ 167,000	
P14331	East Lawrence	Development	2040	3,545	8	$ 116	$ 411,000	$ 82,000	$ 74,000	$ 567,000	
P14357	East Lawrence	Development	2040	2,721	8	$ 116	$ 316,000	$ 63,000	$ 57,000	$ 436,000	
P14335	East Lawrence	Development	2040	2,334	8	$ 116	$ 271,000	$ 54,000	$ 49,000	$ 374,000	
P14337	East Lawrence	Development	2040	2,667	8	$ 116	$ 309,000	$ 62,000	$ 56,000	$ 427,000	
P14371	East Lawrence	Development	2040	2,566	8	$ 116	$ 298,000	$ 60,000	$ 54,000	$ 412,000	
P14355	East Lawrence	Development	2040	2,694	8	$ 116	$ 312,000	$ 62,000	$ 56,000	$ 430,000	
P14343	East Lawrence	Development	2040	2,888	8	$ 116	$ 335,000	$ 67,000	$ 60,000	$ 462,000	
P14345	East Lawrence	Development	2040	2,859	8	$ 116	$ 332,000	$ 66,000	$ 60,000	$ 458,000	
P14347	East Lawrence	Development	2040	2,349	8	$ 116	$ 272,000	$ 54,000	$ 49,000	$ 375,000	
P14349	East Lawrence	Development	2040	2,643	8	$ 116	$ 307,000	$ 61,000	$ 55,000	$ 423,000	
P14353	East Lawrence	Development	2040	2,367	8	$ 116	$ 275,000	$ 55,000	$ 50,000	$ 380,000	
P14351	East Lawrence	Development	2040	2,555	12	$ 169	$ 432,000	$ 86,000	$ 78,000	$ 596,000	
P14341	East Lawrence	Development	2040	2,661	12	$ 169	$ 450,000	$ 90,000	$ 81,000	$ 621,000	
P14333	East Lawrence	Development	2040	2,513	12	$ 169	$ 425,000	$ 85,000	$ 77,000	$ 587,000	
P14327	East Lawrence	Development	2040	688	12	$ 169	$ 116,000	$ 23,000	$ 21,000	$ 160,000	
P14323	East Lawrence	Development	2040	1,233	12	$ 169	$ 208,000	$ 42,000	$ 38,000	$ 288,000	
P14289	East Lawrence	Development	2040	1,775	12	$ 169	$ 300,000	$ 60,000	$ 54,000	$ 414,000	
P14287	East Lawrence	Development	2040	2,640	12	$ 169	$ 446,000	$ 89,000	$ 80,000	$ 615,000	
P14285	East Lawrence	Development	2040	2,362	12	$ 169	$ 399,000	$ 80,000	$ 72,000	$ 551,000	
P14339	East Lawrence	Development	2040	2,407	12	$ 169	$ 407,000	$ 81,000	$ 73,000	$ 561,000	
P14269	East Lawrence	Development	2040	880	12	$ 169	$ 149,000	$ 30,000	$ 27,000	$ 206,000	
P14325	East Lawrence	Development	2040	382	12	$ 590	$ 225,000	$ 45,000	$ 41,000	$ 311,000	Highway Crossing
P14667	East Lawrence	Development	2040	773	12	$ 665	$ 514,000	$ 103,000	$ 93,000	$ 710,000	Highway Crossing
P14601	NW Lawrence	Development	2040	2,696	8	$ 116	$ 313,000	$ 63,000	$ 56,000	$ 432,000	
P14603	NW Lawrence	Development	2040	2,605	8	$ 116	$ 302,000	$ 60,000	$ 54,000	$ 416,000	
P14605	NW Lawrence	Development	2040	2,491	8	$ 116	$ 289,000	$ 58,000	$ 52,000	$ 399,000	
P14653	NW Lawrence	Development	2040	1,445	8	$ 116	$ 168,000	$ 34,000	$ 30,000	$ 232,000	
P14631	NW Lawrence	Development	2040	2,766	8	$ 116	$ 321,000	$ 64,000	$ 58,000	$ 443,000	
P14629	NW Lawrence	Development	2040	1,396	8	$ 116	$ 162,000	$ 32,000	$ 29,000	$ 223,000	
P14627	NW Lawrence	Development	2040	2,615	8	$ 116	$ 303,000	$ 61,000	$ 55,000	$ 419,000	
P14619	NW Lawrence	Development	2040	1,341	8	$ 116	$ 156,000	$ 31,000	$ 28,000	$ 215,000	
P14621	NW Lawrence	Development	2040	2,654	8	$ 116	$ 308,000	$ 62,000	$ 56,000	$ 426,000	
P14625	NW Lawrence	Development	2040	811	12	$ 169	$ 137,000	$ 27,000	$ 25,000	$ 189,000	
P14617	NW Lawrence	Development	2040	1,466	12	$ 169	$ 248,000	$ 50,000	$ 45,000	$ 343,000	
P14615	NW Lawrence	Development	2040	2,088	12	$ 169	$ 353,000	$ 71,000	$ 64,000	$ 488,000	
P14613	NW Lawrence	Development	2040	669	12	$ 169	$ 113,000	$ 23,000	$ 20,000	$ 156,000	
P14633	NW Lawrence	Development	2040	2,756	12	$ 169	$ 466,000	$ 93,000	$ 84,000	$ 643,000	
P14611	NW Lawrence	Development	2040	2,655	12	$ 169	$ 449,000	$ 90,000	$ 81,000	$ 620,000	
P14655	NW Lawrence	Development	2040	2,643	12	$ 169	$ 447,000	$ 89,000	$ 80,000	$ 616,000	
P14623	NW Lawrence	Development	2040	1,360	12	$ 169	$ 230,000	$ 46,000	$ 41,000	$ 317,000	
P14591	NW Lawrence	Development	2040	359	12	$ 590	$ 212,000	$ 42,000	$ 38,000	$ 292,000	Highway Crossing
P14593	NW Lawrence	Development	2040	318	12	$ 590	$ 188,000	$ 38,000	$ 34,000	$ 260,000	Highway Crossing
									Total	$ 21,697,000	

11.0 Storage Tank Condition Assessments

This section of the report discusses the condition assessment of eight storage tanks evaluated as a part of this project that includes recommended maintenance efforts and associated scheduling. The evaluations were conducted by remote operated vehicle (ROV) evaluations for the wet interior areas and physical observations of the exterior conditions. A net present value analysis for rehabilitation cost versus capital improvement cost is included to assist the City's decision on continued storage tank maintenance investment for these aging assets.

11.1 Condition Assessment Summary

The City owns and operates 12 finished water storage tanks of varying size and construction types. Of the 12 storage facilities, 8 were evaluated in this project. The remaining four are recently constructed and/or recently reconditioned. The selected facilities are listed in Table 11-1.

Table 11-1: Storage Tank Assessment Facilities

Facility	Location	Volume (MG)	Type	Year
W 6th Street	6th & Kasold	0.5	Elevated	1967
Kaw WTP Upstairs Clearwell	Kaw WTP	0.6	Underground	1954
Kaw WTP Downstairs Clearwell		0.17	Underground	1917
Kaw WTP Multi-Leg Tower (washwater)		0.075	Elevated	1954
North Oread Reservoir	1220 Oread Ave	0.875	Ground	2017
South Oread Reservoir		0.875	Ground	2017
19th & Kasold Reservoir	1820 Kasold Dr	1.5	Ground	~1969
Stoneridge Tower	6th & Stoneridge Dr	1.0	Elevated	2008

The evaluations were conducted by subconsultants, KLM Engineering, Inc., with ROV evaluations for the wet interior areas and physical observations of the exterior conditions. The condition assessment report for each tank can be found in Appendix D and detail the following:

- The current condition of the interior and exterior of the reservoir.
- For coated reservoirs, a life expectancy estimates of the coatings and/or an estimated
- timeline for coating replacement.
- Structure deficiencies and recommended repairs to bring the reservoir into compliance
- with ACI, AWWA and OSHA requirements.
- Schedule for performing recommended maintenance work.
- Cost estimate for all structure repairs and coating replacement on steel tanks.
- Quantity of sediment and recommend a timeline for clean-out, if warranted.
- Color photographs identifying current conditions and recommended repairs.
- Recommended timeline for future evaluations.

An overview of the recommended maintenance schedule and budgetary estimate for each of the facilities is listed in Table 11-2. Based on the expected remaining life and the extent and cost of the required reconditioning of the W 6th St Tower and the Kaw Washwater Tank, as indicated in Table 11-2, the tanks were further evaluated for full replacement. These facilities are 58 and 71 years old respectively, and both require

extensive rehabilitation including full coating replacements with provisions for handling the existing lead-based coatings, and safety modernizations.

Table 11-2: Recommended Maintenance & Schedule

Facility	Recommended Action	Cost Estimate[1]	Year[2]
W 6th Street	Fully Recondition	$1,015,000	2026
Kaw WTP Upstairs Clearwell	Maintenance	$237,000	2026
Kaw WTP Downstairs Clearwell	Maintenance	$166,000	2029
Kaw WTP Multi-Leg Tower (washwater)	Fully Recondition	$910,000	2026
North Oread Reservoir	Reinspect	$4,500	2029
South Oread Reservoir	Reinspect	$4,500	2029
19th & Kasold Reservoir	Structural Modifications; Interior Spot Repairs	$188,000	2026
Stoneridge Tower	Interior Spot Repairs	$58,000	2029

Notes:

1. Present day estimate based on KLM report estimates for construction plus 20% contingency and 20% engineering of the subtotal construction and contingency.

2. Maintenance and recommendation and year based on KLM inspections during February 2024.

11.2 Net Present Value Analysis

Budget-level construction costs for new tanks were developed with contingency at 20 percent and engineering at 20 percent of the subtotal construction and contingency cost. The net present value analysis for the W 6th St Tower and Kaw Washwater Tank comparing rehabilitation cost and replacement cost for new storage is listed in Tables 11-3 and 11-4 respectively. The rehabilitation cost for W 6th St Tower in Table 11-3 is based on those currently associated with the Harper Tower rehabilitation improvements and, at the City's direction, is applied in the analysis in lieu of the rehabilitation cost listed in Table 11-2.

Table 11-3: W 6th St Tower at 0.5 MG Net Present Value Analysis

NPV Components	Rehabilitate Existing 0.5 MG	New 0.5 MG: with Low End OPCC	New 0.5 MG: with High End OPCC
2025 Rehabilitation or New Construction 2025	$2,000,000	$7,380,000	$9,396,000
NPV of Expenditures	$2,000,000	$7,380,000	$9,396,000
Remaining Value in 2045	$0	($3,072,448)	($3,911,751)
Total NPV	$2,000,000	$4,307,552	$5,484,249

Table 11-4: Kaw WTP Washwater Tank Net Present Value Analysis

NPV Components	Rehabilitate Existing 0.075 MG	New 0.1 MG Washwater Tank
2025 Rehabilitation or New Construction 2025	$936,000	$3,456,000
NPV of Expenditures	$936,000	$3,456,000
Remaining Value in 2045	$0	($1,438,805)
Total NPV	$936,000	$2,017,195

Harper St Tower was not included in the KLM condition assessment efforts as it is currently under contract by the City (with others) for reconditioning. The capital improvement for a new Harper Tower increases the

volume from 0.5 MG to 1.0 MG based on the 2040 water demand projections. The replacement of this tower is included the net present value analysis in Table 11-5 similar to the analyses for W 6th St Tower and Kaw Washwater Tank.

Table 11-5: Harper Tower Net Present Value Analysis

NPV Components	Rehabilitate Existing 0.5 MG[1]	New 1.0 MG: with Low End OPCC	New 1.0 MG: with High End OPCC
2025 Rehabilitation or New Construction 2025	$1,641,500	$9,360,000	$14,400,000
NPV of Expenditures	$1,641,500	$9,360,000	$14,400,000
Remaining Value in 2045	$0	($2,599,933)	($3,999,897)
Total NPV	$1,641,500	$6,760,067	$10,400,103

Notes:

1. Harper rehabilitation cost is actual and provided by City staff.

11.3 Conclusions

As shown in the net present value analyses above, rehabilitation of the existing tanks is the lowest cost option. This is primarily due to the comparison of rehabilitation to the construction of larger volume tanks to provide for additional future storage and operational conditions. Additional comments for these facilities are listed below:

- Harper Tower:
  - The long-term facility plan for Kaw WTP can impact the sizing recommendation for a new Harper Tank; City staff indicated a need/preference for more potable water storage at Kaw WTP. So long as there is emergency power capable of pumping firm capacity into Central Service from Kaw WTP, then a portion of this on-site storage could be allocated to Central Service. This allocation can impact the sizing recommendation for Harper Tower replacement.
  - If long-term facility planning for Kaw WTP is not defined with adequate detail to evaluate alternative Harper Tower replacement sizes before the 2040 planning period, then Harper Tower will be 74 years old; furthermore, the existing Harper Tower is partially submerged, as its overflow elevation is approximately 4 ft lower than the Oread and Kasold ground storage tanks.
- W 6th St Tower:
  - City staff indicated there is no interest in replacing the existing W 6th St Tower with a larger tower at this location. Therefore, the existing tower should be rehabilitated and maintained because the sizing recommendation for the new 2030 West Tower assumes the 0.5 MG capacity is in place throughout the 2040 planning period. The City can reconsider a new tank in this location after the next wave of maintenance improvements (after those detailed herein) are needed. If the fully reconditioned improvements can keep the existing tank in service through 2045 then the W 6th St Tower will be 78 years old.
  - A benefit for consideration of a new tower at this location is the existing W 6th St Tower is partially submerged, as its overflow elevation is approximately 4 ft lower than Stoneridge Tower and Stratford Tower.

Appendix A – ISO Report

Public Protection Classification

(PPC©)

Summary Report

Lawrence Douglas Co Fire and Medical

KANSAS

Prepared by

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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.

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Data Collection and Analysis

ISO has evaluated and classified over 39,000 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

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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.

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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

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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.

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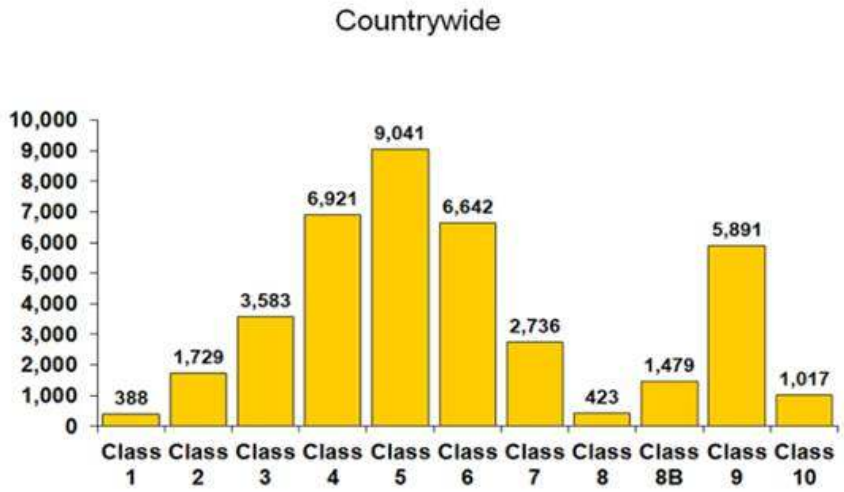
Distribution of PPC Grades

The 2020 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.

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PPC Review

ISO concluded its review of the fire suppression features being provided for Lawrence Douglas Co Fire and Medical. The resulting community classification is **Class 01/1X**.

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	**2.55**	**3**
422. Credit for Telecommunicators	**3.20**	**4**
432. Credit for Dispatch Circuits	**2.85**	**3**
440. Credit for Emergency Communications	**8.60**	**10**
Fire Department		
513. Credit for Engine Companies	**5.96**	**6**
523. Credit for Reserve Pumpers	**0.50**	**0.50**
532. Credit for Pump Capacity	**3.00**	**3**
549. Credit for Ladder Service	**2.67**	**4**
553. Credit for Reserve Ladder and Service Trucks	**0.45**	**0.50**
561. Credit for Deployment Analysis	**6.86**	**10**
571. Credit for Company Personnel	**14.06**	**15**
581. Credit for Training	**9.00**	**9**
730. Credit for Operational Considerations	**2.00**	**2**
590. Credit for Fire Department	**44.50**	**50**
Water Supply		
616. Credit for Supply System	**23.38**	**30**
621. Credit for Hydrants	**2.98**	**3**
631. Credit for Inspection and Flow Testing	**7.00**	**7**
640. Credit for Water Supply	**33.36**	**40**
Divergence	**-1.12**	--
1050. Community Risk Reduction	**5.03**	**5.50**
Total Credit	**90.37**	**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	**2.55**	3
422. Credit for Telecommunicators	**3.20**	4
432. Credit for Dispatch Circuits	**2.85**	3
Item 440. Credit for Emergency Communications:	**8.60**	**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)	**15.00**	**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:	**85.00**	**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. The 2013 Edition of 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 eighty percent of emergency alarm processing shall be completed within 60 seconds and ninety-five percent of alarm processing shall be completed within 106 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.	**0.00**	**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:	**80.00**	**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)” = 2.85 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	**5.96**	6
523. Credit for Reserve Pumpers	**0.50**	0.5
532. Credit for Pumper Capacity	**3.00**	3
549. Credit for Ladder Service	**2.67**	4
553. Credit for Reserve Ladder and Service Trucks	**0.45**	0.5
561. Credit for Deployment Analysis	**6.86**	10
571. Credit for Company Personnel	**14.06**	15
581. Credit for Training	**9.00**	9
730. Credit for Operational Considerations	**2.00**	2
Item 590. Credit for Fire Department:	**44.50**	**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: **5 engine companies**

a) **5 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) **5 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 **5 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)" = 5.96 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)" = 0.50 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)" = 2.67 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)" = 0.45 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)" = 6.86 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 **39.37 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)" = 14.06 points

Item 581 – Credit for Training (9 points)

Training	Earned Credit	Credit Available
A. Facilities, and Use For maximum credit, each firefighter should receive 18 hours per year in structure fire related subjects as outlined in NFPA 1001.	**35.0(**	**35**
B. Company Training For maximum credit, each firefighter should receive 16 hours per month in structure fire related subjects as outlined in NFPA 1001.	**25.00**	**25**
C. Classes for Officers For maximum credit, each officer should be certified in accordance with the general criteria of NFPA 1021. Additionally, each officer should receive 12 hours of continuing education on or off site.	**12.00**	**12**
D. New Driver and Operator Training For maximum credit, each new driver and operator should receive 60 hours of driver/operator training per year in accordance with NFPA 1002 and NFPA 1451.	**5.00**	**5**
E. Existing Driver and Operator Training For maximum credit, each existing driver and operator should receive 12 hours of driver/operator training per year in accordance with NFPA 1002 and NFPA 1451.	**5.00**	**5**
F. Training on Hazardous Materials For maximum credit, each firefighter should receive 6 hours of training for incidents involving hazardous materials in accordance with NFPA 472.	**1.00**	**1**
G. Recruit Training For maximum credit, each firefighter should receive 240 hours of structure fire related training in accordance with NFPA 1001 within the first year of employment or tenure.	**5.00**	**5**
H. Pre-Fire Planning Inspections For maximum credit, pre-fire planning inspections of each commercial, industrial, institutional, and other similar type building (all buildings except 1-4 family dwellings) should be made annually by company members. Records of inspections should include up-to date notes and sketches.	**12.0(**	**12**

Item 580 "Credit for Training (CT)" = 9.00 points

Item 730 – Operational Considerations (2 points)

Item 730 "Credit for Operational Considerations (COC)" evaluates fire department standard operating procedures and incident management systems for emergency operations involving structure fires.

Operational Considerations	Earned Credit	Credit Available
Standard Operating Procedures The department should have established SOPs for fire department general emergency operations	**50**	**50**
Incident Management Systems The department should use an established incident management system (IMS)	**50**	**50**
Operational Considerations total:	**100**	**100**

Item 730 "Credit for Operational Considerations (COC)" = 2.00 points

Water Supply

Forty percent of a community's overall score is based on the adequacy of the water supply system. The ISO field representative evaluated:

- the capability of the water distribution system to meet the Needed Fire Flows at selected locations up to 3,500 gpm.
- size, type and installation of fire hydrants.
- inspection and flow testing of fire hydrants.

	Earned Credit	Credit Available
616. Credit for Supply System	**23.38**	30
621. Credit for Hydrants	**2.98**	3
631. Credit for Inspection and Flow Testing	**7.00**	7
Item 640. Credit for Water Supply:	**33.36**	**40**

Item 616 – Credit for Supply System (30 points)

The first item reviewed is Item 616 "Credit for Supply System (CSS)". This item reviews the rate of flow that can be credited at each of the Needed Fire Flow test locations considering the supply works capacity, the main capacity and the hydrant distribution. The lowest flow rate of these items is credited for each representative location. A water system capable of delivering 250 gpm or more for a period of two hours plus consumption at the maximum daily rate at the fire location is considered minimum in the ISO review.

Where there are 2 or more systems or services distributing water at the same location, credit is given on the basis of the joint protection provided by all systems and services available.

The supply works capacity is calculated for each representative Needed Fire Flow test location, considering a variety of water supply sources. These include public water supplies, emergency supplies (usually accessed from neighboring water systems), suction supplies (usually evidenced by dry hydrant installations near a river, lake or other body of water), and supplies developed by a fire department using large diameter hose or vehicles to shuttle water from a source of supply to a fire site. The result is expressed in gallons per minute (gpm).

The normal ability of the distribution system to deliver Needed Fire Flows at the selected building locations is reviewed. The results of a flow test at a representative test location will indicate the ability of the water mains (or fire department in the case of fire department supplies) to carry water to that location.

The hydrant distribution is reviewed within 1,000 feet of representative test locations measured as hose can be laid by apparatus.

For maximum credit, the Needed Fire Flows should be available at each location in the district. Needed Fire Flows of 2,500 gpm or less should be available for 2 hours; and Needed Fire Flows of 3,000 and 3,500 gpm should be obtainable for 3 hours.

Item 616 "Credit for Supply System (CSS)" = 23.38 points

Item 621 – Credit for Hydrants (3 points)

The second item reviewed is Item 621 "Credit for Hydrants (CH)". This item reviews the number of fire hydrants of each type compared with the total number of hydrants.

There are a total of 3736 hydrants in the graded area.

620. Hydrants, - Size, Type and Installation	Number of Hydrants
A. With a 6 -inch or larger branch and a pumper outlet with or without 2½ -inch outlets	3709
B. With a 6 -inch or larger branch and no pumper outlet but two or more 2½ -inch outlets, or with a small foot valve, or with a small barrel	0
C./D. With only a 2½ -inch outlet or with less than a 6 -inch branch	27
E./F. Flush Type, Cistern, or Suction Point	0

Item 621 "Credit for Hydrants (CH)" = 2.98 points

Item 630 – Credit for Inspection and Flow Testing (7 points)

The third item reviewed is Item 630 "Credit for Inspection and Flow Testing (CIT)". This item reviews the fire hydrant inspection frequency, and the completeness of the inspections. Inspection of hydrants should be in accordance with AWWA M-17, *Installation, Field Testing and Maintenance of Fire Hydrants.*

Frequency of Inspection (FI): Average interval between the 3 most recent inspections.

Frequency	Points
1 year	30
2 years	20
3 years	10
4 years	5
5 years or more	No Credit

Note: The points for inspection frequency are reduced by 10 points if the inspections are incomplete or do not include a flushing program. An additional reduction of 10 points are made if hydrants are not subjected to full system pressure during inspections. If the inspection of cisterns or suction points does not include actual drafting with a pumper, or back-flushing for dry hydrants, 20 points are deducted.

Total points for Inspections = 4.00 points

Frequency of Fire Flow Testing (FF): Average interval between the 3 most recent inspections.

Frequency	Points
5 years	40
6 years	30
7 years	20
8 years	10
9 years	5
10 years or more	No Credit

Total points for Fire Flow Testing = 3.00 points

Item 631 "Credit for Inspection and Fire Flow Testing (CIT)" = 7.00 points

Divergence = -1.12

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.

Community Risk Reduction

	Earned Credit	Credit Available
1025. Credit for Fire Prevention and Code Enforcement (CPCE)	**2.04**	2.2
1033. Credit for Public Fire Safety Education (CFSE)	**1.93**	2.2
1044. Credit for Fire Investigation Programs (CIP)	**1.06**	1.1
Item 1050. Credit for Community Risk Reduction	**5.03**	**5.50**

Item 1025 – Credit for Fire Prevention Code Adoption and Enforcement (2.2 points)	Earned Credit	Credit Available
Fire Prevention Code Regulations (PCR) Evaluation of fire prevention code regulations in effect.	10.00	10
Fire Prevention Staffing (PS) Evaluation of staffing for fire prevention activities.	8.00	8
Fire Prevention Certification and Training (PCT) Evaluation of the certification and training of fire prevention code enforcement personnel.	3.05	6
Fire Prevention Programs (PCP) Evaluation of fire prevention programs.	16.00	16
Review of Fire Prevention Code and Enforcement (CPCE) subtotal:	37.05	40

Item 1033 – Credit for Public Fire Safety Education (2.2 points)	Earned Credit	Credit Available
Public Fire Safety Educators Qualifications and Training (FSQT) Evaluation of public fire safety education personnel training and qualification as specified by the authority having jurisdiction.	10.00	10
Public Fire Safety Education Programs (FSP) Evaluation of programs for public fire safety education.	25.00	30
Review of Public Safety Education Programs (CFSE) subtotal:	35.00	40

Item 1044 – Credit for Fire Investigation Programs (1.1 points)	Earned Credit	Credit Available
Fire Investigation Organization and Staffing (IOS) Evaluation of organization and staffing for fire investigations.	8.00	8
Fire Investigator Certification and Training (IQT) Evaluation of fire investigator certification and training.	5.25	6
Use of National Fire Incident Reporting System (IRS) Evaluation of the use of the National Fire Incident Reporting System (NFIRS) for the 3 years before the evaluation.	6.00	6
Review of Fire Investigation Programs (CIP) subtotal:	19.25	20

Summary of PPC Review

for

Lawrence Douglas Co Fire and Medical

FSRS Item	Earned Credit	Credit Available
Emergency Communications		
414. Credit for Emergency Reporting	**2.55**	**3**
422. Credit for Telecommunicators	**3.20**	**4**
432. Credit for Dispatch Circuits	**2.85**	**3**
440. Credit for Emergency Communications	**8.60**	**10**
Fire Department		
513. Credit for Engine Companies	**5.96**	**6**
523. Credit for Reserve Pumpers	**0.50**	**0.5**
532. Credit for Pumper Capacity	**3.00**	**3**
549. Credit for Ladder Service	**2.67**	**4**
553. Credit for Reserve Ladder and Service Trucks	**0.45**	**0.5**
561. Credit for Deployment Analysis	**6.86**	**10**
571. Credit for Company Personnel	**14.06**	**15**
581. Credit for Training	**9.00**	**9**
730. Credit for Operational Considerations	**2.00**	**2**
590. Credit for Fire Department	**44.50**	**50**
Water Supply		
616. Credit for Supply System	**23.38**	**30**
621. Credit for Hydrants	**2.98**	**3**
631. Credit for Inspection and Flow Testing	**7.00**	**7**
640. Credit for Water Supply	**33.36**	**40**
Divergence	**-1.12**	**--**
1050. Community Risk Reduction	**5.03**	**5.50**
Total Credit	**90.37**	**105.5**

Final Community Classification = 01/1X

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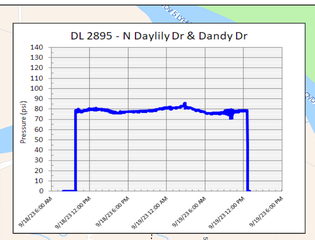
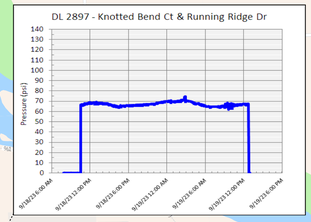
Appendix B – Field Testing Forms

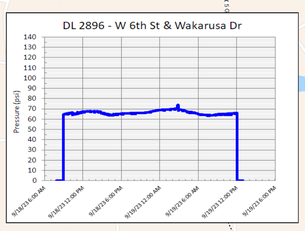
DL 2895 - N Daylily Dr & Dandy Dr



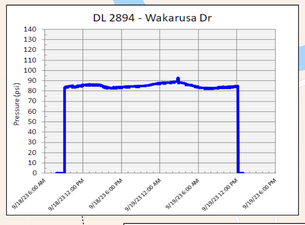
DL 2897 - Knotted Bend Ct & Running Ridge Dr



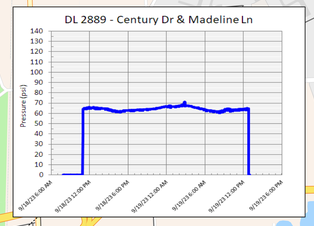
DL 2896 - W 6th St & Wakarusa Dr



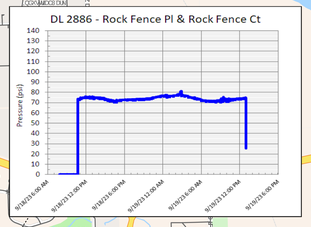
DL 2894 - Wakarusa Dr



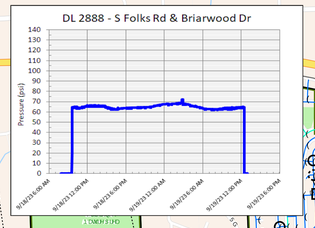
DL 2889 - Century Dr & Madeline Ln



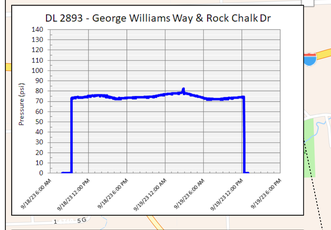
DL 2886 - Rock Fence Pl & Rock Fence Ct



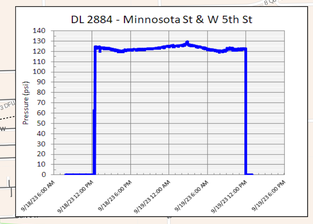
DL 2888 - S Folks Rd & Briarwood Dr



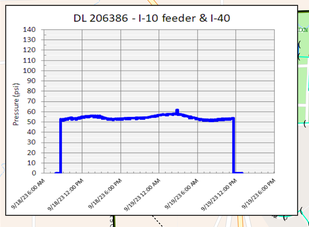
DL 2893 - George Williams Way & Rock Chalk Dr



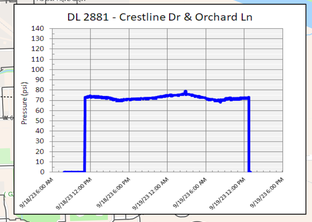
DL 2884 - Minnosota St & W 5th St



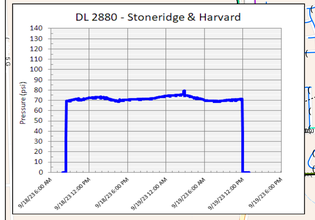
DL 206386 - I-10 feeder & I-40



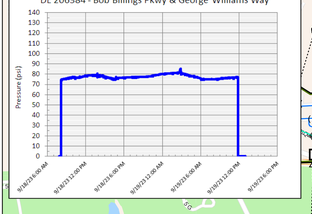
DL 2881 - Crestline Dr & Orchard Ln



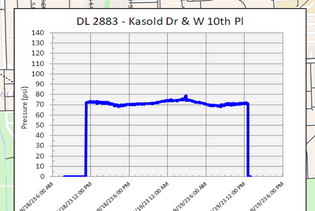
DL 2880 - Stoneridge & Harvard



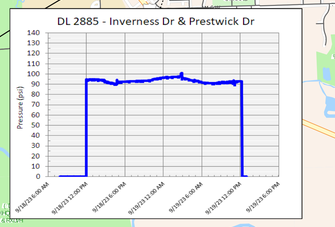
DL 206384 - Bob Billings Pkwy & George Williams Way



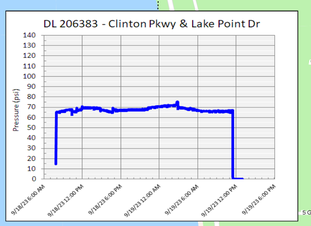
DL 2883 - Kasold Dr & W 10th Pl



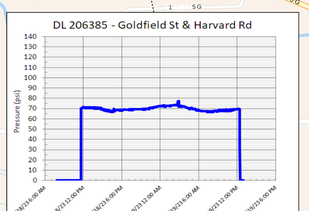
DL 2885 - Inverness Dr & Prestwick Dr



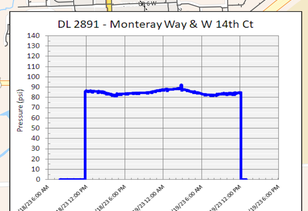
DL 206383 - Clinton Pkwy & Lake Point Dr



DL 206385 - Goldfield St & Harvard Rd



DL 2891 - Monteray Way & W 14th Ct



BREAK HISTORY

6TH ST STORAGE

BREAK HISTOTORY

KAW WTP

STONERIDGE STORAGE

12-INCH BREAK HISTORY

BREAK HISTORY

OREAD STORAGE 2

STRATFORD STORAGE

HARPER STORAGE

KASOLD STORAGE

CLINTON WTP

FIGURE 2: WH PZ
FIELD TEST MAP
DATA LOGGER AND
HYDRANT TEST RESULTS
9/18/23-9/22/23

Lawrence Kansas | BURNS McDONNELL

LEGEND

- HYDRANT A FLOWING
- HYDRANT C RESIDUAL
- DATA LOGGER

/DZUHQFH .6
:DWHU 6\VWHP
:HVW +LOOV 3UHVVXUH

(#) FIRE HYDRANT TEST ID
:HVW +LOOV 3UHVVXUH =RQH
(+\GUDQWV LQ =RQH
Z0DLQV LQ]RQH
'LDPHWHU LQ

3DWK & ?8VHUV?OHUYLFN?2QH'ULYH %XUQV 0F'RQQHOO?3URMHFWV?:$?(5?:DWHUB0RGHO

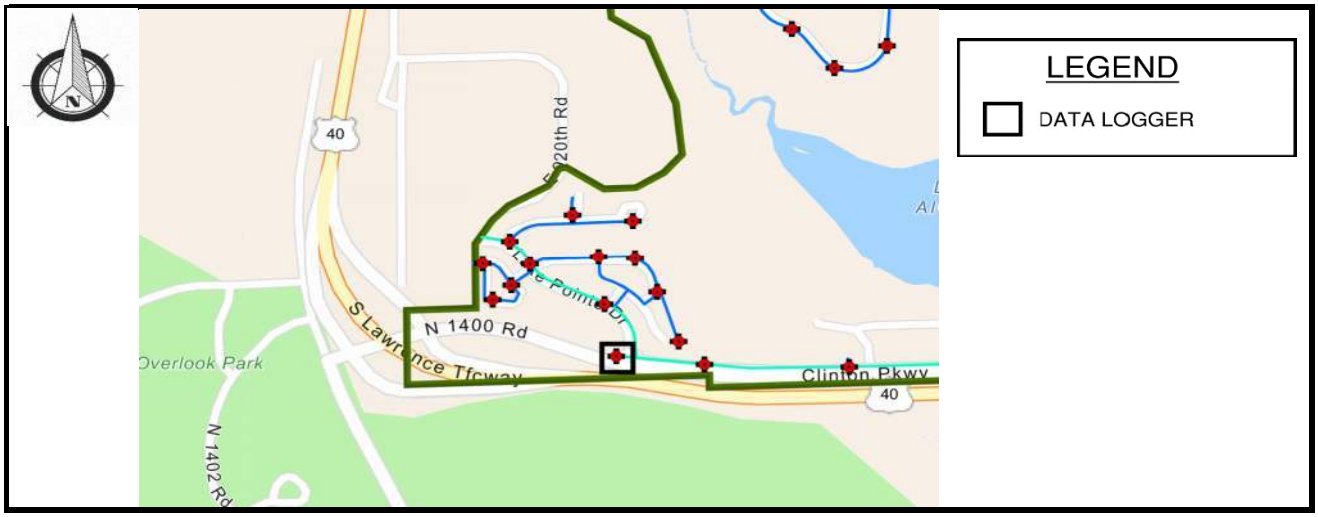
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	206383	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	65	9/18/2023	7:53 AM
Removal:	67	9/19/2023	11:30 AM

Location: Clinton Pkwy & Lake Point Dr

Sketch:



Photos:

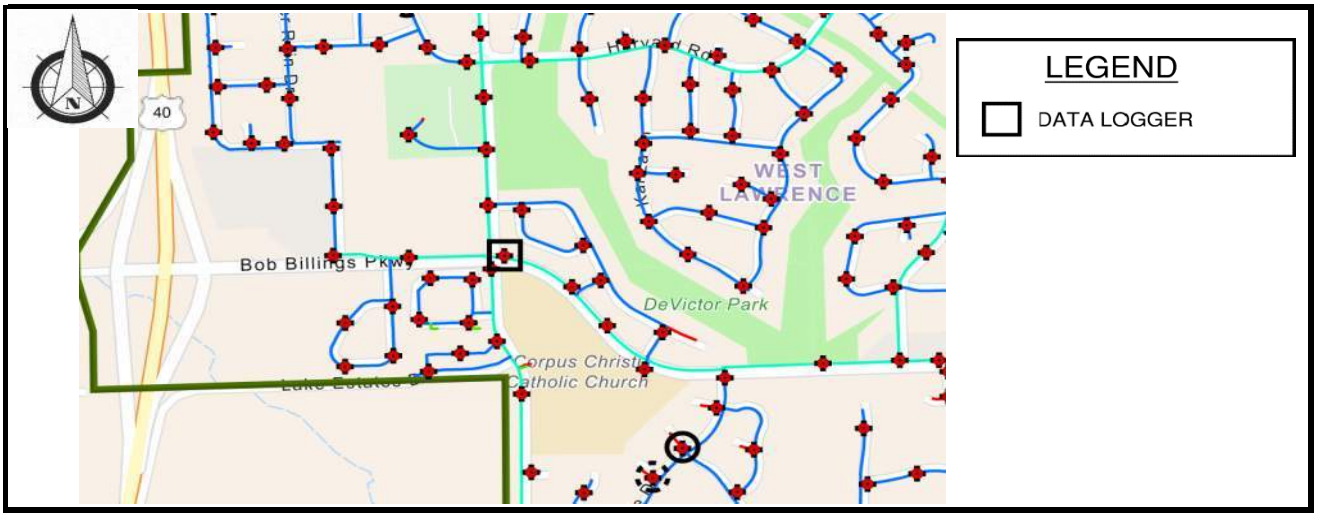
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	206384	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	75	9/18/2023	8:10 AM
Removal:	77	9/19/2023	11:48 AM

Location: Bob Billings Pkwy & George Williams Way

Sketch:



Photos:

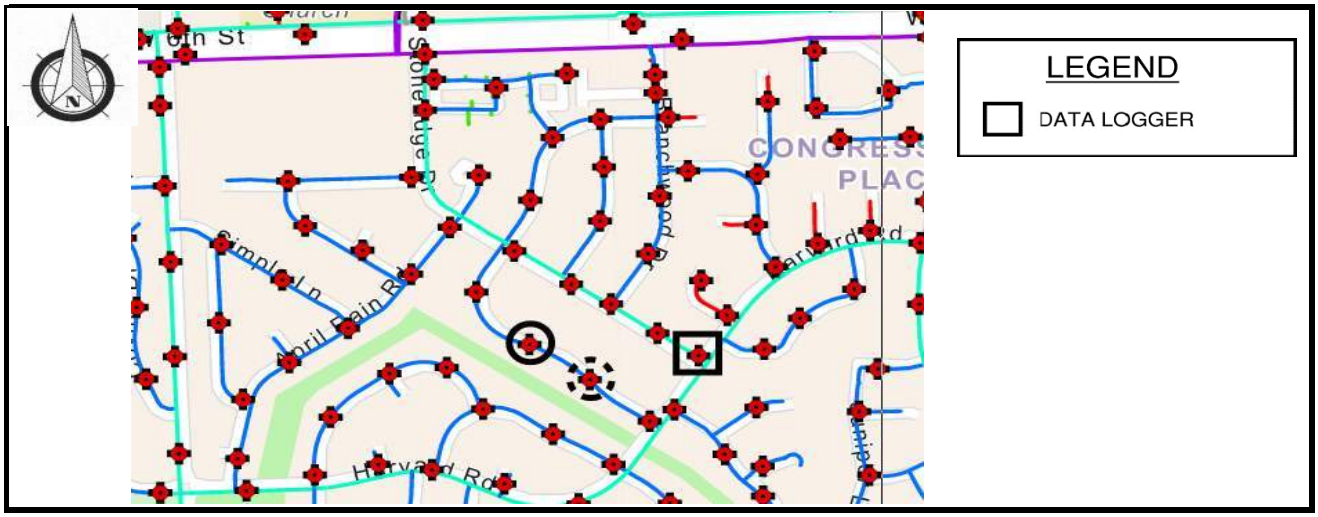
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2880	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	69	9/18/2023	8:24 AM
Removal:	71	9/19/2023	11:57 AM

Location: Stoneridge & Harvard

Sketch:



Photos:

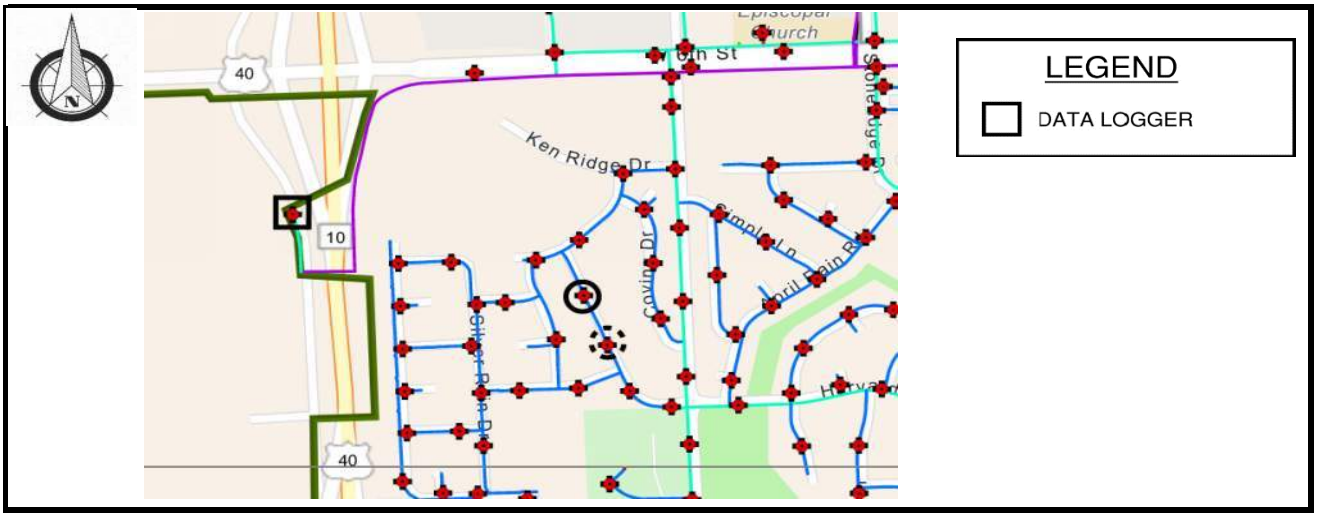
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	206386	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	52	9/18/2023	8:34 AM
Removal:	54	9/19/2023	11:40 AM

Location: I-10 feeder & I-40

Sketch:



Photos:

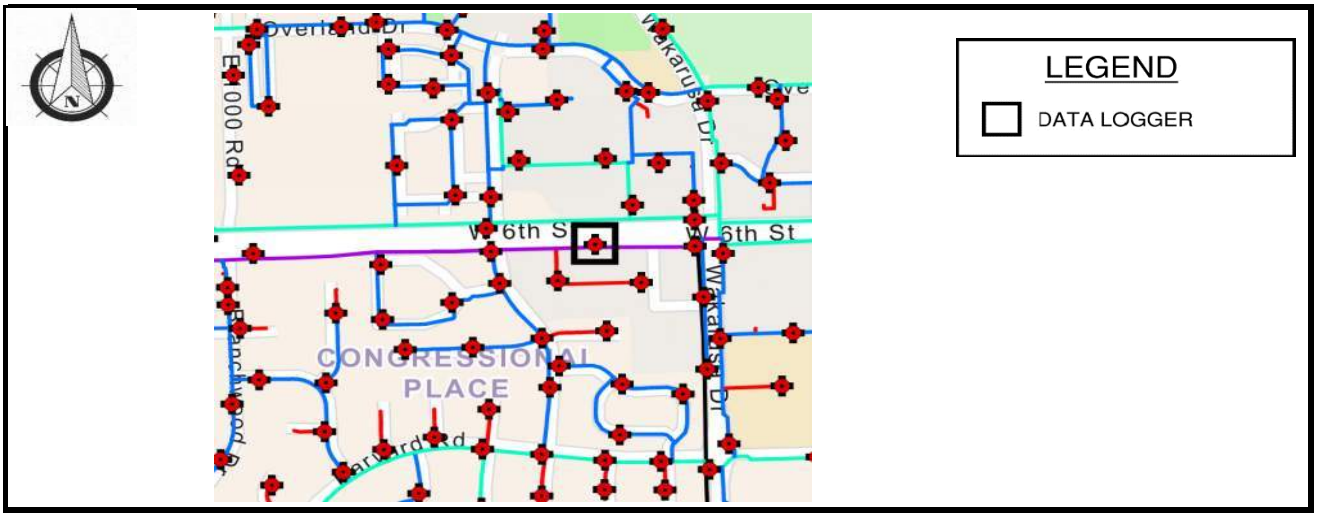
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2896	Main Size:	16"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	65	9/18/2023	8:56 AM
Removal:	66	9/19/2023	12:06 PM

Location: W 6th St & Wakarusa Dr

Sketch:



Photos:

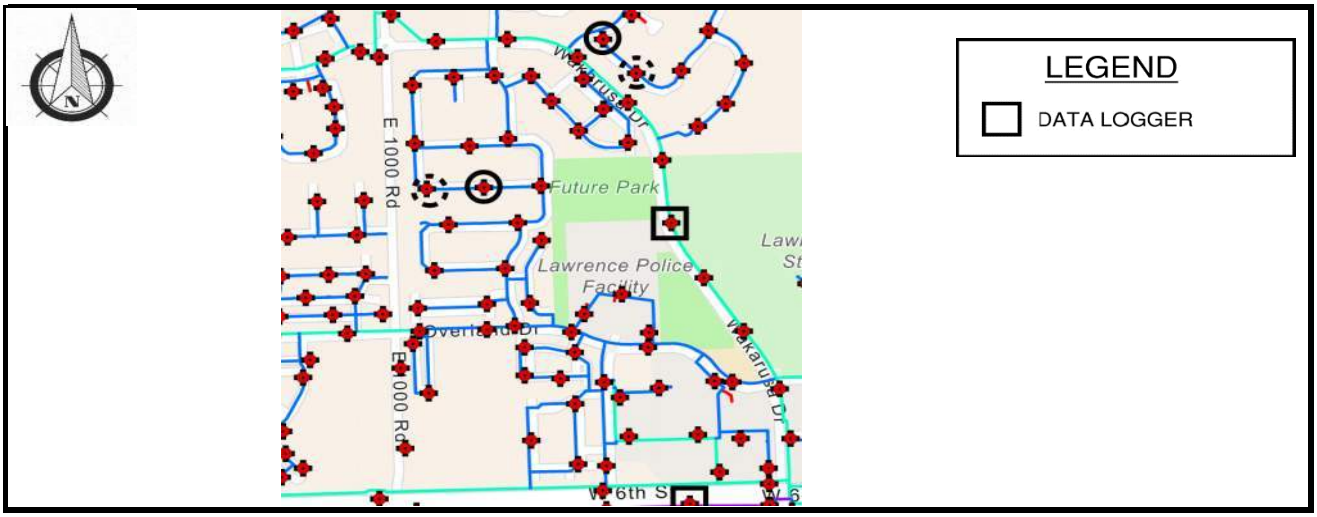
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2894	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	84	9/18/2023	9:09 AM
Removal:	85	9/19/2023	12:14 PM

Location: Wakarusa Dr

Sketch:



Photos:

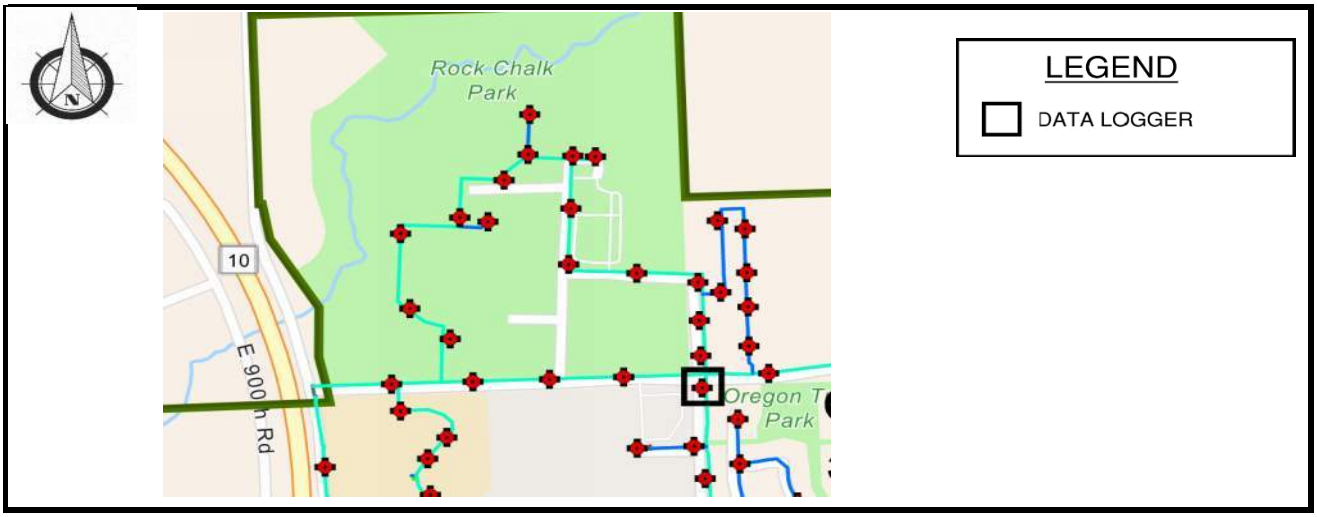
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2893	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	73	9/18/2023	9:19 AM
Removal:	74	9/19/2023	12:20 PM

Location: George Williams Way & Rock Chalk Dr

Sketch:



Photos:

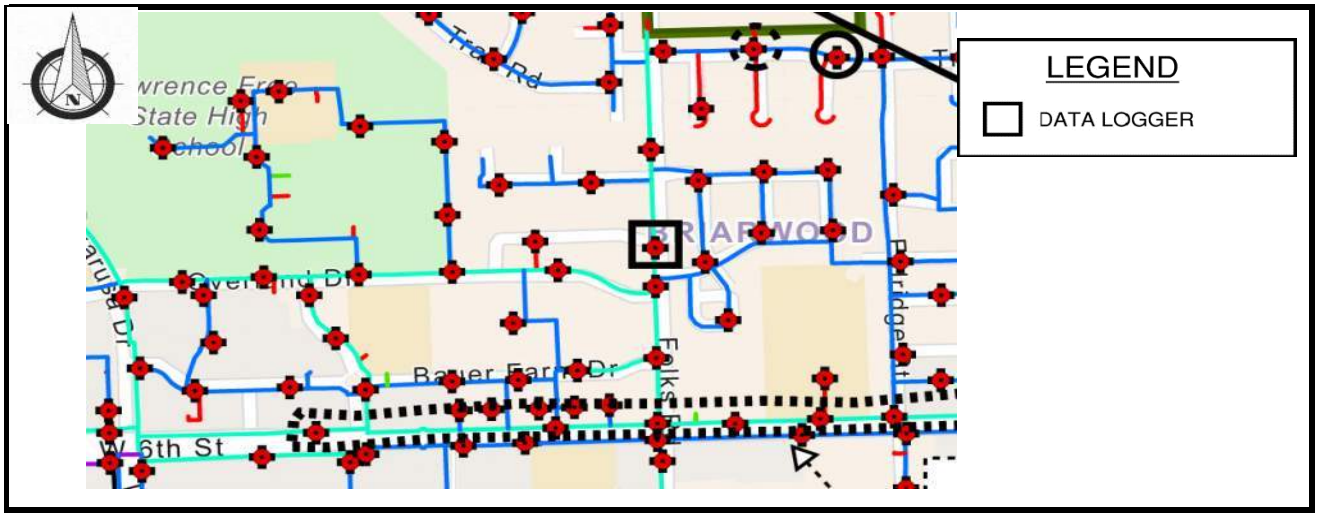
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2888	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	64	9/18/2023	9:35 AM
Removal:	65	9/19/2023	12:30 PM

Location: S Folks Rd & Briarwood Dr

Sketch:



Photos:

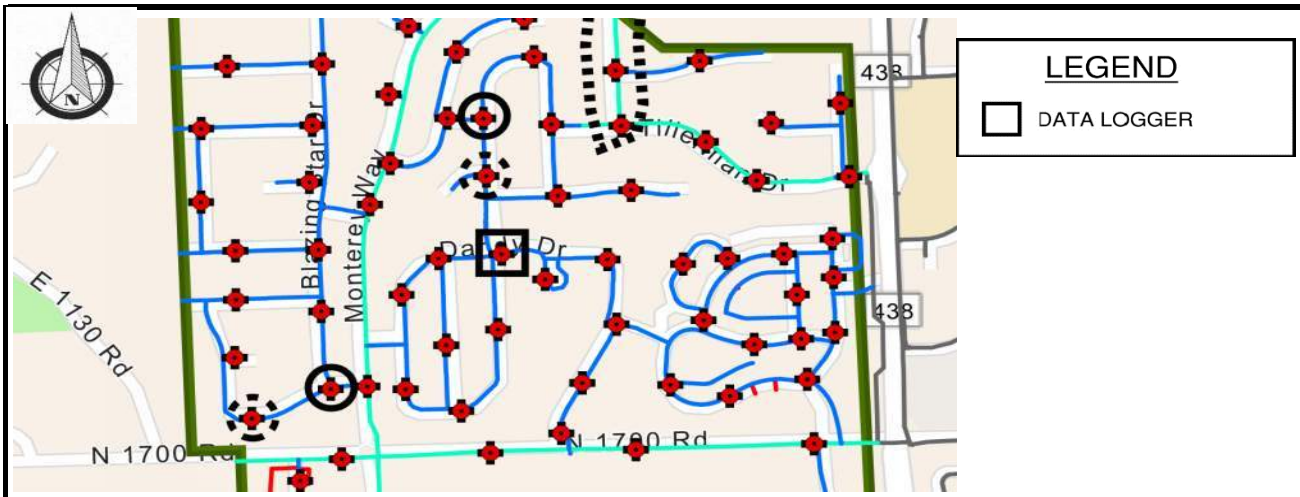
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2895	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	79	9/18/2023	9:47 AM
Removal:	79	9/19/2023	12:37 PM

Location: N Daylily Dr & Dandy Dr

Sketch:



Photos:

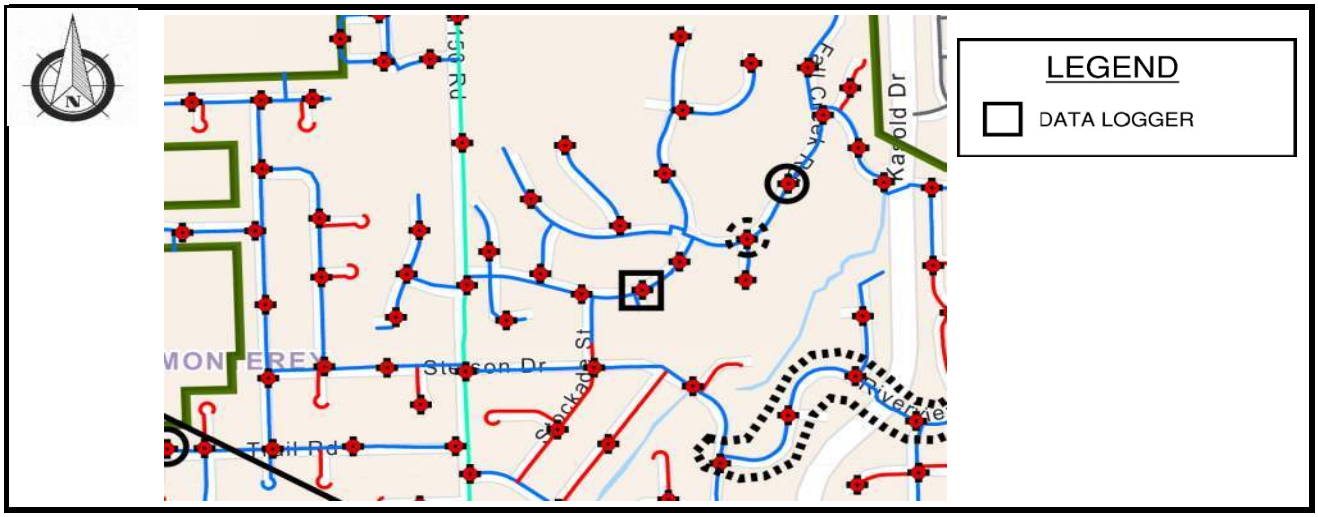
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2897	Main Size:	8″	F.H. Nozzle Diameter:	2.5″

	Pressure (psi)	Date	Time
Install:	67	9/18/2023	10:35 AM
Removal:	67	9/19/2023	12:49 PM

Location: Knotted Bend Ct & Running Ridge Dr

Sketch:



Photos:

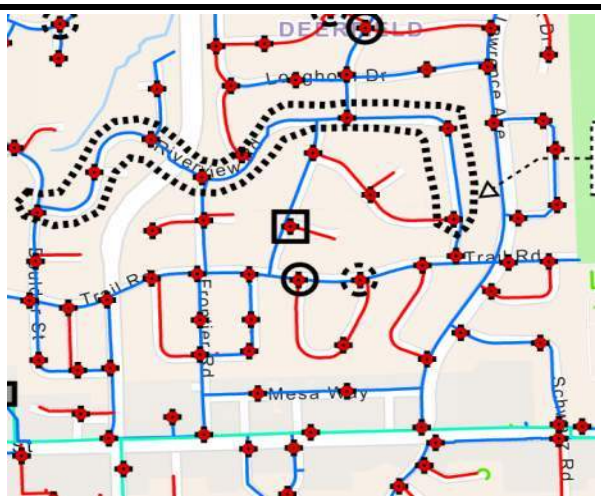
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2886	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	74	9/18/2023	10:42 AM
Removal:	74.5	9/19/2023	1:00 PM

Location: Rock Fence Pl & Rock Fence Ct

Sketch:



Photos:

Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2889	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	64	9/18/2023	10:54 AM
Removal:	64.5	9/19/2023	12:51 PM

Location: Century Dr & Madeline Ln

Sketch:

Photos:

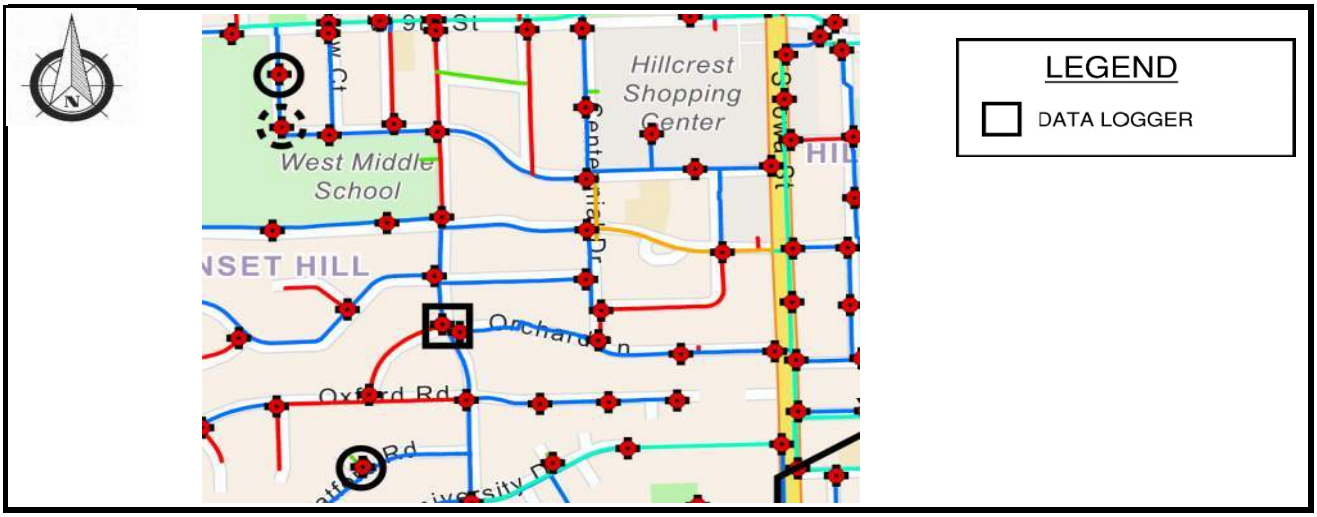
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2881	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	73	9/18/2023	11:04 AM
Removal:	73	9/19/2023	12:46 PM

Location: Crestline Dr & Orchard Ln

Sketch:



Photos:

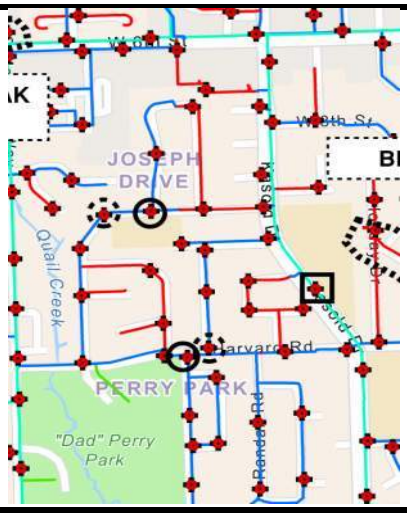
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2883	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	72	9/18/2023	11:19 AM
Removal:	71.5	9/19/2023	12:36 PM

Location: Kasold Dr & W 10th Pl

Sketch:



LEGEND

DATA LOGGER

Photos:

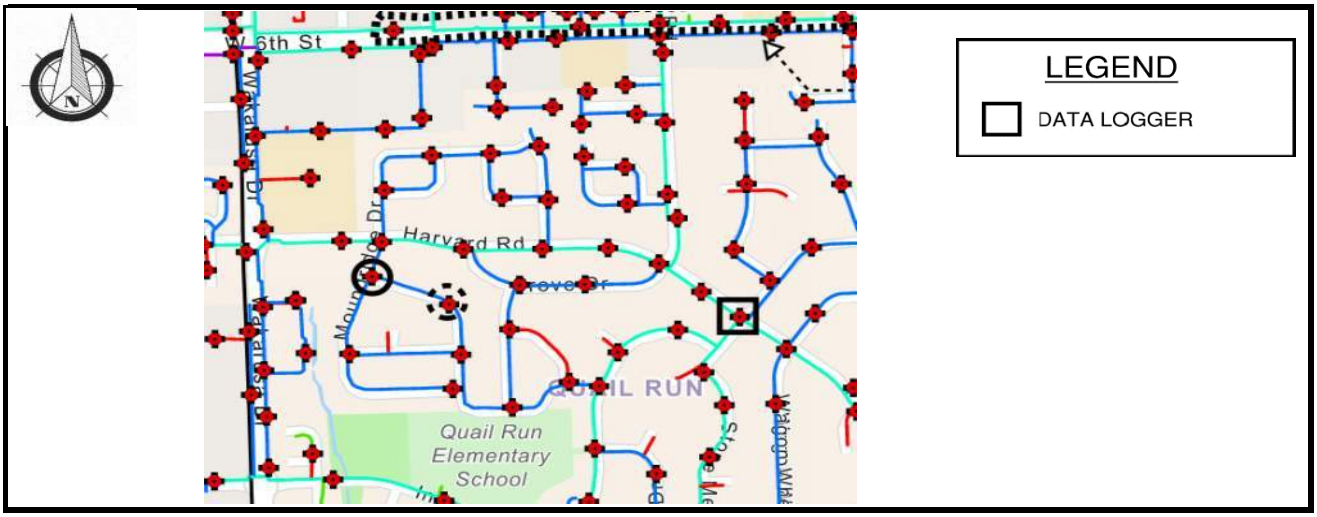
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	206385	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	70	9/18/2023	11:35 AM
Removal:	69	9/19/2023	12:27 PM

Location: Goldfield St & Harvard Rd

Sketch:



Photos:

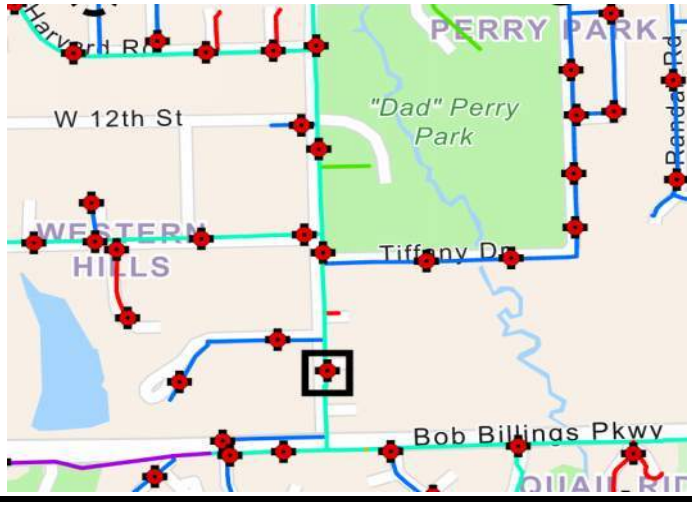
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2891	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	86	9/18/2023	11:50 AM
Removal:	84.5	9/19/2023	12:11 PM

Location: Monteray Way & W 14th Ct

Sketch:



Photos:

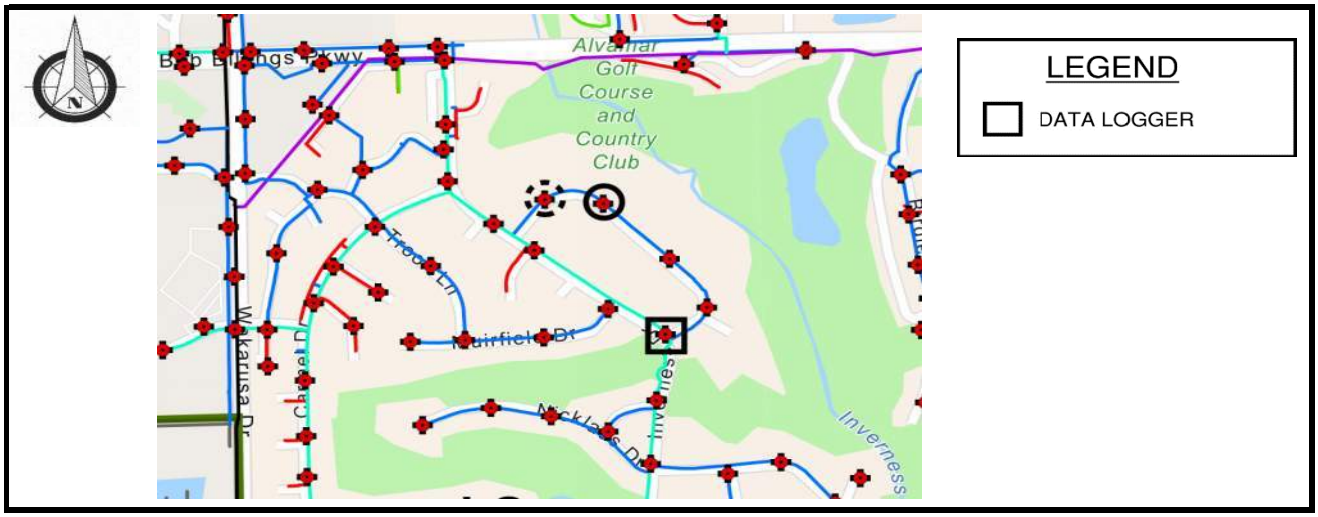
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2885	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	95	9/18/2023	12:00 PM
Removal:	93	9/19/2023	12:18 PM

Location: Inverness Dr & Prestwick Dr

Sketch:



Photos:

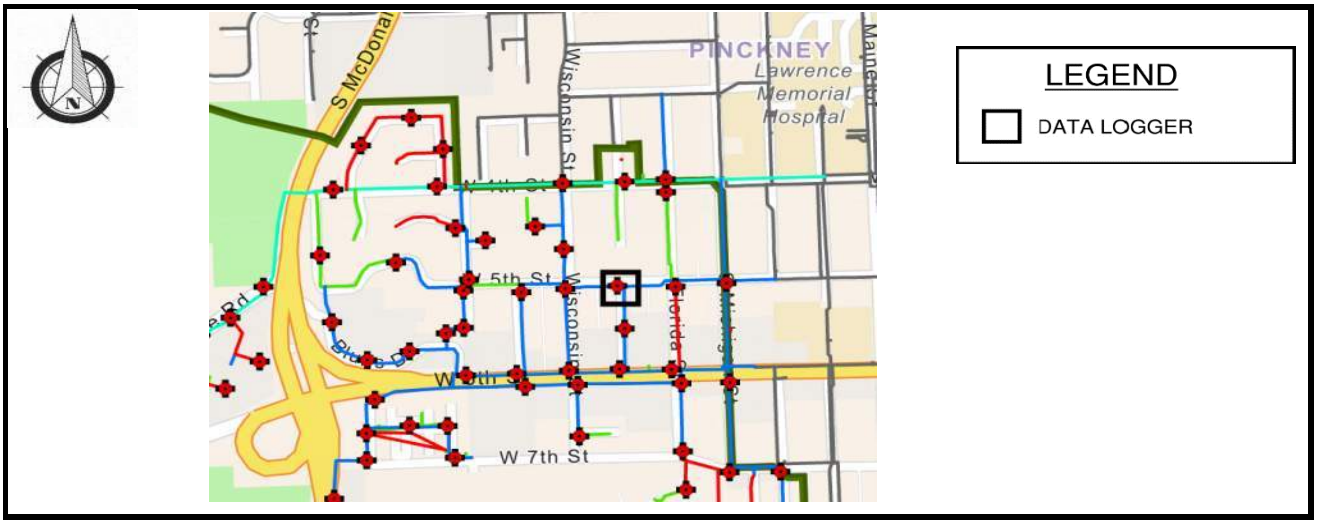
Water Distribution System: Lawrence, KS - West Hills Pressure Zone **Data Logger Installation Form**

Data Logger ID	2884	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	124	9/18/2023	12:24 PM
Removal:	122	9/19/2023	12:00 PM

Location: Minnosota St & W 5th St

Sketch:



Photos:

System: Lawrence, KS - West Hills Pressure Zone **Hydrant Test Form**

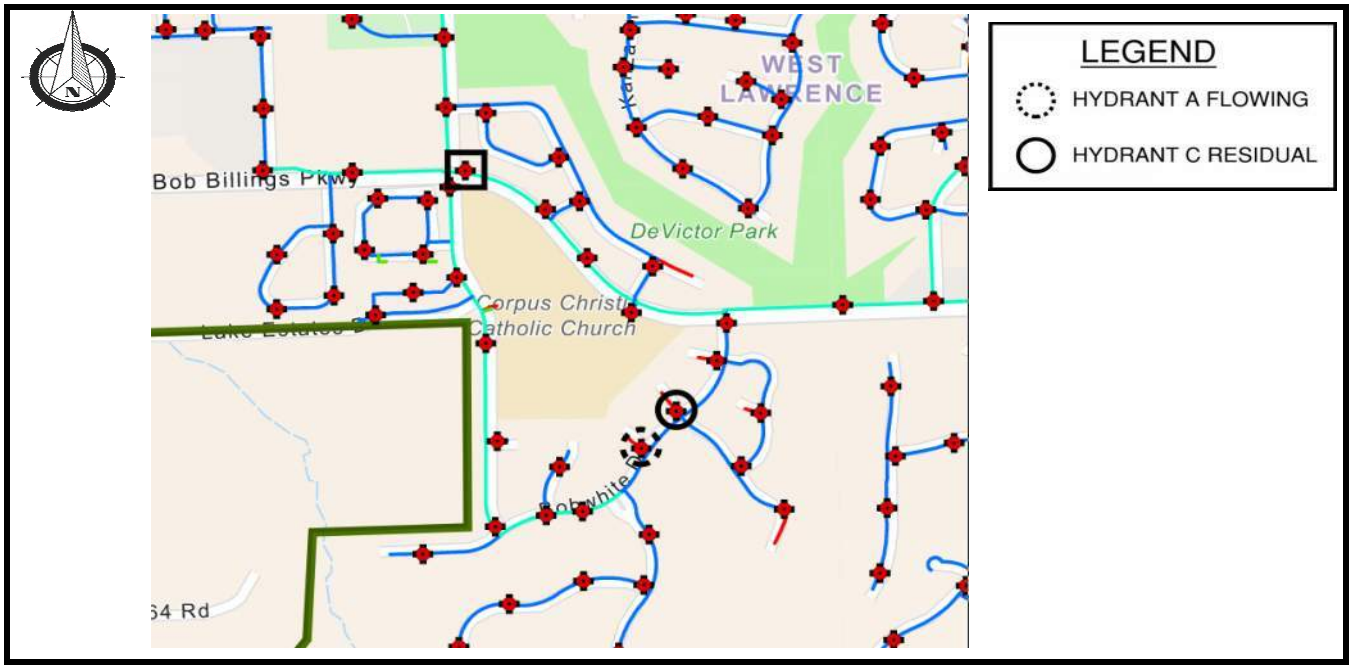
Date:	9/18/2023	Time:	1:48 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	89	75	1,453
Hydrant C:	86	83	

