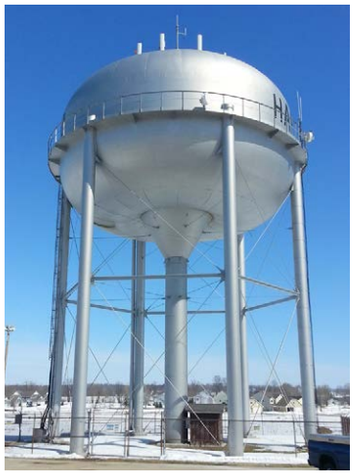

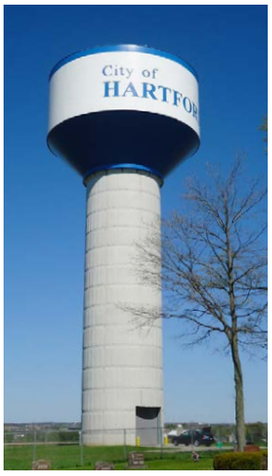

Water Utility Master Plan

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

November 2014

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WATER SYSTEM MASTER PLAN

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

NOVEMBER 2014

Prepared by:

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Consulting Engineers
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Delafield, Wisconsin

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A Glossary of Terms
B List of Abbreviations
C 2013 ISO Report
D Well Performance Data
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1.0 INTRODUCTION

The Hartford Water Utility completed a major master planning effort for the city's water system in December 2003. The 2003 Master Plan Report presented the results of a study into the adequacy of the existing water system to serve present and future water needs of the City of Hartford. Recommendations were presented in the 2003 report to maintain an adequate level of service to Utility customers over a planning period extending to the year 2023, and for long-term development of the Utility's ultimate service area. It was recommended that the 2003 Utility Master Plan be reviewed, re-evaluated, and modified, as appropriate, on a 10-year basis to assure the adequacy of future water system planning efforts and that future system improvements were constructed in a coordinated and economical manner.

The City of Hartford is a growing community of 14,300 persons located in western Washington County in southeastern Wisconsin. Hartford is about 40 miles northwest of Milwaukee, 40 miles south of Fond du Lac, and within six miles of USH 41, a major transportation corridor that connects the Milwaukee metropolitan area to the Fox Valley. Hartford Water Utility provides water service to residential, commercial and industrial customers within the city limits.

The Hartford water system delivers treated groundwater to its customers through a network of pumps, tanks and pipes. The existing facilities include five active water supply wells, one booster pumping station, an interzone transfer station, four elevated storage tanks, and two ground-level storage reservoirs with booster pumps. The water distribution system consists of approximately 100 miles of water main, ranging in size from 4 inches to 16 inches in diameter, and is divided into three pressure zones.

Hartford Utilities water customers include seven major industrial water users, along with smaller industrial and numerous commercial and residential users. Currently, about 47 percent of the total water sales are from residential users, 16 percent from commercial users, and 34 percent from industrial users. The seven major industrial customers make up almost 95 percent of the industrial water sales.

The proximity of Hartford to nearby major metropolitan areas and a principal transportation corridor creates the potential for significant growth and development. Planning is essential to coordinate the expansion of municipal water system facilities that meet the short-term and long-term needs of the community. The information contained in this report should be reviewed, re-evaluated, and modified, as necessary, to assure the adequacy of this report's recommended improvements and those of future planning efforts.

1.1 PURPOSE

This report presents the results of a water system planning study for the Hartford Water Utility. The primary purpose of the study was to update the 2003 Water System Master Plan, completed in December 2003, based on revised population and water consumption information. The objective was to evaluate new data, review current planning information, project future demand, and develop recommendations for system improvements necessary to maintain an adequate level of water service to the current and future Utility customers. This report will serve as a comprehensive plan to guide future expansion of the water system.

1.2 SCOPE

The 20-year planning period for this study extends to the year 2035. The scope of the study included the following activities:

- Service Area Planning
- Water Needs Analysis
- Hydraulic Model Update
- Deficiency Analysis
- Improvement Planning
- Study Reporting

The scope of the project is designed to achieve an estimate of future demands on the water system and a plan to meet the projected demands. Service area planning encompasses collecting and reviewing available sources of data and projections on population and development. Historical data on water use and pumpage was used in the water needs analysis portion of the study to define current and future water use characteristics and trends. The hydraulic model created in 2003 was updated to reflect changes in the system over the past decade. The updated model was used to identify existing system deficiencies and determine performance of recommended improvements. Improvement planning translates the data and analysis into a list of recommendations. This study report documents the development of the master plan for the Hartford water system.

1.3 BACKGROUND

The most recent water system master plan, titled *Water System Master Plan, Hartford, Wisconsin*, was completed and issued in December 2003. As part of the study, a computer model of the Hartford water system was updated to reflect changes to the system since 1994. Computer simulations were used to evaluate the condition and operational characteristics of the existing water system, and to analyze proposed future improvements. The deficiencies reported in the 2003 study included:

1. There were several locations in the distribution system where available fire flows are below the recommended minimum flows.
2. There were 20 hydrants served exclusively by 4-inch mains, in violation of the Wisconsin Administrative Code.
3. The Utility had inadequate reliable supply capacity to meet the maximum day demand in each pressure zone with the largest supply pump out of service.
4. The Utility had insufficient water storage capacity to meet current optimum storage requirements.

To address the above deficiencies the 2003 report included the following recommended improvements:

1. Distribution System Improvements
    a. Replace the remaining 3-inch and 4-inch diameter water mains with larger diameter piping.
    b. Replace older 6-inch diameter water mains along Union Street and Wisconsin Street that serve the industrial area north of Willow Brook Park.

   c. Continue the 12-inch diameter water main on Wilson Avenue south to the 16-inch diameter transmission main on Sumner Street, improving fire flows to the industrial areas north of Willow Brook Park.

2. Distribution System Expansion
   a. Construct transmission mains along major existing and future streets as development expands the service area.
3. Supply
   a. Construct two new wells to serve the Primary Pressure Zone, with a total additional capacity of 1,550 gpm.
   b. Construct two new wells to serve the Low Level Pressure Zone, with a total additional capacity of 1,950 gpm.
4. Storage
   a. Construct a 1.0 million gallon elevated tank in the Primary Pressure Zone within 5 years.
   b. At the time that the High Street Tower is abandoned, replace it with a 0.5 million gallon elevated tank or larger in the Low Level Pressure Zone.
   c. Confirm storage capacity needs with updated population and water demand data.
5. Interzone Transfer
   a. Install a third 750 gpm pump in the existing interzone transfer station on Airport Road, increasing its capacity to 1,500 gpm.
   b. Construct an additional 1,500 gpm interzone transfer station within 5 years.
6. Standby Power Generation
   a. Install a standby power generator at new Well 16 and the new interzone transfer station.
7. Water System Automation
   a. Replace the existing SCADA system with a new PLC-based system that allows complete monitoring and control of the entire water system from the Utility office.

1.4 REPORT ORGANIZATION

Population, community growth, and water consumption projections serve as the foundation for evaluating and identifying recommended improvements to the system. Chapter 2 discusses existing and expected future land uses and community growth. In Chapter 3, the current population and projected growth were used to develop current water consumption patterns and develop water demand projections. Chapter 4 is an overview of existing facilities in the Hartford water system. An evaluation of the water system, including identification of any deficiencies in system pressure and fire flows, is summarized in Chapter 5. A summary of recommended water system improvements is presented in Chapter 6. Chapter 7 completes the report with a recommended capital improvements plan.

2.0 POPULATION AND COMMUNITY GROWTH

This chapter summarizes the planning assumptions made regarding future service area characteristics for the City of Hartford Water Utility. To maintain consistency between individual planning efforts, the results of previous planning efforts were reviewed, and City planning representatives were consulted regarding changes experienced by Hartford since 2003.

Population projections and future service area for the Hartford Water Utility are defined in this section. These are based on information from the US Census Bureau, Wisconsin Department of Administration (WDOA), the Southeast Wisconsin Regional Planning Commission (SEWRPC), and the City of Hartford Planning and Zoning Department. The population estimates and projections are used in subsequent chapters to define current water use patterns and project future residential, commercial and public authority water consumption. The future service area boundary is used to plan future water system improvements.

2.1 POPULATION

There is generally a close relationship between a community's population and water consumption. Residential water sales generally correlate well with service area population. Similarly, commercial and public authority water consumption typically changes in proportion to population. Industrial water consumption is based on a variety of factors, making direct correlation to population unreliable; other methods are used to estimate future industrial demands. Current trends in the population of Hartford and similar nearby communities will help in projection future City growth.

Table 2-1 summarizes the historical and projected population estimates from the US Census Bureau and the WDOA up to the year 2035. Table 2-1 also shows average annual growth rates per period. Historical growth rates were discussed in the December 2003 report. The December 2003 report showed that the City of Hartford experienced an increased rate of population growth. Between 1970 and 1990, Hartford's population increased at an average annual growth rate of about 1 percent. In the 1990s, Hartford's population grew at a rate of about 3 percent per year. The December 2003 report mentioned that Hartford and Washington County as a whole were growing at a rate far exceeding the growth rate for the State of Wisconsin. The WDOA, however, has determined that the anticipated high growth rates would slow down, and WDOA now projects Hartford annual population growth rates between 0.7-1.9 percent over the next 20 years.

SEWRPC population growth rates were extrapolated from growth data for the entire region and then applied to Hartford population data. A comparison of population estimates is graphically illustrated in Table 2-1. Table 2-1 also shows that the WDOA projection is higher than the SEWRPC growth rate projections. In the December 2003 report, the SEWRPC High Growth rate was about 3 percent per year. After the most recent SEWRPC study, *A Regional Land Use Plan for Southeastern Wisconsin: 2035,* the projected growth rates in Washington County have been reduced. Furthermore, the application of region-wide growth to a single municipality with unique characteristics and variables is not a favorable means for forecasting population. Therefore population projections from WDOA will be used for this study, which is consistent with the population projections used by the City of Hartford Planning Commission.

TABLE 2-1

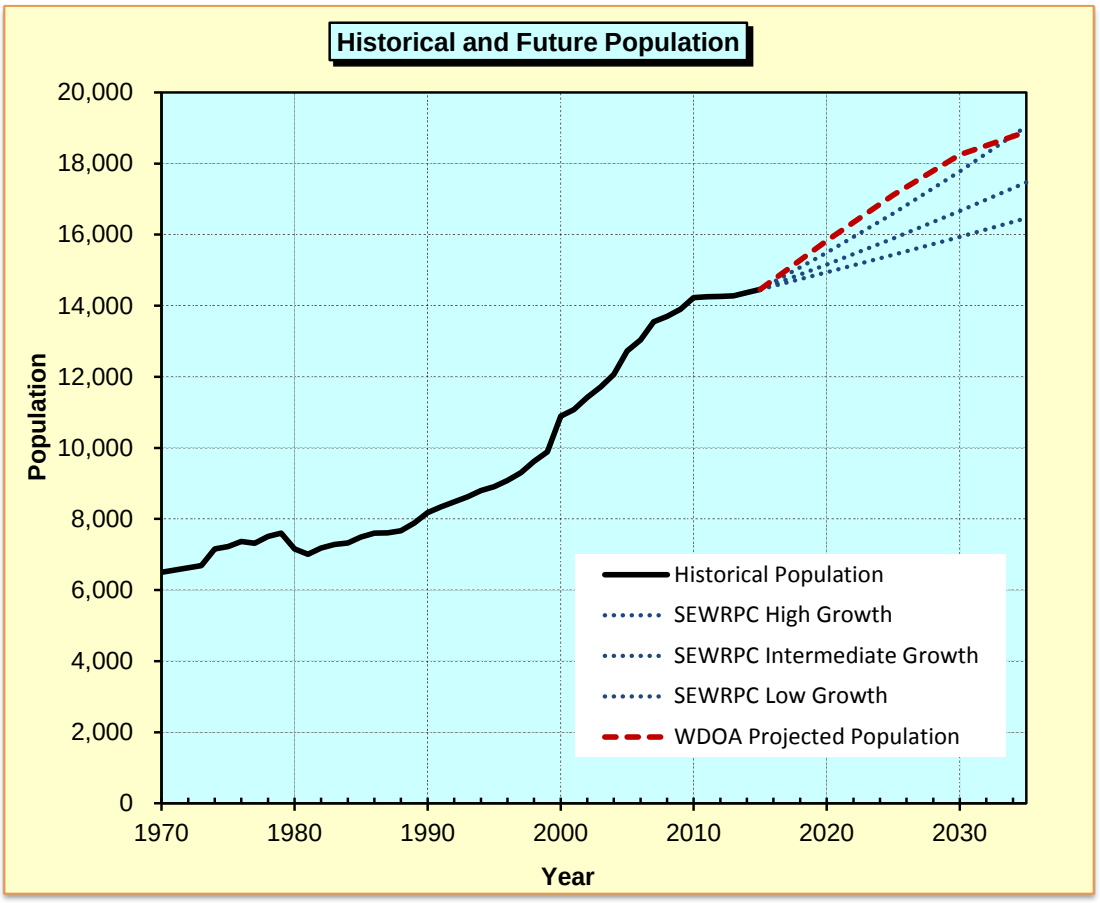
POPULATION TRENDS & PROJECTIONS

HARTFORD UTILITIES
CITY OF HARTFORD, WISCONSIN

Year	Total	Percent Change Per Year
1970	6,499	---
1980	7,159	1.0%
1990	8,179	1.4%
2000	10,895	3.3%
2005	12,728	3.4%
2010	14,223	2.3%
2015	**14,459**	**0.3%**
2020	**15,830**	**1.9%**
2025	**17,114**	**1.6%**
2030	**18,246**	**1.3%**
2035	**18,893**	**0.7%**

Notes

1. Historical City population figures taken from US Census data.
2. Year 2015 - 2035 City population projections based on WDOA data



2.2 EXISTING LAND USE

For this study, existing City land use data was reviewed. Figure 2-1 indicates the current City of Hartford Land Use Map provided from City GIS data. The 2009 Plan Commission Annual Report also provided land use information that was reviewed and used for this study.

In general, the City of Hartford largely consists of medium-density residential properties, a central commercial business district, several municipal buildings, and limited industrial sites adjacent to the Wisconsin & Southern Railroad tracks. Newer sections of the City are a well-planned mix of all forms of development. Commercial properties are primarily located along STH 60 and STH 83. Industrial facilities are mainly located in industrial parks in the western portion of the City that flank the Wisconsin & Southern Railroad tracks. New residential development, a mixture of single-, two- and multi-family housing, is interspersed with parks and open space in the remaining sections of Hartford.

The Adopted Land Use Map designates the planned land uses for all areas within the service area boundary, and is useful in identifying water system improvements through the 2035 planning year.

2.3 FUTURE COMMUNITY GROWTH

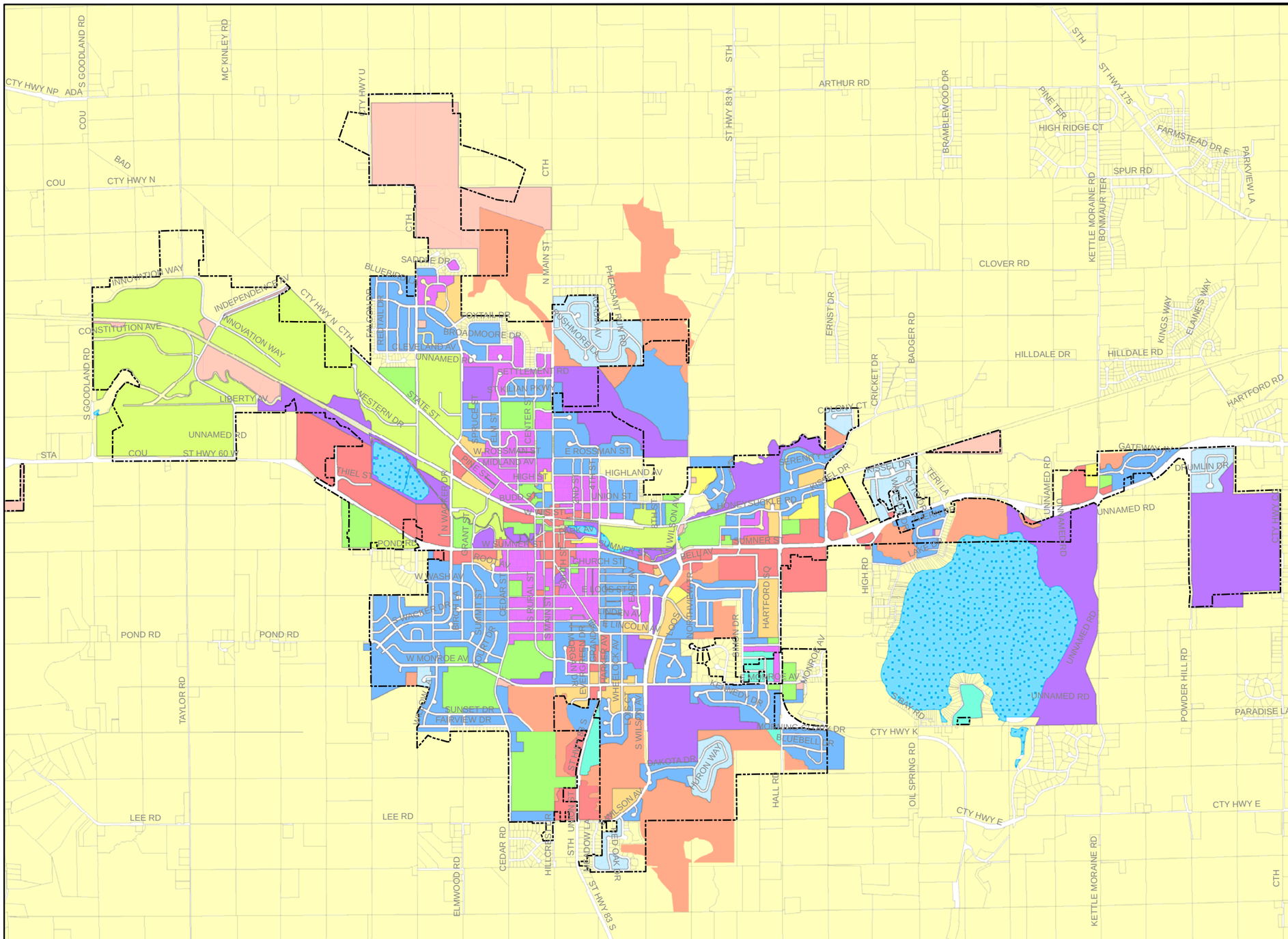
The projected growth patterns for Hartford vary considerably, depending on the assumptions used in the development of the various growth projections. Population projections are based on standard of living, lifestyle and economic conditions. Some estimates are consistent with recent development trends, and reflect the city's long-term land use planning goals and objectives.

The increase in water demand from residential, commercial and public customers is strongly related to population growth. Commercial development is planned to meet the needs of the population around it. An increase in public services typically follows increases in the residential population. Residential, commercial and public water sales are expected to increase proportionally with population.

Table 2-1 indicated shows the historical and projected populations of Hartford. The SEWRPC *Regional Land Use Plan* includes Intermediate- and High-Growth population projections for the Year 2035, updated in 2006. The plan identified that the local economy would be the primary factor of population, rather than historic birth, death, and migration rates. Long-term growth over the 20-year planning period of this study may ultimately be linked to regional economic activity. The growth rate before 2009 was 3.1 percent per year, and then declined to 0.9 percent per year after 2009.

SEWRPC developed three projections to identify the probable range of growth that will occur given unforeseen changes in social and economic conditions. SEWRPC considers the Intermediate-Growth projection, corresponding to an average annual growth rate of 1.0 percent, the most likely scenario for growth within the Hartford service area. According to SEWRPC, the High-Growth projection, corresponding to an average annual growth rate of 1.4 percent, represents the upper extreme of possible growth. The WDOA projected a growth rate of 2.0 percent per year, greater than the high growth rate of 1.4 percent per year by the SEWRPC. The growth rate of 2.0 percent projected by the WDOA was the growth rate used by the Hartford Planning Commission, and thus was used in this study.

The previous water system master plan was based on the high growth SEWRPC population projection from SEWRPC Report No. 45, *Year 2020 Regional Land Use Plan; A Regional Land Use Plan for Southeast Wisconsin: 2020.* That estimate projected a rapid growth rate of 3.1 percent through Year 2020. The SEWRPC high growth rate of 3.1 percent per year was actually quite accurate until the economic downturn in 2009. The projected and actual populations in Harford in 2009 were both approximately 14,000. The reason that this growth rate is no-longer expected is due to the impact of the



Legend

- CITY LIMITS
- AG SPECIAL
- COMMERCIAL
- CONSERVANCY
- HIGH DENSITY
- HIGH DENSITY 2
- INDUSTRIAL
- INSTITUTIONAL
- LOW DENSITY
- MEDIUM DENSITY
- MEDIUM DENSITY 2
- MEDIUM DENSITY 3
- PARK RECREATION
- RURAL AG PRES
- RURAL LOW DEN RES
- RURAL MED DEN RES
- RURAL VERY LOW DEN RES
- TRANSPORTATION
- WATER

0 2,150 4,300 Feet

Source: CIty GIS
Projection: Lambert_Conformal_Conic
Map by: SEH

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DATE: APRIL 2014

WATER SYSTEM EVALUATION
CITY OF HARTFORD, WISCONSIN

EXISTING LAND USE

FIGURE 2-1

economy. Continuing that trend, Hartford was projected to have approximately 16,000 people in 2012, when in reality there were approximately 15,000 people. For this study, the WDOA annual growth rate range of 0.7-1.9 percent is expected to continue through the end of the planning period in 2035.

Using the WDOA population projections, the projected Year 2025 and Year 2035 populations are approximately 17,100 and 18,900, respectively (the previous report projected a population of 21,800 by 2023). Table 2-1 summarized the projections with census data and WDOA population estimates from 1970 through 2035.

2.4 FUTURE LAND USE

As part of this study, a review of the City's 2030 Smart Growth Comprehensive Plan was conducted. The plan demonstrates the City's dedication to continued community planning for future growth and development needs. In general, projected growth patterns for Hartford are consistent with recent development trends, and reflect the City's long-term land use planning goals and objectives. The largest land use within the City is residential. At the end of 2009, 1,670 acres of the City's total 5,095 acres were used for residential purposes. Future anticipated land uses in and immediately around the City of Hartford are presented in Figure 2-2.

The 2009 Comprehensive Plan divided the land between various categories, with 2,200 acres designated to parks, conservancy, an airport, agriculture, right-of-ways, schools, and public buildings. For the purpose of this report, the 115 acres of institutional land and 120 acres of school land will be considered in the public authority land use estimate. There were 800 acres of industrial land in 2009.

The 2030 Smart Growth Comprehensive Plan provided projections for future growth for residential, commercial, and industrial land use through the year 2030, which can be found in Table 2-2.

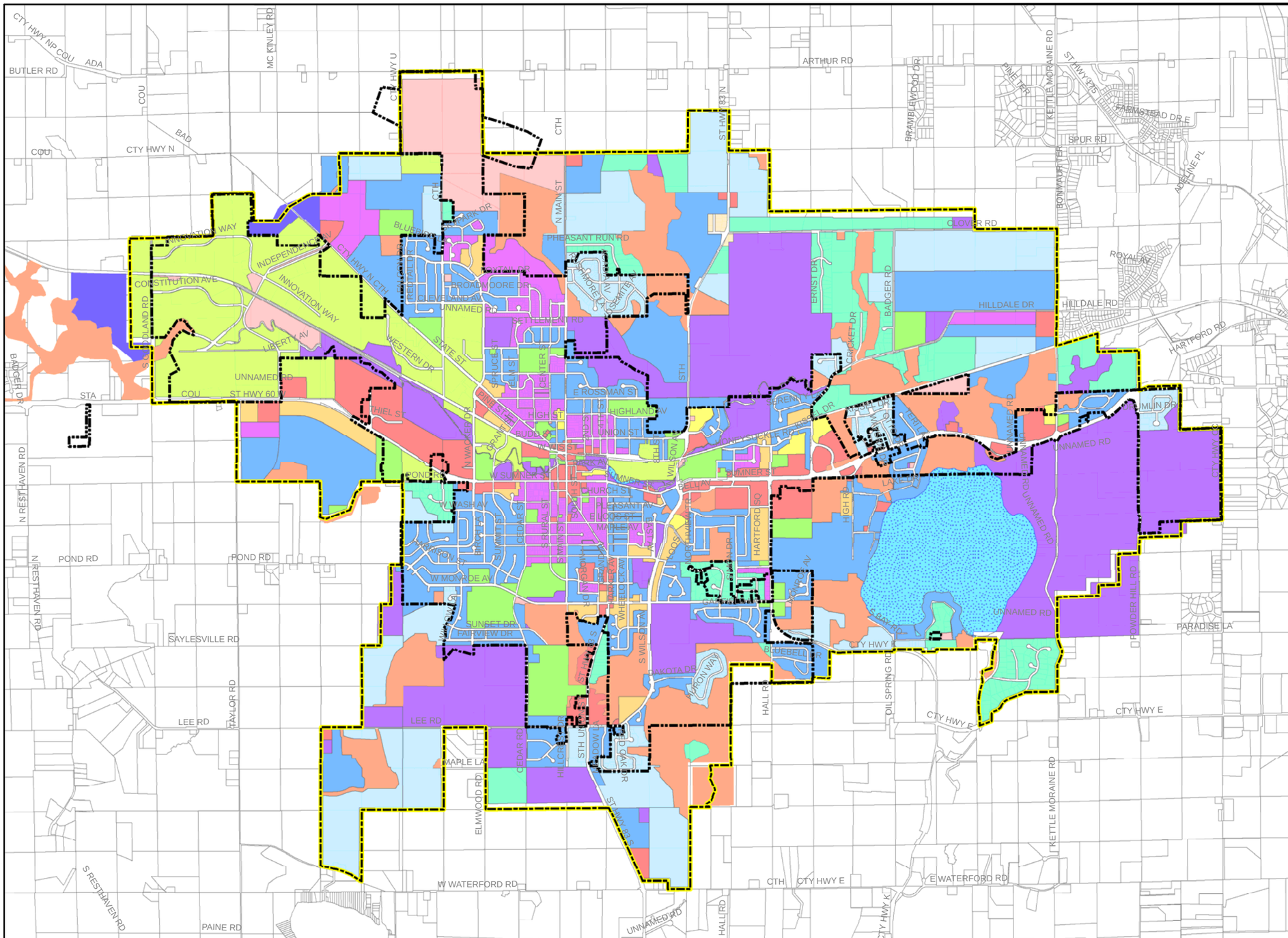
In an effort to project the smart growth plan data through the 2035 planning year, 2035 population data was used to make an estimate of 2035 land use needs. The result of this exercise is documented in Table 2-3. The results shown in this table are the land use growth estimates used in this evaluation through the end of the planning period.

2.5 FUTURE UTILITY SERVICE AREA

Figure 2-3 identifies the boundaries of the year 2035 City of Hartford water service area in addition to future land uses. The water service area is defined as the area in which the City of Hartford is anticipated to provide water service during the planning period. Future expansion is expected to occur as additional land is required to meet future land use growth.

The water service area is based on the 2020 sanitary service area defined in the *Regional Land Use Plan*. The centralized growth pattern, adopted in the *Regional Land Use Plan*, projects a population of 18,200 coinciding with the full build-out of the 2020 sanitary service area.

Development in Hartford is unlikely to occur in a centralized pattern where all vacant lands within the sanitary service boundary are fully developed before expanding beyond this boundary. Development that coincides with an increase in population to 18,900 will likely encompass a larger area than that of the 2020 sanitary service area and assumed 2035 water service area. Full build-out of available parcels generally occurs when expansion of service areas are no longer possible due to abutting service areas in all directions. Expansion of the Hartford service area is only limited on the eastern boundary, common with the Slinger sanitary service area. As a result, the possibility of expansion beyond the defined 2035 water service area is possible.



LEGEND

- EXISTING CITY LIMITS
- PROJECTED CITY LIMITS

FUTURE LAND USE

- AG SPECIAL
- COMMERCIAL
- CONSERVANCY
- HIGH DENSITY
- HIGH DENSITY 2
- INDUSTRIAL
- INSTITUTIONAL
- LOW DENSITY
- MEDIUM DENSITY
- MEDIUM DENSITY 2
- MEDIUM DENSITY 3
- PARK RECREATION
- RURAL AG PRES
- RURAL LOW DEN RES
- RURAL MED DEN RES
- RURAL VERY LOW DEN RES
- TRANSPORTATION
- WATER

0 2,000 4,000 Feet

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Source: City GIS
Projection: Lambert_Conformal_Conic
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DATE: APRIL 2014

WATER SYSTEM EVALUATION
CITY OF HARTFORD, WISCONSIN

FUTURE LAND USE

FIGURE 2-2

TABLE 2-2

SUMMARY OF MAJOR LAND USES

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Use	Current Acres	From Comprehensive Plan	
		Future Acres (2030)	Additional Acres Required
Residential	1,670	2,324	654
Public Authority	235	235	0
Commercial	210	320	110
Industrial	900	1,160	260

Source: City of Hartford Comprehensive Plan (2009) Chapter 8, Table 1

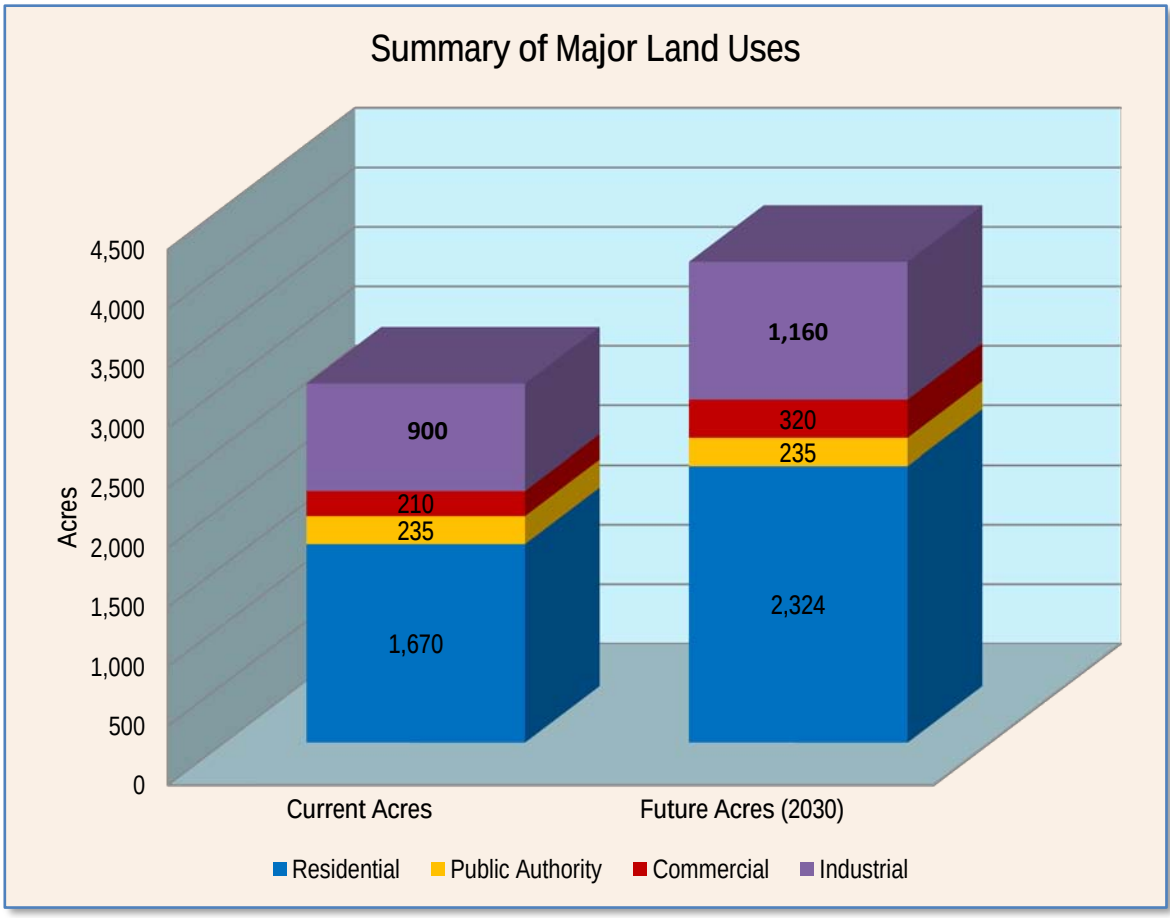


TABLE 2-3

SUMMARY OF MAJOR LAND USES BASED ON UPDATED POPULATION AND LAND USE PROJECTIONS

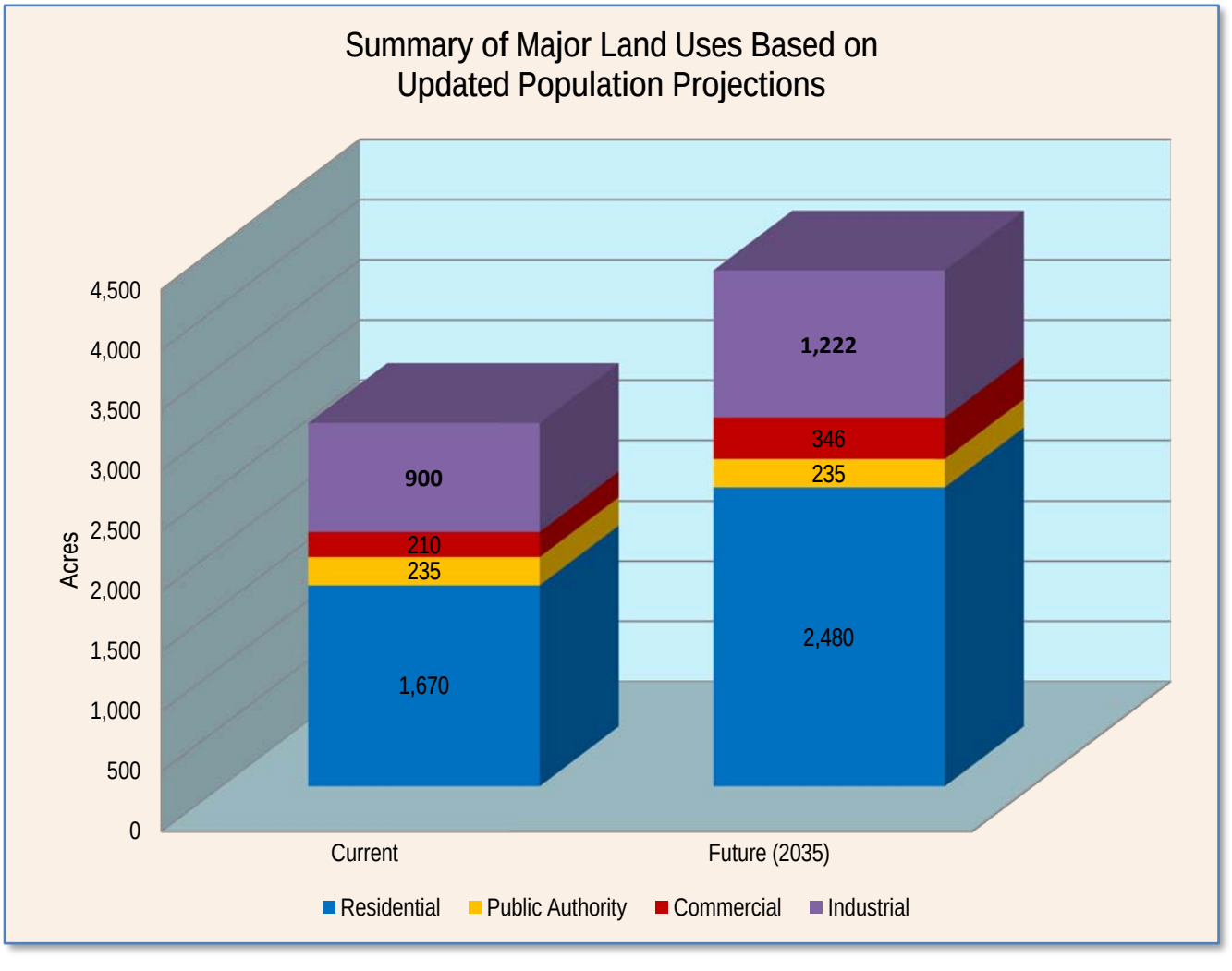
HARTFORD WATER UTILITY

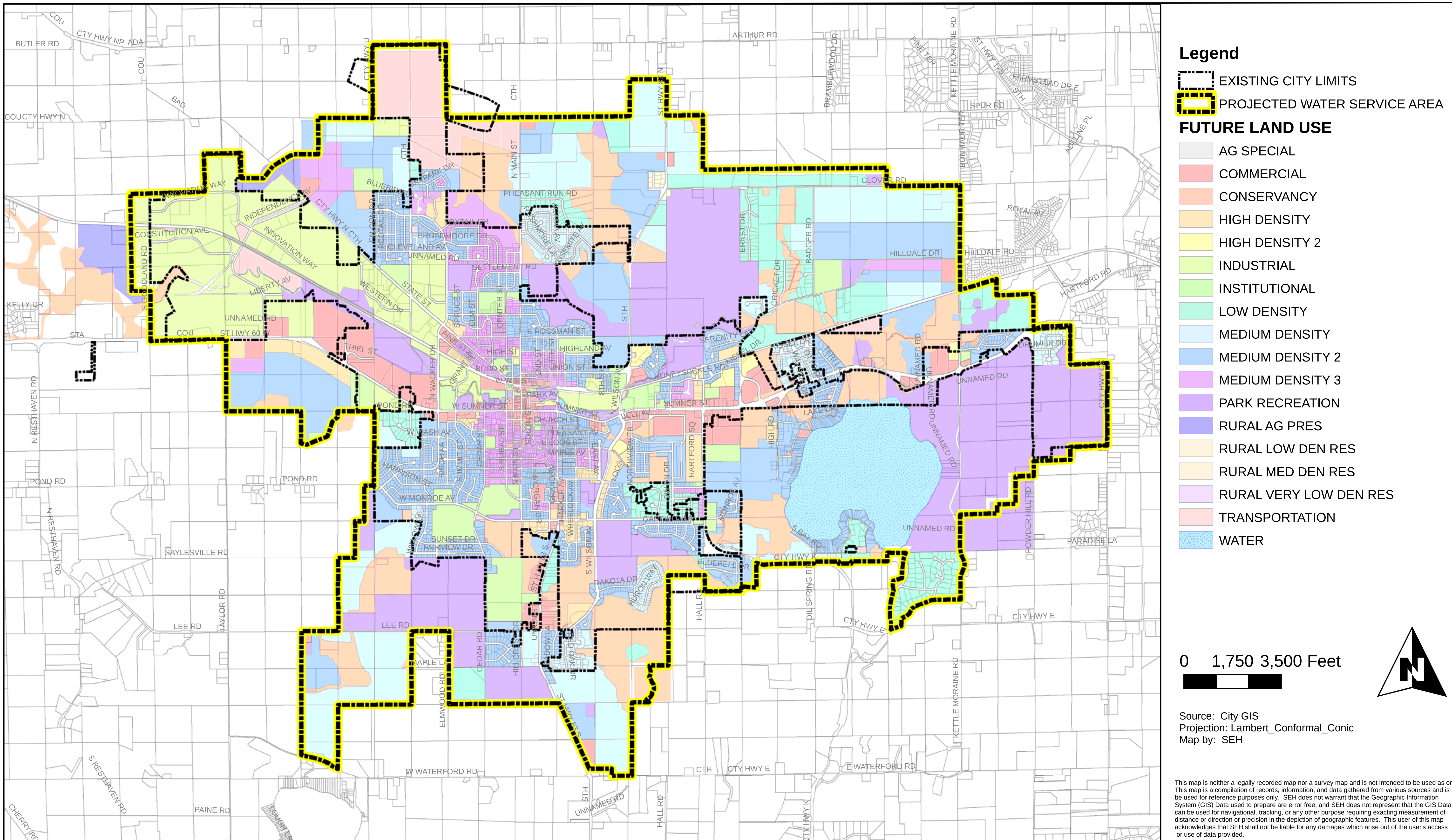
CITY OF HARTFORD, WISCONSIN

Use	Acres	
	Current	Future (2035)
Residential	1,670	2,480
Public Authority	235	235
Commercial	210	346
Industrial	900	1,222

Source: City of Hartford Existing and Future Land Use Mapping, City of Hartford Comprehensive Plan, and DOA

2035 Acres extrapolated from 2030 Smart Growth plan





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HARTU 123623

DATE:
APRIL 2014

WATER SYSTEM EVALUATION

CITY OF HARTFORD, WISCONSIN

FUTURE WATER SERVICE AREA

FIGURE 2-3

Map Document:P:\FJ\H\HARTU\123623\8-planning\GIS

Future service area expansion is projected to be primarily residential, and occur in the northern and northeastern areas of the City, with additional residential development in the southwestern parts of the City. The future service area boundary illustrated in Figure 2-3 identifies the area that is expected to develop over the next 20 years and require water utility service.