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

Location: Bobwhite Drive

Sketch



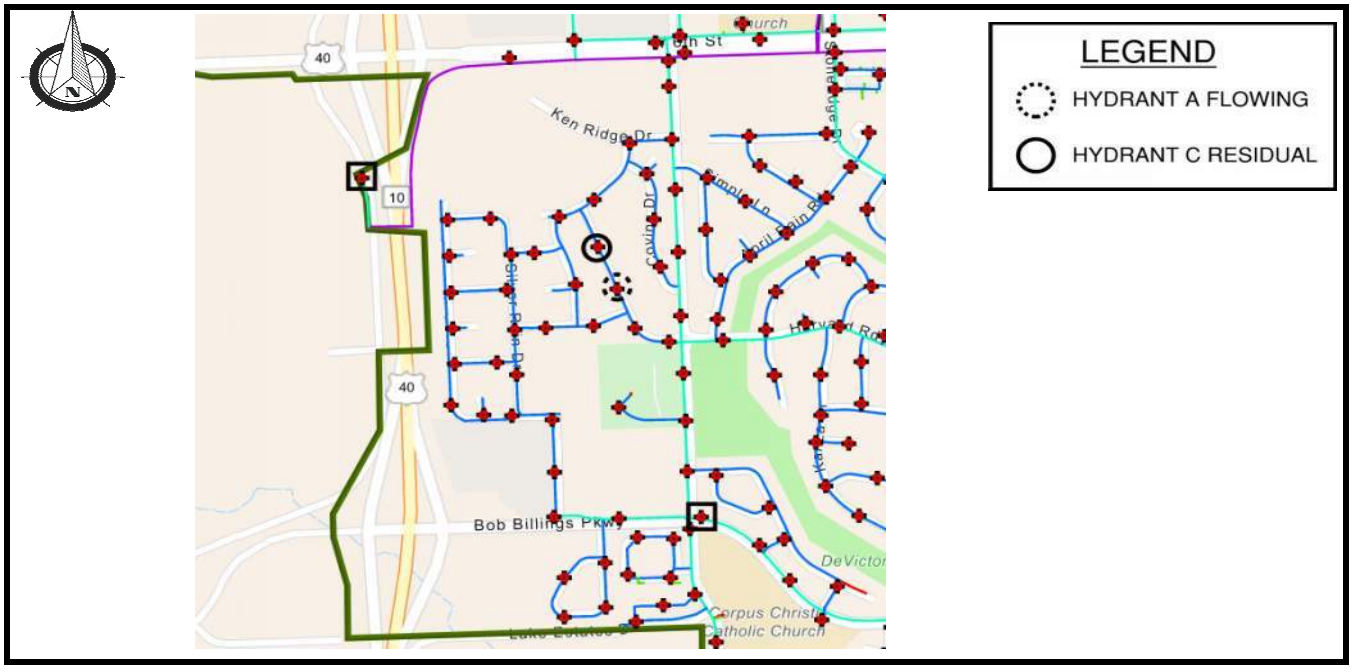
Date:	9/18/2023	Time:	2:09 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	76	69	1,394
Hydrant C:	73	70	

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

Location: Diamondhead Dr

Sketch



System: Lawrence, KS - West Hills Pressure Zone **Hydrant Test Form**

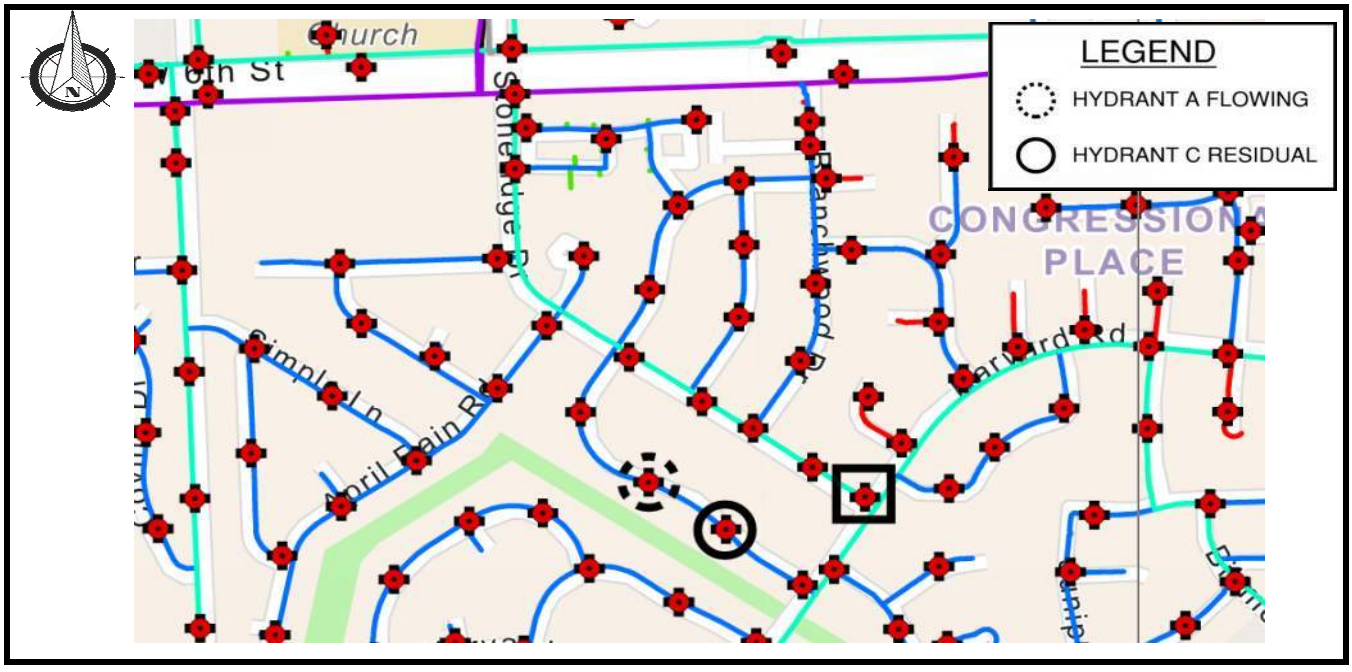
Date:	9/18/2023	Time:	2:29 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	75	70	1,404
Hydrant C:	72	70	

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

Location: Stonecreek Dr

Sketch



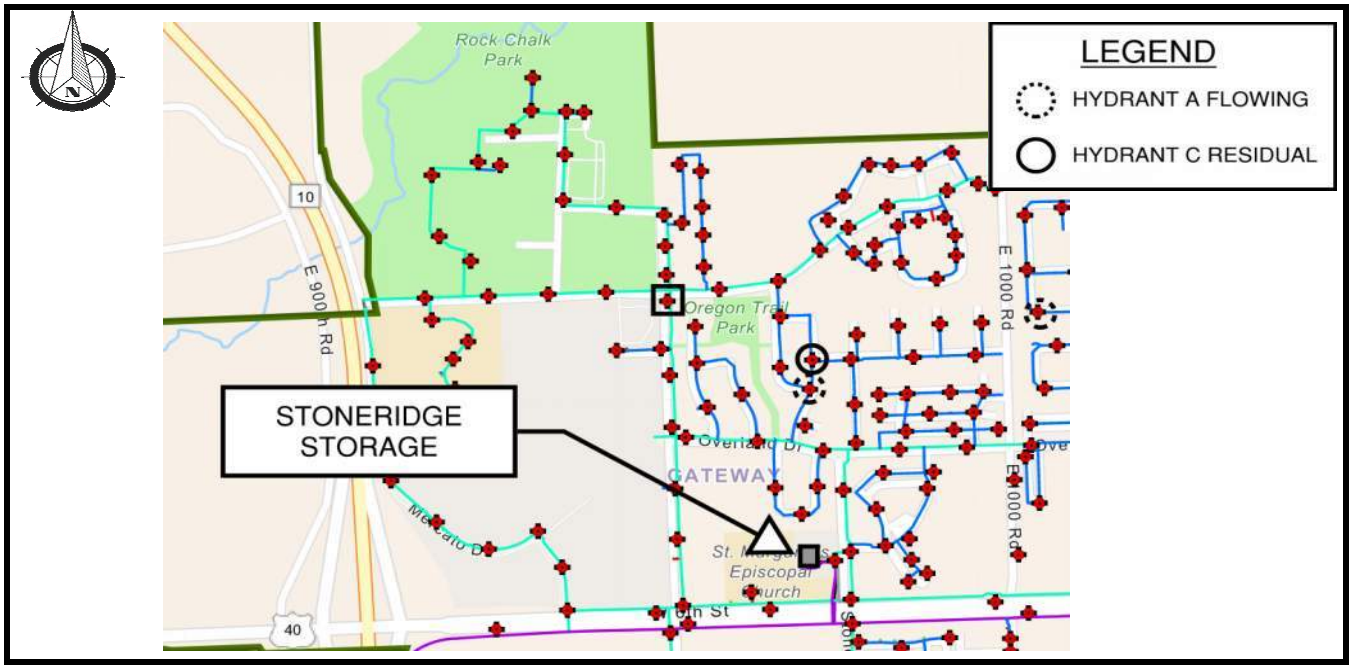
Date:	9/18/2023	Time:	1:50 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	69.5	56	1,256
Hydrant C:	72	71	

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

Location: Fort Laramie Dr

Sketch



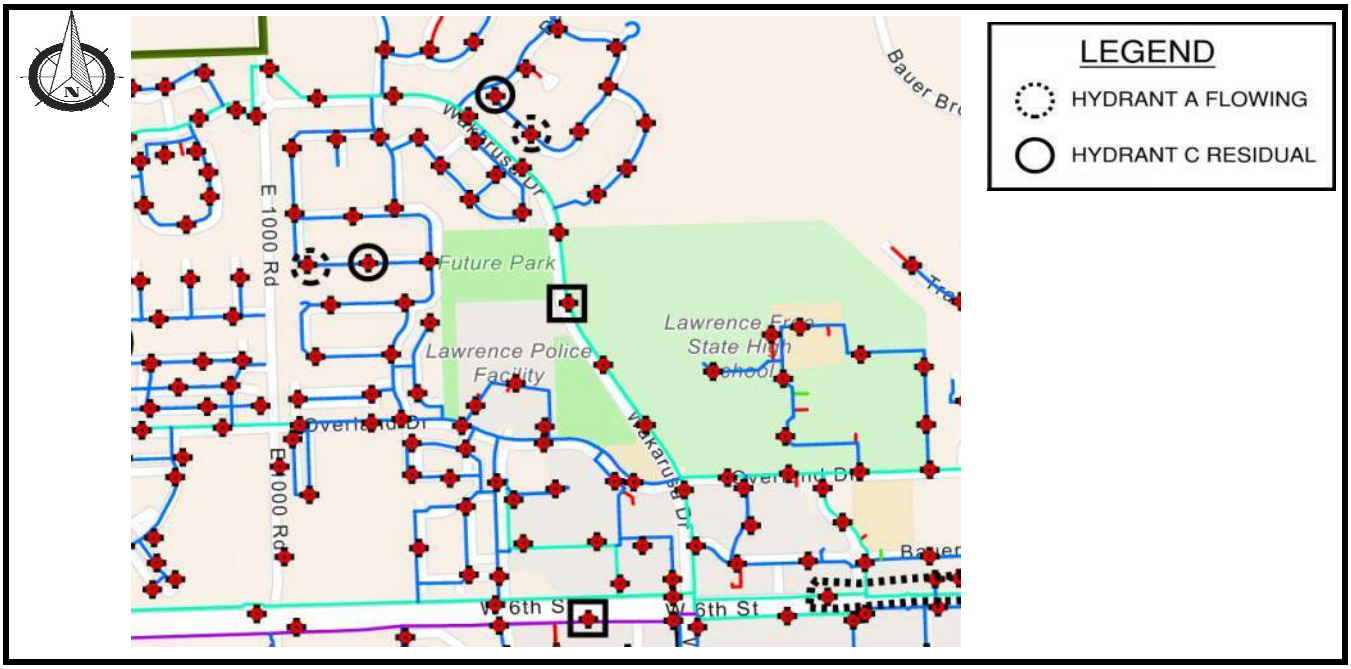
Date:	9/18/2023	Time:	1:50 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	71	62	1,321
Hydrant C:	74	70	

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

Location: Carson Pl

Sketch



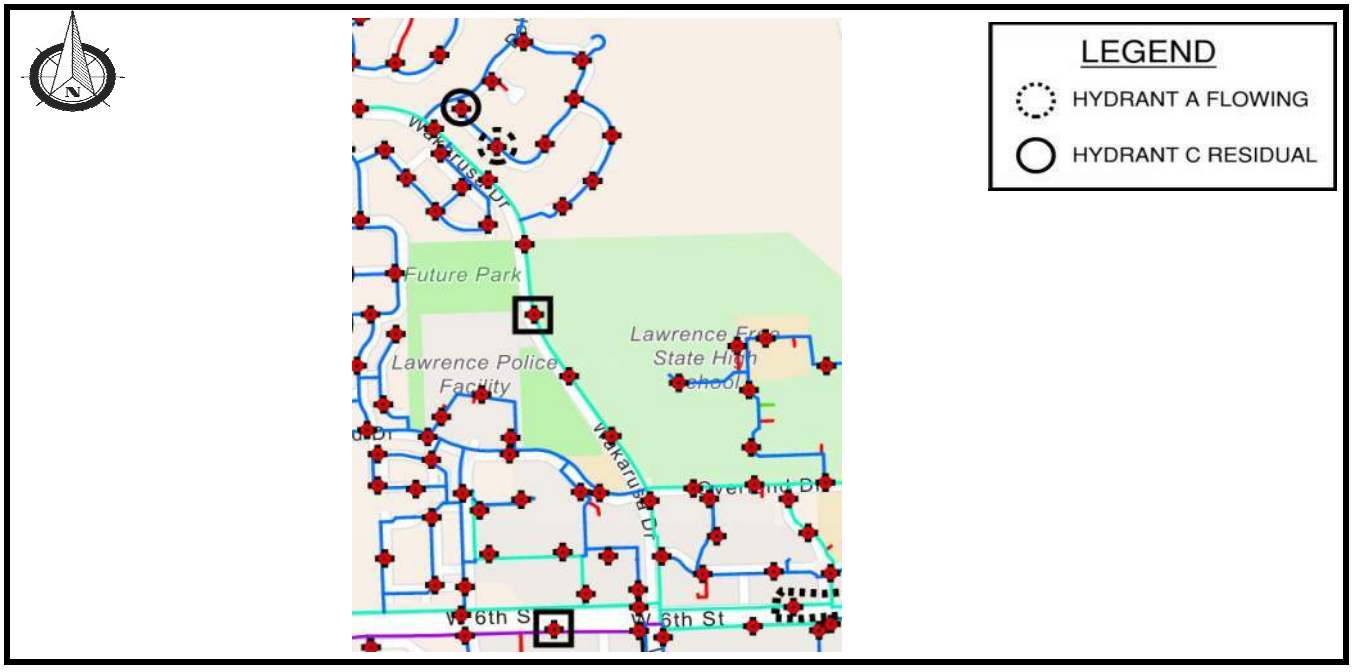
Date:	9/18/2023	Time:	3:23 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	77	71	1,414
Hydrant C:	82	79	

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

Location: Earhart Cir

Sketch



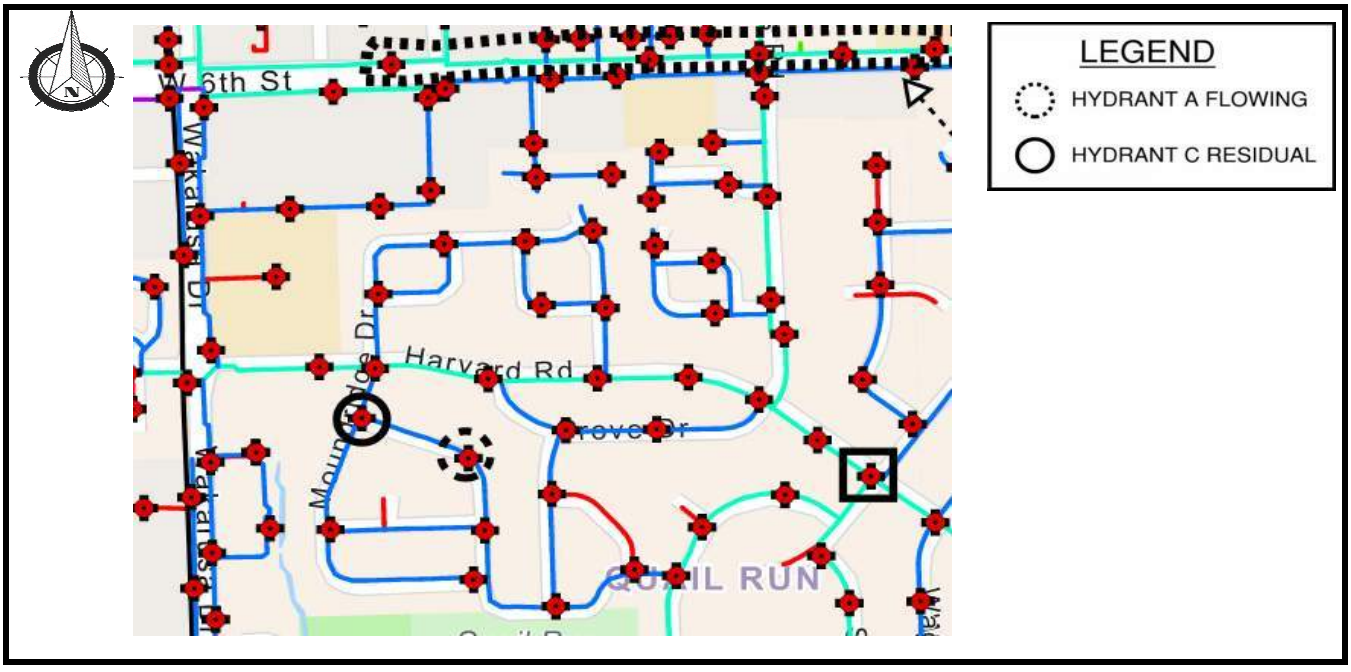
Date:	9/18/2023	Time:	3:45 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	69	68.5	1,389
Hydrant C:	71	69	

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

Location: Hartland Dr

Sketch



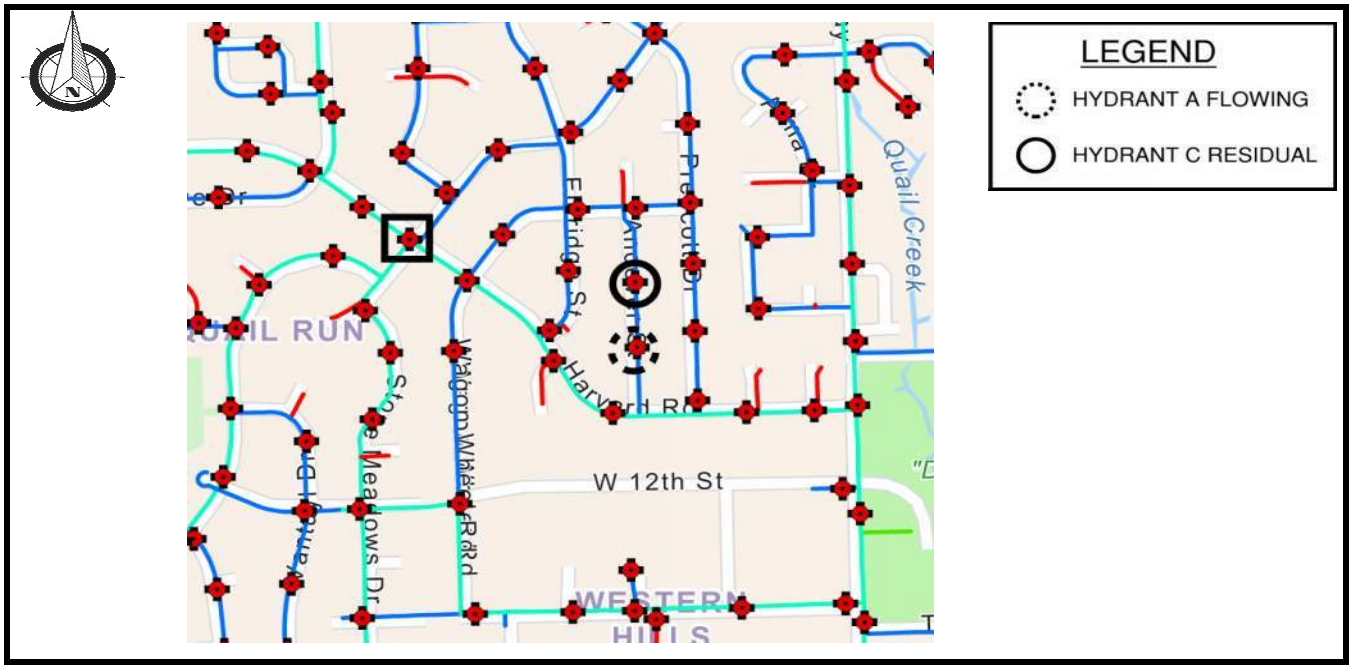
Date:	9/18/2023	Time:	4:02 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	71	65	1,353
Hydrant C:	69	66	

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

Location: Andover St

Sketch



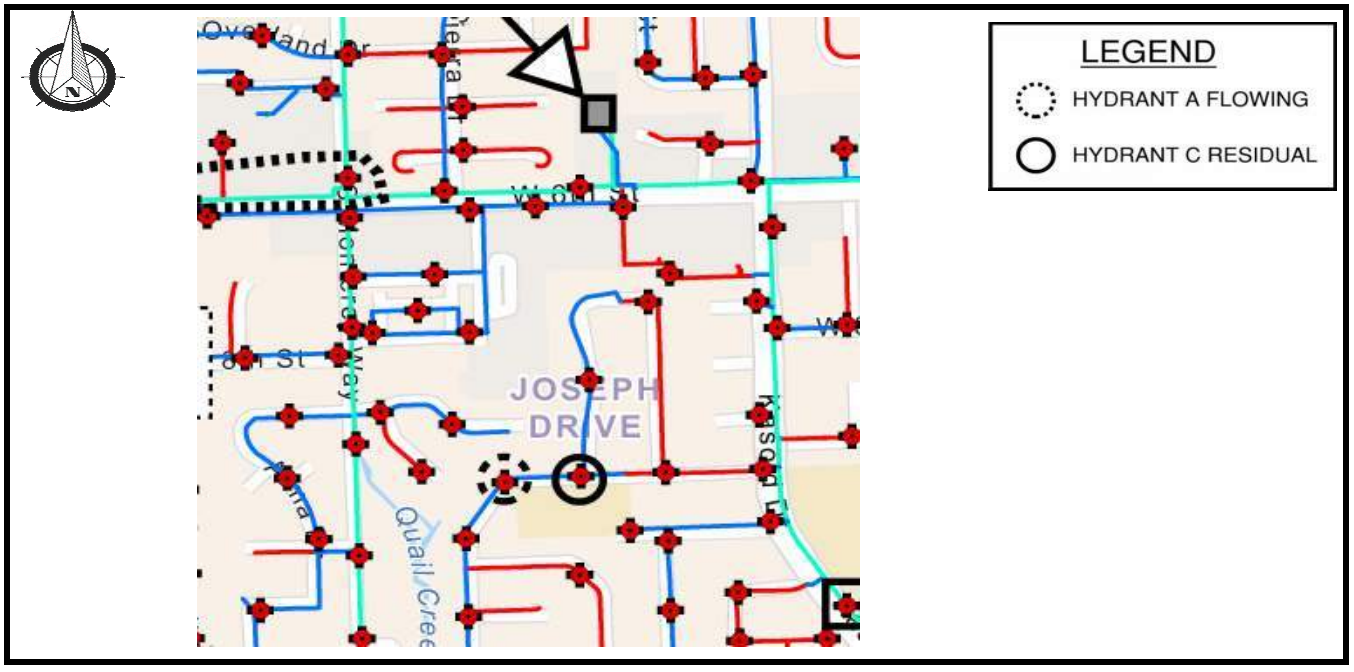
Date:	9/18/2023	Time:	4:25 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	74	65	1,353
Hydrant C:	64	58	

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

Location: W 10th St

Sketch



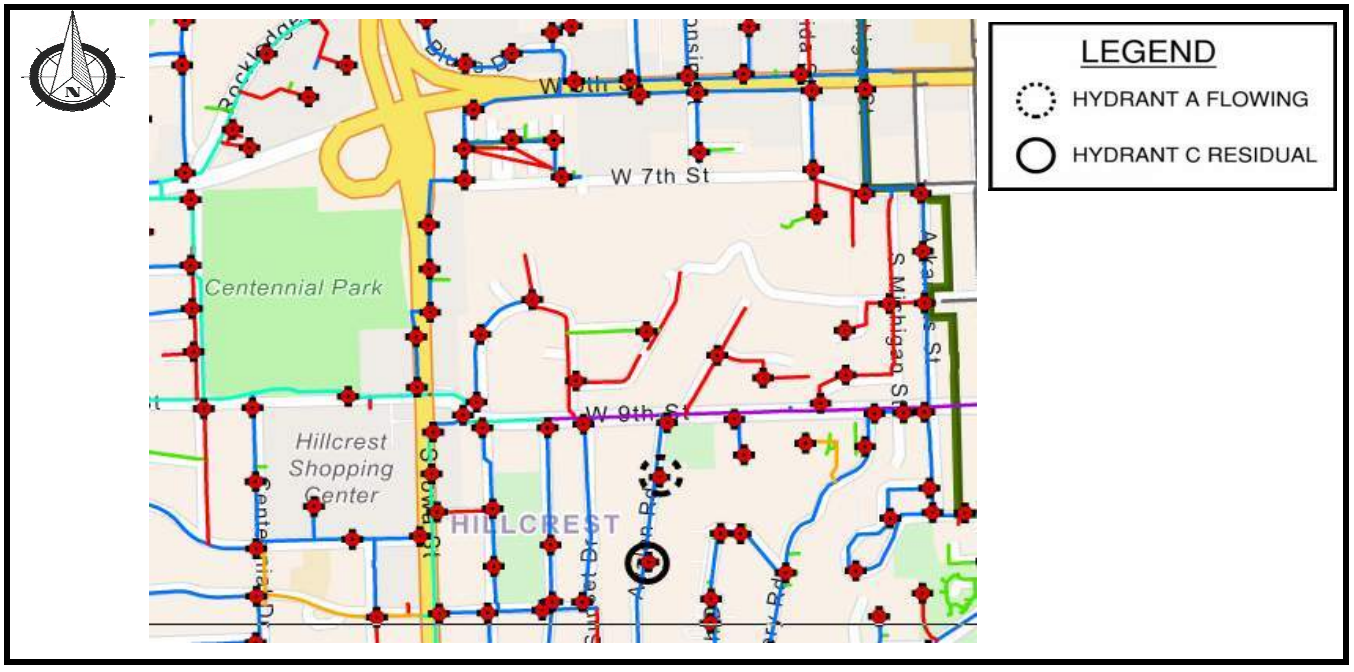
Date:	9/19/2023	Time:	7:53 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	82	74	1,443
Hydrant C:	71	69	

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

Location: Avalon Road

Sketch



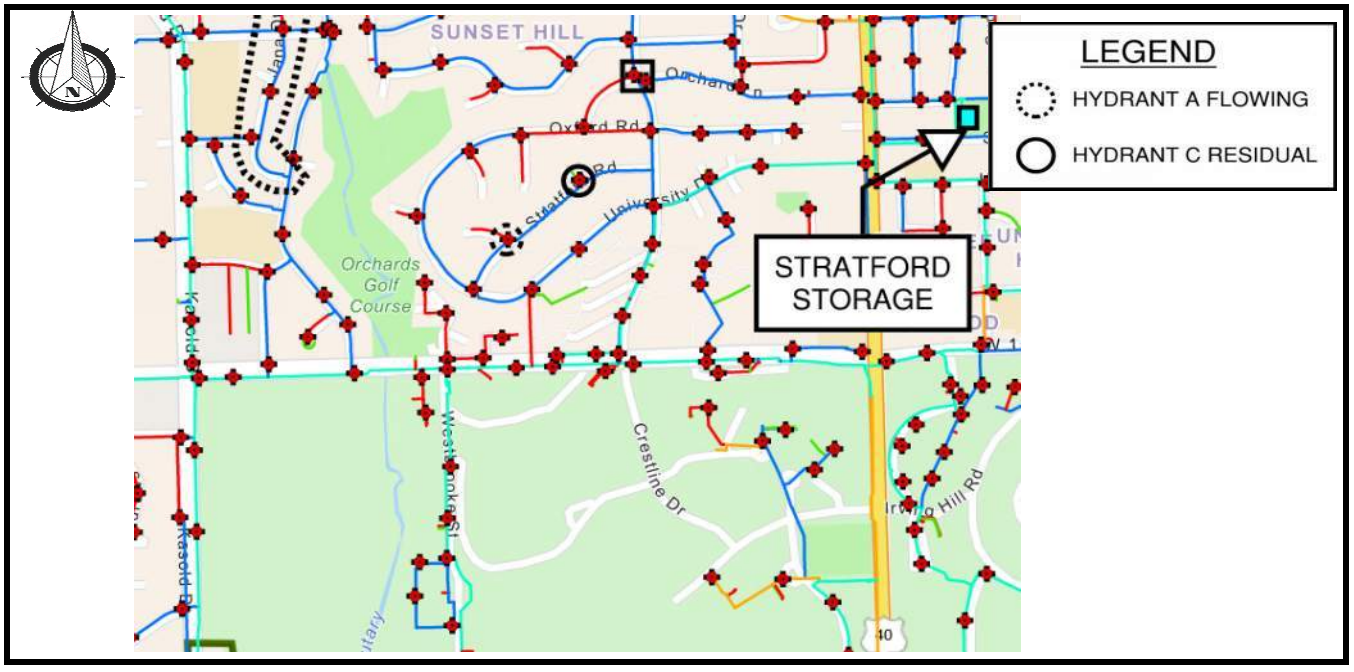
Date:	9/19/2023	Time:	8:18 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	92	75	1,453
Hydrant C:	81	75	

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

Location: Stratford Rd

Sketch



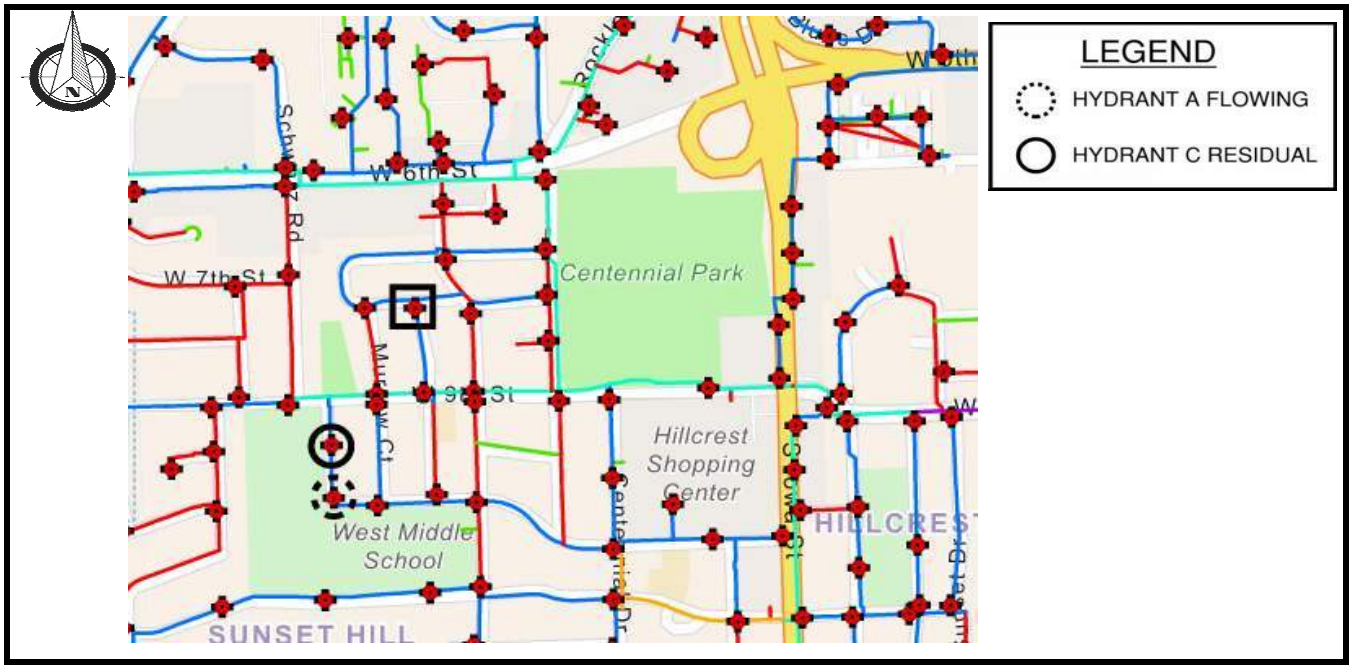
Date:	9/19/2023	Time:	8:35 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	68	53	1,222
Hydrant C:	66	64	

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

Location: Schwarz Rd

Sketch



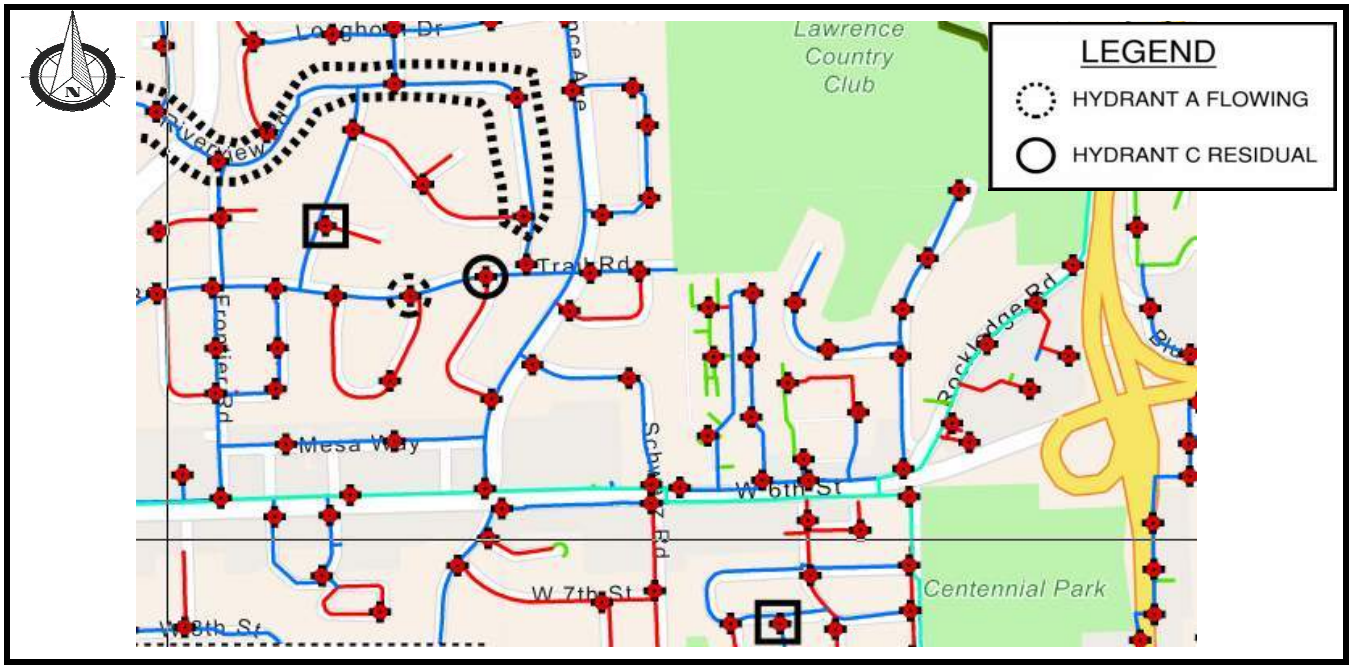
Date:	9/19/2023	Time:	9:04 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	65	52	1,210
Hydrant C:	61	60	

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

Location: Trail Rd & Millstone Dr

Sketch



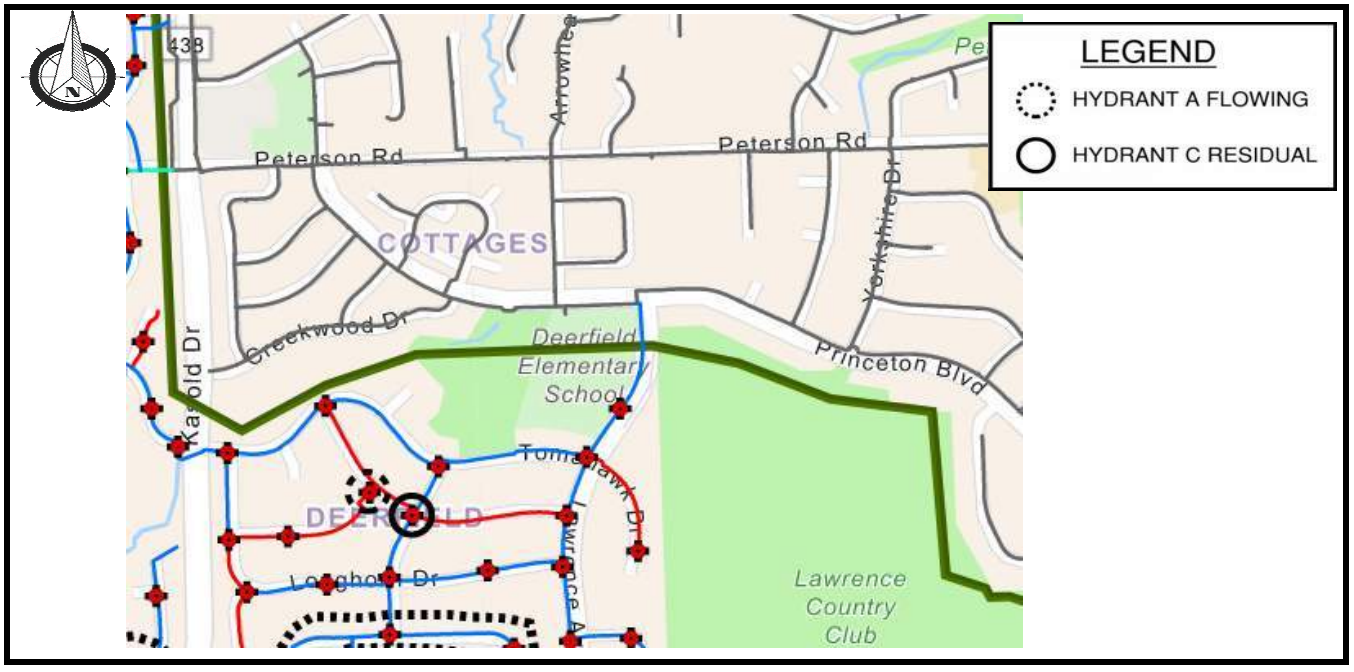
Date:	9/19/2023	Time:	9:25 AM
Main Size (in):	6	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	108	90	1,592
Hydrant C:	107	104	

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

Location: Ranger Dr & Saddlehorn Dr

Sketch



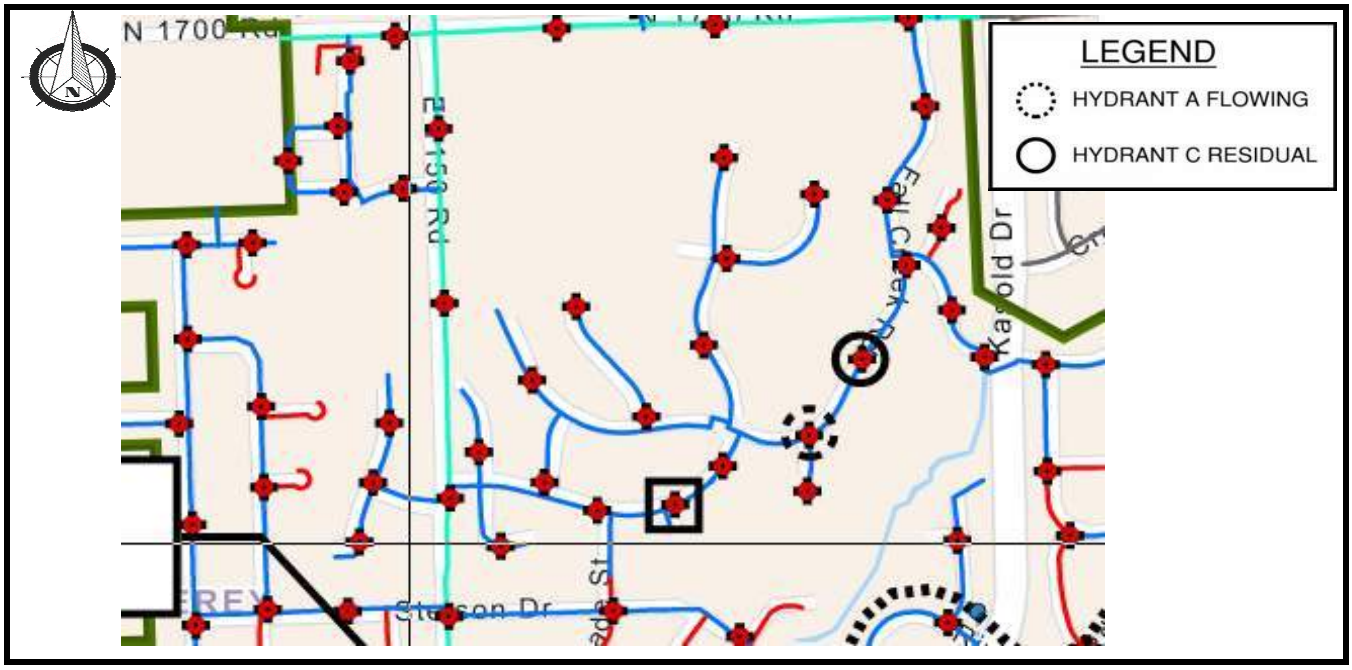
Date:	9/19/2023	Time:	9:40 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	70	64	1,342
Hydrant C:	72	70	

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

Location: Fall Creek Rd & Hidden Ln

Sketch



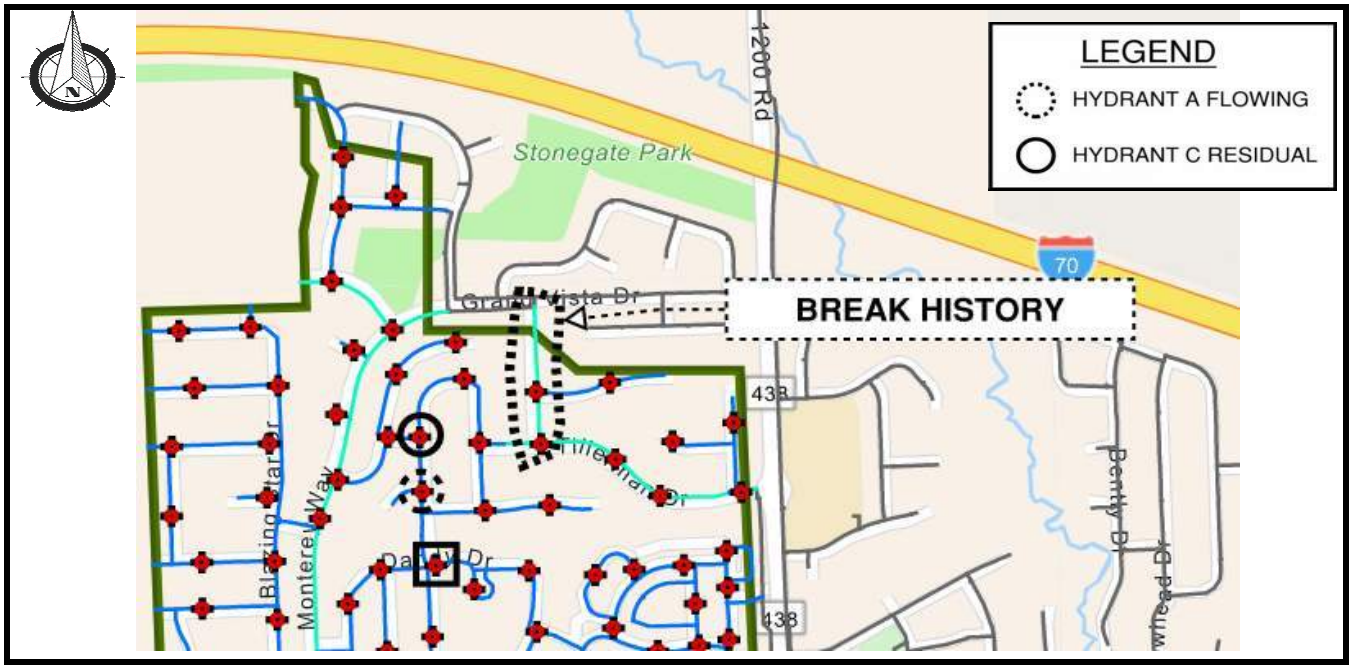
Date:	9/19/2023	Time:	9:58 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	71	64	1,342
Hydrant C:	73	68	

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

Location: N Dayliy Dr

Sketch



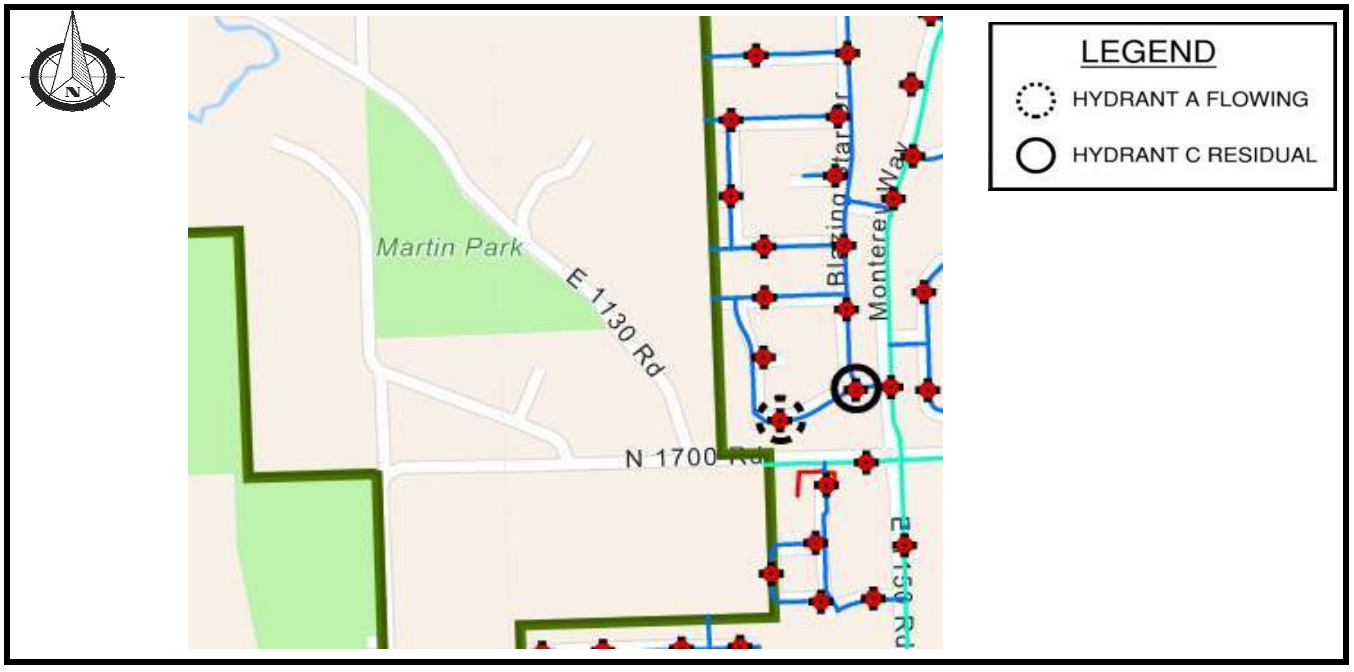
Date:	9/19/2023	Time:	10:14 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	64	56	1,256
Hydrant C:	63	59	

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

Location: Aster St & N Pennycress Dr

Sketch



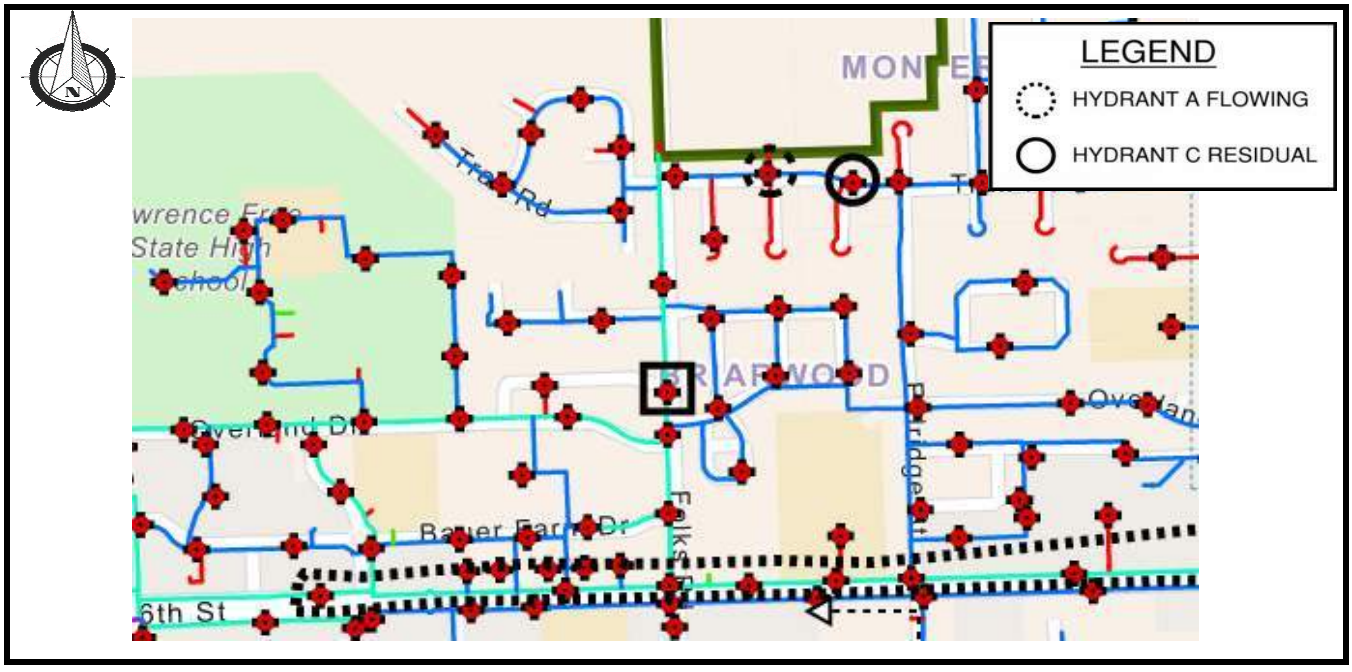
Date:	9/19/2023	Time:	10:30 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	69	61	1,311
Hydrant C:	66	63	

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

Location: Trail Rd & Terri Ct

Sketch



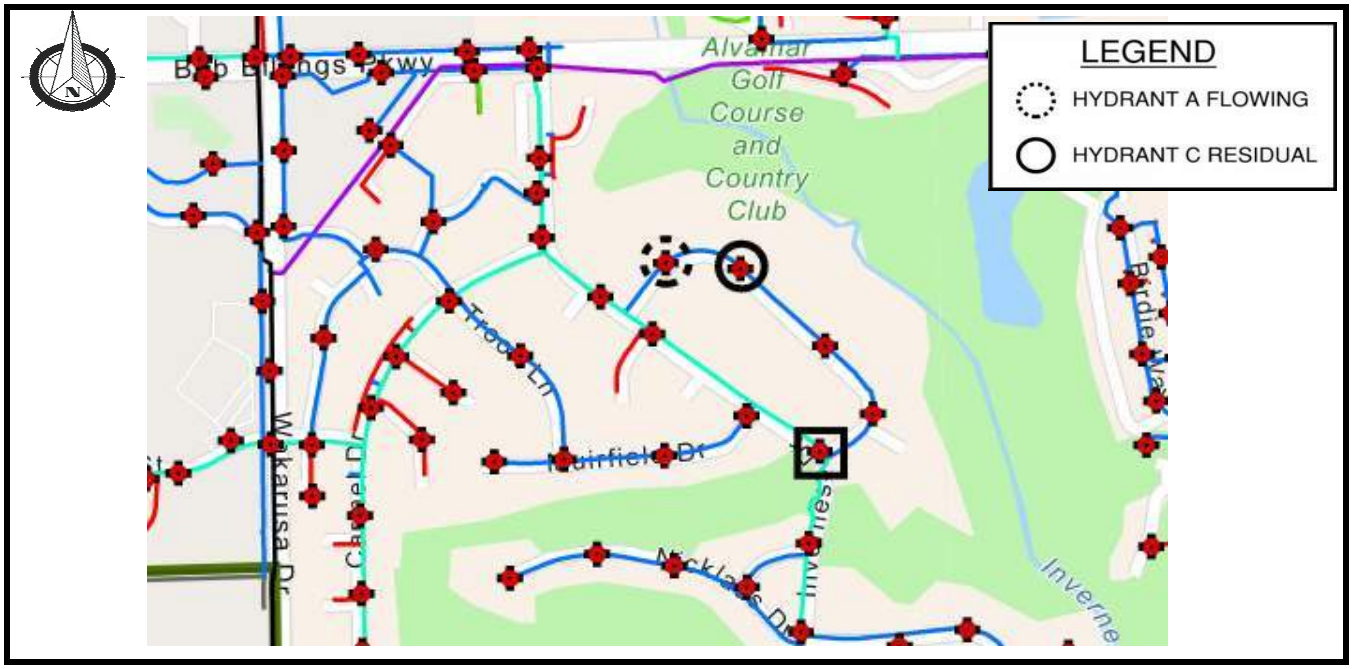
Date:	9/19/2023	Time:	10:53 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	92	84	1,538
Hydrant C:	90	87	

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

Location: Prestwick Dr & Inverness Dr

Sketch



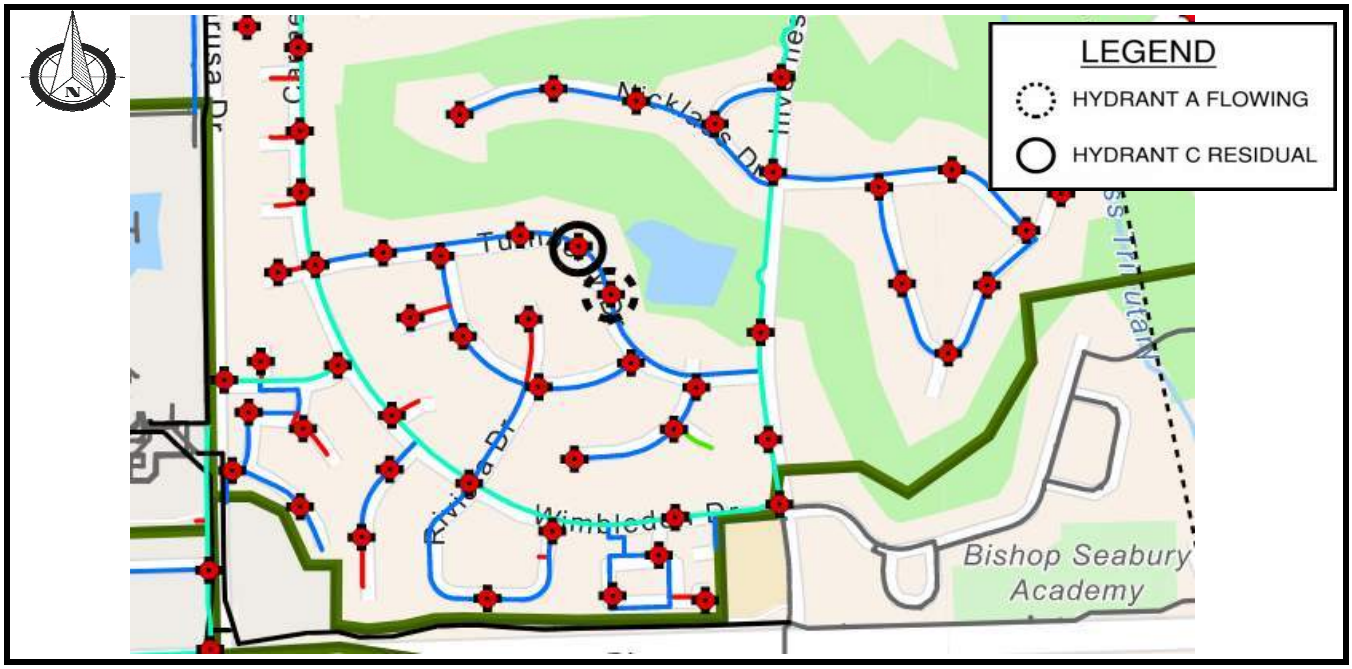
Date:	9/19/2023	Time:	11:10 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

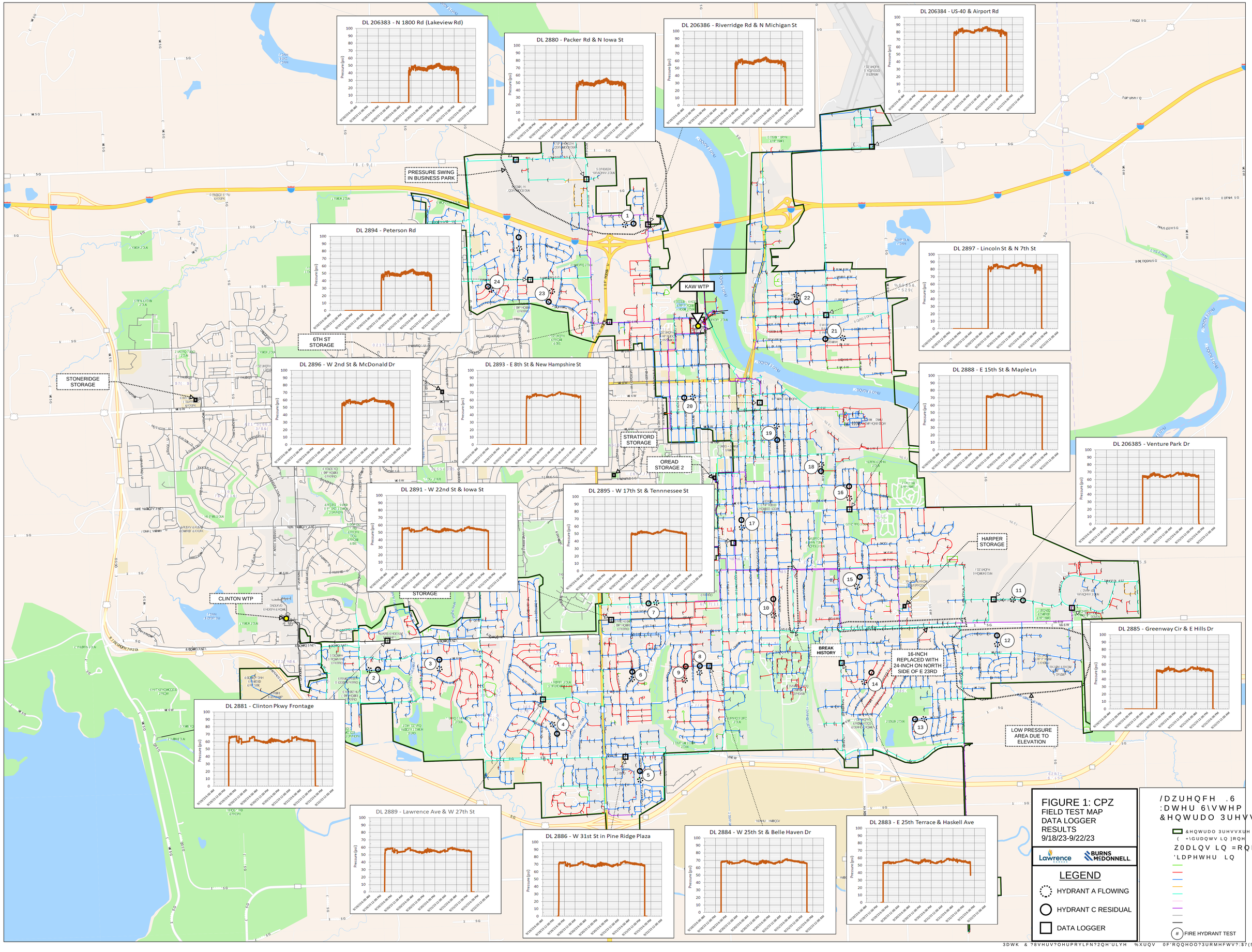
	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	95	85	1,547
Hydrant C:	94	90	

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

Location: Turnberry Dr

Sketch




DL 206383 - N 1800 Rd (Lakeview Rd)
DL 2880 - Packer Rd & N Iowa St
DL 206386 - Riverridge Rd & N Michigan St
DL 206384 - US-40 & Airport Rd
PRESSURE SWING IN BUSINESS PARK
DL 2894 - Peterson Rd
KAW WTP
DL 2897 - Lincoln St & N 7th St
6TH ST STORAGE
STONERIDGE STORAGE
DL 2896 - W 2nd St & McDonald Dr
DL 2893 - E 8th St & New Hampshire St
DL 2888 - E 15th St & Maple Ln
STRATFORD STORAGE
OREAD STORAGE 2
DL 2891 - W 22nd St & Iowa St
DL 2895 - W 17th St & Tennnessee St
DL 206385 - Venture Park Dr
HARPER STORAGE
CLINTON WTP
BREAK HISTORY
16-INCH REPLACED WITH 24-INCH ON NORTH SIDE OF E 23RD
DL 2885 - Greenway Cir & E Hills Dr
LOW PRESSURE AREA DUE TO ELEVATION
DL 2881 - Clinton Pkwy Frontage
DL 2889 - Lawrence Ave & W 27th St
DL 2886 - W 31st St in Pine Ridge Plaza
DL 2884 - W 25th St & Belle Haven Dr
DL 2883 - E 25th Terrace & Haskell Ave
Pressure (psi)
FIGURE 1: CPZ
FIELD TEST MAP
DATA LOGGER
RESULTS
9/18/23-9/22/23
Lawrence
BURNS McDONNELL
LEGEND
HYDRANT A FLOWING
HYDRANT C RESIDUAL
DATA LOGGER
FIRE HYDRANT TEST

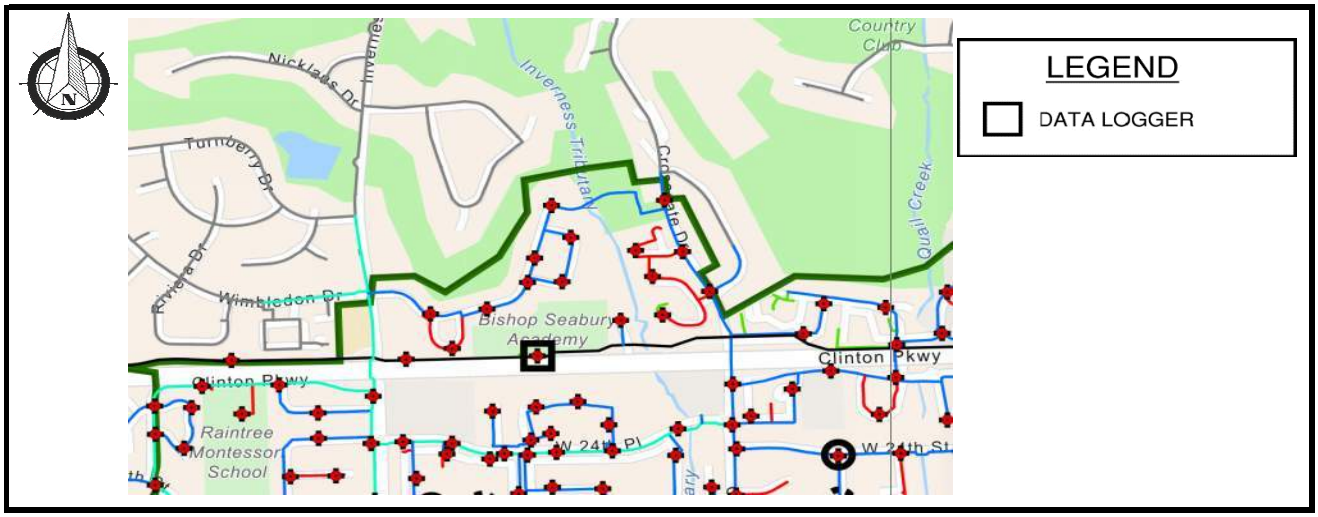
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2881	Main Size:	24-42"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	59.0	9/19/2023	2:05 PM
Removal:	60.4	9/21/2023	2:07 PM

Location: Clinton Pkwy Frontage

Sketch:



Photos:

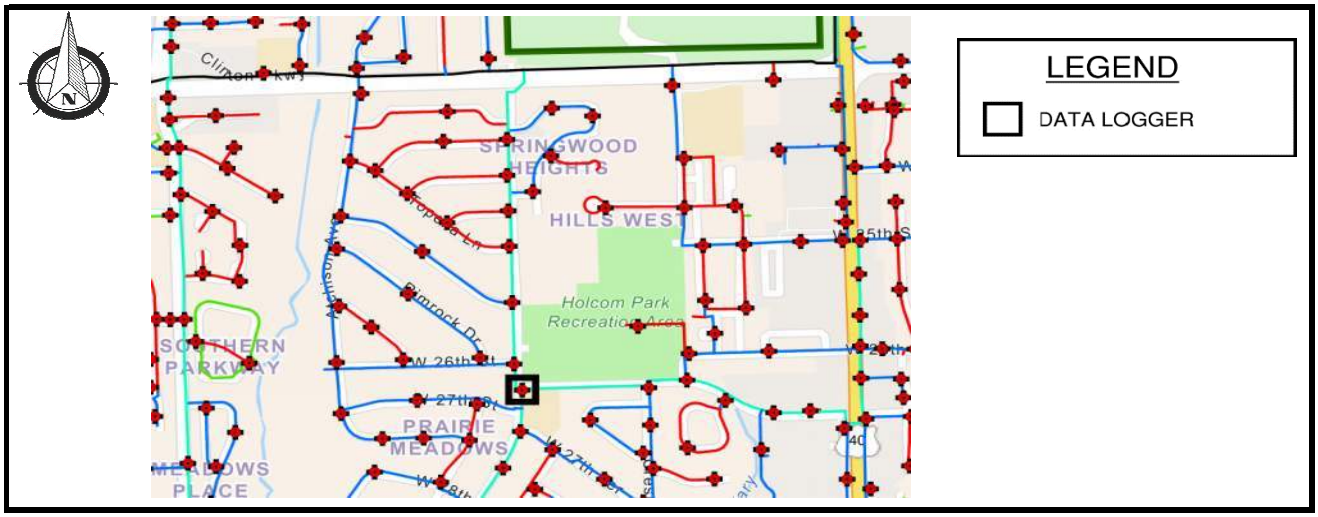
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2889	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	52.9	9/19/2023	2:15 PM
Removal:	54.7	9/21/2023	2:15 PM

Location: Lawrence Ave & W 27th St

Sketch:



Photos:

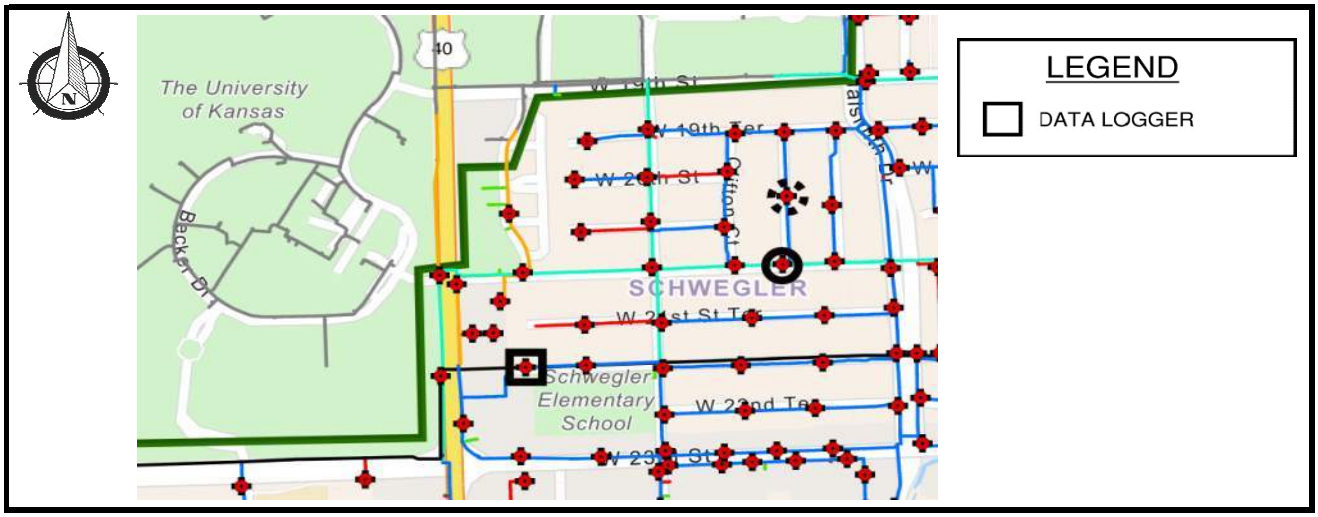
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2891	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	54.1	9/19/2023	2:35 PM
Removal:	52.5	9/21/2023	2:22 PM

Location: W 22nd St & Iowa St

Sketch:



Photos:

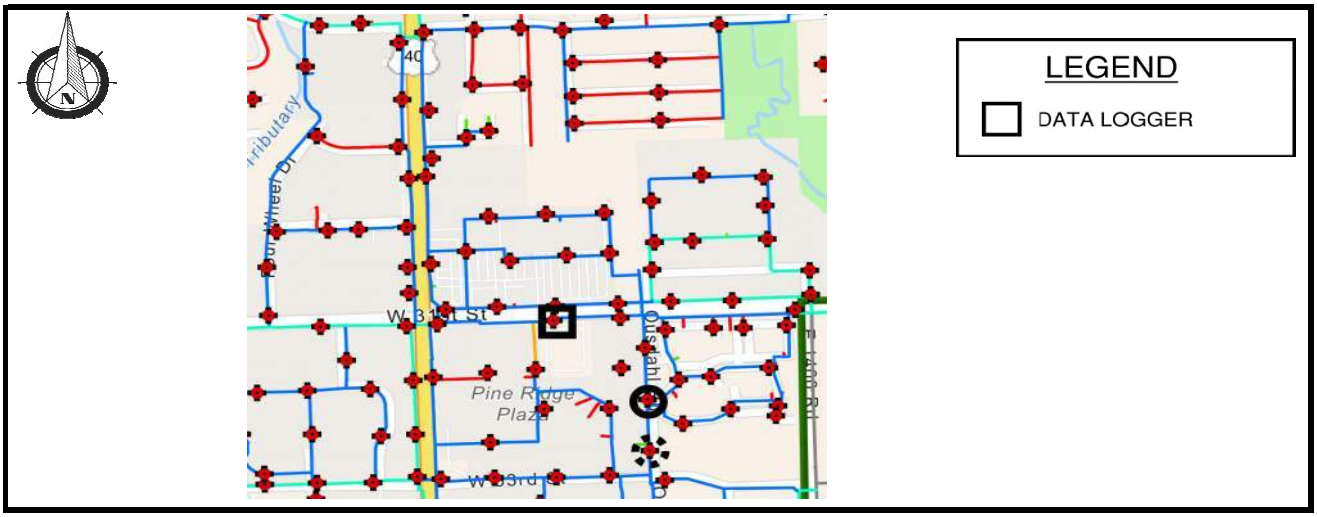
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2886	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	70.9	9/19/2023	2:52 PM
Removal:	68.9	9/21/2023	2:33 PM