2.6 SUMMARY

This chapter summarized the primary assumptions regarding future growth of the City of Hartford urban service area. The present and future needs and characteristics of the identified service area will have a direct impact on the need for expansion of water system facilities. Therefore, the conclusions discussed in this chapter were used as a primary basis for projecting future water needs, evaluating the adequacy of existing water system facilities, and identifying needs for future water system expansion.

3.0 WATER REQUIREMENTS

Projections of customer demands serve as the basis for capital improvements planning. Several standard methods were used in this study to project water supply and storage needs based on estimates of population and community growth. This chapter summarizes the methodology used and the results of these projections.

3.1 WATER CONSUMPTION HISTORY

An analysis was made of past water consumption characteristics by reviewing annual pumpage and water sales records for the period from 1992 to 2013. Average and maximum day water consumption during this period, together with the amount of water sold in each customer category, has been analyzed. Projections of future water requirements are based on the results of this analysis coupled with estimates of population and community growth discussed in Chapter 2.

A summary of historical water sales and pumpage is provided in Table 3-1. Over the 22 year period of data summarized in the table, water sales varied from a low of 392 million gallons per year (MGY) in 1997 to a high of 524 MGY in 2007. Over the past decade, overall water sales have been relatively stable, averaging 479 MGY over the past 5 years.

Water sales and pumpage trends are graphically illustrated in Figure 3-1. Hartford Water Utility's daily pumpage averaged approximately 1.3 million gallons per day (mgd) between 1988 and 1996, and then experienced an increase from 1.3 mgd to 1.7 mgd between 1997 and 2003. Total pumpage has declined over the past 10 years. Figure 3-1 shows a plateau in residential sales and a slight decline in commercial sales after 2003. Water loss rates were as high as 20 percent before 1993, and have declined to approximately 10 percent by 2013. In 2013, the Water Utility's average day pumpage was 1.4 mgd.

Current residential consumption accounts for 49 percent of the total sales, an increase from 45 percent in 2003. Sales to commercial customers over the past 10 years have decreased slightly from 20 percent of total water sales to 15 percent in 2013. However over the same period, industrial water sales increased as a percentage of total sales from 31 percent in 2003 to 33 percent in 2013. Public uses represent a small percentage of total pumpage. Non-revenue water consumption (losses, unmetered and unaccounted-for water) includes estimated water volumes used in hydrant flushing, losses due to main breaks, losses from general system leakage, and errors in metering the volume of water sold and pumped. Hartford's total non-revenue water has averaged approximately 10 percent of total pumpage over the past 5 years.

3.2 WATER SERVICE CONNECTION HISTORY

The City of Hartford currently has approximately 5,240 customers. Of those customers, 90 percent are classified as residential and 8 percent are commercial users. A historical summary of the number of Utility customers from 1991 through 2013 is provided in Table 3-2. The number of residential and commercial connections over this period has increased steadily. The Utility has served an average of about 60 industrial and 42 public authority customers over the past 5 years.

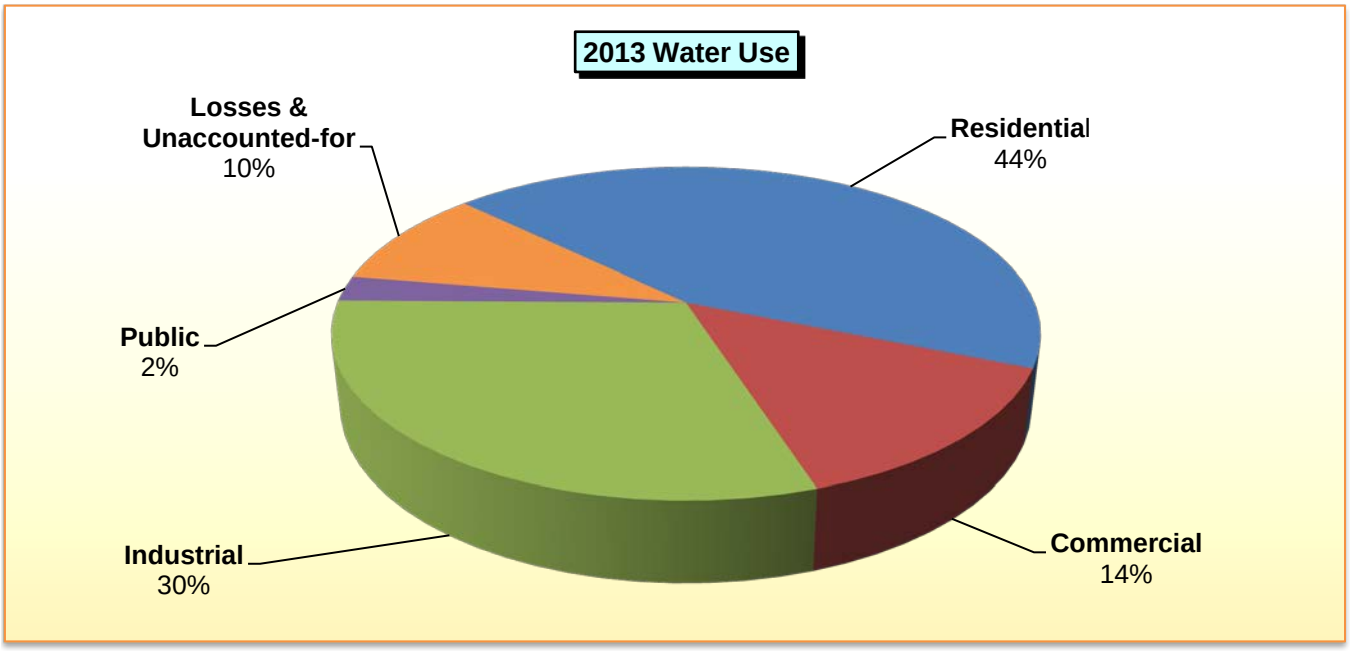
TABLE 3-1

WATER SALES AND PUMPAGE HISTORY

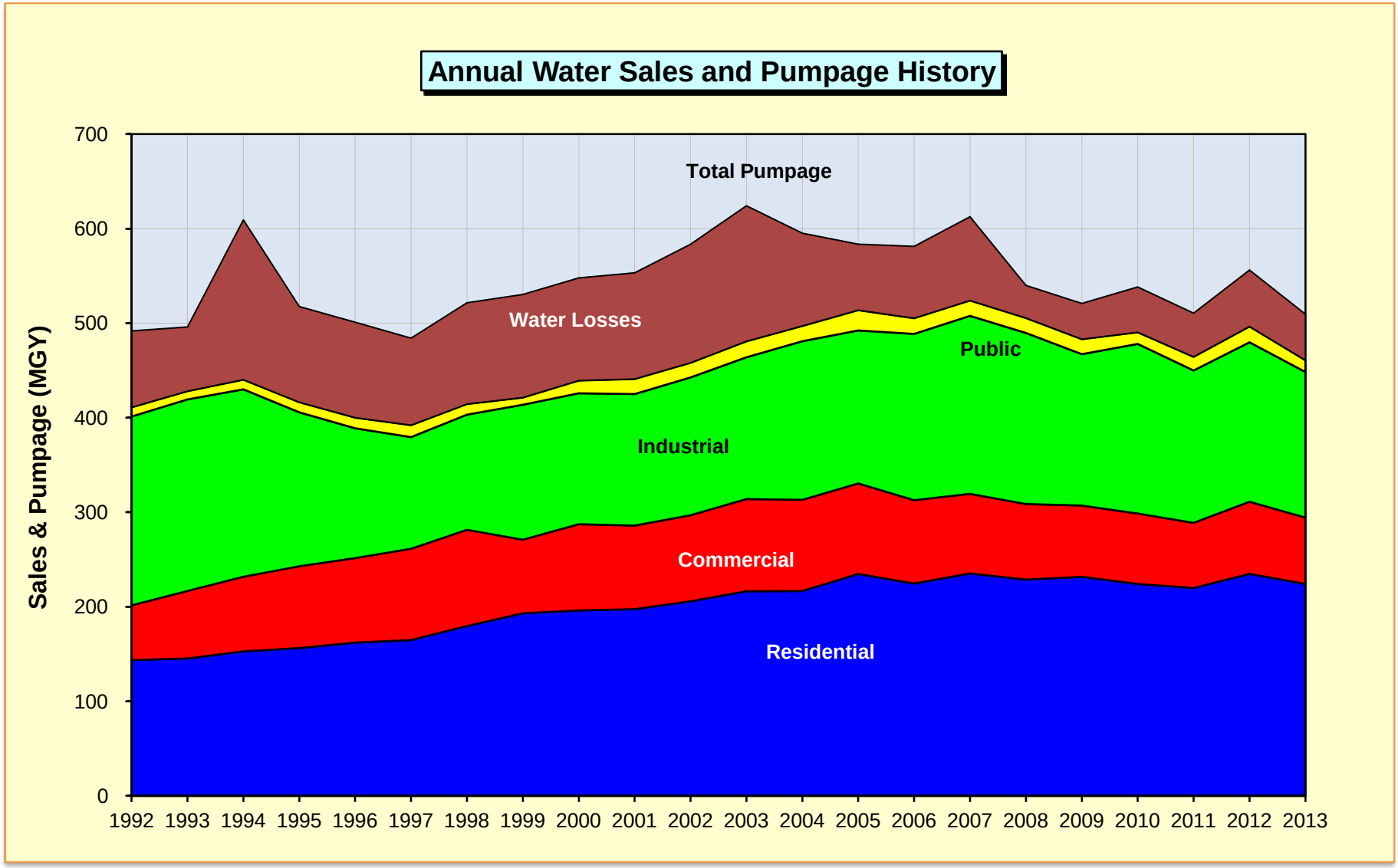
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Year	Annual Water Sales (MGY) Resi-dential	Com-mercial	Indust-rial	Public	Total Sales [MGY]	Total Pumpage [MGY]	Losses & Unnaccounted [MGY]	% Pumpage Metered
1992	144	58	200	10	411	492	81	84%
1993	145	71	203	9	428	496	68	86%
1994	153	79	198	10	440	609	169	72%
1995	156	87	163	11	416	518	101	80%
1996	162	89	137	11	400	501	101	80%
1997	165	97	118	13	392	484	92	81%
1998	180	102	122	11	414	522	107	79%
1999	193	78	143	8	421	530	109	79%
2000	196	91	138	13	439	548	109	80%
2001	198	88	139	16	441	553	112	80%
2002	206	91	146	15	458	584	125	79%
2003	216	98	150	17	481	624	143	77%
2004	217	96	168	16	497	595	98	84%
2005	235	96	162	21	514	584	70	88%
2006	225	88	176	17	505	581	76	87%
2007	235	84	188	16	524	613	89	86%
2008	229	80	181	16	505	540	34	94%
2009	232	75	160	16	483	521	38	93%
2010	224	75	179	12	490	538	48	91%
2011	220	69	161	14	464	511	46	91%
2012	235	76	169	17	496	556	60	89%
2013	224	70	154	12	461	510	49	90%

Maximum Value =



C:\Users\pplanton\Documents\My Documents December 2014\Projects\F-J\Hartford\Water Master Plan\Tables & Figures\Chapter 3\[Tables 3-x.xlsx]Table 3-1



Short Elliott Hendrickson

FIGURE 3-1

HISTORICAL WATER CONSUMPTION

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

February 2014

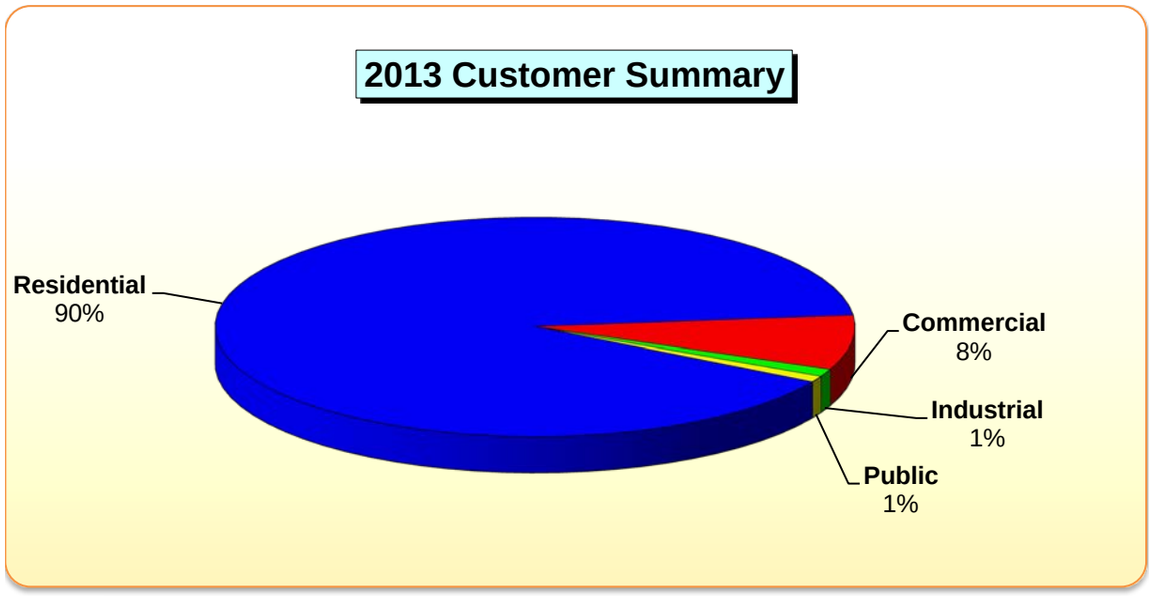
HARTU 123632

TABLE 3-2

HISTORICAL CUSTOMER SUMMARY
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Year	Number of Customer Connections				
	Residential	Commercial	Industrial	Public	Total
1991	2,323	262	39	28	2,652
1992	2,346	282	55	27	2,710
1993	2,404	302	42	29	2,777
1994	2,456	309	42	30	2,837
1995	2,502	341	43	29	2,915
1996	2,585	336	46	29	2,996
1997	2,702	350	44	29	3,125
1998	2,883	359	44	28	3,314
1999	3,097	361	56	27	3,541
2000	3,241	370	51	30	3,692
2001	3,332	390	51	28	3,801
2002	3,464	386	52	29	3,931
2003	3,632	384	55	27	4,098
2004	3,870	386	57	29	4,342
2005	4,112	394	58	30	4,594
2006	4,298	401	62	32	4,793
2007	4,483	429	64	35	5,011
2008	4,596	440	64	37	5,137
2009	4,651	430	63	38	5,182
2010	4,691	442	60	38	5,231
2011	4,707	459	60	38	5,264
2012	4,746	445	59	47	5,297
2013	4,716	418	58	47	5,239

Maximum Value =



C:\Users\pplanton\Documents\My Documents December 2013\Projects\F-J\Hartford\Water Master Plan\Tables & Figures\Chapter 3\[Tables 3-x.xlsx]Table 3-2

3.3 PER CAPITA WATER USAGE

Residential, commercial, and public water usage is often proportional, and therefore correlated with a community's population. An analysis of per capita water consumption for the Hartford Water Utility for each of these customer classifications was made from the available sales records and is summarized in Table 3-3. Figure 3-2 illustrates the results of this analysis. As shown in Figure 3-2, residential per capita consumption has been relatively stable over the past 25 years, typically ranging between 45 and 50 gallons per capita per day (gpcd). However, per capita commercial customer consumption as had a steady decrease over the past decade, declining from a high of 29 gpcd in 1998 and stabilizing around 15 gpcd over the past 5 years.

To project future water needs, average daily water usage for residential customers in the Hartford Water Utility planning area was projected to be 47 gpcd throughout the 20 year planning period. For this study, it was projected that future per capita commercial consumption will average 15 gpcd. Since 1992, per capita public sales have averaged approximately 3 gpcd. For this study, it was projected that future per capita public consumption will remain at 3 gpcd.

3.4 INDUSTRIAL WATER USAGE

Industrial water consumption can vary widely on an annual basis depending on the types of industries served and the annual level of production activity. Fluctuations in water consumption for a particular industrial firm can be attributed to several factors including:

1. Changes in production schedules or operational capacity
1. Changes in manufacturing processes
2. Changes in the number of persons employed
3. Additions or deletions of product lines
4. Seasonal changes in business activity
5. Implementation of conservation measures

Table 3-4 summarizes annual water sales to the Utility's major industrial customers from 2008 through 2013. Table 3-4 graphically illustrates the water sales breakdown by the major industrial customers. The top seven high volume industrial water users consumed about 95 percent of the total 2013 industrial water sales. Consequently, any significant change in water consumption characteristics by these high volume users will have an impact on total water requirements. Projected water usage for the seven high-volume industrial users are individually investigated in a later portion of this section.

3.5 LOSSES AND UNACCOUNTED-FOR WATER

As listed in Table 3-1 and illustrated in Figure 3-1, the total volume of water sold is less than the total volume of water pumped into the water distribution system. The water not metered for sale is often termed "unaccounted-for" water. The amount of unaccounted-for water is often used as an indication of the condition of the water system and is usually expressed as a percentage. When a distribution system is very old or poorly maintained, the percentage of unaccounted-for water often increases dramatically.

Factors contributing to unaccounted-for water include:

1. Unmetered water usage for maintenance purposes such as hydrant flushing and water main repairs

TABLE 3-3

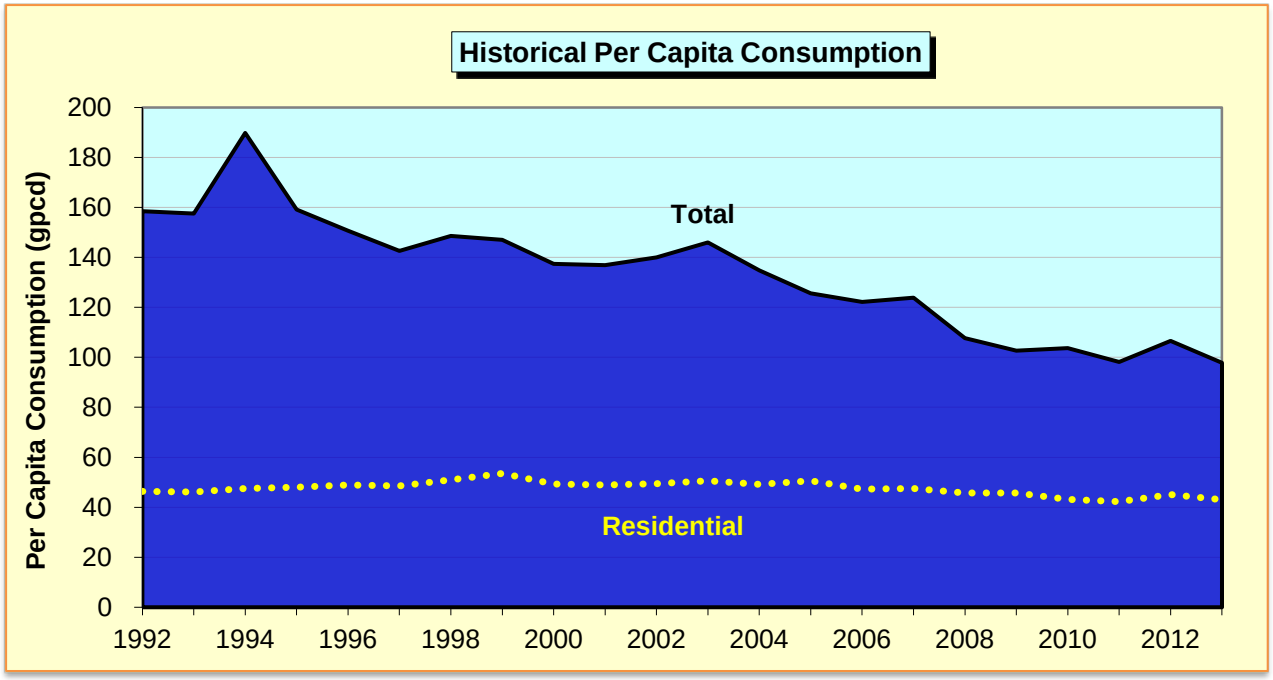
HISTORICAL PER CAPITA USAGE

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Year	Estimated Population	GALLONS PER CAPITA PER DAY					
		Resi-dential	Com-mercial	Public	Industrial	Total Metered	Total Pumpage
1992	8,480	46	19	3	65	133	158
1993	8,626	46	23	3	64	136	158
1994	8,795	47	25	3	62	137	190
1995	8,911	48	27	3	50	128	159
1996	9,086	49	27	3	41	121	151
1997	9,303	49	28	4	35	115	143
1998	9,618	51	29	3	35	118	149
1999	9,884	54	22	2	40	117	147
2000	10,895	49	23	3	35	110	137
2001	11,073	49	22	4	34	109	137
2002	11,420	49	22	4	35	110	140
2003	11,715	51	23	4	35	112	146
2004	12,064	49	22	4	38	113	135
2005	12,728	51	21	5	35	111	126
2006	13,035	47	19	3	37	106	122
2007	13,550	48	17	3	38	106	124
2008	13,700	46	16	3	36	101	108
2009	13,900	46	15	3	32	95	103
2010	14,223	43	14	2	35	94	104
2011	14,253	42	13	3	31	89	98
2012	14,258	45	15	3	32	95	107
2013	14,274	43	13	2	30	88	98

Maximum Value =



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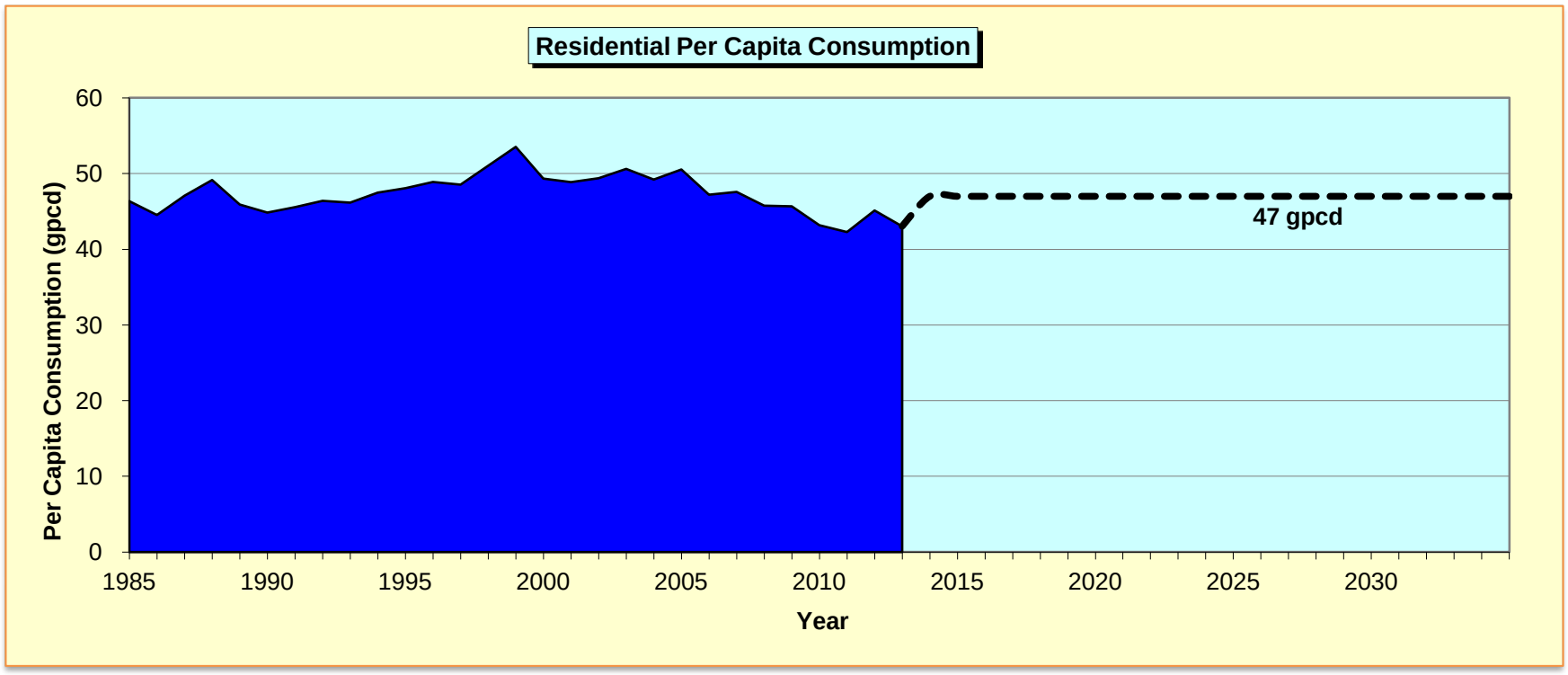

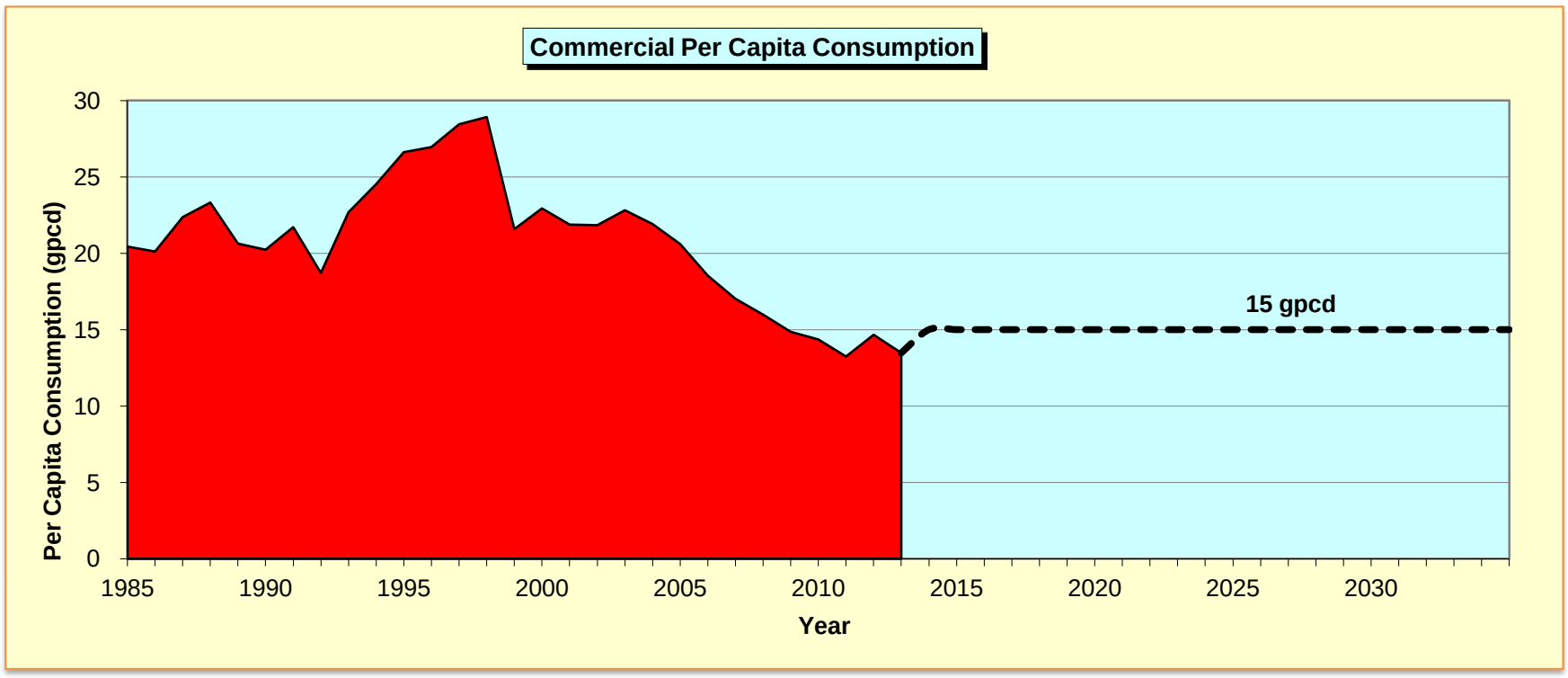

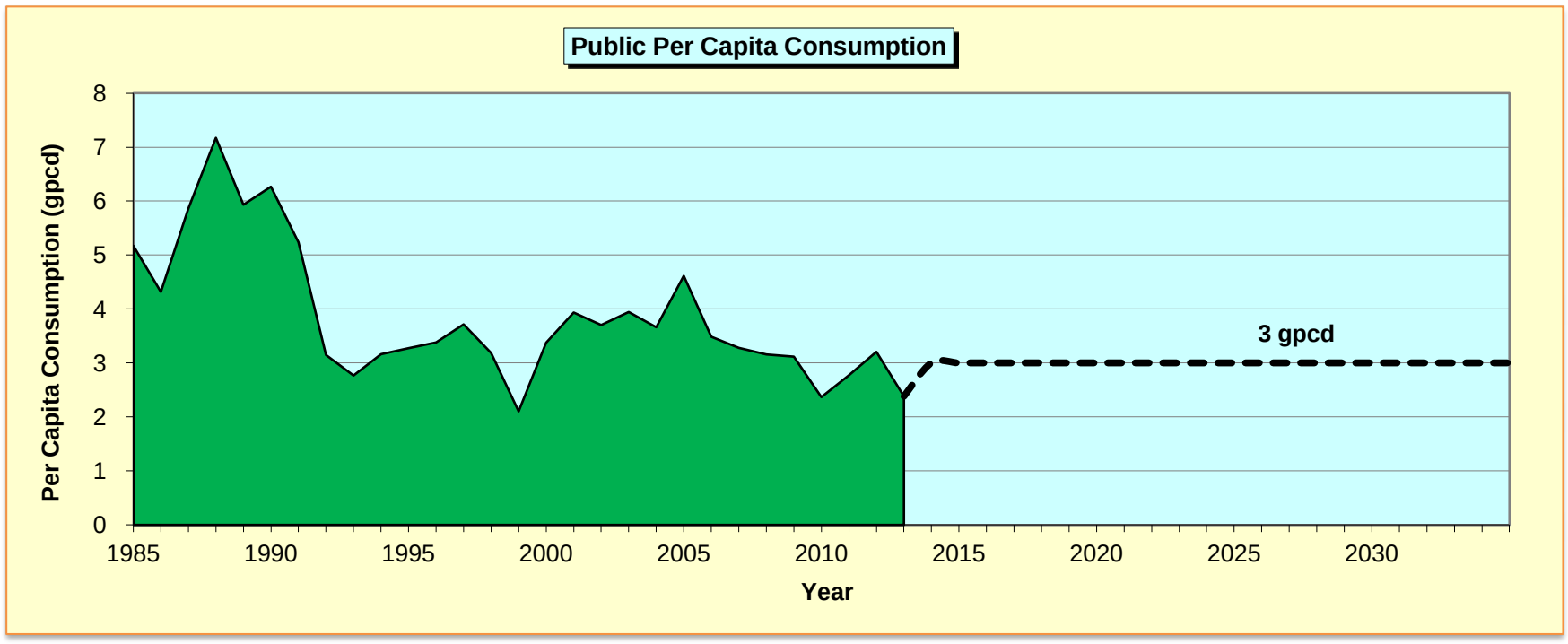

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FIGURE 3-2
HISTORICAL PER CAPITA WATER CONSUMPTION
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

February 2014 HARTU 123623

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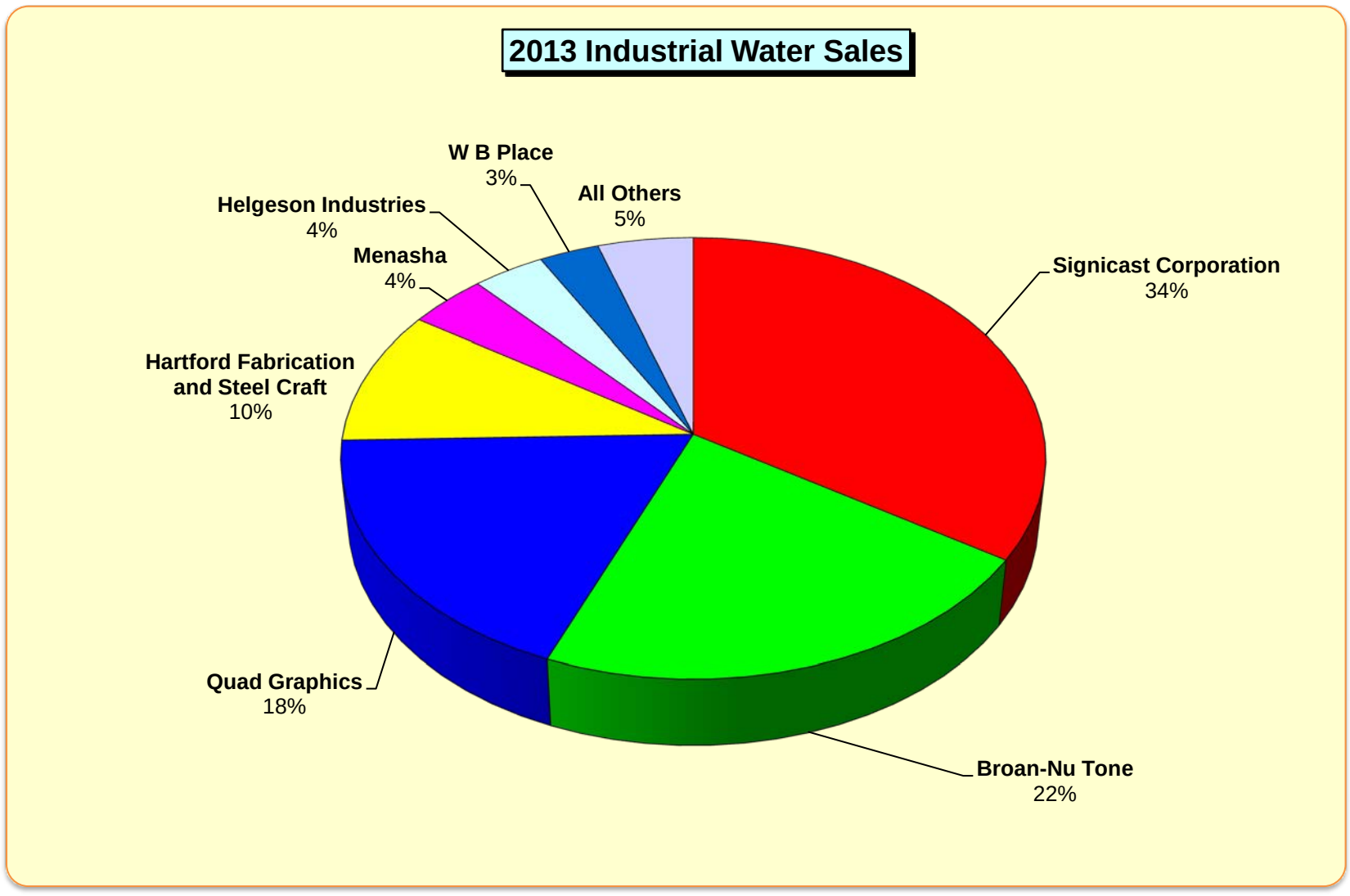
TABLE 3-4

SUMMARY OF LARGEST CUSTOMERS

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

2013 Rank	High Volume Customer	Customer Classification	*MAJOR CUSTOMER CONSUMPTION (MGY)*					
			2008	**2009**	**2010**	**2011**	**2012**	**2013**
1	Signicast Corporation	Industrial	46.4	44.2	43.3	45.1	49.3	52.6
2	Broan-Nu Tone	Industrial	42.4	38.5	51.5	45.0	40.7	33.8
3	Quad Graphics	Industrial	23.9	24.9	28.0	29.9	34.7	28.4
4	Hartford Fabrication and Steel Craft	Industrial	7.5	6.8	10.8	13.6	14.8	15.1
5	Menasha	Industrial	9.3	7.6	6.8	7.5	7.4	6.2
6	Hartford Union High School	Public Authority	8.8	8.6	5.9	8.0	9.7	5.8
7	Helgeson Industries	Industrial	4.7	4.0	5.2	6.0	5.5	5.7
8	W B Place	Industrial	28.3	27.1	27.7	6.1	7.0	4.7
9	Hospital	Commerical	6.9	6.0	6.7	4.6	4.1	3.9
10	API Heath Care	Commerical	---	1.0	2.0	3.0	4.0	1.6
	TOTAL		**178.1**	**168.8**	**187.9**	**168.9**	**177.2**	**157.8**
	High Volume Sales Percent of Total Sales		**35%**	**35%**	**38%**	**36%**	**36%**	**34%**
	Top High Volume Industrial Customer Sales		162.0	154.2	172.4	153.8	161.8	146.5
	Sales to Remaining Industrial Customers		18.5	7.0	6.1	7.8	9.2	7.5
	Industrial High Volume Percent of Total Industrial Sales		90%	96%	97%	95%	95%	95%



2. Unmetered water usage for fire fighting
3. Inaccuracies in water metering devices
4. Unaccounted-for public water usage
5. Leakage within the distribution system

Table 3-1 summarized water sales, total pumpage, water sales as a percentage of total pumpage, and losses and unaccounted-for water from 1992 to 2013. During this time period, losses and unaccounted-for water was as low as 6 percent and as high as 28 percent of total pumpage. The high percentage reported in 1994 was attributed to a major water main leak that went undetected for an extended period of time (leaking water discharged through City's storm sewer system).