Location: W 31st St in Pine Ridge Plaza

Sketch:



Photos:

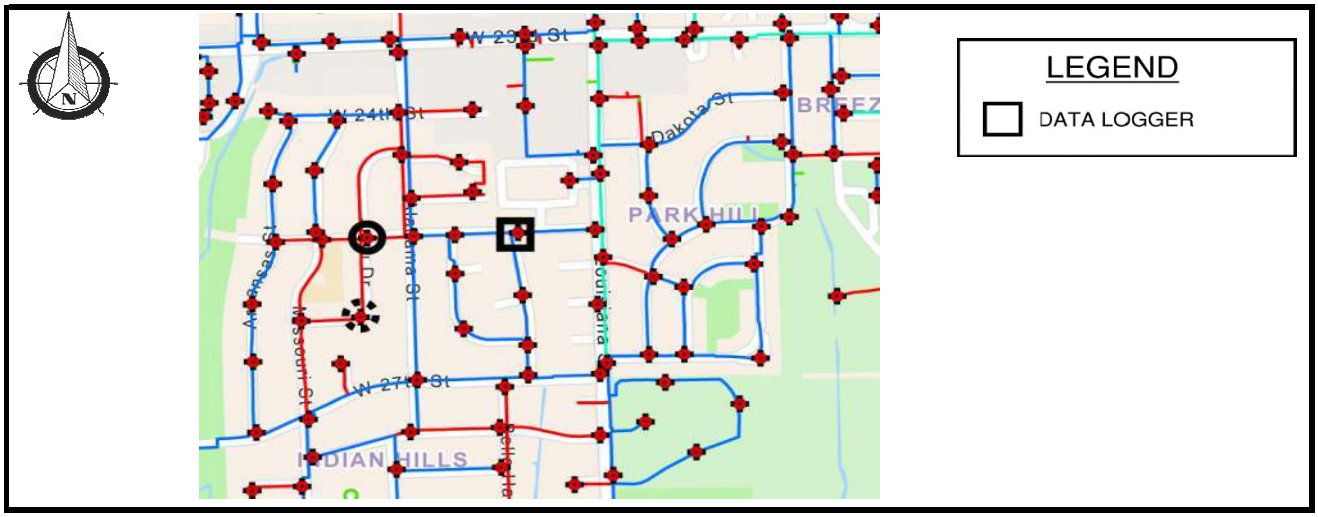
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2884	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	67.2	9/19/2023	3:04 PM
Removal:	66.3	9/21/2023	2:41 PM

Location: W 25th St & Belle Haven Dr

Sketch:



Photos:

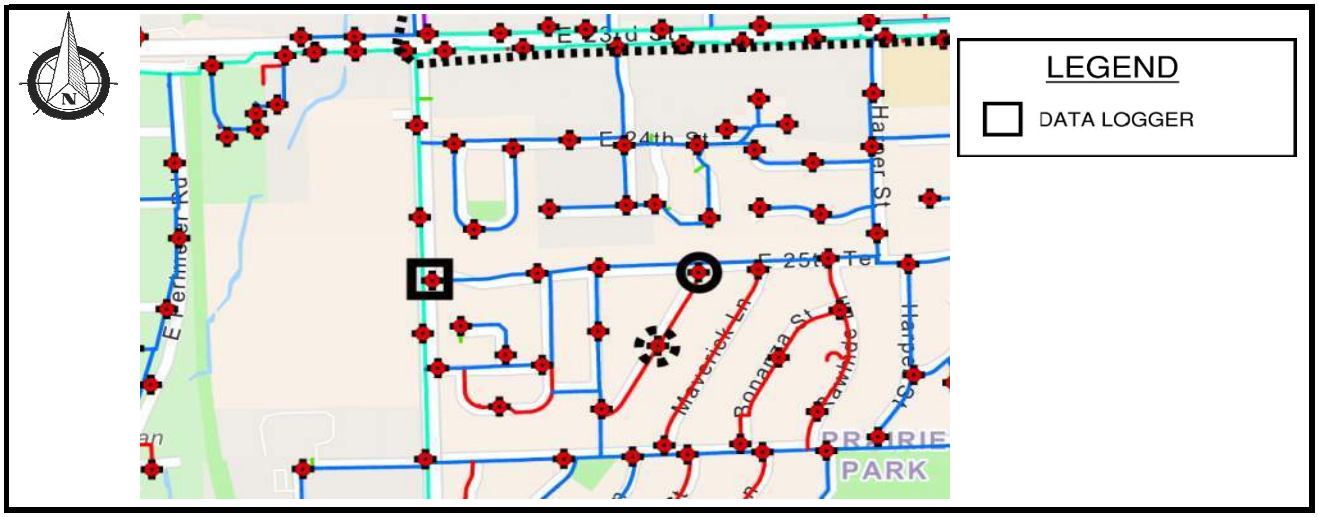
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2883	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	53.3	9/19/2023	3:18 PM
Removal:	54.5	9/21/2023	3:47 PM

Location: E 25th Terrace & Haskell Ave

Sketch:



Photos:

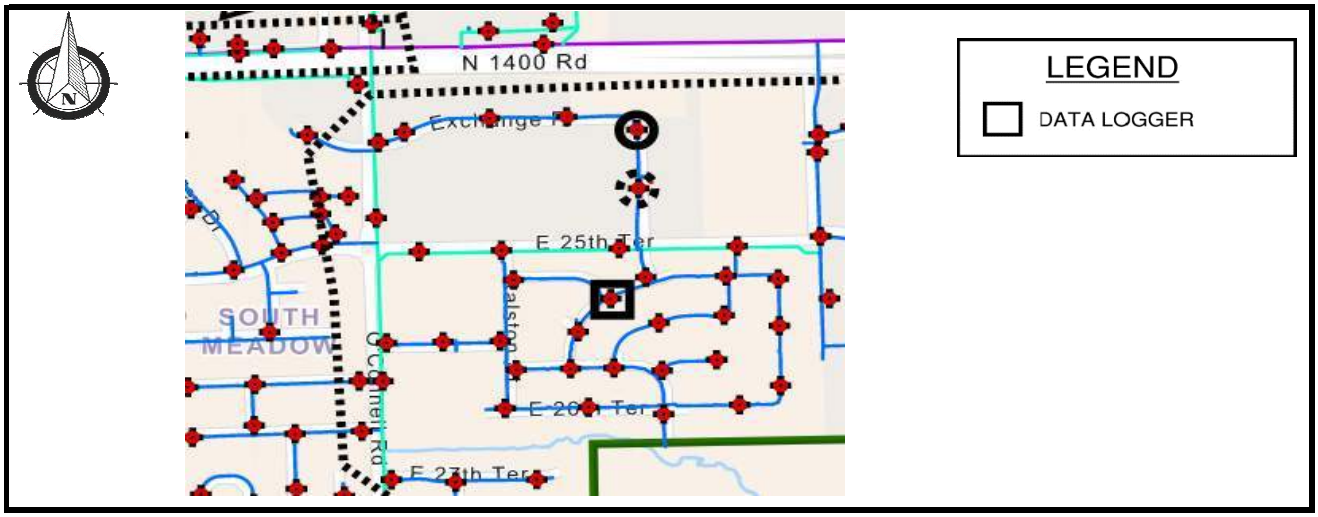
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2882	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	Error [1]	9/19/2023	3:25 PM
Removal:	Error [1]	9/21/2023	3:40 PM

Location: Chasehire Dr & E 25th Pl

Sketch:



Photos:

Note 1: Data Logger Recording Error

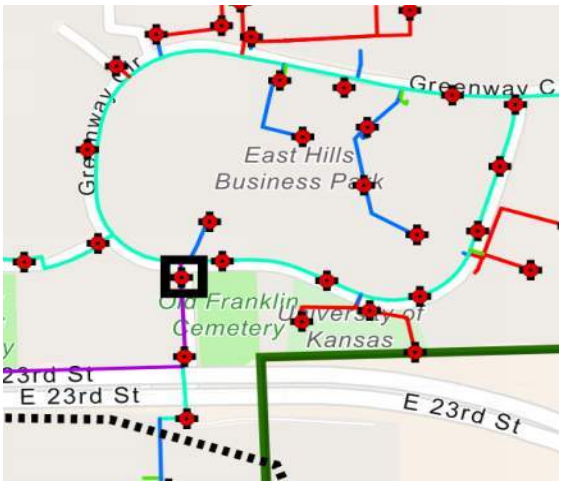
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2885	Main Size:	16"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	51.7	9/20/2023	7:45 AM
Removal:	51.3	9/21/2023	2:56 PM

Location: Greenway Cir & E Hills Dr

Sketch:



LEGEND

DATA LOGGER

Photos:

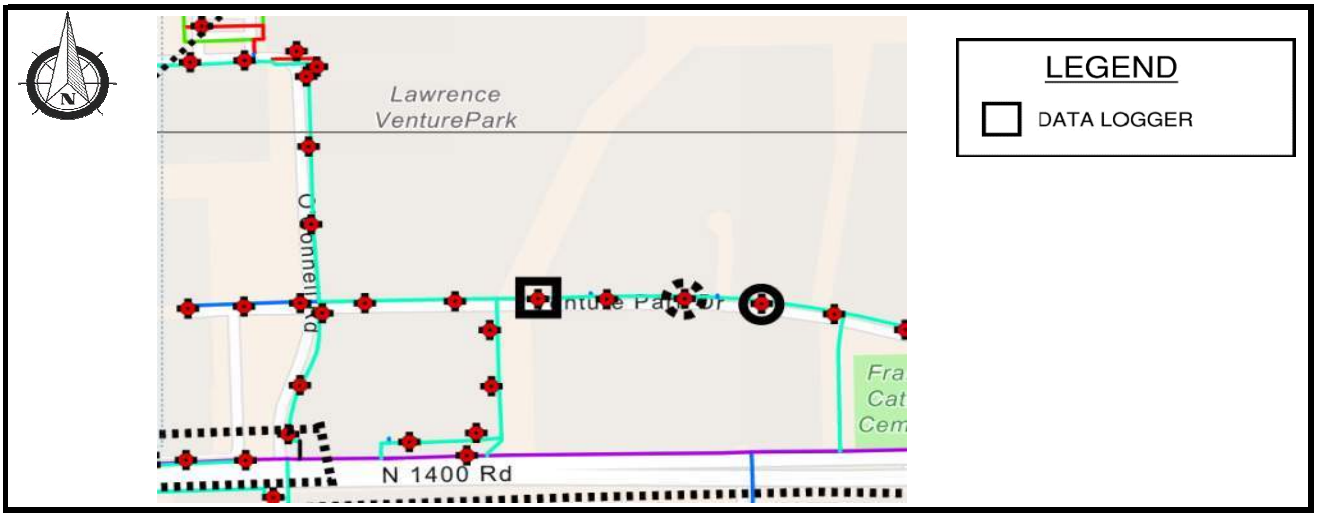
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	206385	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	65.3	9/20/2023	8:05 AM
Removal:	65.3	9/21/2023	3:10 PM

Location: Venture Park Dr

Sketch:



Photos:

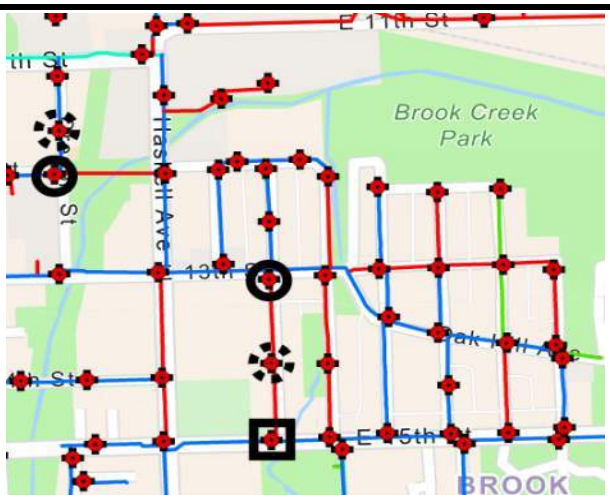
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2888	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	72.2	9/20/2023	8:25 AM
Removal:	72.3	9/21/2023	3:20 PM

Location: E 15th St & Maple Ln

Sketch:



LEGEND
☐ DATA LOGGER

Photos:

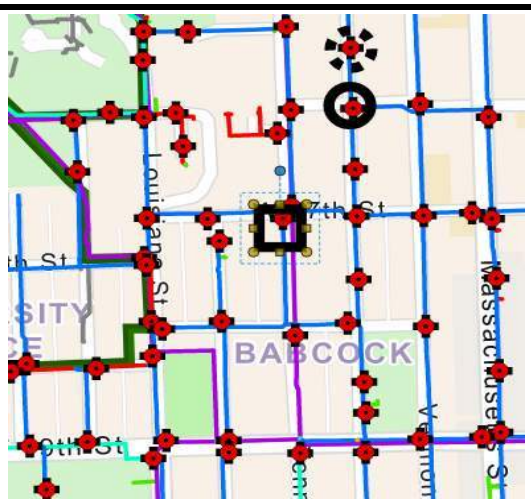
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2895	Main Size:	8"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	50.1	9/20/2023	8:45 AM
Removal:	50.7	9/21/2023	12:56 PM

Location: W 17th St & Tennnessee St

Sketch:



Photos:

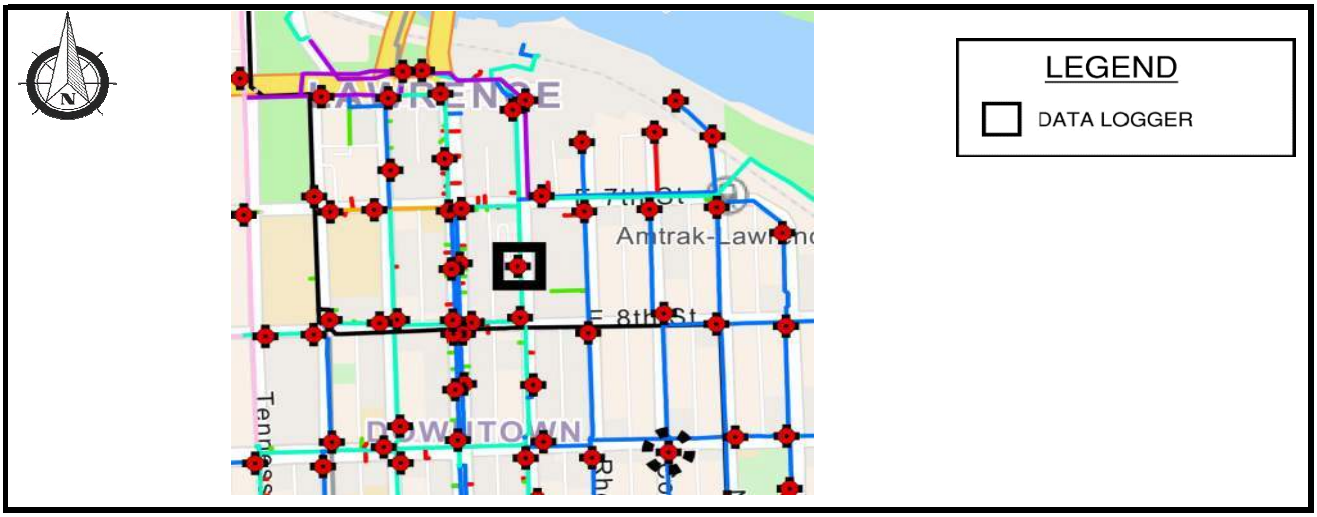
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2893	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	65.3	9/20/2023	9:06 AM
Removal:	65.1	9/21/2023	3:12 PM

Location: E 8th St & New Hampshire St

Sketch:



Photos:

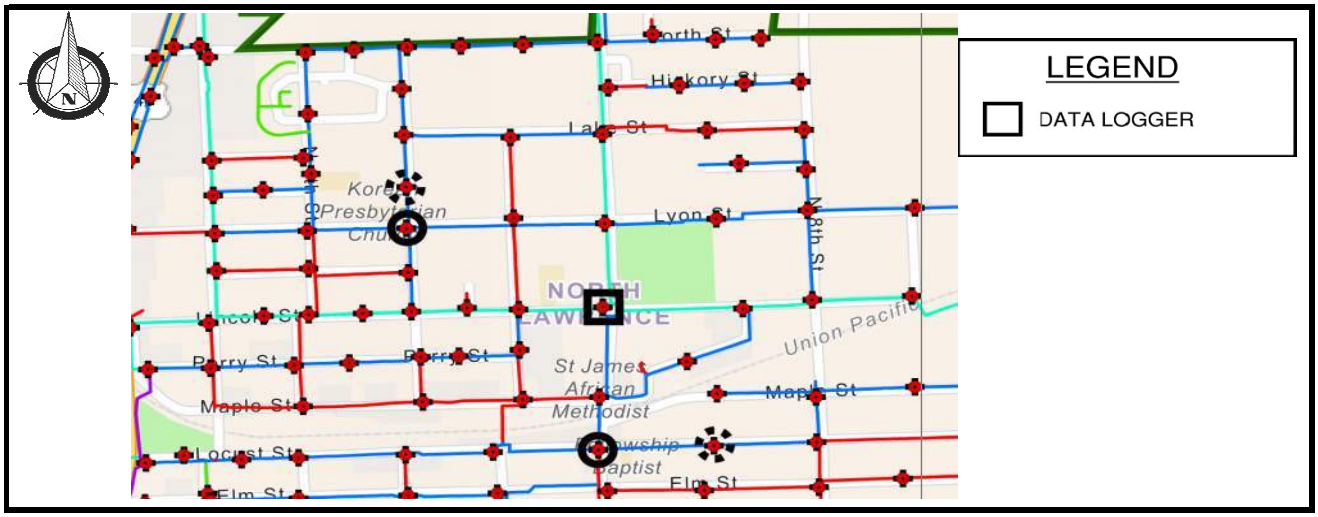
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2897	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	81.1	9/20/2023	9:20 AM
Removal:	86.1	9/21/2023	3:00 PM

Location: Lincoln St & N 7th St

Sketch:



Photos:

Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	206384	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	79.7	9/20/2023	9:40 AM
Removal:	79.2	9/21/2023	2:54 PM

Location: US-40 & Airport Rd

Sketch:

Photos:

Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2896	Main Size:	16"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	55.4	9/20/2023	10:02 AM
Removal:	54.4	9/21/2023	2:46 PM

Location: W 2nd St & McDonald Dr

Sketch:

Photos:

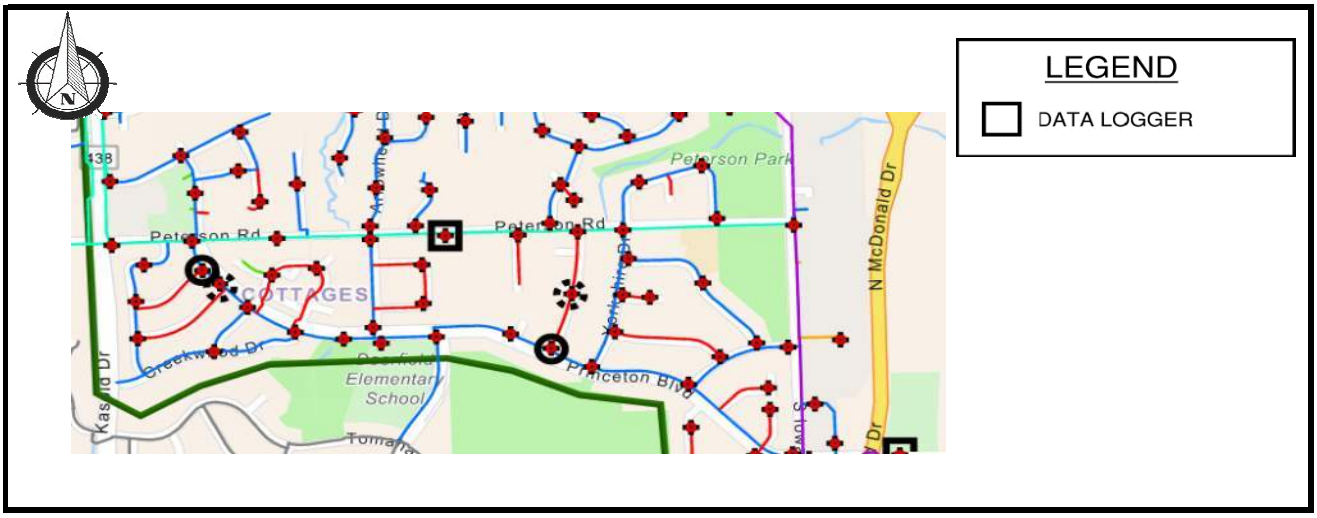
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2894	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	48.2	9/20/2023	10:15 AM
Removal:	41.6	9/21/2023	2:05 PM

Location: Peterson Rd

Sketch:



Photos:

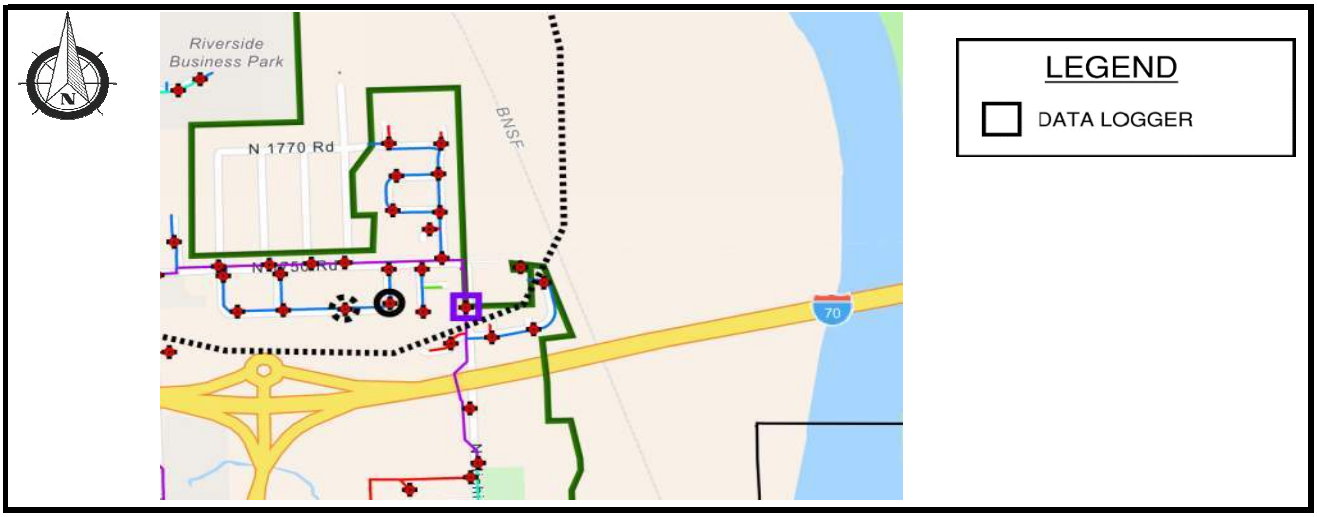
Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	206386	Main Size:	16"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	57.1	9/20/2023	10:33 AM
Removal:	56.1	9/21/2023	2:29 PM

Location: Riverridge Rd & N Michigan St

Sketch:



Photos:

Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	2880	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	45.7	9/20/2023	10:45 AM
Removal:	48.5	9/21/2023	2:16 PM

Location: Packer Rd & N Iowa St

Sketch:

Photos:

Water Distribution System: Lawrence, KS - Central Pressure Zone **Data Logger Installation Form**

Data Logger ID	206383	Main Size:	12"	F.H. Nozzle Diameter:	2.5"

	Pressure (psi)	Date	Time
Install:	43.6	9/20/2023	10:52 AM
Removal:	45.8	9/21/2023	2:20 PM

Location: N 1800 Rd (Lakeview Rd)

Sketch:

Photos:

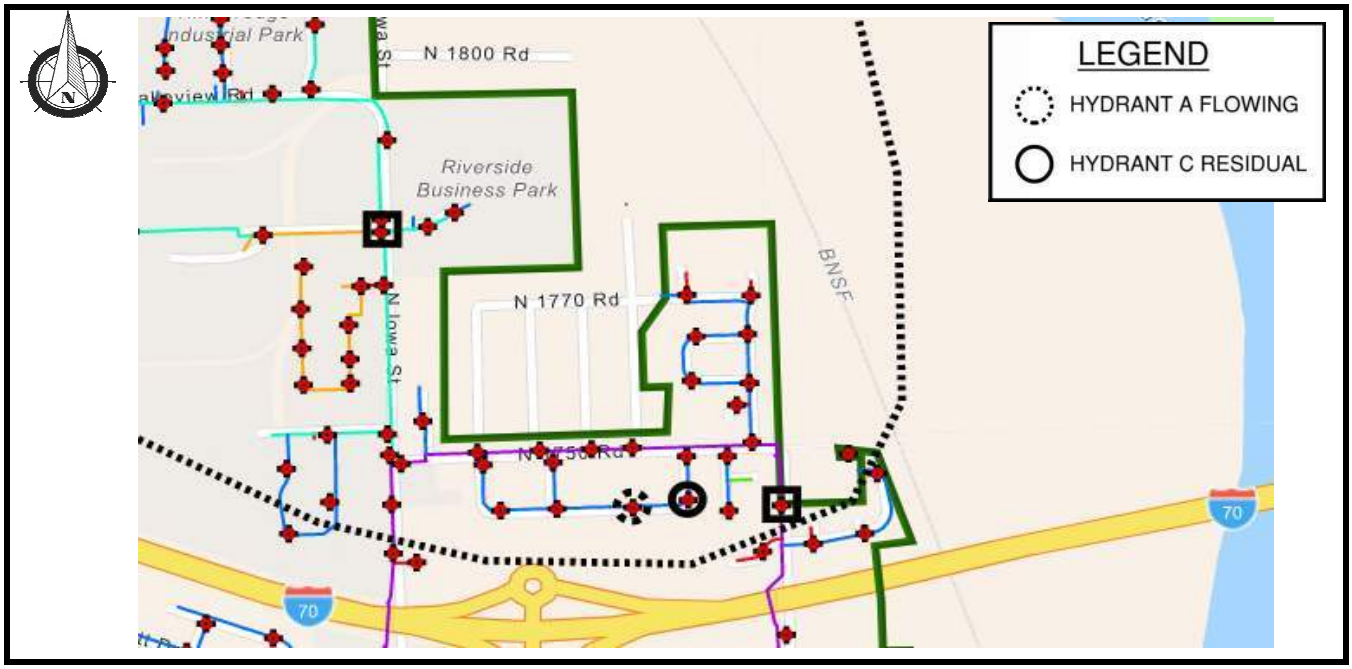
Date:	9/20/2023	Time:	11:22 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	53	44	1,113
Hydrant C:	59	51	

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

Location: Golden Rain Dr & Rebecca Ln

Sketch



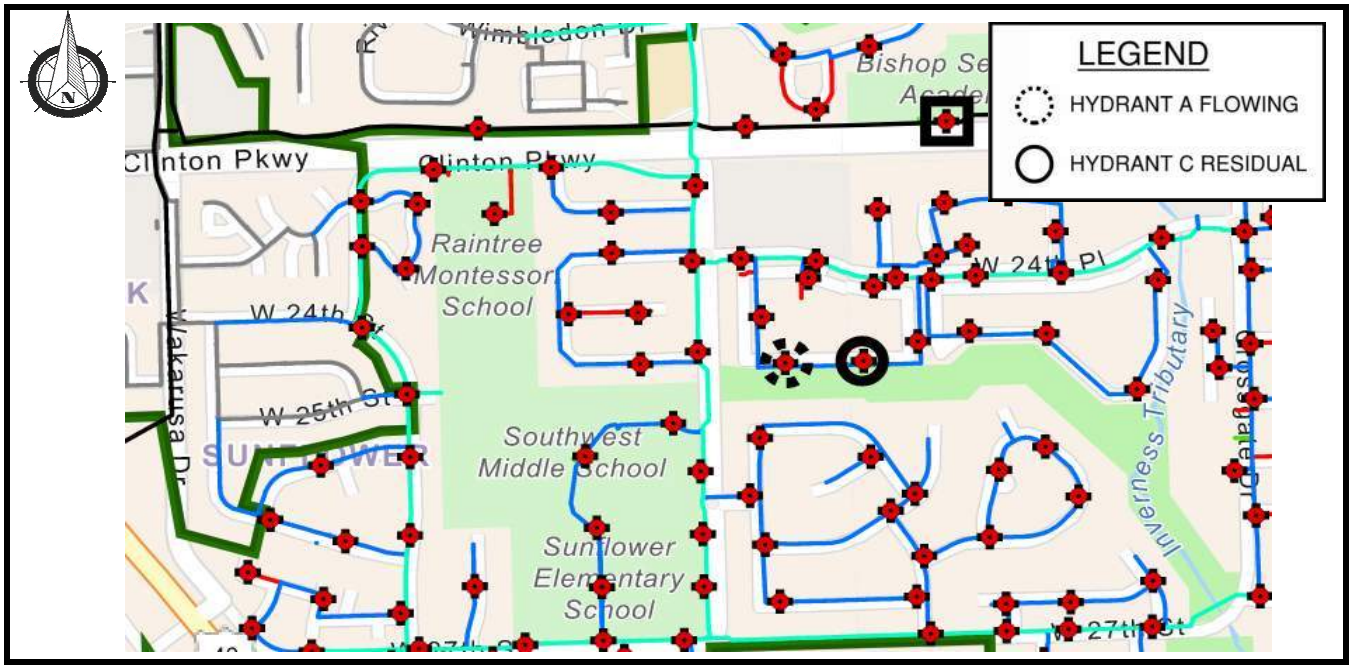
Date:	9/20/2023	Time:	1:12 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	67	60	1,300
Hydrant C:	70	68	

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

Location: W 24th Pl

Sketch



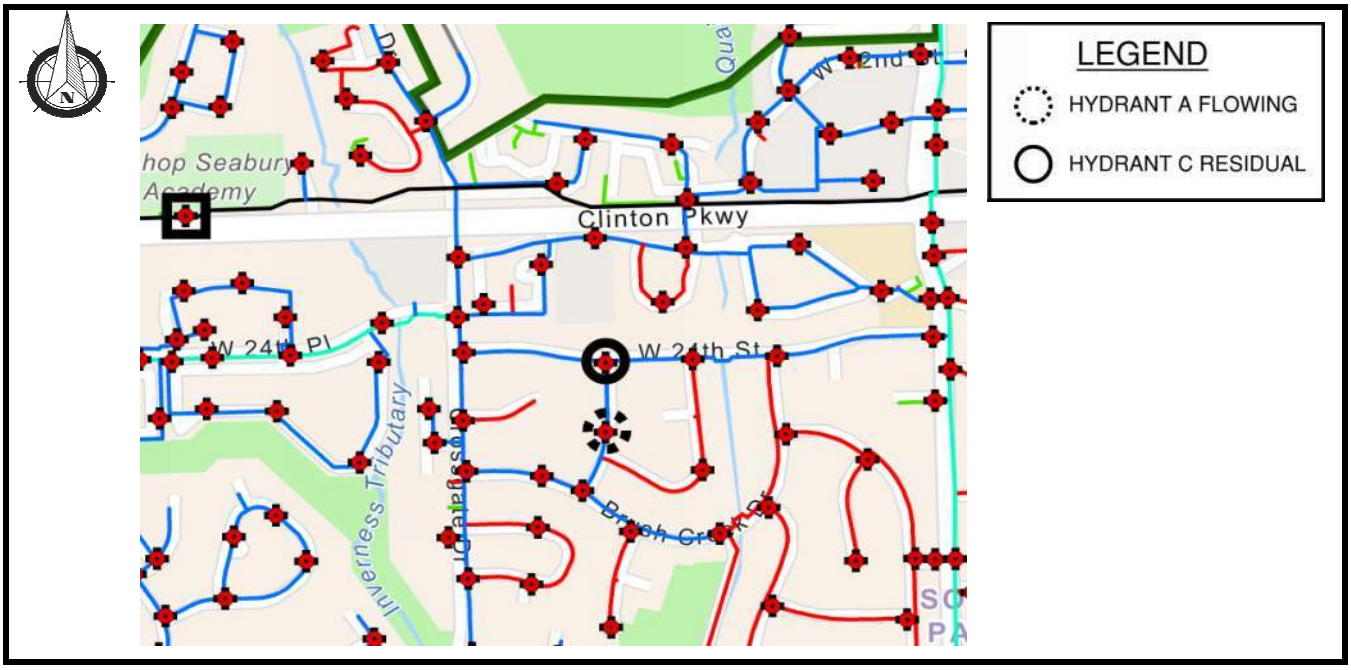
Date:	9/20/2023	Time:	1:30 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	72	64	1,342
Hydrant C:	71	67	

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

Location: Morningside Dr

Sketch



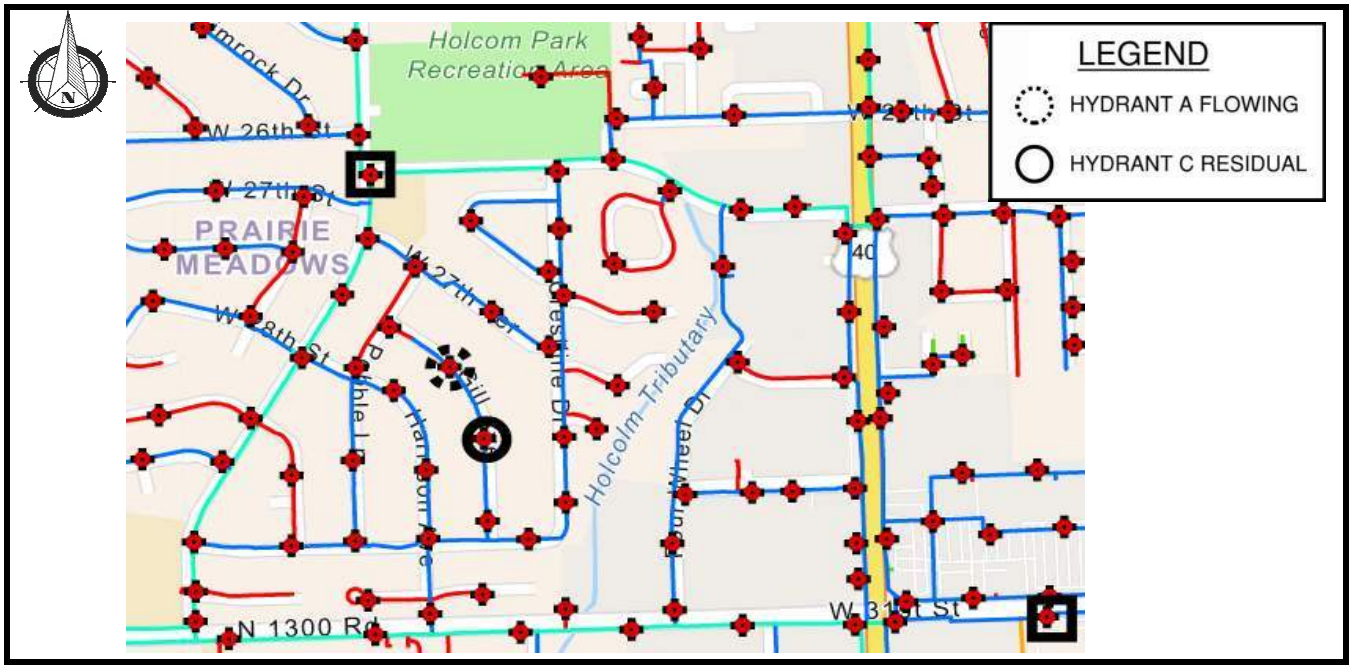
Date:	9/20/2023	Time:	1:53 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	65	59	1,289
Hydrant C:	67	65	

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

Location: Gill Ave

Sketch



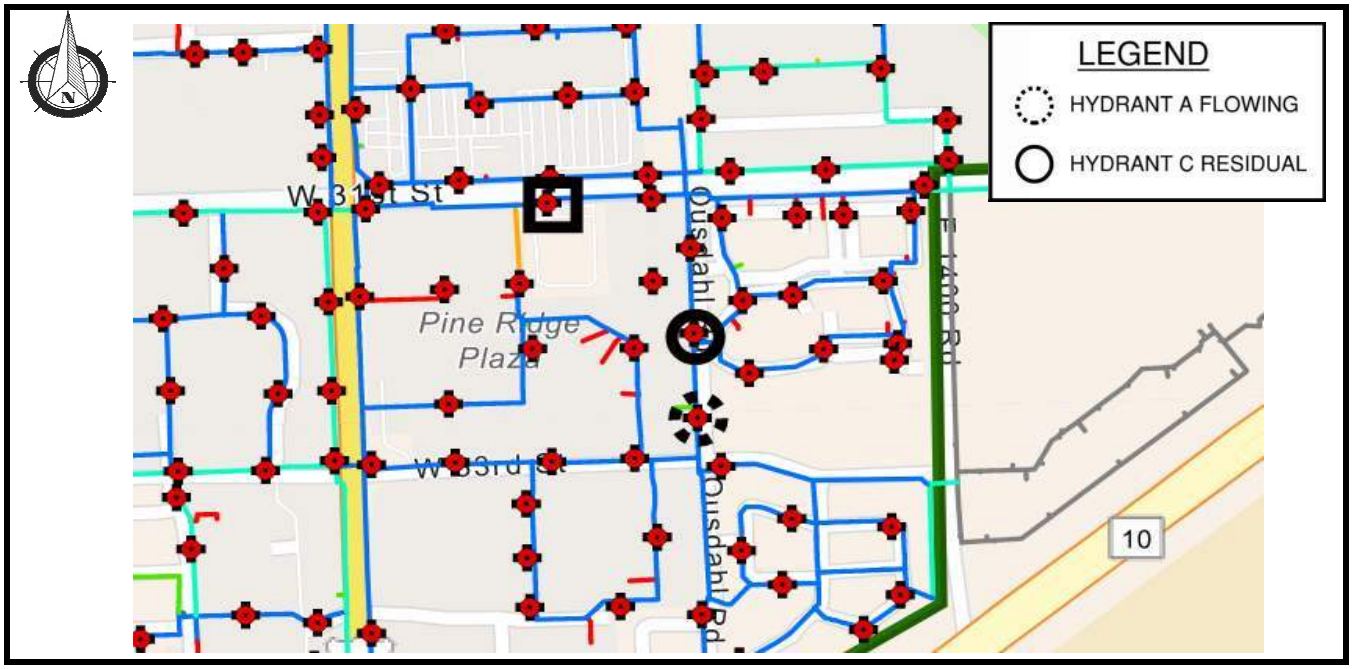
Date:	9/20/2023	Time:	2:26 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	79	72	1,424
Hydrant C:	79	75	

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

Location: Qusdahl Rd

Sketch



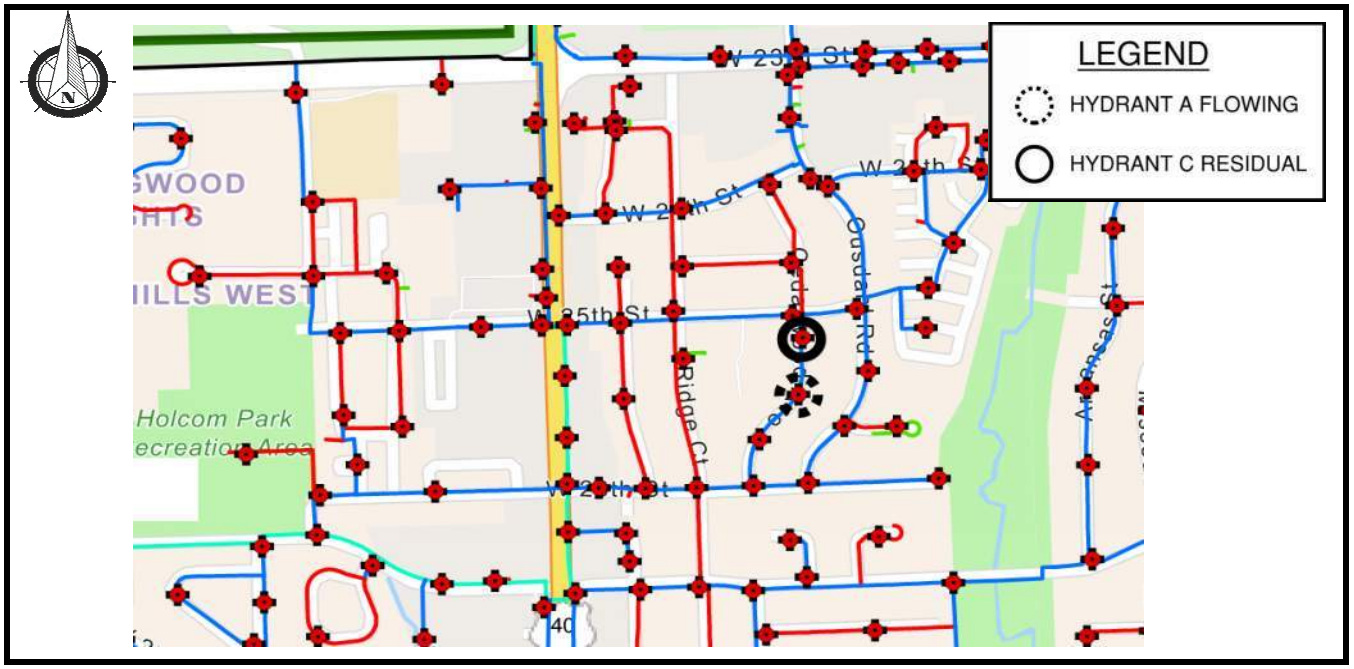
Date:	9/20/2023	Time:	2:55 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	63	58	1,278
Hydrant C:	59	57	

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

Location: Cedarwood Ave

Sketch



Date:	9/20/2023	Time:	3:21 PM
Main Size (in):	12	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	60	55	1,244
Hydrant C:	60	59	

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

Location: Emerald Dr & 21st St

Sketch

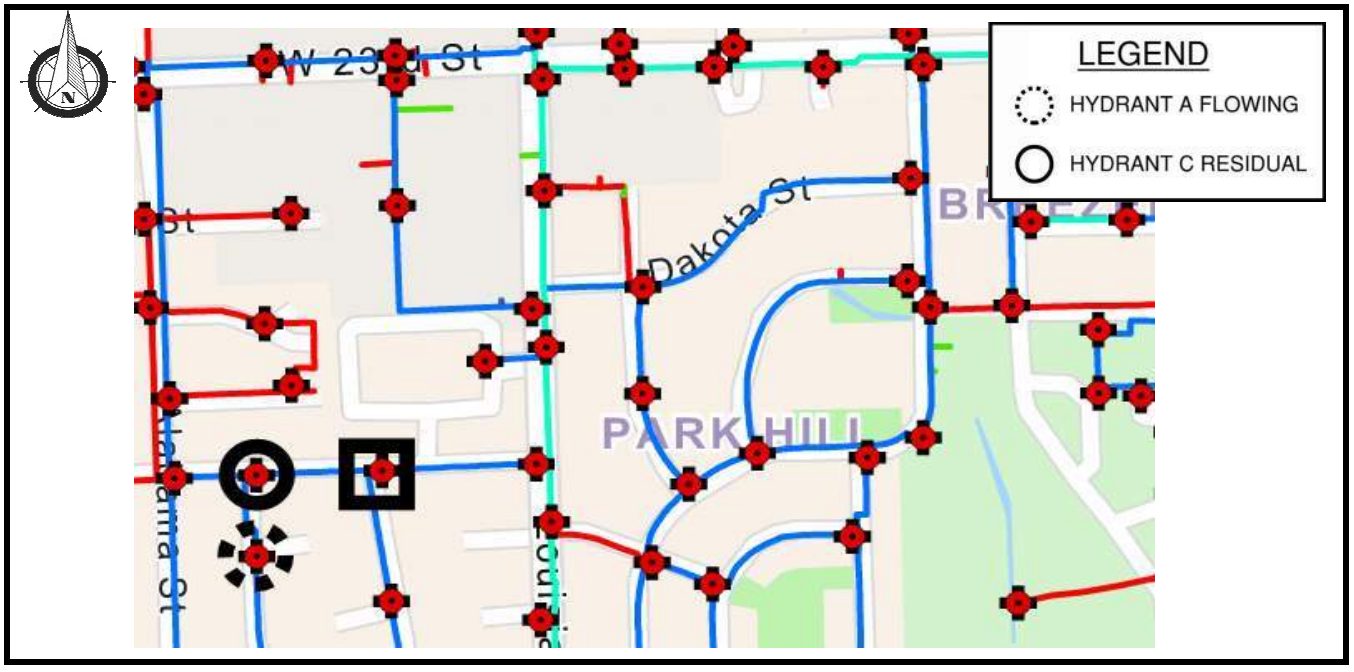
Date:	9/20/2023	Time:	3:44 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	60	54	1,233
Hydrant C:	61	60	

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

Location: Belle Crest Dr & Shelburn Pl

Sketch



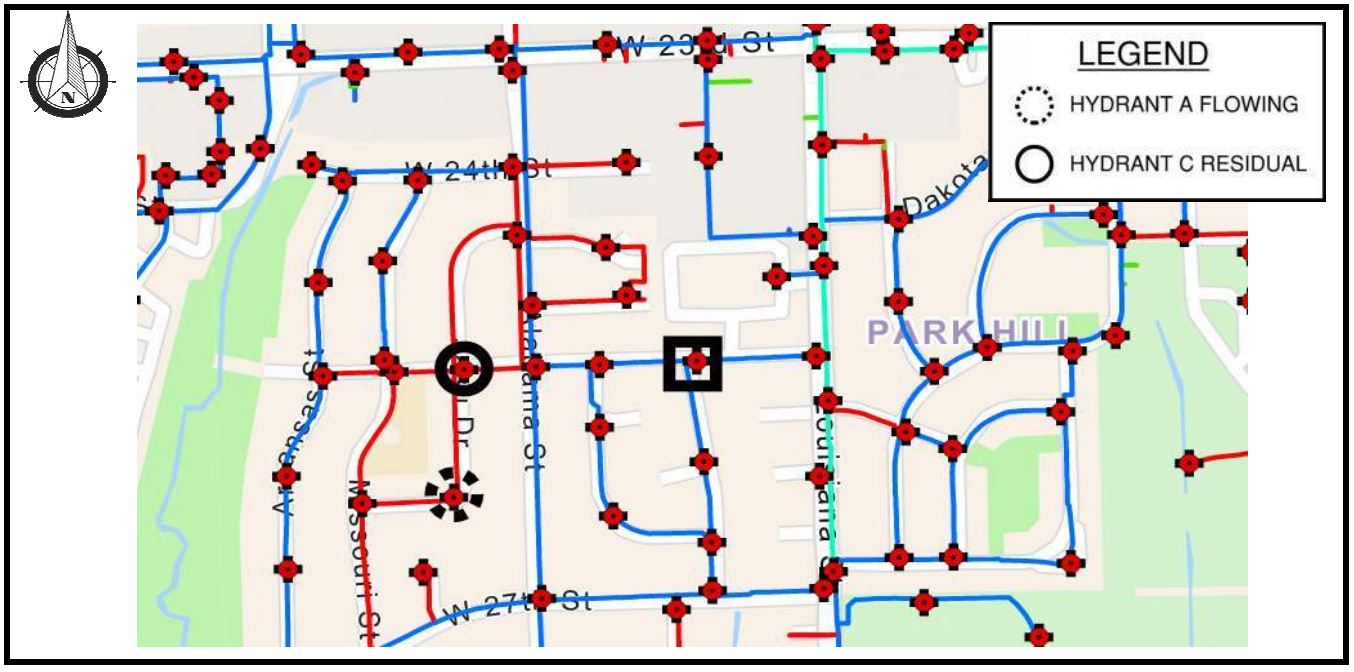
Date:	9/20/2023	Time:	4:04 PM
Main Size (in):	6	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	54	41	1,074
Hydrant C:	49	47	

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

Location: Jasu Dr & W 25th St

Sketch



System: Lawrence, KS - Central Service Pressure Zone **Hydrant Test Form**

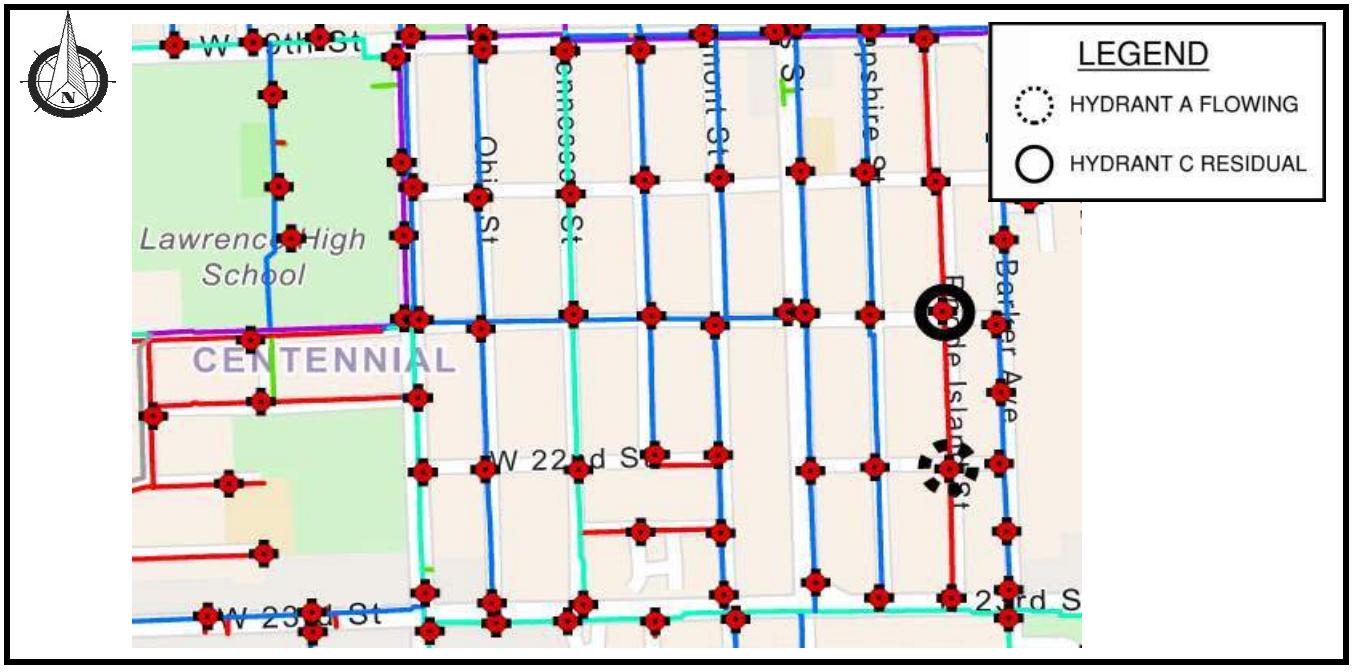
Date:	9/20/2023	Time:	4:32 PM
Main Size (in):	6	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	59	48	1,163
Hydrant C:	66	60	

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

Location: Rhode Island St & E 22nd St

Sketch



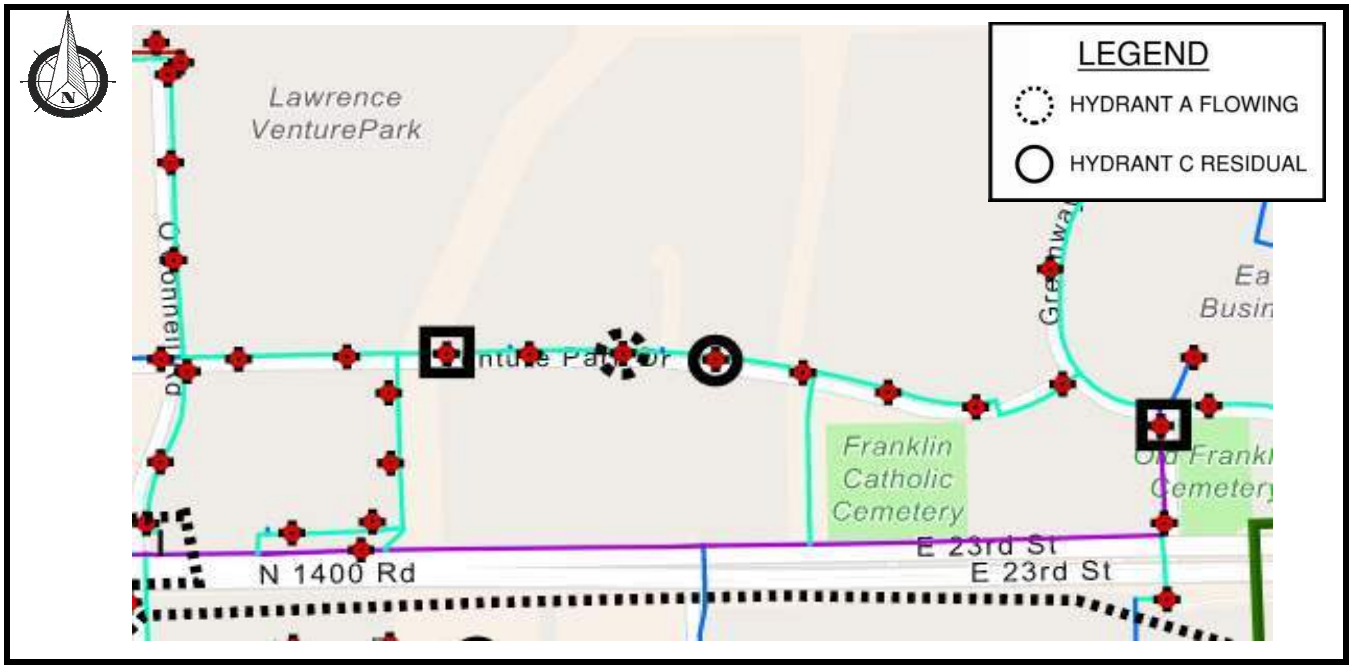
Date:	9/21/2023	Time:	7:38 AM
Main Size (in):	12	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	57	51	1,198
Hydrant C:	56	53	

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

Location: Venture Park Dr

Sketch



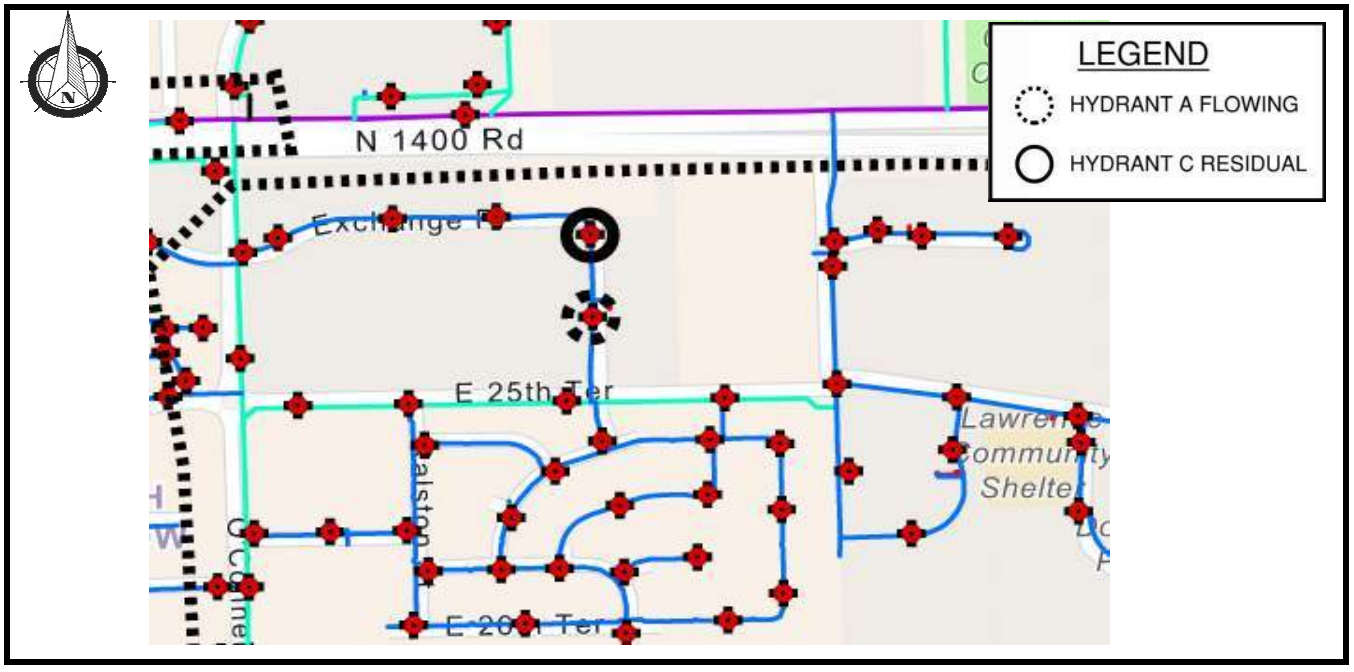
Date:	9/21/2023	Time:	7:53 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	55	49	1,175
Hydrant C:	62	56	

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

Location: Fairfield St & Exchange Pl

Sketch



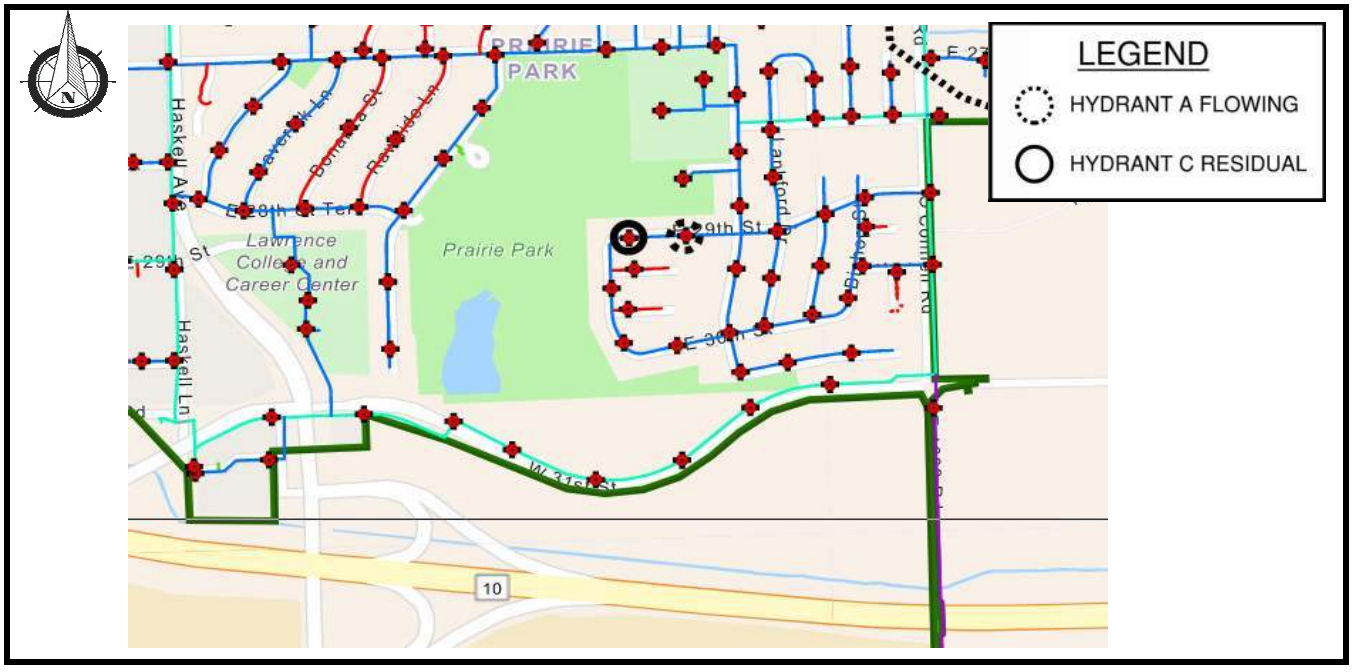
Date:	9/21/2023	Time:	8:12 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	71	59	1,289
Hydrant C:	62	57	

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

Location: E 29th St & Whitmore Dr

Sketch



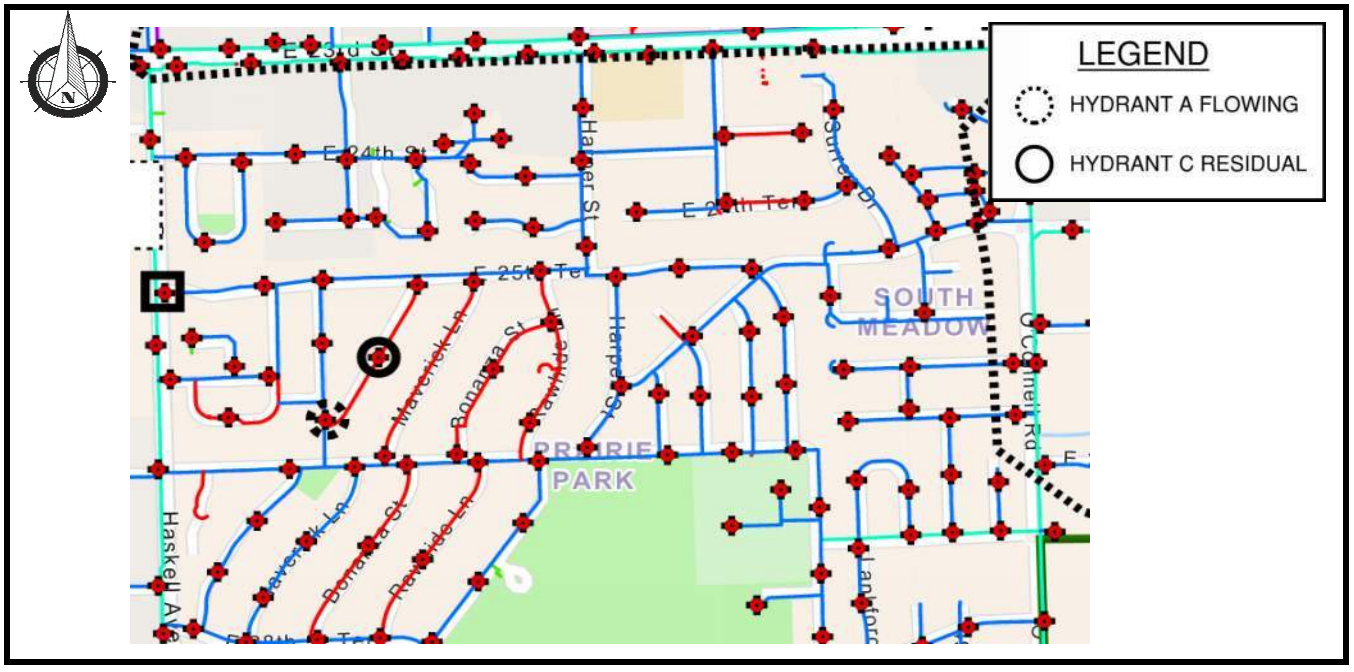
Date:	9/21/2023	Time:	8:38 AM
Main Size (in):	6	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	63	52	1,210
Hydrant C:	65	62	

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

Location: Cimarron Dr

Sketch



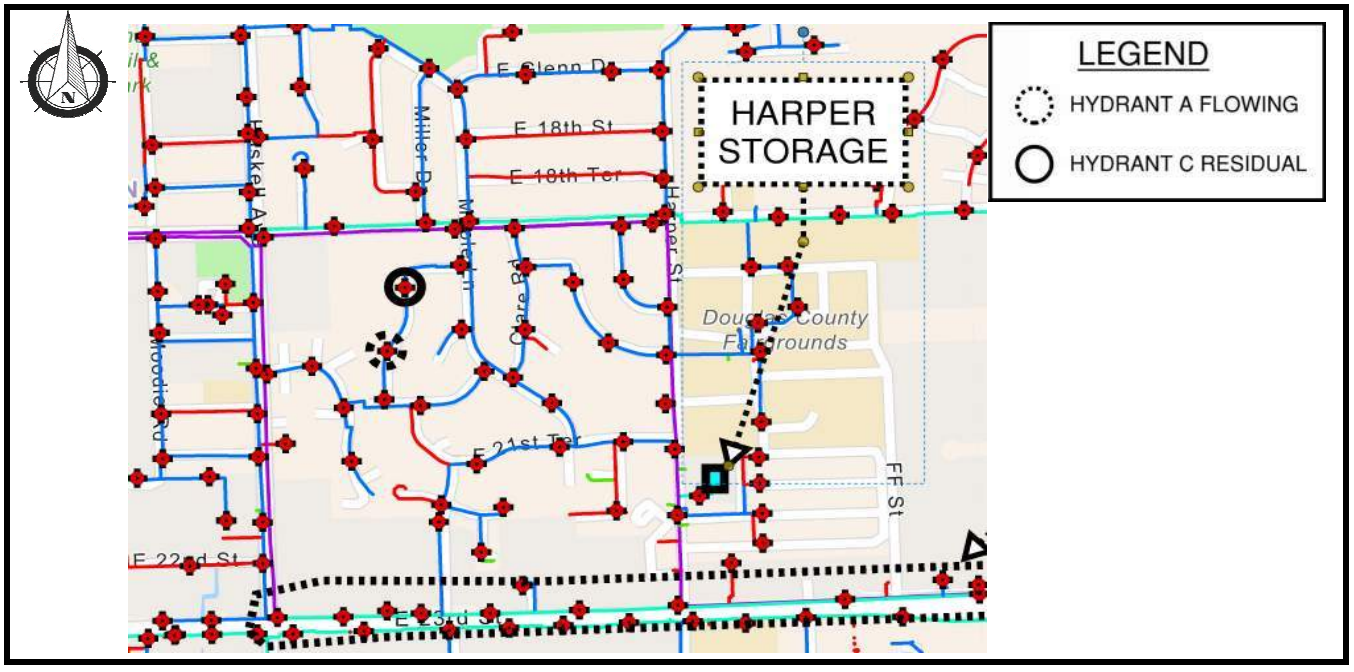
Date:	9/21/2023	Time:	8:54 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	55	49	1,175
Hydrant C:	62	59	

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

Location: Miller Dr & E 21st St

Sketch



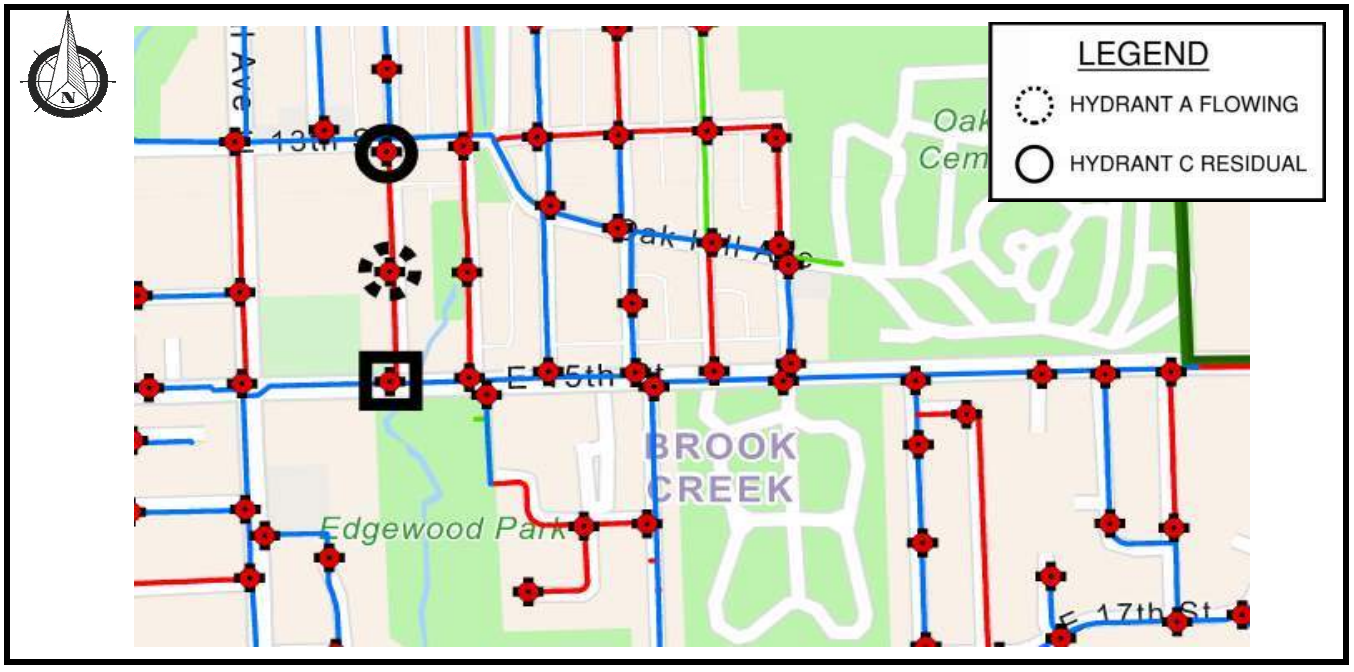
Date:	9/21/2023	Time:	9:16 AM
Main Size (in):	6	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	75	51	1,198
Hydrant C:	77	75	

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

Location: Maple Ln & E 15th St

Sketch



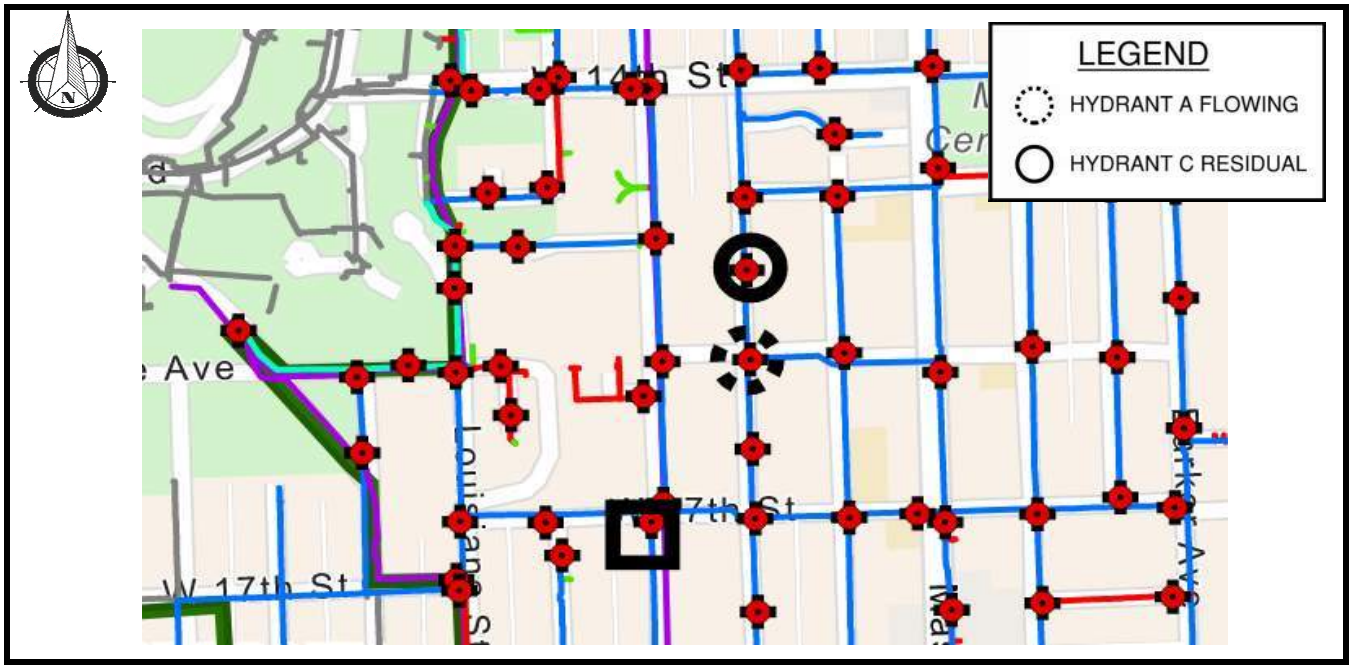
Date:	9/21/2023	Time:	9:53 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	58	53	1,222
Hydrant C:	58	57	

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

Location: Kentucky St & W 16th St

Sketch



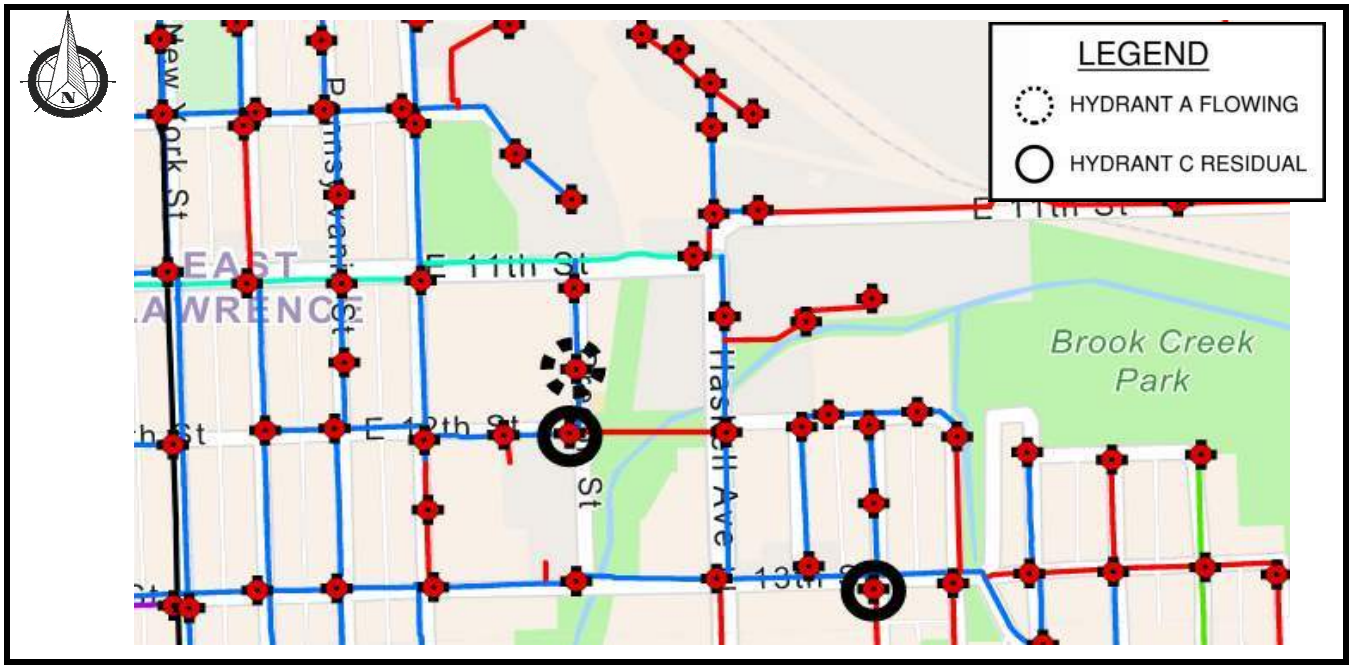
Date:	9/21/2023	Time:	10:15 PM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	77	77	1,472
Hydrant C:	80	78	

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

Location: Oregon St & 12th St

Sketch



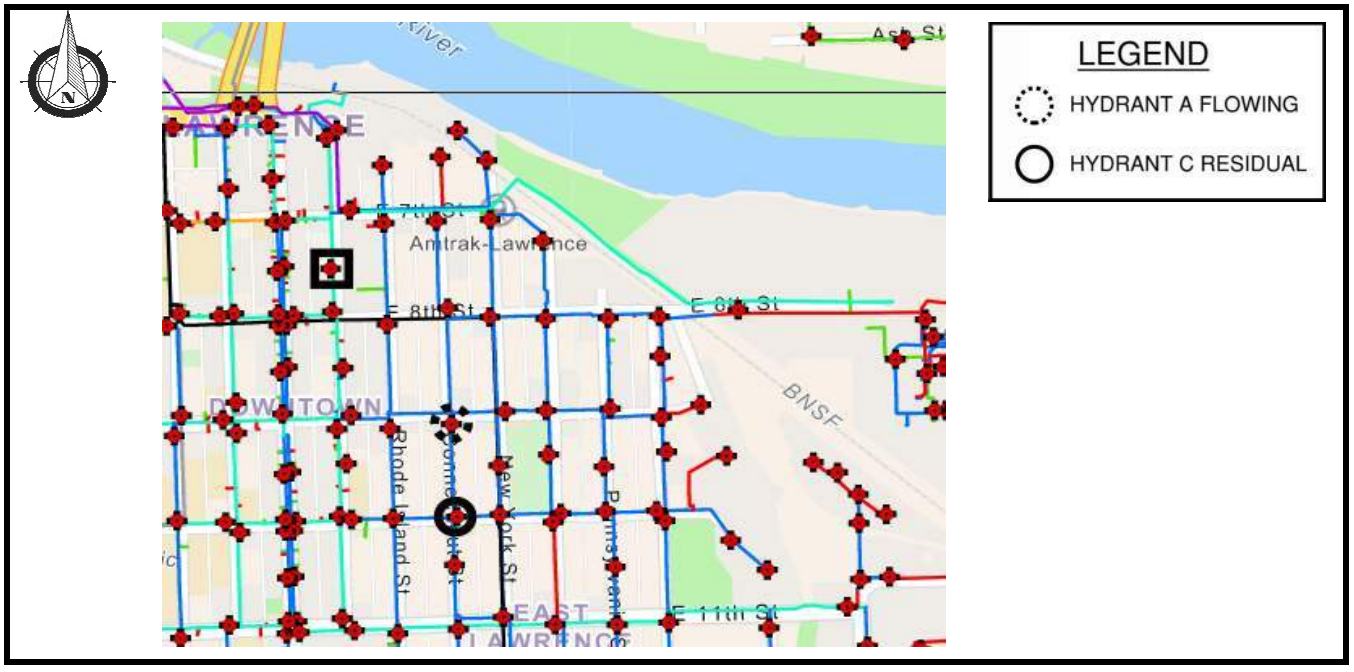
Date:	9/21/2023	Time:	10:42 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	77	65	1,353
Hydrant C:	75	75	

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

Location: Connecticut St & E 10th St

Sketch



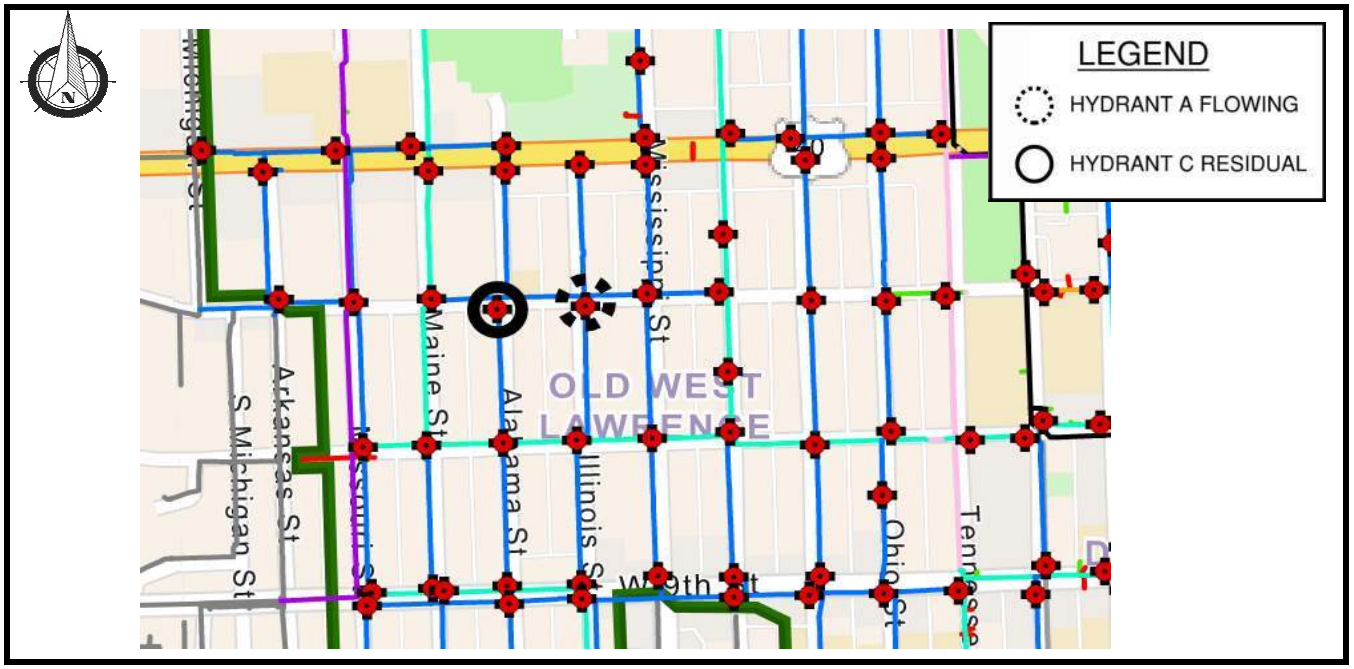
Date:	9/21/2023	Time:	10:58 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	67	52	1,210
Hydrant C:	67.5	67.5	

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

Location: Illinois St & 7th St

Sketch



Date:	9/21/2023	Time:	11:18 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	79	57.5	1,272
Hydrant C:	77	72	

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

Location: Locast St & N 7th St

Sketch

Date:	9/21/2023	Time:	11:40 AM
Main Size (in):	8	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	82	61	1,311
Hydrant C:	81	74	

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

Location: N 5th St & Lyon

Sketch

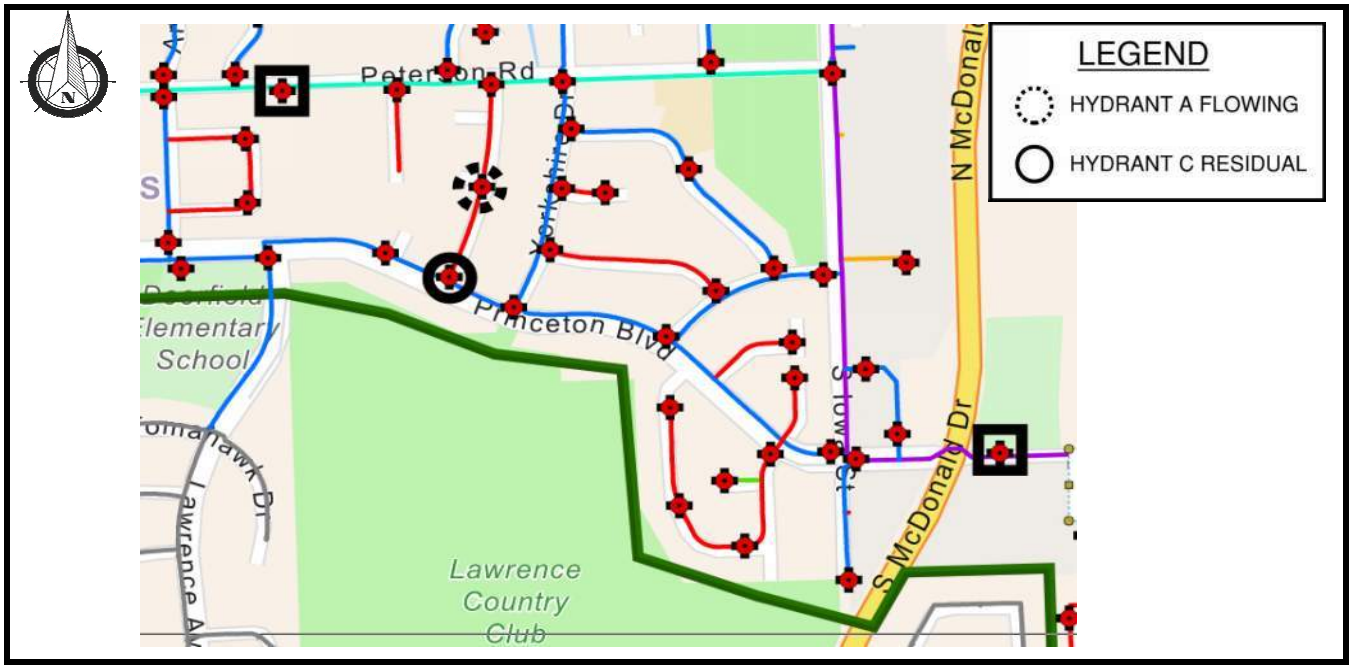
Date:	9/21/2023	Time:	1:19 AM
Main Size (in):	6	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	57	42	1,087
Hydrant C:	61	52	

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

Location: N Crestline Dr & Princeton Blvd

Sketch



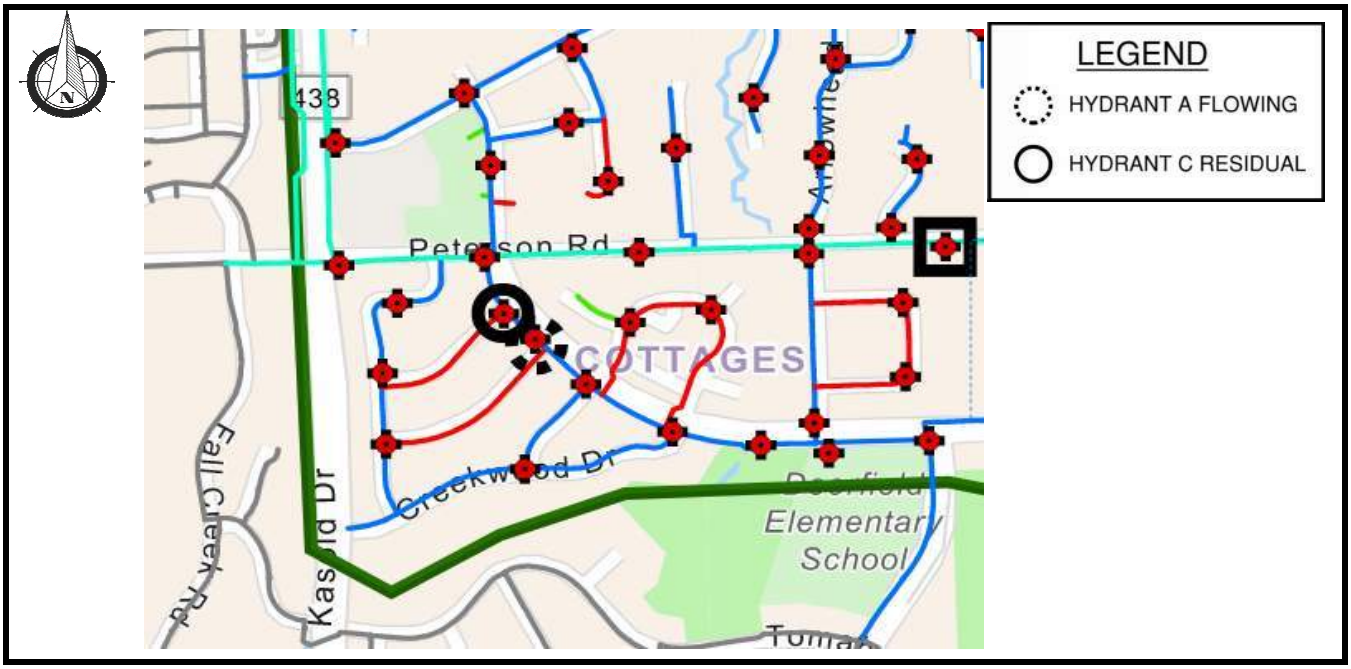
Date:	9/21/2023	Time:	1:19 AM
Main Size (in):	6	FH Nozzle Size (in):	2.5

	Static Pressure (psi)	Residual Pressure (psi)	Calculated Flow[1] (gpm)
Hydrant A:	57	42	1,087
Hydrant C:	61	52	

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

Location: Princeton Blvd & Deerfield Ln

Sketch



Appendix C – Model Calibration Results

Water Distribution System West Hills Pressure Zone: Hydraulic Model Calibration

Fire Hydrant Test Location	Date	Time	Supply: West Hills System Demand	Supply: High Service Pumps KAW WTP: 2rd Floor Flow	Supply: High Service Pumps KAW WTP: 2nd Floor Discharge Pressure	Supply: High Service Pumps Clinton WTP: HSPS1 Flow East	Supply: High Service Pumps Clinton WTP: HSPS1 Flow	Supply: High Service Pumps Clinton WTP: HSPS2 Flow	Supply: High Service Pumps Clinton WTP: HSPS2 Discharge Pressure	Storage: ELEVATED: Stoneridge	Storage: ELEVATED: 6th & Kasold	Storage: ELEVATED: Stratford	Storage: GROUND: 19th & Kasold	Storage: GROUND: 19th & Kasold Booster Flow	Storage: GROUND: Oread North	Storage: GROUND: Oread South	Storage: GROUND: Oread Booster Flow	Storage: GROUND: Oread Reverse Flow from WH	Pressure (psi) Model ID, Data Logger ID, Location: 2880 Stoneridge & Harvard	2881 Crestline Dr & Orchard Ln	2883 Kasold Dr & W 10th Pl	2884 Minnesota St & W 5th St	2885 Inverness Dr & Prestwick Dr	2886 Rock Fence Pl & Rock Fence Ct	2888 S Folks Rd & Briarwood Dr	2889 Century Dr & Madeline Ln	2891 Monteray Way & W 14th Ct	2893 George Williams Way & Rock Chalk Dr	2894 Wakarusa Dr	2895 N Dayilly Dr & Dandy Dr	2896 W 6th St & Wakarusa Dr	2897 Knotted Bend Ct & Running Ridge Dr	206383 Clinton Pkwy & Lake Point Dr	206384 Bob Billings Pkwy & George Williams Way	206385 Goldfield St & Harvard Rd	206386 I-10 feeder & I-40	Hydrant Test[$]: FH-A Flow	FH-A Pressure	FH-C Pressure	Static Reading[$]: FH-A Pressure	FH-C Pressure
			gpm	gpm	psi	gpm	gpm	gpm	psi	ft	ft	ft	ft	gpm	ft	ft	gpm	gpm	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	gpm	psi	psi	psi	psi
Bobwhite Drive							P3 85%	P4 84%		33	27	21	35.50		20.20	20.30																								
Field Data	9/18/2023	13:48:00	6167	0	140	1667	2,778	2,708	87	1,167	1,160	1,166	996	0	1,009	1,009	0	0	72	73	72	123	94	74	65	65	85	76	86	79	67	68	68	77	70	55	1,453	75	83	89	86
Model Results				0	140		2,832	2,735	91					0			0	0	73	74	71	123	96	74	65	65	84	75	86	77	68	66	81	77	70	55	1,453	77	83	88	88
Diamondhead Dr							P3 85%	P4 82%		33	27	21	36		21	21																								
Field Data	9/18/2023	14:09:00	6167	0	139	1667	2,778	2,361	87	1,167	1,160	1,165	996	0	1,010	1,010	0	0	73	73	72	123	94	74	66	64	85	76	86	79	67	67	69	78	70	56	1,394	69	70	76	73
Model Results				0	140		2,862	2,416	90					0					73	74	71	123	96	74	65	65	84	75	85	77	68	66	80	78	70	55	1,394	70	67.5	75	71
Stonecreek Dr							P3 85%	P4 82%		32	27	20	36		21	21																								
Field Data	9/18/2023	14:29:00	6069	0	139	1667	2,778	2,361	87	1,166	1,160	1,165	996	0	1,010	1,010	0	0	72	72	72	123	94	74	65	64	85	75	86	79	67	68	69	78	70	55	1,404	70	70	75	72
Model Results				0	140		2,880	2,437	90					0					72	73	71	123	95	73	65	65	84	75	85	77	67	66	80	78	70	55	1,404	70	72	75	75
Fort Laramie Dr								P4 83%		32	27	20	35.50		21.10	21.10																								
Field Data	9/18/2023	14:51:00	4500	0	138	0	0	2778	84	1,166	1,160	1,164	995.5	0	1010.1	1010.1	0	0	72	72	71	122	92	73	64	64	84	75	85	78	66	67	66	77	69	54	1,256	56	71	70	72
Model Results				0	140		0	2,859	87					0					72	74	71	123	94	74	65	65	84	74	85	77	67	66	77	78	69	55	1,256	68	73	69	74
Carson Pl								P4 81%		31.00	27.20	19.20	35.50		21.00	21.10																								
Field Data	9/18/2023	15:07:00	4500	0	139	0	0	2569	85.5	1165.0	1159.7	1163.7	995.5	0	1010.0	1010.1	0	0	71	71	70	122	92	73	63	63	83	74	84	77	65	66	67	77	69	54	1,321	62	70	71	74
Model Results				0	140		0	2581	86					0					71	73	71	123	93	73	64	64	83	74	83	77	66	66	76	77	69	54	1,321	66	72	72	76
Earhart Cir								P4 81%		29.90	27.20	18.50	35.50		20.90	21.00																								
Field Data	9/18/2023	15:23:00	6569	0	138	0	0	2639	85	1163.9	1159.7	1163.0	995.5	0	1009.9	1010.0	0	0	71	71	70	122	91	73	63	63	83	73	83	77	65	66	67	76	68	53	1,414	71	79	77	82
Model Results				0	139		0	2652	85					0					71	72	70	122	92	72	63	64	82	73	82	76	65	65	75	76	68	54	1,414	71	80	78	85
Hartland Dr								P4 81%		28.70	27.20	17.40	35.50		21.00	21.10																								
Field Data	9/18/2023	15:45:00	6639	0	138	0	0	2639	85.3	1162.7	1159.7	1161.9	995.5	0	1010.0	1010.1	0	0	70	71	69	121	91	72	63	62	82	73	83	76	64	65	66	76	67	54	1,389	69	69	69	71
Model Results				0	139		0	2687	84					0					70	72	70	121	91	72	63	63	82	73	83	75	65	64	75	76	67	53	1,389	62	69	69	73
Andover St								P4 81%		27.70	27.20	16.60	35.50		21.50	21.50																								
Field Data	9/18/2023	16:02:00	6639	0	138	0	0	2639	85	1161.7	1159.7	1161.1	995.5	0	1010.5	1010.5	0	0	70	70	69	120	90	72	62	62	82	73	83	76	64	65	65	75	67	53	1,353	65	66	71	69
Model Results				0	138		0	2705	84					0					70	72	69	121	91	72	63	63	81	73	83	75	65	64	74	75	67	53	1,353	68	65	72	71
W 10th St								P4 81%		26.60	27.10	15.60	35.50		21.20	21.20																								
Field Data	9/18/2023	16:22:00	6932	0	136	0	0	2708	84.8	1160.6	1159.6	1160.1	995.5	0	1010.2	1010.2	0	0	69	70	68	120	90	71	62	61	82	73	82	76	64	64	65	75	67	53	1,353	65	58	74	64
Model Results				0	137		0	2731	84					0					69	71	68	120	91	71	62	62	81	72	82	74	64	63	74	75	67	52	1,353	62	55	74	66
Avalon Rd								P4 89.5% & P5 89%		23.90	27.40	14.50	51.90		26.30	26.40																								
Field Data	9/19/2023	7:53:00	10725	1180	138	0	0	7083	88	1157.9	1159.9	1159.0	1011.9	0	1015.3	1015.4	0	0	69	69	69	119	91	71	62	61	82	72	83	76	64	64	66	75	67	52	1,443	74	69	82	71
Model Results				1244	138		0	7123	91					0					69	69	68	119	93	70	62	61	81	71	82	73	64	62	80	75	67	51	1,443	75	67	80	71
Stratford Rd								P4 & P5 89%		23.70	27.10	13.70	51.90		25.50	25.60																								
Field Data	9/19/2023	8:16:00	10947	1180	137	0	0	7083	87.6	1157.7	1159.6	1158.2	1011.9	0	1014.5	1014.6	0	0	69	68	69	120	91	71	62	61	82	72	82	76	64	64	65	75	67	52	1,453	75	75	92	81
Model Results				1243	138		0	7086	90					0					69	68	68	119	93	69	62	60	81	71	82	73	64	62	79	74	66	51	1,453	79	72	91	80
Schwarz Rd								P4 & P5 89%		23.80	26.80	13.60	51.00	P2 90%	24.60	24.70																								
Field Data	9/19/2023	8:35:00	10947	1180	137	0	0	7013	88	1157.8	1159.3	1158.1	1011.0	1805	1013.6	1013.7	0	0	69	70	69	120	91	71	62	61	82	72	83	76	64	64	66	75	67	52	1,222	53	64	68	66
Model Results				1234	139		0	7026	91					1794					69	70	70	120	94	70	62	61	82	71	82	74	64	63	80	75	67	51	1,222	63	63	65	64
Trail Rd & Millstone Dr								P4 & P5 86%		24.50	27.00	14.00	49.20	P2 95%	23.20	23.20																								
Field Data	9/19/2023	9:04:00	8333	2153	141	0	0	6250	87.3	1158.5	1159.5	1158.5	1009.2	2014	1012.2	1012.2	0	0	70	71	70	122	92	71	63	62	83	73	83	76	64	64	66	76	68	52	1,210	52	60	65	61
Model Results				2282	146		0	6220	90					2010					70	72	71	123	94	68	63	63	83	72	82	73	65	63	79	75	68	52	1,210	56.0	60	63.0	64
Ranger Dr & Saddlehorn Dr								P4 87% & P5 82%		25.20	26.60	14.90	48.00	P2 97%	22.20	22.30																								
Field Data	9/19/2023	9:25:00	6611	2222	140	0	0	5764	86	1159.2	1159.1	1159.4	1008.0	2083	1011.2	1011.3	0	0	70	71	70	122	91	71	63	63	83	73	83	76	64	64	66	76	68	53	1,592	90	104	108	107
Model Results				2270	147		0	5750	89					2090					70	73	71	124	94	73	64	64	84	72	83	76	65	65	79	76	69	52	1,592	88	100	107	107
Fall Creek Rd & Hidden Ln								P4 82.5% & P5 82%		25.60	26.90	15.50	47.10	P2 96%	21.90	21.90																								
Field Data	9/19/2023	9:40:00	6611	2153	142	0	0	5208	86.4	1159.6	1159.4	1160.0	1007.1	2014	1010.9	1010.9	0	0	70	71	70	122	91	72	63	63	83	73	83	74	64	62	66	76	68	53	1,342	64	70	70	72
Model Results				2266	147		0	5183	88					2031					70	73	71	124	93	71	63	64	84	72	83	72	65	60	78	76	68	52	1,342	61	66	69	73
N Dayilly Dr								P4 & P5 82%		26.10	26.90	16.20	46.10	P2 94.5%	21.50	21.50																								
Field Data	9/19/2023	9:58:00	6147	1180	138	0	0	5139	87	1160.1	1159.4	1160.7	1006.1	1944	1010.5	1010.5	0	0	70	71	70	121	92	71	63	62	83	73	83	71	65	63	66	76	68	53	1,342	64	68	71	73
Model Results				1206	142		0	5091	88					1941					70	73	71	123	93	71	63	64	84	72	83	69	65	62	78	76	68	52	1,342	60	64	70	73
Aster St & N Pennycress Dr								P4 83% & P5 82%		26.30	26.90	16.40	45.20	P2 95%	21.00	21.10																								
Field Data	9/19/2023	10:14:00	6147	1180	139	0	0	5208	86.5	1160.3	1159.4	1160.9	1005.2	1944	1010.0	1010.1	0	0	70	71	70	122	92	71	63	63	83	73	83	72	65	63	66	76	68	53	1,256	56	59	64	63
Model Results				1205	142		0	5213	89					1956					70	73	71	123	94	71	63	64	84	73	83	70	65	62	79	76	68	53	1,256	53	56	64	64
Trail Rd & Terri Ct								P4 82% & P5 82.5%		26.50	26.90	16.50	44.30	P2 95%	20.60	20.70																								
Field Data	9/19/2023	10:30:00	7458	1180	138	0	0	5208	87	1160.5	1159.4	1161.0	1004.3	1944	1009.6	1009.7	0	0	70	71	70	122	92	72	63	63	83	73	83	77	65	65	66	76	68	53	1,311	61	63	69	66
Model Results				1207	142		0	5185	88					1955					70	73	71	123	93	72	63	64	83	73	83	75	65	64	78	76	68	53	1,311	63	64	68	67
Prestwick Dr & Inverness Dr								P4 & P5 82%		26.90	26.90	16.80	43.10	P2 93.5%	20.10	20.10																								
Field Data	9/19/2023	10:53:00	7208	1180	139	0	0	5208	86.8	1160.9	1159.4	1161.3	1003.1	1875	1009.1	1009.1	0	0	70	72	71	122	91	73	63	63	83	73	84	77	65	66	66	76	68	53	1,538	84	87	92	90
Model Results				1205	142		0	5230	87					1868					70	73	71	123	91	73	63	64	83	73	83	76	65	65	77	76	68	53	1,538	86	86	93	92
Turnberry Dr								P4 & P5 83%		27.10	26.90	17.10	42.10	P2 94%	19.70	19.70																								
Field Data	9/19/2023	11:10:00	7208	1180	138	0	0	5486	86	1161.1	1159.4	1161.6	1002.1	1875	1008.7	1008.7	0	0	70	71	71	122	89	73	64	63	83	73	84	77	65	66	65	76	68	53	1,547	85	90	95	94
Model Results				1204	142		0	5522	88					1880					70	73	71	123	92	73	64	64	83	73	83	76	65	65	78	76	68	53	1,547	88	90	96	98

Water Distribution System Central Service Pressure Zone: Hydraulic Model Calibration

Fire Hydrant Test Location	Date	Time	Central Service System Demand	Supply					Storage				Pressure (psi) Model ID, Data Logger ID, Location																Hydrant Test[5]			Static Reading[5]	
				High Service Pumps KAW WTP		High Service Pumps Clinton WTP			Ground			Elevated	2880	2881	2883	2884	2885	2886	2888	2889	2891	2893	2894	2895	2896	2897	206383	206384	206385	206386	FH-A		FH-C	FH-A	FH-C
				2rd Floor Flow	2nd Floor Discharge Pressure	HSPS1 Flow West	HSPS2 Flow	HSPS2 Discharge Pressure	19th & Kasold	Oread North	Oread South	Harper	Packer Rd & N Iowa St	Clinton Pkwy Frontage	E 25th Terrace & Haskell Ave	W 25th St & Belle Haven Dr	Greenway Cir & E Hills Dr	W 31st St in Pine Ridge Plaza	E 15th St & Maple Ln	Lawrence Ave & W 27th St	W 22nd St & Iowa St	E 8th St & New Hampshire St	Peterson Rd	W 17th St & Tennnessee St	W 2nd St & McDonald Dr	Lincoln St & N 7th St	N 1800 Rd (Lakeview Rd)	US-40 & Airport Rd	Venture Park Dr	Riverridge Rd & N Michigan St	Flow	Pressure	Pressure	Pressure	Pressure
			gpm	gpm	psi	gpm	gpm	psi	ft	ft	ft	ft	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	gpm	psi	psi	psi	psi
Golden Rain Dr & Rebecca Ln				P4 ON					40.3	16.8	16.8	27.7																						
Field Data	9/20/2023	11:22:00	4373	2430	67	0	0	18	1,000.3	1,005.8	1,005.8	1,005.2	41	59	53	65	51	68	71	53	51	64	41	50	52	81	38	78	64	50	1,113	44	51	53	59
Model Results				2712	73	0	0	14					45	56	54	64	51	66	72	51	50	65	44	48	53	81	41	80	63	52	1,113	48	52	54	58
W 24th Pl				P3 & P4 ON					36.0	19.3	19.4	27.7																						
Field Data	9/20/2023	13:10:00	2703	4722	72	0	0	20	996.0	1,008.3	1,008.4	1,005.2	50	60	56	67	53	70	73	55	53	66	51	52	58	85	47	82	66	60	1,300	60	68	67	70
Model Results				5277	77	0	0	13					52	55	55	65	51	66	73	50	50	67	52	49	60	86	49	84	64	60	1,300	58	59	64	65
Morningside Dr				P3 & P4 ON					36.0	20.2	20.2	27.7																						
Field Data	9/20/2023	13:30:00	2329	4722	71	0	0	21	996.0	1,009.2	1,009.2	1,005.2	49	61	56	68	53	70	74	55	53	66	50	52	58	84	47	81	66	59	1,342	64	67	72	71
Model Results				5265	77	0	0	13					53	56	55	65	52	66	74	51	51	67	52	49	60	86	49	84	64	60	1,342	62	61	69	66
Gill Ave				P3 & P4 ON					36.0	21.2	21.2	27.7																						
Field Data	9/20/2023	13:53:00	2125	4652	73	0	0	21	996.0	1,010.2	1,010.2	1,005.2	51	63	57	69	54	70	74	56	54	67	51	53	59	86	48	83	67	61	1,289	59	65	65	67
Model Results				5252	78	0	0	14					53	56	55	65	52	66	74	51	51	68	53	50	60	87	50	85	64	61	1,289	52	57	62	64
Qusdahl Rd				P3 & P4 ON					36.0	22.6	22.6	27.7																						
Field Data	9/20/2023	14:26:00	2250	4652	73	0	0	21	996.0	1,011.6	1,011.6	1,005.2	50	63	57	69	55	70	75	56	55	68	50	53	59	85	47	82	68	60	1,424	72	75	79	79
Model Results				5240	78	0	0	14					54	57	55	65	52	65	74	51	51	68	53	50	61	87	50	85	64	61	1,424	69	70	75	74
Cedarwood Ave				P3 ON					36.0	23.1	23.1	27.7																						
Field Data	9/20/2023	14:55:00	1681	2361	70	0	0	20	996.0	1,012.1	1,012.1	1,005.2	49	62	56	68	54	70	74	56	54	67	50	53	58	83	47	81	67	59	1,278	58	57	63	59
Model Results				2690	76	0	0	15					52	57	55	65	52	67	74	51	51	67	51	50	59	84	48	83	64	59	1,278	55	52	61	57
Emerald Dr				P3 ON					36.0	23.1	23.2	27.7																						
Field Data	9/20/2023	15:21:00	2264	2361	70	0	0	17	996.0	1,012.1	1,012.2	1,005.2	48	61	56	68	53	70	74	55	53	66	49	52	57	83	45	80	66	58	1,244	55	59	60	60
Model Results				2694	75	0	0	15					51	57	55	65	52	67	74	51	51	67	51	49	58	84	48	82	64	59	1,244	57	55	59	57
Belle Crest				P3 ON					36.0	23.0	23.0	27.7																						
Field Data	9/20/2023	15:47:00	2361	2361	71	0	0	20	996.0	1,012.0	1,012.0	1,005.2	48	62	56	67	53	70	74	56	54	67	48	52	57	84	45	81	66	58	1,233	54	60	60	61
Model Results				2695	75	0	0	15					51	57	55	63	52	67	74	52	51	67	50	49	58	84	48	82	64	59	1,233	53	56	58	59
Jasu Dr				P3 ON					36.0	23.1	23.1	27.7																						
Field Data	9/20/2023	16:04:00	2361	2361	69	0	0	20	996.0	1,012.1	1,012.1	1,005.2	48	61	56	67	53	69	74	55	53	66	49	52	57	83	45	81	66	58	1,074	41	47	54	49
Model Results				2694	75	0	0	15					51	57	55	64	52	67	74	52	51	67	51	49	58	84	48	82	64	59	1,074	38	43	51	47
Rhode Island St				P3 ON					36.0	23.1	23.1	27.7																						
Field Data	9/20/2023	16:32:00	2361	2361	72	0	0	20	996.0	1,012.1	1,012.1	1,005.2	49	62	56	68	54	70	74	56	54	67	50	52	58	84	47	81	67	59	1,163	48	60	59	66
Model Results				2695	75	0	0	15					51	58	55	65	52	68	74	52	52	67	50	49	58	84	48	82	64	59	1,163	37	50	58	63
Venture Park Dr				P1 ON					52.0	25.7	25.7	36.3																						
Field Data	9/21/2023	7:40:00	3458	2292	71	0	0	21	1,012.0	1,014.7	1,014.7	1,013.8	50	63	56	69	53	71	75	57	55	68	51	53	59	85	48	82	65	60	1,198	51	53	57	56
Model Results				2653	77	0	0	19					53	61	57	68	54	71	76	55	55	69	52	52	60	86	49	84	66	60	1,198	54	54	56	55
Fairfield St				P1 ON					52.0	25.5	25.5	36.1																						
Field Data	9/21/2023	7:53:00	3365	2292	71	0	0	20	1,012.0	1,014.5	1,014.5	1,013.6	49	62	56	68	53	70	75	56	54	68	49	53	58	85	46	82	66	58	1,175	49	56	55	62
Model Results				2654	77	0	0	19					53	61	57	68	54	71	76	55	55	69	52	52	60	86	49	84	66	60	1,175	51	55	55	59
E 29th St				P1 ON					52.0	25.1	25.2	36.0																						
Field Data	9/21/2023	8:12:00	3365	2292	71	0	0	20	1,012.0	1,014.1	1,014.2	1,013.5	49	62	56	69	53	71	75	56	55	68	49	53	58	85	46	82	66	59	1,289	59	57	71	62
Model Results				2655	77	0	0	19					53	61	57	68	54	71	76	55	55	69	52	52	60	86	49	84	66	60	1,289	56	53	65	61
Cimarron Dr				P1 ON					52.0	24.7	24.8	35.8																						
Field Data	9/21/2023	8:38:00	3332	2292	70	0	0	21	1,012.0	1,013.7	1,013.8	1,013.3	48	62	55	68	53	71	75	56	54	67	49	53	57	84	45	82	66	58	1,210	52	62	63	65
Model Results				2657	77	0	0	19					53	61	56	68	54	71	76	55	55	69	52	52	60	86	49	84	66	60	1,210	60	60	64	63
Miller Dr				P1 ON					52.0	24.4	24.5	35.7																						
Field Data	9/21/2023	8:55:00	3307	2292	71	0	0	20	1,012.0	1,013.4	1,013.5	1,013.2	50	63	57	69	54	71	75	57	55	68	50	53	58	85	46	82	67	59	1,175	49	59	55	62
Model Results				2659	77	0	0	19					52	61	57	68	54	70	76	55	55	69	52	51	60	85	49	84	66	60	1,175	51	57	54	59
Maple Ln				P1 ON					52.0	24.2	24.2	35.5																						
Field Data	9/21/2023	9:15:00	3141	2292	71	0	0	20	1,012.0	1,013.2	1,013.2	1,013.0	49	62	56	68	53	71	73	56	54	67	49	53	58	84	46	82	67	58	1,198	51	75	75	77
Model Results				2660	77	0	0	19					52	61	57	68	54	70	74	55	55	68	52	51	60	85	49	84	66	60	1,198	62	73	76	76
Kentucky St				P1 ON					52.0	23.8	23.8	35.3																						
Field Data	9/21/2023	9:53:00	2947	2292	70	0	0	21	1,012.0	1,012.8	1,012.8	1,012.8	51	62	57	68	54	70	74	56	54	67	51	53	59	85	48	82	67	60	1,222	53	57	58	58
Model Results				2661	77	0	0	19					52	61	57	68	54	70	76	55	55	68	52	51	59	85	49	84	66	60	1,222	56	55	58	56
Oregon St				P1 ON					52.0	23.5	23.6	35.1																						
Field Data	9/21/2023	10:15:00	1490	2292	70	0	0	21	1,012.0	1,012.5	1,012.6	1,012.6	49	62	56	68	53	70	74	56	54	67	50	52	58	84	47	82	67	59	1,472	77	78	77	80
Model Results				2660	77	0	0	19					53	61	57	68	54	71	76	55	55	68	52	51	60	85	49	84	66	60	1,472	74	77	78	80
Connecticut St				P1 ON					52.0	22.9	22.9	34.4																						
Field Data	9/21/2023	10:48:00	2923	1042	69	0	0	20	1,012.0	1,011.9	1,011.9	1,011.9	49	62	56	68	52	70	74	56	54	66	49	52	57	83	46	81	65	59	1,353	65	75	77	75
Model Results				2667	76	0	0	19					52	61	57	68	54	70	75	55	54	68	51	51	59	85	48	83	66	59	1,353	75	74	77	74
Illinois St				P1 ON					52.0	22.7	22.7	34.2																						
Field Data	9/21/2023	10:58:00	2923	1111	68	0	0	19	1,012.0	1,011.7	1,011.7	1,011.7	47	61	55	67	51	70	73	55	53	66	48	52	56	83	45	80	65	57	1,210	52	68	67	68
Model Results				2671	76	0	0	18					51	61	57	68	54	70	75	55	54	68	51	51	59	85	48	83	66	59	1,210	66	66	68	67
Locust St				P1 ON					52.0	22.2	22.2	33.8																						
Field Data	9/21/2023	11:18:00	2700	1042	69	0	0	20	1,012.0	1,011.2	1,011.2	1,011.3	47	61	55	67	53	70	73	55	53	65	47	51	55	75	44	75	66	57	1,272	58	72	79	77
Model Results				2676	75	0	0	18					51	61	57	68	54	70	75	55	54	68	51	51	58	79	48	78	66	59	1,272	68	73	80	80
N 5th St				P1 ON					51.9	21.9	21.9	33.4																						
Field Data	9/21/2023	11:40:00	2700	2292	70	0	0	21	1,011.9	1,010.9	1,010.9	1,010.9	48	62	55	67	53	71	73	55	54	66	48	51	56	75	45	74	66	57	1,311	61	74	82	81
Model Results				2678	75	0	0	18					51	60	57	67	53	70	75	55	54	67	50	51	58	79	48	77	66	59	1,311	73	76	82	82
N Crestline Dr									51.8	21.2	21.2	32.4																						
Field Data	9/21/2023	13:17:00	2291	0	68	0	0	19	1,011.8	1,010.2	1,010.2	1,009.9	42	61	55	66	52	69	72	55	53	65	42	51	52	80	40	78	65	53	1,087	42	52	57	61
Model Results				0	74	0	0	17					48	60	56	67	53	69	74	54	54	67	46	50	55	83	44	81	65	55	1,087	48	54	61	59
W Princeton Blvd									51.7	20.8	20.8	32.0																						
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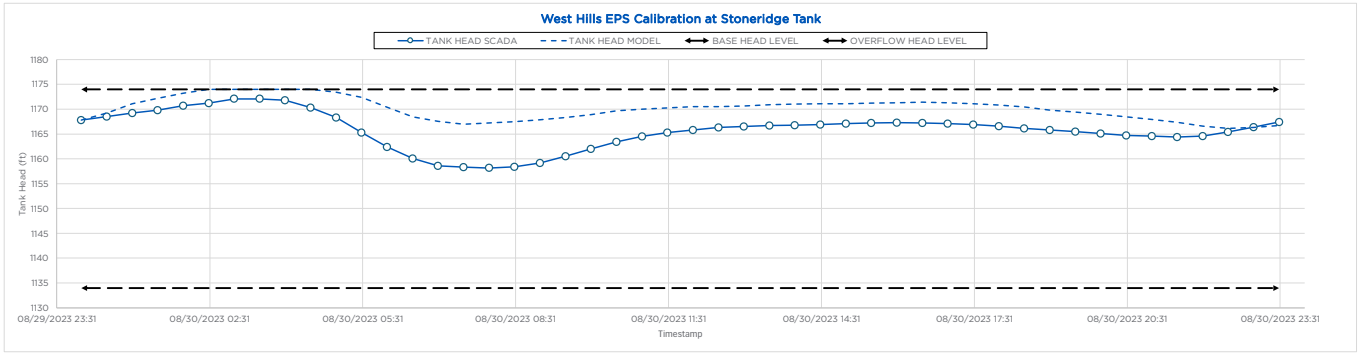
Model Results				0	74	0	0	17					48	60	56	67	53	69	74	54	53	66	46	50	56	83	44	81	65	56	1,007	42	44	49	49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TANK HEAD SCADA
TANK HEAD MODEL
BASE HEAD LEVEL
OVERFLOW HEAD LEVEL
Tank Head (ft)
1180
1175
1170
1165
1160
1155
1150
1145
1140
1135
1130
08/29/2023 23:31
08/30/2023 02:31
08/30/2023 05:31
08/30/2023 08:31
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08/30/2023 23:31
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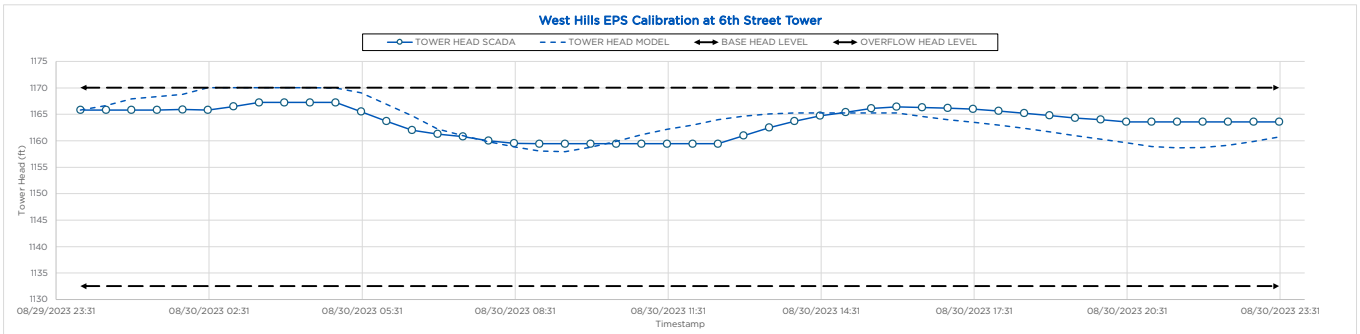
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TOWER HEAD SCADA
TOWER HEAD MODEL
BASE HEAD LEVEL
OVERFLOW HEAD LEVEL
Tower Head (ft)
1175
1170
1165
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1155
1150
1145
1140
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1130
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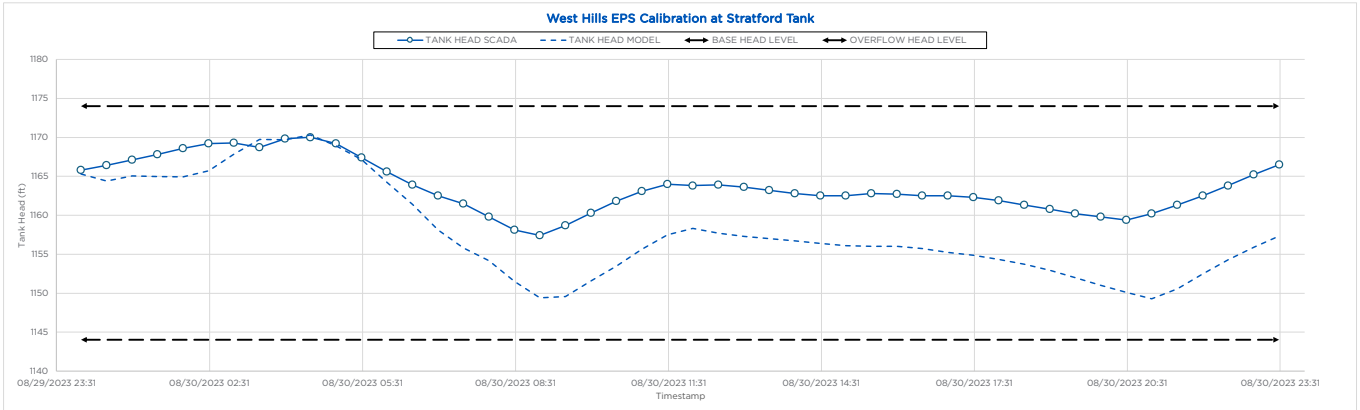
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BASE HEAD LEVEL
OVERFLOW HEAD LEVEL
Tank Head (ft)
1180
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1160
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1150
1145
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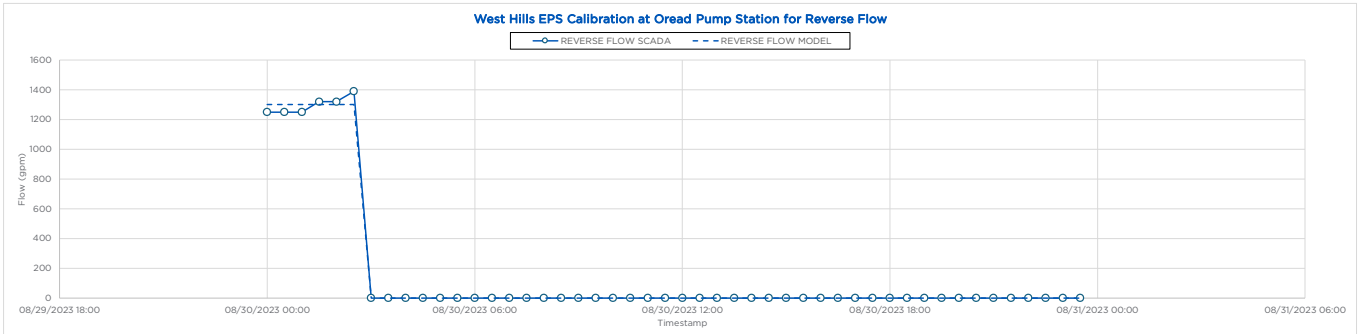
West Hills EPS Calibration at Oread Pump Station for Reverse Flow
REVERSE FLOW SCADA
REVERSE FLOW MODEL
Flow (gpm)
1600
1400
1200
1000
800
600
400
200
0
08/29/2023 18:00
08/30/2023 00:00
08/30/2023 06:00
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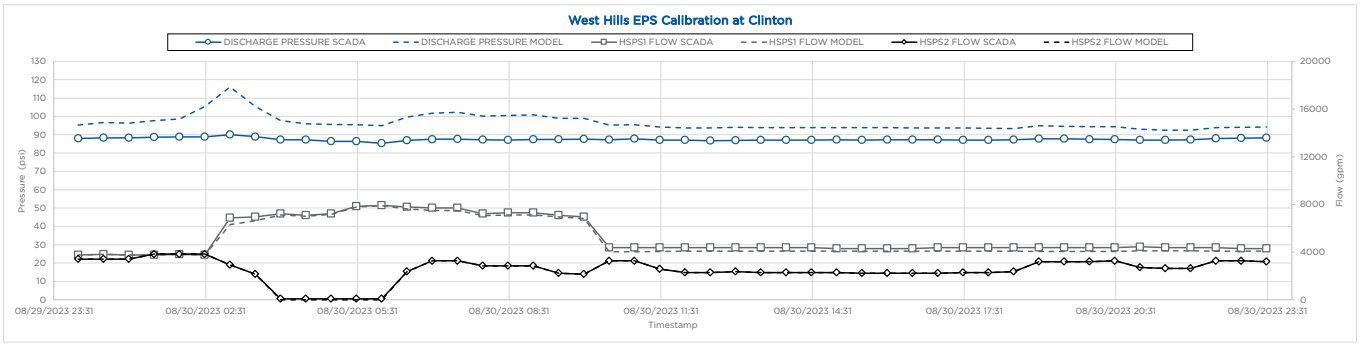
West Hills EPS Calibration at Clinton
DISCHARGE PRESSURE SCADA
DISCHARGE PRESSURE MODEL
HSPS1 FLOW SCADA
HSPS1 FLOW MODEL
HSPS2 FLOW SCADA
HSPS2 FLOW MODEL
Pressure (psi)
Flow (gpm)
Timestamp
08/29/2023 23:31
08/30/2023 02:31
08/30/2023 05:31
08/30/2023 08:31
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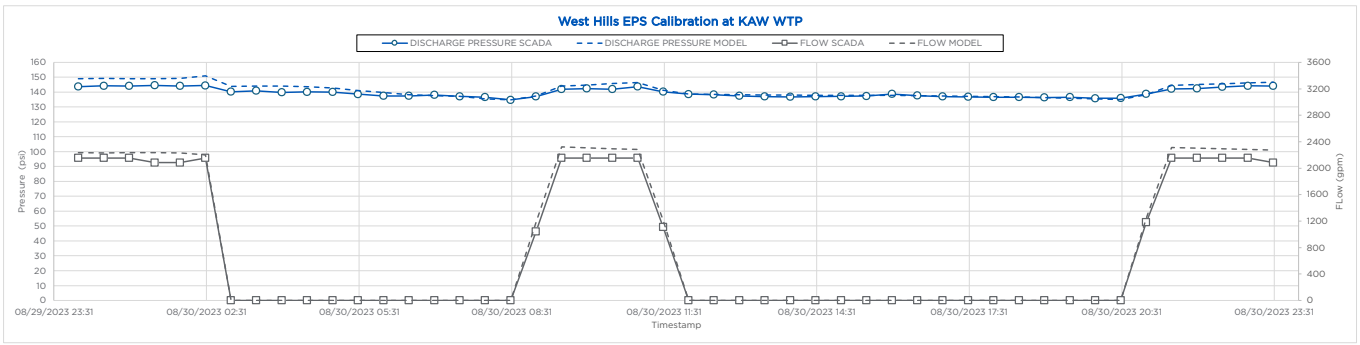
West Hills EPS Calibration at KAW WTP
DISCHARGE PRESSURE SCADA
DISCHARGE PRESSURE MODEL
FLOW SCADA
FLOW MODEL
Pressure (psi)
FLow (gpm)
Timestamp
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08/30/2023 02:31
08/30/2023 05:31
08/30/2023 08:31
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08/30/2023 14:31
08/30/2023 17:31
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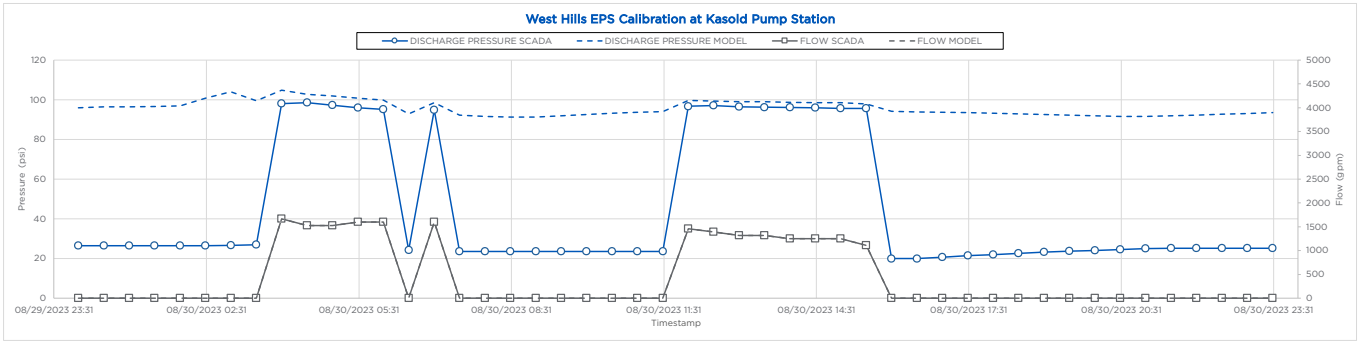
08/30/2023 23:31


West Hills EPS Calibration at Kasold Pump Station
DISCHARGE PRESSURE SCADA
DISCHARGE PRESSURE MODEL
FLOW SCADA
FLOW MODEL
Pressure (psi)
Flow (gpm)
Timestamp
08/29/2023 23:31
08/30/2023 02:31
08/30/2023 05:31
08/30/2023 08:31
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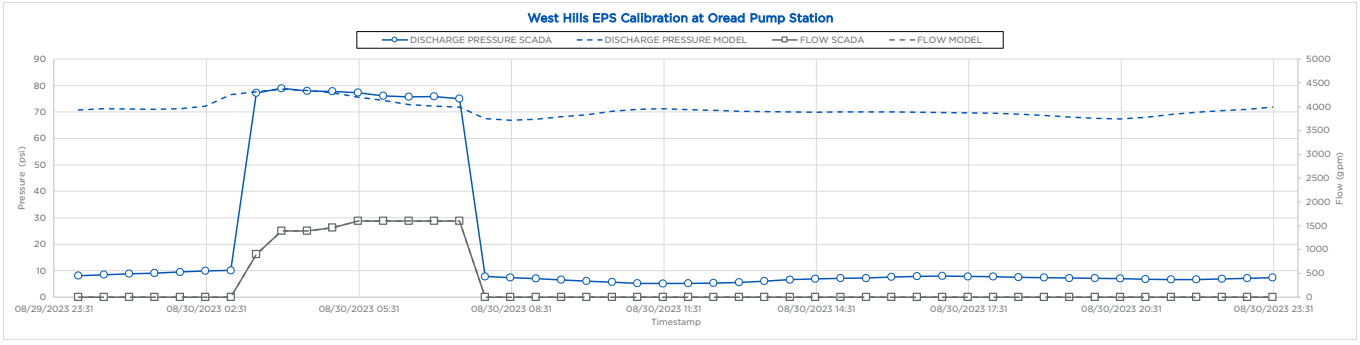
08/30/2023 23:31


West Hills EPS Calibration at Oread Pump Station
DISCHARGE PRESSURE SCADA
DISCHARGE PRESSURE MODEL
FLOW SCADA
FLOW MODEL
Pressure (psi)
Flow (gpm)
Timestamp
08/29/2023 23:31
08/30/2023 02:31
08/30/2023 05:31
08/30/2023 08:31
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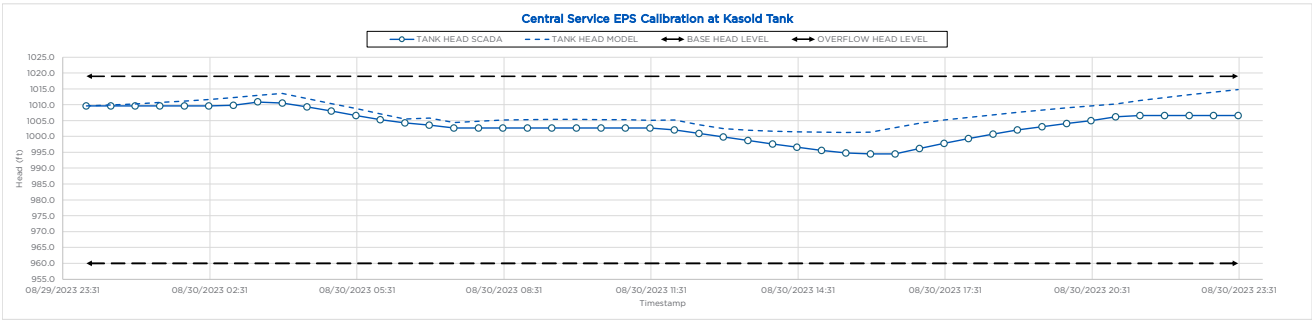
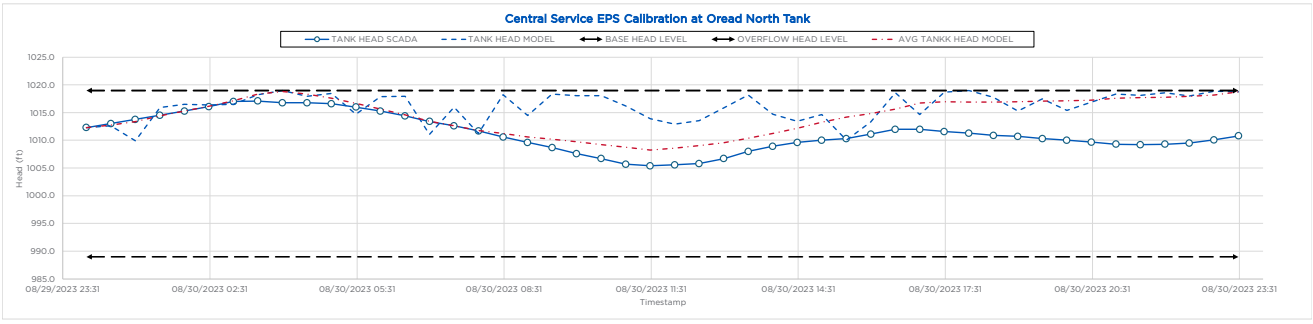
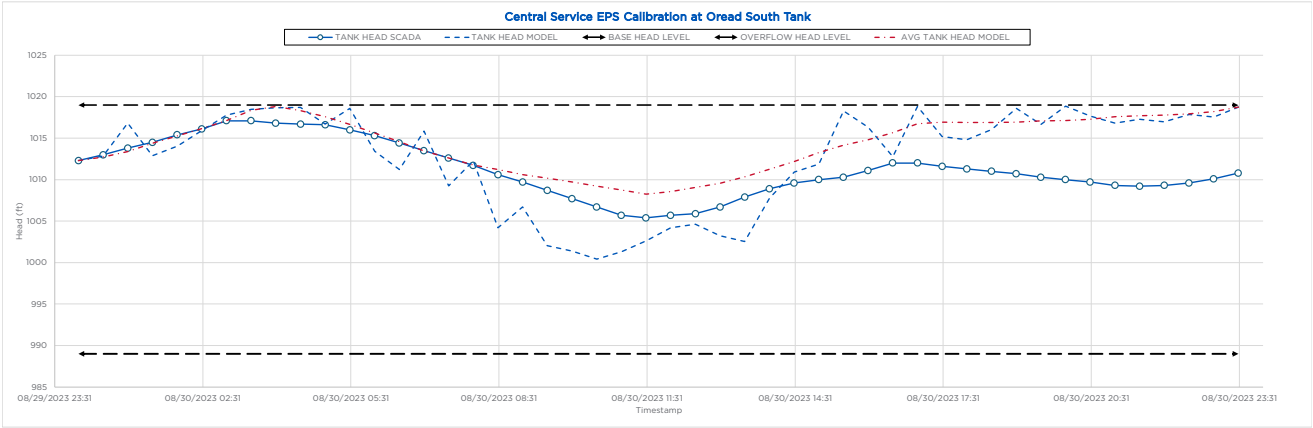
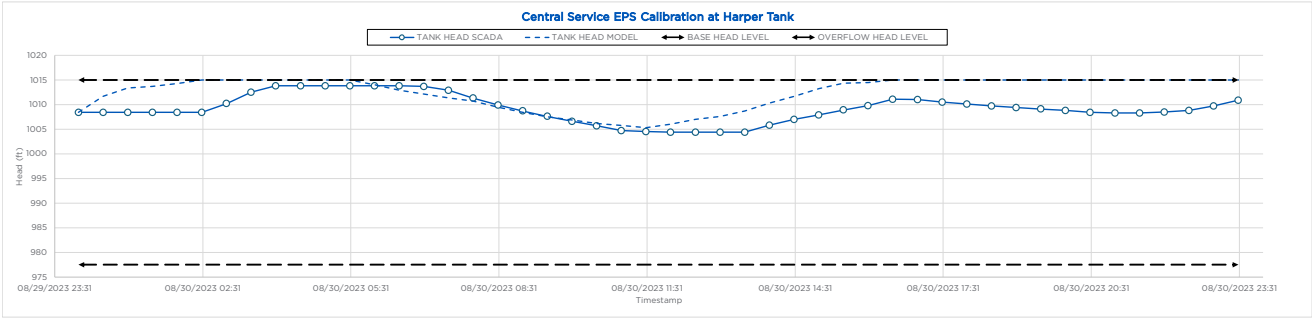
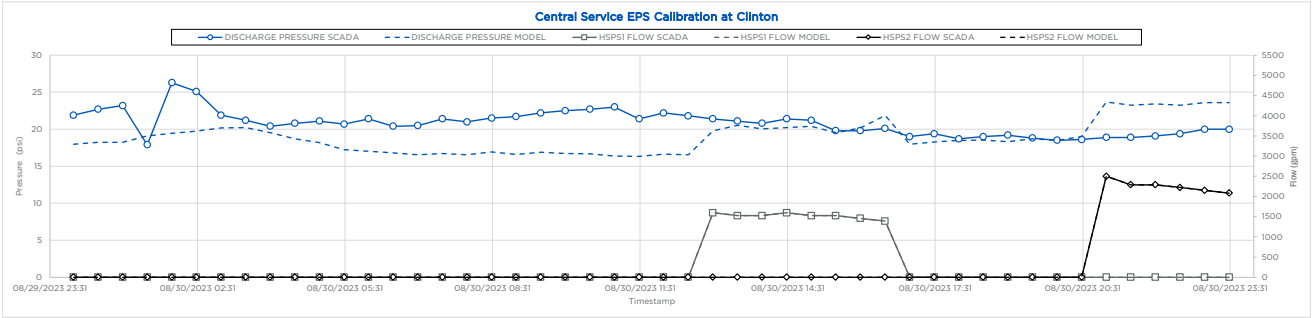

Central Service EPS Calibration at Kasold Tank
TANK HEAD SCADA
TANK HEAD MODEL
BASE HEAD LEVEL
OVERFLOW HEAD LEVEL
Head (ft)
Timestamp


Central Service EPS Calibration at Oread North Tank
TANK HEAD SCADA
TANK HEAD MODEL
BASE HEAD LEVEL
OVERFLOW HEAD LEVEL
AVG TANKK HEAD MODEL
Head (ft)
Timestamp


Central Service EPS Calibration at Oread South Tank
TANK HEAD SCADA
TANK HEAD MODEL
BASE HEAD LEVEL
OVERFLOW HEAD LEVEL
AVG TANK HEAD MODEL
Head (ft)
Timestamp


Central Service EPS Calibration at Harper Tank
TANK HEAD SCADA
TANK HEAD MODEL
BASE HEAD LEVEL
OVERFLOW HEAD LEVEL
Head (ft)
Timestamp


Central Service EPS Calibration at Clinton
DISCHARGE PRESSURE SCADA
DISCHARGE PRESSURE MODEL
HSPS1 FLOW SCADA
HSPS1 FLOW MODEL
HSPS2 FLOW SCADA
HSPS2 FLOW MODEL
Pressure (psi)
Flow (gpm)
Timestamp
08/29/2023 23:31
08/30/2023 02:31
08/30/2023 05:31
08/30/2023 08:31
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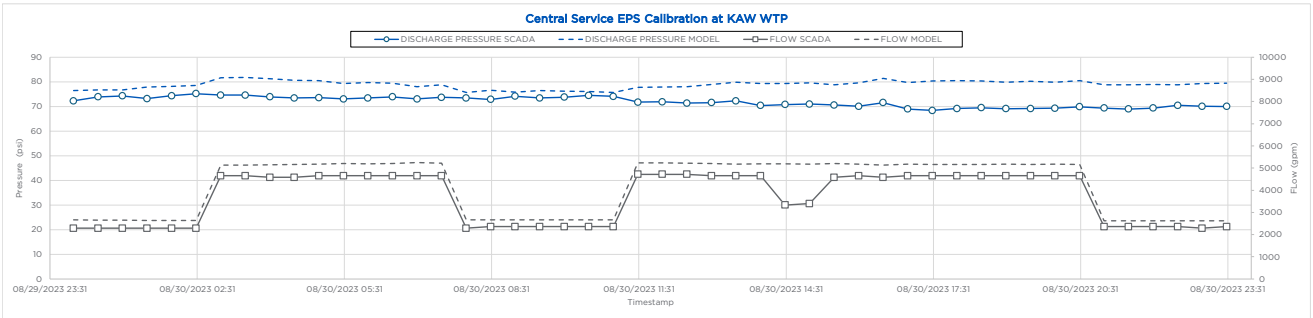
Central Service EPS Calibration at KAW WTP
DISCHARGE PRESSURE SCADA
DISCHARGE PRESSURE MODEL
FLOW SCADA
FLOW MODEL
Pressure (psi)
Flow (gpm)
Timestamp
08/29/2023 23:31
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08/30/2023 23:31

Appendix D – KLM Tank Condition Assessment Reports

2024 Water Storage Facility Assessments
Recommended Maintenance Schedule
Lawrence, Kansas

Priority Color Code Key
High
Medium
Low

KLM Project #	Reservoir Name	Size (MG)	Type	Year Constructed	Last Reconditioned	Current Reconditioning Estimate	Recommended Priority Timeline
3925-24	West 6th Street Tower	0.500	Single Pedestal	1967	Unknown	$700,000 - $725,000	Full recondition within 2 years
5067-24	Kaw - US Clearwell	0.600	Buried Clearwell	~1958	N/A	$160,000 - $165,000	Perform maintenance within 2 years
5068-24	Kaw - DS Clearwell	0.170	Buried Clearwell	~1958	N/A	$95,000 - $115,000	Perform maintenance within 5 years
5069-24	Kaw - Multi Leg Tower	0.0750	Double Ellipsoidal	~1954	Unknown	$625,000 - $650,000	Full recondition within 2 years
5070-24	North Oread Reservoir	0.875	Prestressed	2017	N/A	-	Reinspect in 5 years
5071-24	South Oread Reservoir	0.875	Prestressed	2017	N/A	-	Reinspect in 5 years via DTCO
5072-24	19th Street & Kasold Drive Reservoir	1.50	GSR	~1969	2005	$125,000 - $130,000	Structure mods & spot repair wet in 1 to 2 years
5073-24	Stoneridge Tower	1.50	Composite	2008	N/A	$35,000 - $40,000	Spot repair wet within 5 years

Lawrence, Kansas

Inspection Report:
500,000-Gallon Capacity
West 6th Street Tower

Prepared by:

KLM Engineering, Inc.
1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 3925-24

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APPENDIX A: Photographs

APPENDIX B: Inspection and Evaluation Methods

APPENDIX C: Paint Chip Test Results

1.0| PROJECT INFORMATION

KLM Project No.: 3925-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: West 6th Street Tower

Tank Description: Single Pedestal

Tank Street Location: 3708 West 6th Street, Lawrence, KS 66049

Purpose of Inspection: Condition Assessment

Date of Inspection: February 29, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Manufacturer: Chicago Bridge & Iron Company **Construction Date:** 1967

Serial No.: 9-6946 **Design Code:** AWWA D100-65

Capacity: 500,000 gallons

Type of Construction: Welded

Tank Diameter: 30'-0"

Height to: Overall ~150 feet

Height to: HWL 145'-6" LWL 108'-0"

Tank Construction Drawings: Available to KLM

Previous Inspection Records: None available to KLM

EXISTING COATING INFORMATION

	Interior Wet	Interior Dry	Exterior
Date Last Coated	Unknown	Unknown	Unknown
Full or Spot Repair	Full	Overcoat	Overcoat
Coating Contractor	Unknown	Unknown	Unknown
Surface Preparation	Unknown	Unknown	Unknown
Paint System	Epoxy	Alkyd/epoxy	Alkyd
Paint Manufacturer	Unknown	Unknown	Unknown
Paint Chip Samples	Taken	Taken	Taken

Lawrence, Kansas

500,000 – GALLON CAPACITY
WEST 6TH STREET TOWER

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. General guidelines of AWWA Manual M42 Appendix C “Inspecting and Repairing Steel Water Tanks, and Elevated Tanks for Water Storage.”

c. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

d. AWWA Standard D100; Welded Carbon Steel Tanks for Water Storage.

3.0| COATINGS EVALUATION

3.1| Lead and Chromium Content Analysis

The total lead and chromium content of the interior and exterior coatings was analyzed. The results in Appendix C show a 5.7 percent lead content for the interior wet coating, a 12 percent lead content for the interior dry coating, and a 9.5 percent content for the exterior coating. Results exceeding 0.50 percent lead can be a health hazard according to federal regulation. Consequently, the interior and exterior coatings are classified as lead-based paints. Removal of lead-based paint must be performed in accordance with applicable local, state, and federal regulations. Reconditioning specifications must include provisions for full containment as well as provisions to prevent hazardous waste generation. Chromium levels indicate levels between 0.0096 and 5.7 percent chromium. Levels over 0.50 percent chromium could possibly pose problems in the waste streams during reconditioning. Further testing may be required to ensure satisfactory TCLP testing and the generation of non-hazardous waste.

3.2| Interior Wet Coating

The tower was constructed and originally painted in 1967 by Chicago Bridge & Iron Company. It is unknown when the interior wet coating was last replaced or by whom. The interior wet coating is in poor condition above the high-water line (HWL) with approximately 25 percent visible coating failures. Failures consist of corrosion around the drywell tube and along roof overlap joints. Severe corrosion has occurred on the roof rafters, ladder, and plate edges. Some corrosion has advanced to where steel is requiring replacement. The coating below the HWL is in fair condition with approximately five percent visible coating failures ranging from random pinhole failures to more widespread corrosion on the ladder and drywell tube. See photos in Appendix A.

3.3| Interior Dry Coating

It is unknown when the interior dry area was last overcoated or by whom. The interior dry coating is in fair overall condition, with approximately five percent visible coating failures. Failures consist of random areas of pinhole corrosion, mechanical damage, and topcoat delamination. Field testing indicates poor inner coat adhesion characteristics. See photos in Appendix A.

3.4| Exterior Coating

It is unknown when the exterior was last overcoated or by whom. The exterior coating is in poor overall condition with more than five percent visible coating failures observed throughout the structure. Failures consist of random areas of corrosion, mechanical damage, as well as severe corrosion around the drywell tube to roof connection and access manway curb. See photos in Appendix A.

3.5| Replacement Coating Systems

When the next full reconditioning is performed KLM recommends preparing surfaces in accordance with NACE guidance and applying a coating system for each area according to the following.

3.5.1| Interior Wet Coating

Surface preparation should be performed according to SSPC-SP10 Near White Metal Blast criteria.

Apply a two-coat system:

1. moisture cured zinc-rich
2. NSF 61 certified epoxy

3.5.2| Interior Dry Coating

Surface preparation should be performed according to SSPC-SP6 Commercial Blast Clean criteria.