From 2004 to 2013, total non-revenue water (losses and unmetered uses) decreased from an average of 20 percent in the 1990s to approximately 10 percent over the past 10 years. As a general rule, the percentage of total pumpage metered should be maintained above 90 percent, which would correspond to total non-revenue water amounting to less than 10 percent. For planning purposes, the future percentage of losses and unaccounted-for water is assumed to be 10 percent.

3.6 VARIATIONS IN CUSTOMER DEMANDS AND PUMPAGE

Seasonal fluctuations in water usage are important factors in the design and sizing of water supply and storage facilities. The seasonal nature of water consumption in the City of Hartford can be demonstrated by an analysis of monthly pumpage variations. The Utility's monthly pumpage variations in 2013 are presented in Table 3-5. In 2013, the maximum monthly pumpage occurred in August, while the minimum monthly pumpage occurred in November.

Maximum daily water demands usually occur during the summer months on hot days when additional water is used for watering lawns, gardening, bathing, and industrial cooling. The maximum day demand is defined as the amount of water pumped during a single day of the year with the highest water usage, and is often expressed as a ratio of the annual average day pumpage. The maximum day pumpage is of particular importance to water system planning, because water supply facilities are sized to meet this demand.

Table 3-6 presents the average and maximum day pumpage for each year from 1992 to 2013. The maximum day pumpage usually occurs during June, July, or August. The minimum day pumpage typically occurs during winter or early spring. Over the last 22 years, the maximum day pumpage ratio (ratio of maximum to average day pumpage) has varied from a low of approximately 142 percent in 2011 and 2013 to a high of 308 percent in 1999.

To gain a better understanding of expected fluctuations in customer demands for the Hartford Water Utility, a statistical analysis was performed of historical maximum day pumpage ratios. Table 3-7 summarizes the results of this analysis. Two periods of analysis were examined; the entire period of 1992 to 2013, and the latest 10 year period from 2004 to 2013.

For the years 1992 to 2013, the average maximum day demand ratio was 175 percent, with a standard deviation of 43 percent. In comparison, over the period of 2004 to 2013, the average ratio was 156 percent, with a standard deviation of 14 percent. For this study, it was projected that future demand variations will resemble the variations observed over the most recent 10 year period.

TABLE 3-5

SEASONAL PUMPAGE VARIATIONS
HARTFORD UTILITIES
CITY OF HARTFORD, WISCONSIN

Month	2013 Monthly Pumpage (MG)	Percentage of Annual Total Pumpage	Percentage of Monthly Average Pumpage
January	39.7	7.8%	94%
February	34.0	6.7%	80%
March	39.9	7.8%	94%
April	40.5	7.9%	95%
May	47.3	9.3%	111%
June	44.2	8.7%	104%
July	47.7	9.4%	112%
August	52.3	10.3%	123%
September	44.0	8.6%	104%
October	42.4	8.3%	100%
November	38.0	7.5%	90%
December	39.6	7.8%	93%
Total	**509.6**	**100%**	

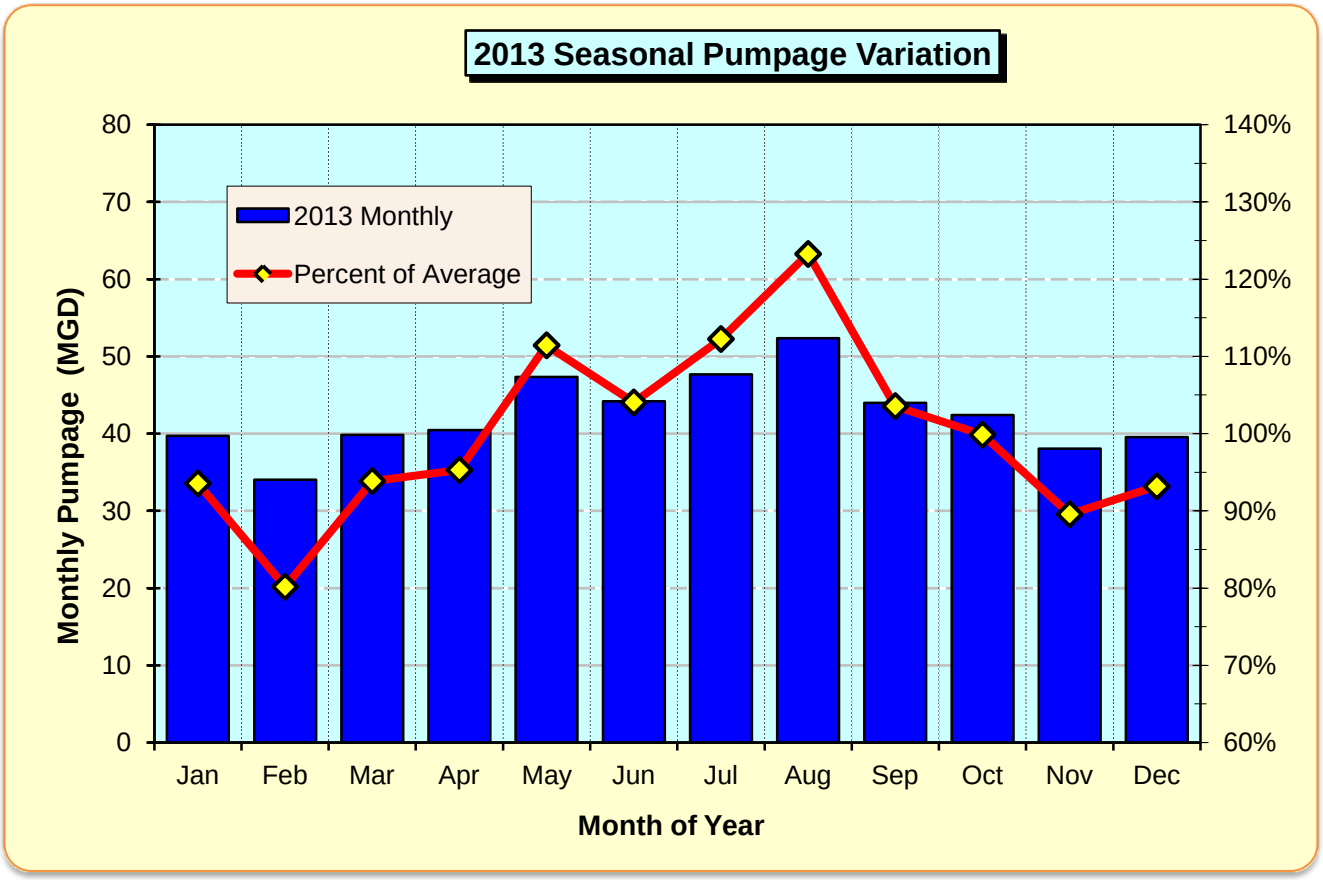


TABLE 3-6

DAILY PUMPAGE VARIATIONS

HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Year	Avg. Day Pumpage (MGD)	Min. Day Pumpage (MGD)	Minimum Day (Date)	Max. Day Pumpage (MGD)	Maximum Day (Date)	Ratio of Min. to Avg. Day	Ratio of Max. to Avg. Day
1992	1.34	0.54	12/25	2.01	10/05	40%	149%
1993	1.36	0.49	12/03	2.90	03/17	36%	213%
1994	1.67	0.85	01/15	2.75	01/20	51%	165%
1995	1.42	0.63	01/08	2.28	06/20	44%	161%
1996	1.37	0.61	12/13	2.36	02/05	45%	173%
1997	1.33	0.50	04/14	3.70	06/04	38%	279%
1998	1.43	0.54	10/02	3.00	07/13	38%	210%
1999	1.45	0.67	10/02	**4.48**	06/20	46%	**308%**
2000	1.50	0.82	12/02	2.42	08/06	55%	162%
2001	1.52	0.71	05/15	2.57	06/15	47%	169%
2002	1.60	0.72	05/10	2.60	07/30	45%	163%
2003	**1.71**	1.00	05/16	2.85	08/21	59%	167%
2004	1.63	0.89	05/29	2.65	07/28	54%	163%
2005	1.60	0.85	05/06	3.00	09/15	53%	187%
2006	1.59	0.99	12/25	2.33	06/15	62%	146%
2007	1.68	0.98	11/23	2.59	06/25	58%	154%
2008	1.48	0.87	12/25	2.15	08/27	59%	146%
2009*	1.43	1.47	11/06	2.33	07/26	~~103%~~	~~163%~~
2010	1.47	0.94	12/25	2.20	05/24	64%	149%
2011	1.40	0.90	12/25	1.99	07/19	64%	142%
2012	1.52	0.90	12/25	2.40	07/11	59%	158%
2013	1.40	0.96	11/29	1.99	08/27	**69%**	142%

Maximum Value =

* PSCW indicates a 2009 Max day of 1.33 MGD, which is less than the AD use, as a result this data was assumed to be 2.33 and not used in the analysis

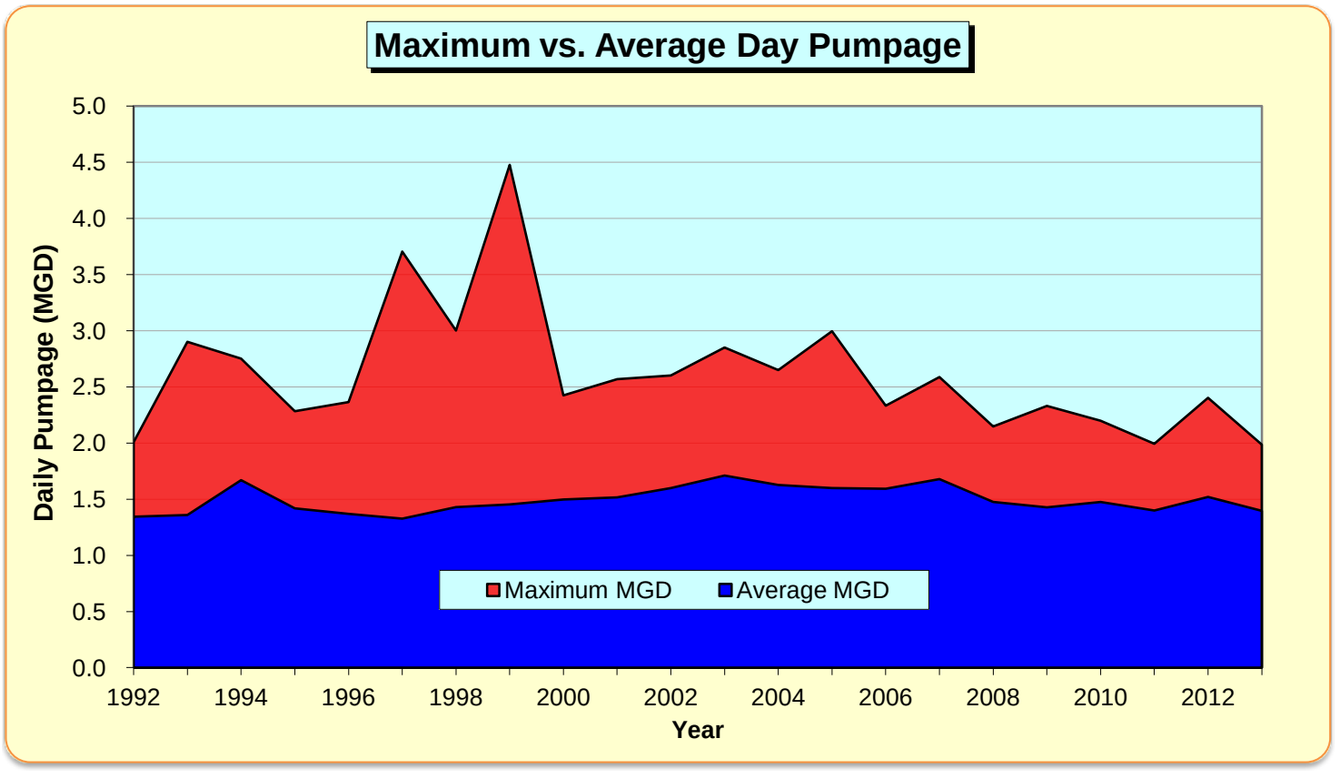


TABLE 3-7

STATISTICAL ANALYSIS:
RATIO OF MAXIMUM TO AVERAGE DAY DEMAND

HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

	Past 10 Years 2004 to 2013	Past 22 Years 1992 to 2013
Number of years of Data	10	22
Maximum Ratio - Max. to Avg. Day Pumpage	187%	308%
Minimum Ratio - Max. to Avg. Day Pumpage	142%	142%
Average Ratio Max. to Avg. Day Pumpage	156%	175%
Standard Deviation	14%	43%

Confidence Level [%]	Ratio of Max. to Avg. Day Pumpage	Ratio of Max. to Avg. Day Pumpage
80%	160%	183%
85%	161%	185%
90%	162%	187%
95%	164%	191%
98%	166%	194%
99%	168%	198%

Note

The "Confidence Level" represents the probability (expressed as a percentage) that in any given year, the actual ratio of maximumto average day pumpage will be less than or equal to the ratio indicated in the table. The ratios in thetable were determined based on a statistical analysis of historical ratios over each period of analysis, assuming a normal distribution.

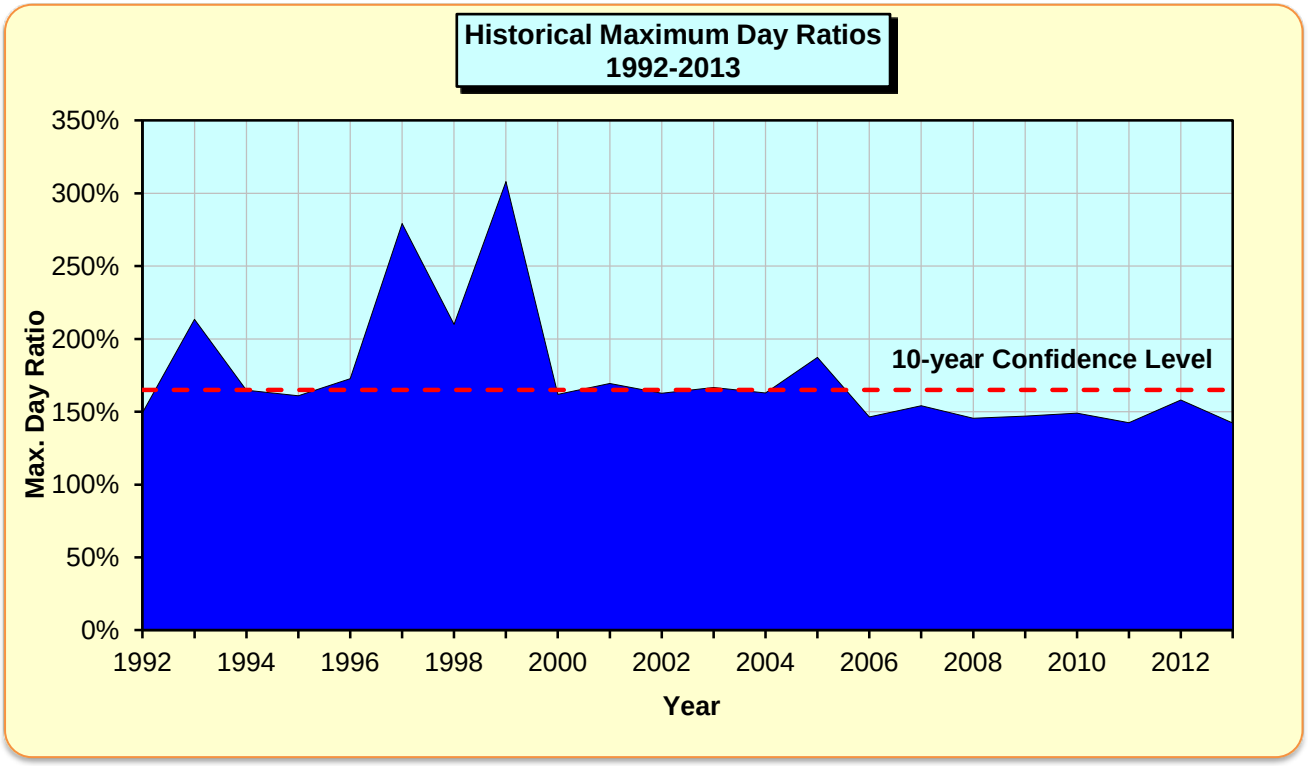


Table 3-7 also includes a statistical analysis of expected maximum day pumpage ratios for various normal distribution confidence levels. For example, based on the analysis of the data from 2004 to 2013, there is an 80 percent chance in any given year that the actual maximum day pumpage ratio will be less than or equal to 160 percent. Conversely, there is a 20 percent chance the actual ratio will exceed 160 percent.

To evaluate future water supply and storage needs, a maximum day pumpage ratio of 165 percent was used for this study. This ratio provides a confidence level of over 95 percent based on maximum day pumpage ratios over the past 10 years.

3.7 HOURLY DEMAND FLUCTUATIONS

The hour-to-hour variation of customer demands is also an important characteristic used to evaluate water supply and storage requirements. Similar to maximum day demand, the peak hour demand is often expressed as a ratio of peak hour to average day demand for the year. The peak hour demand is simply the hour of maximum demand that occurs on the maximum day.

The peak hourly rate for Hartford was estimated from data provided by the Water Utility. Figure 3-3 depicts the average hourly system demand for the seven days of the weeks of July 7, 2013, and September 15, 2013, with the high/low bars indicating the highest and lowest hourly demands recorded over the 14 days of data evaluated. The typical peak hour demand in the Hartford system appears to occur in the morning around 9 A.M., and equating to approximately 160 percent of the average hourly demand over the 14 days of data. To evaluate future water supply and storage needs, a peak hour demand ratio of 160 percent was used for this study

3.8 WATER CONSUMPTION AND PUMPAGE PROJECTIONS

Future sales and pumpage projections are based on assumptions of water demand, coupled with estimates of future population and community growth. The projections and assumptions for each category are discussed below. A summary is given in Table 3-8.

3.8.1 Residential Sales

Residential sales were projected based on current trends and assumptions regarding future population served and per capita water consumption. By the year 2035, it is estimated that the residential consumption rate will remain approximately 47 gallons per capita day (gpcd), resulting in total residential sales of 324 MGY.

3.8.2 Public Sales

Future per capita sales to public customers were projected to remain approximately 3.0 gpcd throughout the planning period. By the year 2035, it is estimated that public sales will be approximately 21 MGY.

3.8.3 Commercial Sales

Future per capita consumption by commercial customers was projected to be approximately 15 gpcd over the planning period. Total annual sales to commercial customers are projected to reach 103 MGY by 2035.

3.8.4 Industrial Sales

Sales to existing industrial customers were projected by analyzing sales of high volume customers separately from all other industrial customers. The seven high volume industrial customers listed in Table 3-4 account for 95 percent of the total industrial sales of the Hartford Water Utility. As a result,

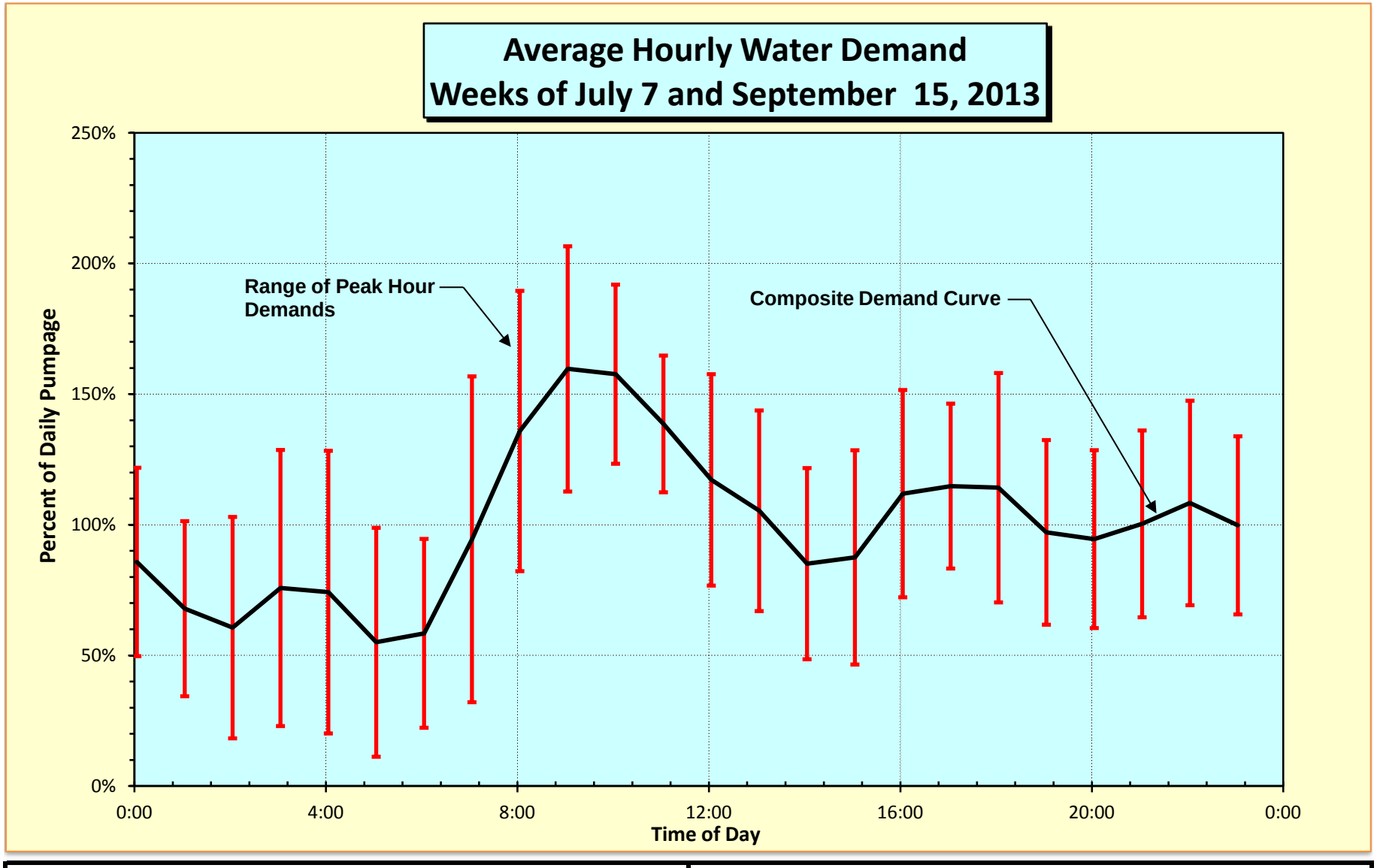


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FIGURE 3-3

HOURLY DEMAND CURVES

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

February 2014 HARTU 123623

TABLE 3-8

WATER SALES AND PUMPAGE PROJECTIONS

HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Customer Classification	Actual 2013	Projected 2025	Projected 2035
Population Served	14,274	17,100	18,900
Residential Sales			
Per Capita Sales [gpcd]	43	47	47
Annual Sales [MGY]	224	293	324
Commercial Sales			
Per Capita Sales [gpcd]	13	15	15
Annual Sales [MGY]	70	94	103
Industrial Sales			
Annual Sales - Existing Customers [MGY]	154	165	174
Annual Sales - Future Customers [MGY]	0	33	66
Public Sales			
Per Capita Sales [gpcd]	2.4	3.0	3.0
Annual Sales [MGY]	12	19	21
TOTAL WATER SALES [MGY]	**461**	**603**	**688**
Average Day Water Sales [MGD]	1.26	1.65	1.89
Losses and Unaccounted-For Water [MGD][1]	0.13	0.18	0.21
AVERAGE DAY PUMPAGE [MGD]	***1.39***	***1.84***	***2.10***

Footnote

1. Unaccounted-for water was projected at 10% of total pumpage for future years.

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these customers were evaluated separately from the remaining group of smaller industrial customers. For purposes of this study it was assumed that existing smaller volume industrial customers will not experience any significant changes in water use. Table 3-9 summarizes this anaylsis.

3.8.4.1 Signicast Corporation

Signicast Corporation has been one of the Utility's largest water users in the City. Signicast operates a large high-quality investment casting plant in the northwest side of the City. At its Hartford complex, each module of the plant operates as a plant unto itself. Signicast recently expanded adding an addition plant module to its existing operations in Hartford, and has been steadily adding new jobs. It is anticipated that Signicast's water usage will rise proportionately with the new plant module, and slight increases in water use are projected over the planning period.

3.8.4.2 Broan-Nu Tone, LLC

Broan-Nu Tone is a manufacturer of residential home products. Their main use of Utility water is for the existing three paint production lines. Since 2003 Brian-Nu Tone has consumed a relatively constant amount of water and no major increases in water use are anticipated.

3.8.4.3 W.B. Place

W.B. Place is a manufacturer of leather goods. Tanning is the primary production process and water consumption. The 2003 report noted that water conservation was the primary reason for a sharp decline in water consumption through the 1990s. Water use has declined significantly since 2010, decreasing from 28 MGY in 2010 to 5 MGY in 2013. For this study, the recent water use pattern was used throughout the planning period.

3.8.4.4 Quad Graphics

In recent years, the facility has experienced a steady increase in water use increasing from 24 MGY in 2008 to 35 MGY in 2012. About 50 percent of water is used for equipment cooling. Other uses include solutions, cafeteria, and employee sanitary uses. Small increases have been projected for Quad Graphics over the planning period. No major increase in consumption volumes over the 2013 level was projected for future years.

3.8.4.5 Hartford Finishing

Hartford Finishing is a compilation of three companies: Steelcraft, Hartford Finishing and Snoway. A steady increase in water use has been experienced over the past 5 years from 7.5 MGY in 2008 to 15 MGY in 2013. For this study, the recent water use pattern was used throughout the planning period.

3.8.4.6 Menasha Packaging

Water use for this industrial customer has remained relatively constant over the past 5 years, averaging 8 MGY. No major changes to water use patterns were project for this study.

3.8.4.7 Helgesen Industries

Helgeson Industries has two facilities within the City of Hartford: one along Sumner Street and the second along Innovation Way. Helgesen's water use has remained relatively consistent over the past 5 years averaging 5 MGY. No major changes in the firm's water usage were project for future years.

TABLE 3-9

INDUSTRIAL WATER SALES PROJECTIONS
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Industrial Customer	Actual 2013 Water Sales [MGY]	Projected 2025 Water Sales [MGY]	Projected 2035 Water Sales [MGY]
Signicast Corporation	53	56	60
Broan-Nu Tone, LLC.	34	36	36
Quad Graphics Inc.	28	29	30
Hartford Finishing, Inc.	15	16	17
Menasha Packaging	6	7	8
Helgeson Industries Inc.	6	7	8
W B Place	5	6	7
Total Water Sales to High-Volume Industrial Customers [MGY]	**147**	**157**	**166**
Total Water Sales to Current Low-Volume Industrial Customers[1]	7	8	8
Total Water Sales to Future Industrial Customers Projected Water Sales[2]	0	33	66
Total Water Sales to All Industrial Customers [MGY]	***154***	**198**	**240**

Footnotes

1. Future sales to current industrial customers was assumed to remain at 5% of the large users.
2. Future sales to new customers is based on an average increase of 3.2 MGY/year.

3.8.4.8 Future Industrial Growth

The Hartford Planning and Zoning Department anticipates future industrial development to support projected future community and regional growth in population. Additional acreage outside of the 2020 SEWRPC sanitary service boundary (north and west of the current Dodge Industrial Park) will be zoned for industrial development. In addition to this available land, the City will continue efforts to use city-owned industrial properties within older industrial zones that are managed by the Hartford Area Development Corporation (HADC).

Future industrial customer water demand is difficult to predict, as it is highly dependent on the type of industries that could locate within the City during the planning period. The future water sales to new industrial customers are often projected based on an average water demand of 1,500 gpd per acre per day.

Existing industrial water use rates were calculated from the total industrial water use and industrial land area in 2009. The growth in industrial water sales was calculated based on historical data for Hartford industrial development from 1990 to 2009 as noted in the 2009 Hartford Planning Commission Annual Report. Using these parameters, the average annual increase in industrial water demand over this period was 3.2 MGY per year.

This projected increase in industrial water use is considered to be conservative. Using this rate of industrial water use increases, total sales to future industrial customers in 2035 would be 66 MGY. Because water sales to industrial customers is a large component of Hartford's overall water demand, it is recommended that these industrial water demand projections be reviewed and revised every five years.

3.9 SUMMARY OF TOTAL DEMANDS AND PUMPAGE REQUIREMENTS

The total annual metered sales projections summarized in Table 3-8 were based on a summation of sales projections for each major customer classification. An allowance was also made for unmetered miscellaneous system water usage and losses (unaccounted-for water) to arrive at total pumpage projections. Figure 3-4 graphically illustrates the future sales and pumpage projections.

Table 3-10 summarizes the current projections of future water needs. Future annual sales are projected to increase from approximately 461 MGY in 2013 to 688 MGY by the year 2035. Total annual pumpage should increase to approximately 764 MGY by the year 2035.

Estimates of daily demand fluctuations have also been made based on projections of future annual sales. By the year 2035, average day pumpage is projected to increase to 2.1 mgd, and maximum day pumpage is projected to increase to 3.5 MGD. Future projections of maximum day pumpage are based on a ratio of maximum day to average day of 165 percent.

Peak hour demand was projected in a similar fashion. Peak hour demand was projected by assuming a ratio of peak hour demand to maximum day demand of 160 percent. Given these criteria, peak hour demand is projected to increase to a rate of approximately 3,800 gpm by the year 2035.

3.10 ZONE DEMANDS AND PUMPAGE REQUIREMENTS

The Hartford water distribution system is segmented into two major pressure zones The two zones operate independently with the exception of the interzone transfer station, which has the ability to send water from one zone to the other. During normal operation, the interzone transfer station pumps water from the Low Level Pressure Zone to the Primary Pressure Zone. Under emergency conditions, a bypass in the interzone transfer station can back-feed water to the Low Level Pressure Zone from the Primary

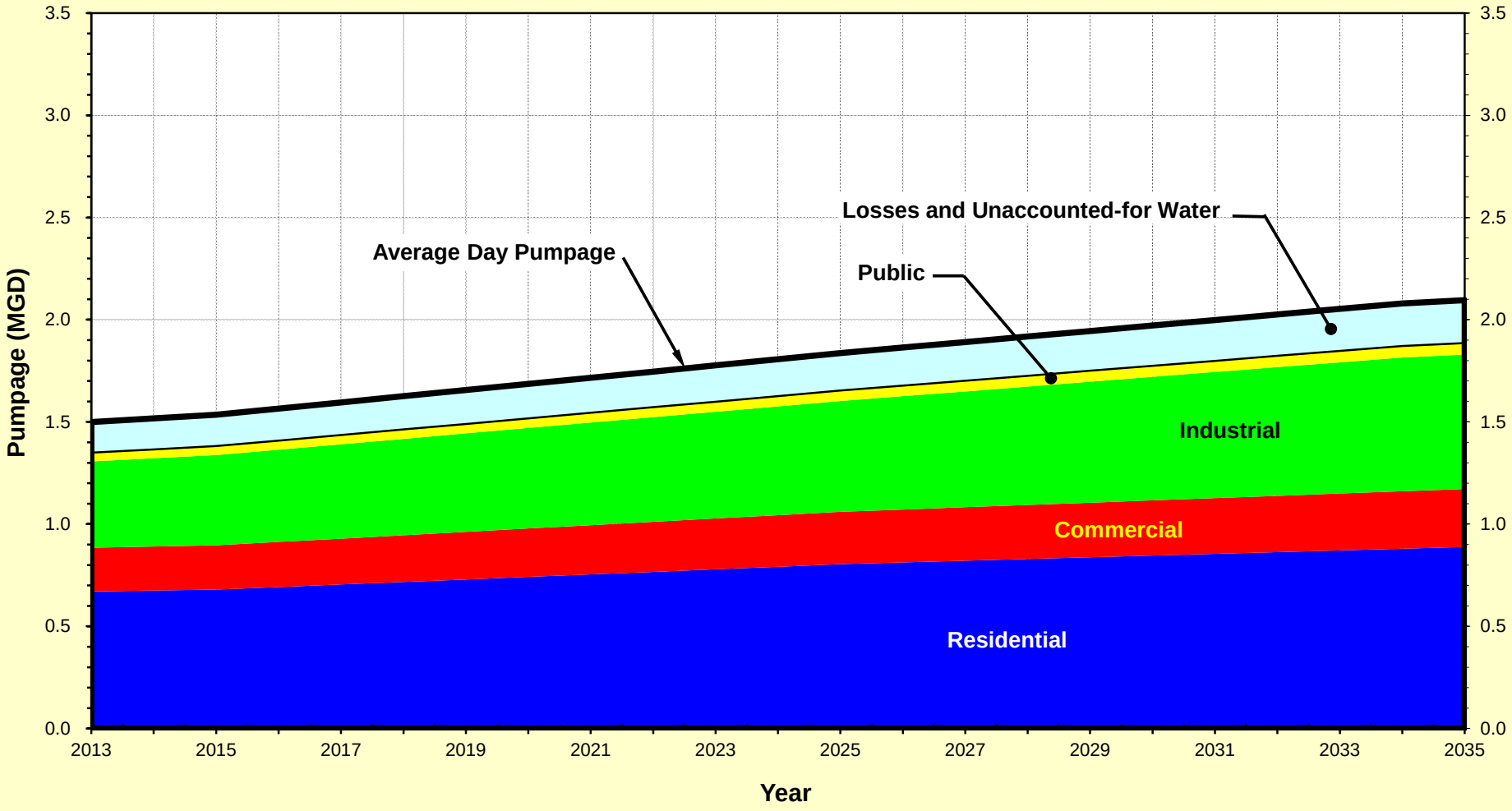

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FIGURE 3-4

AVERAGE DAY PUMPAGE PROJECTIONS

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

November 2014 HARTU 123623

TABLE 3-10

FUTURE PUMPAGE PROJECTIONS
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

	Actual 2013	Projected 2025	Projected 2035
Total Annual Water Sales [MGY]	461	603	688
Average Day Water Sales [MGD]	1.26	1.65	1.89
Losses and Unaccounted-for Water [MGD]	0.13	0.18	0.21
Average Day Pumpage [MGD]	1.39	1.84	2.10
Design Maximum Day Pumpage [MGD]	2.29	3.03	3.46
Design Peak Hour Demand [gpm]	2,500	3,400	3,800

Notes

1. Year 2013, 2025 and 2035 design maximum day pumpage projections were estimated using a ratio of maximum to average day pumpage of 165 percent.
2. Year 2013, 2025 and 2035 design peak hour demand projections were estimated using a ratio of peak hour demand to maximum day pumpage of 160 percent.

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Pressure Zone. Since the two zones operate with limited interaction between the pressure zones, planning for future demands requires an analysis of each pressure zone.

Table 3-11 lists the current and future industrial water sales for each of the major pressure zones. Future industrial development is projected to occur mainly in the Low Level Pressure Zone. Some additional industrial water demand is projected for the Primary Pressure Zone primarily from redevelopment of older industrial sites. Water sales to new industrial customers are based on 4.4 acres/year of development in the Low Level Pressure Zone and 0.2 acres/year of development in the Primary Pressure Zone.

Table 3-12 defines the current and projected water sales and pumpage projections for the major customer classifications for each pressure zone. Ninety percent of future residential, commercial and public development is projected to occur in the Primary Pressure Zone, and 10 percent in the Low Level Pressure Zone. As it is difficult to predict where development is likely to occur first, these assumptions should be reviewed every five years and at every facility upgrade to insure that the planned improvements meet the future demands.

Table 3-13 is a summary of future water demand projections for each pressure zone. The average daily pumpage to the Primary Pressure Zone is projected to increase from about 1.08 MGD in 2013 to about 1.52 MGD by the year 2035. Similarly, the maximum day demand is expected to increase from 1.79 MGD to 2.52 MGD in 2035.

The average daily pumpage for the Low Level Pressure Zone is projected to increase from about 0.31 MGD to 0.58 MGD by the year 2035. The maximum day pumpage for this pressure zone is expected to increase from 0.52 MGD to 0.95 MGD in 2035.

3.11 WATER NEEDS FOR FIRE PROTECTION

In addition to the water supply requirements for residential, public, commercial, and industrial consumption, water system planning for fire protection needs is an important consideration. In most instances, water main sizes are designed specifically to supply needed fire flow requirements.

Guidelines for determining fire flow requirements are developed based on recommendations offered by the Insurance Services Office (ISO), the organization responsible for evaluating and classifying municipalities for fire insurance rating purposes. When a community evaluation is conducted by ISO, the water system is evaluated for its capacity to provide needed fire flow at a specific location and will depend on land use characteristics and the types of properties to be protected. However, in high value districts, fire flow requirements of up to 3,500 gpm can be expected. Therefore, for the purposes this study, a basic fire flow requirement of 3,500 gpm for three hours was used for establishing water supply and storage requirements. Based on current insurance classification guidelines, this basic fire flow requirement is not expected to change over the planning period.

TABLE 3-11

INDUSTRIAL WATER SALES PROJECTIONS BY PRESSURE ZONE

HARTFORD UTILITIES

CITY OF HARTFORD, WISCONSIN

Industrial Customer	Actual 2013 Water Sales [MGY]	Projected 2025 Water Sales [MGY]	Projected 2035 Water Sales [MGY]
Primary Pressure Zone			
Broan-Nu Tone, LLC.	34	36	36
W B Place	5	6	7
Hartford Finishing, Inc.	15.1	16.0	17.0
Helgeson Industries Inc.	5.7	7.0	8.0
Subtotal PP Zone High-volume Customers [MGY	**59**	**65**	**68**
PP Zone Low-volume Industrial Customers[1,2]			
Existing Customers [MGY]	2.5	2.6	2.8
Future Customers [MGY]	---	1.6	3.3
Total PP Zone Industrial Sales [MGY]	***62***	***69***	***74***
Low Level Pressure Zone			
Signicast Corporation	53	56	60
Quad Graphics Inc.	28	29	30
Menasha Packaging	6.2	7.0	8.0
Subtotal LP Zone High-volume Customers [MGY	**87**	**92**	**98**
LP Zone Low-volume Industrial Customers[1,3]			
Existing Customers	5.0	5.2	5.5
Future Customers	---	31	62
Total LP Zone Industrial Sales [MGY]	***92***	***128***	***166***
Combined			
Total Water Sales to High-Volume Industrial Customers [MGY]	**147**	**157**	**166**
Total Water Sales to Low-Volume Industrial Customers			
Existing Customers [MGY]	7	8	8
Future Customers [MGY]	---	33	66
Total Water Sales to All Industrial Customers [MGY]	***154***	***198***	***240***

Notes

1. Future industrial sales based on figures from Table 3-9
2. Five percent of the future industrial development is assumed to be in the Primary Pressure Zone.
3. 95 percent of the future industrial development is assumed to be in the Low Level Pressure Zone.

TABLE 3-12

WATER SALES AND PUMPAGE PROJECTIONS BY PRESSURE ZONE

HARTFORD UTILITIES
CITY OF HARTFORD, WISCONSIN

Customer Classification	Actual 2013 Sales & Pumpage	Projected 2025 Sales & Pumpage	Projected 2035 Sales & Pumpage
Primary Pressure Zone			
Residential Sales[1] [MGY]	222	284	312
Commercial Sales[1] [MGY]	65	86	95
Industrial Sales			
Existing Customers [MGY]	62	68	71
Future Customers [MGY]	---	1.6	3.3
Public Sales[1] [MGY]	11	17	19
Total PP Zone Sales [MGY]	**359**	**456**	**499**
Average Day PP Zone Sales [MGD]	0.98	1.25	1.37
PP Zone Losses and Unaccounted-for[2] [MGD]	0.10	0.14	0.15
Average Day PP Zone Pumpage [MGD]	***1.08***	***1.39***	***1.52***
Low Level Pressure Zone			
Residential Sales[1] [MGY]	2	9	12
Commercial Sales[1] [MGY]	6	8	9
Industrial Sales			
Existing Customers [MGY]	92	97	104
Future Customers [MGY]	---	31	62
Public Sales[1] [MGY]	1.2	1.9	2.1
Total LP Zone Sales [MGY]	**101**	**147**	**189**
Average Day LP Zone Sales [MGD]	0.28	0.40	0.52
LP Zone Losses and Unaccounted-for[2] [MGD]	0.04	0.04	0.06
Average Day LP Zone Pumpage [MGD]	***0.31***	***0.45***	***0.58***
Combined Zones			
Residential Sales [MGY]	224	293	324
Commercial Sales [MGY]	70	94	103
Industrial Sales			
Existing Customers [MGY]	154	165	174
Future Customers [MGY]	---	33	66
Public Sales [MGY]	12	19	21
Total Water Sales [MGY]	**461**	**603**	**688**
Average Day Water Sales [MGD]	1.26	1.65	1.89
Losses and Unaccounted-for[2] [MGD]	0.13	0.18	0.21
AVERAGE DAY PUMPAGE [MGD]	***1.39***	***1.84***	***2.10***

Notes

1. Future residential, commercial and public water sales assumed to be split 90%/10% between the Primary and Low Level Pressure Zones, respectively.
2. Losses and Unaccounted-for water estimated at 10% of total pumpage for Year 2025 and 2035 projections.

TABLE 3-13

FUTURE DESIGN PUMPAGE PROJECTIONS BY PRESSURES ZONE

HARTFORD UTILITIES
CITY OF HARTFORD, WISCONSIN

Primary Pressure Zone	Actual 2013	Projected 2025	Projected 2035
Total PP Zone Annual Sales [MGY]	359	456	499
Average Day PP Zone Sales [MGD]	0.98	1.25	1.37
PP Zone Losses and Unaccounted-for [MGD]	0.10	0.14	0.15
Average Day PP Zone Pumpage [MGD]	**1.08**	**1.39**	**1.52**
Design Maximum Day PP Zone Pumpage [MGD]	**1.79**	**2.29**	**2.51**
Design Peak Hour PP Zone Demand [gpm]	2,000	2,500	2,800
Low Level Pressure Zone			
Total LP Zone Annual Sales [MGY]	101	147	189
Average Day LP Zone Sales [MGD]	0.28	0.40	0.52
LP Zone Losses and Unaccounted-for [MGD]	0.04	0.04	0.06
Average Day LP Zone Pumpage [MGD]	**0.31**	**0.45**	**0.58**
Design Maximum Day LP Zone Pumpage [MGD]	**0.52**	**0.74**	**0.95**
Design Peak Hour LP Zone Demand [gpm]	500	800	1,100
Combined Zones			
Total Annual Sales [MGY]	461	603	688
Average Day Sales [MGD]	1.26	1.65	1.89
Losses and Unaccounted-for [MGD]	0.13	0.18	0.21
Average Day Pumpage [MGD]	**1.39**	**1.84**	**2.10**
Design Maximum Day Pumpage [MGD]	**2.29**	**3.03**	**3.46**
Design Peak Hour Demand [gpm]	2,500	3,400	3,800

Notes

1. Year 2013, 2025 and 2035 design maximum day pumpage projections were estimated using a ratio of maximum to average day pumpage of 165 percent.
2. Year 2013, 2025 and 2035 design peak hour demand projections were estimated using a ratio of peak hour demand to maximum day pumpage of 160 percent.

4.0 EXISTING WATER SYSTEM FACILITIES

The Water Utility has added significant system improvements since the previous water study was conducted in 2003. In addition, the Utility upgraded its water control system and rehabilitated several wells and pump stations.

The water system facilities operated and maintained by Hartford Utilities include:

1. Five active groundwater wells.
2. Four elevated water storage tanks.
3. Two ground-level reservoirs with booster pumps at each location.
4. An interzone transfer station pumping water between the Primary and Low Level Pressure Zones.
5. A booster pumping station to supply the Powder Hill Pressure Zone from the Primary Pressure Zone
6. Water system controls located in the Utility office
7. A network of transmission and distribution water mains

The general location and layout of the water system facilities is illustrated in Figure 4-1. A schematic of the water system is illustrated in Figure 4-2. This chapter presents a summary of the design and operating characteristics of the existing water system components.

4.1 EXISTING WELLS

The Utility operates five groundwater wells to meet the water supply needs of its customers. Tables 4-1 and 4-2 summarize the well and pump design and operating data for the Utility's supply wells. Well yields range in capacity from 350 gpm at Well 11 to as high as 1,600 gpm for Well 16.

Water pumped from Wells 10 and 16 discharge ground-level reservoirs located at or near each well. High service booster pumps transfer water from the reservoirs into the Hartford distribution system. Water from Wells 11, 12 and 15 is pumped directly into the distribution system.

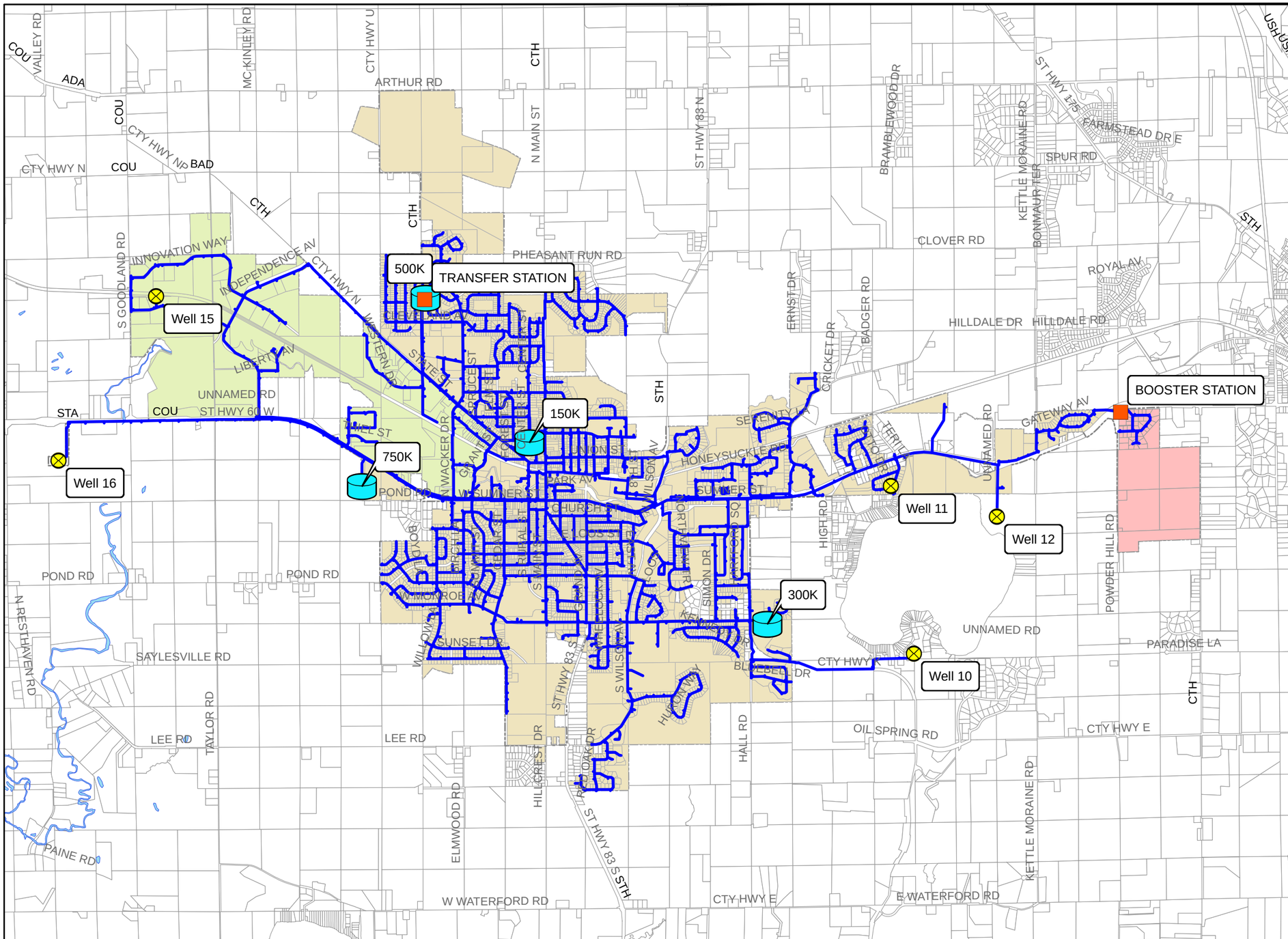
Since the 2003 Report was written, Utility Wells 4 and 13 have been removed from active service; Well 4 due to high radium concentrations in the water and Well 13 due to high nitrate levels in the well water. The water from each well exceeded the primary drinking water standard for each of the regulated water quality parameters.

Also since 2003 other changes to the City's water supply have been implemented. Well 16 was constructed in 2007 and put into service in 2009 following the construction of the Well 16 water treatment plant.

A summary description of each supply well facility is summarized below as well as in Tables 4-3 through 4-7.

4.1.1 Well 4

Well 4 was abandoned in 2010 due to high radium levels in the well water.



Legend

- Transfer/Booster Station
- Elevated Water Storage Tanks
- Active Water Supply Wells
- Existing Water Main
- Primary Pressure Zone
- Boosted Pressure Zone
- Low Pressure Zone
- CITY LIMITS

Source: City & County Data
Map by: SEH

This map is neither a legally recorded map nor a survey map and is not intended to be used as one. This map is a compilation of records, information, and data gathered from various sources and is to be used for reference purposes only. SEH does not warrant that the Geographic Information System (GIS) Data used to prepare are error free, and SEH does not represent that the GIS Data can be used for navigational, tracking, or any other purpose requiring exacting measurement of distance or direction or precision in the depiction of geographic features. This user of this map acknowledges that SEH shall not be liable for any damages which arise out of the user's access or use of data provided.

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DATE: APRIL 2014

WATER SYSTEM EVALUATION
CITY OF HARTFORD, WISCONSIN

EXISTING WATER SYSTEM MAP

FIGURE 4-1

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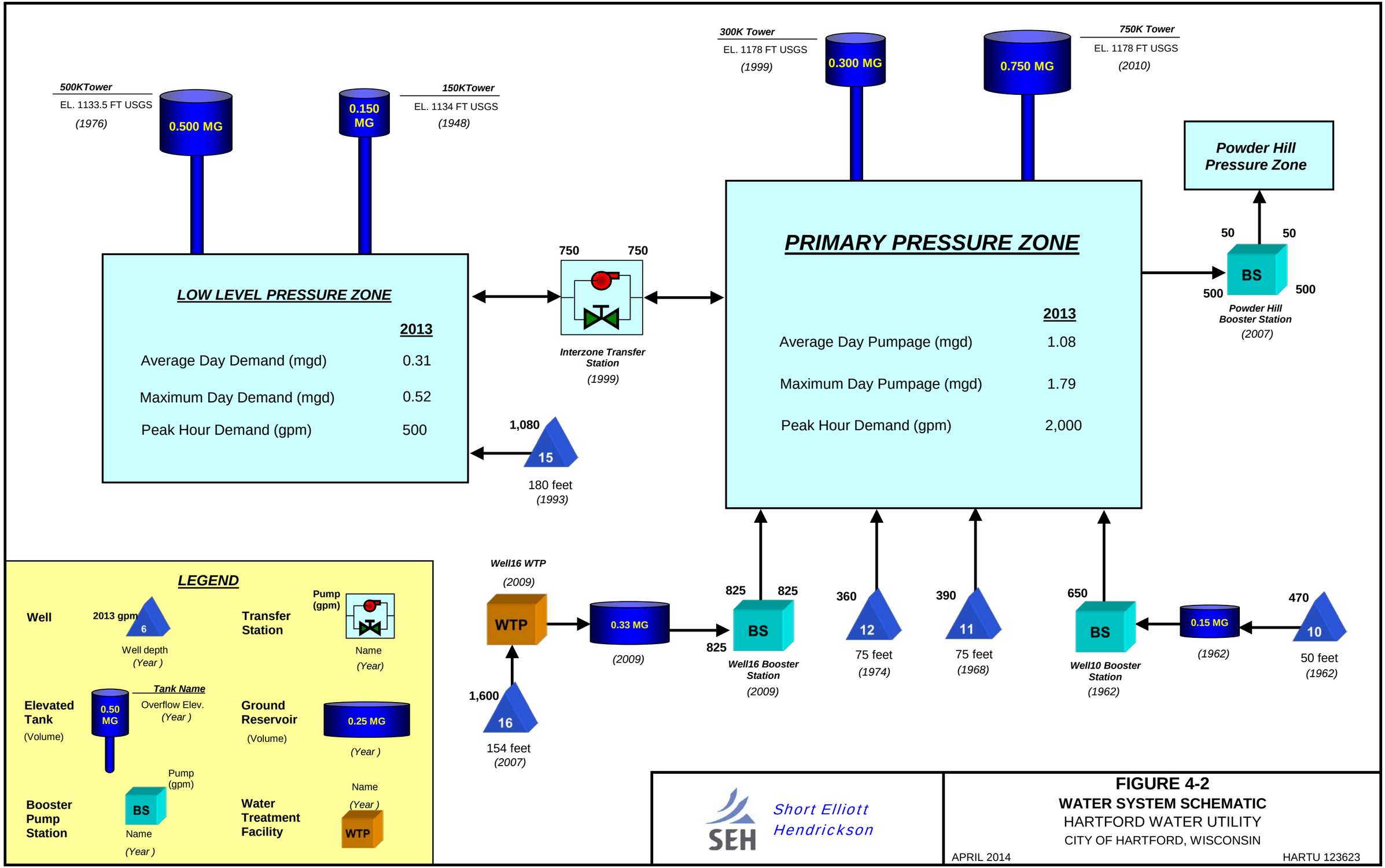


FIGURE 4-2
WATER SYSTEM SCHEMATIC
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

TABLE 4-1

EXISTING WELL DATA

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

	SUPPLY WELLS				
Well Data	**Well 10**	**Well 11**	**Well 12**	**Well 15**	**Well 16**
Year Constructed	1962	1968	1974	1993	2007
Depth (feet)	50	75	75	180	154
Casing: Diameter (in.)	20	18	18	20	24
Depth (ft.)	40	54	60	130	122
Grouted Depth (ft.)	40	54	50	113	105
Screen Length (ft.)	10	21	15	50	32
Original Construction:					
Static Water Level (ft.)	16	6	25	26	4
Pumping Water Level(ft.)	27	51	52	52	85
Drawdown (ft.)	11	45	27	26	81
Pumping Rate (gpm)	800	355	700	1,000	1,650
Specific Capacity (gpm/ft)	74.8	7.9	25.9	38.5	20.3
2013 Average Conditions:					
Static Water Level (ft.)	18	9	24	46	18
Pumping Water Level(ft.)	33	45	48	69	55
Drawdown (ft.)	15	36	24	23	37
Pumping Rate (gpm)	470	390	360	1080	900
Specific Capacity (gpm/ft)	31.3	10.8	15.0	47.0	24.3

TABLE 4-2

EXISTING WELL PUMP DATA

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

	Supply Wells				
	Well 10	**Well 11**	**Well 12**	**Well 15**	**Well 16**
Pump Data					
Type	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Submersible
Manufacturer	Layne	American	Layne	Layne	Layne
Year Installed	1994	19779	1995	1993	2009
Pump Setting (feet)	40	50	60	100	120
Design:					
Flow Rate (gpm)	800	350	400	1,200	1,600
TDH (feet)	n/a	263	211	260	138
2013 Operations:					
Flow Rate (gpm)	460	380	360	1,080	1,600
Pump Discharges to:	*Well 10 Ground Reservoir*	*Distribution System Primary Zone*	*Distribution System Primary Zone*	*Distribution System Low Level Zone*	*Treatment Plant Clearwell*
Motor Data					
Manufacturer	U.S. Motors	U.S. Motors	U.S. Motors	General Electric	U.S. Motors
Horsepower	15	25	30	100	100
RPM	1750	1760	1,760	1,770	3,500
Voltage	460	460	460	460	460
Phase / Cycles	3 / 60	3 / 60	3 / 60	3 / 60	3 / 60
Standby Power:	Yes	Yes	Yes	Yes	Yes
Type	Standby Engine	Standby Engine	Standby Engine	Standby Generator	Standby Generator
Fuel	Natural Gas	Natural Gas	Natural Gas	Diesel	Diesel

4.1.2 Well 10

Well 10 is located along Eagle Point Road as shown in Figure 2-1 in the southeast part of the Hartford area. The well was constructed in 1962 to a total depth of 50 feet.. The well contains a 40-foot long, 20-inch diameter well casing, and a 10-foot long well screen. The well is grouted to a depth of 40 feet.

Well 10's original static water level in 1962 was reported to be 16 feet below the ground surface, with a specific capacity of 75 gpm per foot of drawdown. The average 2013 operating conditions included a static water level of 18 feet, with a specific capacity of 31 gpm per foot. The most recent well maintenance was performed in 2008.

Well 10 is equipped with a vertical turbine pump and 15 Hp motor. The well pump is set at 40 feet below the ground surface. The pump is rated for 800 gpm. Water from this well is discharged to an adjacent 150,000 gallon ground level reservoir from which water is drawn and pumped to the distribution system using a vertical turbine pump and 75 Hp electric motor. Water from Well 10 is pump into the Primary Pressure Zone. Well 10 currently is pumped at a rate of approximately 470 gpm. The most recent well pump maintenance was performed in 2008.

TABLE 4-3

WELL 10
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Well 10 (Eagle Point Road)		
Year Constructed		1962
Well Type		Screened Sand & Gravel
Well Size:	Depth	50 feet
	Diameter	20 inches
2013 Static Water Level Average		16 feet
2013 Pumping Level Average		27 feet
Well Pump		
Pump Type		Vertical Turbine
Pumping Design Rate		800 gpm
Pump Design Head		n/a feet
Motor Hp		15 Hp
Water Treatment		
Gas Chlorine, Fluoride, Polyphosphate (sequestration)		
Standby Power		
Type		Engine
Fuel		Natural Gas
Comments: Well water discharges to adjacent ground reservoir.		

4.1.3 Well 11

Well 11 is located along Teri Lane as shown in Figure 2-1 in the eastern part of the City. The well was constructed in 1968 to a depth of 75 feet. The well contains a 54-foot long, 18-inch diameter well casing, and a 21 foot long well screen. The well is grouted to a depth of 54 feet.

Well 11's original static water level in 1968 was reported to be 6 feet below the ground surface, with a specific capacity of 7.9 gpm per foot of drawdown. The average 2013 operating conditions included a static water level of 9 feet, with a specific capacity of 11 gpm per foot. The most recent well maintenance was performed in 2012.

Well 11 is equipped with a vertical turbine pump and 25 Hp electric motor. The well pump is set at 50 feet below the ground surface. The pump is rated for 350 gpm at 263 feet TDH. Water from this well is pumped into the Primary Pressure Zone. Well 11 currently is pumped at a rate of approximately 380 gpm. The most recent pump maintenance was performed in 2012.

TABLE 4-4

WELL 11
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Well 11 (Teri Lane)		
Year Constructed		1968
Well Type		Screened Sand & Gravel
Well Size:	Depth	75 feet
	Diameter	18 inches
2013 Static Water Level Average		9 feet
Pumping Level Average		45 feet
Well Pump		
Pump Type		Vertical Turbine
Pump Design Rate		350 gpm
Pump Design Head		263 feet
Motor Hp		25 hp
Water Treatment		
Gas Chlorine, Fluoride		
Polyphosphate (sequestration)		
Standby Power		
Type		Engine
Fuel		Natural Gas

Comments: None

4.1.4 Well 12

Well 12 is located south of STH 60 in eastern Hartford as shown in Figure 2-1, east of Well 11. The well was constructed in 1969 to a depth of 75 feet.. The well contains a 60-foot long, 18-inch diameter well casing, and a 15 foot long well screen. The well is grouted to a depth of 50 feet.

Well 12's original static water level in 1969 was reported to be 25 feet below the ground surface, with a specific capacity of 26 gpm per foot of drawdown. The average 2013 operating conditions included a static water level of 24 feet, with a specific capacity of 15 gpm per foot. The most recent well maintenance was performed in 2007.

Well 12 is equipped with a vertical turbine pump and 30 Hp electric motor. The well pump is set at 60 feet below the ground surface. The pump is rated for 400 gpm at 211 feet TDH. Water from this well is pumped into the Primary Pressure Zone. Well 12 currently is pumped at a rate of approximately 360 gpm. The most recent pump maintenance was performed in 2007.

TABLE 4-5

WELL 12
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Well 12 (STH 60)		
Year Constructed		1969
Well Type		Screened Sand & Gravel
Well Size:	Depth	75 feet
	Diameter	18 inches
2013 Static Water Level Average		24 feet
2013 Pumping Level Average		48 feet
Well Pump		
Pump Type		Vertical Turbine
Pump Design Rate		400 gpm
Pump Design Head		211 feet
Motor HP		30 hp
Water Treatment		
Gas Chlorine, Fluoride		
Polyphosphate (sequestration)		
Standby Power		
Type		Engine
Fuel		Propane
Comments: None		

4.1.5 Well 13

Well 13 was abandoned in 2010 due to high nitrate levels in the well water.

4.1.6 Well 15

Well 15 is located along Goodland Road as shown in Figure 2-1 in the far northwestern part of the City. The well was constructed in 1993 to a depth of 180 feet. The well contains a 130-foot long, 20-inch diameter well casing, and a 50 foot long well screen. The well is grouted to a depth of 113 feet.

Well 15's original static water level in 1993 was reported to be 26 feet below the ground surface, with a specific capacity of 39 gpm per foot of drawdown. The average 2013 operating conditions included a static water level of 46 feet, with a specific capacity of 47 gpm per foot. The most recent well maintenance was performed in 2009.

Well 15 is equipped with a vertical turbine pump and 100 Hp electric motor. The well pump is set at 100 feet below the ground surface. The pump is rated for 1,200 gpm at 260 feet TDH. Water from this well is pumped into the Low Level Pressure Zone. Well 15 currently is pumped at a rate of approximately 1,00 gpm. The most recent pump maintenance was performed in 2011.

TABLE 4-6

WELL 15
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Well 15 (Goodland Road)		
Year Constructed		1993
Well Type		Screened Sand & Gravel
Well Size:	Depth	182 feet
	Diameter	20 inches
2013 Static Water Level Average		46 feet
2013 Pumping Water Level Average		69 feet
Well Pump		
Pump Type		Vertical Turbine
Pump Design Rate		1,200 gpm
Pump Design Head		260 feet
Motor Hp		100 Hp
Water Treatment		
Gas Chlorine, Fluoride		
Polyphosphate (sequestration)		
Standby Power		
Type		Generator
Fuel		Diesel
Comments: Only supply source pumped into the Low Level Pressure Zone		

4.1.7 Well 16

Well 16 is located west of the City of Hartford along STH 60 as shown in Figure 2-1. The well was constructed in 2007 to a depth of 154 feet. The well contains a 122-foot long, 24-inch diameter casing, and a 32 foot long well screen. The well is grouted to a depth of 105 feet. Well 16's original static water level in 2007 was reported to be 4 feet below the ground surface, with a specific capacity of 20 gpm per foot of drawdown. The average 2013 operating conditions included a static water level of 18 feet, with a specific capacity of 24 gpm per foot. No major maintenance has been performed on the well to date.

Well 16 is equipped with a submersible pump and 100 Hp motor. The well pump is set at 120feet below the ground surface. The pump is rated for 1,600 gpm, but is typically operated at 800 gpm. Water from this well is discharged into four concrete filter basins in the adjacent Water Treatment Plant. The treatment plant was constructed in 2008-09 and placed into full time service in May 2009. The plant was design to remove the high levels of dissolved iron in the Well 16 raw water (2.0 mg/l). Treated water from the Well 16 treatment plant is booster pumped using three high service pumps. Water from the treatment plant is discharged into the Primary Pressure Zone.

TABLE 4-7

WELL 16
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Well 16 (STH 60)		
Year Constructed		2007
Well Type		Screened Sand & Gravel
Well Size:	Depth	154 feet
	Diameter	40 inches
Static Water Level Average		18 feet
Pumping Level Average		55 feet
Well Pump		
Pump Type		Submersible
Pump Design Rate		1,600 gpm
Pump Design Head		138 feet
Motor Hp		100 Hp
Water Treatment		
Iron and Manganese Removal – Gravity Filtration (sand, anthracite), gas chlorine disinfection, fluoride, polyphosphate (corrosion control)		
Standby Power		
Type		Generator
Fuel		Diesel
Comments: Filter backwash water is recycled using plate settler.		

4.1.8 Historical Supply Comparison

Table 4-8 lists annual well production data from 2010 to 2013, with the results graphically illustrated in Figures 4-3 and 4-4.

Well 15 produced an average of 39 percent of the total water supply (209 MGY) over the past four years. In the same period, Well 10 provided the second largest percentage of Hartford's water supply (20 percent). New Well 16 supplied approximately 18 percent of the total water supply since it was placed into active service in 2009.

4.1.9 Historical Well Maintenance Summary

The four older wells have all had maintenance performed on them since 2007. Table 4-9 summarizes the historical well maintenance summary for the Utility's water supply wells over the past 20 year period.

The most recent well and pump maintenance period for the wells is summarized below.

Supply Well	Most Recent Maintenance	Previous Maintenance	Maintenance Period
Well 10	2008	2002	6 years
Well 11	2012	2003	9 years
Well 12	2011	2006	5 years
Well 15	2009	2003	6 years
Well 16	None	2007 (new)	7 years

4.1.10 Historical Well Performance

The historical performance of each water supply well was reviewed and analyzed. The most recent 14 years (2000-2013) of well performance data was reviewed. The performance indicators include static and pumping water levels, pumping rate, and well specific capacity, as well as field testing results that were collected over the past year. The performance of each well with respect to each of the performance indicators is graphically summarized in Appendix C.

4.1.10.1 Well 10

Well 10's original specific capacity after construction in 1962 was reported to be 75 gpm/ft. The well's specific capacity experienced a significant decline after 30 years of operation. After well rehabilitation in 1994, the well's specific capacity was report to be 47 gpm/ft.

Well 10 underwent significant well rehabilitation again eight years later in 2002, after the specific capacity declined 40 percent to below 30 gpm/ft. The 2002 well rehabilitation that was performed was very successful in restoring Well 10's specific capacity to the 1994 post-rehabilitation value of 47 gpm/ft.

Well 10 was rehabilitated again in 2008 after the specific capacity declined 21 percent to 37 gpm/ft. No discernible improvement to the well's specific capacity was measured in the historical well performance data review and graphically illustrated in Figure C-1 in Appendix C.