Apply a three-coat system:

1. moisture cured zinc-rich
2. polyamidoamine epoxy
3. polyamidoamine epoxy

3.5.3| Exterior Coating

Surface preparation should be performed according to SSPC-SP6 Commercial Blast Clean criteria.

Apply a four-coat system:

1. moisture cured zinc-rich
2. polyamidoamine epoxy
3. aliphatic acrylic urethane
4. fluoropolymer

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time. Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 Replace the severely deteriorated ladder in its entirety with an OSHA compliant ladder. See photos 9, 10, and 12 through 15.

4.1.2 Install an anchor point on the underside of the roof adjacent to the access manway. Include a self-retracting lifeline (SRL) to allow for safe access while ascending and descending the new ladder.

4.1.3 Replace the two severely deteriorated roof rafters in their entirety. See photos 2 through 5.

4.1.4 Seal weld the roof overlap joints, manway penetrations, and drywell tube curb to roof connection. See photos 2 through 6.

4.1.5 Remove the cathodic protection system in its entirety. See photos 3, 5, and 6.

4.1.6 Seal weld the intermittently welded stiffener rings on the drywell tube in compliance with AWWA D100. See photo 14.

4.1.7 Replace the gasket on the drywell tube manway. See photo 18.

4.1.8 Grind off all weld spatter and erection scab marks for compliance with AWWA D100.

4.1.9 Install two bars on top of the fill pipe to prevent accidental entry of unwanted material during maintenance activities. See photo 18.

4.2| Interior Dry Modifications

4.2.1 Remove the cable expansion brackets in the drywell tube and permanently install ½ moon style standoff brackets. See photos 30 and 31.

4.2.2 Extend the upper platform on one side of the existing walkway (opposite side of the fill pipe). Remove the existing handrail on the side of the new platform. See photos 35 and 36.

4.2.3 Install a pressure style manway in the tower bowl above the new platform extension. This will improve the ventilation during reconditioning and bring the tank into compliance with OSHA confined space entry requirements. Include a ladder from the platform to the bowl for safe access. See photos 32 and 33.

4.2.4 Install a stainless-steel freeze-resistant valve and ½-coupling in the bowl to better facilitate cleaning and draining the tank. Include the installation of a clear, rigid, high-pressure hose connecting the valve to the overflow pipe.

4.2.5 Replace all light fixtures with LED style fixtures.

4.2.6 Install cable brackets inside the pedestal and base cone, equally spaced, for the attachment of electrical and coaxial cables.

4.2.7 Remove the insulation from the fill pipe to facilitate blasting and painting of the pipe. Install new closed cell insulation and aluminum jacketing. See photos 34, 37, 38, and 41 through 43.

4.2.8 Install ports in the center of each of the pedestal landings to facilitate the containment system used during the next reconditioning. See photos 35, 39, and 42.

4.2.9 Replace the condensate drain with a 2-inch diameter drain pipe. See photo 42.

4.2.10 Replace the fill pipe expansion joint in the base cone with a stainless-steel, bellows style joint. See photo 44.

4.3| Exterior Modifications

4.3.1 Remove the existing antenna mount above the drywell tube and replace the top two feet of the drywell tube. Include the installation of a new drywell tube cap piece and aluminum lid with interior locking hasp. See photos 28, 45 through 48, and 52.

4.3.2 Install a climb assist on the exterior (roof side) of the drywell tube to improve safety while transitioning in and out of the tube.

4.3.3 Replace the deteriorated access manway and lid. See photo 50.

4.3.4 Install a new aluminum pressure pallet style vent. The new vent and vent screen design should meet AWWA D100 and Kansas Department of Health and Environment regulations. The removable top will improve ventilation, provide access to the tank interior during reconditioning, and aid in compliance with OSHA confined space entry requirements.

4.3.5 Install a pipe-style roof handrail conforming to OSHA regulations to enclose the existing roof manway(s) and the new finial vent. Install a non-skid walkway within the area of the handrailing. See photos 49, and 53 through 55.

4.3.6 Install two hinge-covered ventilation manways on the roof outside the new handrail. These will provide additional ventilation during the interior surface preparation and coating.

4.3.7 Replace the aviation light with a new double LED style aviation light, sensor, and bracket. Install the new obstruction light and new bracket on the roof handrail. Modify electrical conduit and wiring as required.

4.3.8 Replace the steel curb around the drywell tube with a rubber sleeve to waterproof the roof. This will bring the roof into compliance with Kansas Department of Health and Environment regulations. See photo 52.

4.3.9 Install cover plates cover plates over the cathodic protection hand holes in the tank roof and seal weld inside and outside. See photo 49.

4.3.10 Replace the threaded rigging couplings with the same size unthreaded couplings and rubber weathertight covers.

4.3.11 To comply with Kansas Department of Health and Environment regulations modify the existing overflow pipe at ground level to include a 12 to 24-inch air-break above grade, overflow pipe screen retainer and screens, and a steel catch basin cone. Use corrosion-resistant, heavy-gauge, No. 4, and No. 24 mesh screens on the outlet (#4 downstream of #24). See photo 60.

4.4| Cathodic Protection (CP) System

4.4.1 The tower has an antiquated hanging style CP system. Per Item 4.1.5 above, KLM recommends removing the system in its entirety. The corrosion inhibitors of modern coating systems have eliminated the need for a separate cathodic protection system on potable water reservoirs.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The site is located behind Lawrence Fire Station No. 3 and includes the tank and antenna structures inside a chain link fence.

5.1.2 In conformance with Kansas Department of Health and Environment regulations, an analysis has been performed to determine the methods of pollution control required for this storage structure during reconditioning. To maintain air quality and to prevent the drift of dust and fugitive emissions, full containment will be required, including impervious ground cover, a top cover or bonnet and negative air dust collection.

5.2| Telecommunications Considerations

5.2.1 The tower has some telecommunications equipment, including antennas, coaxial cables, support brackets and other miscellaneous equipment. The Owner is advised to maintain accurate records of each of the antenna sites on the tower, including as-built drawings, site manager and owner contact information, upgrades performed, and plans for future antenna installations or upgrades. These records will help facilitate the future reconditioning with a minimal amount of effort on the Owner's part.

5.2.2 Prior to reconditioning, in accordance with the lease requirements of each antenna owner, the Owner should notify the telecommunications owners or manager of the work to be performed. The Owner should also determine whether: a) the antenna owners will pay the additional costs to work around and protect the antennas; b) the antenna owners will temporarily remove their antennas and associated equipment to facilitate reconditioning; or c) the Owner will have to pay for these costs themselves.

5.2.3 Prior to reconditioning, KLM recommends an assessment be performed on the telecommunications installations to determine or verify the following: a) the owners (carrier) of each of the antennas; b) the antenna locations and attachment methods; c) the coaxial cable locations and attachment methods; and d) recommendations for modifications to the existing antenna installations prior to or during the reconditioning. KLM recommends the engineering firm chosen to perform engineering on the reconditioning conduct the telecommunications assessment, so they are intimately aware of the antenna conditions.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

KLM recommends performing the noted modifications and replacing the interior wet, interior dry, and exterior coatings within the next two years to maximize the life of the structure, eliminate more costly future repairs, and aid in improving water quality.

The costs for structure modifications and replacing the interior and exterior coatings (including the containment and removal of the lead-based paint) are estimated between $700,000 and $725,000. This estimate is based on current pricing and does not include costs for engineering and/or inspection services. For competitive bids, the project should be bid 9 to 12 months before the desired starting date.

An experienced tank-coating contractor with the proper crew and equipment should be able to complete the project in ten weeks. At the time of reconditioning, the tower, will need to be drained and remain off-line during interior structure modifications, abrasive blasting, and painting. However, most of the exterior structure modifications can be performed prior to draining, with the tank in-service.

KLM ENGINEERING, INC.

Report prepared by:

Joseph Clasemann

Joseph Clasemann, E.I.T.
Civil Engineer-In-Training
EIT Certification No. 157889

Report reviewed by:

Rodney Ellis

Rodney Ellis
Vice President/COO
NACE Certified Coatings Inspector No. 1686
AWS/CWI 0404031

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of the tower

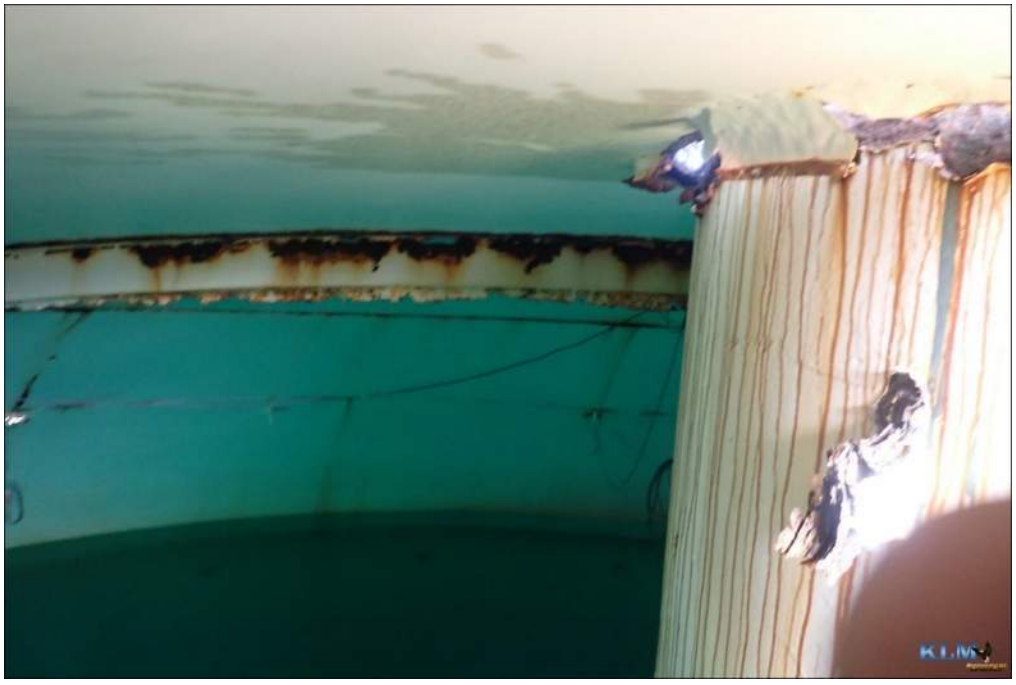

Photo No. 2
Interior roof, roof rafters, and top of drywell tube conditions

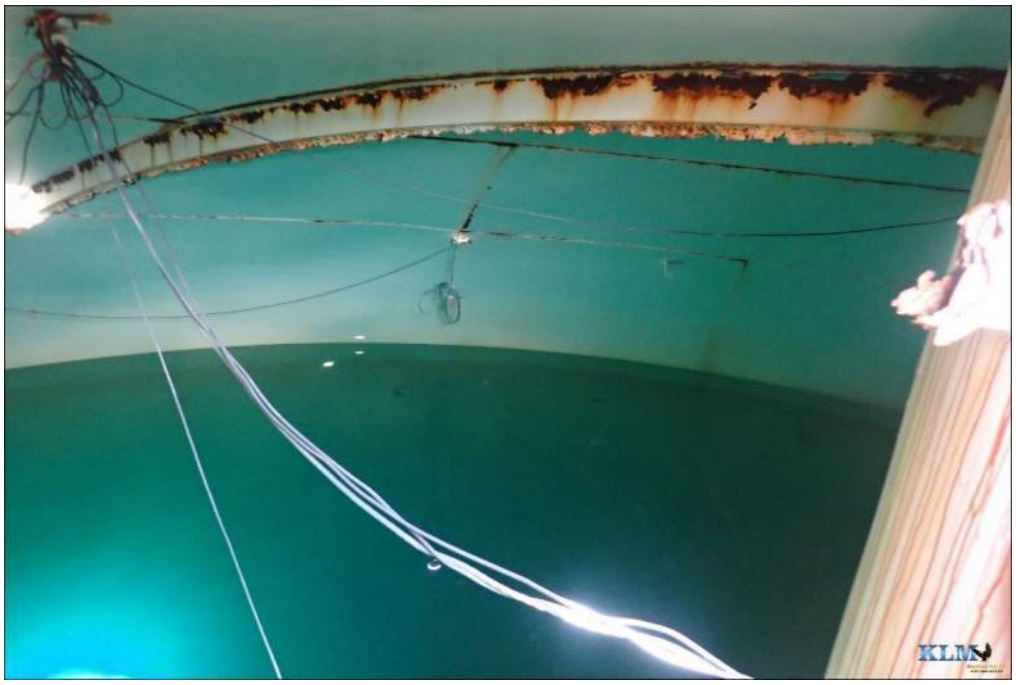

Photo No. 3
Roof rafter condition
Note: cathodic protection wiring

Photo No. 4
Roof rafter condition

Photo No. 5
Condition of roof

Photo No. 6
Roof condition

Photo No. 7
Drywell tube to roof connection

Photo No. 8
Drywell tube to roof connection

Photo No. 9
Deteriorated ladder

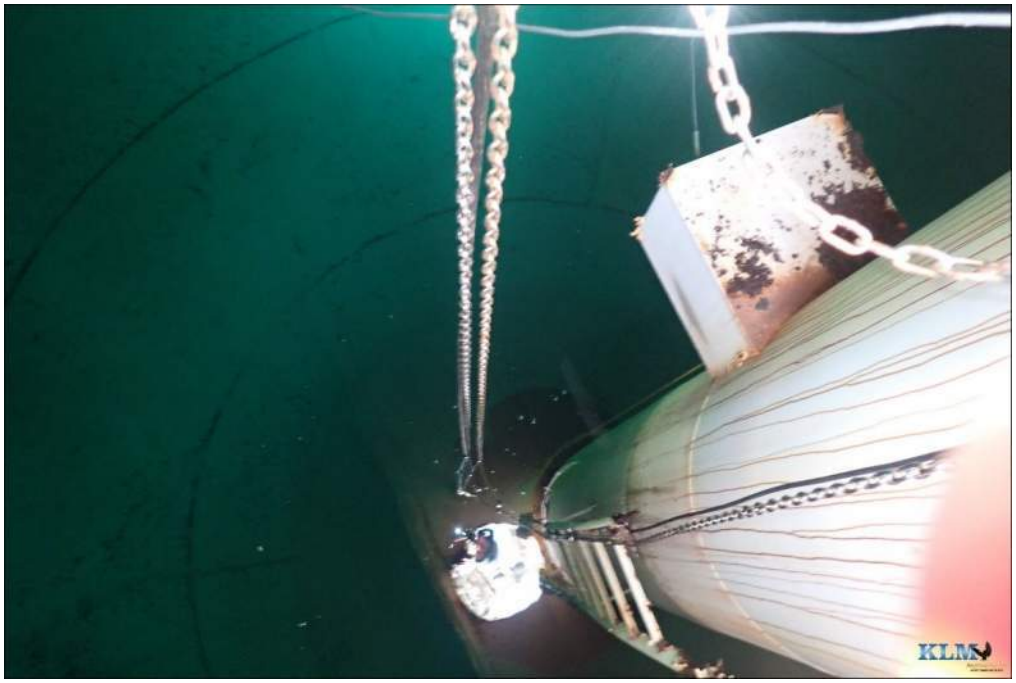

Photo No. 10
Drywell tube, overflow, and mixer chains
Note: deteriorated ladder

Photo No. 11
Severely corroded roof plate at access manway

Photo No. 12
Drywell tube and ladder

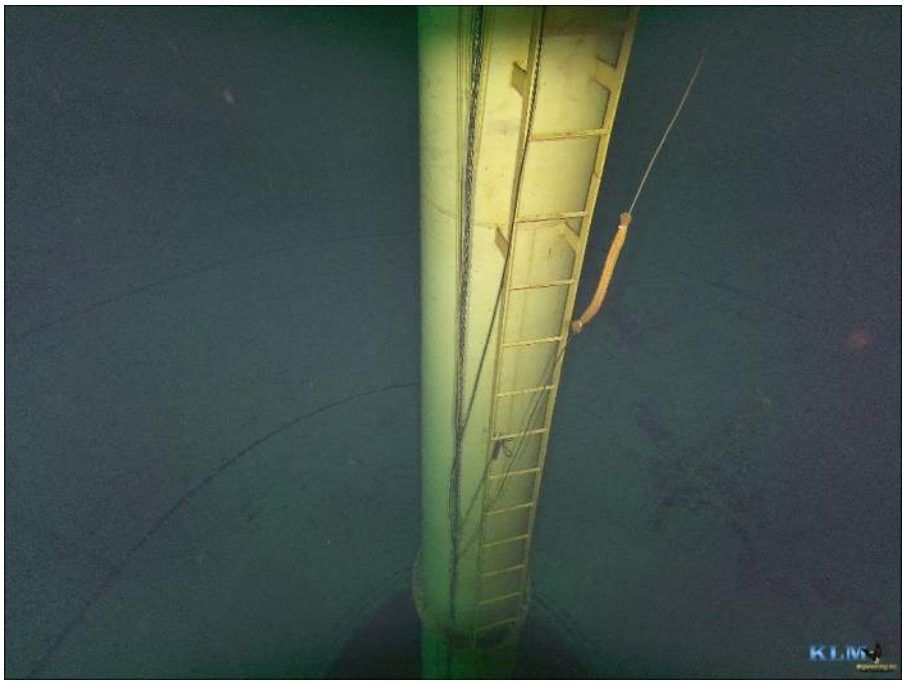

Photo No. 13
Overall condition of drywell tube and ladder

Photo No. 14
Unwelded drywell tube stiffener

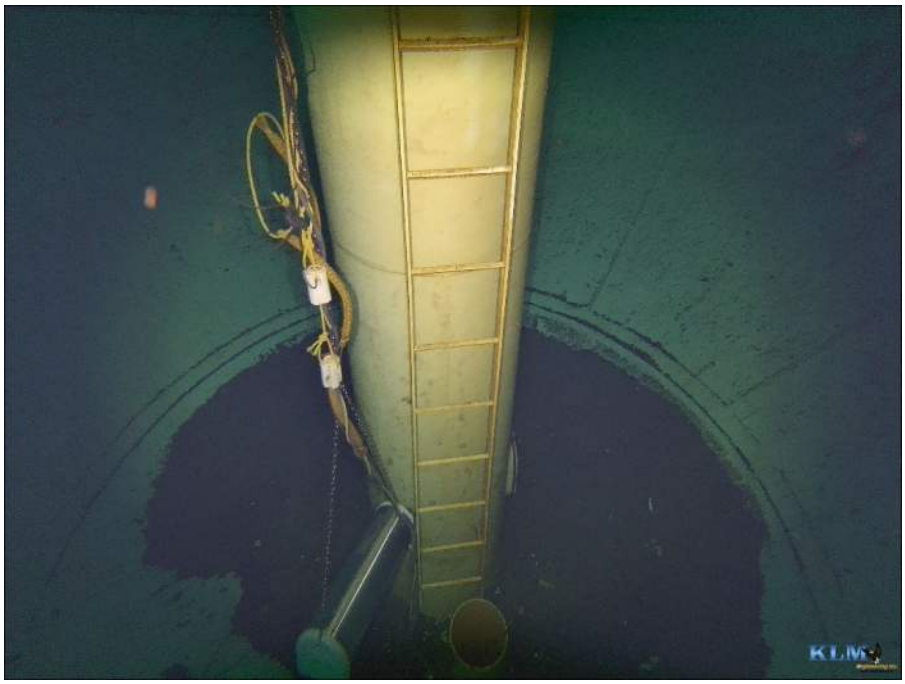

Photo No. 15
Drywell tube, mixer, and bowl condition

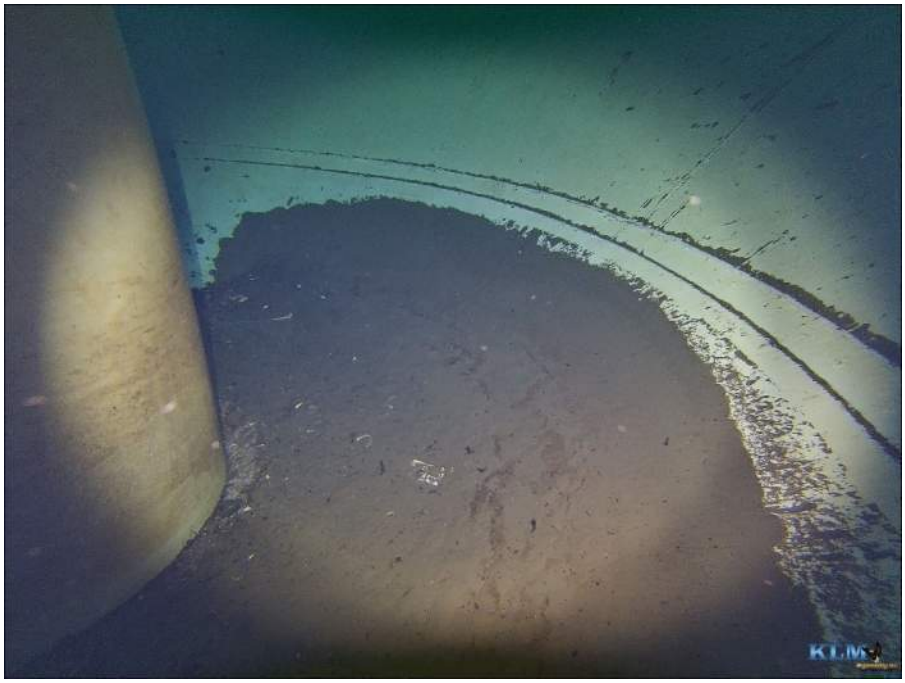

Photo No. 16
Sediment in bowl

Photo No. 17
Bowl conditions

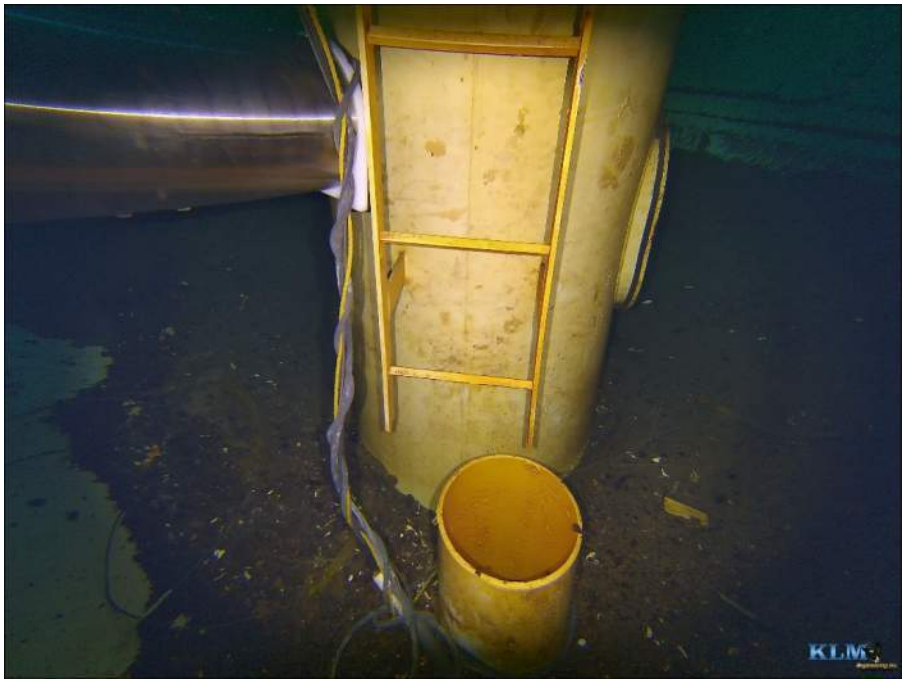

Photo No. 18
Bowl conditions with fill pipe, mixer, and drywell tube manway

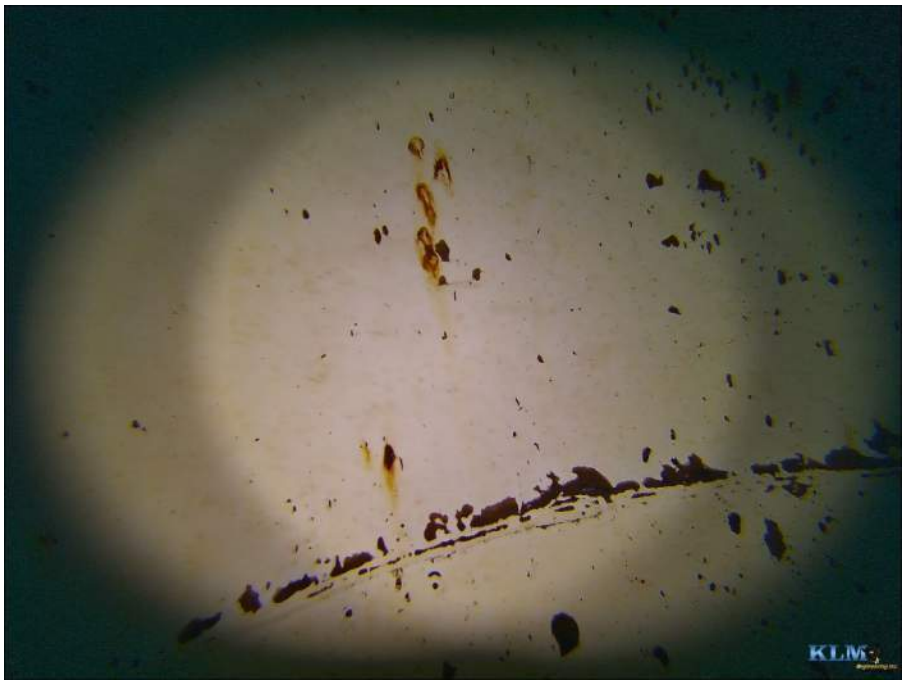

Photo No. 19
Corrosion cells in bowl

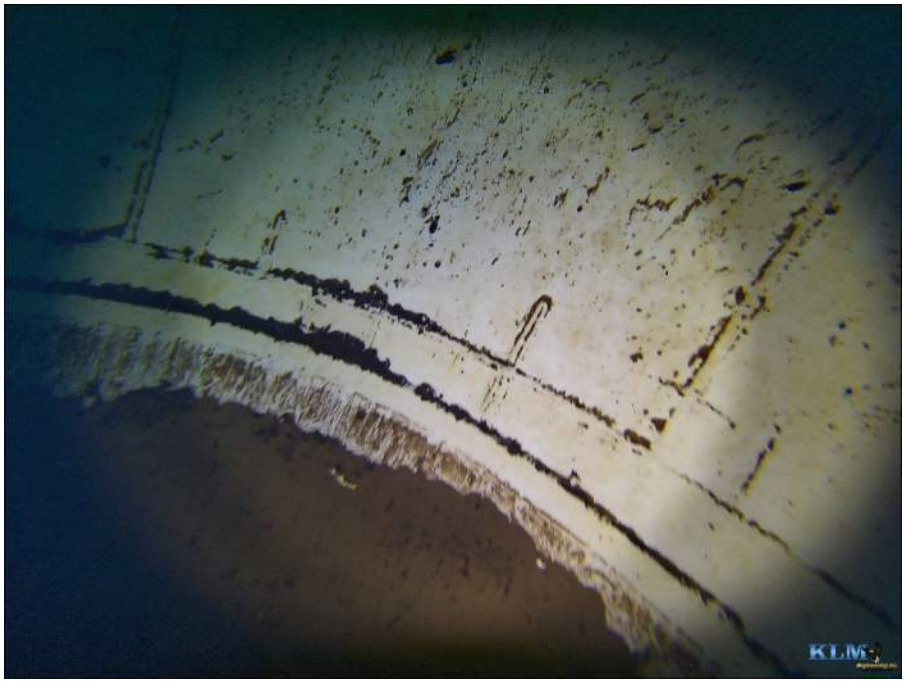

Photo No. 20
Bowl conditions

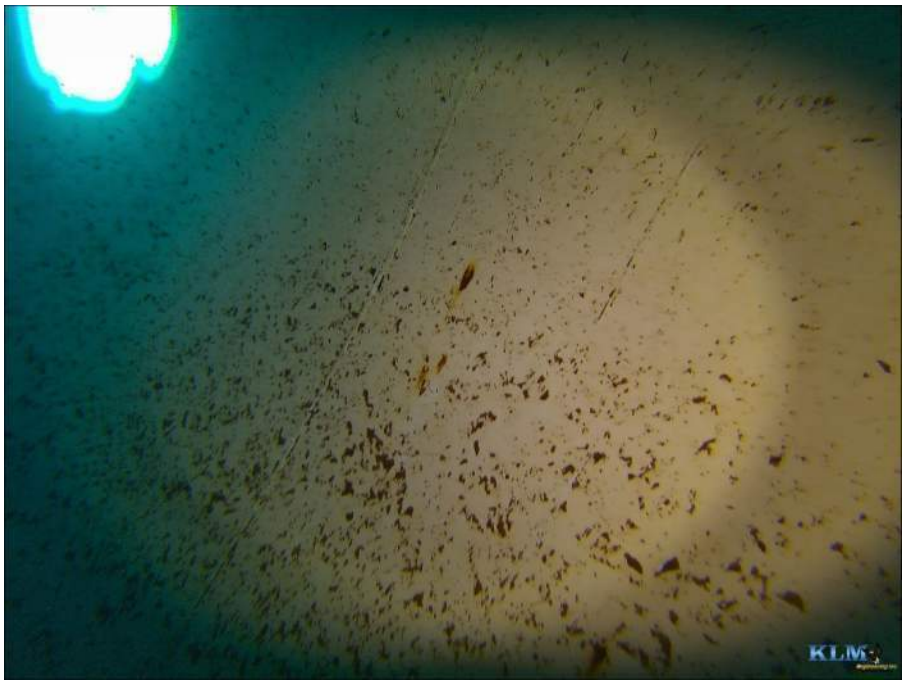

Photo No. 21
Lower torus

Photo No. 22
Condition of shell

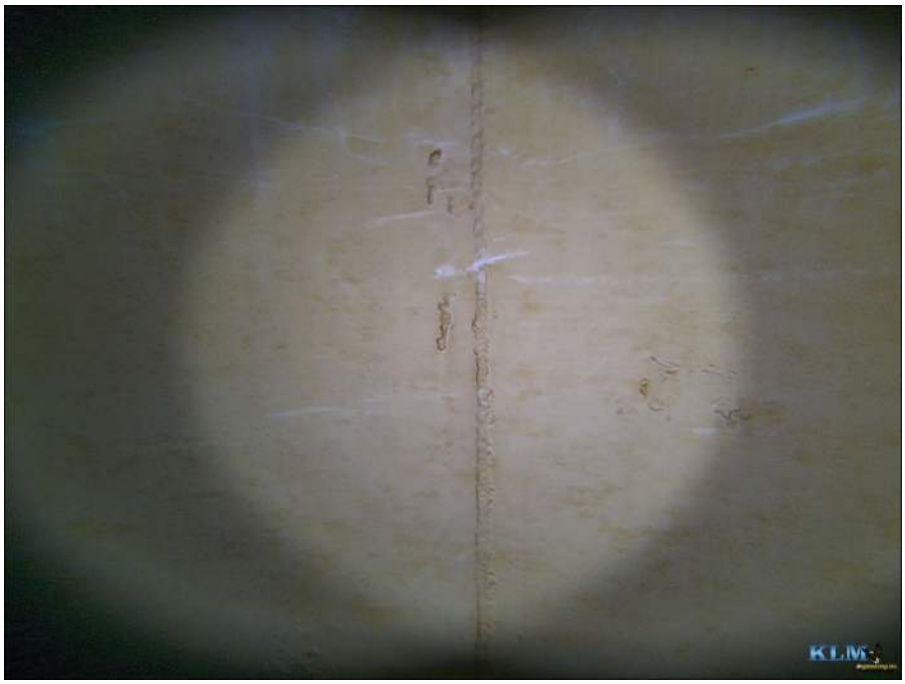

Photo No. 23
Condition of shell

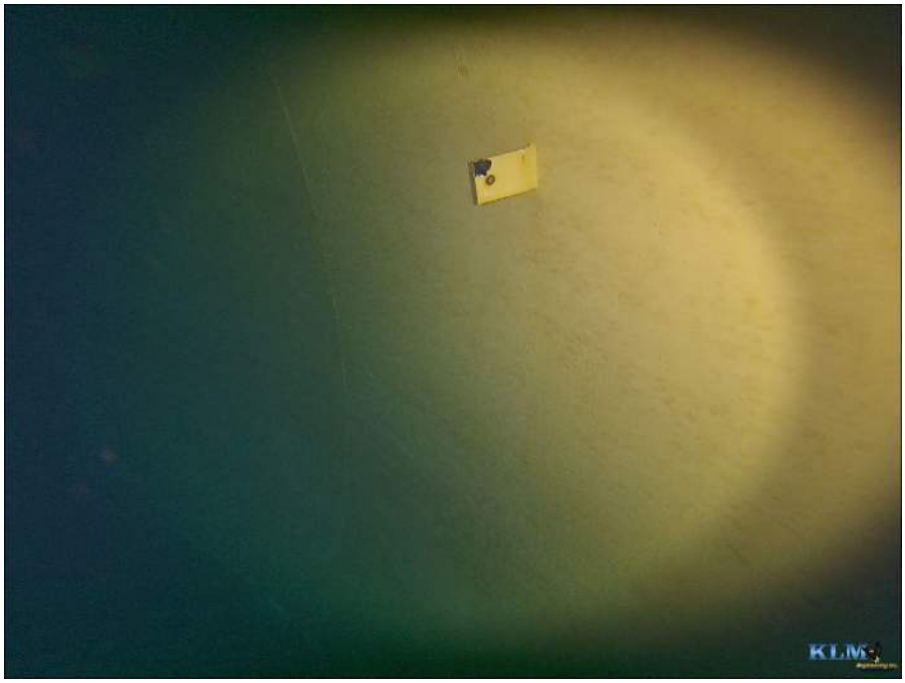

Photo No. 24
Shell condition with rigging tab

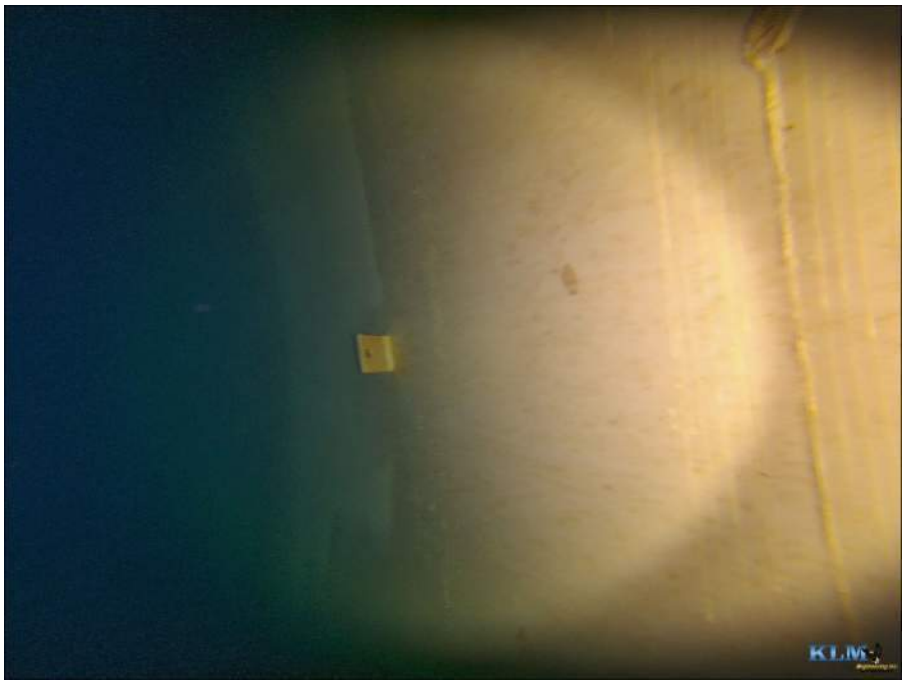

Photo No. 25
Shell condition with rigging tab

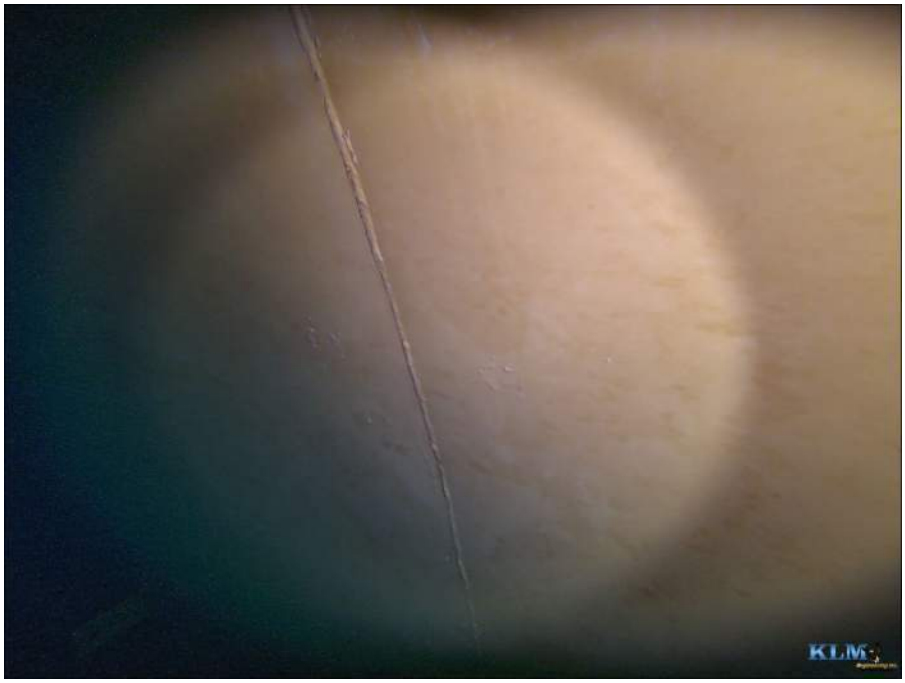

Photo No. 26
Shell condition

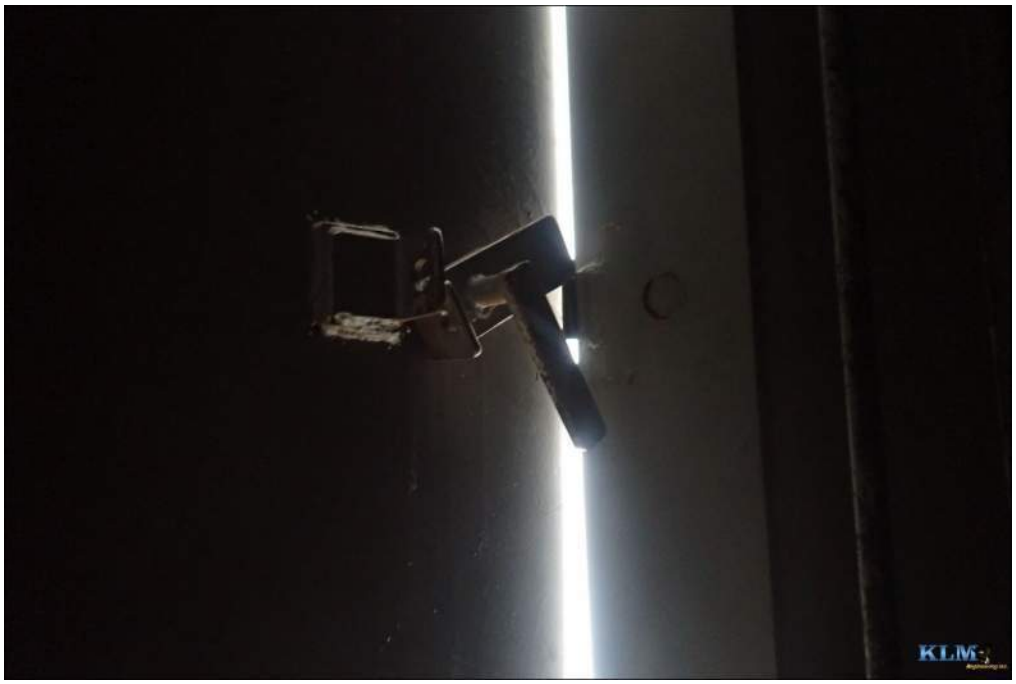

Photo No. 27
Misaligned locking hasp on antenna drywell extension

Photo No. 28
Corroded holes in top of drywell tube

Photo No. 29
Coating condition at top of drywell tube

Photo No. 30
Conditions at top of drywell tube looking up into antenna extension

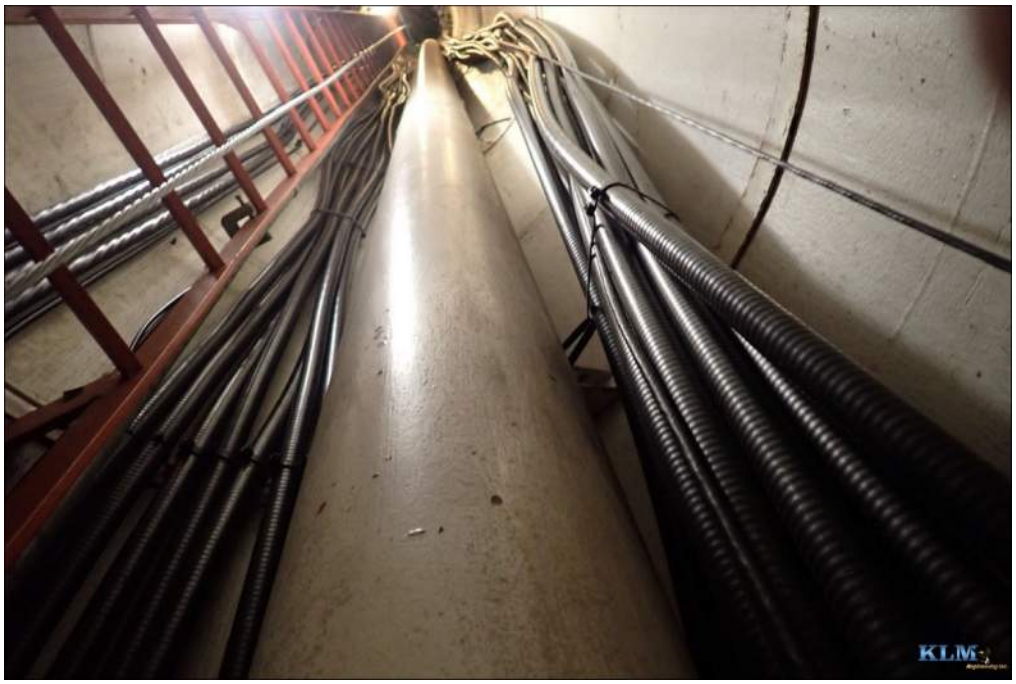

Photo No. 31
Conditions in drywell tube

Photo No. 32
Bowl conditions

Photo No. 33
Bowl conditions

Photo No. 34
Fill pipe to bowl connection

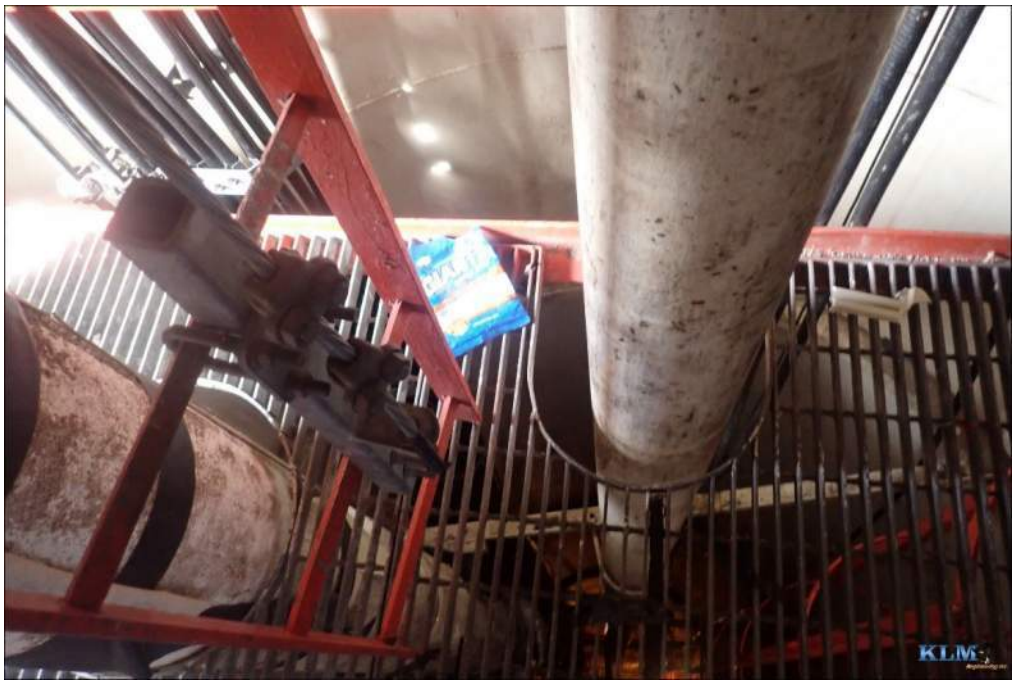

Photo No. 35
Upper platform

Photo No. 36
Upper platform

Photo No. 37
Conditions in pedestal

Photo No. 38
Conditions in pedestal

Photo No. 39
Conditions in pedestal

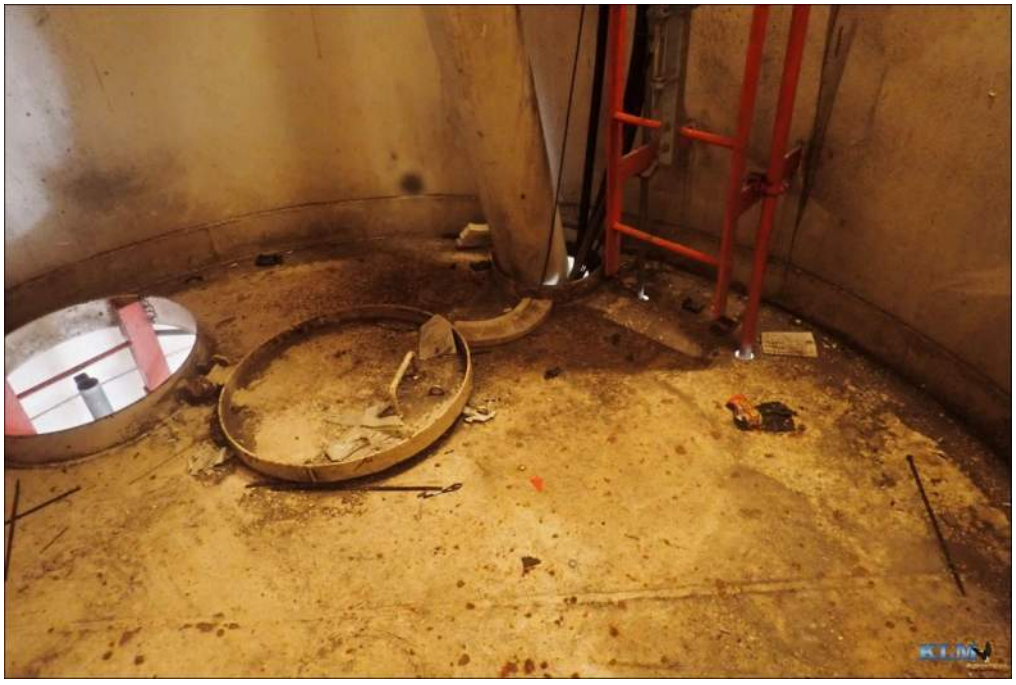

Photo No. 40
Landing at bottom of pedestal

Photo No. 41
Landing at bottom of pedestal

Photo No. 42
Base cone conditions

Photo No. 43
Conditions in base

Photo No. 44
Piping in valve pit

Photo No. 45
Antenna extension mount on top of drywell tube

Photo No. 46
Antenna extension mount on top of drywell tube

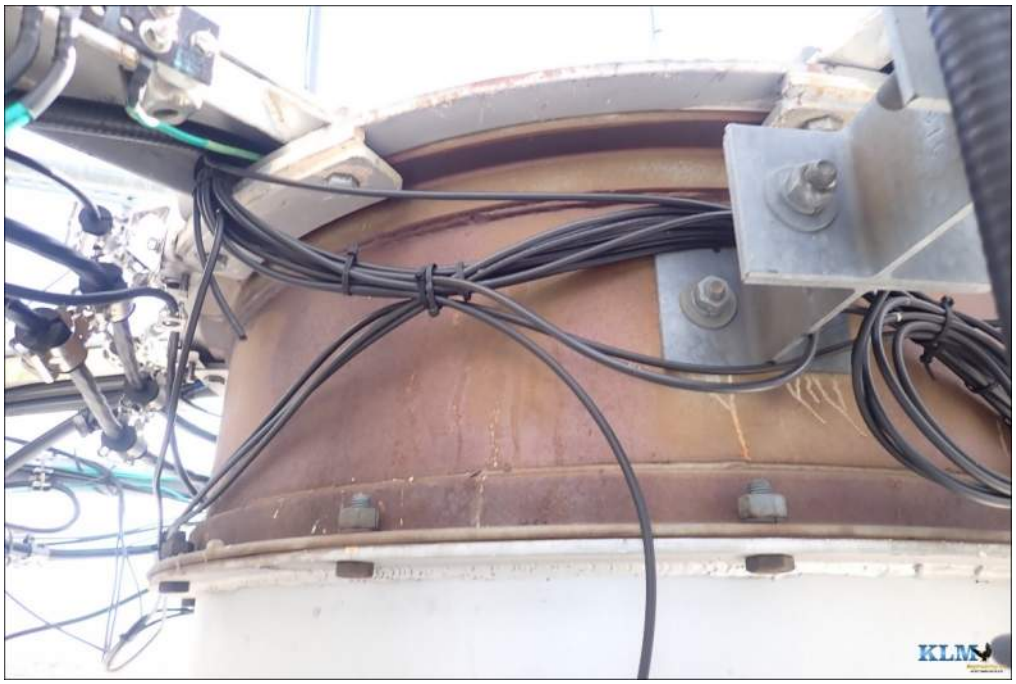

Photo No. 47
Antenna extension mount on top of drywell tube

Photo No. 48
Antenna extension mount on top of drywell tube

Photo No. 49
Roof access manway and conditions
Note: CP hand-hole cover

Photo No. 50
Severely deteriorated roof access manway

Photo No. 51
Conditions on roof

Photo No. 52
Deteriorated drywell tube curb to roof connection

Photo No. 53
Roof conditions

Photo No. 54
Roof conditions

Photo No. 55
Roof conditions

Photo No. 56
Overall condition of water compartment

Photo No. 57
Overall condition of water compartment

Photo No. 58
Overall condition of pedestal and bowl

Photo No. 59
Base cone

Photo No. 60
Base cone with overflow visible

Photo No. 61
Base cone

Photo No. 62
Antenna shelter

APPENDIX B

INSPECTION AND EVALUATION METHODS

1.0| INSPECTION AND EVALUATION METHODS

Some or all of the following procedures were performed as applicable.

1.1| Methods

1.1.1 The inspection of the base metal and coatings on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the base metal and coating on the interior wet surfaces were examined from either a rubber raft while the tank was being drained, by a Remote Operated Vehicle (ROV) with the tower in service, or with both.

1.1.2 Tank plate thickness was measured at random locations on the liquid holding shell. The overall structural condition of the tank was visually examined.

1.1.3 No structural analysis was done to determine if the tank design complies with the AWWA D100-11 Standard for "Welded Carbon Steel Tanks for Water Storage." However, any observed non-conformance to the AWWA D100-11 standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2| Examination and Evaluation Techniques

Some or all of the following procedures were performed as applicable.

1.2.1| Site

The tank site was evaluated for proper drainage conditions affecting access and lead paint abatement during reconditioning.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2| Foundations

The tank concrete foundation(s) were/was visually examined for cracks, spalling, conditions of grout, indications of distress/settlement, and elevation above grade.

1.2.3| Tank Plate Thickness

Plate thickness measurements were taken using ultrasonic methods (UTM). The readings were taken using a digital readout Elcometer MTG6 Ultrasonic Thickness Gage that has a dual element probe (transducer). The probe's transmitter element sends a short ultrasonic pulse through the material. The pulse gets reflected as an echo from the opposite side of the plate and returns to the probe's receiver element. The round-trip time is directly related to the material's thickness.

1.2.4| Coating Thickness

Interior and exterior coatings, where accessible, were tested in accordance with Steel Structures Painting Council SSPC-PA2-18 "Procedure for Determining Conformance to Dry Coating Thickness Requirements" using PosiTector-6000-F1 Type 2 gages.

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1.2.5| Coating Adhesion

Adhesion testing of the coating to the steel, and inner coat adhesion, was performed by ASTM D-3359: Shear Adhesion Test, Measuring Adhesion by Tape Test. In addition, subjective coating adhesion evaluation was performed using a penknife.

1.2.6| Coating Serviceability

The estimated remaining coating life or serviceability evaluation was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all accessible coatings. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the steel underneath the coating, or any other defects affecting the intended service.

1.2.7| Coating Lead and Chromium Content Analysis

Samples may have been taken of the various types of coatings present on the interior and exterior surfaces. GPI Laboratories, Inc. of Grand Rapids, Michigan tests these coatings in conformance with ASTM D-3335 Standard Test Methods for Concentrations of Lead and Chromium in Paint.

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APPENDIX C

PAINT CHIP TEST RESULTS

ANALYTICAL LABORATORY REPORT

CUSTOMER: KLM Engineering, Inc.
1976 Wooddale Drive
Woodbury, MN 55125

DATE RECEIVED: Monday, March 11, 2024
PO/PROJECT #: 3925-24 / 5069-24
SUBMITTAL #: 2024-03-11-001

LAB NUMBER: AD31278

Sampled By:
Job Location: Lawrence, KS
Sample Identification: 1 : Interior Wet (3925-24)

Date Sampled: 2/29/2024
Sample Description: Paint Chips

Preparation Method: EPA 3050B-P-M (Acid Digestion for Paints)
Analysis Method: EPA 6010D-M (ICP-AES Method for Determination of Metals)
Date Analyzed: Wednesday, March 13, 2024

ELEMENT	RESULT (by dry	REPORTING LIMIT (RL)
Cadmium	**< RL**	0.00038 %
Chromium	**2.2 %**	0.00065 %
Lead	**5.7 %**	0.0013 %

LAB NUMBER: AD31279

Sampled By:
Job Location: Lawrence, KS
Sample Identification: 2 : Interior Dry (3925-24)

Date Sampled: 2/29/2024
Sample Description: Paint Chips

Preparation Method: EPA 3050B-P-M (Acid Digestion for Paints)
Analysis Method: EPA 6010D-M (ICP-AES Method for Determination of Metals)
Date Analyzed: Wednesday, March 13, 2024

ELEMENT	RESULT (by dry	REPORTING LIMIT (RL)
Cadmium	**< RL**	0.00038 %
Chromium	**0.0096 %**	0.00065 %
Lead	**12 %**	0.0013 %

LAB NUMBER: AD31280

Sampled By:
Job Location: Lawrence, KS
Sample Identification: 3 : Exterior (3925-24)

Date Sampled: 2/29/2024
Sample Description: Paint Chips

Preparation Method: EPA 3050B-P-M (Acid Digestion for Paints)
Analysis Method: EPA 6010D-M (ICP-AES Method for Determination of Metals)
Date Analyzed: Wednesday, March 13, 2024

ELEMENT	RESULT (by dry	REPORTING LIMIT (RL)
Cadmium	**< RL**	0.00038 %
Chromium	**0.43 %**	0.00065 %
Lead	**9.5 %**	0.0013 %

GPI Laboratories, Inc. has obtained accreditation under the programs detailed on the final page of the laboratory report. The accreditations pertain only to the testing performed for the elements, and in accordance with the test methods, listed in the scope of accreditation table. Testing which is performed by GPI Laboratories, Inc. according to other test methods, or for elements which are not included in the table fall outside of the current
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ANALYTICAL LABORATORY REPORT

CUSTOMER: KLM Engineering, Inc.
1976 Wooddale Drive
Woodbury, MN 55125

DATE RECEIVED: Monday, March 11, 2024
PO/PROJECT #: 3925-24 / 5069-24
SUBMITTAL #: 2024-03-11-001

Unless otherwise noted, the condition of each sample was acceptable upon receipt, all laboratory quality control requirements were met, and sample results have not been adjusted based on field blank or other analytical blank results. Individual sample results relate only to the sample as received by the laboratory.

Tests Reviewed By: David Johnson, Project Manager

Reporting Limit (RL): The lowest concentration of analyte in a sample that can be reported with a defined, reproducible level of certainty. This value is based on the lowest standard used for instrument calibration and must be at least twice the MDL.

GPI Laboratories, Inc. is accredited to ISO/IEC 17025 by A2LA, for the specific testes listed on www.a2la.org.

A2LA: American Association for Laboratory Accreditation (Certificate 5033.02)

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GPI Laboratories, Inc.
4403 Donker Court, Grand Rapids MI 49512-4054
(616) 940-3112 | GRLabsInfo@gpinet.com | www.gpinet.com

FOR LAB USE ONLY			
Properly Contained	YES	NO	N/A
ASTM E1792 wipes	YES	NO	N/A
Adequate Ph Adjust	YES	NO	N/A
Lab acidified: By/Date:			

Company: KLM Engineering, Inc.	Address: 1976 Wooddale Drive, Suite 4, Woodbury, MN 55125	Company Contact: Olivia Harrington Telephone: 651-773-5111 E-Mail: oharrington@klmengineering.com	P.O./Proj #: 3925-24/5069-24 Location: Lawrence, KS

Matrix	TCLP (Waste)	Metals Content	Other Tests	Turnaround Time
☑ Paint Chips ☐ Wipe	☐ Lead	☐ Lead	☐ pH (Corrosivity)	☐ Same Day*
☐ Soil ☐ Filter	☐ RCRA (8) Metals	☑ Lead, Cad., Chrome.	☐ Ignitability	☑ Rush*
☐ Abrasive ☐ _____	☐ _____	☐ RCRA (8) Metals	☐ VOC (Method 24, etc)	☐ Standard
☐ Wastewater		☐ _____	☐ _____	☐ _____

Comments:

GPI Labs accepts Visa, MasterCard, and American Express. *Accelerated Turnaround is not available for every test. Please call for information.

Laboratory ID	Sample Number	Date/Time Sampled	Sample Identification / Location:	Special Instructions:	Wipes: Area wiped (sq.ft.)	Air Sampling Filters: ☐ TSP ☐ PM10 ☐ 37 mm Cassette — Minutes	Flow Rate	UNITS
A031278	1	2-29-24	Interior Wet (3925-24)					
A031279	2	2-29-24	Interior Dry (3925-24)					
A031280	3	2-29-24	Exterior (3925-24)					
A031281	3-11-24							
A031282	1	2-27-24	Exterior (5069-24)					
A031282	2	2-27-24	Interior Wet (5069-24)					

Sampled By (Please print) : _____ Date Submitted: 3/7/2024 Signature: Nancy Hofer

Received by: _____ Date/Time: _____ Relinquished Date/Time: _____

Received by: _____ Date/Time: _____ Relinquished Date/Time: _____

Page 1 of 1

Method of Shipment: _____

Received for Laboratory by: Brad Gilman Date/Time: 3-11-24 10:30 Submittal #: 2024-03-11-017

1/18/17 Form #: 53-12

Lawrence, Kansas

Inspection Report:
600,000-Gallon Capacity
Kaw – US Clearwell

Prepared by:

KLM Engineering, Inc.
1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 5067-24

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5.0| PROPERTY CONSIDERATIONS 5
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6.0| RECONDITIONING SUMMARY 5
6.1| Reconditioning Summary and Cost Estimate 5

APPENDIX A: Photographs

APPENDIX B: Concrete Inspection and Evaluation Methods

1.0| PROJECT INFORMATION

KLM Project No.: 5067-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: Kaw – US Clearwell

Tank Description: Buried Concrete Reservoir

Tank Street Location: 720 West 3rd Street, Lawrence, KS 66044

Purpose of Inspection: Condition Assessment

Date of Inspection: February 28, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Builder: Unknown **Construction Date:** ~1958

Engineer: Unknown **Design Code:** AWWA/ACI

Capacity: 600,000 gallons

Type of Construction: Cast-in place Concrete

Tank Dimensions: ~85 feet x ~110 feet

Tank Depth: Overall ~12 feet

Height to: HWL ~10 feet LWL Tank floor

Tank Construction Drawings: None available to KLM

Previous Inspection Records: None available to KLM

Lawrence, Kansas

600,000 – GALLON CAPACITY
KAW – US CLEARWELL

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

c. Appendix B Concrete Inspection and Evaluation Methods.

3.0| COATINGS EVALUATION AND STRUCTURE EVALUATION

Note: Hairline cracks on the interior can appear to be larger than they are due to efflorescence present and the tendency to attract sediment and biofilm. Efflorescence is due to the migration of moisture through the cracks and is not harmful.

The reservoir is used to store potable water and is rectangular in shape. Access to the reservoir interior is achieved by an exterior manway.

Photographs of the structure areas can be found in Appendix A.

3.1| Interior Wet

3.1.1| Coating

The interior of the reservoir is uncoated concrete and presumably has never been coated. Concrete potable water tanks are typically not recommended to be coated unless there are concerns of degradation of the structure, water infiltration, biofilm accumulation, or difficult to clean surfaces. In non-potable storage applications, use of coating products helps protect the concrete from deterioration by corrosive gases and liquids.

The interior piping is constructed of ductile iron and heavily corroded.

3.1.2| Structure

a) Roof, Walls, and Beams

The roof, walls, and beams are cast-in-place concrete that is in good to fair condition. Failures consist of several random locations of shrinkage cracks with efflorescence present. One piece of spalled concrete was observed on the floor but the location it came from on the ceiling could not be found. There is also visible dotted corrosion on the roof and walls, which is resultant of the uncoated “feet” on the chairs used to support reinforcement bars during construction. These failures are not a structural concern at this time.

b) Columns

The rectangular columns are cast-in-place concrete and are in good visible condition. Structural defects such as buckling, rotation, or major cracking are not observed in any of the columns. One spot of corrosion was observed on a column. Typically, this is a result of rebar being too close to the concrete edge.

c) Floor

The reservoir floor is a cast-in-place concrete slab in good visible condition to the extent of observation. There were no observations made that might indicate the presence of structural defects, such as major cracking with exfiltration or settlement. Moderate sediment is present on the floor.

3.2| Exterior

3.2.1| Coating

The reservoir is buried with grass growing on the roof. KLM has no knowledge of whether there are any exterior concrete coatings. The access manway hood is aluminum and is in good condition. The reservoir vent coatings are in poor condition with extensive coating failures and bare steel visible.

3.2.2| Structure

a) Roof and Walls

The primary structure is completely buried and cannot be analyzed without excavation. However, KLM anticipates the buried roof and walls are in similar good condition as the interior roof and walls.

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, ACI and AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time.

Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 Repair cracks on the roof, walls, and floor as noted. Blast and coat exposed rebar. See photos 7, 8, 10, 13, 16, 17, and 29.

4.1.2 Blast and coat all piping. See photos 21 and 34 through 37.

4.2| Exterior Modifications

4.2.1 Modify the J-vent outlet elevation to provide 24-inch air gap from grade to comply with AWWA and Kansas Department of Health and Environment regulations. See photos 38 and 39.

4.2.2 Modify the access manway to provide 24-inch elevation from the hatch to grade to comply with AWWA and Kansas Department of Health and Environment regulations. See photos 40 and 41.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The Clearwell is located at the Kaw River Water Treatment Plant. The reservoir is completely buried with access from an exterior manway.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

KLM recommends performing the structure modifications and coating noted within two years to bring the Clearwell into compliance with current standards and to maximize the life of the structure, eliminate more costly future repairs, and aid in improving water quality.

For budgetary purposes, the cost to perform the modifications and blast and paint the piping are estimated between $160,000 and $165,000. This estimate is based on current pricing and does not include costs for engineering and/or inspection services.

An experienced concrete repair and coating contractor with proper crew and equipment should be able to complete the project in four weeks. At the time of repairs, the reservoir will need to be drained and remain off-line.

KLM ENGINEERING, INC.

Report prepared by:

Joseph Clasemann

Joseph Clasemann, E.I.T.
Civil Engineer-In-Training
EIT Certification No. 157889

Report reviewed by:

Rodney Ellis

Rodney Ellis
Vice President/COO
NACE Certified Coatings Inspector No. 1686
AWS/CWI 0404031

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of Clearwell location

Photo No. 2
Condition of ceiling

Photo No. 3
Condition of ceiling

Photo No. 4
Condition of ceiling

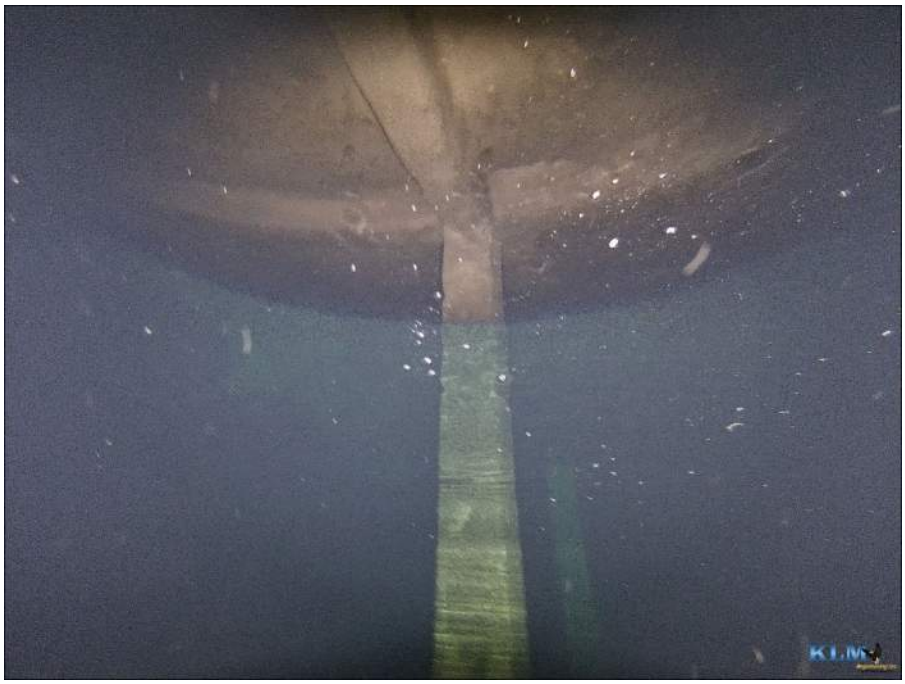

Photo No. 5
Condition of ceiling

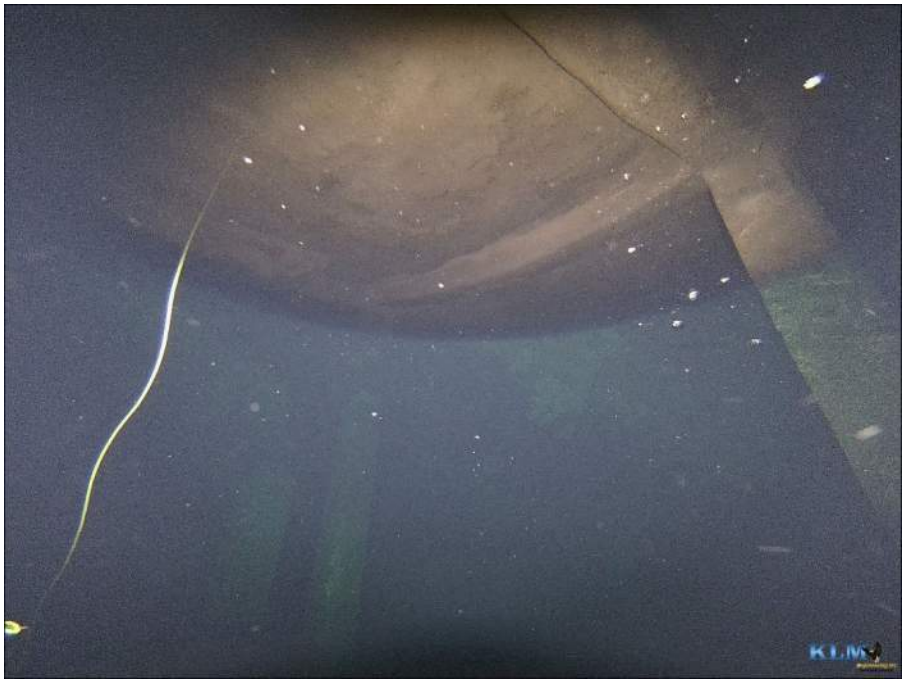

Photo No. 6
Condition of ceiling

Photo No. 7
Condition of ceiling

Photo No. 8
Wall condition

Photo No. 9
Wall condition

Photo No. 10
Wall condition

Photo No. 11
Wall condition

Photo No. 12
Wall condition

Photo No. 13
Wall condition

Photo No. 14
Wall condition

Photo No. 15
Wall condition with pass through

Photo No. 16
Wall condition

Photo No. 17
Wall condition

Photo No. 18
Condition of wall at corner

Photo No. 19
Condition of wall at corner

Photo No. 20
Wall to floor connection

Photo No. 21
Wall to floor connection with piping visible

Photo No. 22
Wall to floor connection

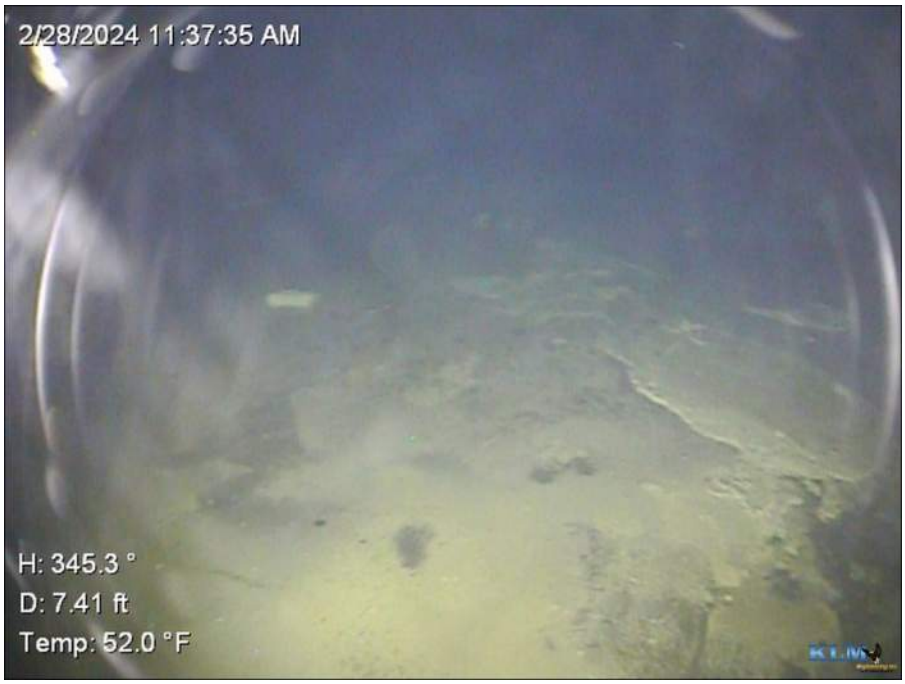

Photo No. 23
Floor condition

Photo No. 24
Floor condition

Photo No. 25
Condition of floor

Photo No. 26
Condition of floor

Photo No. 27
Condition of floor

Photo No. 28
Condition of floor

Photo No. 29
Column base at floor
Note: corrosion

Photo No. 30
Column base at floor

Photo No. 31
Column to roof beams

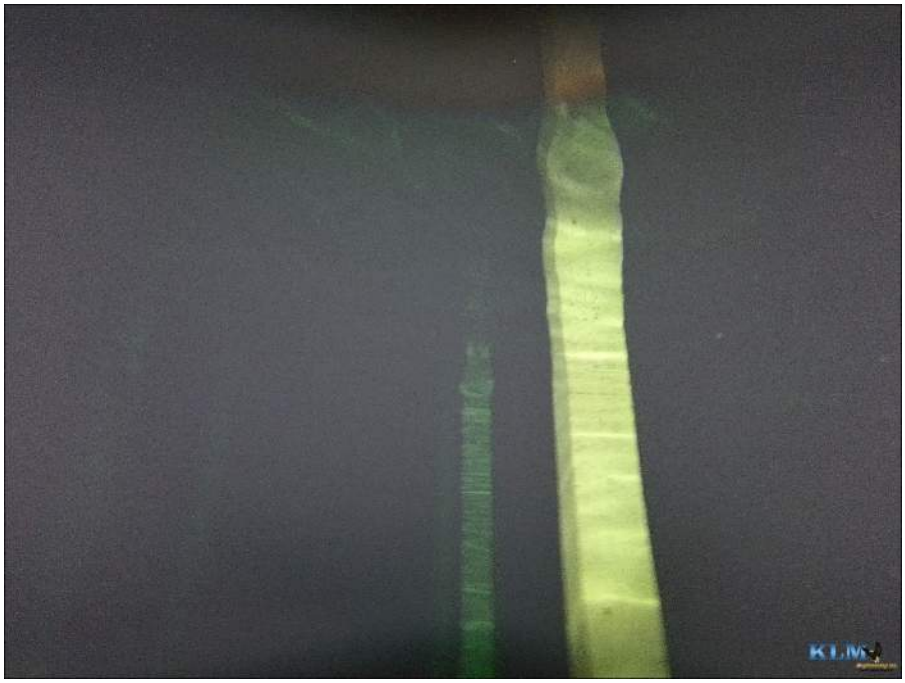

Photo No. 32
Overall condition of column

Photo No. 33
Overall condition of column

Photo No. 34
Piping at wall connection

Photo No. 35
Piping condition

Photo No. 36
Piping condition

Photo No. 37
Piping condition

Photo No. 38
J-vent

Photo No. 39
Coating condition of vent and ground clearance

Photo No. 40
Access manway

Photo No. 41
Manway ground clearance

Photo No. 42
Site conditions

APPENDIX B

CONCRETE INSPECTION AND EVALUATION METHODS

1.0|INSPECTION AND EVALUATION METHODS

Some or all the following procedures were performed as applicable.

1.1|Methods

1.1.1 The inspection of the concrete and coatings (if present) on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the concrete and coating on the interior wet surfaces were examined from either a rubber raft while the reservoir was being drained, by a Remote Operated Vehicle (ROV) with the reservoir in service, or with both.

1.1.2 Reservoir concrete conditions including cracking and spalling were measured where accessible. The overall structural condition of the reservoir was visually examined per ACI 201.1R-2.

1.1.3 No structural analysis was done to determine if the reservoir design complies with the ACI Standard 318 for "Building Code Requirements for Reinforced Concrete." However, any observed non-conformance to the ACI Standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2|Examination and Evaluation Techniques

Some or all the following procedures were performed as applicable.

1.2.1|Site

The reservoir site was evaluated for proper drainage conditions and access to vents, manways and overflow pipe discharges.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2|Shell and Roof

The exterior reservoir concrete shell and roof were visually examined where accessible for OSHA, AWWA and State code compliances. Conditions of grout and/or caulk at shell to roof joint, indications of distress/settlement, and elevation of roof above or below grade is noted in this report.

1.2.3|Concrete Condition

All visible exterior and interior concrete reservoir components including the roof, shell, floor, columns, pilasters and baffle walls were inspected as follows. Concrete surface conditions are visually inspected for bugholes, honeycombing, cracking, surface deterioration and spalling. The size, type and orientation of cracks (i.e., horizontal, vertical, diagonal, shrinkage, etc.), the presence of efflorescence and exposed reinforcement steel are included in the inspection and noted in the evaluation.

1.2.4|Coating Thickness

Interior and exterior coatings, where accessible and if present, were tested by destructive testing removing a sample of the coating with a knife or other instrument and measuring the thickness with a gauge.

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1.2.5|Coating Serviceability

The estimated remaining coating life or serviceability evaluation, where accessible and if present, was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all the interior coating's accessible areas. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the concrete underneath the coating, or any other defects affecting the intended service.

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Lawrence, Kansas

Inspection Report:
170,000- Gallon Capacity
Kaw – DS Clearwell

Prepared by:

KLM Engineering, Inc.
1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 5068-24

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APPENDIX A: Photographs

APPENDIX B: Concrete Inspection and Evaluation Methods

1.0| PROJECT INFORMATION

KLM Project No.: 5068-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: Kaw – DS Clearwell

Tank Description: Buried Concrete Reservoir

Tank Street Location: 720 West 3rd Street, Lawrence, KS 66044

Purpose of Inspection: Condition Assessment

Date of Inspection: February 28, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Builder: Unknown **Construction Date:** ~1958

Engineer: Unknown **Design Code:** AWWA/ACI

Capacity: 170,000 gallons

Type of Construction: Cast-in place Concrete

Tank Dimensions: Unknown

Tank Depth: Overall ~10 feet

Height to: HWL ~7 feet LWL Tank floor

Tank Construction Drawings: None available to KLM

Previous Inspection Records: None available to KLM

Lawrence, Kansas

170,000 – GALLON CAPACITY
KAW – DS CLEARWELL

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

c. Appendix B Concrete Inspection and Evaluation Methods.

3.0| COATINGS EVALUATION AND STRUCTURE EVALUATION

Note: Hairline cracks on the interior can appear to be larger than they are due to efflorescence present and the tendency to attract sediment and biofilm. Efflorescence is due to the migration of moisture through the cracks and is not harmful.

The reservoir is used to store potable water and is rectangular in. Access to the reservoir interior is achieved by a rectangular hatch on the roof inside the plant.

Photographs of the structure areas can be found in Appendix A.

3.1| Interior Wet

3.1.1| Coating

The interior of the reservoir is uncoated concrete and presumably has never been coated. Concrete potable water tanks are typically not recommended to be coated unless there are concerns of degradation of the structure, water infiltration, biofilm accumulation, or difficult to clean surfaces. In non-potable storage applications, use of coating products helps protect the concrete from deterioration by corrosive gases and liquids.

The pump casings are severely corroded adjacent to the screens.

3.1.2| Structure

a) Roof, Walls, and Beams

The roof, walls, and beams are cast-in-place concrete that is in good to fair condition. Failures consist of several random locations of shrinkage cracks on the roof with evidence of efflorescence, and random spots of spalled concrete on the walls resulting in exposed rebar. Although not a structural concern at this time, the cracks on the roof should be monitored with regular inspections to better determine if expanding is occurring. At the time of this inspection, no records were available to compare previous conditions.

b) Columns

The rectangular columns are cast-in-place concrete and are in good visible condition. Structural defects such as buckling, rotation, or major cracking are not observed in any of the columns.

c) Floor

The reservoir floor is a cast-in-place concrete slab in good visible condition. Minor cracking was observed in random locations. These cracks should be monitored with regular inspections to better determine if expanding is occurring. At the time of this inspection, no records were available to compare previous conditions.

3.2| Exterior

3.2.1| Coating

The reservoir is located below grade. The presence of a coating below grade is unknown. The access manway hatch is aluminum and in good condition.

3.2.2| Structure

a) Roof and Walls

The primary structure is completely buried and cannot be analyzed without excavation. However, KLM anticipates the buried roof and walls are in similar good condition as the interior roof and walls.

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, ACI and AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time.

Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 Repair cracks on the roof, walls, and floor as noted. Blast and coat exposed rebar. See photos 8 and 10 through 13.

4.1.2 Blast and coat the pump casings. See photos 3 and 4.

4.2| Exterior Modifications

4.2.1 No defects were observed, and no repairs are required.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The Clearwell is located under the Kaw River Water Treatment Plant. Access to the tank is from a manway located within a building. Field evidence suggests vehicles are parked either directly above the tank, or adjacent to the tank, on the same concrete slab as the tank roof. KLM recommends not allowing vehicles to park in the shop to eliminate potential infiltrating contamination.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

KLM recommends repairing the noted cracks and blasting/painting of the pump casings within the next five years to maximize the life of the structure, eliminate more costly future repairs, and aid in improving water quality.

For budgetary purposes, the concrete repairs and reservoir modifications are estimated between $95,000 and $115,000. This estimate is based on current pricing and does not include costs for engineering and/or inspection services.

An experienced concrete repair and coating contractor with proper crew and equipment should be able to complete the project in three weeks. At the time of repairs, the reservoir will need to be drained and remain off-line.

KLM ENGINEERING, INC.

Report prepared by:

Joseph Clasemann

Joseph Clasemann, E.I.T.
Civil Engineer-In-Training
EIT Certification No. 157889

Report reviewed by:

Rodney Ellis

Rodney Ellis
Vice President/COO
NACE Certified Coatings Inspector No. 1686
AWS/CWI 0404031

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of Clearwell location

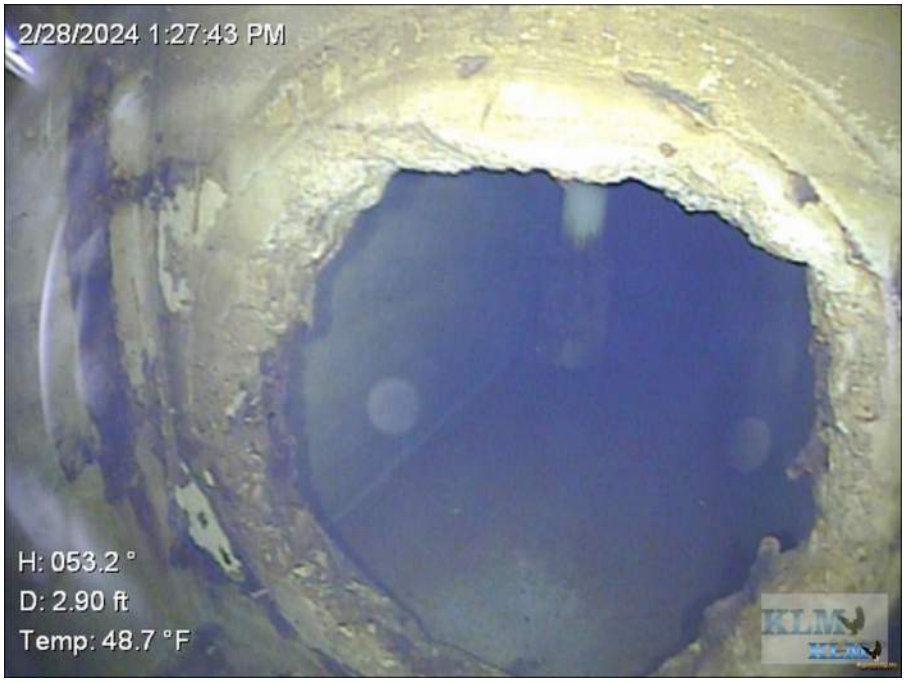

Photo No. 2
Opening in wall to service pumps

Photo No. 3
Service pump room

Photo No. 4
Service pump room

Photo No. 5
Service pump room, looking up

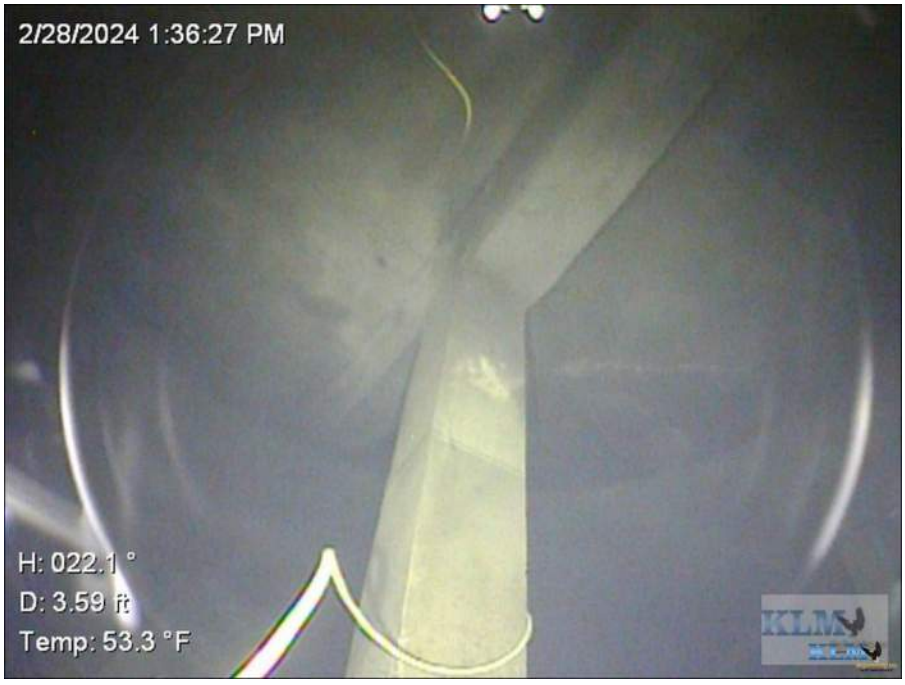

Photo No. 6
Clearwell ceiling conditions

Photo No. 7
Clearwell ceiling conditions

Photo No. 8
Shrinkage cracks in ceiling

Photo No. 9
Ceiling conditions

Photo No. 10
Ceiling conditions

Photo No. 11
Ceiling conditions

Photo No. 12
Ceiling conditions
Note: cracks and efflorescence

Photo No. 13
Ceiling conditions
Note: cracks and efflorescence

Photo No. 14
Condition of walls at corner

Photo No. 15
Condition of walls at corner

Photo No. 16
Condition of wall

Photo No. 17
Condition of wall

Photo No. 18
Condition of wall with crack and exposed rebar

Photo No. 19
Crack on wall

Photo No. 20
Wall condition with exposed rebar

Photo No. 21
Cracks on wall

Photo No. 22
Efflorescence on wall

Photo No. 23
Typical condition of column

Photo No. 24
Typical column at floor

Photo No. 25
Typical condition of column

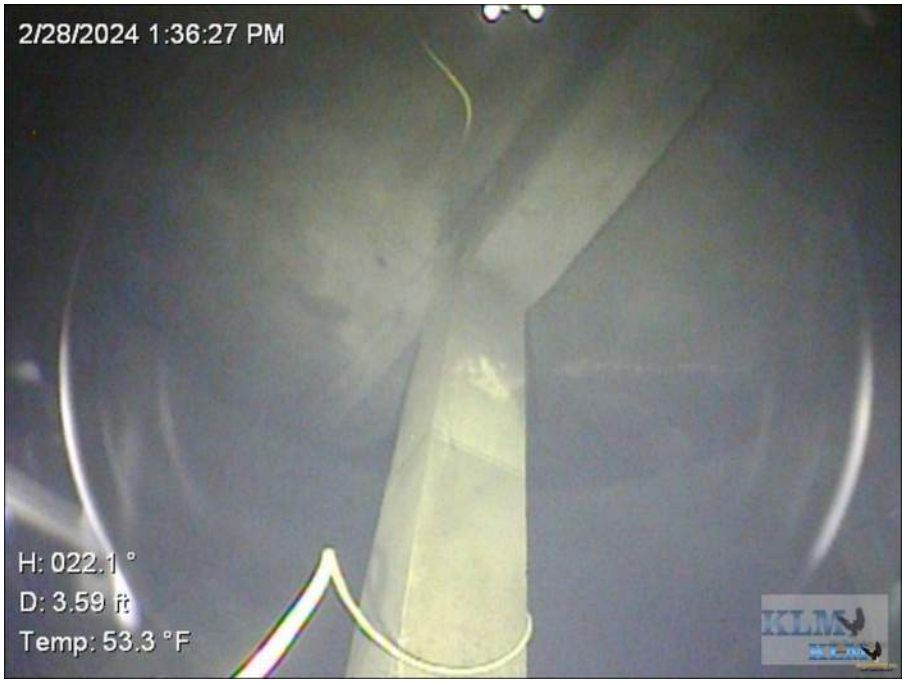

Photo No. 26
Column to beam connection

Photo No. 27
Floor and wall conditions in service pump chamber

Photo No. 28
Floor to wall condition in clearwell

Photo No. 29
Floor conditions

Photo No. 30
Floor conditions with debris

Photo No. 31
Floor conditions

Photo No. 32
Floor conditions

Photo No. 33
Crack on floor

Photo No. 34
Floor conditions

Photo No. 35
Clearwell manway

Photo No. 36
Clearwell manway

APPENDIX B

CONCRETE INSPECTION AND EVALUATION METHODS

1.0|INSPECTION AND EVALUATION METHODS

Some or all the following procedures were performed as applicable.

1.1|Methods

1.1.1 The inspection of the concrete and coatings (if present) on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the concrete and coating on the interior wet surfaces were examined from either a rubber raft while the reservoir was being drained, by a Remote Operated Vehicle (ROV) with the reservoir in service, or with both.

1.1.2 Reservoir concrete conditions including cracking and spalling were measured where accessible. The overall structural condition of the reservoir was visually examined per ACI 201.1R-2.

1.1.3 No structural analysis was done to determine if the reservoir design complies with the ACI Standard 318 for "Building Code Requirements for Reinforced Concrete." However, any observed non-conformance to the ACI Standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2|Examination and Evaluation Techniques

Some or all the following procedures were performed as applicable.

1.2.1|Site

The reservoir site was evaluated for proper drainage conditions and access to vents, manways and overflow pipe discharges.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2|Shell and Roof

The exterior reservoir concrete shell and roof were visually examined where accessible for OSHA, AWWA and State code compliances. Conditions of grout and/or caulk at shell to roof joint, indications of distress/settlement, and elevation of roof above or below grade is noted in this report.

1.2.3|Concrete Condition

All visible exterior and interior concrete reservoir components including the roof, shell, floor, columns, pilasters and baffle walls were inspected as follows. Concrete surface conditions are visually inspected for bugholes, honeycombing, cracking, surface deterioration and spalling. The size, type and orientation of cracks (i.e., horizontal, vertical, diagonal, shrinkage, etc.), the presence of efflorescence and exposed reinforcement steel are included in the inspection and noted in the evaluation.

1.2.4|Coating Thickness

Interior and exterior coatings, where accessible and if present, were tested by destructive testing removing a sample of the coating with a knife or other instrument and measuring the thickness with a gauge.

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1.2.5|Coating Serviceability

The estimated remaining coating life or serviceability evaluation, where accessible and if present, was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all the interior coating's accessible areas. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the concrete underneath the coating, or any other defects affecting the intended service.

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Lawrence, Kansas

Inspection Report:
75,000-Gallon Capacity
Kaw – Multi Leg Tank

Prepared by:

KLM Engineering, Inc.
1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 5069-24

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APPENDIX B: Inspection and Evaluation Methods

APPENDIX C: Paint Chip Test Results

1.0| PROJECT INFORMATION

KLM Project No.: 5069-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: Kaw – Multi Leg Tank

Tank Description: Double Ellipsoidal

Tank Street Location: 720 West 3rd Street, Lawrence, KS 66044

Purpose of Inspection: Condition Assessment

Date of Inspection: February 27, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Manufacturer: Unknown **Construction Date:** ~1954

Serial No.: None listed **Design Code:** AWWA D100

Capacity: 75,000 gallons

Type of Construction: Welded

Tank Diameter: ~28 feet

Height to: Overall ~55 feet

Height to: HWL ~45 feet LWL ~25 feet

Tank Construction Drawings: None available to KLM

Previous Inspection Records: None available to KLM

EXISTING COATING INFORMATION

	Interior Wet	Exterior
Date Last Coated	Unknown	Unknown
Full or Spot Repair	Full	Overcoat
Coating Contractor	Unknown	Unknown
Surface Preparation	Unknown	Unknown
Paint System	Epoxy	Alkyd
Paint Manufacturer	Unknown	Unknown
Paint Chip Samples	Taken	Taken

Lawrence, Kansas

75,000 – GALLON CAPACITY
KAW – MULTI LEG TANK

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. General guidelines of AWWA Manual M42 Appendix C “Inspecting and Repairing Steel Water Tanks, and Elevated Tanks for Water Storage.”

c. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

d. AWWA Standard D100; Welded Carbon Steel Tanks for Water Storage.

3.0| COATINGS EVALUATION

3.1| Lead and Chromium Content Analysis

The total lead and chromium content of the interior and exterior coatings was analyzed. The results in Appendix C show a 6.6 percent lead content for the interior wet coating, and a 13 percent lead content for the exterior coating. Results exceeding 0.50 percent lead can be a health hazard according to federal regulation. Consequently, the interior and exterior coatings are classified as lead-based paints. Removal of lead-based paint must be performed in accordance with applicable local, state, and federal regulations. Reconditioning specifications must include provisions for full containment as well as provisions to prevent hazardous waste generation. Chromium levels vary from below the Reporting Limit (RL) to 0.027 percent. These chromium levels are not high enough to be a concern in the waste streams generated during reconditioning.

3.2| Interior Wet Coating

The tower was constructed and originally painted in approximately 1954, around the time the Kaw River Water Treatment Plant received funding for improvements. It is unknown when the interior wet coating was last replaced or by whom. The interior wet coating is in poor condition above and below the high-water line (HWL) with more than 50 percent visible coating failures throughout the area. Failures consist of widespread surface corrosion, pinhole failures, and random areas of more aggressive corrosion. See photos in Appendix A.

3.3| Exterior Coating

It is unknown when the exterior coating was last replaced or by whom. The exterior coating is in poor overall condition with approximately 15 to 20 percent visible coating failures observed throughout the structure. Failures consist of widespread and sporadic pinhole failures, oxidation, and surface corrosion. See photos in Appendix A.

3.4| Replacement Coating Systems

When the next full reconditioning is performed, KLM recommends preparing surfaces in accordance with NACE guidance and applying a coating system for each area according to the following.

3.4.1| Interior Wet Coating

Surface preparation should be performed according to SSPC-SP10 Near White Metal Blast criteria.

Apply a two-coat system:

1. moisture cured zinc-rich
2. NSF 61 certified 100% solid epoxy

3.4.2| Exterior Coating

Surface preparation should be performed according to SSPC-SP6 Commercial Blast Clean criteria.

Apply a four-coat system:

1. moisture cured zinc-rich
2. polyamidoamine epoxy
3. aliphatic acrylic urethane
4. fluoropolymer

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time.

Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 Add two rafters spanning the roof equally spaced from the finial vent. This is to support the exterior containment system during reconditioning. See photos 2 through 5.

4.1.2 Seal weld the interior seam of the roof access manway.

4.1.3 Seal weld the overflow stand-off brackets to the upper torus. See photo 7.

4.1.4 Remove the abandoned cathodic protection system in its entirety. Include the removal of all wiring and rectifier. See photo 3.

4.1.5 Replace the grating on the wet riser with a welded-in-place grating. This grating should be capable of supporting a painter's rigging with a center, hinged opening. Having this arrangement facilitates future

maintenance of the wet riser interior and the grating prevents personnel from falling down the wet riser. See photos 15 and 16.

4.1.6. Replace the gasket on the riser manway. See photo 36.

4.1.7 Grind off all weld spatter and erection scab marks for compliance with AWWA D100.

4.1.8 Consider installing a submersible mixer in the tower to reduce the likelihood and magnitude of ice formation in cold weather and prevent stratification in warm weather.

4.2| Exterior Modifications

4.2.1 Replace the non-conforming finial vent with an aluminum pressure pallet style vent. The new vent and vent screen design should meet AWWA D100 and Kansas Department of Health and Environment regulations. The removable top will improve ventilation, provide access to the tank interior during reconditioning, and aid in compliance with OSHA confined space entry requirements. See photo 17.

4.2.2 Replace the exterior roof, shell, and support column ladders with new ladders conforming to OSHA regulations. The existing ladders do not meet current OSHA regulations for width. Include OSHA compliant, cable style safety climb devices on the new ladders. See photos 23, 25, and 39.

4.2.3 Install a pipe-style roof handrail conforming to OSHA regulations to enclose the existing roof access manway and the new finial vent. Include a self-closing swing gate at the handrail opening and a non-skid walkway within the area of the handrailing. See photos 17 through 22.

4.2.4 Install two hinge-covered ventilation manways on the roof outside the new handrail. These will provide additional ventilation during the interior surface preparation and coating.

4.2.5 Replace the cover plates over the cathodic protection hand-holes in the tank roof and seal weld inside and outside. Remove the cathodic protection system control box, all attachment brackets, and conduit. See photos 20 and 21.

4.2.6 Extend the stub overflow pipe to 18-inches above grade. Include a splash pad as recommended by AWWA. Include a screen retainer and screens. Use corrosion-resistant, heavy-gauge, No. 4, and No. 24 mesh screens on the outlet (#4 downstream of #24). See photos 25 and 28.

4.2.7 Seal weld the intermittent weld between the topside of the balcony and the tank shell using a fillet weld in conformance to AWWA D100. See photo 32.

4.2.8 Replace the balcony handrail with an angle-style handrail conforming to OSHA regulations. The existing balcony handrail does not meet the OSHA top-of-rail height requirements or the requirement for a mid-rail, and access from the leg ladder to the balcony is difficult and unsafe. Include a self-closing swing gate at the handrail opening. See photos 25, and 29 through 32.

4.2.9 Install one additional pressure-style manway in the bottom section of the wet riser, 180 degrees from the existing manway. This will improve the ventilation during reconditioning and bring the tank into compliance with OSHA confined space entry requirements. See photo 36.

4.2.10 Install a hinged, locking cover over the lower 8 feet of the new column ladder. This will restrict access by unauthorized personnel.

4.2.11 Expose the foundation around the wet riser and one of the columns as recommended by AWWA. Regrade area to direct drainage away from the tank. See photos 35 and 37.

4.3| Cathodic Protection (CP) System

4.3.1 The tower has an abandoned hanging CP system. Per Item 4.1.4 above, KLM recommends removing the system in its entirety. The corrosion inhibitors of modern coating systems have eliminated the need for a separate cathodic protection system on potable water reservoirs.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The tank is located adjacent to a building on the site of the Kaw River Water Treatment Plant.

5.1.2 In conformance with Kansas Department of Health and Environment regulations, an analysis has been performed to determine the methods of pollution control required for this storage structure during reconditioning. To maintain air quality and to prevent the drift of dust and fugitive emissions, full containment will be required, including impervious ground cover, a top cover or bonnet and negative air dust collection.

5.2| Telecommunications Considerations

5.2.1 The tower has a camera installed on the roof. The camera and all associated wiring will need to be removed during the reconditioning process. No additional equipment is located on the tank.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

KLM recommends performing the noted modifications and replacing the interior wet, interior dry, and exterior coatings within the next two years to maximize the life of the structure, eliminate more costly future repairs, and aid in improving water quality.

The costs for structure modifications and replacing the interior and exterior coatings (including the containment and removal of the lead-based paint) are estimated between $625,000 and $650,000. This estimate is based on current pricing and does not include costs for engineering and/or inspection services. For competitive bids, the project should be bid 9 to 12 months before the desired starting date.

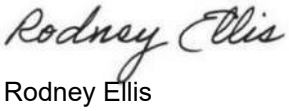
An experienced tank-coating contractor with the proper crew and equipment should be able to complete the project in six weeks. At the time of reconditioning, the tower, will need to be drained and remain off-line during interior structure modifications, abrasive blasting, and painting. However, most of the exterior structure modifications can be performed prior to draining, with the tank in-service.

KLM ENGINEERING, INC.

Report prepared by:

Joseph Clasemann, E.I.T.
Civil Engineer-In-Training
EIT Certification No. 157889

Report reviewed by:



Rodney Ellis
Vice President/COO
NACE Certified Coatings Inspector No. 1686
AWS/CWI 0404031

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of the tower

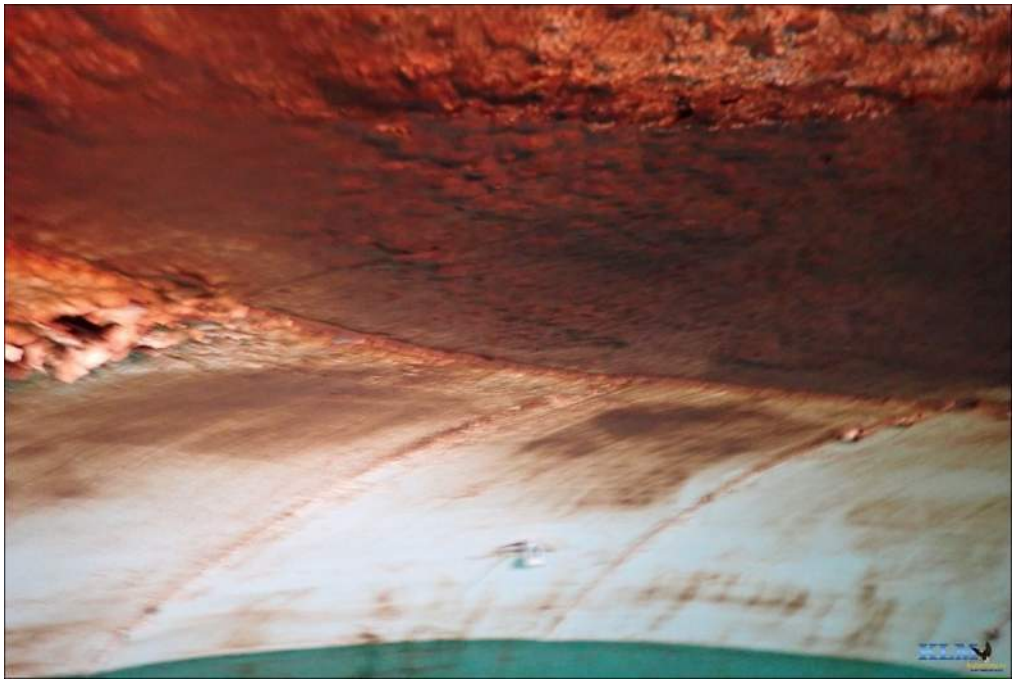

Photo No. 2
Interior roof

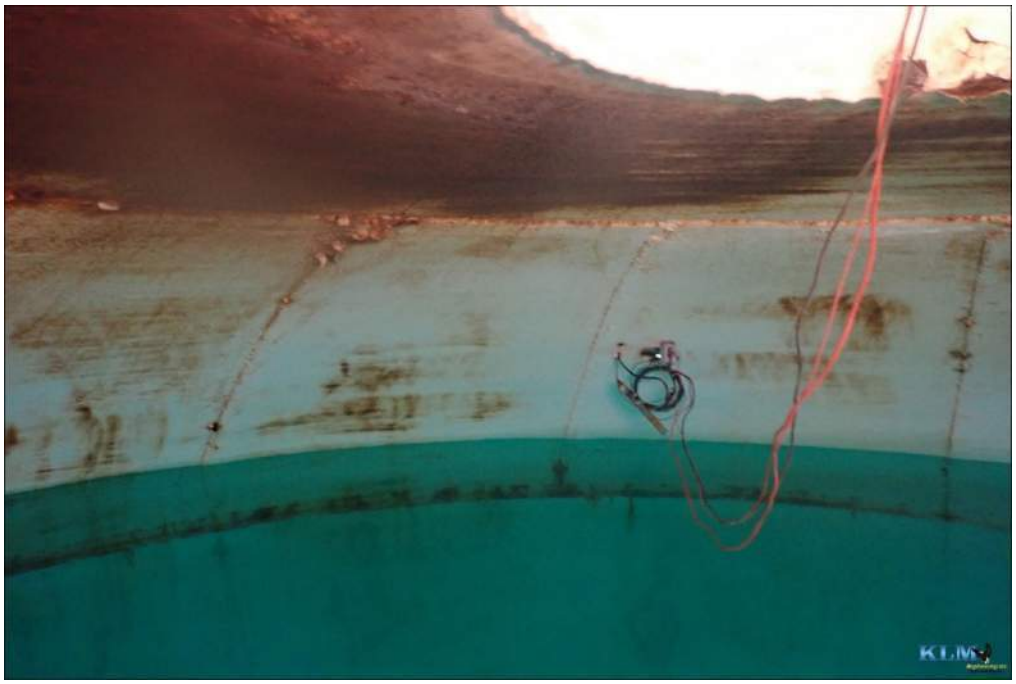

Photo No. 3
Roof and upper torus

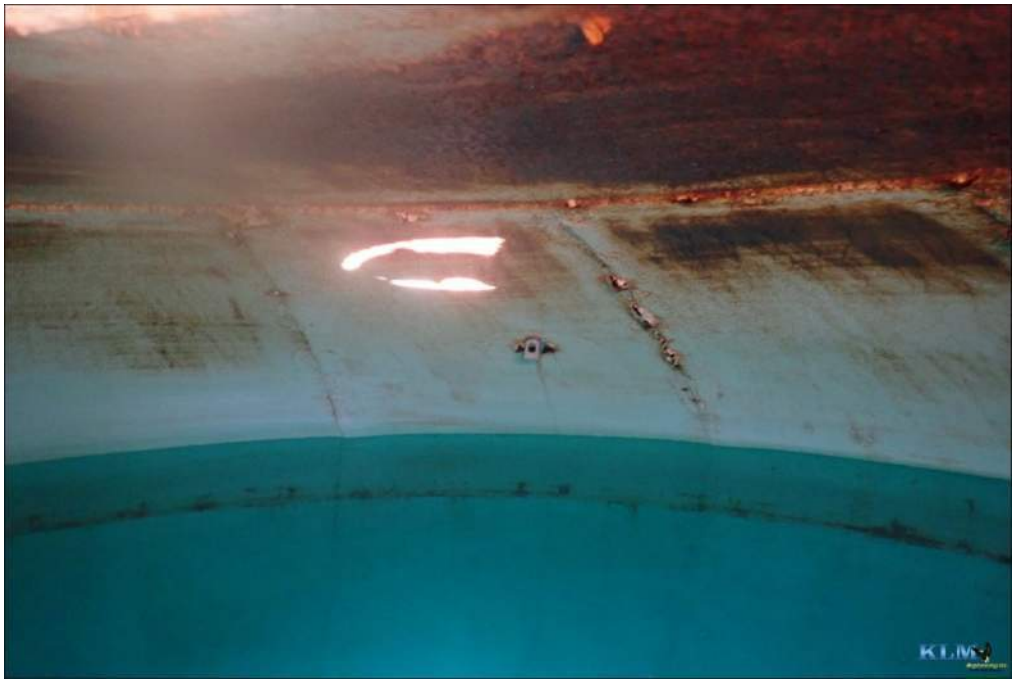

Photo No. 4
Roof and upper torus

Photo No. 5
Upper torus and shell

Photo No. 6
Overflow

Photo No. 7
Overflow stand-off brackets and conditions

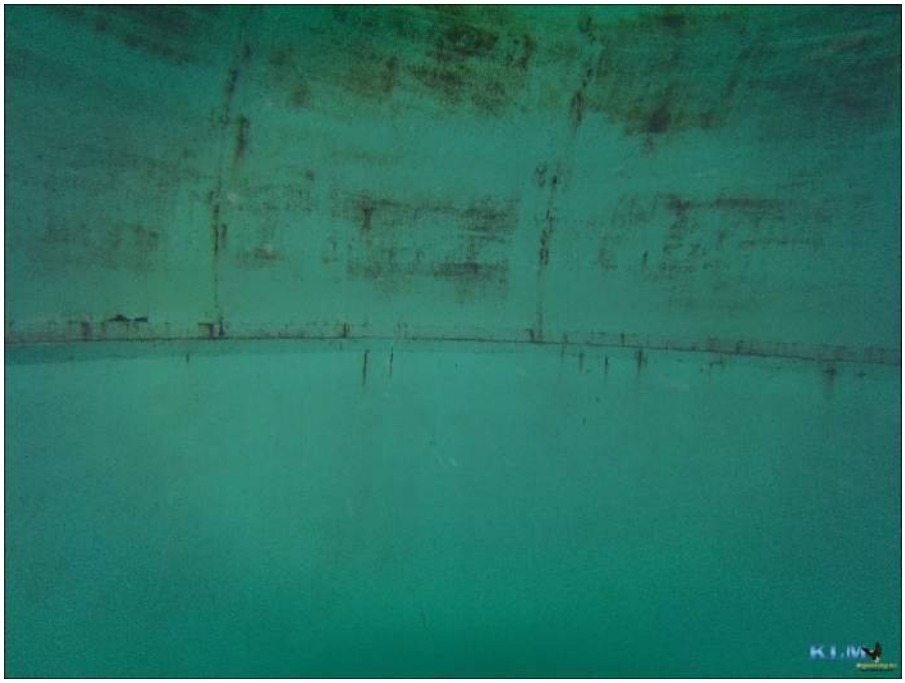

Photo No. 8
Shell condition

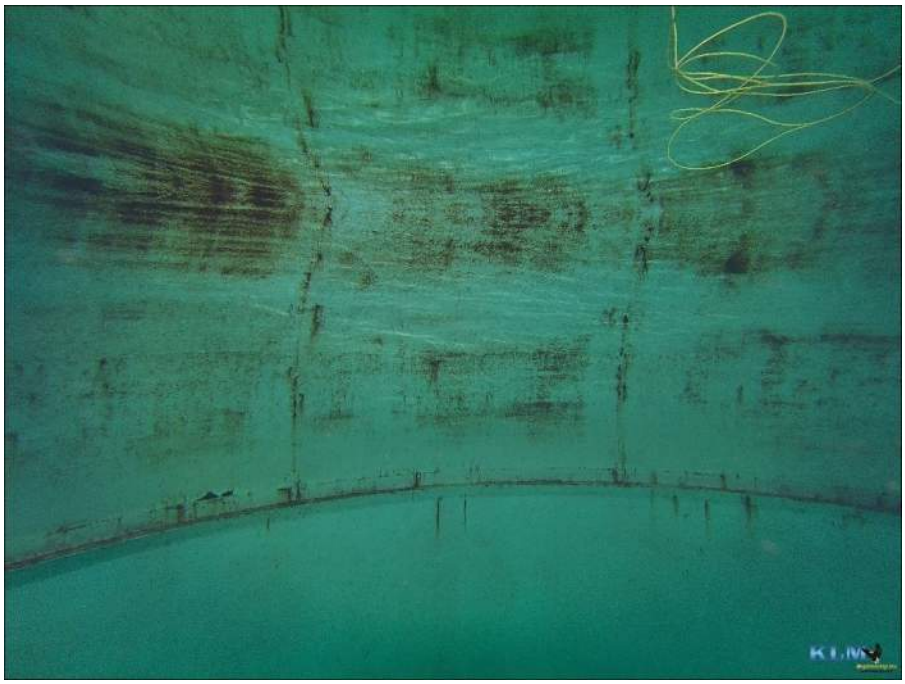

Photo No. 9
Shell condition

Photo No. 10
Shell stiffener and conditions

Photo No. 11
Shell stiffener and conditions

Photo No. 12
Shell conditions

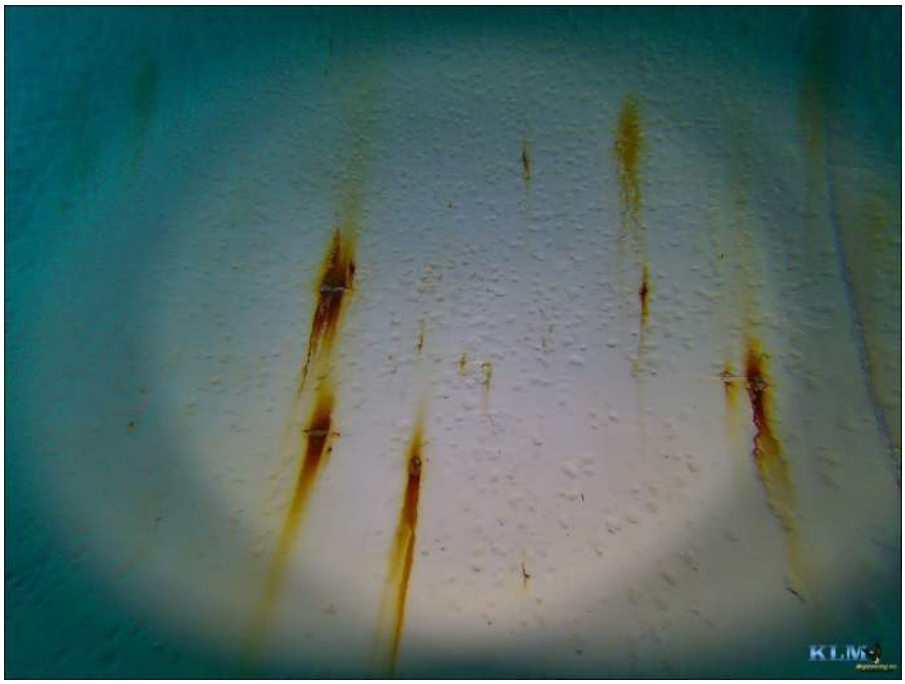

Photo No. 13
Coating failures in bowl

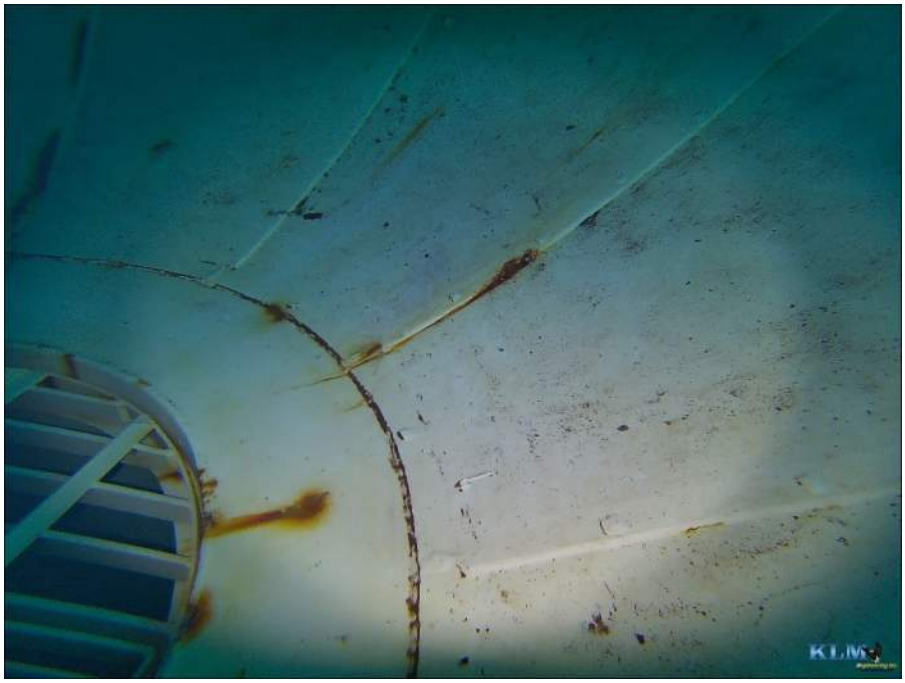

Photo No. 14
Coating failures in bowl

Photo No. 15
Wet riser grating and bowl conditions

Photo No. 16
Overall condition of bowl

Photo No. 17
Finial vent

Photo No. 18
Camera mounted on finial vent

Photo No. 19
Roof access manway

Photo No. 20
Roof condition

Photo No. 21
Roof condition
Note: CP hand-hole cover

Photo No. 22
Roof condition

Photo No. 23
Rolling roof and shell ladders

Photo No. 24
Shell condition

Photo No. 25
Overall condition of water compartment

Photo No. 26
Shell condition

Photo No. 27
Coating failure on shell

Photo No. 28
Stub overflow pipe

Photo No. 29
Shell, balcony and handrailing

Photo No. 30
Shell, balcony and handrailing

Photo No. 31
Balcony, handrailing and access

Photo No. 32
Balcony condition and connection to shell

Photo No. 33
Underside of balcony

Photo No. 34
Bowl to wet riser conditions

Photo No. 35
Wet riser and site conditions
Note: grade around wet riser and columns

Photo No. 36
Wet riser and manway

Photo No. 37
Covered column footing

Photo No. 38
Column footing condition

Photo No. 39
Column ladder

Photo No. 40
Site conditions

APPENDIX B

INSPECTION AND EVALUATION METHODS

1.0| INSPECTION AND EVALUATION METHODS

Some or all of the following procedures were performed as applicable.

1.1| Methods

1.1.1 The inspection of the base metal and coatings on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the base metal and coating on the interior wet surfaces were examined from either a rubber raft while the tank was being drained, by a Remote Operated Vehicle (ROV) with the tower in service, or with both.

1.1.2 Tank plate thickness was measured at random locations on the liquid holding shell. The overall structural condition of the tank was visually examined.

1.1.3 No structural analysis was done to determine if the tank design complies with the AWWA D100-11 Standard for "Welded Carbon Steel Tanks for Water Storage." However, any observed non-conformance to the AWWA D100-11 standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2| Examination and Evaluation Techniques

Some or all of the following procedures were performed as applicable.

1.2.1| Site

The tank site was evaluated for proper drainage conditions affecting access and lead paint abatement during reconditioning.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2| Foundations

The tank concrete foundation(s) were/was visually examined for cracks, spalling, conditions of grout, indications of distress/settlement, and elevation above grade.

1.2.3| Tank Plate Thickness

Plate thickness measurements were taken using ultrasonic methods (UTM). The readings were taken using a digital readout Elcometer MTG6 Ultrasonic Thickness Gage that has a dual element probe (transducer). The probe's transmitter element sends a short ultrasonic pulse through the material. The pulse gets reflected as an echo from the opposite side of the plate and returns to the probe's receiver element. The round-trip time is directly related to the material's thickness.

1.2.4| Coating Thickness

Interior and exterior coatings, where accessible, were tested in accordance with Steel Structures Painting Council SSPC-PA2-18 "Procedure for Determining Conformance to Dry Coating Thickness Requirements" using PosiTector-6000-F1 Type 2 gages.

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1.2.5| Coating Adhesion

Adhesion testing of the coating to the steel, and inner coat adhesion, was performed by ASTM D-3359: Shear Adhesion Test, Measuring Adhesion by Tape Test. In addition, subjective coating adhesion evaluation was performed using a penknife.

1.2.6| Coating Serviceability

The estimated remaining coating life or serviceability evaluation was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all accessible coatings. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the steel underneath the coating, or any other defects affecting the intended service.

1.2.7| Coating Lead and Chromium Content Analysis

Samples may have been taken of the various types of coatings present on the interior and exterior surfaces. GPI Laboratories, Inc. of Grand Rapids, Michigan tests these coatings in conformance with ASTM D-3335 Standard Test Methods for Concentrations of Lead and Chromium in Paint.

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APPENDIX C

PAINT CHIP TEST RESULTS

ANALYTICAL LABORATORY REPORT

CUSTOMER: KLM Engineering, Inc.
1976 Wooddale Drive
Woodbury, MN 55125

DATE RECEIVED: Monday, March 11, 2024
PO/PROJECT #: 3925-24 / 5069-24
SUBMITTAL #: 2024-03-11-001

LAB NUMBER: AD31281

Sampled By:
Job Location: Lawrence, KS
Sample Identification: 1 : Exterior (5069-24)

Date Sampled: 2/27/2024
Sample Description: Paint Chips

Preparation Method: EPA 3050B-P-M (Acid Digestion for Paints)
Analysis Method: EPA 6010D-M (ICP-AES Method for Determination of Metals)
Date Analyzed: Wednesday, March 13, 2024

ELEMENT	RESULT (by dry	REPORTING LIMIT (RL)
Cadmium	**< RL**	0.00038 %
Chromium	**0.027 %**	0.00065 %
Lead	**13 %**	0.0013 %

LAB NUMBER: AD31282

Sampled By:
Job Location: Lawrence, KS
Sample Identification: 2 : Interior Wet (5069-24)

Date Sampled: 2/27/2024
Sample Description: Paint Chips

Preparation Method: EPA 3050B-P-M (Acid Digestion for Paints)
Analysis Method: EPA 6010D-M (ICP-AES Method for Determination of Metals)
Date Analyzed: Wednesday, March 13, 2024

ELEMENT	RESULT (by dry	REPORTING LIMIT (RL)
Cadmium	**< RL**	0.00038 %
Chromium	**< RL**	0.00065 %
Lead	**6.6 %**	0.0013 %

GPI Laboratories, Inc. has obtained accreditation under the programs detailed on the final page of the laboratory report. The accreditations pertain only to the testing performed for the elements, and in accordance with the test methods, listed in the scope of accreditation table. Testing which is performed by GPI Laboratories, Inc. according to other test methods, or for elements which are not included in the table fall outside of the current
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ANALYTICAL LABORATORY REPORT

CUSTOMER: KLM Engineering, Inc.
1976 Wooddale Drive
Woodbury, MN 55125

DATE RECEIVED: Monday, March 11, 2024
PO/PROJECT #: 3925-24 / 5069-24
SUBMITTAL #: 2024-03-11-001

Unless otherwise noted, the condition of each sample was acceptable upon receipt, all laboratory quality control requirements were met, and sample results have not been adjusted based on field blank or other analytical blank results. Individual sample results relate only to the sample as received by the laboratory.

Tests Reviewed By: David Johnson, Project Manager

Reporting Limit (RL): The lowest concentration of analyte in a sample that can be reported with a defined, reproducible level of certainty. This value is based on the lowest standard used for instrument calibration and must be at least twice the MDL.

GPI Laboratories, Inc. is accredited to ISO/IEC 17025 by A2LA, for the specific testes listed on www.a2la.org.

A2LA: American Association for Laboratory Accreditation (Certificate 5033.02)

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4403 Donker Court, Grand Rapids MI 49512-4054
(616) 940-3112 | GRLabsInfo@gpinet.com | www.gpinet.com

FOR LAB USE ONLY			
Properly Contained	YES	NO	N/A
ASTM E1792 wipes	YES	NO	N/A
Adequate Ph Adjust	YES	NO	N/A
Lab acidified: By/Date:			

Company: KLM Engineering, Inc.	Address: 1976 Wooddale Drive, Suite 4, Woodbury, MN 55125	Company Contact: Olivia Harrington Telephone: 651-773-5111 E-Mail: oharrington@klmengineering.com	P.O./Proj #: 3925-24/5069-24 Location: Lawrence, KS

Matrix	TCLP (Waste)	Metals Content	Other Tests	Turnaround Time
☑ Paint Chips ☐ Wipe	☐ Lead	☐ Lead	☐ pH (Corrosivity)	☐ Same Day*
☐ Soil ☐ Filter	☐ RCRA (8) Metals	☑ Lead, Cad., Chrome.	☐ Ignitability	☑ Rush*
☐ Abrasive ☐ _____	☐ _____	☐ RCRA (8) Metals	☐ VOC (Method 24, etc)	☐ Standard
☐ Wastewater		☐ _____	☐ _____	☐ _____

Comments:

GPI Labs accepts Visa, MasterCard, and American Express. *Accelerated Turnaround is not available for every test. Please call for information.

Laboratory ID	Sample Number	Date/Time Sampled	Sample Identification / Location:	Special Instructions:	Wipes: Area wiped (sq.ft.)	Air Sampling Filters: ☐ TSP ☐ PM10 ☐ 37 mm Cassette — Minutes	Flow Rate	UNITS
A031278	1	2-29-24	Interior Wet (3925-24)					
A031279	2	2-29-24	Interior Dry (3925-24)					
A031280	3	2-29-24	Exterior (3925-24)					
A031281	3-11-24							
A031282	1	2-27-24	Exterior (5069-24)					
A031282	2	2-27-24	Interior Wet (5069-24)					

Sampled By (Please print) : _____ Date Submitted: 3/7/2024 Signature: Nancy Hofer

Received by: _____ Date/Time: _____ Relinquished Date/Time: _____

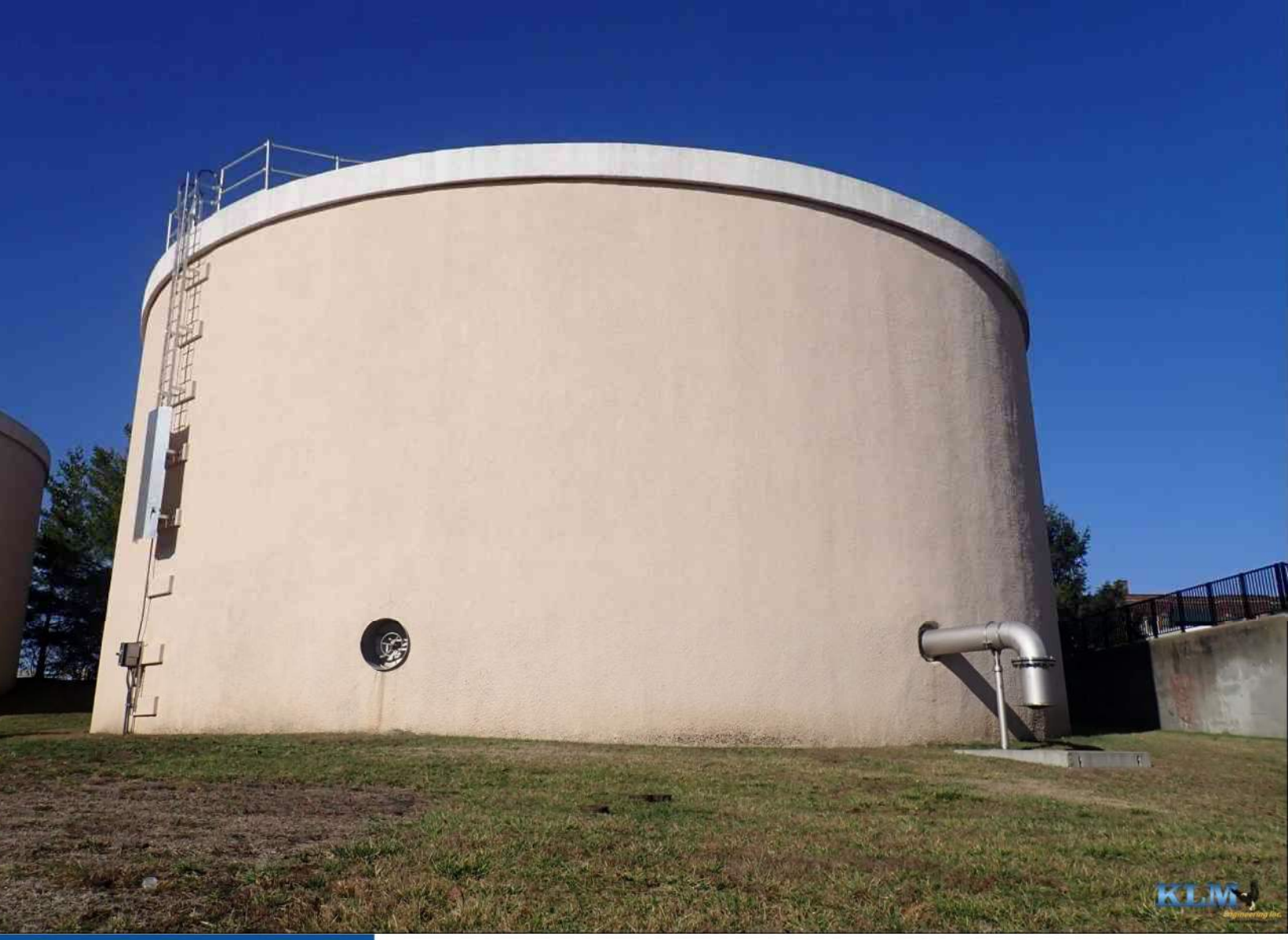
Received by: _____ Date/Time: _____ Relinquished Date/Time: _____

Page 1 of 1

Method of Shipment: _____

Received for Laboratory by: Brad Gilman Date/Time: 3-11-24 10:30 Submittal #: 2024-03-11-017

1/18/17 Form #: 53-12



Lawrence, Kansas

Inspection Report:
875,000-Gallon Capacity
North Oread Reservoir

Prepared by:

KLM Engineering, Inc.
1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 5070-24

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6.1| Reconditioning Summary and Cost Estimate 5

APPENDIX A: Photographs

APPENDIX B: Concrete Inspection and Evaluation Methods

1.0| PROJECT INFORMATION

KLM Project No.: 5070-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: North Oread Reservoir

Tank Description: Concrete GSR

Tank Street Location: 1220 Oread Avenue, Lawrence, KS 66045

Purpose of Inspection: Condition Assessment

Date of Inspection: February 27, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Builder: DN Tanks **Construction Date:** 2017

Engineer: HDR & PEC **Design Code:** AWWA/ACI

Capacity: 875,000 gallons

Type of Construction: Prestressed Concrete

Tank Diameter: 70'-6"

Tank Depth: Overall ~35 feet

Height to: HWL 30'-0" LWL Tank floor

Tank Construction Drawings: Available to KLM

Previous Inspection Records: None available to KLM

EXISTING COATING INFORMATION

	Interior Wet	Exterior
Date Last Coated	2017	2017
Full or Spot Repair	Joints	Full/New
Coating Contractor	Unknown	Unknown
Surface Preparation	Unknown	Unknown
Paint System	Polyether	Unknown
Paint Manufacturer	Unknown	Unknown

Lawrence, Kansas

875,000 – GALLON CAPACITY
NORTH OREAD RESERVOIR

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

c. Appendix B Concrete Inspection and Evaluation Methods.

3.0| COATINGS EVALUATION AND STRUCTURE EVALUATION

Note: Hairline cracks on the interior can appear to be larger than they are due to efflorescence present and the tendency to attract sediment and biofilm. Efflorescence is due to the migration of moisture through the cracks and is not harmful.

The reservoir is used to store potable water and is circular in shape. Access to the reservoir interior is achieved by one large rectangular hatch on the roof.

Photographs of the structure areas can be found in Appendix A.

3.1| Interior Wet

3.1.1| Coating

The interior of the reservoir is primarily uncoated concrete and presumably has never been coated except for the roof and shell joints, which contain a polyether sealant and is in good visible condition.

Interior coating is likely unnecessary due to the good overall condition of the concrete. Concrete potable water tanks are typically not recommended to be coated unless there are concerns of degradation of the structure, water infiltration, biofilm accumulation, or difficult to clean surfaces. In non-potable storage applications, use of coating products helps protect the concrete from deterioration by corrosive gases and liquids.

The exposed portion of the fill pipe on the floor is in good condition with no visible coating failures. The interior ladder is stainless-steel covered in calcium buildup on the lower section, but in good condition. The shell manway is stainless-steel and in good condition.

3.1.2| Structure

a) Roof and Shell

The roof is precast concrete, and the shell is prestressed concrete. The roof and shell are in good condition with no evidence of spalling or cracking. One visible corrosion spot was observed on the overflow column. This spot is the result of an exposed rebar end and is not a structural concern.

b) Floor

The reservoir floor is a cast-in-place concrete slab in good visible condition. There were no observations made that might indicate the presence of structural defects, such as major cracking with exfiltration or settlement. Minimal sediment is present on the floor allowing for adequate inspection.

3.2| Exterior

3.2.1| Coating

An unknown coating, typically cementitious in nature, was applied on the roof and shell. The coating is in good condition with no visible failures.

3.2.2| Structure

a) Roof and Shell

The roof and shell are in good condition with no major visible failures.

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, ACI, AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time.

Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 No defects were observed, and no repairs are required.

4.2| Exterior Modifications

4.2.1 Replace the non-conforming finial vent with an aluminum pressure pallet style vent. The new vent and vent screen design should meet AWWA and Kansas Department of Health and Environment regulations. The removable top will improve ventilation, provide access to the tank interior during reconditioning, and aid in compliance with OSHA confined space entry requirements. See photos 26 and 27.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The site includes the North and South Oread reservoirs and pumphouse located adjacent to the Jayhawk Welcome Center. The area around the reservoirs is well maintained.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

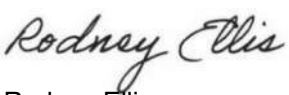
The reservoir is in good overall condition with no repairs required at this time. The reservoir should be inspected and reevaluated in five years per Kansas Department of Health and Environment standards to monitor conditions.

KLM ENGINEERING, INC.

Report prepared by:

Joseph Clasemann, E.I.T.
Civil Engineer-In-Training
EIT Certification No. 157889

Report reviewed by:



Rodney Ellis
Vice President/COO
NACE Certified Coatings Inspector No. 1686
AWS/CWI 0404031

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of the reservoir

Photo No. 2
Condition of roof

Photo No. 3
Condition of roof

Photo No. 4
Overflow weir

Photo No. 5
Typical condition of roof and upper shell

Photo No. 6
Water clarity

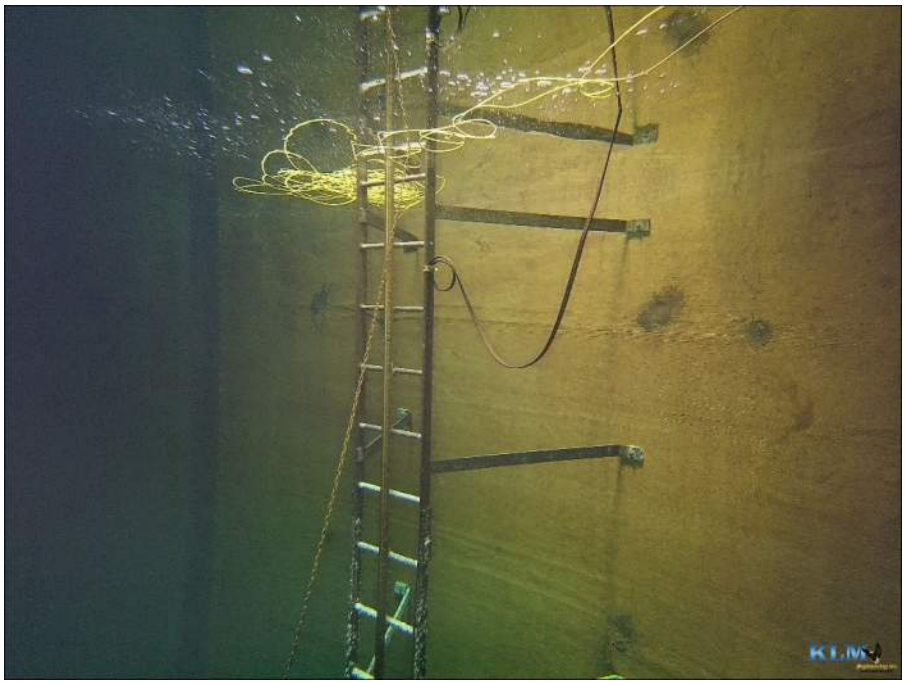

Photo No. 7
Ladder and shell

Photo No. 8
Ladder and shell

Photo No. 9
Shell condition

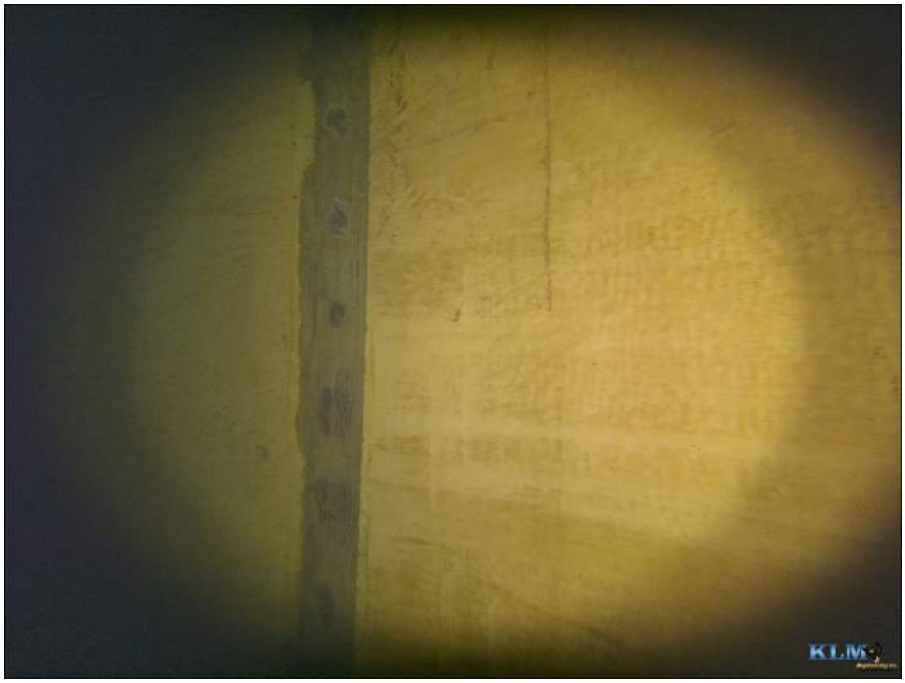

Photo No. 10
Shell condition

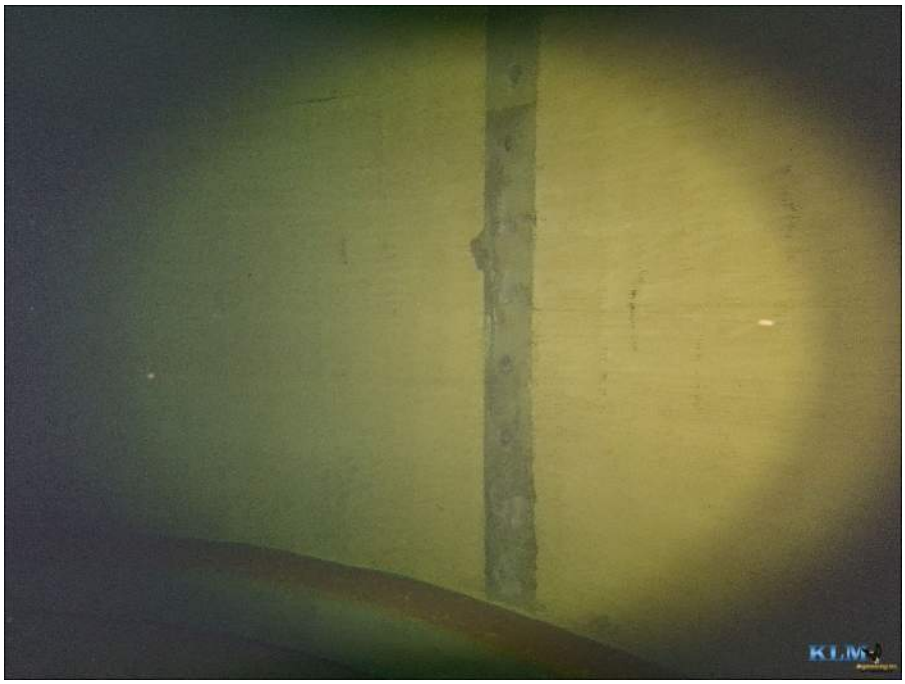

Photo No. 11
Shell condition

Photo No. 12
Shell condition

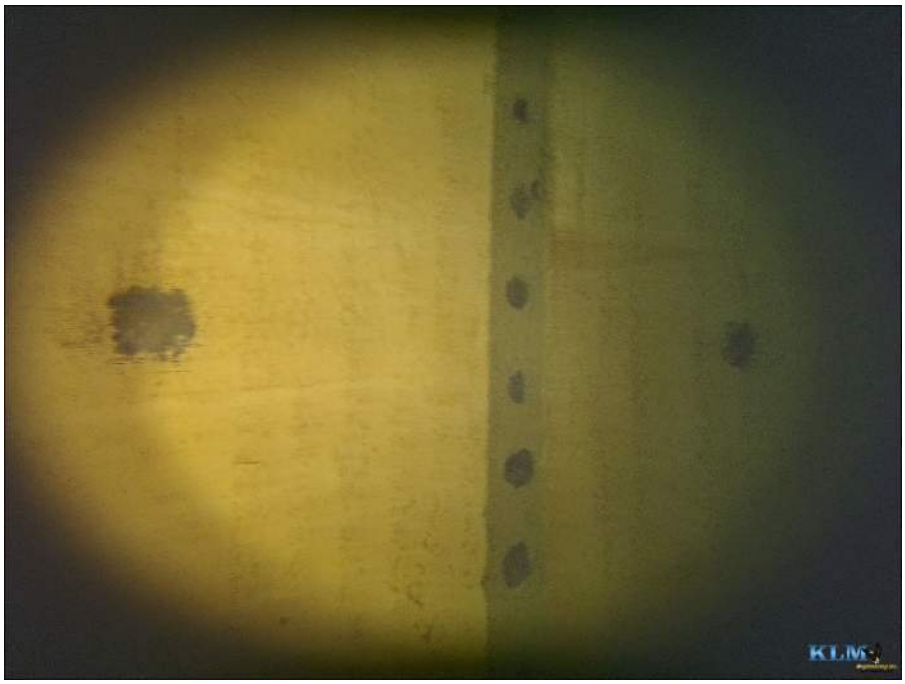

Photo No. 13
Shell condition

Photo No. 14
Exposed rebar end on overflow

Photo No. 15
Overall condition of shell

Photo No. 16
Shell manway

Photo No. 17
Fill pipe

Photo No. 18
Shell to floor connection

Photo No. 19
Shell to floor connection

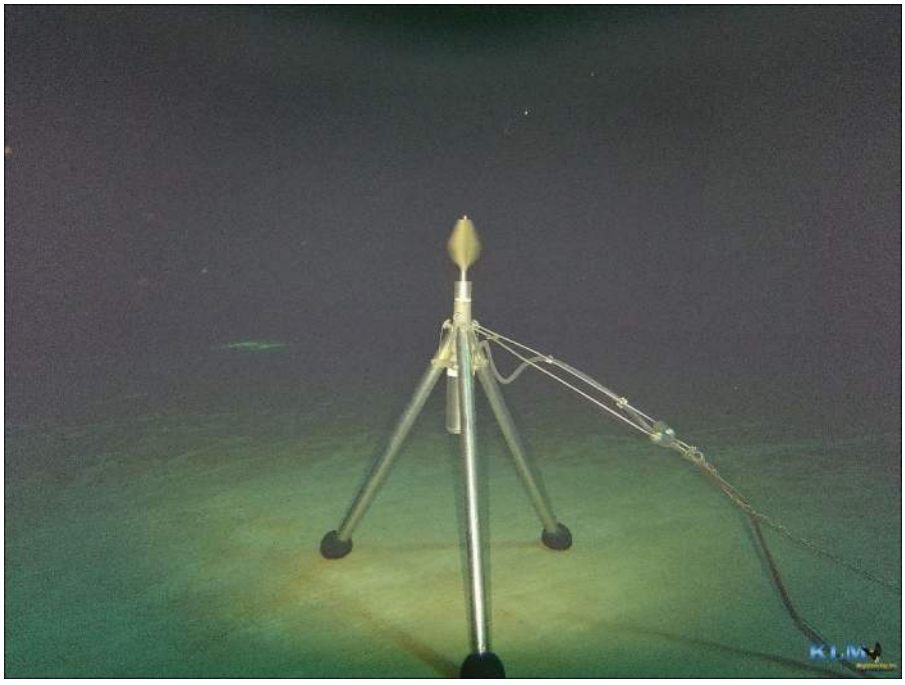

Photo No. 20
PAX mixer

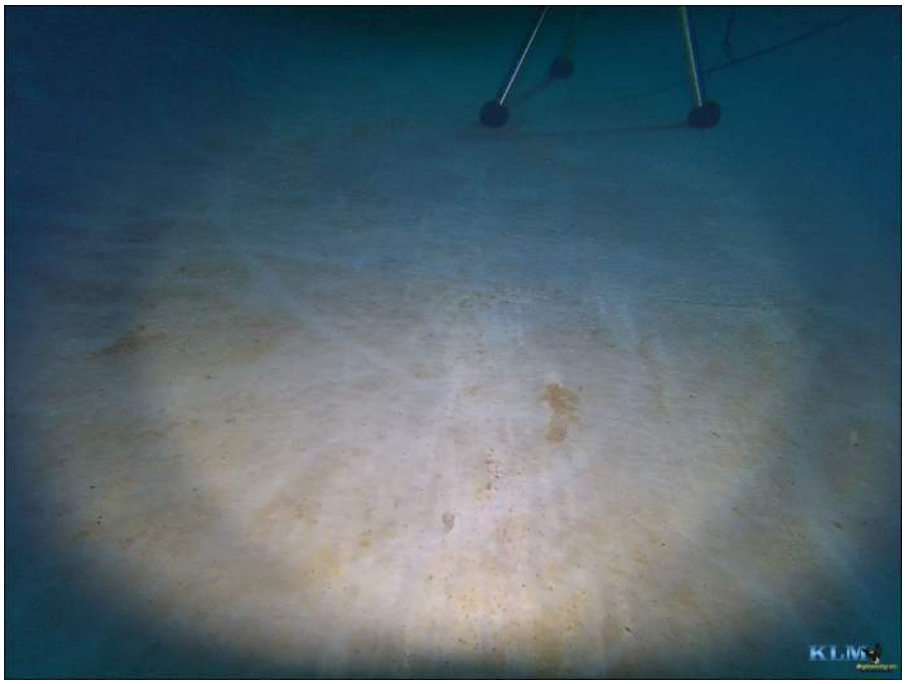

Photo No. 21
Condition of floor

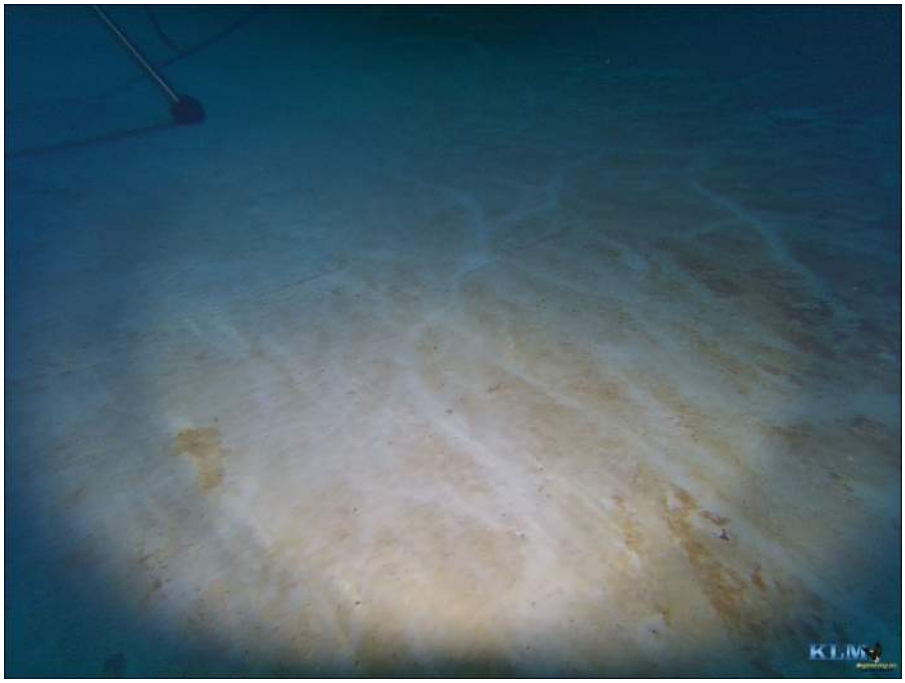

Photo No. 22
Condition of floor

Photo No. 23
Overall condition of floor

Photo No. 24
Floor condition

Photo No. 25
Bottom of ladder with scaling

Photo No. 26
Overall condition of roof and finial vent

Photo No. 27
Finial vent screen

Photo No. 28
Roof condition

Photo No. 29
Roof condition

Photo No. 30
Roof handrailing

Photo No. 31
Access manway

Photo No. 32
Roof to shell connection

Photo No. 33
Roof to shell connection

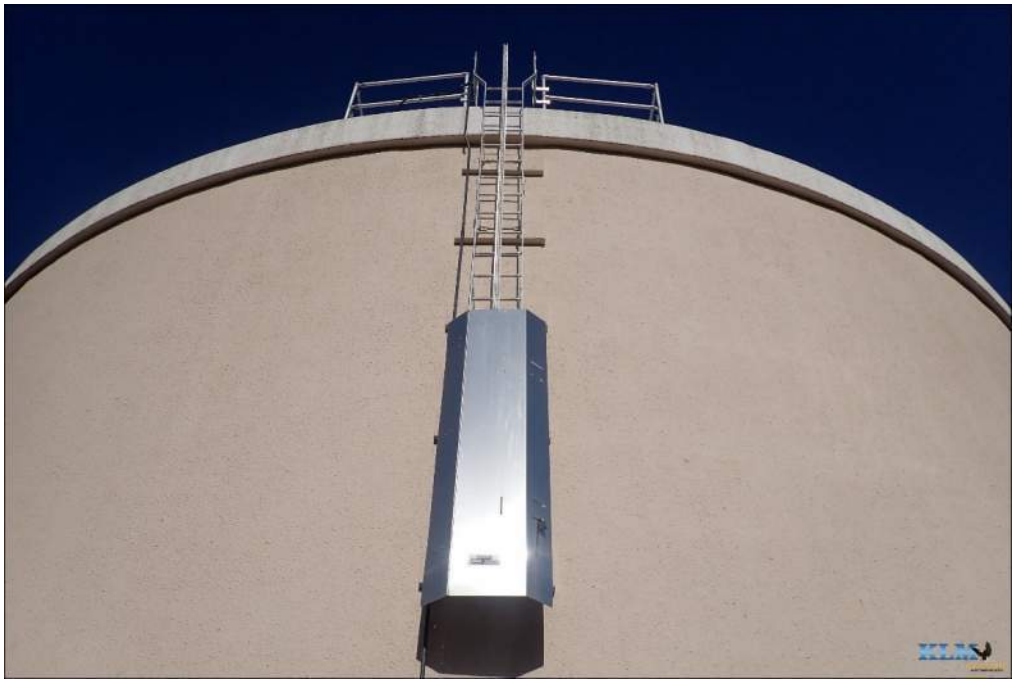

Photo No. 34
Ladder and conditions

Photo No. 35
Shell manway

Photo No. 36
Shell condition

Photo No. 37
Shell condition

Photo No. 38
Overall condition of shell

Photo No. 39
Overflow discharge

Photo No. 40
Overflow screen

Photo No. 41
Conditions in pump house

Photo No. 42
Site conditions

APPENDIX B

CONCRETE INSPECTION AND EVALUATION METHODS

1.0|INSPECTION AND EVALUATION METHODS

Some or all the following procedures were performed as applicable.