Well 10 specific capacity at the end of 2013 was calculated to be approximately 30 gpm/ft, or a 36 percent decline since 2002, and a 19 percent decline since the 2008 well rehabilitation. Based on the

TABLE 4-8

ANNUAL WELL PRODUCTION

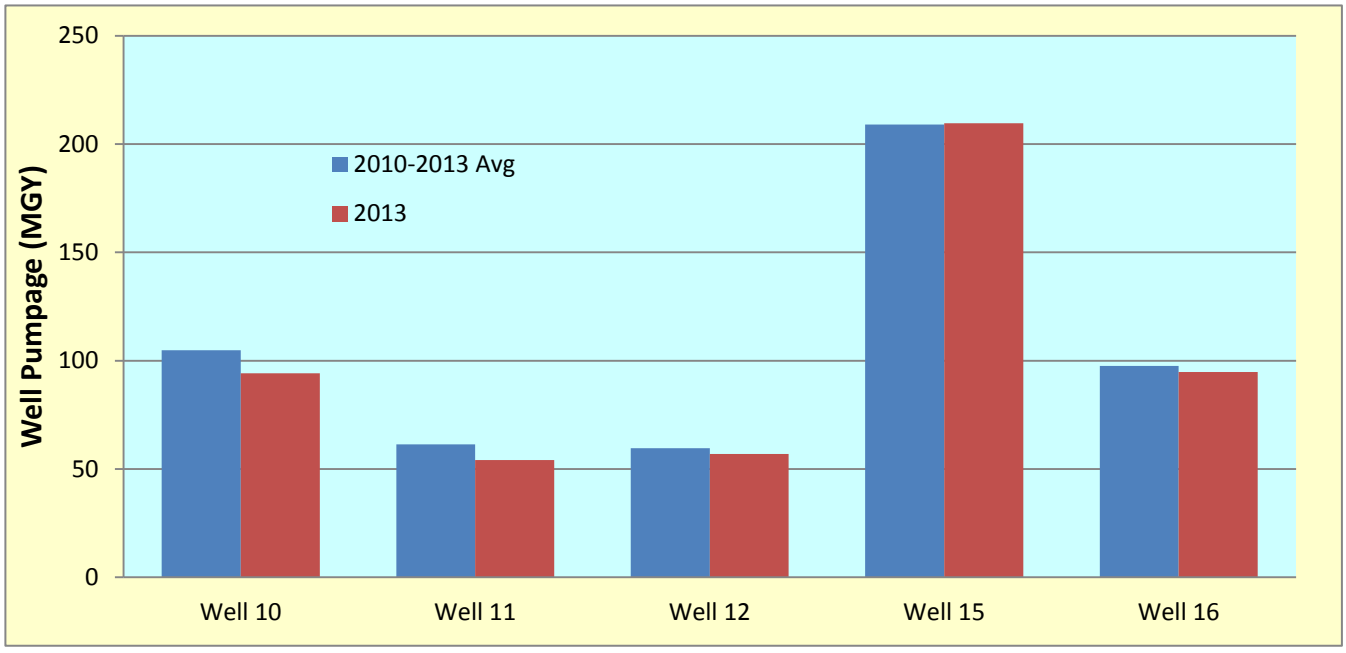
HARTFORD WATER UTILITY

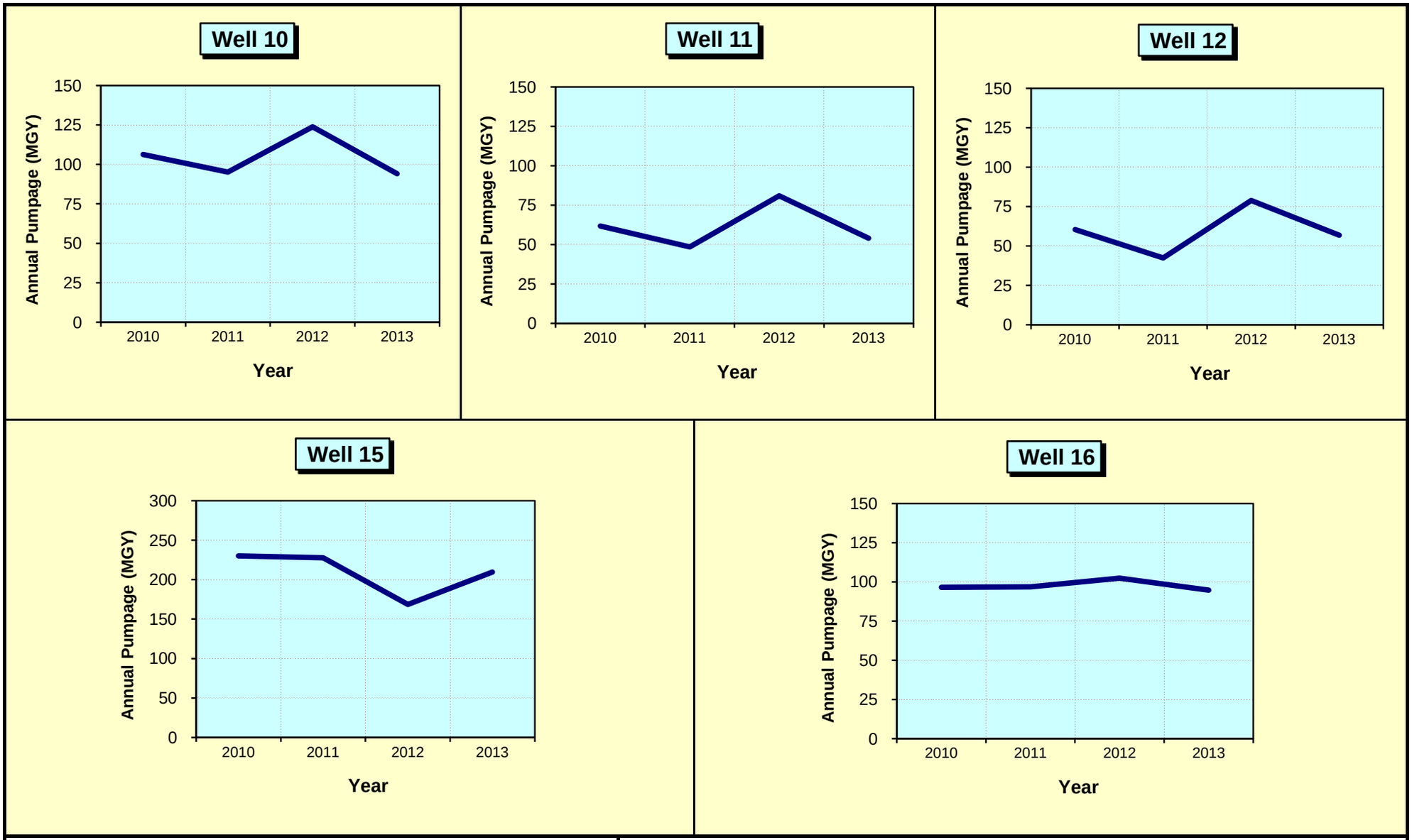
CITY OF HARTFORD, WISCONSIN

Well Production (MGY)						
Year	**Well 10**	**Well 11**	**Well 12**	**Well 15**	**Well 16**	**Total**
2010	106.3	61.8	60.4	230.1	96.6	**555.1**
2011	95.1	48.5	42.5	227.7	96.9	**510.6**
2012	123.8	80.9	78.9	168.6	102.4	**554.7**
2013	94.2	54.1	56.9	209.6	94.8	**509.6**
Average	*104.9*	*61.3*	*59.7*	*209.0*	*97.6*	***532.5***

Percentage of Water Supply Produced						
Year	**Well 10**	**Well 11**	**Well 12**	**Well 15**	**Well 16**	**Total**
2010	19.1%	11.1%	10.9%	41.5%	17.4%	**100%**
2011	18.6%	9.5%	8.3%	44.6%	19.0%	**100%**
2012	22.3%	14.6%	14.2%	30.4%	18.5%	**100%**
2013	18.5%	10.6%	11.2%	41.1%	18.6%	**100%**
Average	*20%*	*11%*	*11%*	*39%*	*18%*	***100%***

Largest Annual Supply Well





SHORT ELLIOTT HENDRICKSON

SEH

FIGURE 4-3

ANNUAL WELL PRODUCTION

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

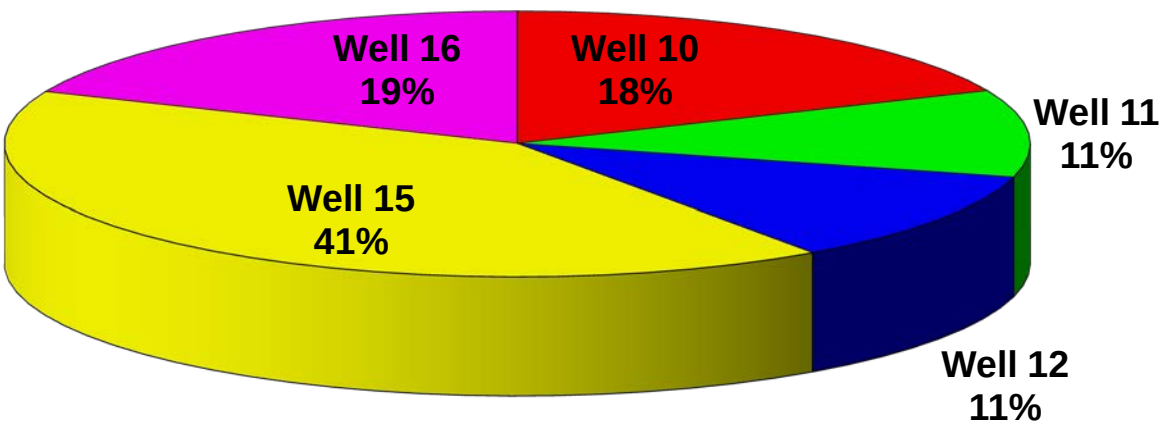
MARCH 2014

HARTU 123632

C:\Users\pplanton\Documents\My Documents December 2013\Projects\F-J\Hartford\Water Master Plan\Tables & Figures\Chapter 4\[table 4-x.xls]Fig 4-3

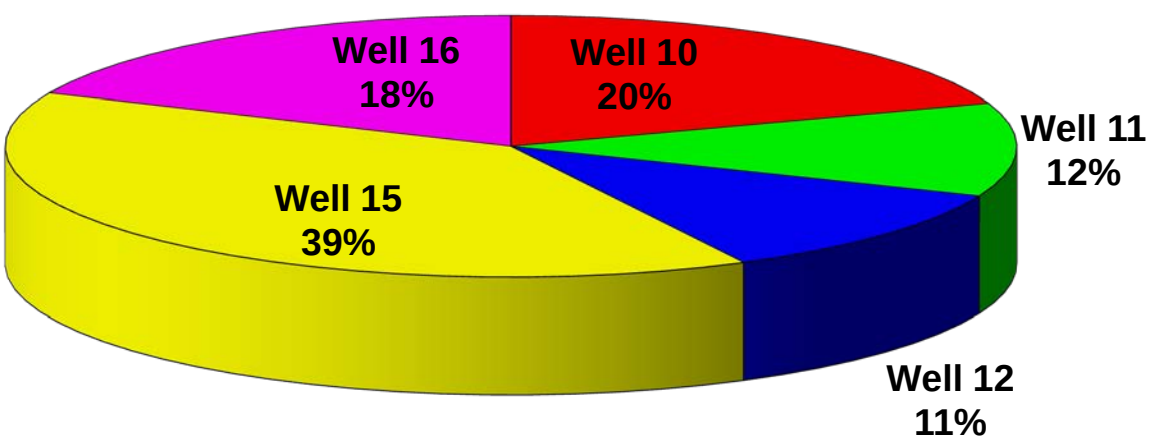
WATER SUPPLY COMPARISON

2013



WATER SUPPLY COMPARISON

2010-2013



SHORT ELLIOTT
HENDRICKSON

FIGURE 4-4
WELL WATER SUPPLY COMPARISON
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

MARCH 2014 HARTU 123632

C:\Users\pplanton\Documents\My Documents December 2013\Projects\F-J\Hartford\Water Master Plan\Tables & Figures\Chapter 4\[table 4-x.xls]Fig 4-4

TABLE 4-9

HISTORICAL WELL MAINTENANCE SUMMARY
1993-2013

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Well Maintenance Chronology

Year	Well Maintenance
1993	***Well 15 Constructed***
1994	***Well 10***
1995	***Well 12***
1996	None
1997	None
1998	None
1999	None
2000	None
2001	None
2002	***Well 10***
2003	***Well 11, Well 15***
2004	None
2005	None
2006	None
2007	***Well 12, Well 16 Constructed***
2008	***Well 10***
2009	***Well 15***
2010	***Wells 4 & 13 Abandoned***
2011	***Well 12***
2012	***Well 11***
2013	None

Recent Well Maintenance Summary

Well 10	1994, 2002, 2008
Well 11	2003, 2012
Well 12	1995, 2007, 2011
Well 15	2003, 2009
Well 16	None

historical performance of this well, it is recommended that Well 10 be scheduled for rehabilitation, with consideration of using similar techniques and treatment chemicals that were used in the 2002 rehabilitation process.

4.1.10.2 Well 11

Well 11's original specific capacity after construction in 1968 was reported to be only 10 percent of that of Well 10 at 7.9 gpm/ft. Over the past 14 years of operational data reviewed for Well 11, the specific capacity has not varied significantly, ranging between 8 and 10 gpm/ft, which is slightly higher that the well's original value.

Well 11 underwent rehabilitation in 2003 when the pump setting was raised from 60 feet deep to 50 feet deep. Well 11 has consistently been pumped between 300 and 400 gpm, without any noticeable declines in specific capacity over the 14 years of data. It is recommended that Well 11 be put on a 10 year well and pump maintenance cycle.

4.1.10.3 Well 12

Well 12's original specific capacity after construction in 1969 was reported to be 26 gpm/ft. Prior to well rehabilitation in 2006, Well 12's specific capacity was 21 gpm/ft. Following the 2006 maintenance work, the well's specific capacity was increased to 26 gpm/ft, equal to the original value after construction in 1969. The specific capacity has declined substantially since this rehab work was done, with recent values below 15 gpm/ft. Well 12 was rehabilitated again in 2011 with a small increase in specific capacity.

Well 12 has also been consistently pumped between 300 and 400 gpm over the past 14 years, but with a noticeable specific capacity decline compared to Well 11. Given that Well 12's specific capacity has declined over 50 percent since 2001, Well 12 should also be scheduled for rehabilitation, and its performance continued to be monitored to determine the appropriate rehabilitation cycle.

4.1.10.4 Well 15

Well 15's original specific capacity after construction in 1993 was reported to be 39 gpm/ft. The well's specific capacity has varied over the past 14 years from a low of 30 gpm/ft to over 50 gpm/ft. Well 10's most recent value (end of 2013) was report to be 48 gpm/ft, which is also substantially above the well's original value.

The well underwent rehabilitation in 2009 when the specific capacity declined quickly from 50 gpm/ft in 2008 to 30 gpm/ft one year later. The well has been able to maintain a specific capacity between 45 and 50 gpm/ft over the past two years. The well performance should continue to be monitored, but it appears that Well 15 could also be place on a 10 year rehabilitation cycle like Well 12.

4.1.10.5 Well 16

Well 16's original specific capacity after construction in 2007 was reported to be 20 gpm/ft. The well only has four years of operational data, so trends in performance are easily discernible, especially since the well has not been extensively pumped at its rated capacity of 1,600 gpm. Over the past two years, the well's specific capacity has been running above the original value of 20 gpm/ft.

Similar to Well 11 and 15, Well 16's performance should be monitored, but it appears that Well 16 could also be placed on a 10 year rehabilitation cycle like those other two Utility supply wells.

4.2 EXISTING BOOSTER PUMP FACILITIES

The Harford Water Utility owns and operates two booster pumping stations which provides the ability to move water between pressure zones, plus high service pumping units that serve Wells 10 and 16.

4.2.1 Interzone Transfer Station

The Interzone Transfer Station (ITS) was built in 1998 and is located immediately adjacent to the 500K Water Tower on the City's north side. The ITS gives the Utility the flexibility to easily move water between the Primary Pressure Zone and the Low Level Pressure Zone as needed.

The ITS is equipped with two booster pumps to allow water to move from the LLPZ into the PPZ. The ITS is also equipped with a flow control value which allows water to flow by gravity from the PPZ into the LLPZ, and can be set for various flow rates. The booster pump and flow control valve are monitored and controlled remotely by the Utility's SCADA system master station, also located in a large panel inside the ITS.

TABLE 4-10

INTERZONE TRANSFER STATION
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

INTERZONE TRANSFER STATION		
Number of Pumps	2	
Number of Valves	1	
Booster Pumps	#1	#2
Pump Type	Centrifugal	Centrifugal
Pump Design Rate	750	750
Pump Design Head	92	92
Motor HP	25	25
Transfer Valve		
Type	Pressure Reducing / Flow Control	
Diameter	12 inches	
Comments: Station allows water to flow to either pressure zone.		

4.2.2 Powder Hill Booster Station

As recommended in the 2003 Report, the Water Utility implemented a new, very small pressure zone on the City's far east side, along the south side of STH 60 near the extremity of the service area. The Powder Hill Booster Station supplies water at higher pressure to serve a small residential development. The station was constructed and placed into service in 2007.

The station is supplied by the Primary Pressure Zone and boosts system pressures to the Powder Hill Road area which is has higher land elevations than can be adequately served by the PPZ. The station is equipped with higher capacity pumps that can provide fire protection flows to the small pressure zone.

TABLE 4-11

POWDER HILL BOOSTER STATION
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

POWDER HILL BOOSTER STATION				
Number of Pumps	4			
Number of Valves	1			
Booster Pumps	#1	#2	#3	#4
Pump Type	End Suction	End Suction	End Suction	End Suction
Pump Design Rate	50	50	500	500
Pump Design Head	70	70	80	80
Motor Hp	2	2	20	20

Comments: All pumps equipped with Variable Frequency Drives.

4.2.3 Well 10 High Service Booster Pump

Well 10 was designed as a two pumping system. The Well 10 well pump discharges water into a 150,000 gallon ground reservoir immediately adjacent to th facility. The Well 10 pumping station includes one vertical turbine, high service booster pump that takes water from the reservoir and discharges into the Hartford water distribution system and the Primary Pressure Zone.

TABLE 4-12

WELL 10 HIGH SERVICE PUMP
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Well 10 High Service Booster Pump	
Booster Pump	
Pump Type	Vertical Turbine
Pump Design Rate	650 gpm
Pump Design Head	n/a Feet
Motor Hp	75 Hp
Ground Reservoir	
Volume	150,000 gallons
Construction Material	Reinforced Concrete
Standby Power	
Type	Engine
Fuel	Natural Gas

Comments: Booster pump discharges water to the distribution system.

4.2.4 Well 16 High Service Booster Pumps

The water treatment plant constructed for Well 16 in 2009 also required a two pumping system approach at this facility. Water pumped from Well 16 is discharged into the gravity filters at the water treatment plant. Filtered water is discharged into a clearwell and then flows into two pumping chambers prior to being booster pumped.

The facility is equipped with three high service, vertical turbine booster pumps. The booster pumps have the same pumping capacity. Water from the high service pumps is discharged into the Hartford distribution system and the Primary Pressure Zone.

TABLE 4-13

WELL 16 HIGH SERVICE PUMPS
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

WELL 16 WATER TREATMENT PLANT			
Booster Pump	#1	#2	#3
Pump Type	Vertical Turbine	Vertical Turbine	Vertical Turbine
Pump Design Rate	825 gpm	825 gpm	825 gpm
Pump Design Head	286 feet	286 feet	286 feet
Motor Hp	75 hp	75 hp	75 hp
Storage	Clearwell	Pumping Chamber #1	Pumping Chamber #2
Volume (gallons)	150,000	70,000	60,000
Construction Material	Reinforced Concrete		
Standby Power			
Type		Generator	
Fuel		Diesel	
Comments: Water pumped into the Primary Pressure Zone.			

4.3 EXISTING WATER TREATMENT FACILITIES

Treatment performed at Wells 10, 11, 12 and 15 is chemical addition. Chemical additions are made at the discharge piping at each facility for disinfection (gas chlorine), dental protection (fluoride) and sequestration and corrosion control (polyphosphate).

Water treatment at Well 16 consists of physical removal of high levels of naturally occurring dissolved iron in the raw well water. The raw water is chemically oxidized using chlorine to precipitate the minerals which can then be removed from the water using conventional gravity filtration. Additional chemical treatments of chlorine, fluoride and polyphosphate are also added to the filtered water prior to being discharged to the Hartford distribution system.

4.4 EXISTING STORAGE FACILITIES

The Water Utility owns, operates and maintains four separate elevated storage tanks; two tanks serve the Primary Pressure Zone and two serve the Low Level Pressure Zone. The following sections summarize the design and operating characteristics of each elevated storage facility.

4.4.1 300K Water Tower (CTH K Tower)

The Primary Pressure Zone includes a 300,000 gallon pedestal spheroid water tower located along County Highway K (CTH K) on the southeast side of the City. The tower is commonly referred to as the 300K Tower. The 300K Tower was constructed in 1999 and has an overflow elevation of 1178 feet USGS. The tower's design and operating characteristics are summarized in Table 4-14 below.

TABLE 4-14

300K WATER TOWER
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

300K TOWER (CTH K)	
Capacity	300,000 gallons
Year Constructed	1999
Constructed By	Maguire Iron
Type	Spheroid
Construction Material	Steel
Height to Overflow	117 feet
Overflow Elevation	1178 feet USGS
Base Elevation	1061 feet USGS
Diameter	46 feet
Head Range	35 feet
Comments: Serves the Primary Pressure Zone	

4.4.2 750K Water Tower

The Primary Pressure Zone is also served by a 750,000 gallon composite-style water tower located along STH 60 on the west side of the City. The 750K Tower was constructed in 2010 and has an overflow elevation of 1178 feet USGS.

The base of the water tower is equipped with an altitude valve which is designed to eliminate overflows from occurring by the tower. The valve has been set to close when the water level in the elevated tank approaches the normal high water level (overflow level).

The tower's design and operating characteristics are summarized in Table 4-15 below.

TABLE 4-15

750K TOWER
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

750K TOWER	
Capacity	750,000 gallons
Year Constructed	2010
Constructed By	Landmark Structures
Type	Composite
Construction Material	Steel/Concrete
Height to Overflow	139.5 feet
Overflow Elevation	1178 feet USGS
Base Elevation	1038.5 feet USGS
Diameter	60 feet
Head Range	39.5 feet

Comments: Serves Primary Pressure Zone. Tower includes an altitude valve.

4.4.3 150K Elevated Tank

The Low Level Pressure Zone is served by a 150,000 gallon elevated tank located along High Street in the central part of the city. The 150K was constructed in 1948 and has an overflow elevation of 1,134 feet. The tower's design and operating characteristics are summarized in Table 4-16 below.

TABLE 4-16

150K TOWER
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

150K Tower (High Street Tower)	
Capacity	150,000 gallons
Year Constructed	1948
Type	Multi-leg
Construction Material	Steel
Height to Overflow	112 feet
Overflow Elevation	1134 feet USGS
Base Elevation	1022 feet USGS
Diameter	25.75 feet
Head Range	24 feet

Comments: Serves Low Level Pressure Zone.

4.4.4 500K Elevated Tank

The Low Level Pressure Zone is also served by a 500,000 gallon elevated tank located along CTH U on the northwest side of the City. The 500K Tower was constructed in 1976 and has an overflow elevation of 1,133.5 feet. The tower's design and operating characteristics are summarized in Table 4-17 below.

TABLE 4-17

500K TOWER
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

500K TOWER (CTH U Tower)	
Capacity	500,000 gallons
Year Constructed	1976
Type	Multi-leg
Construction Material	Steel
Height to Overflow	80.5 feet
Overflow Elevation	1133.5 feet USGS
Base Elevation	1053 feet USGS
Diameter	56 feet
Head Range	30 feet
Comments: Serves Low Level Pressure Zone	

4.4.5 Storage Facility Maintenance

The three older elevated tanks and the Well 10 ground reservoir have all either been inspected or had maintenance performed on them since the 2003 Study Report was completed. Table 4-18 summarizes the historical tank maintenance summary for the Utility's water storage facilities over the past 20 year period.

The most recent storage facility inspections and maintenance is summarized below.

Storage Facility	Most Recent Inspection	Most Recent Maintenance	Next Inspection Due
Well 10 Reservoir	2013	Before 1993	2018
Well 16 Ground Tanks	None	None	2014
150K Tower	2013	2003	2018
300K Tower	2011	2013	2016

TABLE 4-18

HISTORICAL STORAGE FACILITY MAINTENANCE SUMMARY
1993-2013

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Storage Facility Maintenance Chronology		
Year	**Inspection**	**Maintenance**
1993		150K Tower Repainted (Interior)
1994		500K Tower Repainted
1995		
1996		
1997		
1998		
1999		
2000		
2001	500K Tower	
2002		
2003		150K Tower Exterior Repainted
2004	300K Tower	
2005		
2006		
2007	500K Tower	
2008	Well 10 Reservoir; 150K Tower	300K Tower Exterior Washed
2009	300K Tower	
2010		
2011	750K Tower; 300K Tower	
2012	500K Tower	
2013	Well 10 Reservoir; 150K Tower	300K Tower Exterior Washed

Recent Storage Facility Inspection & Maintenance Summary	
Well 10 Reservoir	2008, 2013
Well 16 Reservoirs	None
150K Tower	1993, 2003, 2008, 2013
300K Tower	2004, 2008, 2009, 2011, 2013
500K Tower	1994, 2001, 2002, 2007, 2012
750K Tower	2011 Warranty Inspection

Storage Facility	Most Recent Inspection	Most Recent Maintenance	Next Inspection Due
500K Tower	2012	1994	2017
750K Tower	2011	None	2015

4.5 WATER DISTRIBUTION SYSTEM

The City's water distribution system provides a means of transporting and distributing water from the supply sources to Utility customers and other points of usage. The distribution system must be capable of supplying adequate quantities of water at reasonable pressures throughout the service area under a range of operating conditions. Furthermore, the distribution system must be able to provide not only uniform distribution of water during normal and peak demand conditions, but must also be capable of delivering adequate water supplies for fire protection purposes.

The City of Hartford's water system consists of nearly 100 miles of water mains ranging in size from 4 inches to 16 inches in diameter. Water mains are sized in accordance with its primary function. In general, mains 10 inches and larger are considered transmissions mains, with the primary purpose of conveying large flow rates along major routes. Water mains 8 inches and smaller are generally considered distribution mains, conveying water from the transmission mains to customer service laterals.

The current water main size inventory is listed in Table 4-19 and graphically shown in Figure 4-5. Of the approximately 100 miles of water main, 43 percent are transmission mains; the remaining 57 percent are distribution mains less than 10 inches in diameter. The Utility still maintains substandard water mains (3 and 4 inch diameter) with currently represents about 16 percent of the total water distribution system length.

The current water main age distribution is listed in Table 4-20 and graphically shown in Figure 4-6. The existing Hartford distribution system is relatively new with nearly one-half of the system piping being newly installed or replaced since the year 2000.

4.6 WATER SYSTEM CONTROLS

The Master Station for the Water Utility's supervisory control and data acquisition (SCADA) system is located in a large panel at the Interzone Transfer Station. Control and monitoring communication between the Master Station and remote water system facilities is performed using UHF radio signals.

The main control station is located at the Utility Office on Sumner Street. SCADA signals from the Master Station are sent to the Utility Office using a high speed spread spectrum radio.

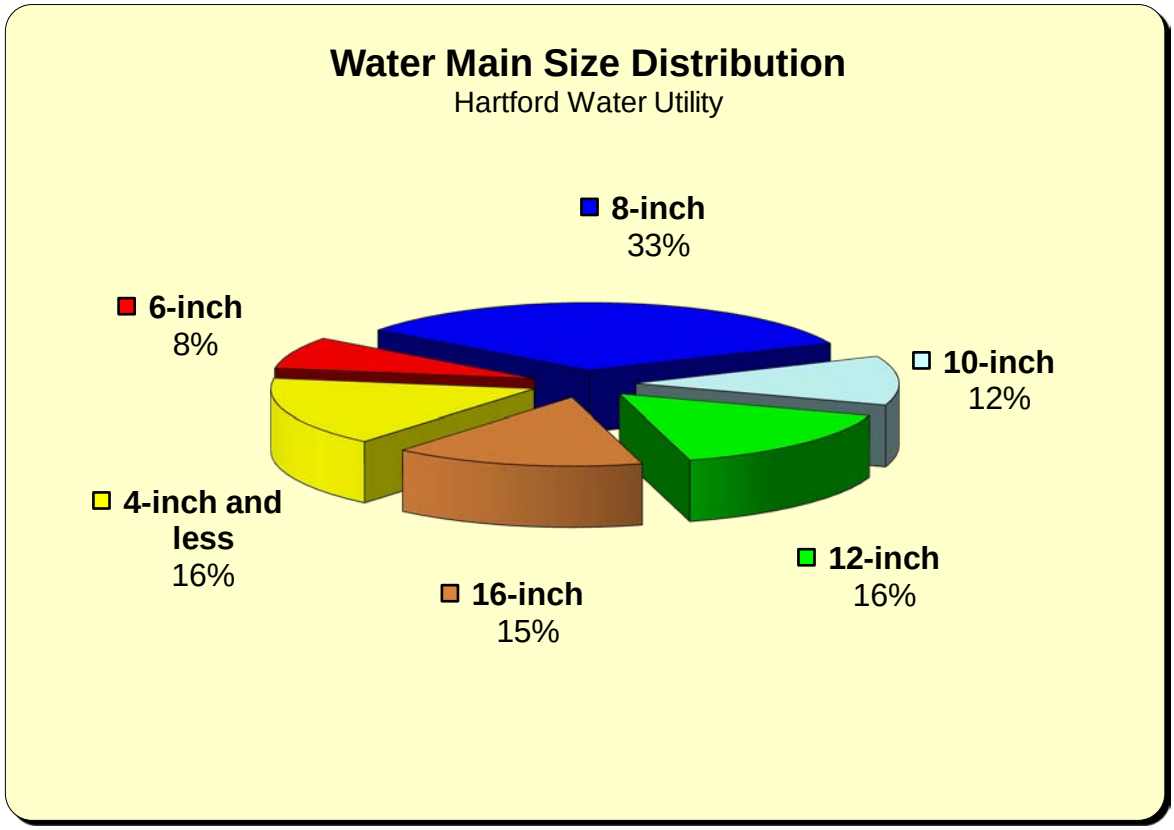
The old Utility control system was replaced in 2005. The upgraded system replaced all of the old remote telemetry units (RTUs) with their outdated printed circuit boards with new programmable logic controllers (PLCs). The upgraded system allows operators to operate and control pumps, monitor supply pump flow rates and discharge pressures, and monitor and trend elevated tank levels. System well and high service booster pumps are scheduled and automatically sequenced by operators using a pump selection matrix system that uses water levels in the elevated tanks for pump operating control.

The water level in the 300K Tower serves as the primary control for the Primary Pressure Zone supply sources. The 500K Tower water level serves as the primary control for the Low Level Pressure Zone supply sources.

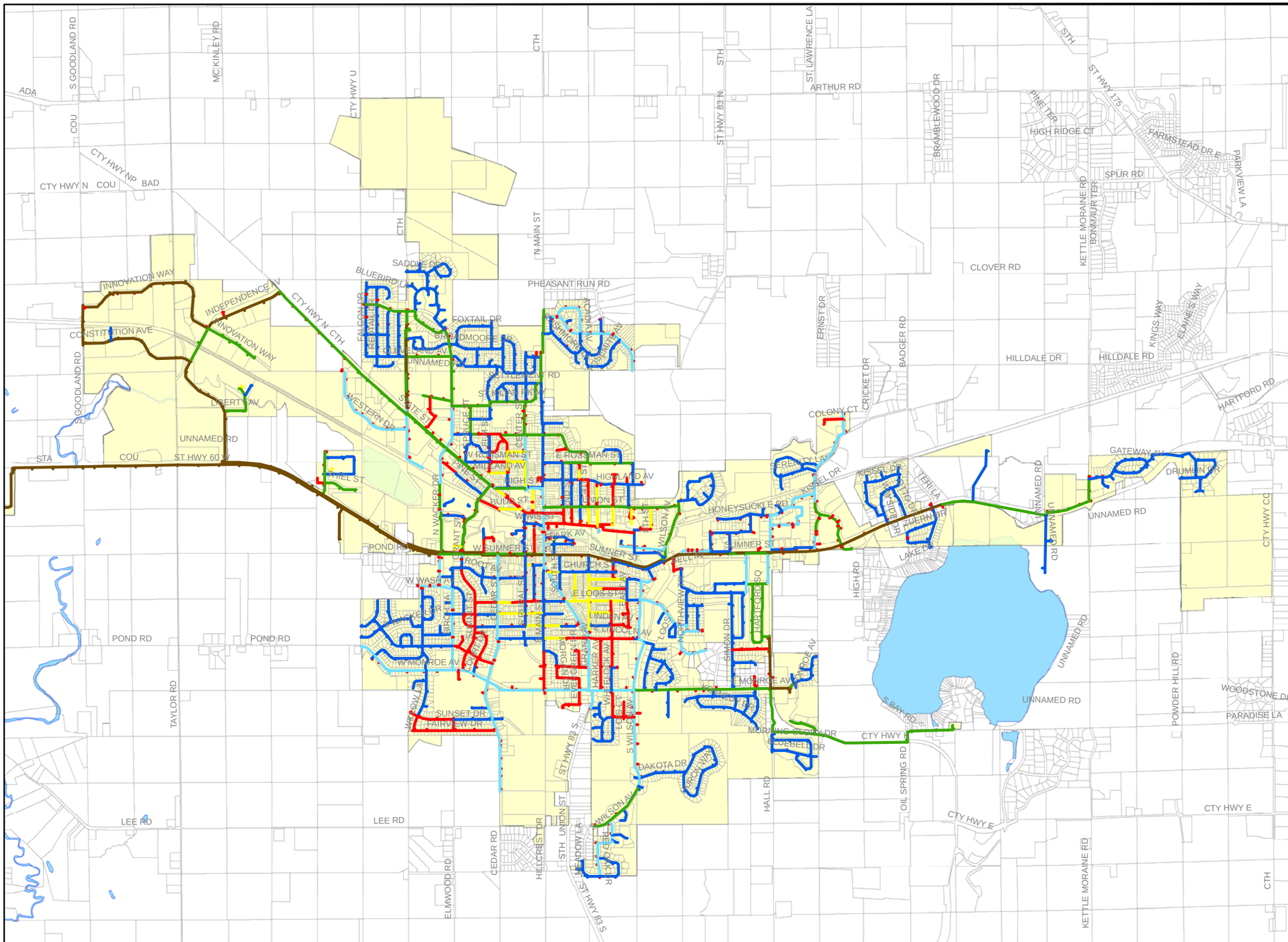
TABLE 4-19

WATER MAIN SIZE DISTRIBUTION
HARTFORD WATER UTILTY
CITY OF HARTFORD, WISCONSIN

Diameter	Approximate Total Length	Percentage of Total
4-inch and less	85,340	16.3%
6-inch	40,109	7.7%
8-inch	174,074	33.3%
10-inch	60,873	11.7%
12-inch	81,299	15.6%
16-inch	80,396	15.4%
Total	**522,091 feet**	**100%**



Note: Water main size distribution based on 2013 PSC Annual Report data.
Hydrant Leads and transfer piping not included