1.1|Methods

1.1.1 The inspection of the concrete and coatings (if present) on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the concrete and coating on the interior wet surfaces were examined from either a rubber raft while the reservoir was being drained, by a Remote Operated Vehicle (ROV) with the reservoir in service, or with both.

1.1.2 Reservoir concrete conditions including cracking and spalling were measured where accessible. The overall structural condition of the reservoir was visually examined per ACI 201.1R-2.

1.1.3 No structural analysis was done to determine if the reservoir design complies with the ACI Standard 318 for "Building Code Requirements for Reinforced Concrete." However, any observed non-conformance to the ACI Standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2|Examination and Evaluation Techniques

Some or all the following procedures were performed as applicable.

1.2.1|Site

The reservoir site was evaluated for proper drainage conditions and access to vents, manways and overflow pipe discharges.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2|Shell and Roof

The exterior reservoir concrete shell and roof were visually examined where accessible for OSHA, AWWA and State code compliances. Conditions of grout and/or caulk at shell to roof joint, indications of distress/settlement, and elevation of roof above or below grade is noted in this report.

1.2.3|Concrete Condition

All visible exterior and interior concrete reservoir components including the roof, shell, floor, columns, pilasters and baffle walls were inspected as follows. Concrete surface conditions are visually inspected for bugholes, honeycombing, cracking, surface deterioration and spalling. The size, type and orientation of cracks (i.e., horizontal, vertical, diagonal, shrinkage, etc.), the presence of efflorescence and exposed reinforcement steel are included in the inspection and noted in the evaluation.

1.2.4|Coating Thickness

Interior and exterior coatings, where accessible and if present, were tested by destructive testing removing a sample of the coating with a knife or other instrument and measuring the thickness with a gauge.

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1.2.5|Coating Serviceability

The estimated remaining coating life or serviceability evaluation, where accessible and if present, was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all the interior coating's accessible areas. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the concrete underneath the coating, or any other defects affecting the intended service.

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Lawrence, Kansas

Inspection Report:
875,000-Gallon Capacity
South Oread Reservoir

Prepared by:

KLM Engineering, Inc.
1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 5071-24

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APPENDIX B: Concrete Inspection and Evaluation Methods

1.0| PROJECT INFORMATION

KLM Project No.: 5071-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: South Oread Reservoir

Tank Description: Concrete GSR

Tank Street Location: 1220 Oread Avenue, Lawrence, KS 66045

Purpose of Inspection: Condition Assessment

Date of Inspection: February 27, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Builder: DN Tanks **Construction Date:** 2017

Engineer: HDR & PEC **Design Code:** AWWA/ACI

Capacity: 875,000 gallons

Type of Construction: Prestressed Concrete

Tank Diameter: 70'-6"

Tank Depth: Overall ~35 feet

Height to: HWL 30-0" LWL Tank floor

Tank Construction Drawings: Available to KLM

Previous Inspection Records: None available to KLM

EXISTING COATING INFORMATION

	Interior Wet	Exterior
Date Last Coated	2017	2017
Full or Spot Repair	Joints	Full/New
Coating Contractor	Unknown	Unknown
Surface Preparation	Unknown	Unknown
Paint System	Polyether	Unknown
Paint Manufacturer	Unknown	Unknown

Lawrence, Kansas

875,000 – GALLON CAPACITY
SOUTH OREAD RESERVOIR

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

c. Appendix B Concrete Inspection and Evaluation Methods.

3.0| COATINGS EVALUATION AND STRUCTURE EVALUATION

Note: Hairline cracks on the interior can appear to be larger than they are due to efflorescence present and the tendency to attract sediment and biofilm. Efflorescence is due to the migration of moisture through the cracks and is not harmful.

The reservoir is used to store potable water and is circular in shape. Access to the reservoir interior is achieved by one large rectangular hatch on the roof.

Photographs of the structure areas can be found in Appendix A.

3.1| Interior Wet

3.1.1| Coating

The interior of the reservoir is primarily uncoated concrete and presumably has never been coated except for the roof and shell joints, which contain a polyether sealant and is in good visible condition.

Interior coating is likely unnecessary due to the good overall condition of the concrete. Concrete potable water tanks are typically not recommended to be coated unless there are concerns of degradation of the structure, water infiltration, biofilm accumulation, or difficult to clean surfaces. In non-potable storage applications, use of coating products helps protect the concrete from deterioration by corrosive gases and liquids.

The exposed portion of the fill pipe on the floor is in good condition with no visible coating failures. The interior ladder is stainless-steel covered in calcium buildup on the lower section, but in good condition. The shell manway is stainless-steel and in good condition.

3.1.2| Structure

a) Roof and Shell

The roof is precast concrete, and the shell is prestressed concrete. The roof and shell are in good condition with no evidence of spalling or cracking. Two visible spots of corrosion were observed on the shell. These spots are the result of wire positioned too close to the concrete edge. Although not a structural concern at this time, the spots should be monitored with regular inspections for signs of concrete spalling.

b) Floor

The reservoir floor is a cast-in-place concrete slab in good visible condition. There were no observations made that might indicate the presence of structural defects, such as major cracking with exfiltration or settlement. Minimal sediment is present on the floor allowing for adequate inspection.

3.2| Exterior

3.2.1| Coating

An unknown coating, typically cementitious in nature, was applied on the roof and shell. The coating is in good condition with no visible failures.

3.2.2| Structure

a) Roof and Shell

The roof and shell are in good condition with no major visible failures.

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, ACI, AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time.

Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 No defects were observed, and no repairs are required.

4.2| Exterior Modifications

4.2.1 Replace the non-conforming finial vent with an aluminum pressure pallet style vent. The new vent and vent screen design should meet AWWA and Kansas Department of Health and Environment regulations. The removable top will improve ventilation, provide access to the tank interior during reconditioning, and aid in compliance with OSHA confined space entry requirements. See photos 23 and 24.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The site includes the North and South Oread reservoirs and pumphouse located adjacent to the Jayhawk Welcome Center. The area around the reservoirs is well maintained.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

The reservoir is in good overall condition with no repairs required at this time. The reservoir should be inspected and reevaluated in five years per Kansas Department of Health and Environment standards to monitor conditions. The next scheduled inspection should be a dry tank cleanout to more closely inspect the two spots in the wet area of corroded wire to better determine a repair schedule.

KLM ENGINEERING, INC.

Report prepared by:

Joseph Clasemann

Joseph Clasemann, E.I.T.
Civil Engineer-In-Training
EIT Certification No. 157889

Report reviewed by:

Rodney Ellis

Rodney Ellis
Vice President/COO
NACE Certified Coatings Inspector No. 1686
AWS/CWI 0404031

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of the reservoir

Photo No. 2
Overall condition of roof

Photo No. 3
Roof and upper shell

Photo No. 4
Roof and upper shell

Photo No. 5
Roof to shell connection with overflow weir

Photo No. 6
Typical roof to shell connection

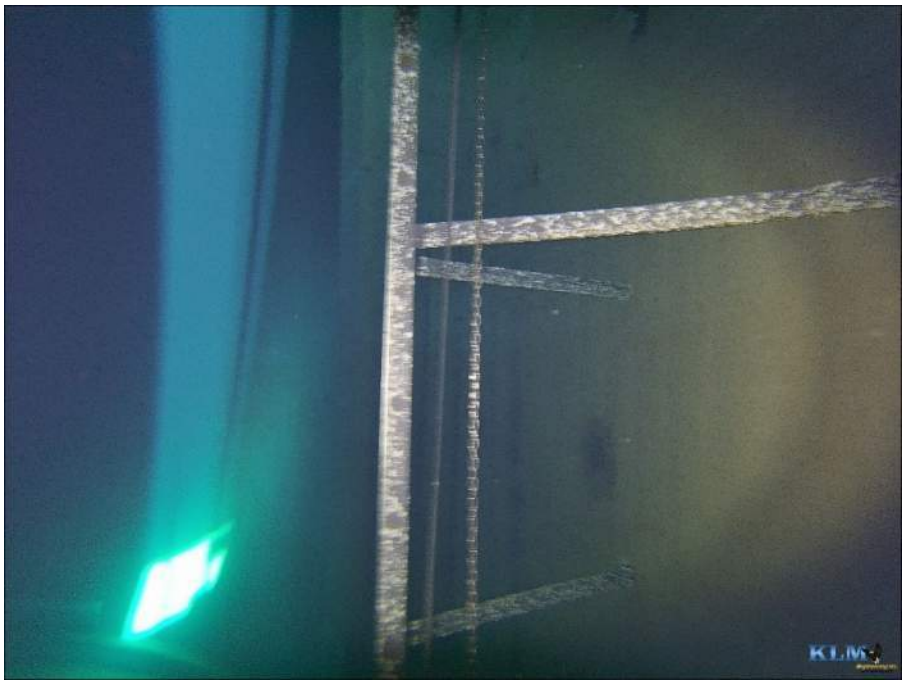

Photo No. 7
Ladder and shell

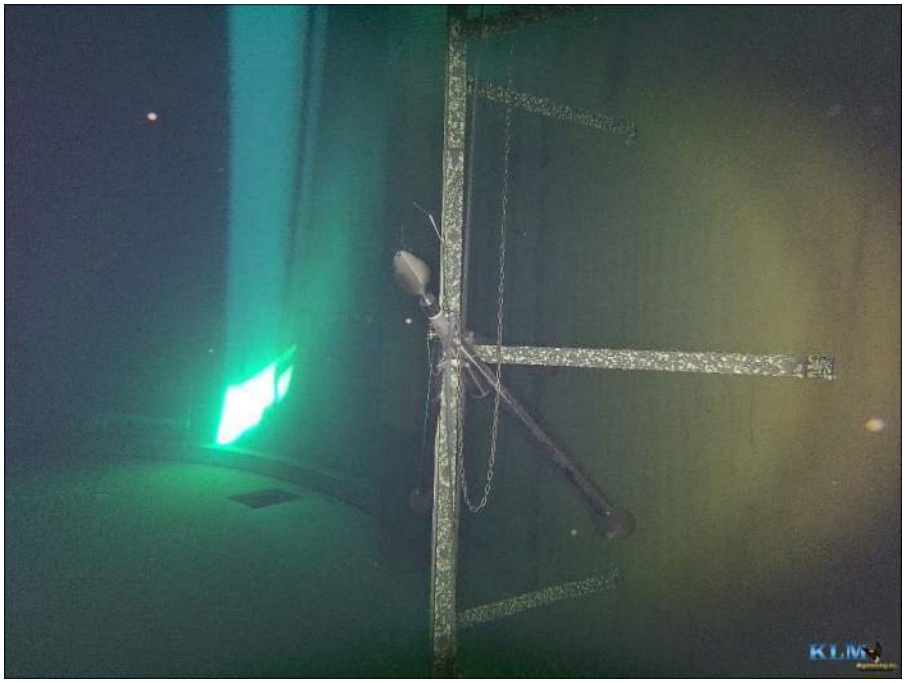

Photo No. 8
Ladder and shell

Photo No. 9
Ladder with scale buildup
Note: location of PAX mixer

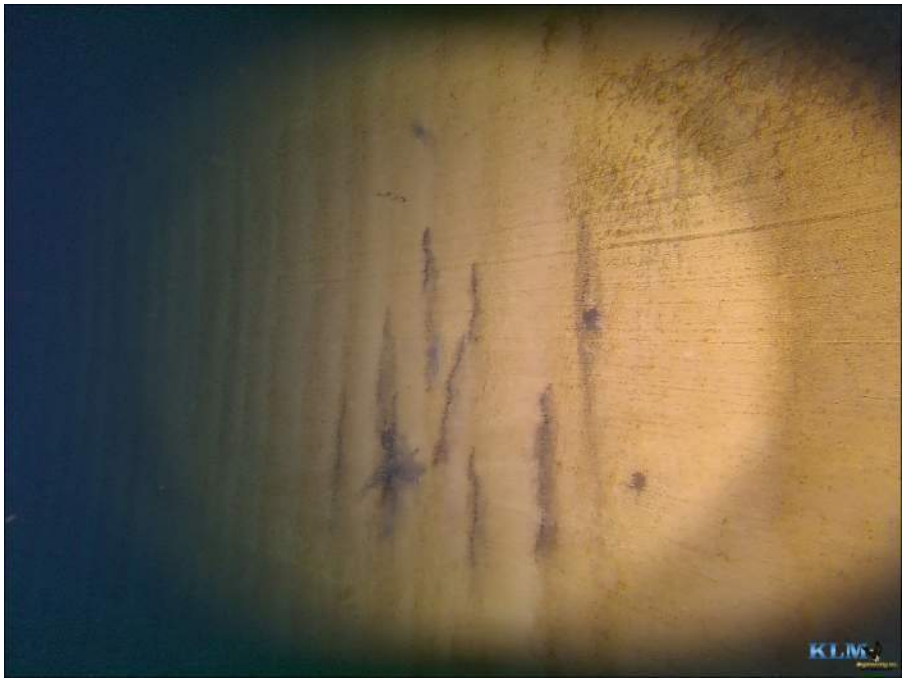

Photo No. 10
Condition of shell

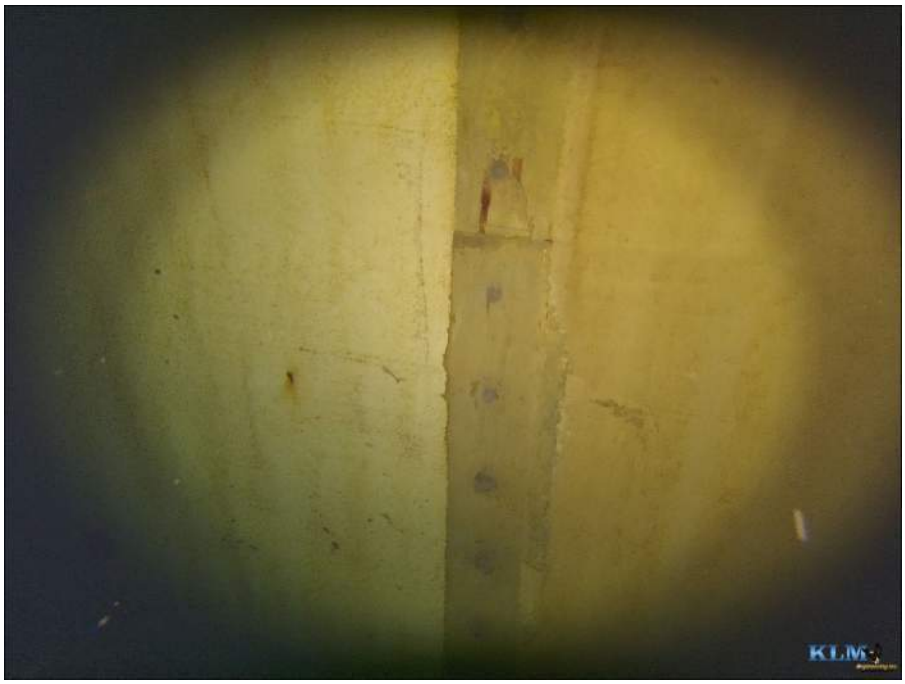

Photo No. 11
Condition of shell

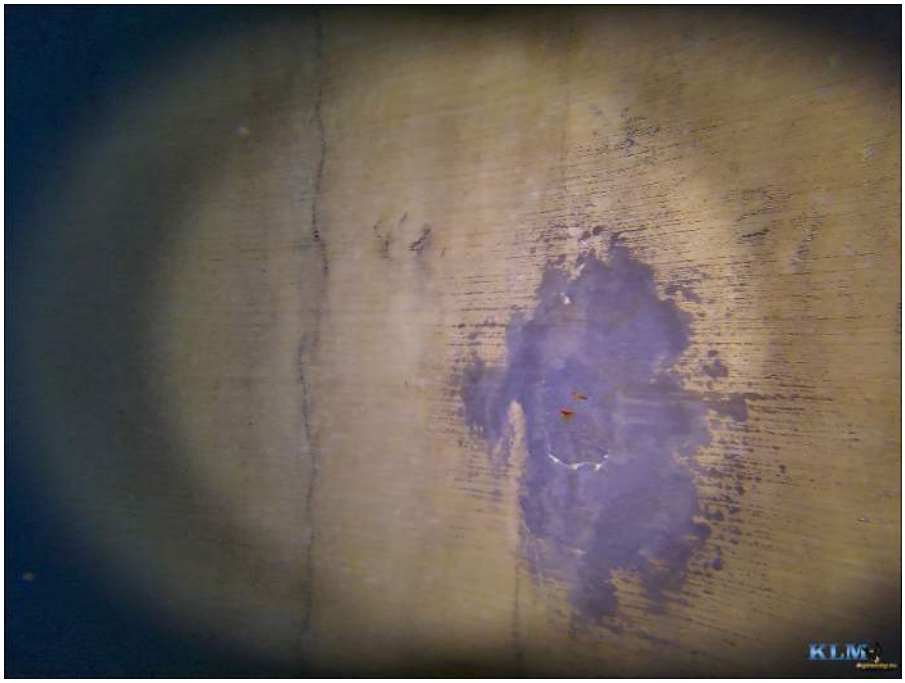

Photo No. 12
Patch repair on shell

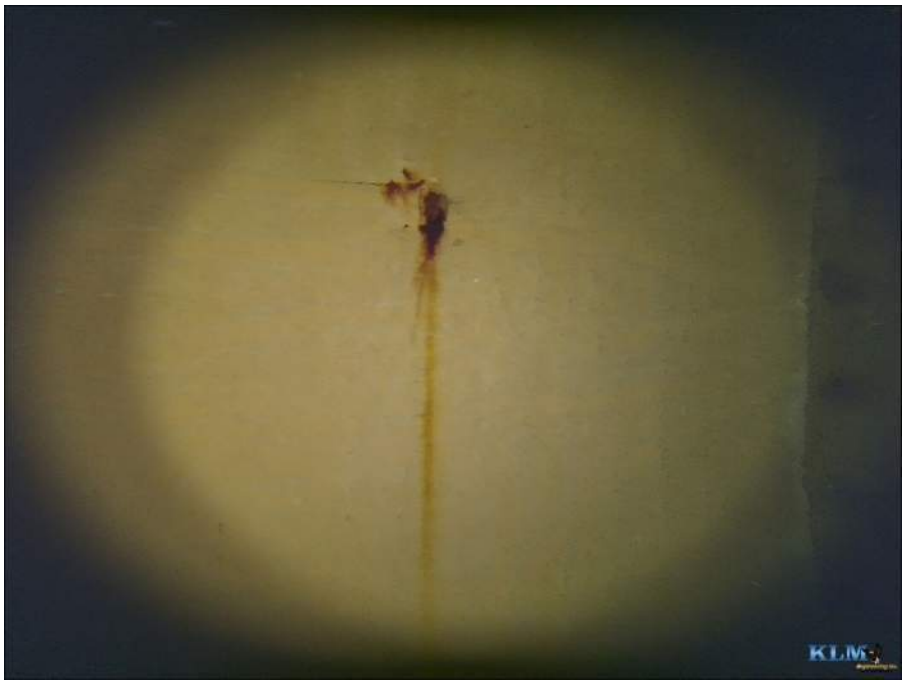

Photo No. 13
Corrosion on shell

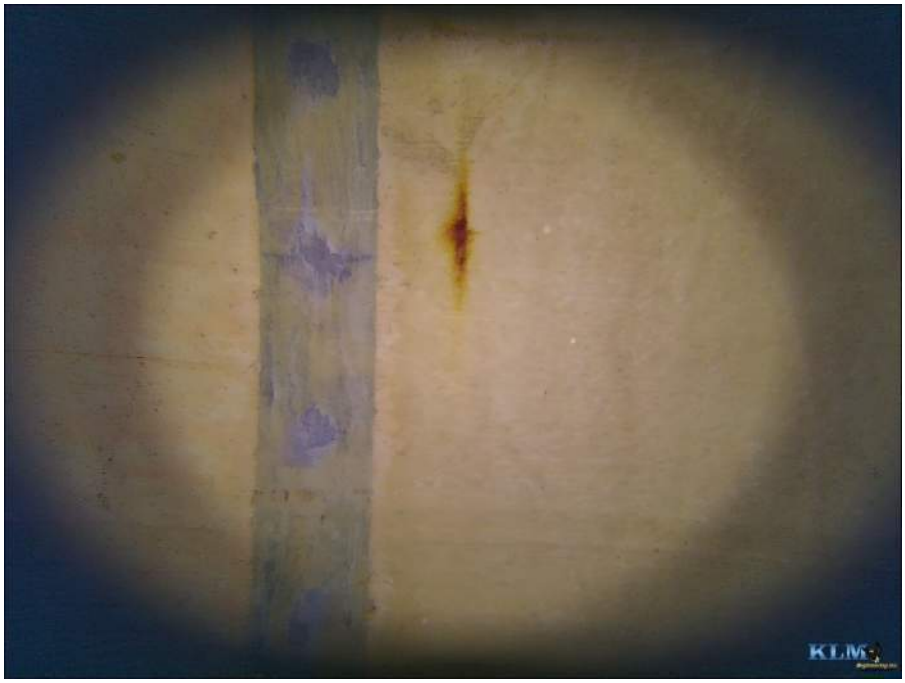

Photo No. 14
Shell condition with corrosion

Photo No. 15
Overflow connection to shell

Photo No. 16
Shell manway

Photo No. 17
Shell to floor connection

Photo No. 18
Shell to floor connection

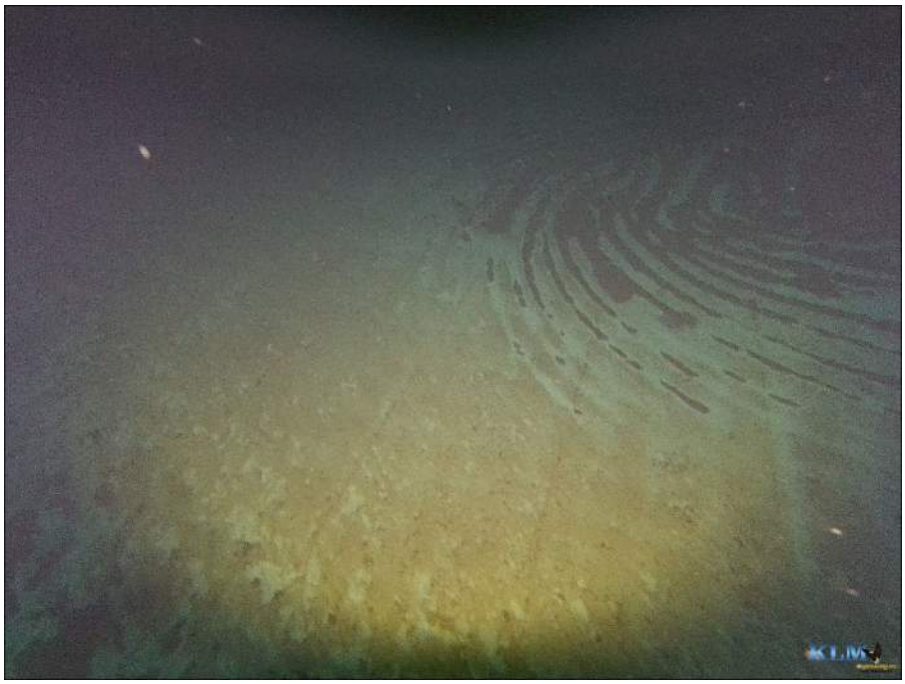

Photo No. 19
Floor conditions

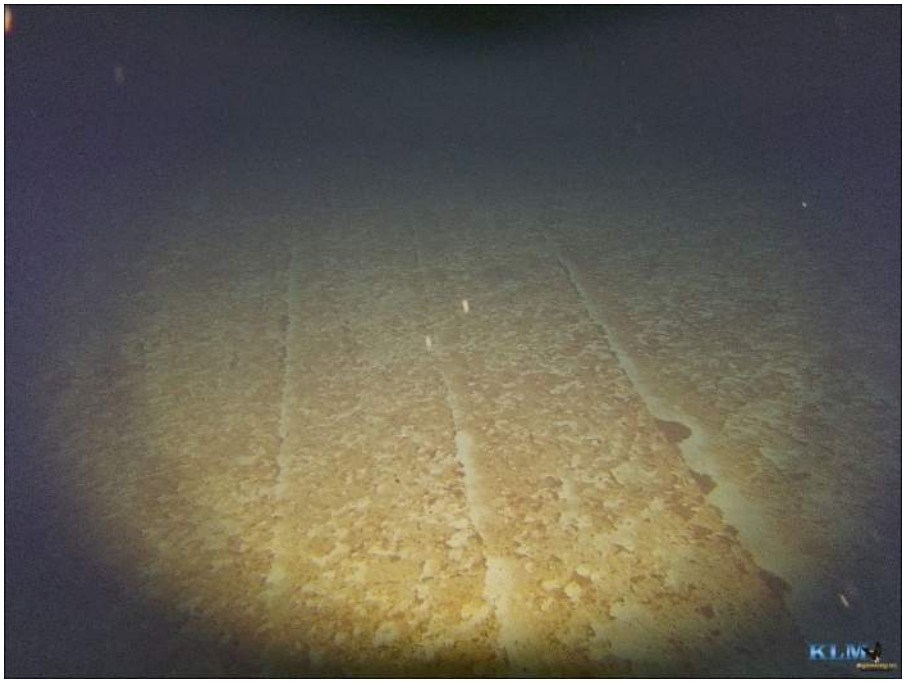

Photo No. 20
Floor conditions

Photo No. 21
Floor conditions

Photo No. 22
Fill pipe

Photo No. 23
Overall roof condition with finial vent

Photo No. 24
Finial vent screen

Photo No. 25
Roof conditions

Photo No. 26
Roof conditions

Photo No. 27
Roof conditions

Photo No. 28
Roof handrailing

Photo No. 29
Roof access manway

Photo No. 30
Roof to shell connection

Photo No. 31
Roof to shell connection

Photo No. 32
Overall condition of shell

Photo No. 33
Shell conditions

Photo No. 34
Ladder and shell conditions

Photo No. 35
Shell manway

Photo No. 36
Overflow discharge

Photo No. 37
Overflow screen

Photo No. 38
Site conditions

APPENDIX B

CONCRETE INSPECTION AND EVALUATION METHODS

1.0|INSPECTION AND EVALUATION METHODS

Some or all the following procedures were performed as applicable.

1.1|Methods

1.1.1 The inspection of the concrete and coatings (if present) on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the concrete and coating on the interior wet surfaces were examined from either a rubber raft while the reservoir was being drained, by a Remote Operated Vehicle (ROV) with the reservoir in service, or with both.

1.1.2 Reservoir concrete conditions including cracking and spalling were measured where accessible. The overall structural condition of the reservoir was visually examined per ACI 201.1R-2.

1.1.3 No structural analysis was done to determine if the reservoir design complies with the ACI Standard 318 for "Building Code Requirements for Reinforced Concrete." However, any observed non-conformance to the ACI Standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2|Examination and Evaluation Techniques

Some or all the following procedures were performed as applicable.

1.2.1|Site

The reservoir site was evaluated for proper drainage conditions and access to vents, manways and overflow pipe discharges.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2|Shell and Roof

The exterior reservoir concrete shell and roof were visually examined where accessible for OSHA, AWWA and State code compliances. Conditions of grout and/or caulk at shell to roof joint, indications of distress/settlement, and elevation of roof above or below grade is noted in this report.

1.2.3|Concrete Condition

All visible exterior and interior concrete reservoir components including the roof, shell, floor, columns, pilasters and baffle walls were inspected as follows. Concrete surface conditions are visually inspected for bugholes, honeycombing, cracking, surface deterioration and spalling. The size, type and orientation of cracks (i.e., horizontal, vertical, diagonal, shrinkage, etc.), the presence of efflorescence and exposed reinforcement steel are included in the inspection and noted in the evaluation.

1.2.4|Coating Thickness

Interior and exterior coatings, where accessible and if present, were tested by destructive testing removing a sample of the coating with a knife or other instrument and measuring the thickness with a gauge.

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1.2.5|Coating Serviceability

The estimated remaining coating life or serviceability evaluation, where accessible and if present, was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all the interior coating's accessible areas. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the concrete underneath the coating, or any other defects affecting the intended service.

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Lawrence, Kansas

Inspection Report:
1,500,000-Gallon Capacity
19th Street & Kasold Drive Reservoir

Prepared by:

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1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 5072-24

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5.2| Telecommunications Considerations 6

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6.1| Reconditioning Summary and Cost Estimate 7

APPENDIX A: Photographs

APPENDIX B: Inspection and Evaluation Methods

1.0| PROJECT INFORMATION

KLM Project No.: 5072-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: 19th Street & Kasold Drive Reservoir

Tank Description: Ground Storage Reservoir

Tank Street Location: 1820 Kasold Drive, Lawrence, KS 66047

Purpose of Inspection: Condition Assessment

Date of Inspection: February 29, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Manufacturer: Pittsburgh-Des Moines Steel Company **Construction Date:** ~1969

Serial No.: None listed **Design Code:** AWWA D100

Capacity: 1,500,000 gallons

Type of Construction: Welded

Tank Diameter: ~65 feet

Height to: Overall ~65 feet

Height to: HWL ~50 feet LWL Grade

Tank Construction Drawings: None available to KLM

Previous Inspection Records: None available to KLM

EXISTING COATING INFORMATION

	Interior Wet	Interior Dry	Exterior
Date Last Coated	2005	2005	2005
Full or Spot Repair	Spot repair	Full	Full
Coating Contractor	Unknown	Unknown	Unknown
Surface Preparation	SSPC-SP 10	SSPC-SP 7	SSPC-SP 10
Paint System	Zinc/epoxy	Epoxy	Zinc/epoxy/urethane
Paint Manufacturer	Tnemec	Tnemec	Tnemec
Paint Chip Samples	Not taken	Not taken	Not taken

Lawrence, Kansas

1,500,000 – GALLON CAPACITY
19TH STREET & KASOLD DRIVE RESERVOIR

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. General guidelines of AWWA Manual M42 Appendix C “Inspecting and Repairing Steel Water Tanks, and Elevated Tanks for Water Storage.”

c. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

d. AWWA Standard D100; Welded Carbon Steel Tanks for Water Storage.

3.0| COATINGS EVALUATION

3.1| Lead and Chromium Content Analysis

Although not required at this time, KLM recommends performing sampling and testing of the interior and exterior coatings prior to the next reconditioning to determine if existing coatings contain lead and/or chromium in excess of current federal limits. Coatings exceeding the limits would be considered hazardous and require additional safety measures to protect public and contractor health. Removal and disposal of lead and/or chromium-based paints must be performed in accordance with applicable local, state, and federal regulations. Proprietary products or other commercial methods are available to contractors to incorporate into their removal process to mitigate risks and convert the waste to a non-hazardous material allowing for more disposal options.

3.2| Interior Wet Coating

The tank was constructed and originally painted in approximately 1969 by Pittsburgh-Des Moines Steel Company. Records indicate the interior wet area was spot repaired in 2005. The interior wet coating is in fair to poor condition above and below the high-water line (HWL) with less than five percent visible coating failures. Failures above the HWL range from random pinhole corrosion to more severe corrosion around the top flange of the drywell tube. Additional failures consist of corrosion on the roof structure and unwelded seams. Failures below the HWL consist of widespread pinhole corrosion and randomly located topcoat delamination on the shell, and surface corrosion on the drywell tube. See photos in Appendix A.

3.3| Interior Dry Coating

The interior dry area of the reservoir consists of the inside of the drywell tube. Records indicate the coating on the drywell tube was last fully replaced in 2005. The interior dry coating is in fair to poor overall condition, with more than ten percent coating failures. Failures consist of widespread pinhole corrosion and more aggressive corrosion around brackets and connection seams. See photos in Appendix A.

3.4| Exterior Coating

Records indicate the exterior coating was last fully replaced in 2005. The exterior coating is in good overall condition with less than one percent visible coating failures observed throughout the structure. Failures consist of isolated pinhole corrosion and typical wear on handrailing and roof plates. Areas of standing water are also evident on the roof and flat surface around the roof structure. See photos in Appendix A.

3.5| Replacement Coating Systems

When the next full reconditioning is required, KLM recommends preparing surfaces in accordance with NACE guidance and applying a coating system for each area according to the following.

3.5.1| Interior Wet Coating

Surface preparation should be performed according to SSPC-SP10 Near White Metal Blast criteria.

Apply a two-coat system:

1. moisture cured zinc-rich
2. NSF 61 certified epoxy

3.5.2| Interior Dry Coating

Surface preparation should be performed according to SSPC-SP6 Commercial Blast Clean criteria.

Apply a three-coat system:

1. moisture cured zinc-rich
2. polyamidoamine epoxy
3. polyamidoamine epoxy

3.5.3| Exterior Coating

Surface preparation should be performed according to SSPC-SP6 Commercial Blast Clean criteria.

Apply a four-coat system:

1. moisture cured zinc-rich
2. polyamidoamine epoxy
3. aliphatic acrylic urethane
4. fluoropolymer

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time. Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 Remove the corroded roof drain pipes. Seal weld plates over the drain opening on the roof and top of the shell. See photos 12 through 14, 61, and 69.

4.1.2 Seal weld the intermittently welded stiffener(s) on the drywell tube. See photos 21 and 22.

4.1.3 Install a 12-inch removable silt stop on the fill pipe. See photo 44.

4.1.4 Replace the gaskets on the drywell tube and shell manways. See photos 24 and 39.

4.1.5 Grind off all weld spatter and erection scab marks for compliance with AWWA D100.

4.2| Interior Dry Modifications

4.2.1 Install two 4-inch diameter couplings at the top of the drywell tube for coax routing. Remove existing coax and repair the resulting holes. See photo 46.

4.2.2 Seal weld the round seams inside the drywell tube. See photos 48 through 50.

4.2.3 Replace the pipe-style safety climb device with an OSHA compliant cable-style safety climb device on the drywell tube ladder. See photo 53.

4.2.4 Install cable brackets inside the drywell tube, equally spaced, for the attachment of electrical and coaxial cables. Move cables and cords from the side of the ladder to the cable brackets to bring the ladder into OSHA compliance. See photos 49 and 53.

4.2.5 The overflow pipe is currently located inside the drywell tube and is routed directly into a storm sewer. Due to the design of the reservoir and overflow system, a determination will need to be made by the Kansas Department of Health and Environment for compliance. Overflow discharges do not comply if a visible air gap does not exist. See photos 55 and 56.

4.3| Exterior Modifications

4.3.1 Realign the cathodic protection hand-hole covers to provide a water tight seal. See photos 13 and 14.

4.3.2 Install a self-closing swing gate at the ladder opening on the roof edge. See photo 64.

4.3.3 Replace the lid on the wet access manway. See photo 57.

4.3.4 Install an aluminum pressure pallet style vent. The new vent and vent screen design should meet AWWA D100 and Kansas Department of Health and Environment regulations. The removable top will improve ventilation, provide access to the tank interior during reconditioning, and aid in compliance with OSHA confined space entry requirements.

4.3.5 Remove the stich welded angles on the roof. Grind surface flush with surrounding plates. See photo 60.

4.3.6 Remove the stich welded frame from the roof. Grind surface flush with surrounding plates. See photo 60.

4.3.7 Replace the pipe-style safety climb device with an OSHA compliant cable-style safety climb device on the roof access ladder. See photos 65 and 66.

4.3.8 Install cable brackets on the roof structure, equally spaced, for the attachment of electrical and coaxial cables. See photos 65 and 66.

4.3.9 Seal weld plates over the screened vents on the side of the roof structure. Remove the corresponding boxes from the inside of the reservoir. The screens are not compliant with Kansas Department of Health and Environment. See photos 15, 16, and 68.

4.3.10 Install three hinge-covered ventilation manways on the roof. These will provide additional ventilation during the interior surface preparation and coating.

4.4| Cathodic Protection (CP) System

4.4.1 The reservoir has a submerged CP system. The current interior wet area surface conditions observed below the water level suggest the system is not working correctly. The system may be removed during the next reservoir reconditioning as the corrosion inhibitors of modern coating systems have eliminated the need for a separate cathodic protection system on potable water reservoirs.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The site is adjacent to residential property to the south and north with a chain link fence surrounding the tank and well house.

5.1.2 Although full reconditioning is not required at this time, in conformance with Kansas Department of Health and Environment regulations, an analysis has been performed to determine the methods of pollution control required for this storage structure during reconditioning. To maintain air quality and to prevent the drift of dust and fugitive emissions, full containment will be required, including impervious ground cover, a top cover or bonnet and negative air dust collection during the next full reconditioning.

5.2| Telecommunications Considerations

5.2.1 The reservoir has some telecommunications equipment, including antennas, coaxial cables, support brackets and other miscellaneous equipment. The Owner is advised to maintain accurate records of each of the antenna sites on the reservoir, including as-built drawings, site manager and owner contact information, upgrades performed, and plans for future antenna installations or upgrades. These records will help facilitate the future reconditioning with a minimal amount of effort on the Owner's part.

5.2.2 Working around and protecting the telecommunications equipment, including antennas, coaxial cables, support brackets, and other miscellaneous equipment during future reconditioning will incur additional costs. The antenna owner(s) should be responsible for these expenses under clause(s) in the antenna lease agreements. These costs are not included in the cost estimate, as they vary considerably from site to site.

5.2.3 Prior to reconditioning, in accordance with the lease requirements of each antenna owner, the Owner should notify the telecommunications owners or manager of the work to be performed. The Owner should also determine whether: a) the antenna owners will pay the additional costs to work around and protect the antennas; b) the antenna owners will temporarily remove their antennas and associated equipment to facilitate reconditioning; or c) the Owner will have to pay for these costs themselves.

5.2.4 Prior to reconditioning, KLM recommends an assessment be performed on the telecommunications installations to determine or verify the following: a) the owners (carrier) of each of the antennas; b) the antenna locations and attachment methods; c) the coaxial cable locations and attachment methods; and d) recommendations for modifications to the existing antenna installations prior to or during the reconditioning. KLM recommends the engineering firm chosen to perform engineering on the reconditioning conduct the telecommunications assessment, so they are intimately aware of the antenna conditions.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

KLM recommends performing the noted structure modifications to bring the reservoir into compliance with Kansas Department of Environment and performing spot repairs to the interior wet coating within one to two years to maximize the life expectancy of the coating, eliminate more costly future repairs, and aid in improving water quality.

The costs for performing the noted structure modifications to bring the reservoir into compliance with Kansas Department of Health and Environment regulations, and performing spot repairs to the interior wet coating, is estimated between $125,000 and $130,000. This estimate is based on current pricing and does not include costs for engineering and/or inspection services. For competitive bids, the project should be bid 9 to 12 months before the desired starting date.

An experienced tank-coating contractor with the proper crew and equipment should be able to complete the project in three weeks. At the time of reconditioning, the reservoir will need to be drained and remain off-line for the duration of the project.

KLM ENGINEERING, INC.

Report prepared by:

Joseph Clasemann

Joseph Clasemann, E.I.T.
Civil Engineer-In-Training
EIT Certification No. 157889

Report reviewed by:

Rodney Ellis

Rodney Ellis
Vice President/COO
NACE Certified Coatings Inspector No. 1686
AWS/CWI 0404031