Legend

Water Main Size

- 4 INCH AND LESS
- 6 INCH
- 8 INCH
- 10 INCH
- 12 INCH
- 14 INCH
- 16 INCH
- CITY LIMITS

0 2,000 4,000 Feet

Source: City County & Data
Map by: SEH

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DATE: APRIL 2014

WATER SYSTEM EVALUATION

CITY OF HARTFORD, WISCONSIN

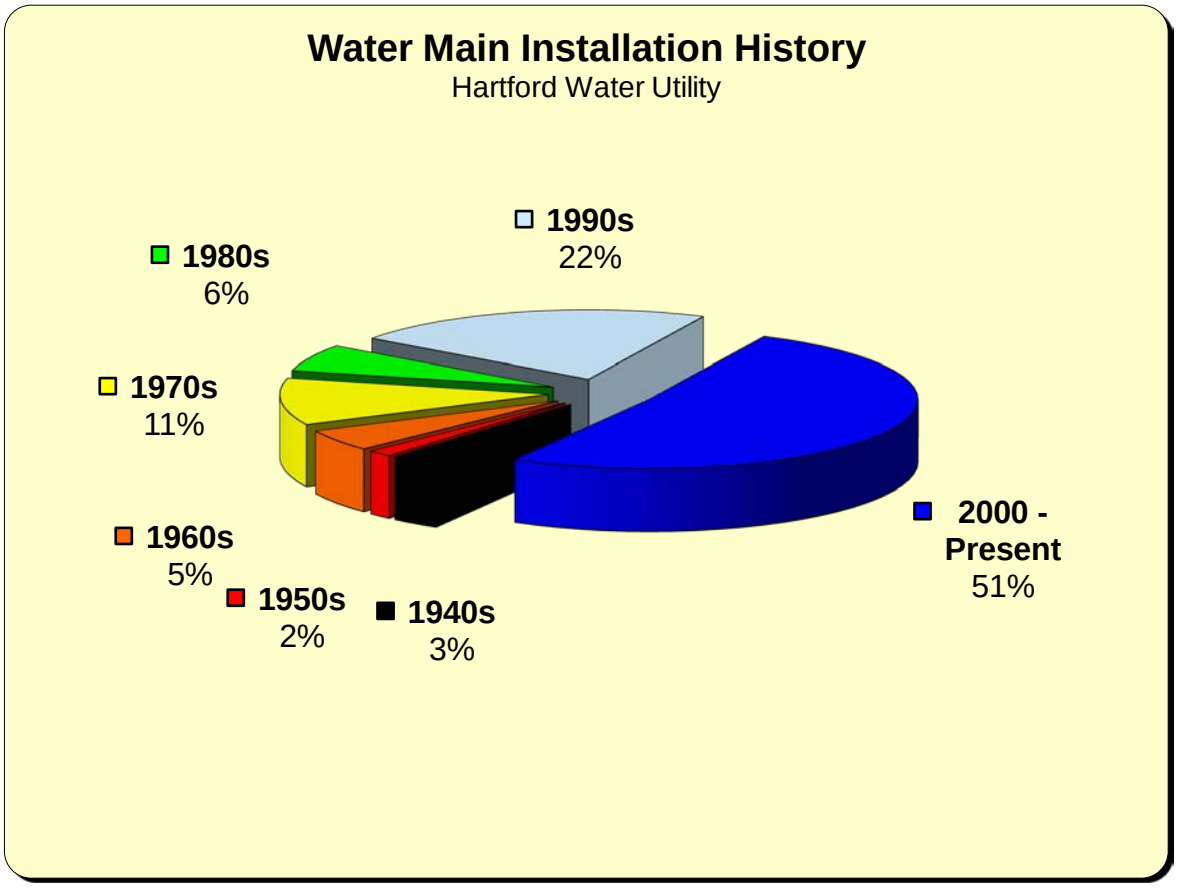
EXISTING DISTRIBUTION SYSTEM WATER MAIN BY DIAMETER

FIGURE 4-5

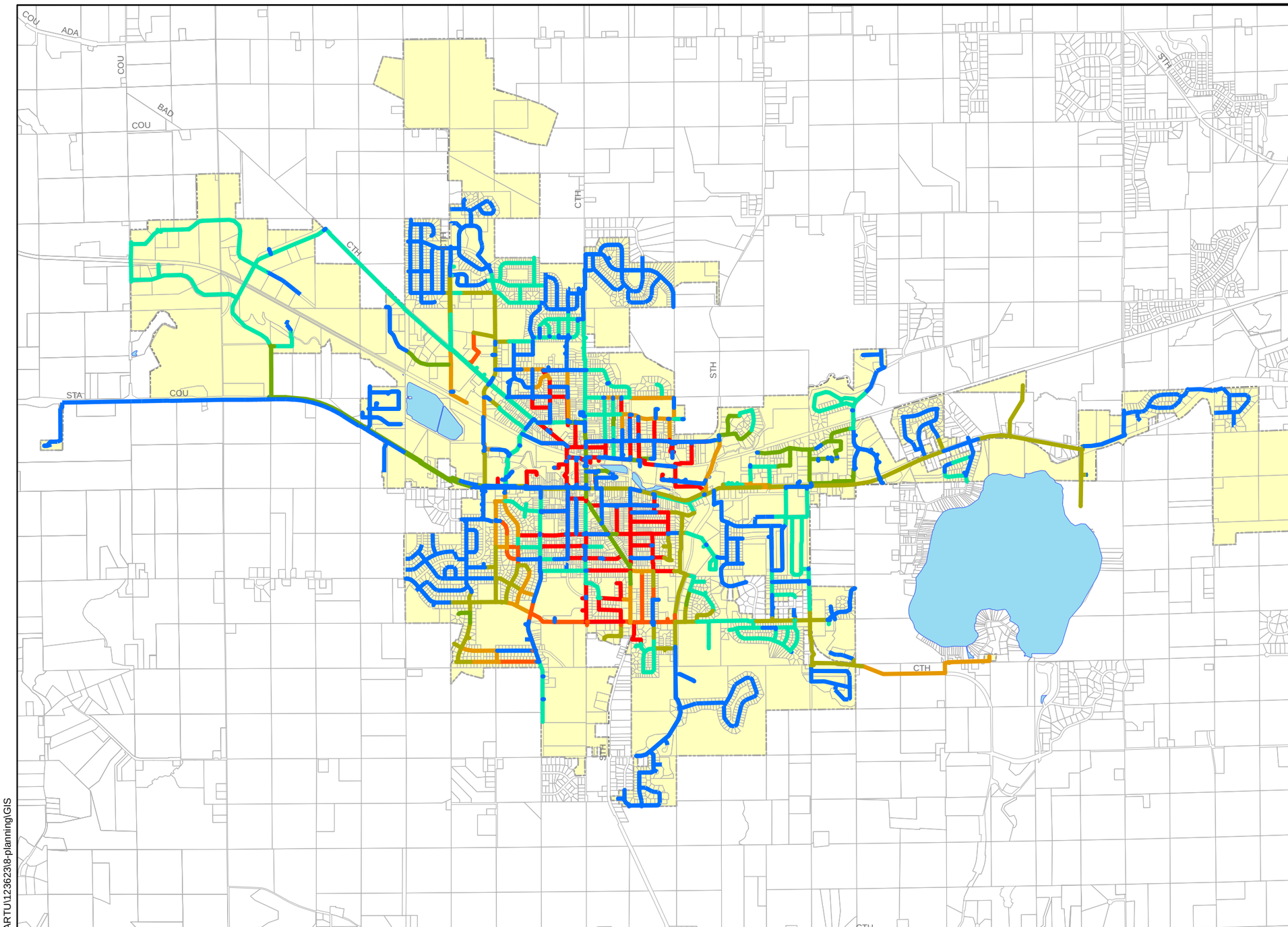
TABLE 4-20

WATER MAIN INSTALLATION DATE DISTRIBUTION
HARTFORD WATER UTILTY
CITY OF HARTFORD, WISCONSIN

Installation Decade	Approximate Total Length	Percentage of Total
1940s	15,631	3.0%
1950s	7,751	1.5%
1960s	26,136	5.0%
1970s	57,184	11.0%
1980s	32,756	6.3%
1990s	114,814	22.0%
2000 - Present	267,819	51.3%
Total	**522,091 feet**	**100%**



Note: Water main installation date distribution estimated based on City GIS and 2013 PSC Annual Report data.



Legend

City Limits

Water Main Age

Decade Installed

- 1940s
- 1950s
- 1960s
- 1970s
- 1980s
- 1990s
- 2000+

0 2,000 4,000 Feet

Source: City & County Data
Projection: NAD_1927_StatePlane_Wisconsin_South
Map by: SEH

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WATER SYSTEM EVALUATION

CITY OF HARTFORD, WISCONSIN

EXISTING WATER DISTRIBUTION SYSTEM WATER MAIN AGE

FIGURE

4-6

5.0 WATER SYSTEM EVALUATION

An important component of the Utility's master planning process was the evaluation of the existing water system and performing a deficiency analysis. This chapter summarizes the findings from this evaluation.

5.1 EXISTING SYSTEM DEFICIENCY ANALYSIS

Water systems are analyzed, planned, and designed primarily through the application of basic hydraulic principles. Some important factors that must be considered when performing this analysis include:

1. The location and capacity of supply facilities
2. The location, sizing, and design of storage facilities
3. The location, magnitude, and variability of customer demands
4. Water system geometry and geographic topography
5. Minimum and maximum pressure requirements
6. Land use characteristics with respect to fire protection needs
7. Other operational criteria which define the manner in which the system can most efficiently be operated

For this study, an evaluation of the Hartford water system was performed to determine the adequacy of the system to supply existing and future water needs and to supply water for fire protection purposes.

The system was evaluated based on the following criteria:

1. Pressure
2. Flow capacity
3. Reliability
4. Supply
5. Storage

The water system evaluation was based on compliance with State code requirements and standard water industry engineering practice.

5.2 WATER SYSTEM COMPUTER MODEL

The existing computer model of the Utility's water distribution system that was developed for the 2003 Study was updated to reflect changes to the system since 2003. The Hartford system was modeled using WaterCad computer modeling software developed by Bentley. Pipe roughness coefficients were estimated based on the diameter and types of pipe materials, and approximate age of each section of water main using roughness aging curves developed from field testing of the Hartford system.

The Hartford water system model was calibrated using results of flow testing performed for this study in 2013. Table 5-1 lists the flow test locations, and Table 5-2 summarizes flow test results. During the model calibration process, pumping rates, customer demands, and tower water levels were set to the field conditions, and pipe roughness coefficients were adjusted until the calibrated system model adequately simulated field test data.

TABLE 5-1

SUMMARY OF FLOW AND PRESSURE TESTS

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Flow Test Number	Flowing Hydrant	Residual Hydrant #1	Residual Hydrant #2
F-1	Goodland Road, 1st Hyd. S. of Railroad (1-303)	Constitution Ave. & Goodland Rd. (1-302)	Independence Ave, Innovation Way
F-3	Falcon Dr. & Nighthawk Dr.	Redtail Dr. & Nighthawk Dr.	N Wacker Dr. & Oriole Dr.
F-4	Woodruff Way & Foxtail Dr.	Foxtail Dr. 1st west of flowing	Mulberry & Cleveland
F-5	Yosemite Ave. & Yellowstone Dr.	Yellowstone Rd. West of Yosemite Ave	Yellowstone & Hwy K
F-6	Victor Dr. & Forest St. (337)	Forest St. & Russel Ave. (325)	State St & Grant St
F-9	Durango West of Harrison	Harrison and Durango	Willow and Wacker
F-10	Washington East of Summit	Summit St. & West Washington Ave.	Root & Birtch
F-11	Fairview Dr. & Willow La. (446)	Sunset Dr. & Willow La. (440)	Cedar South of Monroe
F-12	Firefly across from Red Oak	Red Oak North of Firefly	End of Dakota
F-15	East Ave. & Linden Ave. (156)	Linden Ave. at Curve (157)	Branch & Loos
F-18	Gateway & East Gate	South Gate West of F18F	Hwy 60 nearest Well 12
F-19	East end Highland Ave.	Between Rossman and Highland	Rossman & 4th
F-20	Tamarack Ave. & Honeysuckle Rd. (258)	Honeysuckle Rd. & Karen Court (262)	Briarwood & Hilldale
F-21	On Gold Bug Court	Gold Bug Court & Kissel Dr.	Wayside & Hwy 60
F-22	Simon & Valley View (N)	Simon & Valley View (S)	Simon & Novak

TABLE 5-2

SUMMARY OF COMPUTER MODEL CALIBRATION

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Test No.	Flowing Hydrant F1	Residual Hydrant R1	FIELD TEST RESULTS			
			Static Pressure (psi)	Residual Pressure (psi)	Pressure Differential (psi)	Flow (gpm)
1	Goodland Road, 1st Hyd. S. of Railroad (1-303)	Constitution Ave. & Goodland Rd. (1-302)	55	45	10	2,200
3	Falcon Dr. & Nighthawk Dr.	Redtail Dr. & Nighthawk Dr.	57	50	7	2,230
4	Woodruff Way & Foxtail Dr.	Foxtail Dr. 1st west of flowing	55	43	12	2,070
5	Yosemite Ave. & Yellowstone Dr.	Yellowstone Rd. West of Yosemite Ave	55	40	15	1,770
6	Victor Dr. & Forest St. (337)	Forest St. & Russel Ave. (325)	59	49	10	1,930
9	Durango West of Harrison	Harrison and Durango	78	60	18	1,890
10	Washington East of Summit	Summit St. & West Washington Ave.	56	51	5	1,890
11	Fairview Dr. & Willow La. (446)	Sunset Dr. & Willow La. (440)	56	30	26	1,070
12	Firefly across from Red Oak	Red Oak North of Firefly	60	29	31	1,360
15	East Ave. & Linden Ave. (156)	Linden Ave. at Curve (157)	78	50	28	2,000
18	Gateway & East Gate	South Gate West of F18F	64	26	38	1,510
19	East end Highland Ave.	Between Rossman and Highland	60	52	8	2,000
20	Tamarack Ave. & Honeysuckle Rd. (258)	Honeysuckle Rd. & Karen Court (262)	75	70	5	2,230
21	On Gold Bug Court	Gold Bug Court & Kissel Dr.	62	41	21	1,850
22	Simon & Valley View (N)	Simon & Valley View (S)	46	41	5	2,070

5.3 WATER SYSTEM PRESSURES

The Hartford water system model was used to evaluate existing water distribution system characteristics and identify deficiencies with respect to pressures and flow capacities. Water system pressure will vary around the service area based on differences in topographic elevations, as well as supply rates and customer demands. In general, as customer demands increase, pressures decrease. Areas higher in topographic elevation will also tend to exhibit lower water system pressures.

A water distribution system must be designed to provide pressures within a range of minimum and maximum allowable conditions. When system pressure is too low, customers may complain of inadequate water supply, customer meters may tend to record inaccurately, and fire protection will be limited. Pressures that are too high can cause problems with system operation and maintenance, and will tend to cause higher consumption rates by customers. High water system pressures can also increase the amount of water loss, as leakage rates will increase with increases in system pressure.

The Wisconsin Administrative Code requires that municipal water systems be designed with a minimum pressure of 35 psi and a maximum pressure of 100 psi at all locations in the service area under normal operating conditions. Furthermore, water systems are required to be operated so that under fire flow conditions, the residual pressure in the system will not fall below 20 psi at any location.

Figure 5-1 illustrates water system pressure contours throughout the City for a typical peak hour demand condition in 2013. As the figure indicates, system pressures can vary throughout the Utility's existing service area.

Essentially all areas of the Hartford water system have pressures that are within the required range of pressures of 35 psi and 100 psi under all normal conditions. To address concerns with low and high pressure areas of the system, the Hartford system was segmented into two pressure zones in 1998 to adequately serve current and future Utility customers with adequate water pressure.

Currently, water pressures in the Primary Pressure Zone range from 40 psi to 90 psi; pressures in the Low Level Pressure Zone range from 40 psi to 75 psi. The lowest pressures generally occur in the Primary Pressure Zone in areas with ground elevations from 1060 feet to 1072 feet USGS. The Primary Zone will not adequately serve areas with elevations above 1075 feet USGS.

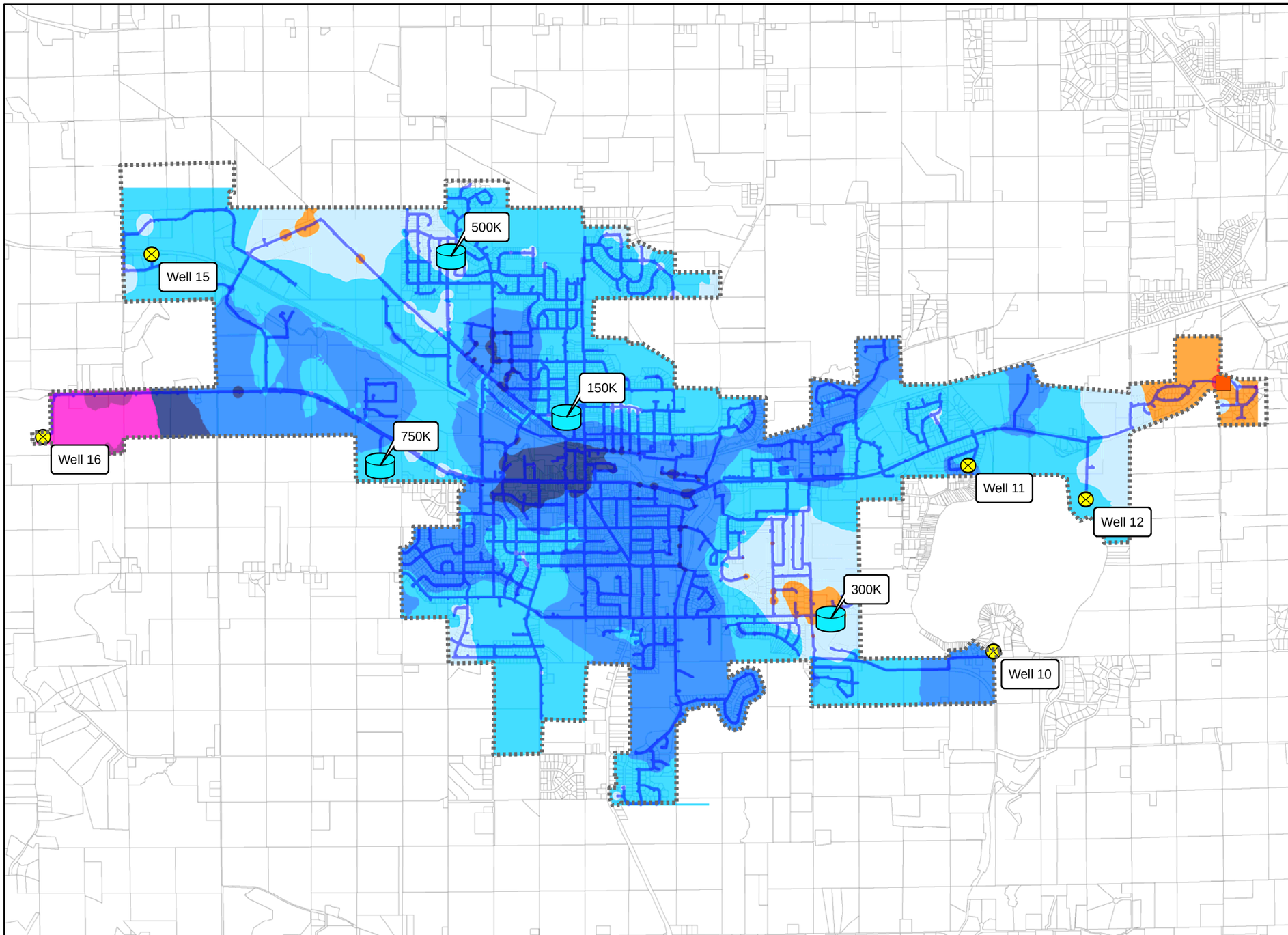
Lowest Primary Zone system pressures are in the immediate area of the 300K Tower and in the far east along STH 60 where peak hour pressures approach 40 psi. USGS.

Low Level Pressure Zone areas with the lowest pressures (40-45 psi) are the industrial area on the northeast end of Independence Avenue near the intersection with CTH N. Ground elevations in this area vary from 1020 feet to 1040 feet USGS.

5.4 FIRE FLOW CAPACITIES

Determining the maximum amount of flow that is available for fire protection is an important part of water system planning. In most instances, water main sizes are designed specifically to supply desired fire flows.

Guidelines for determining fire flow requirements are provided by the ISO. ISO, the Insurance Services Office, is a national non-profit organization responsible for evaluating and classifying municipalities for fire insurance rating purposes. After inspection and testing, ISO classifies each community on a scale of 1 to 10, with Class 1 being ideal. Each portion of fire fighting capability of the city, including water supply, fire department, and fire services communications, comprises a specific portion of the total rating.



Legend

- Existing Water Service Area
- Elevated Water Storage Tanks
- Active Water Supply Wells
- Transfer/Booster Station
- Existing Water Main

System Pressure (psi)

- <40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100
- 100+

0 2,000 4,000 Feet

Source: City & County Data
Map by: SEH

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DATE: APRIL 2014

WATER SYSTEM EVALUATION

CITY OF HARTFORD, WISCONSIN

EXISTING WATER SYSTEM PRESSURE

FIGURE 5-1

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The most recent City of Hartford survey was conducted last fall in November 2013. The previous survey was completed in September 1994 where Hartford received a total credit score of 66.95 points, corresponding to a Class 4 rating. In 2013 Hartford received a total credit score of 71.94 points, which improved the City's ISO rating to a Class 3. Hartford water supply received 38.78 out of a possible total 40 points. ISO typically performs surveys of communities every 15 years.

Fire protection requirements vary with the physical characteristics of each building that needs protection. Required fire flows for a specific building can vary from 500 gpm to as high as 12,000 gpm, depending on habitual classifications, separation distances between buildings, height, materials of construction, size of the building, and the presence or absence of building sprinklers. Municipal fire insurance ratings are partially based on the city's ability to provide needed fire flows up to 3,500 gpm. If a specific building has a needed fire flow greater than this amount, the community's fire insurance rating will only be based on the water system's ability to provide 3,500 gpm.

Table 5-3 is a list of some typical fire flow requirements for various land uses. These requirements were used as a basis for evaluating the Hartford water system. The requirements listed in the table are only intended as a general guideline. The actual needed fire flow for a specific building can vary considerably as discussed above.

Figure 5-2 illustrates the estimated available fire flow throughout the City for a typical maximum day water demand while maintaining a residual pressure of 20 psi throughout the system. In general, the vast majority of the City is very well protected with minimum fire flows of 3,000 gpm or more in most areas. Areas with lower available flows are primarily served by small dead end water mains, or are located on the extreme south or eastern western portions of the City.

Figure 5-3 compares available fire flow areas with existing City land uses (previously illustrated in Figure 2-1) and their associated fire flow needs, and identifies areas where lower than recommended fire flow currently exist. In general, the limited areas identified with fire flow deficiencies are served by older, small diameter and/or dead end water mains. As shown in Figure 5-3, there are only a few small, isolated areas with fire flow deficiencies served by dead-end water mains.

5.5 HYDRANTS SERVED BY SUBSTANDARD SIZE WATER MAINS

As noted in the 2003 Report, there were almost 20 hydrants in the distribution system that were served by 4 inch diameter water mains. The Wisconsin Administrative Code Chapter NR811 requires all public water systems to have hydrants served by a minimum 6 inch diameter water main. The Water Utility has been very proactive over the past 11 years in addressing this issue, and only a few isolated hydrants remain on the system that are served by 4 inch mains. The Utility continues to plan for the upgrading of the distribution to replace all 4 inch diameter water mains, especially those serving fire hydrants.

5.6 SUPPLY RELIABILITY

For any water utility to serve its customers and protect the public welfare, water system facilities, equipment, and distribution systems must be reliable under all operating conditions. Reliability of utility service comprises a large part of the water utility's investment in plant and equipment.

Wisconsin Administrative Code requires all pumping stations to be served by a power supply from at least two independent electrical substations, or from a standby, auxiliary power source dedicated to water supply use. As a general rule, the Utility should be able to reliably supply average day customer demands and maintain adequate fire protection using auxiliary power sources.

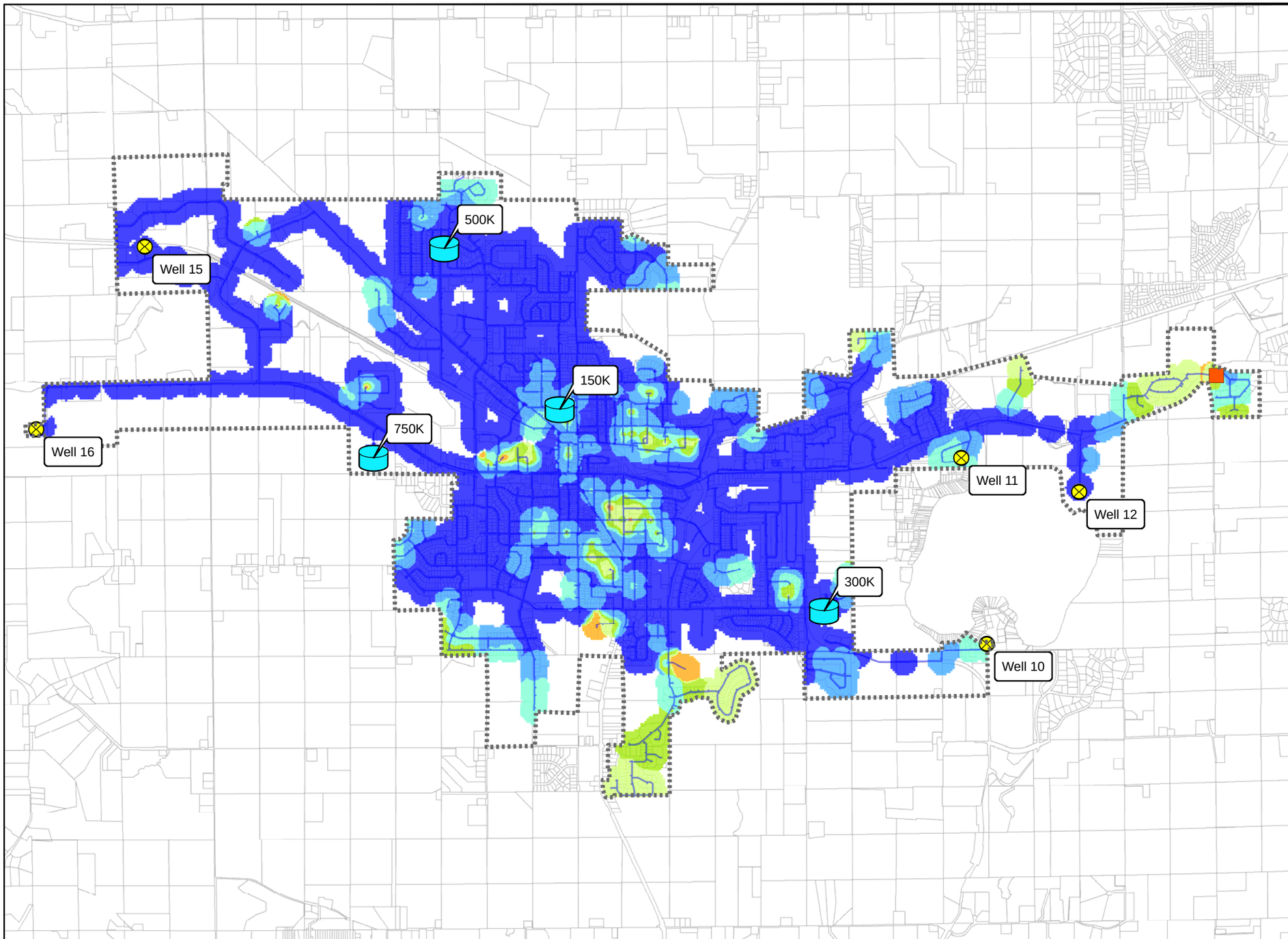
TABLE 5-3

TYPICAL FIRE FLOW REQUIREMENTS

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Land Use	Range of Needed Fire Flows (gpm)
Single & Two-Family:	
Over 100 feet Building Separation	500
31 to 100 feet Building Separation	750
11 to 30 feet Building Separation	1,000
10 feet or Less Building Separation	1,500
Multiple Family Residential Complexes	2,000 to 3,000+
Average Density Commercial	1,500 to 2,500+
High Value Commercial	2,500 to 3,500+
Light Industrial	2,000 to 3,500
Heavy Industrial	2,500 to 3,500+
Other Commercial, Industrial & Public Buildings	Up to 12,000



Legend

- Existing Water Service Area
- Elevated Water Storage Tanks
- Active Water Supply Wells
- Transfer/Booster Station
- Existing Water Main

Available Fire Flow (gpm)

- 1,000 - 1,500
- 1,500 - 2,000
- 2,000 - 2,500
- 2,500 - 3,000
- 3,000 - 3,499
- 3,500+

0 2,000 4,000 Feet

Source: City & County Data
Map by: SEH

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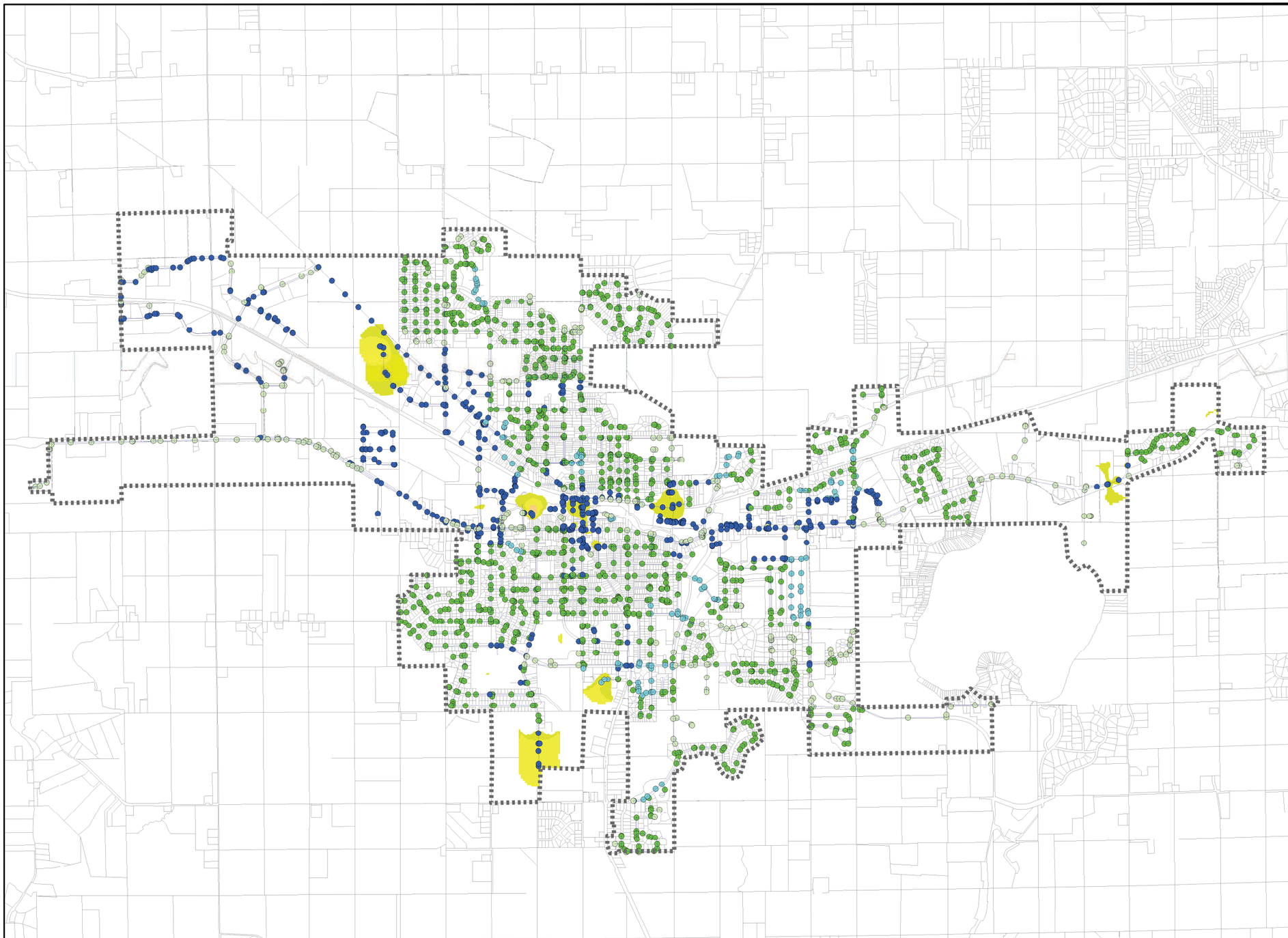
WATER SYSTEM EVALUATION

CITY OF HARTFORD, WISCONSIN

EXISTING AVAILABLE FIRE FLOW

FIGURE 5-2



Legend

Existing Water Service Area

Existing Water Main

Required Fire Flow (gpm)

- 1,000
- 1,500
- 2,000
- 2,500-3,500

Additional Fire Flow Needed (gpm)

- 3,000+
- 2,500-3,000
- 2,000-2,500
- 1,500-2,000
- 1,000-1,500
- 500-1,000
- 0-500
- 0

0 2,000 4,000 Feet

N

Source: City & County Data
Map by: SEH

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WATER SYSTEM EVALUATION

CITY OF HARTFORD, WISCONSIN

EXISTING SYSTEM FIRE FLOW DEFICIENCIES

FIGURE

5-3

Well 15, Well 16 and the Interzone Transfer Station are currently served with electricity by a Hartford Electric Utility substation on Independence Avenue and CTH N. The remaining active wells are all in the eastern portion of the City and are served with electric power by WE Energies substations.

Well 15, Well 16 and the Interzone Transfer Station have standby generators as their auxiliary power sources for operation in the event of an emergency or other power interruption. Wells 10, 11, and 12 have auxiliary power engines capable of operating the pumps in an emergency. Wells 10 and 12 have reduced capacities operating under the auxiliary systems.

From a review of the alternative power and supply sources available, the system can supply more than 5 mgd using standby power sources in the event of an emergency or other power interruption. The system has sufficient auxiliary power to meet current and future needs throughout the planning period. It will be important for the Utility to continue to maintain a water supply capacity provided with auxiliary sources of power to meet a minimum of an average day water demand.

5.7 WATER SUPPLY AND STORAGE

A critical step in long-range planning for the Hartford water system was identifying the future needs of the service area coupled with an assessment of water supply and storage requirements for the system and for each pressure zone.

Water supply and storage needs are closely related. The primary criteria used in determining required supply rates and storage volumes include maximum day demands, peak hour demands, operational characteristics, and fire protection requirements.

5.7.1 Reliable Supply Capacity

The reliable supply capacity of a water system is the total available delivery rate with the largest pumping unit out of service. The reliable supply capacity is less than the total supply capacity because well and other high service pumps must be periodically taken out of service for maintenance. These water supply pumps can be off-line for periods of several days to several weeks, depending on the nature of the maintenance being performed. Hartford's future reliable supply capacity may be less than the current reliable supply because the wells often lose capacity between maintenance cycles. Figure 5-4 compares historical water supply capacities with the historical Utility maximum day pumpage.

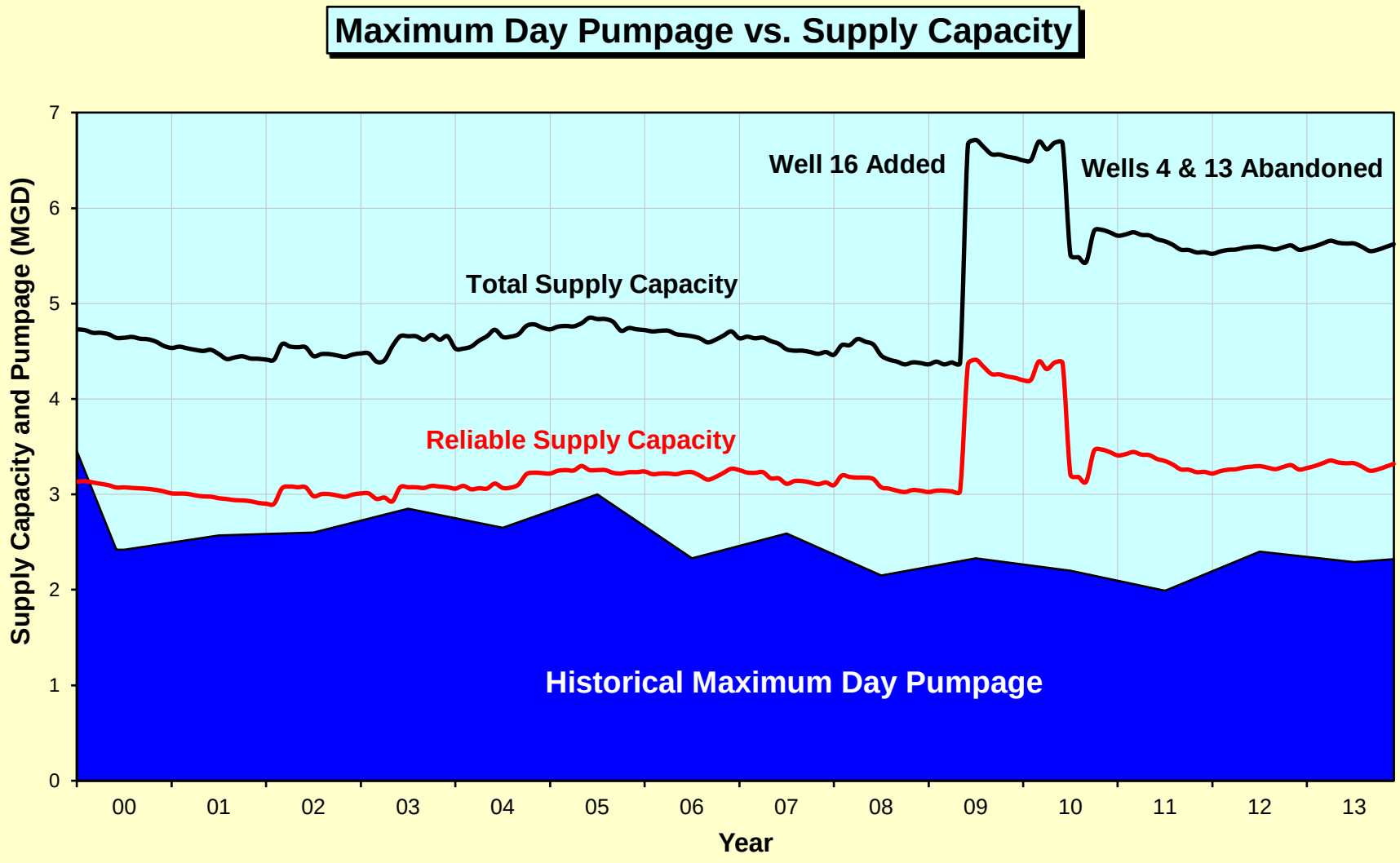
The current and projected reliable water supply capacity is given in Table 5-4. Under present operating conditions, the existing wells have a combined total capacity of about 3,900 gpm. However, the reliable capacity of the supply wells is 2,300 gpm with the largest unit (Well 16) out of service. The projected availability of this reliable supply capacity assumes that there will be no significant declines or changes in the water supply capacity over the next 20 years.

The Hartford water system was evaluated using the following criteria:

1. Reliable supply capacity equal to or greater than maximum day pumpage requirements.
2. Sufficient water storage capacity to meet peak hour and other short-term demands.

If both criteria are met, supply facilities will have adequate capacity to replenish storage during off peak hours, while depletion of available storage occurs during peak demand hours. Using this criteria and projections of future water supply needs, Table 5-5 summarizes minimum future supply needs.

The analysis indicated that the current reliable supply capacity should be sufficient to meet the projected Hartford system pumpage requirements to at least the year 2025. An additional 100 gpm of reliable



SHORT ELLIOTT HENDRICKSON

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FIGURE 5-4

HISTORICAL MAXIMUM DAY PUMPAGE vs. SUPPLY CAPACITY

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

APRIL 2014

HARTU 123623

TABLE 5-4

RELIABLE SUPPLY CAPACITY

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

		Current Minimum Operating Capacities	
Supply Source		**(gpm)**	**(MGD)**
Well 10		470	0.68
Well 11		390	0.56
Well 12		360	0.52
Well 15		1,080	1.56
Well 16		1,600	2.30
Total Supply Capacity		**3,900**	**5.62**
Less: Largest Supply Unit		1,600	2.30
RELIABLE SUPPLY CAPACITY		**2,300**	**3.31**
High Lift Well and Booster Pumps:		**(gpm)**	**(MGD)**
Well 10	Booster Pump	650	0.94
Well 11		390	0.56
Well 12		360	0.52
Well 15		1,080	1.56
Well 16	Booster Pump 1	800	1.15
Well 16	Booster Pump 2	800	1.15
Well 16	Booster Pump 3	800	1.15
Total Supply Capacity		**4,880**	**7.03**
Less: Largest Supply Unit		1,080	1.56
RELIABLE SUPPLY CAPACITY		**3,800**	**5.47**

Notes

Approximate minimum operating capacities of well and/or booster pumps based on current available operating data.

TABLE 5-5

RECOMMENDED SUPPLY CAPACITY

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

	Actual 2013	Projected 2025	Projected 2035
Total Annual Pumpage (MGY)	507	670	764
Average Day Pumpage (MGD)	1.39	1.84	2.10
Design Maximum Day Pumpage (MGD)	2.29	3.03	3.46
Existing Reliable Supply Capacity (MGD)	3.31	3.31	3.31
ADDITIONAL CAPACITY REQUIRED (MGD)	**None**	**None**	**0.14**
ADDITIONAL CAPACITY REQUIRED (gpm)	***0***	***0***	***100***

Note

Design maximum day pumpage requirements were estimated based on 165 percent of average day pumpage.

supply capacity will be needed to meet the projected year 2035 pumpage requirements. Figure 5-5 compares the current Utility water supply capacity with the projected maximum day pumpage requirements. As illustrated in the figure, the current reliable supply is sufficient to meet the current design maximum daily demand for approximately 14 years. The Utility would need to add supply capacity to meet the year 2035 projected pumpage.

The additional supply capacities summarized in Table 5-5 are considered minimum requirements. Actual water supply requirements will depend on the amount of water storage available. Therefore, the evaluation of Utility supply needs was considered together with an analysis of Utility storage needs.

5.7.2 Water Storage Needs

Water system storage is used for many purposes: as a "cushion" to equalize fluctuations in customer demands, establish and maintain water system pressures, provide operational flexibility for water supply facilities, an immediate supply of water for fire protection, and improve water supply reliability. The primary criteria used in this study for evaluating storage volume needs includes maximum day and peak hour demands, water supply capacities, and fire protection needs.

In general, storage facilities should be adequately sized to provide sufficient quantities of water for fire protection on days of maximum customer demands. Although storage requirements for fire protection are not anticipated to change over the planning period of this study, peak hour demands and reliable supply capacities will change as the City grows and improvements are implemented.

Figure 5-6 illustrates general categories of system storage. As customer demands exceed supply capacities during peak hour conditions, these excess demands must be met by depleting available storage. The amount of storage depleted is referred to as equalizing storage for peak hour requirements. Storage should also be available for fire protection purposes. To assure a reliable supply for fire protection, this storage should not be utilized to meet peak hour requirements.

In some instances, it may be desirable to provide additional reserve storage for other purposes. Reserve storage may be needed as a safety factor in emergencies or where customer demands are unpredictable and fluctuate widely. Additional storage may also be desired where the Utility wishes to take advantage of off peak electrical rates for pumping. Additional reserve storage of 10 to 15 percent is usually provided to allow an operating range for well and high service booster pump operation.

Three primary criteria were used to develop the relationship between supply capacities and optimum storage volumes for the Hartford Water Utility:

1. Reliable supply capacity should at least equal the projected maximum day pumpage requirements.
2. Total available storage should be capable of meeting fire protection needs, assuming reliable supply capacity is just adequate to meet maximum day requirements. A base fire flow of 3,500 gpm for three hours was used.
3. Reliable supply capacity, plus available storage volume, should equal or exceed fire flow requirements plus maximum day requirements.

5.7.3 Available Storage Capacity

Total available system storage was calculated based on the effective storage volume available from the elevated tanks. The effective storage volume of the elevated storage tanks is the volume in storage above

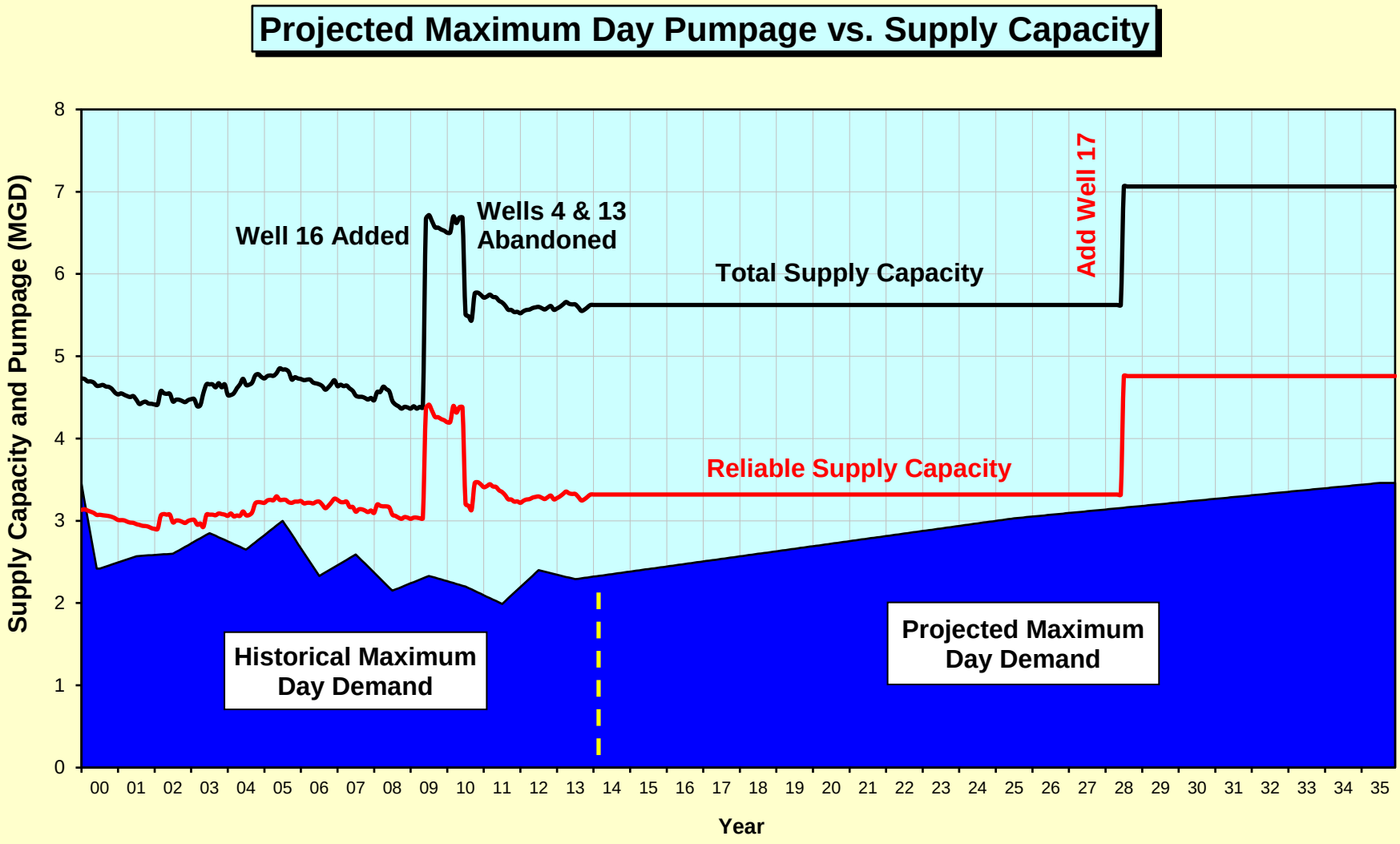

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FIGURE 5-5

PROJECTED MAXIMUM DAY PUMPAGE vs. SUPPLY CAPACITY

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

NOVEMBER 2014 HARTU 123623

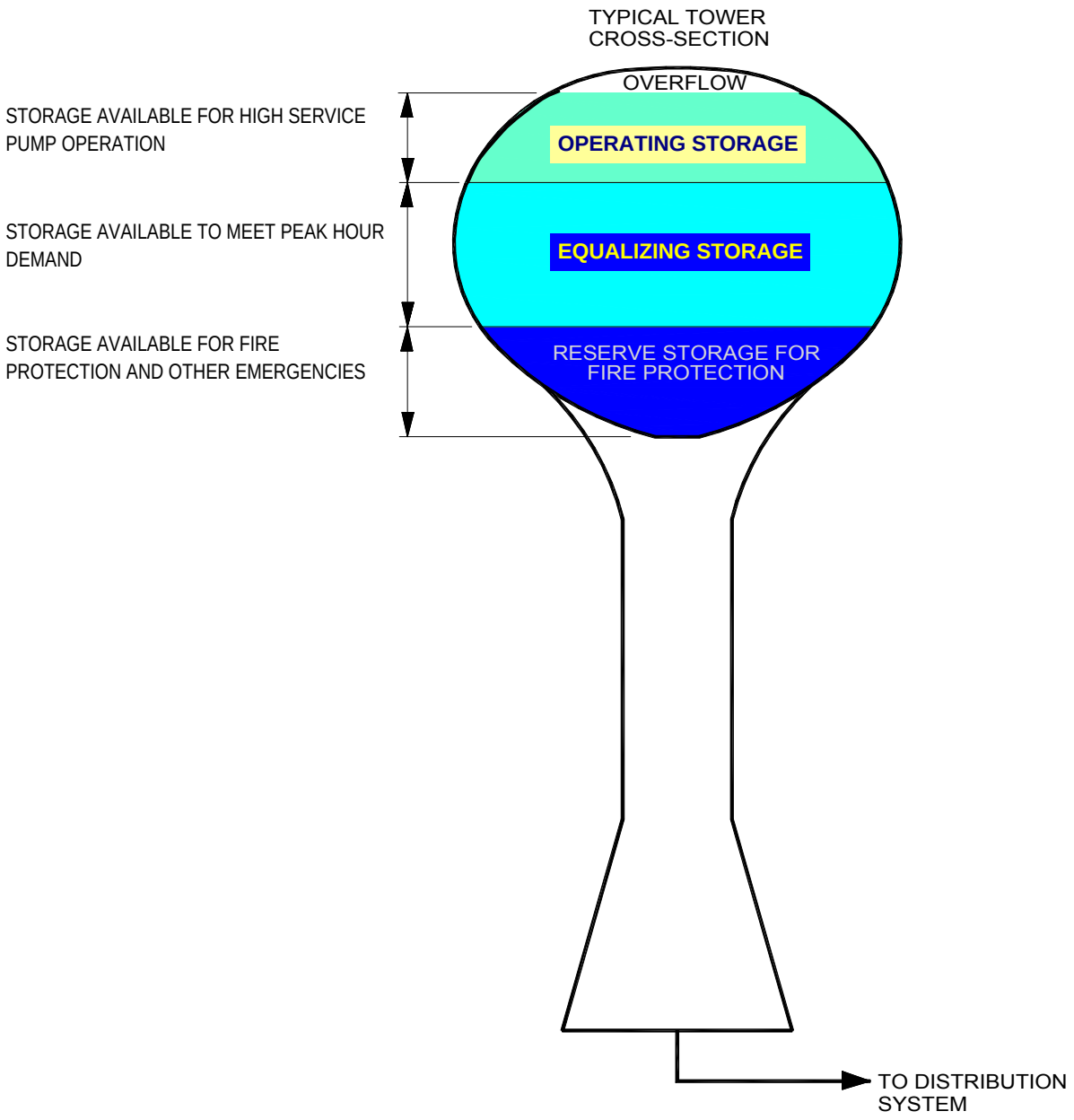

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FIGURE 5-6

SYSTEM STORAGE REQUIREMENTS

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

APRIL 2014 HARTU 123623

the lowest water level that could by maintained and provides minimum required pressures in the system. Under normal conditions, system pressures are required to be maintained above 35 psi. Under emergency conditions, pressures may be reduced to 20 psi. Effective peak hour operating storage and emergency storage volumes for the Hartford system have been determined based on minimum required system pressures in the distribution system.

The 150,000-gallon ground-level reservoir at Well 10 is not included in effective storage volume. This reservoir is small in volume and generally exists to compensate for differences in pumping rates between the well pump and high service booster pump.

The 130,000 gallon ground level storage volume in the two pumping chambers at the Well 16 water treatment plant is considered to be effective storage for the system. The water stored in these two tanks can be pumped into the Hartford system to meet peak hour demands, for fire protection or to meet other emergencies. The filtered water in the Well 16 treatment plant's 150,000 gallon clearwell is not considered effective storage as it is required to provide adequate chlorine contact time for the filtered water.

The current and projected storage requirements are summarized in Table 5-6. Storage requirements include estimates for equalization storage, fire protection, and reserve storage. The total effective storage capacity is 1.83 million gallons from the system's four elevated tanks and the Well 16 ground tanks. The current storage volume needs of the Hartford water system is 1.08 million gallons.

The updated supply-storage relationship for Hartford summarized in Table 5-6 is illustrated in Figure 5-7. A point is plotted on the graph for the current supply and storage conditions. There is sufficient reliable supply capacity to meet current and projected future needs for about 14 years. The Utility has sufficient water storage capacity to meet system needs throughout the 20 year planning period.

5.7.4 Zone Supply and Storage Requirements

Since the Hartford water distribution system consists of two major pressure zones, a separate supply and storage analysis was performed for each zone. The two zones operate independently with the exception of the Interzone Transfer Station, which gives the Utility the ability to move water from one zone to the other.

A summary of the reliable supply capacity for both zones is presented in Table 5-7. The analysis used to determine the Primary Pressure Zone supply and storage requirements is presented in Tables 5-8 and 5-9. The supply and storage analysis for the Low Level Pressure Zone is presented in Tables 5-10 and 5-11.

With all pumps in service, the Low Level Pressure Zone has excess supply capacity. The current normal operation is to pump water from the Low Level Pressure Zone into the Primary Pressure Zone using the Interzone Transfer Station.

5.7.4.1 Primary Pressure Zone Supply and Storage Requirements

The current Primary Pressure Zone reliable supply capacity is 2.79 mgd. This reliable supply capacity will decrease slightly in the future as less water will be available on days of maximum pumpage from the Low Level Pressure Zone. The PPZ reliable supply capacity is projected to be 2.55 mgd by the year 2025, and 2.33 mgd by the year 2035. There is sufficient supply capacity to serve the Primary Pressure Zone to the year 2025. An additional 100 gpm of reliable supply capacity to serve the Zone will be needed to meet projected demands by the year 2035.

TABLE 5-6

SUPPLY AND STORAGE NEEDS

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

SUPPLY REQUIREMENTS	**Actual 2013**	**Projected 2025**	**Projected 2035**
Recommended Reliable Supply Capacity (gpm)	1,590	2,100	2,400
Present Reliable Supply Capacity (gpm)	2,300	2,300	2,300
Additional Capacity Required (gpm)	**None**	**None**	**100**

STORAGE REQUIREMENTS	**Actual 2013**	**Projected 2025**	**Projected 2035**
Peak Hour Equalizing Requirements (gallons)	291,000	385,000	439,000
Optimum Fire Protection Needs (gallons)	630,000	630,000	630,000
Reserve Storage (gallons; 15% of Total)	162,000	179,000	188,000
Total Optimum Storage Requirements (gallons)	**1,083,000**	**1,194,000**	**1,257,000**
Effective Existing Storage Capacity (gallons):			
150K Tower	150,000	150,000	150,000
300K Tower	300,000	300,000	300,000
500K Tower	500,000	500,000	500,000
750K Tower	750,000	750,000	750,000
Well 16 WTP Tanks	130,000	130,000	130,000
Total	**1,830,000**	**1,830,000**	**1,830,000**
Additional Capacity Required (gallons)	***None***	***None***	***None***

Notes

1. Peak hour storage is storage required to meet demands which exceed the reliable supply capacity. Future peak hour equalizing storage requirements were calculated assuming the available supply is equal to the maximum day demand rate.
2. Reserve storage is storage required to provide a start/stop range for well and booster pump operation and an emergency reserve storage supply.

C:\Users\pplanton\Documents\My Documents December 2014\Projects\F-J\Hartford\Water Master Plan\Report v.2\Tables & Figures\Chapter 5\[table5-x new.xls]TABLE 5-6

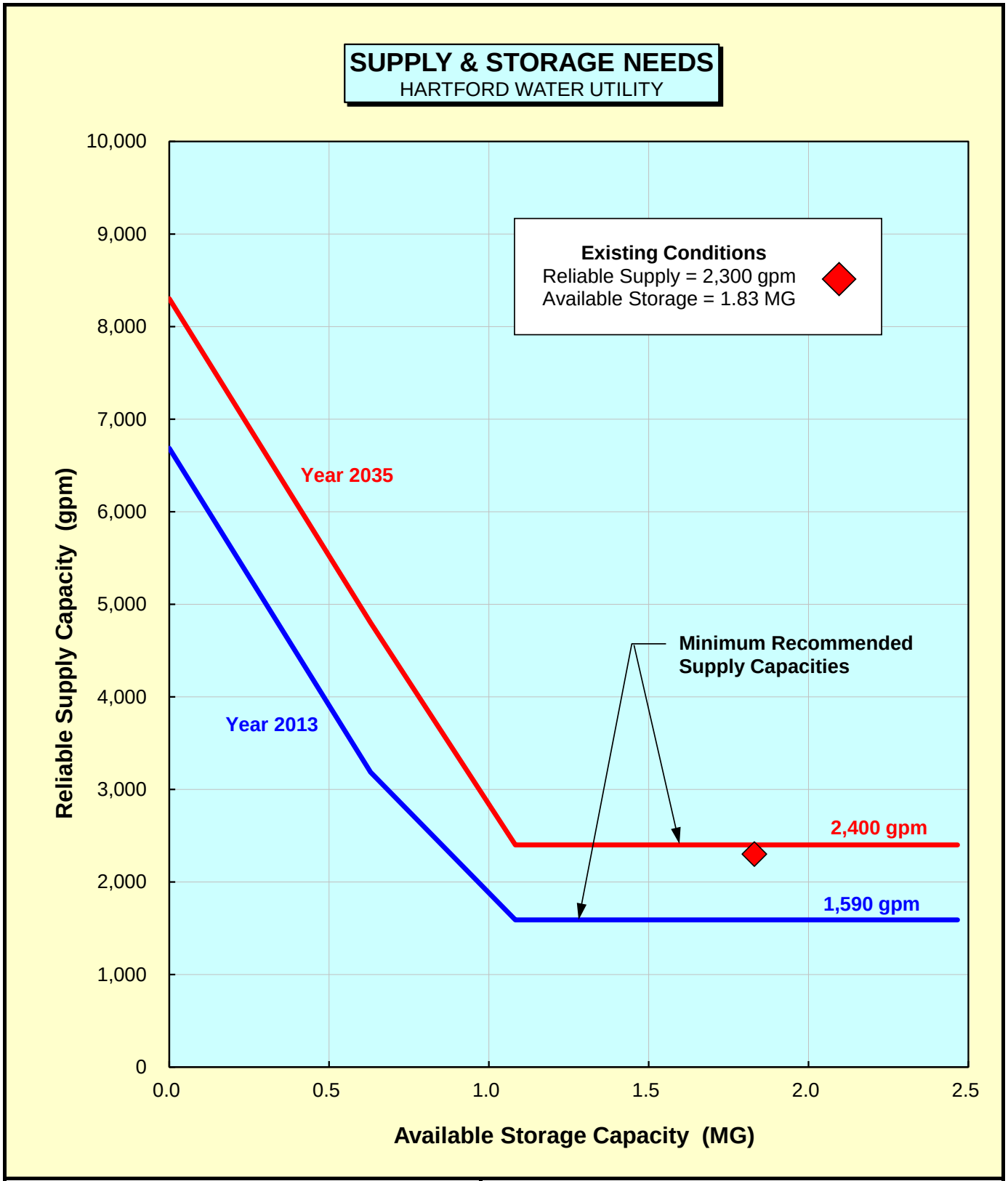

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FIGURE 5-7
SUPPLY & STORAGE NEEDS
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN
NOVEMBER 2014 HARTU 123623

TABLE 5-7

RELIABLE SUPPLY CAPACITIES
MAJOR PRESSURE ZONES

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

PRIMARY PRESSURE ZONE	*Current Minimum Operating Capacities*	
Supply Source	**(gpm)**	**(MGD)**
Well 10	470	0.68
Well 11	390	0.56
Well 12	360	0.52
Well 16	1,600	2.30
Interzone Transfer Station	720	1.04
Total Supply Capacity	**3,540**	**5.10**
Less: Largest Supply Unit	1,600	2.30
RELIABLE SUPPLY CAPACITY	**1,940**	**2.79**

LOW LEVEL PRESSURE ZONE		
Supply Source	**(gpm)**	**(MGD)**
Well 15	1,080	1.56
Interzone Transfer Station	1,000	1.44
Total Supply Capacity	**2,080**	**3.00**
Less: Largest Supply Unit	1,080	1.56
RELIABLE SUPPLY CAPACITY	**1,000**	**1.44**

Notes

1. Approximate minimum operating capacities of well pumps based on current available operating data.
2. Estimated supply available from transfer station on maximum day demand period.

TABLE 5-8

RECOMMENDED SUPPLY CAPACITY
PRIMARY PRESSURE ZONE

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

	Actual 2013	Projected 2025	Projected 2035
Total Annual Pumpage (MGY)	395	507	555
Average Day Pumpage (MGD)	1.08	1.39	1.52
Design Maximum Day Pumpage (MGD)	1.79	2.29	2.51
Available Reliable Supply Capacity (MGD)	2.79	2.55	2.33
ADDITIONAL CAPACITY REQUIRED (MGD)	**None**	**None**	**0.18**
ADDITIONAL CAPACITY REQUIRED (gpm)	***0***	***0***	***120***

Notes

1. Design maximum day pumpage requirements were estimated based on 165 percent of average day pumpage.
2. Reliable supply capacity decreases over time due to less water available from Low Level Pressure Zone (more water needed to meet maximum day pumpage in LLPZ).

TABLE 5-9

SUPPLY AND STORAGE NEEDS
PRIMARY PRESSURE ZONE
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

SUPPLY REQUIREMENTS	**Actual 2013**	**Projected 2025**	**Projected 2035**
Recommended Reliable Supply Capacity (gpm)	1,240	1,590	1,740
Present Reliable Supply Capacity (gpm)	1,940	1,770	1,620
Additional Capacity Required (gpm)	**None**	**None**	**120**

STORAGE REQUIREMENTS	**Actual 2013**	**Projected 2025**	**Projected 2035**
Peak Hour Equalizing Requirements (gallons)	227,000	291,000	319,000
Optimum Fire Protection Needs (gallons)	630,000	630,000	630,000
Reserve Storage (gallons; 15% of Total)	151,000	162,000	167,000
Total Optimum Storage Requirements (gallons)	**1,008,000**	**1,083,000**	**1,116,000**
Effective Existing Storage Capacity (gallons):			
300K Tower	300,000	300,000	300,000
750K Tower	750,000	750,000	750,000
Well 16 WTP Tanks	130,000	130,000	130,000
Total	**1,180,000**	**1,180,000**	**1,180,000**
Additional Capacity Required (gallons)	***None***	***None***	***None***

Notes

1. Peak hour storage is storage required to meet demands which exceed the reliable supply capacity. Future peak hour equalizing storage requirements were calculated assuming the available supply is equal to the maximum day demand rate.
2. Reserve storage is storage required to provide a start/stop range for well and booster pump operation and an emergency reserve storage supply.

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TABLE 5-10

RECOMMENDED SUPPLY CAPACITY
LOW LEVEL PRESSURE ZONE

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

	Actual 2013	Projected 2025	Projected 2035
Total Annual Pumpage (MGY)	115	164	210
Average Day Pumpage (MGD)	0.31	0.45	0.58
Design Maximum Day Pumpage (MGD)	0.52	0.74	0.95
Available Reliable Supply Capacity (MGD)	1.44	1.44	1.30
ADDITIONAL CAPACITY REQUIRED (MGD)	**None**	**None**	**None**
ADDITIONAL CAPACITY REQUIRED (gpm)	***0***	***0***	***0***

Notes

1. Design maximum day pumpage requirements were estimated based on 165 percent of average day pumpage.
2. Reliable supply capacity decreases over time due to less water available from Primary Pressure Zone (more water needed to meet maximum day pumpage in PPZ).

TABLE 5-11

SUPPLY AND STORAGE NEEDS
LOW LEVEL PRESSURE ZONE
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

SUPPLY REQUIREMENTS	**Actual 2013**	**Projected 2025**	**Projected 2035**
Recommended Reliable Supply Capacity (gpm)	360	520	660
Present Reliable Supply Capacity (gpm)	1,000	1,000	900
Additional Capacity Required (gpm)	**None**	**None**	**None**

STORAGE REQUIREMENTS	**Actual 2013**	**Projected 2025**	**Projected 2035**
Peak Hour Equalizing Requirements (gallons)	66,000	94,000	121,000
Optimum Fire Protection Needs (gallons)	630,000	630,000	630,000
Reserve Storage (gallons; 15% of Total)	122,000	127,000	132,000
Total Optimum Storage Requirements (gallons)	**818,000**	**851,000**	**883,000**
Effective Existing Storage Capacity (gallons):			
150K Tower	150,000	150,000	150,000
500K Tower	500,000	500,000	500,000
Total	**650,000**	**650,000**	**650,000**
Additional Capacity Required (gallons)	***168,000***	***201,000***	***233,000***

Notes

1. Peak hour storage is storage required to meet demands which exceed the reliable supply capacity. Future peak hour equalizing storage requirements were calculated assuming the available supply is equal to the maximum day demand rate.
2. Reserve storage is storage required to provide a start/stop range for well and booster pump operation and an emergency reserve storage supply.

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The updated supply-storage relationship for the Primary Pressure Zone summarized in Table 5-9 is illustrated in Figure 5-8. Points are plotted on the graph for the current and future supply and storage conditions. There is sufficient reliable supply capacity to meet current and projected future needs for through year 2025. There is adequate storage capacity currently serving the Primary Pressure Zone to meet the storage needs throughout the 20 year planning period.

5.7.4.2 Low Level Pressure Zone Supply and Storage Requirements

The current Low Level Pressure Zone reliable supply capacity is 1.44 mgd. This reliable supply capacity will slightly decrease after year 2025 as less water will be available on days of maximum pumpage from the Primary Pressure Zone. The LLPZ reliable supply capacity is projected to remain 1.44 mgd by the year 2025, and slightly decrease to 1.30 mgd by the year 2035.

There is currently sufficient supply and storage capacity to serve the Low Level Pressure Zone. It is anticipated that the Zone will require additional reliable supply capacity or storage capacity to meet year 2025 needs and beyond. The updated supply-storage relationship for the Low Level Pressure Zone summarized in Table 5-11 is illustrated in Figure 5-9. Points are plotted on the graph for the current and future supply and storage conditions. There is sufficient reliable supply capacity to meet current but not projected future needs by the year 2025.

5.8 SUMMARY

This chapter summarizes the findings from evaluation of the Hartford water system. Major findings from this evaluation include the following:

1. Under all normal operating conditions, the Water Utility provides system pressures above the minimum recommended pressure of 35 psi to all portions of the City, and below the maximum recommended pressure of 100 psi.
2. There are very few isolated locations in the system where available fire flows are below recommended minimum flows.
3. The system can currently supply adequate water to meet average day customer demands by using standby power generating equipment. This capacity to provide water using standby power equipment will be sufficient throughout the planning period of this study.
4. The Water Utility has adequate reliable supply and storage capacity to meet current optimum supply and storage requirements. The Water Utility will need to add an additional 100 gpm of supply capacity by year 2028 to meet projected year 2035 supply needs.
5. The Water Utility has adequate reliable supply and storage capacity to meet current optimum supply and storage requirements in the Primary Pressure Zone. The Water Utility will need to add an additional 120 gpm of supply capacity by year 2025 to meet projected Zone year 2035 supply needs.
6. The Water Utility has adequate reliable supply and storage capacity to meet current optimum supply and storage requirements in the Low Level Pressure Zone. The Water Utility will need to add additional reliable supply and/or storage capacity to meet the projected year 2025 supply and storage needs.

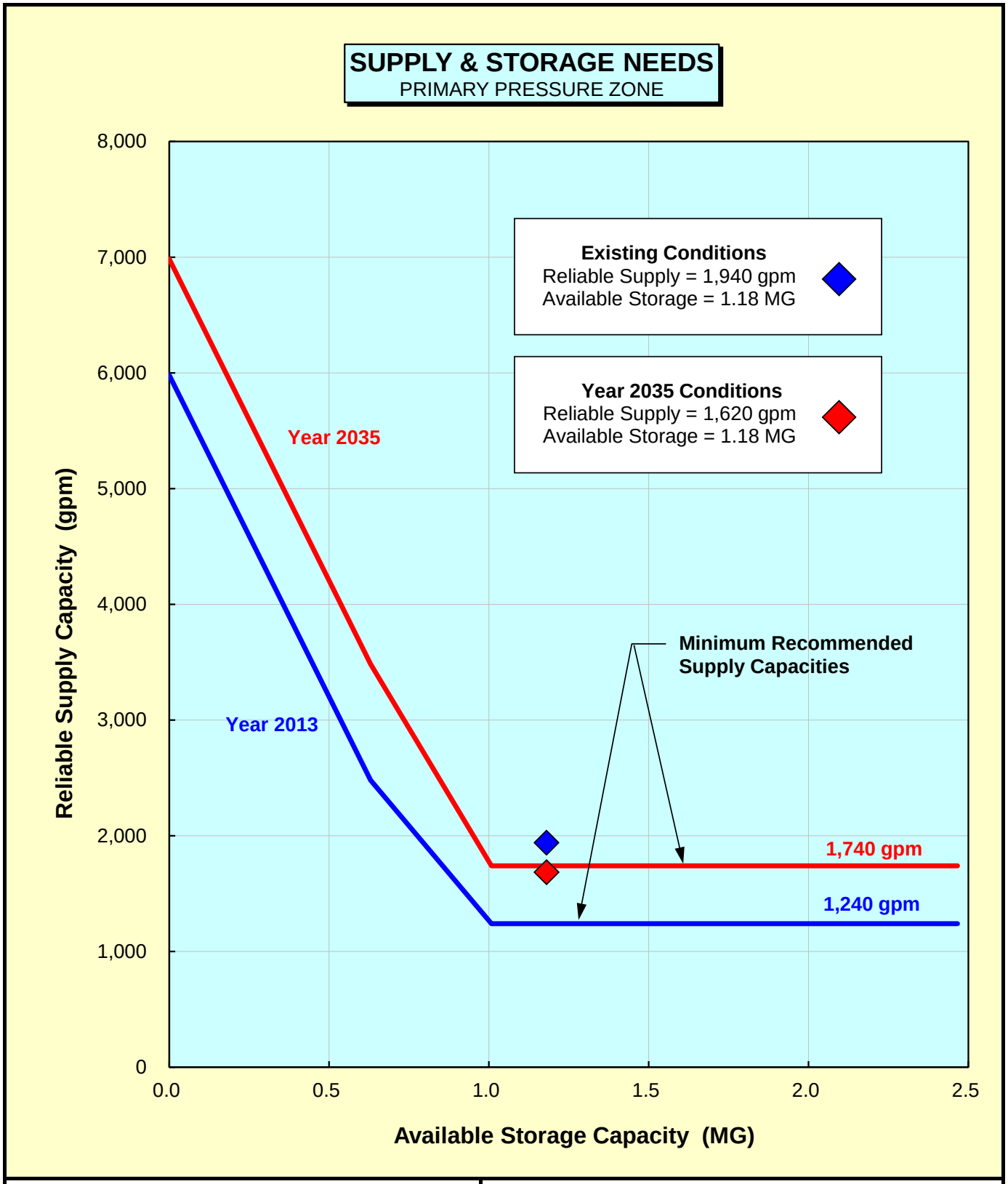

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FIGURE 5-8
SUPPLY & STORAGE NEEDS
PRIMARY PRESSURE ZONE
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN
NOVEMBER 2014 HARTU 123623

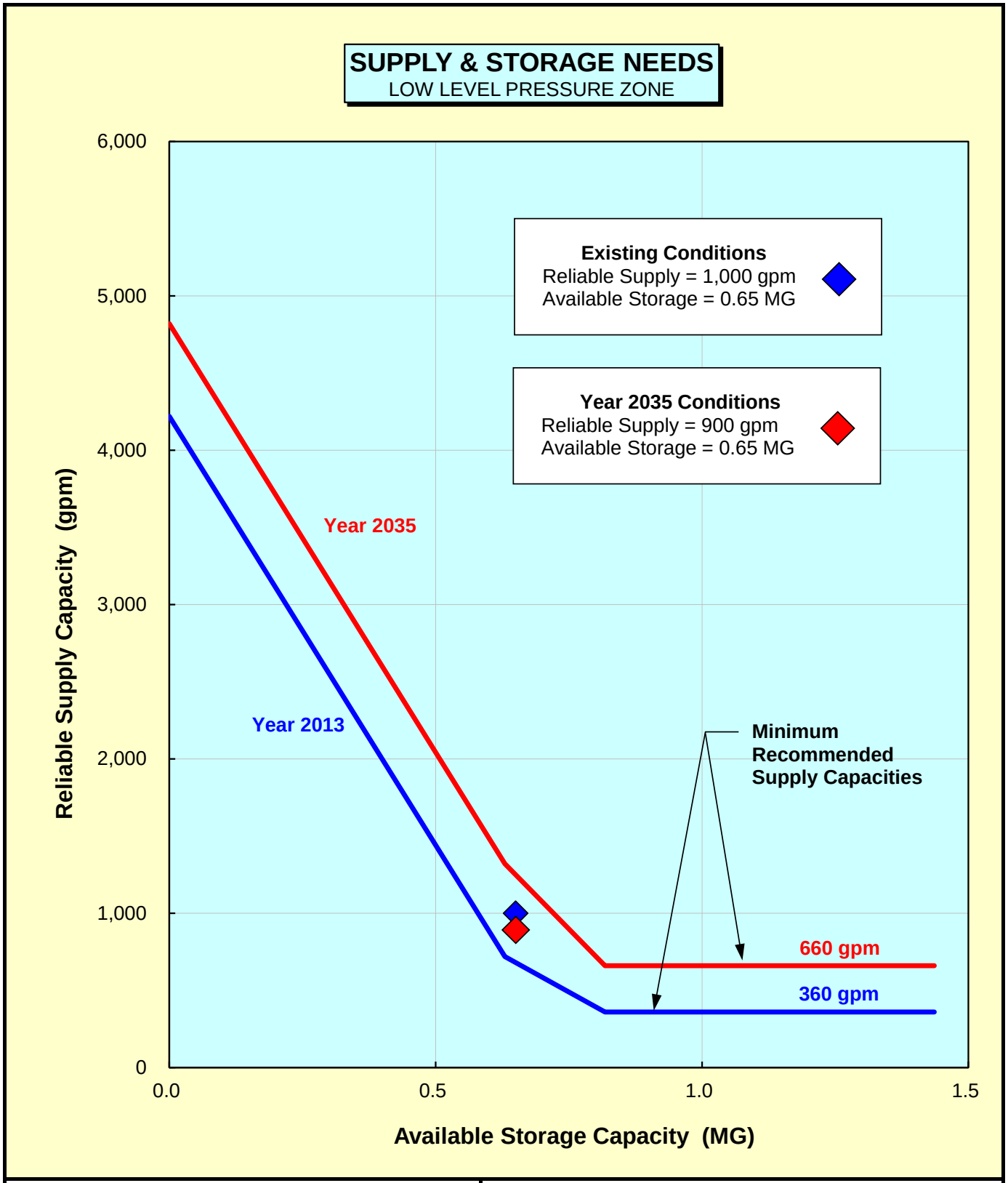

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FIGURE 5-9
SUPPLY & STORAGE NEEDS
LOW LEVEL PRESSURE ZONE
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN
NOVEMBER 2014 HARTU 123623

6.0 RECOMMENDED WATER SYSTEM IMPROVEMENTS

This chapter summarizes recommended water system improvements based on the projected growth planned for the Hartford Water Utility service area. The water system will require improvements to accommodate future service needs and address existing system deficiencies. The improvements are grouped into the following categories:

1. Water supply improvements
2. Water storage improvements
3. Pressure zone expansion
4. Distribution system improvements
5. Distribution system expansion

The following sections summarize the recommended water system improvement plans.