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of the reservoir

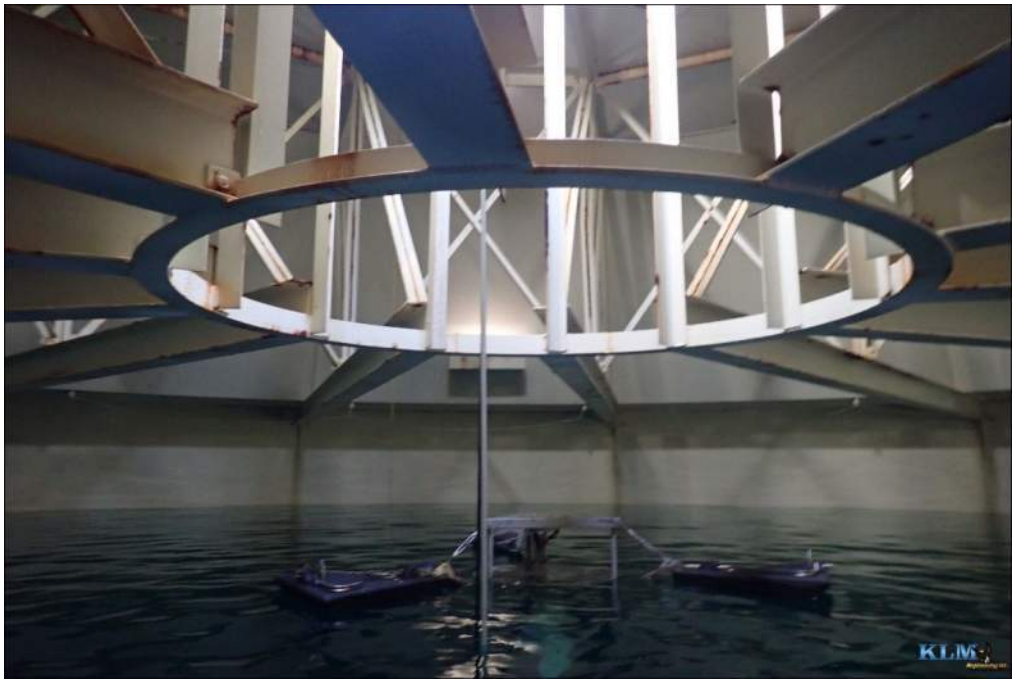

Photo No. 2
Center of roof structure

Photo No. 3
Roof structure

Photo No. 4
Corrosion on main roof structure

Photo No. 5
Typical unwelded roof structure

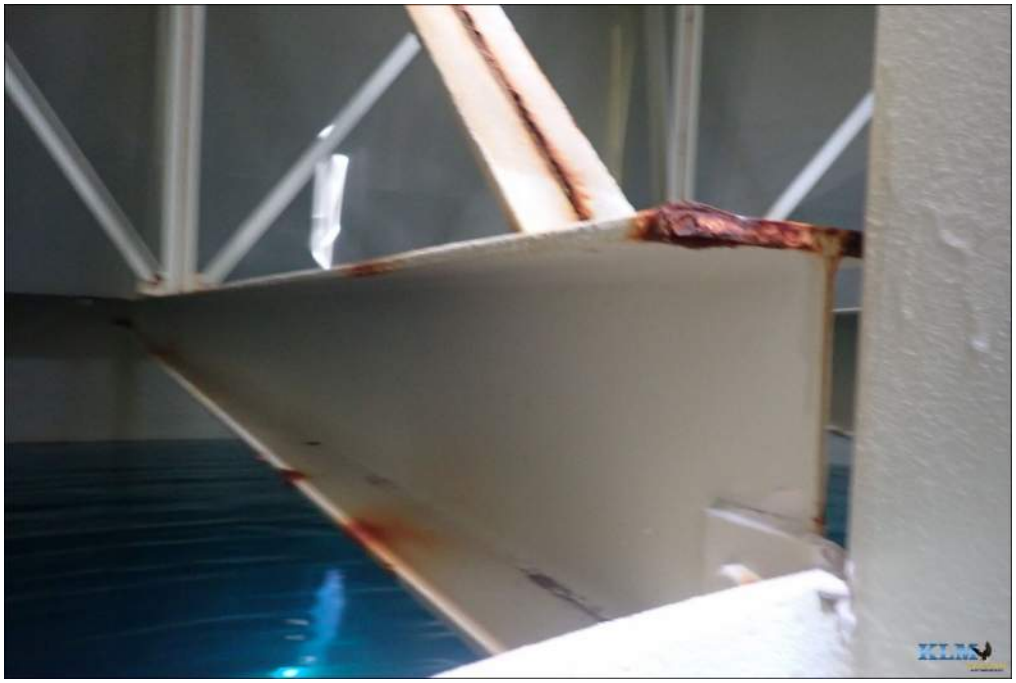

Photo No. 6
Roof structure condition

Photo No. 7
Typical bolted connection in roof structure

Photo No. 8
Roof structure

Photo No. 9
Roof structure

Photo No. 10
Drywell tube to roof connection

Photo No. 11
Drywell tube stiffener

Photo No. 12
Roof drain piping

Photo No. 13
Corrosion on roof drain piping
Note: cathodic protection wiring

Photo No. 14
Corrosion and open areas of roof drain piping and CP hand-hole

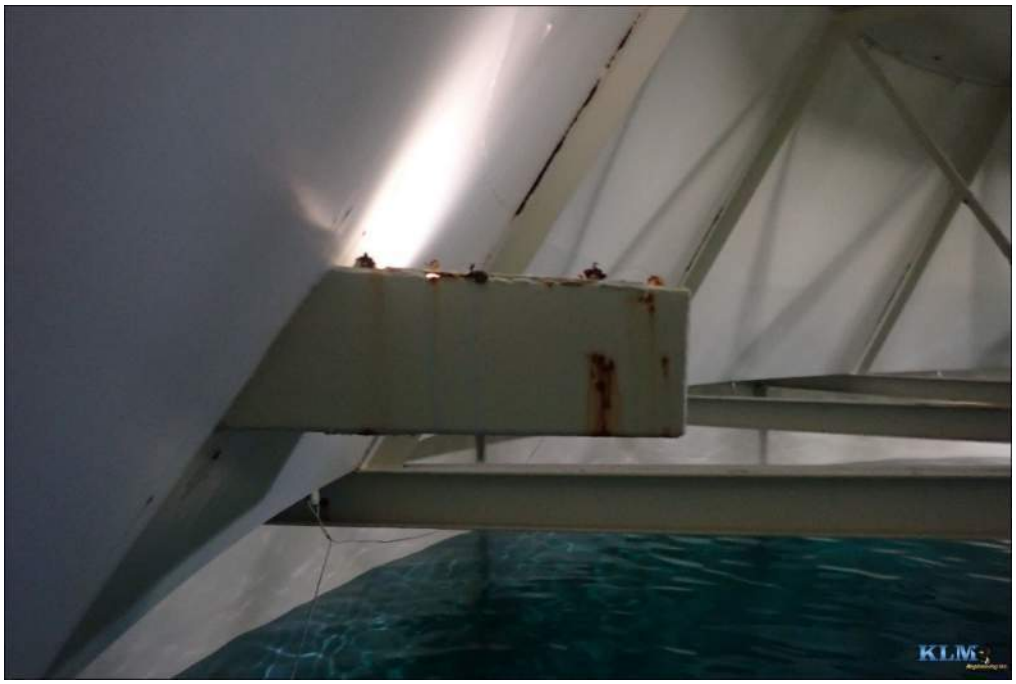

Photo No. 15
Inside configuration of screened openings

Photo No. 16
Inside configuration of screened openings

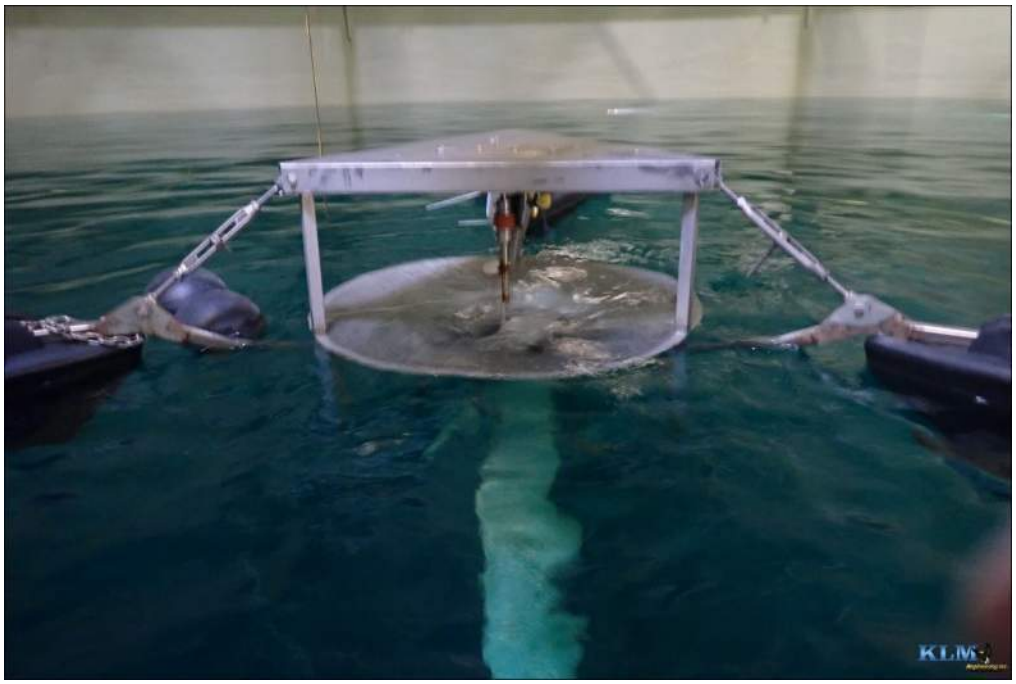

Photo No. 17
SolarBee mixer

Photo No. 18
SolarBee mixer under roof structure

Photo No. 19
Coating condition of shell and drywell tube

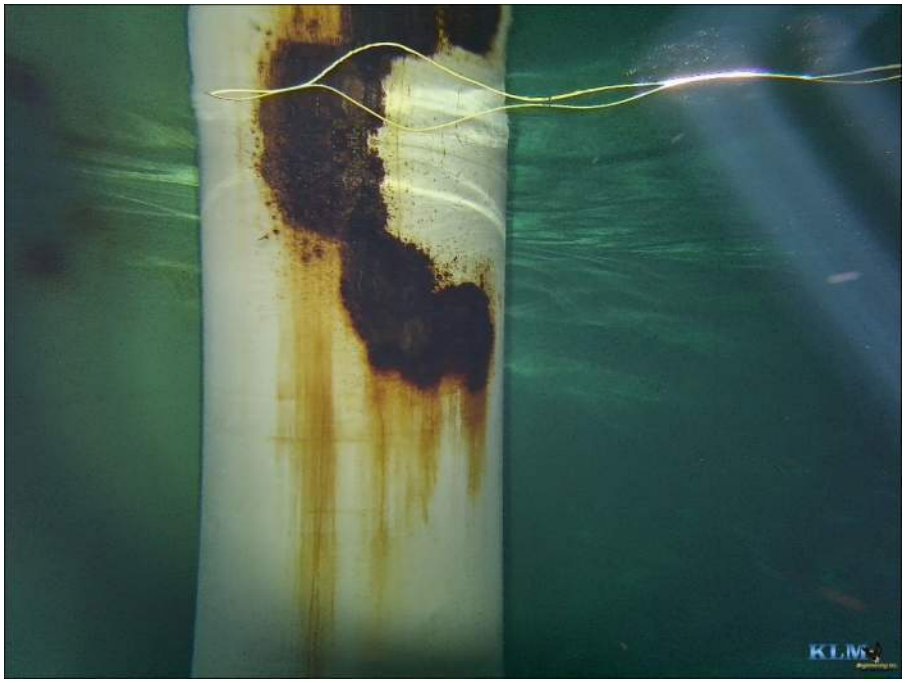

Photo No. 20
Coating failures on drywell tube

Photo No. 21
Drywell tube stiffener

Photo No. 22
Drywell tube stiffener

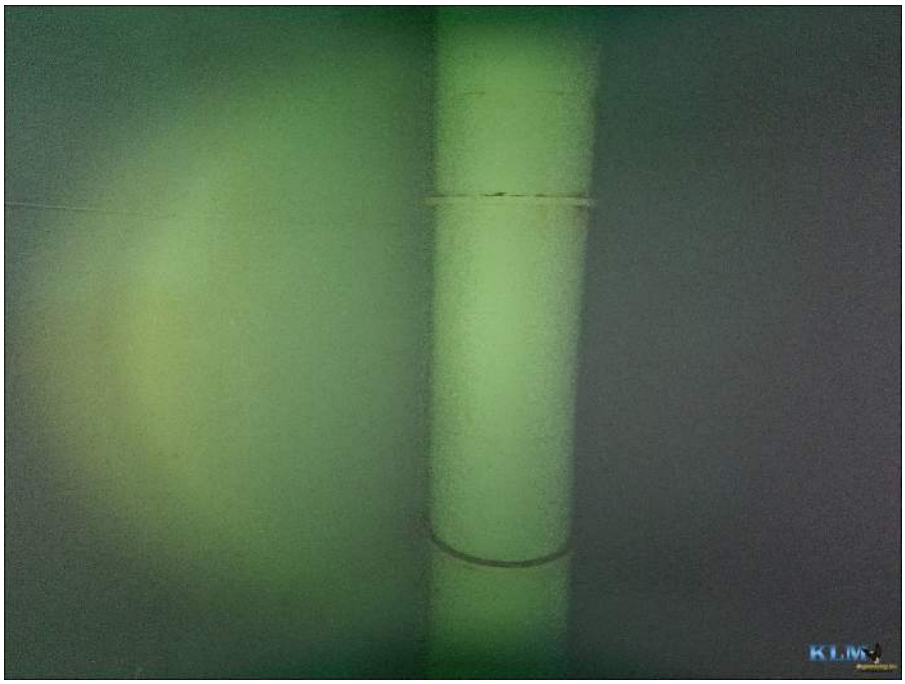

Photo No. 23
Overall condition of drywell tube

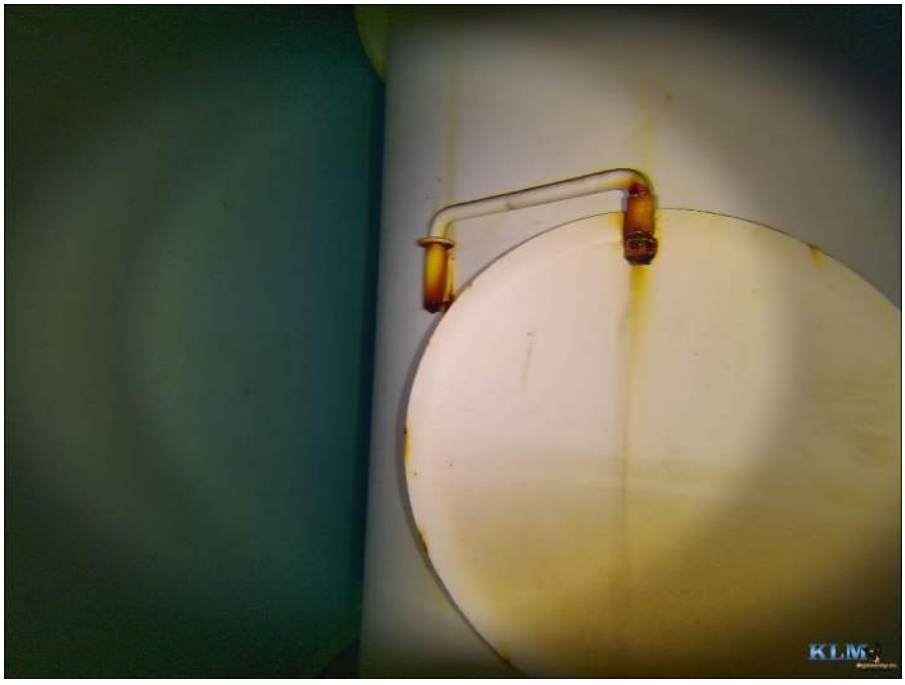

Photo No. 24
Drywell tube manway

Photo No. 25
Drywell tube connection at floor

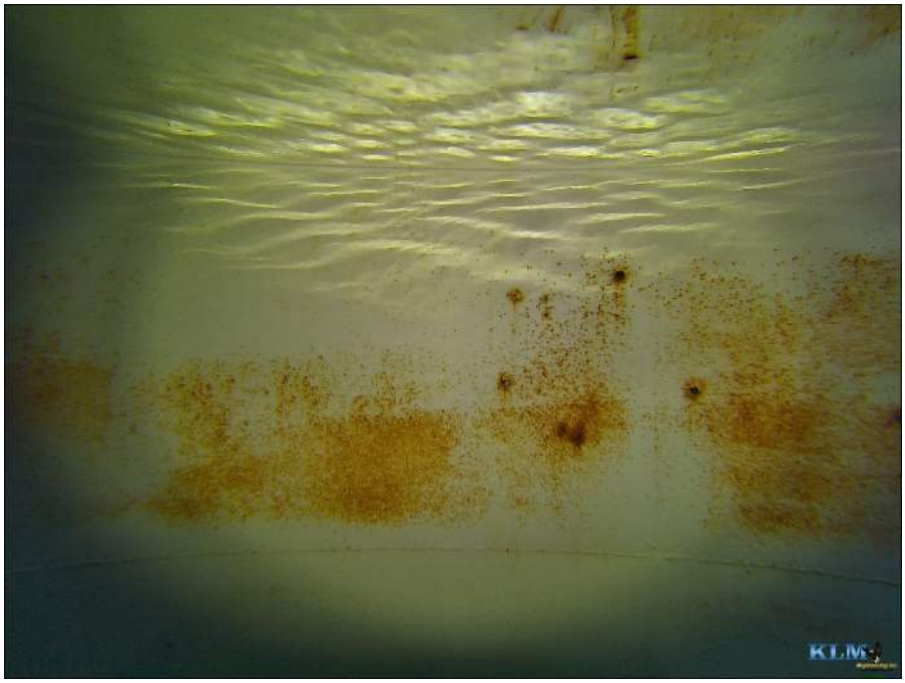

Photo No. 26
Coating failures on shell

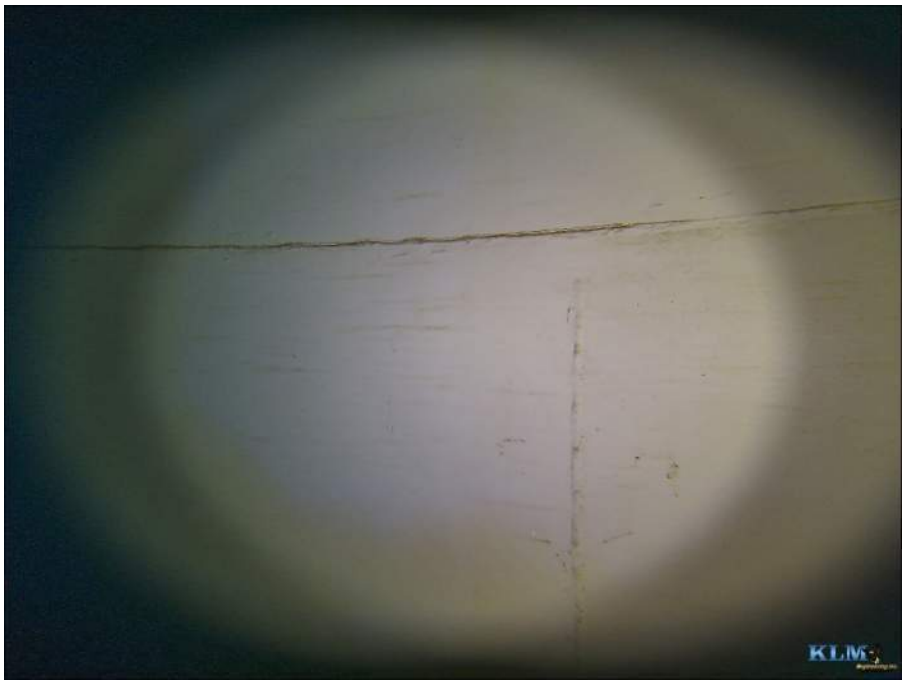

Photo No. 27
Shell coating condition

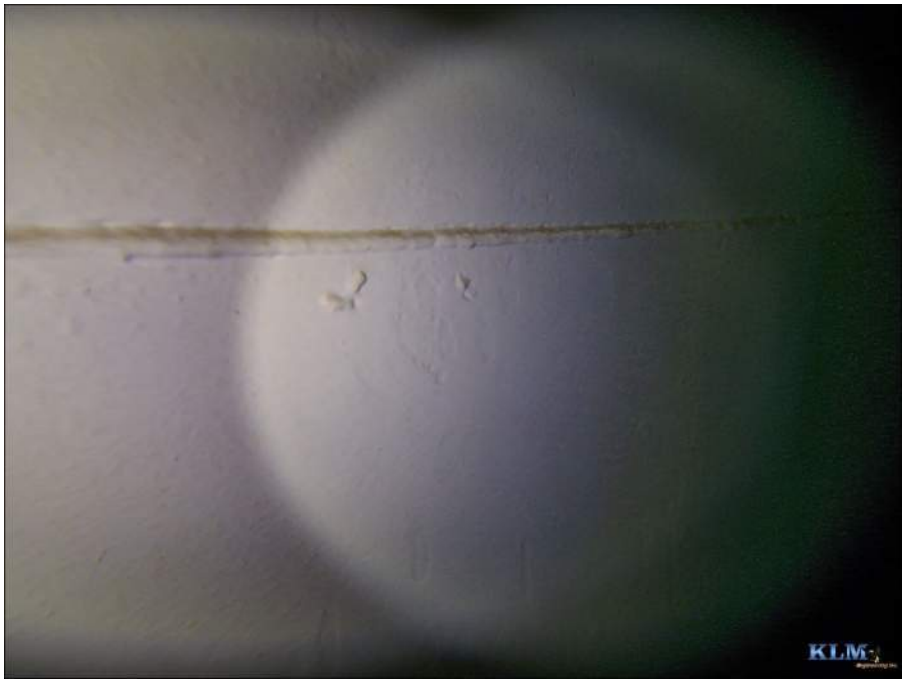

Photo No. 28
Shell coating condition

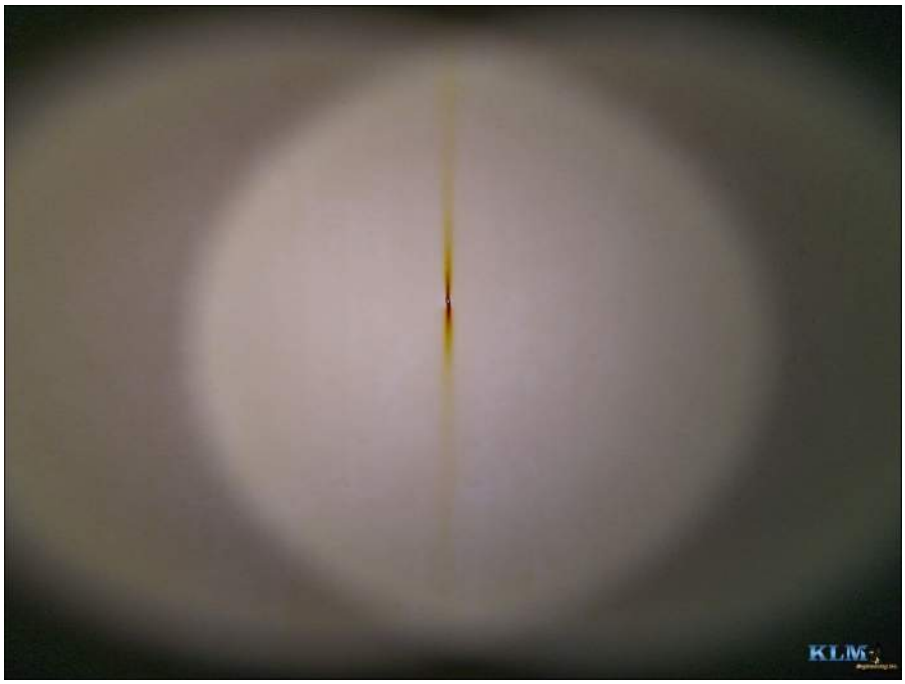

Photo No. 29
Shell coating condition

Photo No. 30
Shell coating condition

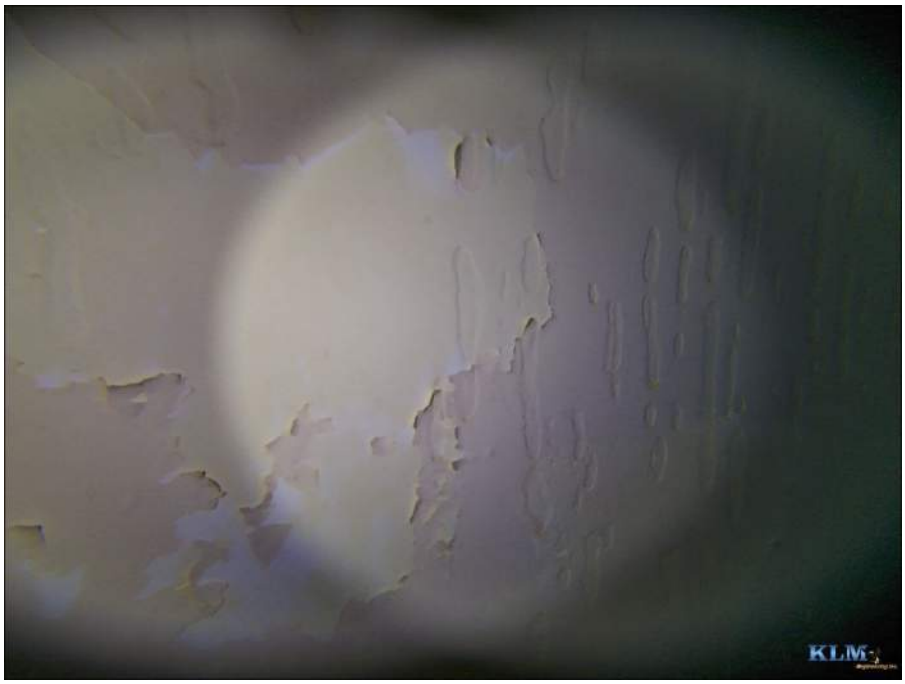

Photo No. 31
Shell coating condition

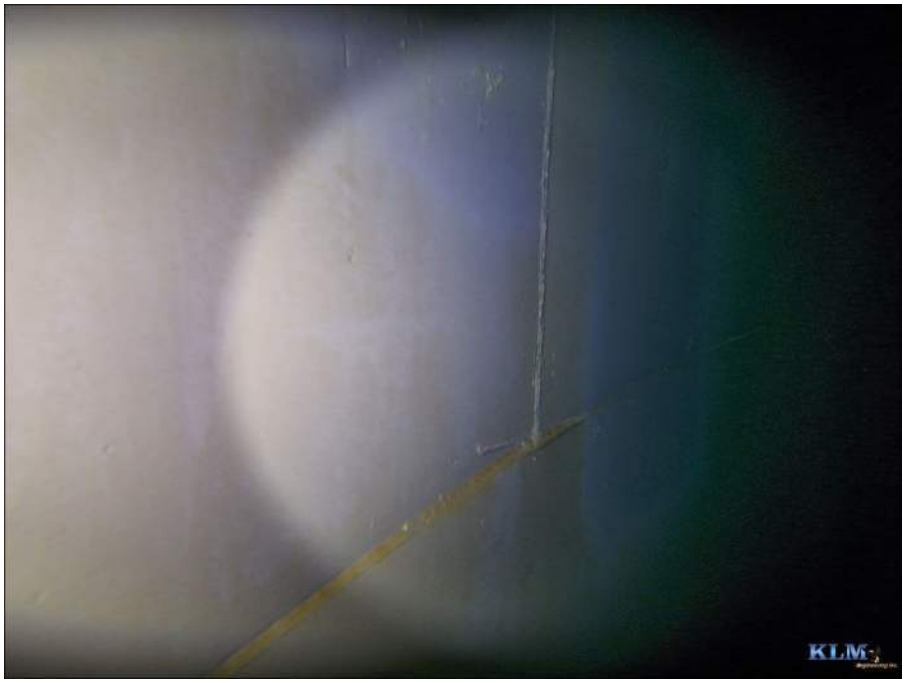

Photo No. 32
Shell coating condition

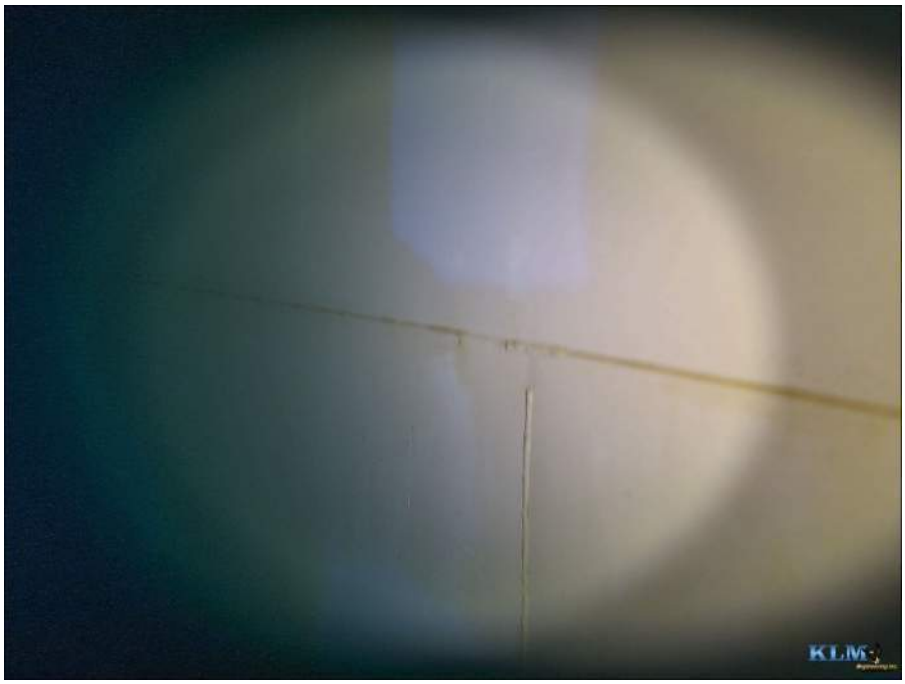

Photo No. 33
Shell coating condition

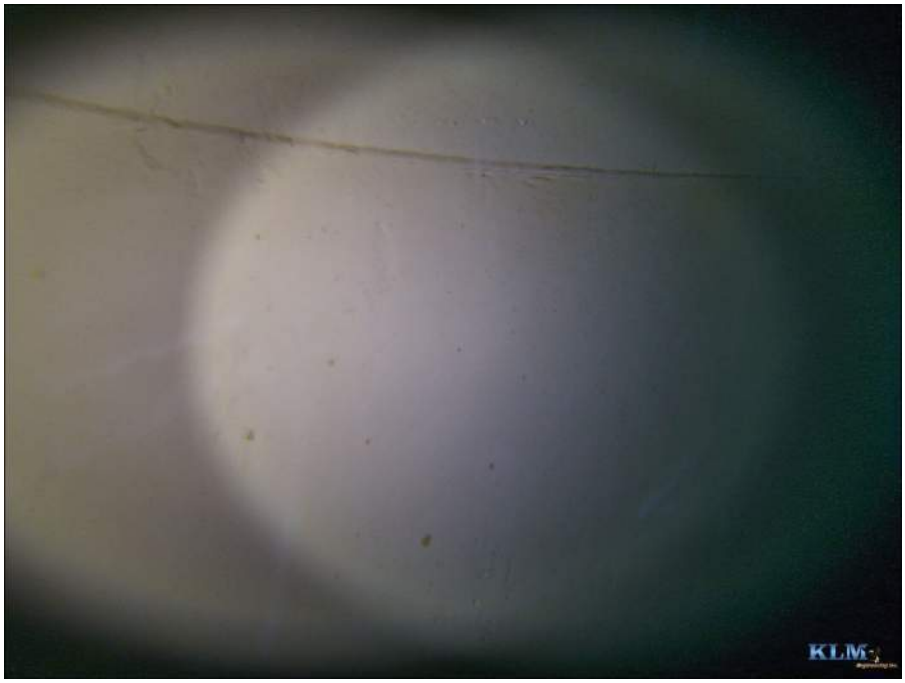

Photo No. 34
Shell coating condition

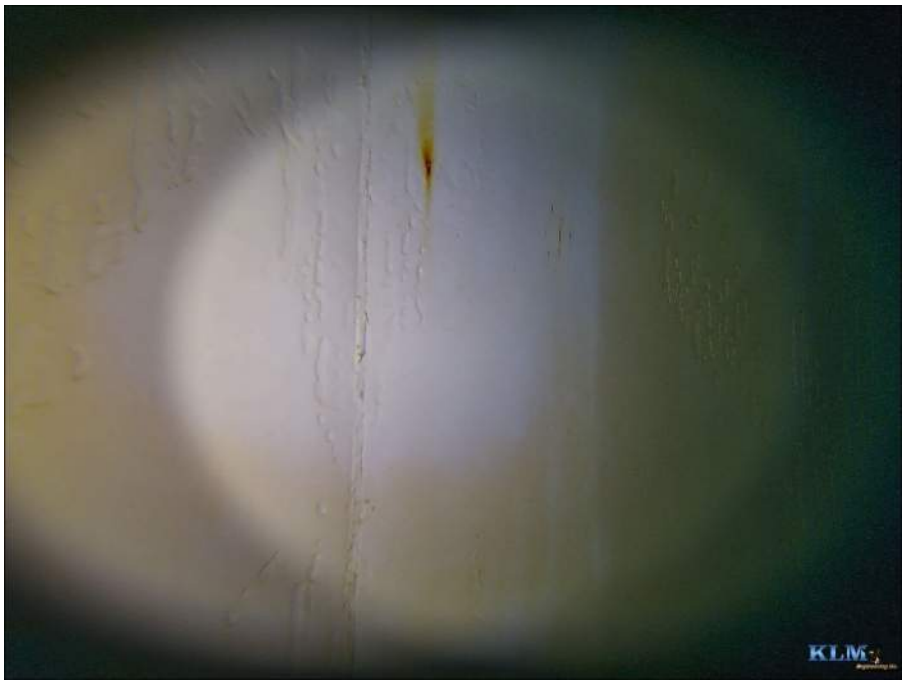

Photo No. 35
Shell coating condition

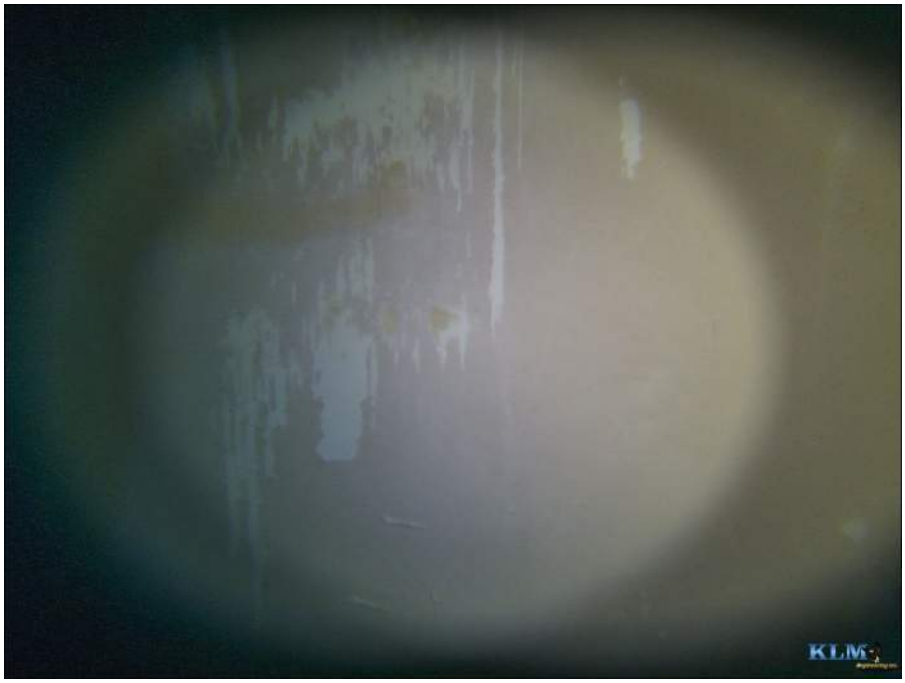

Photo No. 36
Shell coating condition

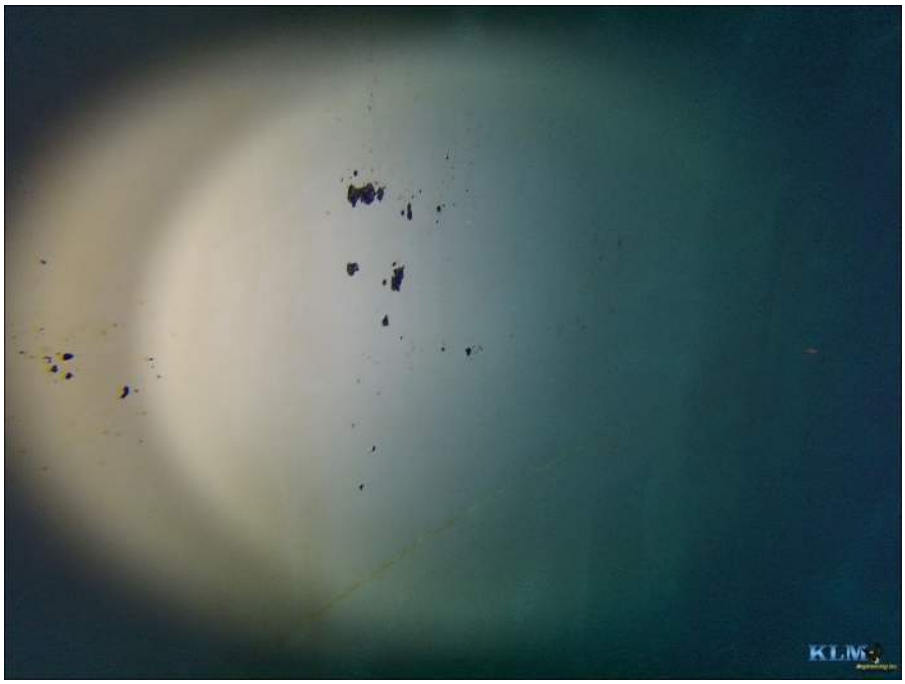

Photo No. 37
Coating failures on shell

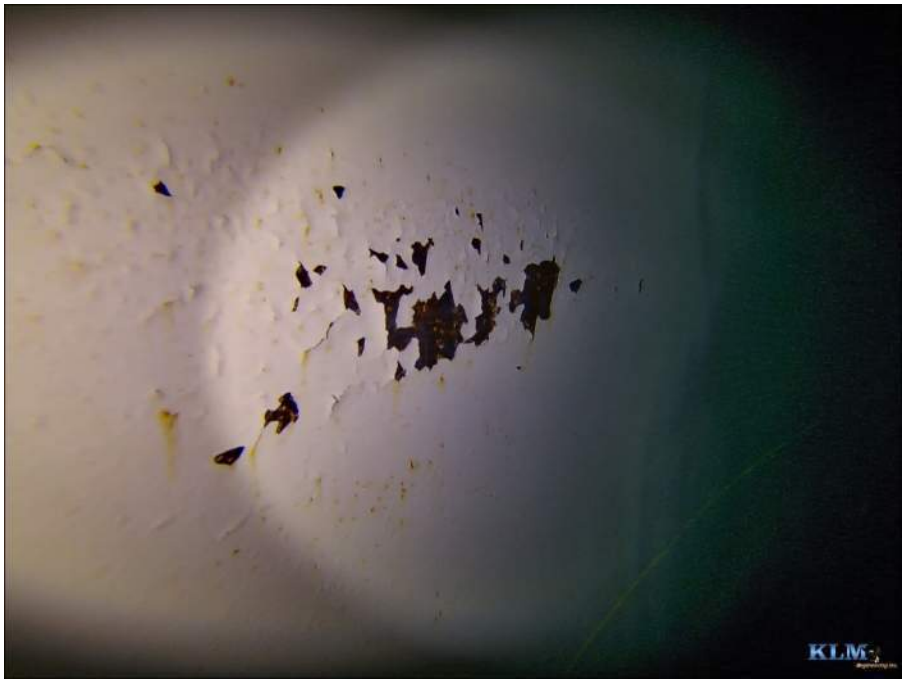

Photo No. 38
Coating failures on shell

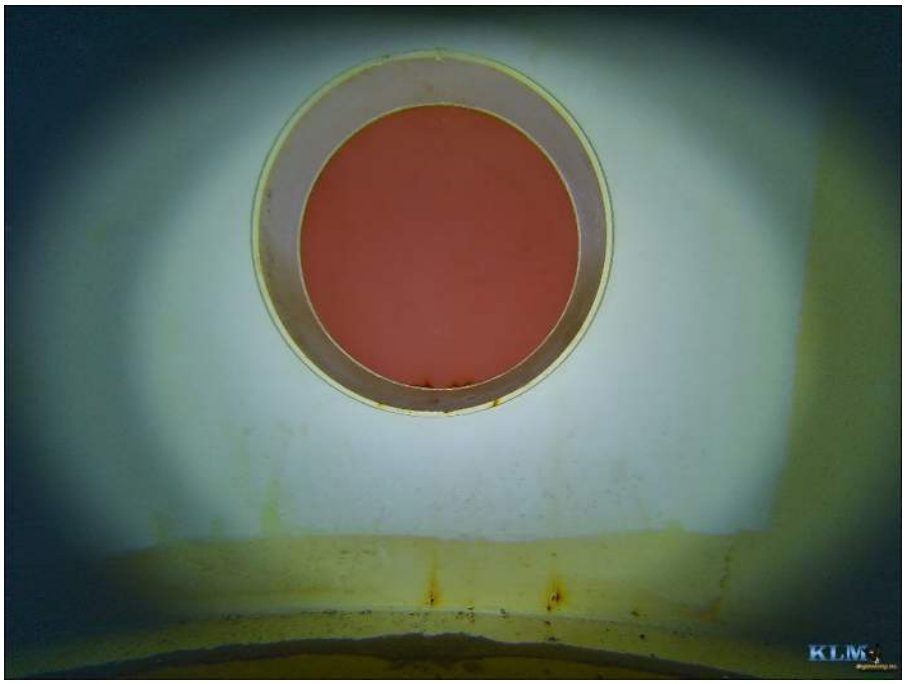

Photo No. 39
Shell manway

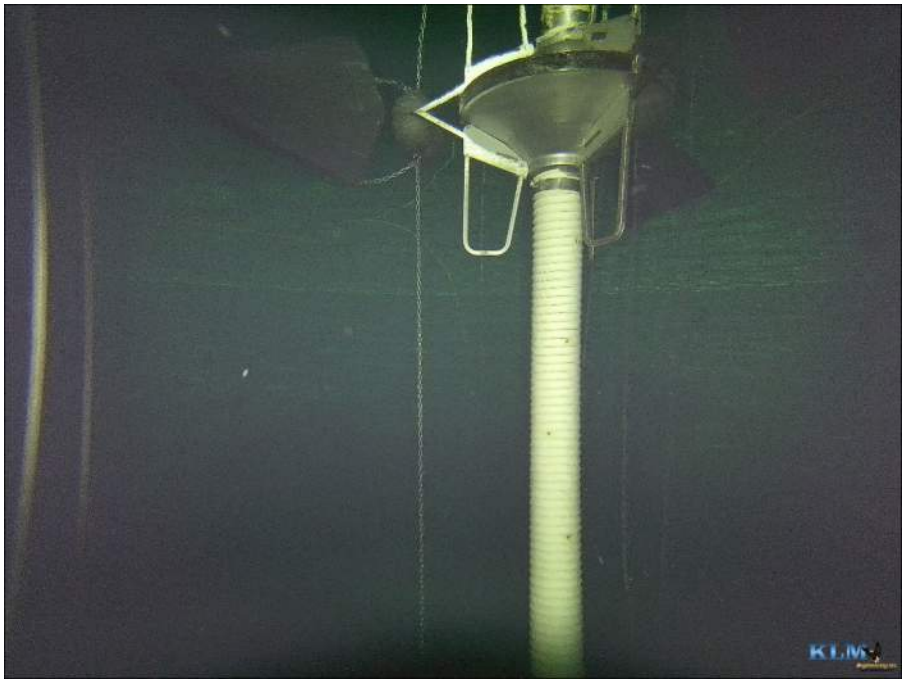

Photo No. 40
Mixer tubing

Photo No. 41
Mixer tubing on floor

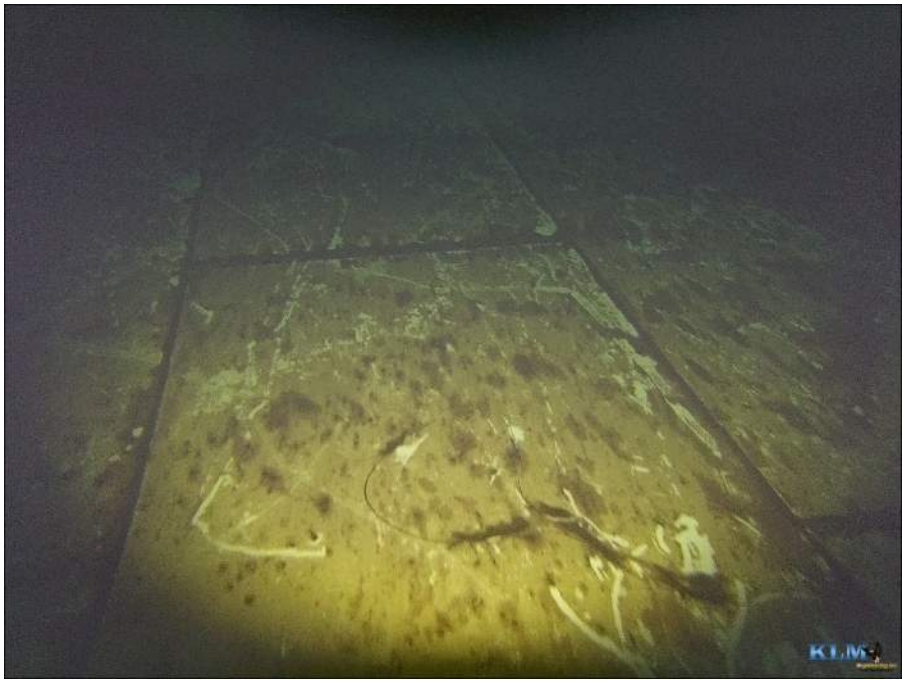

Photo No. 42
Conditions on floor

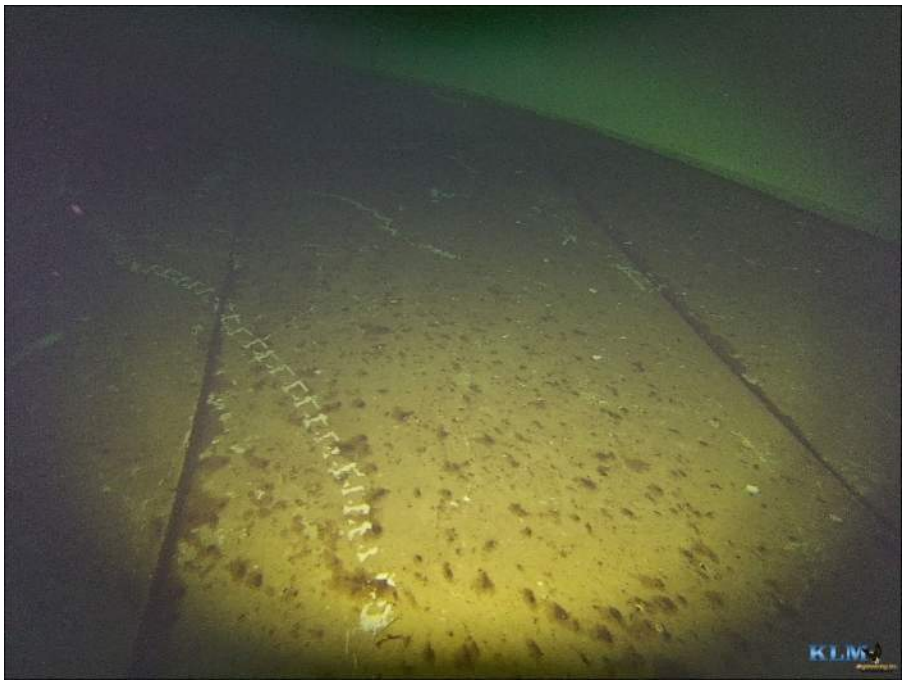

Photo No. 43
Conditions on floor

Photo No. 44
Floor conditions
Note: fill pipe

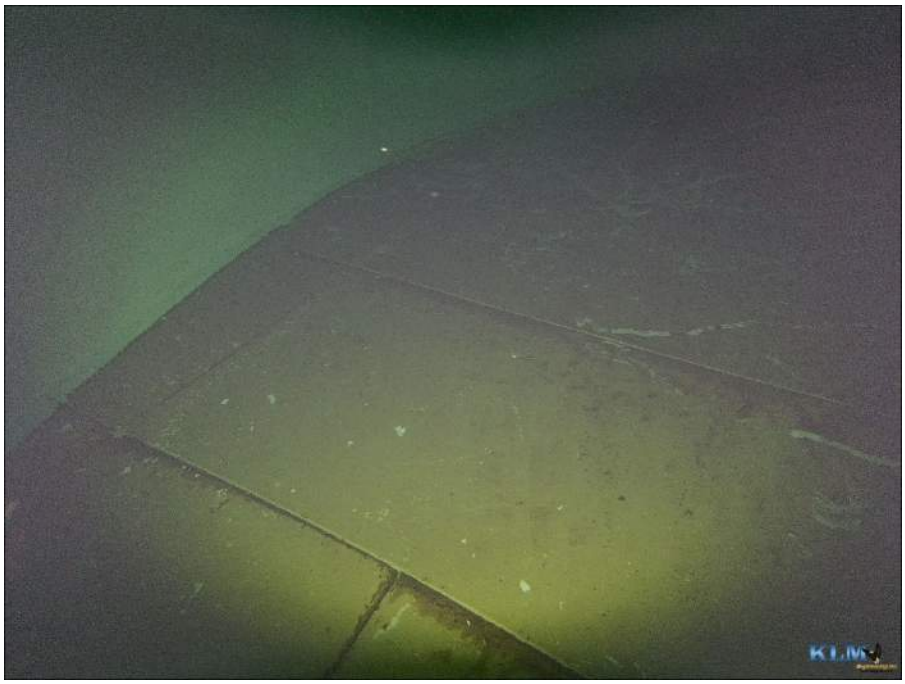

Photo No. 45
Floor conditions

Photo No. 46
Coax penetration at top of drywell tube

Photo No. 47
Conditions at top of drywell tube
Note: 4-inch roof drain line to overflow pipe

Photo No. 48
Coating failures in drywell tube

Photo No. 49
Coating failures in drywell tube

Photo No. 50
Typical round seam in drywell tube

Photo No. 51
Coating condition in drywell tube

Photo No. 52
Coating condition in drywell tube

Photo No. 53
Overall condition in drywell tube

Photo No. 54
Drywell tube manway and conditions

Photo No. 55
Overflow pipe

Photo No. 56
Access to bottom of drywell tube

Photo No. 57
Roof conditions with finial vent/access manway visible

Photo No. 58
Access manway

Photo No. 59
SolarBee mixer charger

Photo No. 60
Conditions of roof

Photo No. 61
Roof drain adjacent to access manway

Photo No. 62
Roof coating conditions

Photo No. 63
Roof coating conditions

Photo No. 64
Conditions on roof and access

Photo No. 65
Access onto roof

Photo No. 66
Coating condition of roof structure

Photo No. 67
Access from drywell tube to roof structure

Photo No. 68
Screened vent on roof structure

Photo No. 69
Drain adjacent to access manway

Photo No. 70
Typical condition of shell to roof structure transition

Photo No. 71
Overall condition of shell

Photo No. 72
Overall condition of shell

Photo No. 73
Shell manway and conditions at base

Photo No. 74
Shell conditions at base

Photo No. 75
Shell manway and conditions at base

Photo No. 76
Overall condition of shell and site conditions

APPENDIX B

INSPECTION AND EVALUATION METHODS

1.0| INSPECTION AND EVALUATION METHODS

Some or all of the following procedures were performed as applicable.

1.1| Methods

1.1.1 The inspection of the base metal and coatings on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the base metal and coating on the interior wet surfaces were examined from either a rubber raft while the tank was being drained, by a Remote Operated Vehicle (ROV) with the tower in service, or with both.

1.1.2 Tank plate thickness was measured at random locations on the liquid holding shell. The overall structural condition of the tank was visually examined.

1.1.3 No structural analysis was done to determine if the tank design complies with the AWWA D100-11 Standard for "Welded Carbon Steel Tanks for Water Storage." However, any observed non-conformance to the AWWA D100-11 standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2| Examination and Evaluation Techniques

Some or all of the following procedures were performed as applicable.

1.2.1| Site

The tank site was evaluated for proper drainage conditions affecting access and lead paint abatement during reconditioning.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2| Foundations

The tank concrete foundation(s) were/was visually examined for cracks, spalling, conditions of grout, indications of distress/settlement, and elevation above grade.

1.2.3| Tank Plate Thickness

Plate thickness measurements were taken using ultrasonic methods (UTM). The readings were taken using a digital readout Elcometer MTG6 Ultrasonic Thickness Gage that has a dual element probe (transducer). The probe's transmitter element sends a short ultrasonic pulse through the material. The pulse gets reflected as an echo from the opposite side of the plate and returns to the probe's receiver element. The round-trip time is directly related to the material's thickness.

1.2.4| Coating Thickness

Interior and exterior coatings, where accessible, were tested in accordance with Steel Structures Painting Council SSPC-PA2-18 "Procedure for Determining Conformance to Dry Coating Thickness Requirements" using PosiTector-6000-F1 Type 2 gages.

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1.2.5| Coating Adhesion

Adhesion testing of the coating to the steel, and inner coat adhesion, was performed by ASTM D-3359: Shear Adhesion Test, Measuring Adhesion by Tape Test. In addition, subjective coating adhesion evaluation was performed using a penknife.

1.2.6| Coating Serviceability

The estimated remaining coating life or serviceability evaluation was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all accessible coatings. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the steel underneath the coating, or any other defects affecting the intended service.

1.2.7| Coating Lead and Chromium Content Analysis

Samples may have been taken of the various types of coatings present on the interior and exterior surfaces. GPI Laboratories, Inc. of Grand Rapids, Michigan tests these coatings in conformance with ASTM D-3335 Standard Test Methods for Concentrations of Lead and Chromium in Paint.

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Lawrence, Kansas

Inspection Report:
1,500,000-Gallon Capacity
Stoneridge Tower

Prepared by:

KLM Engineering, Inc.
1976 Wooddale Drive, Suite 4 | Woodbury, MN 55125
651.773.5111 | www.klmengineering.com

March 2024

Project No.: 5073-24

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6.0| RECONDITIONING SUMMARY 6
6.1| Reconditioning Summary and Cost Estimate 6

APPENDIX A: Photographs

APPENDIX B: Inspection and Evaluation Methods

1.0| PROJECT INFORMATION

KLM Project No.: 5073-24 **Customer P. O. Number:** N/A

Tank Owner: Lawrence, Kansas **Phone:** 785-832-7800

Street/City/State/Zip: 6 East 6th Street, Lawrence, KS 66044

Tank Owner Contact: Chris Rice, P.E., Senior Project Engineer

Owner's Tank Designation: Stoneridge Tower

Tank Description: Composite Elevated Tank

Tank Street Location: 555 Stoneridge Drive, Lawrence, KS 66049

Purpose of Inspection: Condition Assessment

Date of Inspection: February 29, 2024

Inspected By: Ethan Hutar, NACE #76055 and Lucas Tomperi, NACE #69209

Type of Inspection: KLM Standard ROV Evaluation

Manufacturer: Landmark Structures **Construction Date:** 2008

Serial No.: None listed **Design Code:** AWWA D107

Capacity: 1,500,000 gallons

Type of Construction: Welded with cast-in-place Concrete Column

Tank Diameter: ~84 feet

Height to: Overall ~105 feet

Height to: HWL ~100 feet LWL ~60 feet

Tank Construction Drawings: Available to KLM

Previous Inspection Records: None available to KLM

EXISTING COATING INFORMATION

	Interior Wet	Interior Dry	Exterior
Date Last Coated	2008	2008	2008
Full or Spot Repair	Full/New	Full/New	Full/New
Coating Contractor	Landmark	Landmark	Landmark
Surface Preparation	Blast	Blast	Blast
Paint System	Zinc/epoxy	Zinc/epoxy	Zinc/epoxy/urethane
Paint Manufacturer	Tnemec	Tnemec	Tnemec
Paint Chip Samples	Not taken	Not taken	Not taken

Lawrence, Kansas

1,500,000 – GALLON CAPACITY
STONERIDGE TOWER

2.0| REFERENCES

The tank interior and exterior areas were evaluated in conformance with the following:

a. KLM Engineering, Inc. Proposal.

b. General guidelines of AWWA Manual M42 Appendix C “Inspecting and Repairing Steel Water Tanks, and Elevated Tanks for Water Storage.”

c. KLM "Procedures and Guidelines for Inspecting Existing Steel and Concrete Water Storage Tanks."

d. AWWA Standard D107; Composite Elevated Tanks for Water Storage.

3.0| COATINGS EVALUATION

3.1| Lead and Chromium Content Analysis

The total lead and chromium content of the interior and exterior coatings was not analyzed. Based on the 2008 construction date of the tank, and regulations in effect at that time limiting the use of lead or chromium-based coatings, KLM anticipates that neither the interior nor exterior coatings are lead or chromium-based paints and will not generate hazardous waste during reconditioning.

3.2| Interior Wet Coating

The tower was constructed and originally painted in 2008 by Landmark Structures. The interior wet coating is in good to fair condition above the high-water line (HWL) with less than two percent visible coating failures. Failures consist of corrosion on the galvanized painter’s T-rails, ladder stand-off brackets, and manway edges. The coating below the HWL is in good condition with no failures observed. See photos in Appendix A.

3.3| Interior Dry Coating

The coating in the interior dry area consists of only the drywell tube. The concrete bowl and column are uncoated and in excellent condition. The same is true for the galvanized ladders and catwalk. The coating in the drywell tube is in good condition with no failures observed. See photos in Appendix A.

3.4| Exterior Coating

The exterior coating is in good overall condition with virtually no coating failures observed with the exception of typical wear on the roof plates around the manways, and normal oxidation of the top coat on the roof. See photos in Appendix A.

3.5| Replacement Coating Systems

When the next full reconditioning is required, KLM recommends preparing surfaces in accordance with NACE guidance and applying a coating system for each area according to the following.

3.5.1| Interior Wet Coating

Surface preparation should be performed according to SSPC-SP10 Near White Metal Blast criteria.

Apply a two-coat system:

1. moisture cured zinc-rich
2. NSF 61 certified epoxy

3.5.2| Interior Dry Coating

Surface preparation should be performed according to SSPC-SP6 Commercial Blast Clean criteria.

Apply a three-coat system:

1. moisture cured zinc-rich
2. polyamidoamine epoxy
3. polyamidoamine epoxy

3.5.3| Exterior Coating

Surface preparation should be performed according to SSPC-SP6 Commercial Blast Clean criteria.

Apply a four-coat system:

1. moisture cured zinc-rich
2. polyamidoamine epoxy
3. aliphatic acrylic urethane
4. fluoropolymer

4.0| STRUCTURE MODIFICATIONS

Structure modifications and repairs serve to bring the tank into compliance with OSHA regulations, AWWA standards, and Kansas Department of Health and Environment regulations. They also improve areas of the tank that are prone to premature development of corrosion, repair surface defects resultant from tank construction, remove abandoned and unnecessary equipment, and improve tank maintenance capabilities.

The following is a list of recommended modifications and repairs to be included during the next reservoir reconditioning. Detailed information important to each item will be determined when developing the project specifications. Additional minor modifications, not impacting on the estimated project cost, may be identified, and incorporated at that time.

Photographs referred to in this section are in Appendix A.

4.1| Interior Wet Modifications

4.1.1 Remove the flat bar style safety climb device on the ladder. Install an anchor point on the underside of the roof adjacent to the access manway. Include a self-retracting lifeline (SRL) to allow for safe access while ascending and descending the ladder. See photo 12.

4.1.2 Realign the silt stop on top of the fill pipe. See photo 14.

4.1.3 Replace the gasket on the bowl manway. See photo 31.

4.1.4 Grind off all weld spatter and erection scab marks for compliance with AWWA D100.

4.1.5 Consider installing a submersible mixer in the tower to reduce the likelihood and magnitude of ice formation in cold weather and prevent stratification in warm weather.

4.2| Interior Dry Modifications

4.2.1 Install a pressure style manway in the drywell tube. This will improve the ventilation during reconditioning and bring the tank into compliance with OSHA confined space entry requirements. Include a manway step-off platform and hand grabs.

4.3| Exterior Modifications

4.3.1 Remove the hand grabs and install a climb assist on the exterior (roof side) of the drywell tube to improve safety while transitioning in and out of the tube. See photo 37.

4.3.2 Replace the bolts connecting the finial vent to the manway collar. The bolts were found dislodged at the time of inspection. The bolts were replaced, however new hardware should be installed. See photos 39 and 40.

4.3.3 To comply with Kansas Department of Health and Environment regulations, install heavy-gauge, No. 4, and No. 24 mesh screens on the overflow outlet (#4 downstream of #24) above the flapper. See photos 49 and 50.

4.4| Cathodic Protection (CP) System

4.4.1 The tower has a submerged CP system. The current interior wet area surface conditions observed below the water level suggest the system is working correctly. It should continue to be maintained and operated properly to reduce tank corrosion.

5.0| PROPERTY CONSIDERATIONS

5.1| Site and Environmental Considerations

5.1.1 The tank site includes a chain link fence for security and is located in a residential area with Saint Margaret's Episcopal Church bordering the west side.

5.2| Telecommunications Considerations

5.2.1 The reservoir has no telecommunications equipment, either antennas or other associated equipment. Antennas generally have the effect of dramatically increasing the cost of reconditioning water storage reservoirs. If the owner is considering allowing antennas to be installed on the tower, lease agreements should be written to ensure the antenna owners are responsible for increased maintenance costs

due to their presence. Installations should be reviewed to ensure that they do not interfere with normal use or maintenance of the tower, present safety hazards, or violate state or federal regulations.

6.0| RECONDITIONING SUMMARY

6.1| Reconditioning Summary and Cost Estimate

KLM recommends inspecting and reevaluating the tank in five years to monitor conditions. Spot repairs should be performed in the interior wet area within the next five years to postpone more costly future repairs.

The cost for spot repairing the corrosion in the interior wet area is estimated between $35,000 and $40,000. This estimate is based on current pricing and does not include costs for engineering and/or inspection services. For competitive bids, the project should be bid 9 to 12 months before the desired starting date.

An experienced tank-coating contractor with the proper crew and equipment should be able to complete the spot repair work in two weeks including cure times. At the time of spot repairs, the tower will need to be drained and remain off-line for the duration of the project.

While not required due to the exterior coating being in good condition, the exterior could be overcoated at the same time interior wet spot repairs are performed to improve tower aesthetics.

The cost for overcoating the exterior is estimated between $105,000 and $115,000. This estimate is based on current pricing and does not include costs for engineering and/or inspection services.

If performed at the same time, an experienced tank-coating contractor with the proper crew and equipment should be able to complete the interior spot repair work and exterior overcoating in three weeks including cure times. At the time of repairs, the tower will need to be drained and remain off-line for the duration of the project.

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APPENDIX A

PHOTOGRAPHS

Photo No. 1
Overall view of the tower

Photo No. 2
Roof conditions
Note: corrosion on inner painter's T-rail

Photo No. 3
Roof conditions
Note: corrosion on inner painter's T-rail

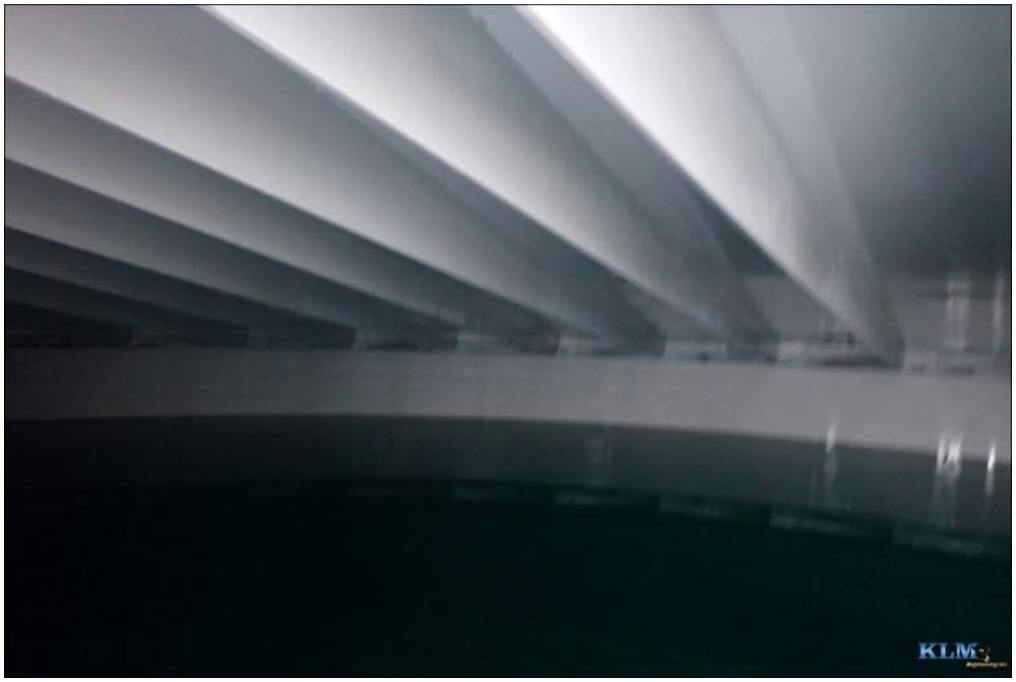

Photo No. 4
Roof conditions

Photo No. 5
Roof and upper shell

Photo No. 6
Roof and upper shell

Photo No. 7
Wet ladder stand-off bracket

Photo No. 8
Compression ring and access manway

Photo No. 9
Conditions in access manway tube

Photo No. 10
Conditions in access manway tube

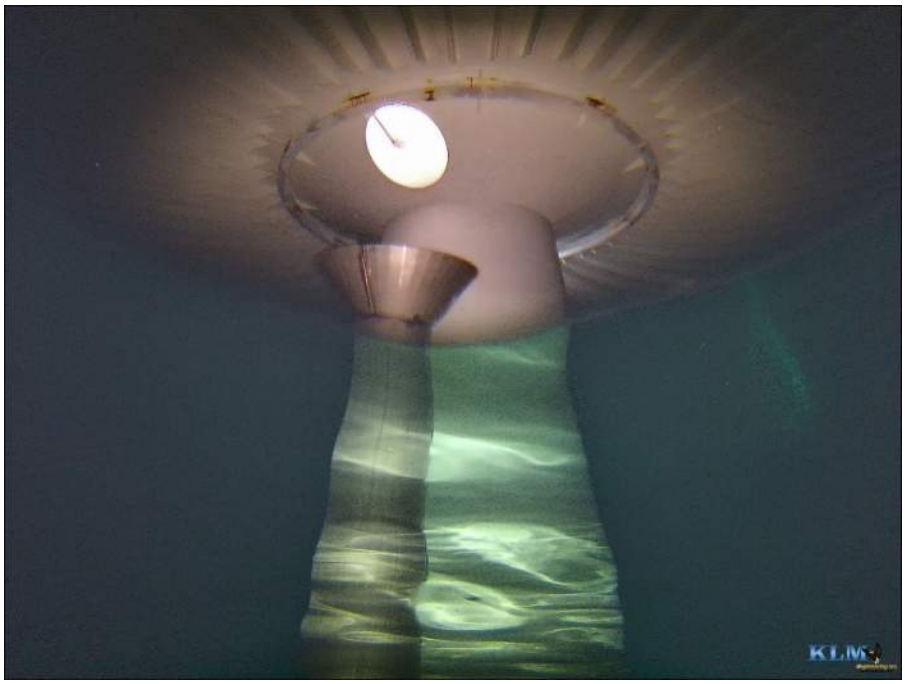

Photo No. 11
Drywell tube, stainless-steel overflow, and roof conditions

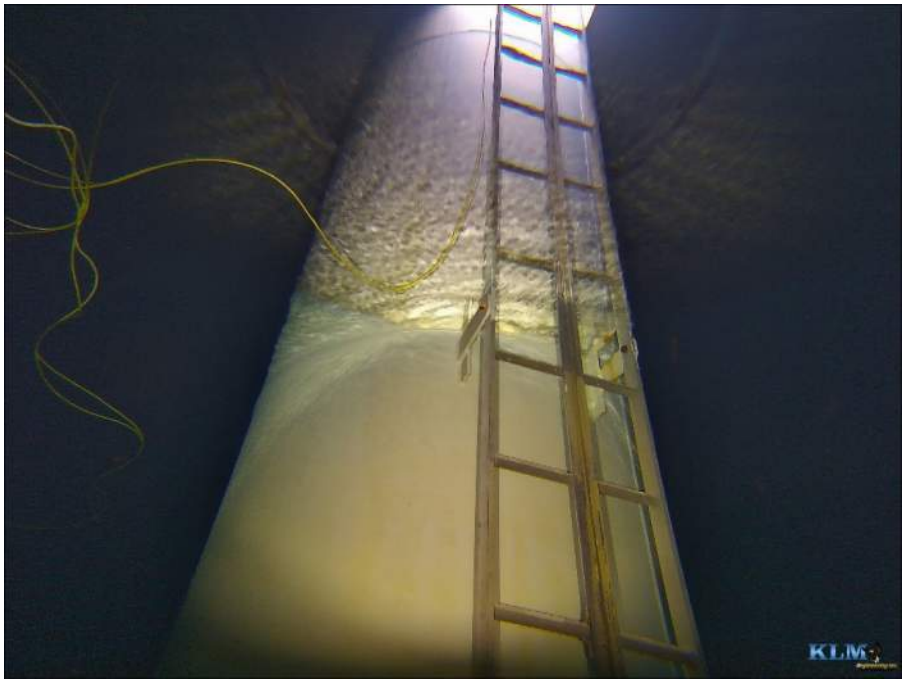

Photo No. 12
Drywell tube and ladder

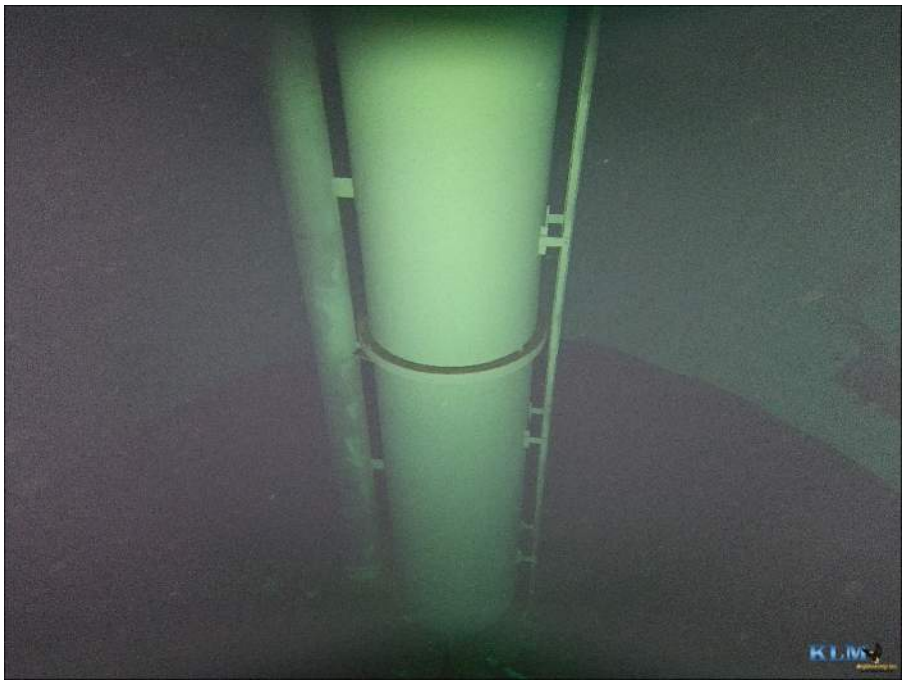

Photo No. 13
Overall condition of drywell tube

Photo No. 14
Fill pipe with dislodged silt stop

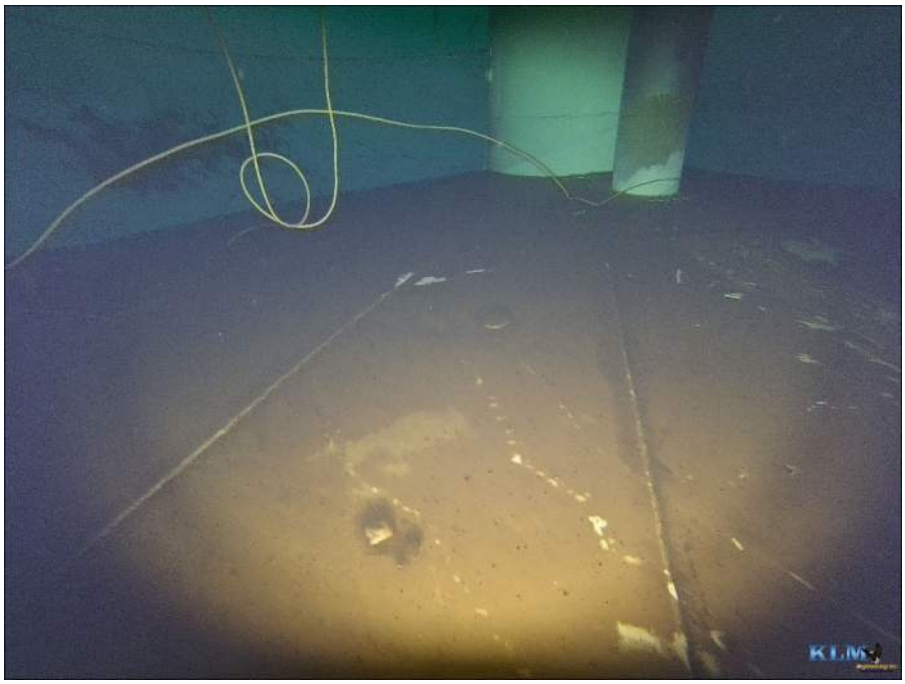

Photo No. 15
Bowl conditions

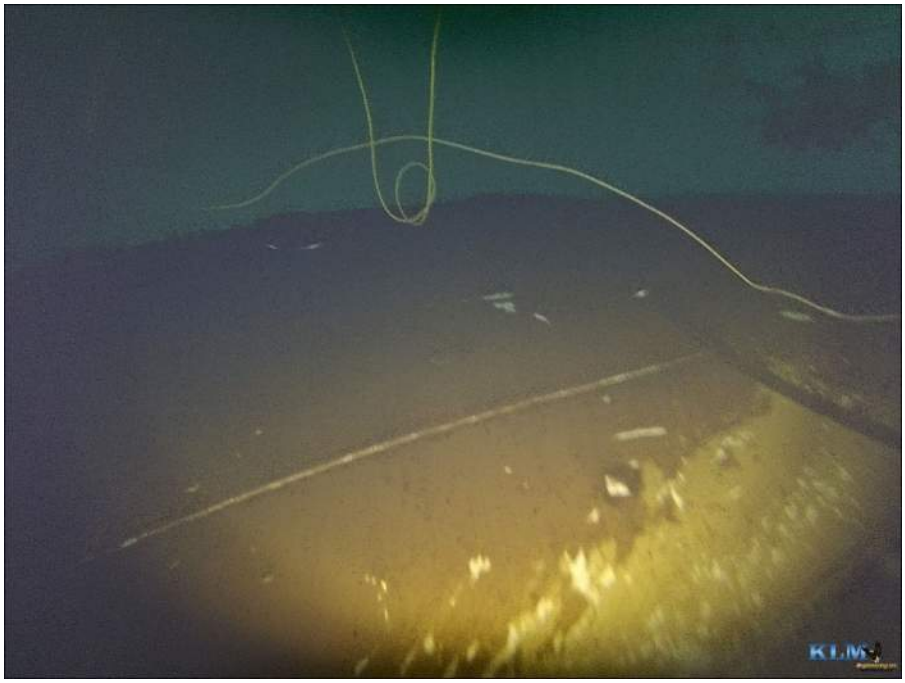

Photo No. 16
Bowl conditions

Photo No. 17
Bowl conditions

Photo No. 18
Overall coating conditions in bowl

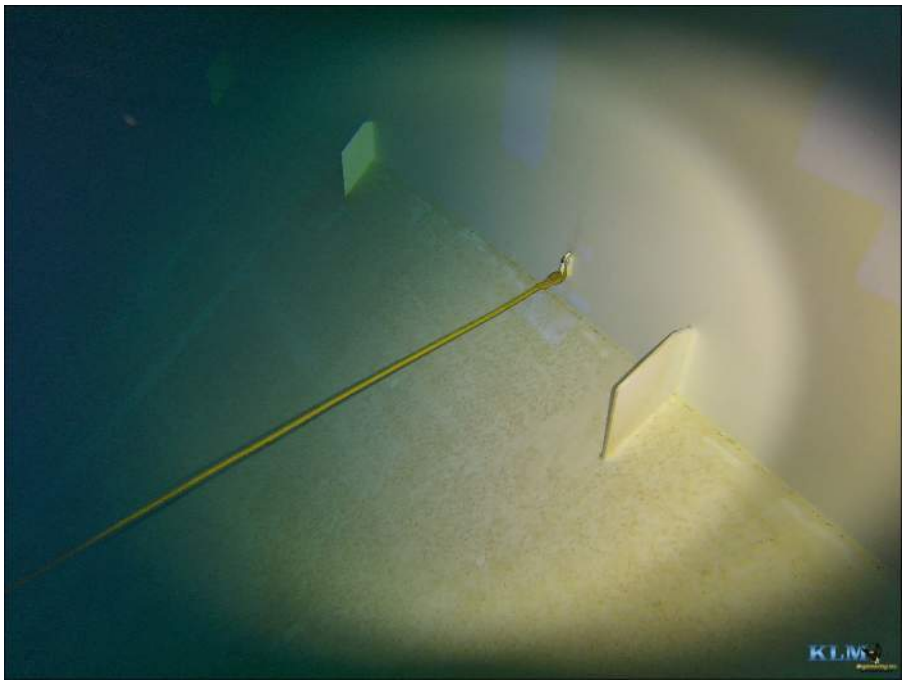

Photo No. 19
Cathodic protection attachment and bowl conditions

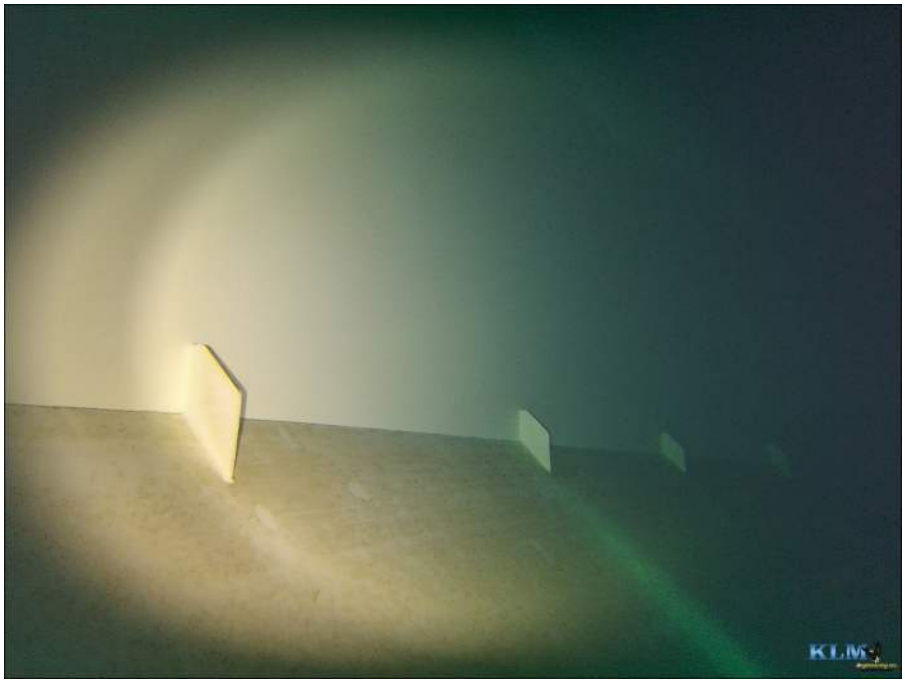

Photo No. 20
Typical bowl to shell connection

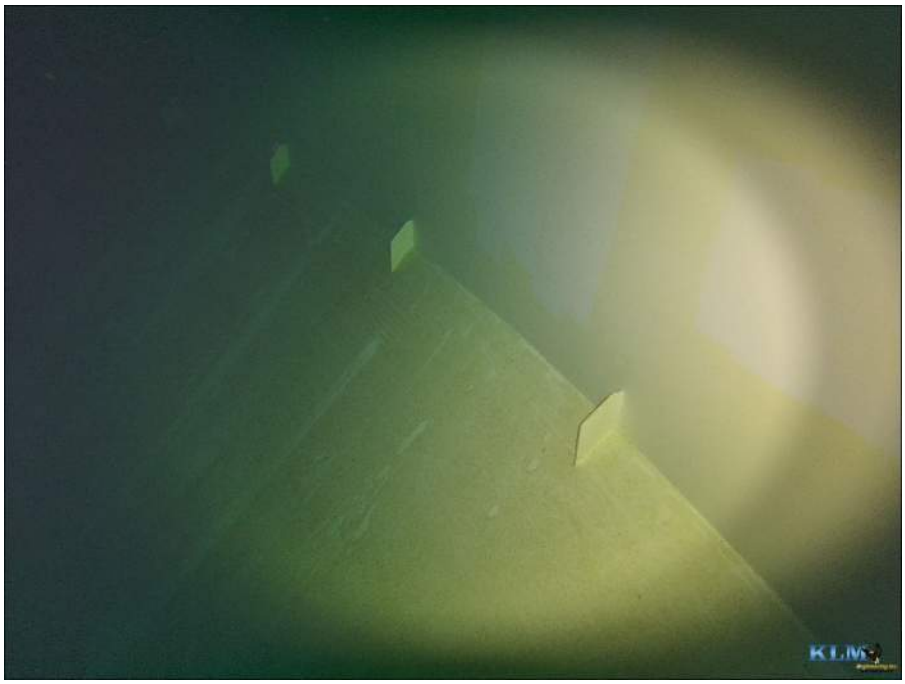

Photo No. 21
Typical bowl to shell connection

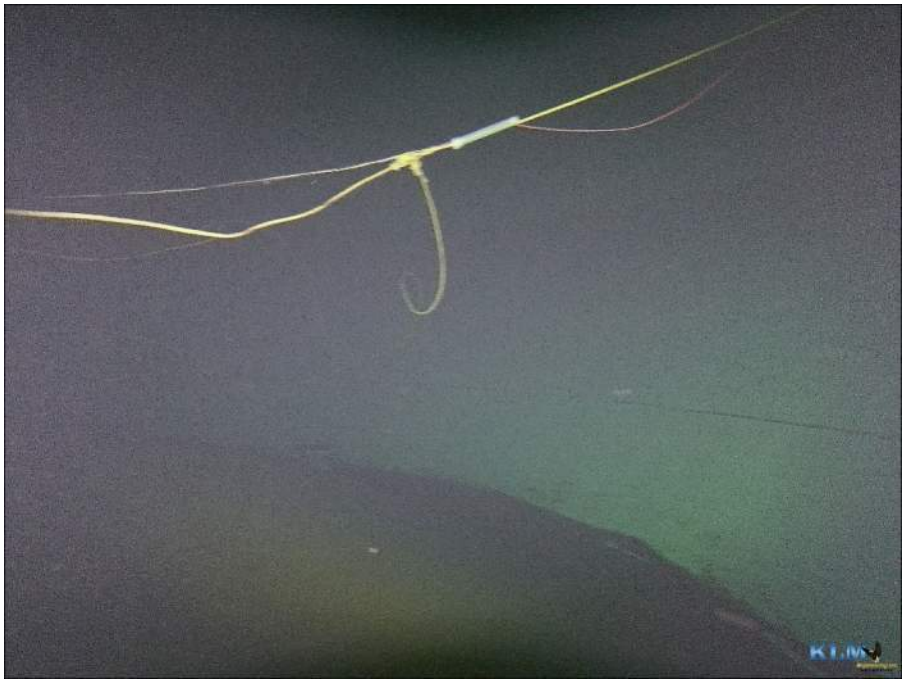

Photo No. 22
Cathodic protection

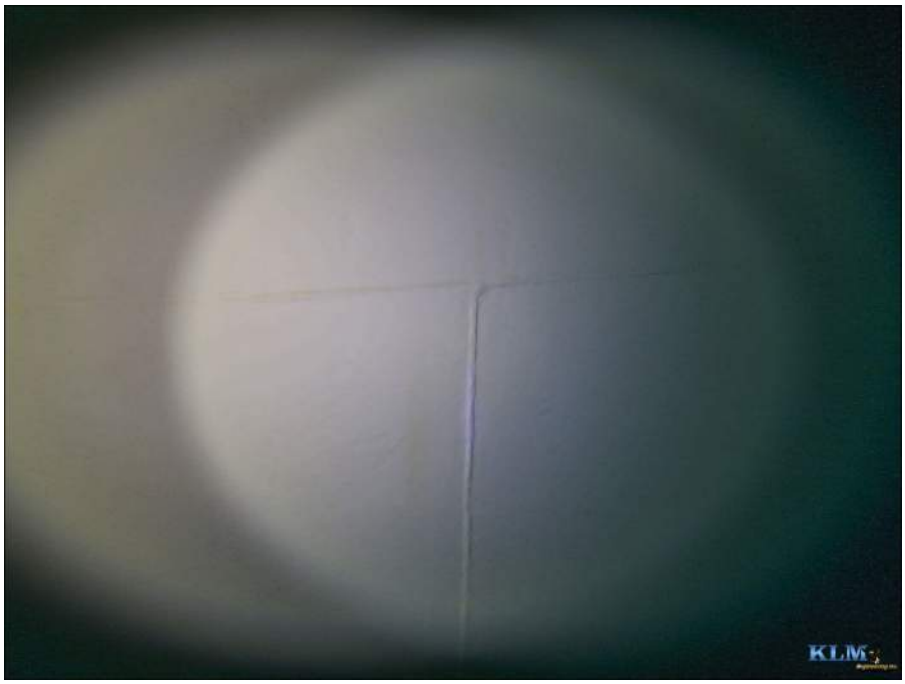

Photo No. 23
Typical shell coating

Photo No. 24
Typical shell coating

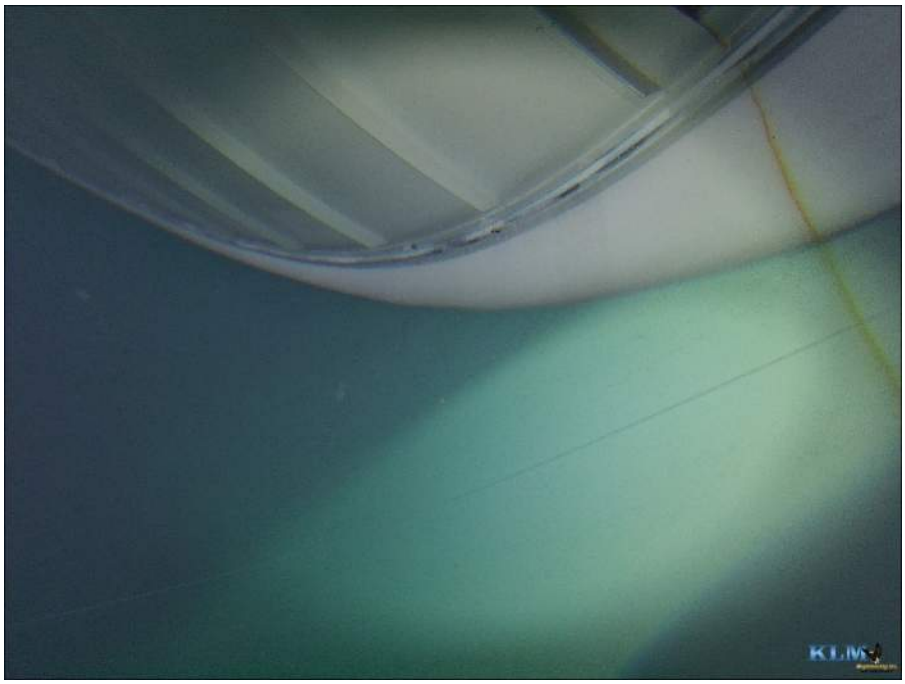

Photo No. 25
Overall condition of shell

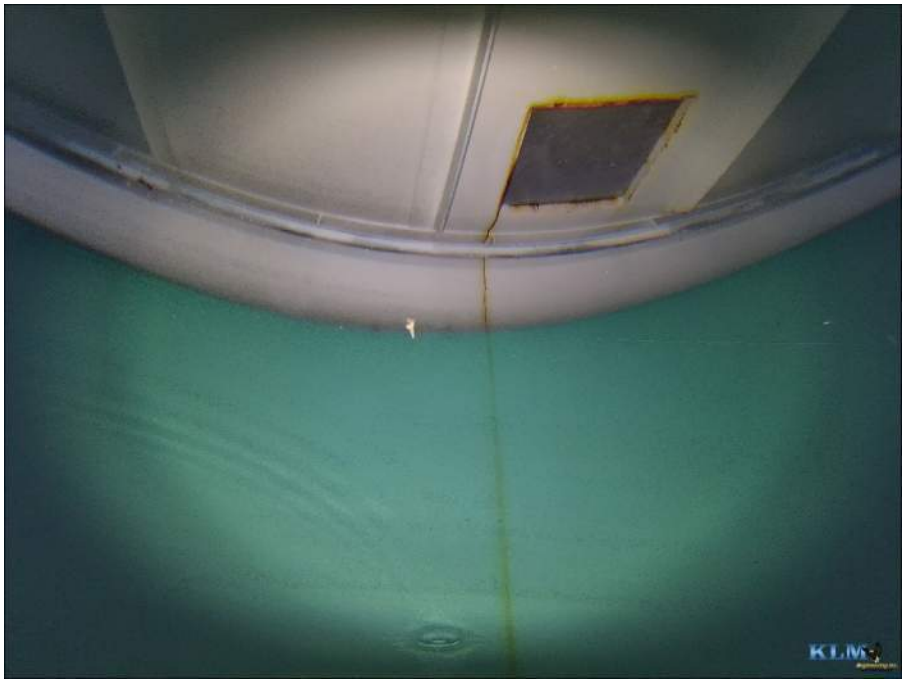

Photo No. 26
Coating failures around outer ventilation manway

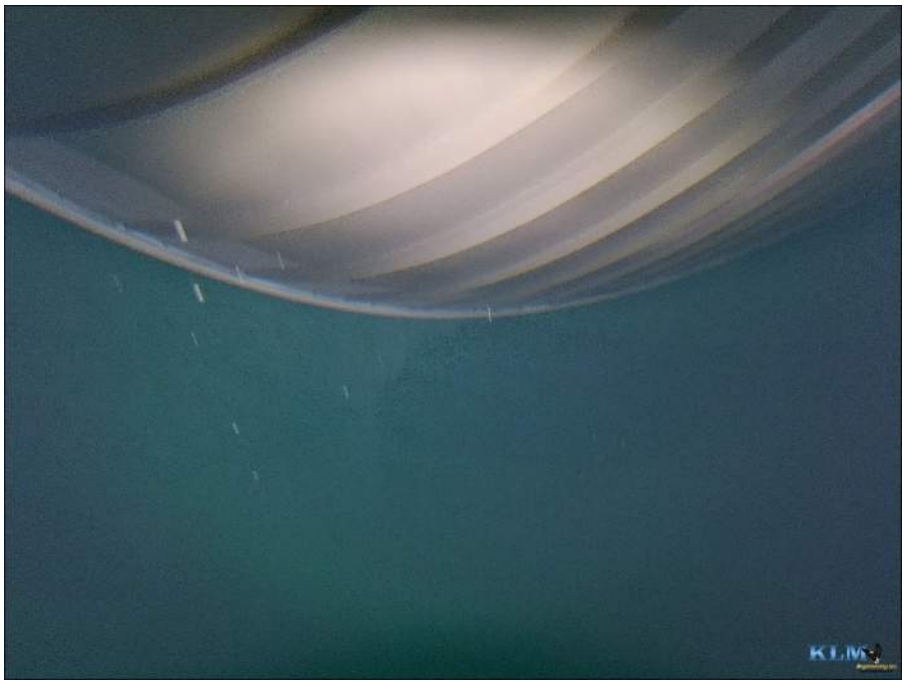

Photo No. 27
Typical roof condition

Photo No. 28
Conditions in drywell tube

Photo No. 29
Drywell tube

Photo No. 30
Overall condition of bowl

Photo No. 31
Bowl manway

Photo No. 32
Catwalk conditions

Photo No. 33
Catwalk conditions

Photo No. 34
Overall conditions of bowl and column

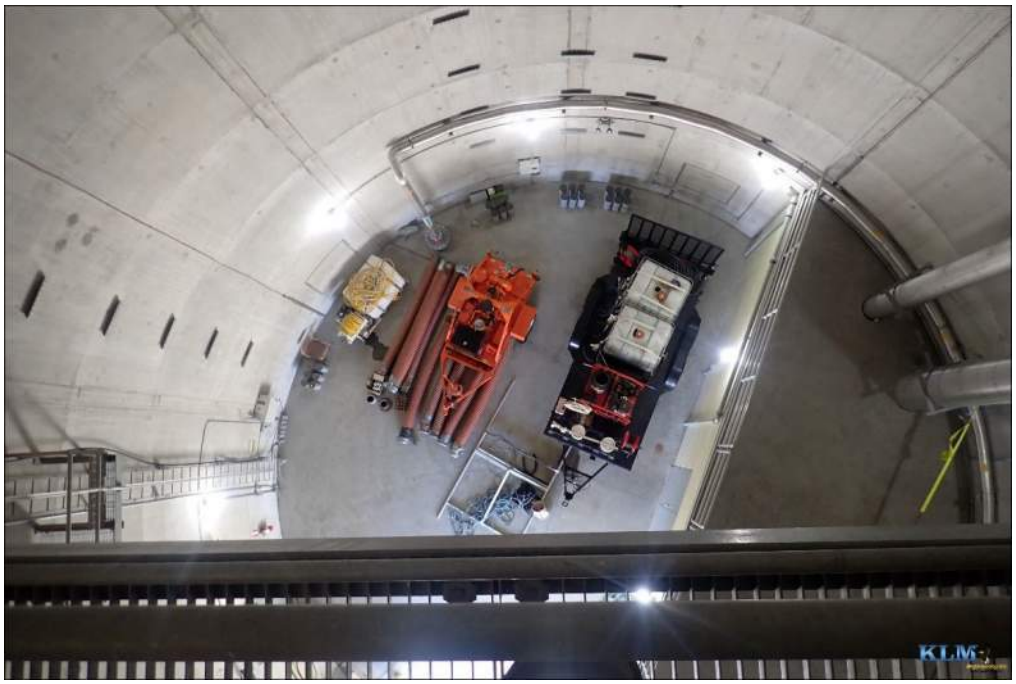

Photo No. 35
Overall conditions in base

Photo No. 36
Piping in base

Photo No. 37
Roof conditions
Note: finial vent and drywell tube manway

Photo No. 38
Conditions in wet access manway

Photo No. 39
Bolt connecting finial vent to manway collar

Photo No. 40
Bolts connecting finial vent to manway collar

Photo No. 41
Ventilation manway and roof conditions

Photo No. 42
Roof coating conditions

Photo No. 43
Roof coating conditions

Photo No. 44
Roof coating conditions

Photo No. 45
Typical shell and bowl conditions

Photo No. 46
Typical shell and bowl conditions

Photo No. 47
Concrete column

Photo No. 48
Concrete column

Photo No. 49
Overflow discharge

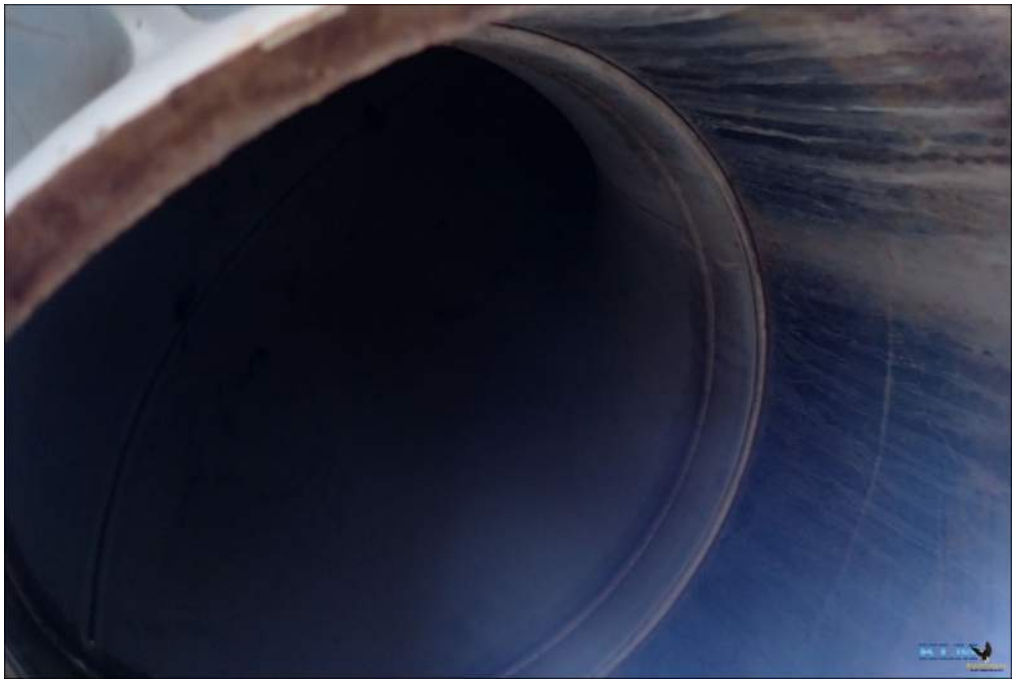

Photo No. 50
Inside overflow flapper

APPENDIX B

INSPECTION AND EVALUATION METHODS

1.0| INSPECTION AND EVALUATION METHODS

Some or all of the following procedures were performed as applicable.

1.1| Methods

1.1.1 The inspection of the base metal and coatings on interior and exterior surfaces included only areas accessible without scaffolding or special rigging. Where possible, the base metal and coating on the interior wet surfaces were examined from either a rubber raft while the tank was being drained, by a Remote Operated Vehicle (ROV) with the tower in service, or with both.

1.1.2 Tank plate thickness was measured at random locations on the liquid holding shell. The overall structural condition of the tank was visually examined.

1.1.3 No structural analysis was done to determine if the tank design complies with the AWWA D100-11 Standard for "Welded Carbon Steel Tanks for Water Storage." However, any observed non-conformance to the AWWA D100-11 standard is noted in this report.

1.1.4 Although compliance with OSHA regulations was not a part of this inspection, any unsafe conditions or violations of current OSHA regulation that were observed are noted in this report.

1.2| Examination and Evaluation Techniques

Some or all of the following procedures were performed as applicable.

1.2.1| Site

The tank site was evaluated for proper drainage conditions affecting access and lead paint abatement during reconditioning.

Also, the following site dimensions were obtained: distance to fence(s), power lines, owner buildings, public property, private property/buildings, school/playgrounds, public parks, and other property.

1.2.2| Foundations

The tank concrete foundation(s) were/was visually examined for cracks, spalling, conditions of grout, indications of distress/settlement, and elevation above grade.

1.2.3| Tank Plate Thickness

Plate thickness measurements were taken using ultrasonic methods (UTM). The readings were taken using a digital readout Elcometer MTG6 Ultrasonic Thickness Gage that has a dual element probe (transducer). The probe's transmitter element sends a short ultrasonic pulse through the material. The pulse gets reflected as an echo from the opposite side of the plate and returns to the probe's receiver element. The round-trip time is directly related to the material's thickness.

1.2.4| Coating Thickness

Interior and exterior coatings, where accessible, were tested in accordance with Steel Structures Painting Council SSPC-PA2-18 "Procedure for Determining Conformance to Dry Coating Thickness Requirements" using PosiTector-6000-F1 Type 2 gages.

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1.2.5| Coating Adhesion

Adhesion testing of the coating to the steel, and inner coat adhesion, was performed by ASTM D-3359: Shear Adhesion Test, Measuring Adhesion by Tape Test. In addition, subjective coating adhesion evaluation was performed using a penknife.

1.2.6| Coating Serviceability

The estimated remaining coating life or serviceability evaluation was performed using a wide variety of inspection instruments such as dry film thickness gauge, pen knife, Tooke gauge, adhesion tester(s), 30x microscope and serviceability evaluation experience (minimum experience 10 years).

The instrument inspection was combined with a close visual inspection of all accessible coatings. This was done to detect any holidays (misses), skips, runs, sags, surface containments, overspray, dry spray, poor coating cohesion, inter-coat delamination, loss of adhesion to the substrate, adverse conditions of the steel underneath the coating, or any other defects affecting the intended service.

1.2.7| Coating Lead and Chromium Content Analysis

Samples may have been taken of the various types of coatings present on the interior and exterior surfaces. GPI Laboratories, Inc. of Grand Rapids, Michigan tests these coatings in conformance with ASTM D-3335 Standard Test Methods for Concentrations of Lead and Chromium in Paint.

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