6.1 WATER SUPPLY IMPROVEMENTS

As summarized in Chapter 5, the Utility will need an additional 100 gpm of reliable supply capacity to meet the projected future Hartford water demand by the end of the 20 year planning period. These requirements are based on the population growth discussed in Chapter 2 and the water needs described in Chapter 3. With regularly scheduled maintenance to the existing five water supply wells, it is projected that the City's maximum day demand will exceed the Utility's reliable supply capacity by the year 2028.

To reliably supply future water demands, it is anticipated that an additional well (Well 17) will be needed within 14 years. Based on the groundwater supply evaluations performed prior to the construction of Well 16, it is anticipated that comparable groundwater supplies should be available in the surrounding areas in the Well 16 vicinity. The design of the Well 16 water treatment plant included provisions for expansion to accommodate an additional water supply source that would require treatment similar to Well 16. In addition, the design of the two mile, 16-inch diameter transmission main that currently connects the Well 16 water supply to the Hartford distribution was sized to accommodate an additional water supply source from the Well 16 treatment plant.

Assuming the minimum supply capacity of Well 17 will be similar to the well yield of Well 16, this additional water supply capacity will be sufficient to meet the Hartford water demand beyond 2028 and well into the future.

It is recommended that a new Well 17 be located in an area in the vicinity of Well 16. It is recommended that the Water Utility continue to monitor its maximum daily pumpage needs on an annual basis and begin the planning for siting Well 17 by the year 2024.

A well siting study should be completed to identify the most suitable location for Well 17. The study should evaluate, at a minimum, the following factors to consider when choosing a well site:

1. Estimated yield potential
2. Estimated water quality characteristics

3. Location of known potential and existing contamination sources
4. Minimum recommended separation distances to potential contamination sources
5. Minimum recommended separation distance from Well 16
6. Land availability
7. Raw water transmission main requirements to Well 16 (if needed for treatment)
8. Probable wellhead protection requirements and the impacts on surrounding land uses
9. Proximity to existing private wells, wetlands, and surface waters
10. Other possible limitations that may affect the feasibility of a well site area

6.2 WATER STORAGE IMPROVEMENTS

As summarized in the supply and storage analysis in Chapter 5, under current operational conditions the Low Level Pressure Zone requires an additional 168,000 gallons of storage. However, because there is surplus supply capacity available to this zone from the Interzone Transfer Station, additional Low Level Pressure Zone storage (or supply) should not be needed for approximately 10 years.

Hartford's water storage tanks are used to provide water to meet peak hour demands, for providing fire flows, and to provide the Water Utility an easy and reliable means for operating water supply pumps in addition to providing reserve storage for emergencies.

To meet the projected 2035 water storage needs for the Low Level Zone, an additional 233,000 gallons of elevated storage will be required. By the year 2025 or the next time the 150K Tower needs significant maintenance, the Water Utility should consider the retirement of the 150K Tower, and constructing a new water tower with a minimum storage volume of 400,000 gallons. This storage volume will replace the 150,000 gallons from the 150K Tower and satisfy the additional water storage needs of the zone at the end of the planning period. The 150K Tower was placed into operation in 1948 and has been in continuous service to the City of Hartford Water Utility for 66 years.

Another option that the Utility might consider in lieu of replacing the 150K Tower or constructing a third water storage facility to serve the zone is the implementation of a second interzone transfer station to supply the Low Level Zone from the Primary Pressure Zone.

If the Utility opts to replace the 150K Tower during the planning period with a new, larger elevated storage facility, there will be several factors to considered when choosing a location for this new elevated storage tank, including:

1. Land availability
2. Transmission main requirements
3. Land elevation
4. Proximity to areas with higher fire flows
5. Future development beyond the 2035 service area

Depending on the location selected, a new water tower to replace the 150K Tower may also need to be equipped with an altitude valve to prevent accidental overflows, similar to the design of the 750K Tower that was placed into service in 2010.

6.3 PRESSURE ZONE EXPANSION

It is required by the Wisconsin Administrative Code NR 811 that water systems are designed with a minimum water pressure of 35 psi and a maximum pressure of 100 psi. Furthermore, water systems are required to be operated so that under fire flow conditions, the residual pressure in the system will not fall below 20 psi at any location.

The location of Hartford within the Kettle Moraine area of eastern Wisconsin includes land areas with widely varied topographies. As the Hartford water system expands within its future Utility planning service area, these varying topographies and their impact on water system pressures will need to be considered. Hartford's existing water system can adequately supply areas with elevations between 950 feet to 1070 feet USGS.

Figure 6-1 indicates areas within the immediate City of Hartford surrounding area with ground elevations higher than 1070 feet. Developments with elevations greater than 1070 feet will require the creation of a special hydraulically separate pressure zone, similar to the small Powder Hill Pressure Zone on the City's far east side.

The recommended delineation of the proposed 2035 service area into Primary and Low Level Pressure Zones is also shown in Figure 6-1. The red shaded areas indicate those future locations that cannot be adequately served with system pressure by the existing Hartford water system.

The largest portion of the 2035 water utility service area with elevations greater than 1070 feet is east of Pike Lake. The vast majority of this area is planned for conservancy; park and open space (see Figure 2-1), and includes Pike Lake State Park.

The existing developed areas near the intersection of Kettle Moraine Road and CTH E to the east, and STH 83 and Clover Road to the north have ground elevations that exceed 1170 feet USGS. These existing developments, or any other future developments with similar elevations, will require the creation of a small, new pressure zone in order to be adequately served by the Hartford water system.

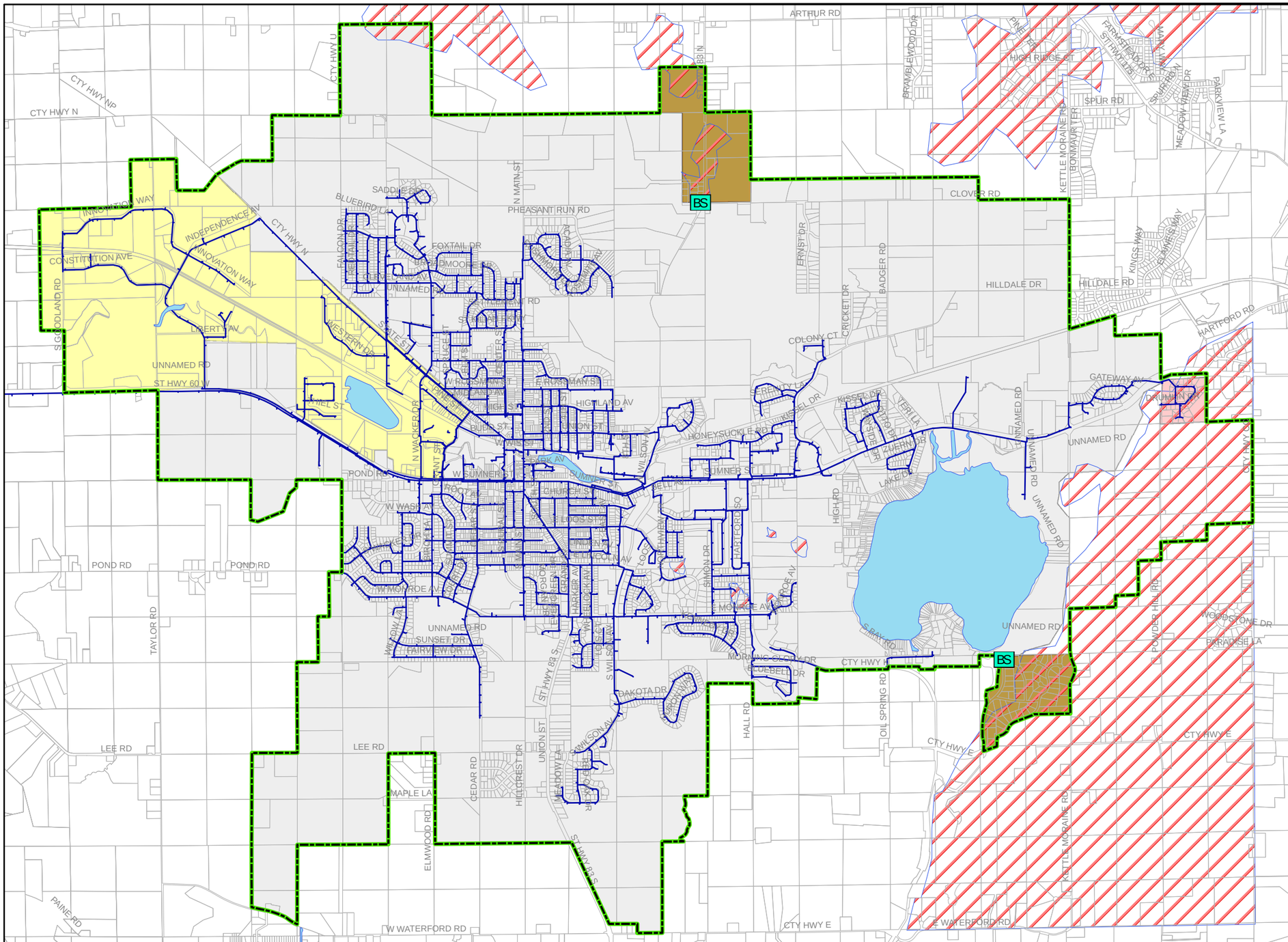
6.4 DISTRIBUTION SYSTEM IMPROVEMENTS

This section summarizes distribution system improvements that are recommended to strengthen the existing system, enhance supply reliability, loop major transmission mains and improve flow capacity and fire protection to various parts of the City.

For the City of Hartford, typical industry fire flow requirements were assigned by land use classification served as follows:

- 500 gpm for open/natural areas
- 1,000 gpm for single-family residential
- 2,500 gpm for multi-family residential, commercial and public
- 3,500 gpm for industrial and the central business district

Using the Hartford's hydraulic model, the maximum available fire flow throughout the system was calculated, while maintaining a residual system pressure of 20 psi throughout the system. Available fire flows ranged from approximately 500 gpm to more than 3,500 gpm. Figure 5-2 illustrated the available system fire flow under a maximum day water demand throughout the water system. There are only a few isolated locations within the City of Hartford water distribution system where less than the suggested fire



Legend

- WATER
- FUTURE WATER SERVICE AREA
- EXISTING WATER MAIN
- ELEVATIONS ABOVE 1070'
- MAIN PRESSURE ZONE
- LOW LEVEL PRESSURE ZONE
- POWDER HILL PRESSURE ZONE
- FUTURE LEVEL HIGH PRESSURE ZONE
- BS BOOSTER STATION

0 2,000 4,000 Feet

Source: City GIS
Projection: Lambert_Conformal_Conic
Map by: SEH

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PROJECT: HARTU 123623

DATE: SEPT 2014

WATER SYSTEM EVALUATION
CITY OF HARTFORD, WISCONSIN

FUTURE WATER SERVICE AREA & PRESSURE ZONES

FIGURE 6-1

flows can be provided as illustrated in Figure 5-3. These areas consist of dead ended water mains or are in areas that are served by substandard size water mains.

The Water Utility continues to operate substandard size water mains throughout the City. Any water main pipe less than 6 inches in diameter is considered to be substandard and in violation of Wisconsin Administrative Code Chapter NR 811. Figure 6-2 identifies the locations of substandard water mains that are recommended to be replaced. It is recommended that the Water Utility continue with an infrastructure replacement program that targets the substandard size water mains within the system. Using close coordination with the City's Public Works Department, this main replacement program could be combined and coordinated with improvements and/or replacement of other City utility systems. Table 6-1 summarizes the recommended water main replacements over the 2015-2019 period that have also been identified in the City of Hartford's current Capital Improvement Program for the Water Utility.

6.5 DISTRIBUTION SYSTEM EXPANSION

As the Utility begins to grow into the Hartford future urban service area, it will be necessary to further expand the water transmission main system to adequately accommodate these new service areas. Figure 6-3 illustrates the recommended improvements that will be needed to serve the 2035 service area. All major transmission mains identified in Figure 6-3 have been sized to meet projected future water system demands, and support system supply sources and storage facilities to serve outlying area land uses. Mains were sized to provide at least 3,500 gpm of flow capacity in industrial areas and 1,500 gpm in commercial areas at a residual pressure of 20 psi. Needed transmission mains are summarized in Table 6-2.

The mains shown in Figure 6-3 are only the recommended transmission mains. Smaller local service mains have not been shown. The transmission mains shown follow known or presumed locations for major streets or roads in the future urban service area. Adjustments in the actual location of these mains can be expected at the time the mains are required or as local needs dictate.

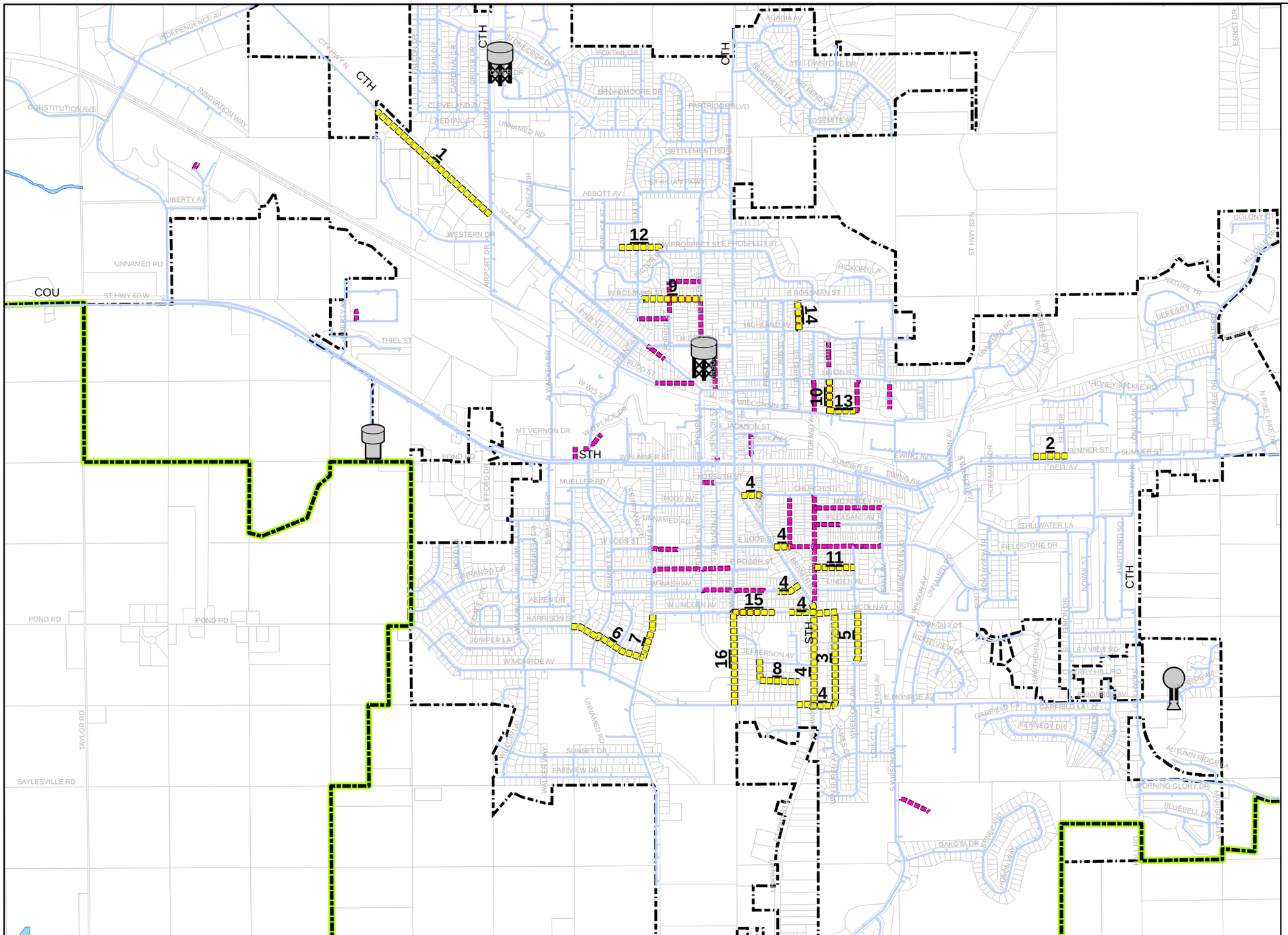
Water mains to serve developing residential land should be sized at a minimum of 8 inches in diameter. These mains should provide a minimum of 1,000 gpm at a 20 psi residual pressure in single-family areas. Fire flows of 1,500 gpm should be used as the criterion for multiple family developments.

As the Hartford water system expands, the Utility should continue to loop existing dead end mains to improve fire flows and help build strength to the areas where the system is expanding.

6.6 SUMMARY

The recommended improvement plan to serve the future service area has been developed as a tool to guide the Utility in the siting and sizing of future system improvements. While the plan may represent the current planned expansion of the Hartford system, future changes in land use, water demands, or customer characteristics could substantially alter the implementation of the plan. For this reason, it is recommended that the plan be periodically reviewed and updated using City planning information to reflect the most current projections of Hartford area growth and development.

The improvement plan is a guidance document that details existing conditions and recommendations for the future. The plan is based on future conditions as perceived in 2014. As time progresses, additional information will become available and events will shape the development of the Hartford area. The plan must be dynamic in response; it should be studied and used but also adjusted to conform to the changes



Legend

- CIP WATER MAIN REPLACEMENT
- EXISTING WATER MAIN < 6-INCH
- EXISTING WATER MAIN
- FUTURE WATER SERVICE AREA
- EXISTING CITY LIMITS

0 1,250 2,500 Feet

Source: City & County Data
Map by: SEH

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WATER SYSTEM EVALUATION
CITY OF HARTFORD, WISCONSIN

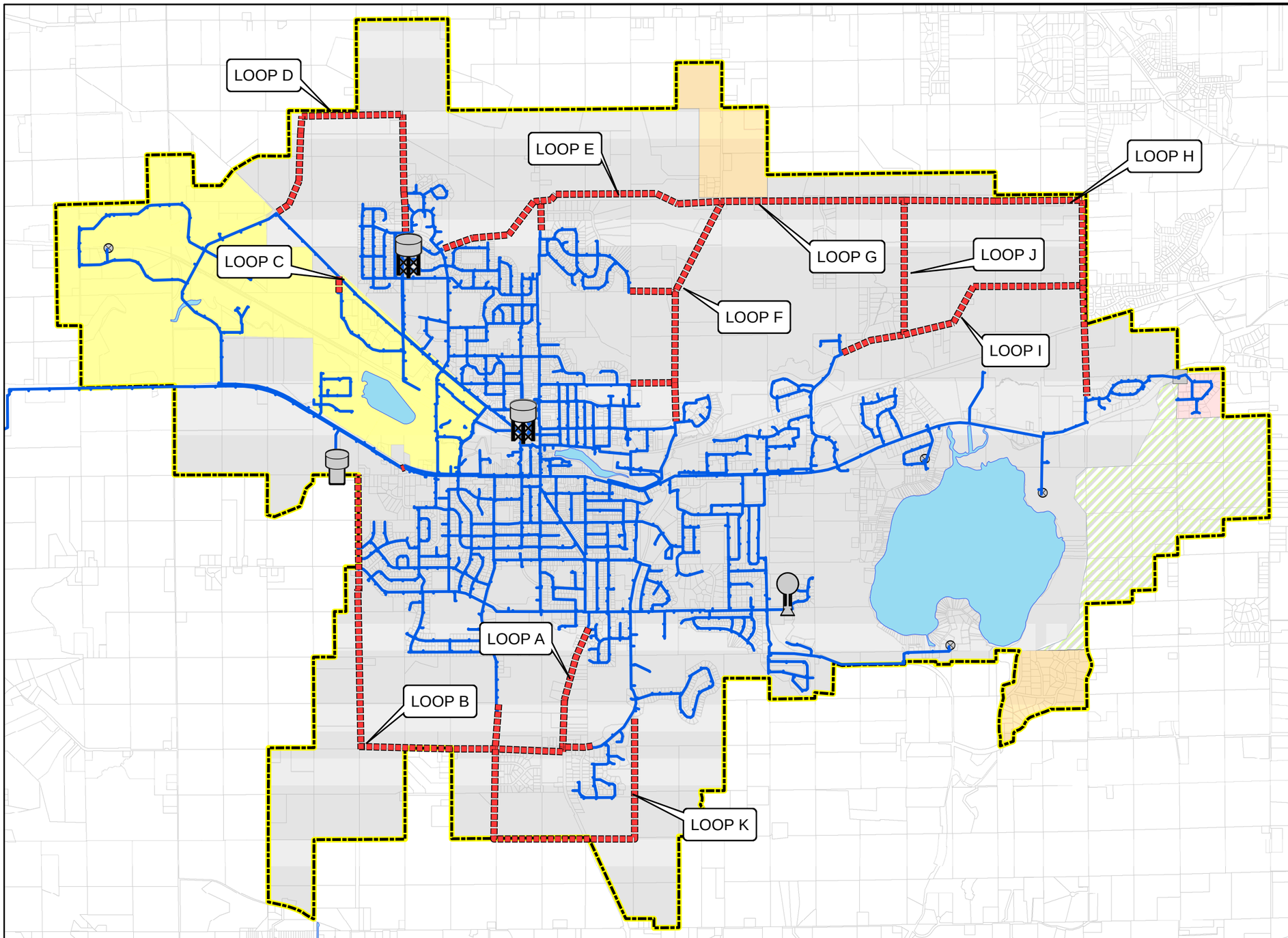
RECOMMENDED WATER SYSTEM IMPROVEMENTS

FIGURE 6-2

TABLE 6-1

RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS
2015-2019
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

I.D. Number (Figure 6-2)	Year	Location	Existing Pipe Size	Proposed Piping Size	Length (ft)
1	2015	Highway N Between Airport Drive and Independence Ave	12 in.	12 in.	1,100
2	2015	East Sumner Street Between East Sell Dr and West Sell Dr	8 in.	10 in.	600
3	2016	Harker Ave Between East Monroe Ave and Lincoln Ave	6 in.	8 in.	1,800
4	2016	Grand Ave Between East Monroe Ave and Lincoln Ave	10 in.	10 in.	2,200
5	2017	Wheelock Ave Between Lincoln Ave and Jefferson Ave	6 in.	8 in.	900
6	2017	Harrison Street Between Cedar and Birch Street	6 in.	8 in.	1,300
7	2017	Cedar Street Between Harrison Street and Lincoln Avenue	6 in.	10 in.	800
8	2017	Martin & Morgan Streets between Jefferson Ave and Evergreen Dr	6 in.	8 in.	1,000
9	2018	West Rossman St Between Elm St and Center St	4 in and 6 in.	8 in.	1,100
10	2018	Fifth St Between Union St and East Wisconsin St	4 in.	10 in.	580
11	2018	Maple Ave Between Weelock Ave and Grand Ave	4 in.	8 in.	700
12	2019	West Prospect St Between Forest Ave and Spruce St	6 in.	12 in.	700
13	2019	East Wisconsin Street Between 5th Street and 6th Street	6 in.	8 in.	500
14	2019	Third Street Watermain Replacement Between Highland Avenue and Rossman Street	4 in. and 6 in.	8 in.	500
15	2019	East Lincoln Ave Between South Main St and Grand Ave	4 in.	8 in.	1,300
16	2019	South Main Street Between Monroe and Lincoln Ave	6 in.	8 in.	1,200



Legend

- 12" TRANSMISSION MAIN
- EXISTING WATER MAIN
- FUTURE WATER SERVICE AREA
- PRIMARY PRESSURE ZONE
- POWDER HILL PRESSURE ZONE
- LOW LEVEL PRESSURE ZONE
- FUTURE HIGH LEVEL PRES. ZONE
- NON-DEVELOPABLE PARK LAND

0 2,000 4,000 Feet

N

Source: City & County Data
Map by: SEH

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WATER SYSTEM EVALUATION

CITY OF HARTFORD, WISCONSIN

FUTURE WATER SYSTEM TRANSMISSION MAIN

FIGURE 6-3

TABLE 6-2

RECOMMENDED FUTURE TRANSMISSION MAIN IMPROVEMENTS 2015-2035

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

Loop	Location	Proposed Size (in)	Length (ft)
A	STH 83/Lee Road	12	4,400
B	LEE Road/Future Pond Road	12	11,300
C	Future Western Drive Connected to CTH N	12	500
D	Future Independence/CTH U	12	8,600
E	Future Clover Road/North Main Street	12	8,900
F	STH 83/Future Yellowstone Drive/Future Rossman Street	12	9,500
G	Clover Road Between STH 83 and Badger Road	12	5,400
H	Clover Road Between Badger Road and Kettle Moraine Road	12	5,300
I	Hilldale Drive Between Kettle Moraine Road and Mount Vernon Drive	12	7,700
J	Badger Road Between Clover Road and Hilldale Drive	12	4,000
K	Cedar Street connected to South Wilson Avenue	12	11,200

and knowledge that will come with time. Updates should be made on a regular basis, probably every five to ten years.

7.0 CAPITAL IMPROVEMENTS PLAN

Chapter 6 evaluated the water system improvements anticipated to be needed throughout the planning period. This chapter summarizes the recommended water system improvements and presents a proposed Water Utility capital improvements program. The recommended Capital Improvements Plan prioritizes system improvements and provides a schedule for the timing of construction. Budget cost estimates for each improvement are also summarized.

7.1 RECOMMENDED SYSTEM IMPROVEMENTS

7.1.1 Supply

Based upon the current and projected water supply needs, one additional supply well will be required within 14 years to provide sufficient reliable supply capacity for the latter half of the planning period. The Utility currently has sufficient reliable supply capacity to meet the projected needs to about the year 2028. The Utility will need an additional 100 gpm to provide reliable supply capacity by the end of the planning period.

7.1.2 Storage

The Utility currently has sufficient water storage capacity available to meet present storage needs. However, by the end of the planning period, the Utility will need an additional 233,000 gallons of storage volume to adequately serve the Low Level Pressure Zone. It is recommended that by the time the Utility will need additional water supply capacity (about 10 years), the Utility consider either replacing the old 150K Tower with a new 400,000 gallon capacity elevated tank; or add a third storage facility with 250,000 gallons to serve the Low Level Zone; or construct a second interzone transfer station that would allow the Primary Pressure Zone to supply additional water to the Low Level Zone in conjunction with a future Well 17 project.

7.1.3 Future Service Areas

As the water system expands to begin serving areas within the Utility's future service area, two locations will require the implementation of small high level pressure zones to adequately serve those areas with water pressure. These two locations include the area north of the City along STH 83 and Clover Road, and area south of Pike Lake near the intersection of CTH E and Kettle Moraine Road. When these two areas of higher topographic elevation are needed to be served by the Water Utility, it is recommended that the Utility implement new high level pressure zones. Each zone will be very similar to the Utility's existing small Powder Hill Pressure Zone, and require a small booster pumping station to provide the needed pressure and fire flows to the zone.

7.1.4 Distribution System

Figures 6-2 and 6-3 illustrated the recommended improvements to the existing distribution system and the recommended transmission mains required to serve the future service area. The improvements have been recommended to strengthen and expand the existing transmission main network, and support system expansion into future service areas.

To address existing distribution system deficiencies and replace substandard size water mains around the City, approximately 13,500 feet (approximately 2.5 miles) of new water main are recommended in the short-term capital improvements plan. To adequately serve the future Utility service area by the end of the 20-year planning period, an additional 65,000 feet (approximately 12 miles) will be needed in the long-term improvements plan to provide adequate service as the City continues to develop.

7.2 CAPITAL IMPROVEMENTS PLAN

A proposed Capital Improvements Plan is presented in Table 7-1. The plan presents budget cost estimates and a proposed schedule for the recommended system-wide improvements that should be implemented over the planning period.

The proposed Capital Improvements Plan has been formulated based on all the information presented in this study. All the improvements have been developed and prioritized based on deficiencies identified in the existing water system, and the needs of the Utility's future service area. Improvements have been broken down into two categories:

1. Short-term improvements (2015 – 2019)
2. Long-term improvements (2020 – 2035)

The actual construction cost for the recommended improvements may vary from the costs outlined in this report, depending on the year facilities are constructed, the rate of increase in future construction costs, and unforeseen conditions which could be encountered during design of the improvements.

In establishing priorities for these improvements, it will be necessary to take into consideration the availability of Utility financial resources and local City needs to assure that the recommended improvements are implemented in an orderly, coordinated, and economical fashion.

7.3 FUTURE MAINTENANCE PLAN

It is recommended that the Utility budget funds for all wells and well pumps to be inspected and rehabilitated as necessary on an interval of at least once every 10 years. The Water Utility should continue to test and monitor well pump performance on an annual basis.

All water storage tanks should be scheduled to be professionally inspected and cleaned on a 5 year interval in accordance with DNR Code requirements. In addition, the Utility should budget funds and plan to have all storage tank protective coatings rehabilitated on a 10 year interval. The rehabilitation of the tanks could have a longer cycle than 10 years depending on the condition of the coatings as indicated in the 5 year inspection reports..

The recommended facility maintenance plan is summarized in Table 7-2.

TABLE 7-1

RECOMMENDED CAPITAL IMPROVEMENTS PLAN
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

SHORT-TERM IMPROVEMENTS (2015-2019)

Item	Budget Estimate
Infrastructure Replacement Program	
Water Main Replacements	$2,300,000
Short-Term Total	**$2,300,000**

LONG-TERM IMPROVEMENTS (2020-2035)

Item	Budget Estimate
New Low Level Zone Water Tower to replace 150K Tower	$2,000,000
New Well 17 and Transmission Main	$1,000,000
Well 16 Treatment Plant Expansion	$2,500,000
Implement North Pressure Zone (STH 83 & Clover Road)	$500,000
Implement Southeast Pressure Zone (CTH E & Kettle Moraine Road)	$500,000
Infrastructure Replacement Program - Substandard Size Main Replacements	$9,000,000
Transmission System Expansion to serve Future Service Area	$8,000,000
Long-Term Total	**$23,500,000**

Note

Estimates include engineering and contingency costs.

C:\Users\pplanton\Documents\My Documents December 2014\Projects\F-J\Hartford\Water Master Plan\Tables & Figures\Chapter 7\[Table 7-1.xls]TABLE 7-1

TABLE 7-2

RECOMMENDED MAJOR FACILITY MAINTENANCE SCHEDULE
2014-2035
HARTFORD WATER UTILITY
CITY OF HARTFORD, WISCONSIN

Year	Well & Pump Rehabilitation	Elevated Tank Inspection & Maintenance	Ground Reservoir Inspection & Maintenance
2014	***Well 10***	None	***Well 16 Ground Tanks***
2015	***Well 12***	***750 K Tower***	None
2016	***Well 16***	***300 K Tower***	None
2017	***Well 11***	***500 K Tower***	None
2018	None	***150 K Tower***	***Well 10 Reservoir***
2019	***Well 15***	None	***Well 16 Ground Tanks***
2020	None	***750 K Tower***	None
2021	None	***300 K Tower***	None
2022	***Well 10***	***500 K Tower***	None
2023	None	***150 K Tower***	***Well 10 Reservoir***
2024	None	None	***Well 16 Ground Tanks***
2025	***Well 12***	***750 K Tower***	None
2026	***Well 16***	***300 K Tower***	None
2027	***Well 11***	***500 K Tower***	None
2028	None	***150 K Tower***	***Well 10 Reservoir***
2029	***Well 15***	None	***Well 16 Ground Tanks***
2030	***Well 10***	***750 K Tower***	None
2031	None	***300 K Tower***	None
2032	None	***500 K Tower***	None
2033	None	***150 K Tower***	***Well 10 Reservoir***
2034	None	None	***Well 16 Ground Tanks***
2035	***Well 12***	***750 K Tower***	None

APPENDIX A

GLOSSARY OF TERMS

APPENDIX A

GLOSSARY OF TERMS

Aquifer:	A saturated geological formation capable of transmitting significant quantities of water under normal hydraulic gradients.
Average Day Demand:	The average quantity of daily water usage in a municipal water system.
Drawdown:	The difference between the pumping water level and static water level in a well (usually expressed as feet at a specific flow rate).
Elevated Storage:	A facility for storing water supplies above ground level at a specific elevation
Flow Capacity:	The maximum flow rate that can be supplied by a water distribution system at a specified location and residual pressure (usually expressed as gallons per minute).
Formation:	A geological soil and rock profile.
Future Service Area:	The area which is expected to develop in the future and require municipal utility services.
Groundwater Level (or Water Table):	The highest elevation of fully saturated soil in a geological formation.
Groundwater Depletion:	The removal of water supplies from a groundwater system.
Groundwater Recharge:	The entry of water into the saturated zone of a geological formation, together with the associated flow away from the water table.
Hydraulic Gradient:	The unconfined change in water surface elevation with respect to horizontal distance for a sloping water surface.
Hydrology:	Study of the physical behavior of water from its occurrence as precipitation to its entry into streams, lakes and reservoirs, and its return to the atmosphere.
Maximum Day Demand:	The highest quantity of daily water usage in a municipal water system.
Maximum Day Ratio:	The ratio of maximum day to average pumpage (usually expressed as a percentage).
Peak Hour Demand:	The daily rate of water usage during the hour of greatest water demand on a maximum usage day.
Peak Hour Demand Ratio:	The ratio of peak hour pumpage (expressed as a daily rate) to average day pumpage (usually expressed as a percentage).

Pipe Roughness Coefficient:	A coefficient (generally assumed to be constant) which describes the energy loss due to friction that will occur as water flows through a section of piping.
Pumping Water Level:	The water level in a well while it is being pumped (usually measured from ground surface or top of well casing).
Reliable Supply Capacity:	The pumping capacity of a water supply facility with the largest pumping unit out of service.
Residual Pressure:	Pressure at a specified location in the water distribution system when water is being removed or flowed.
Specific Capacity:	The specific capacity of a well is the yield per unit of drawdown (usually expressed as gallons per minutes per foot of drawdown).
Static Pressure:	Normal pressure at a specified location in the water distribution system when no water is being removed or flowed.
Static Water Level:	The water level in a well when no water is being taken from the aquifer either by pumping or free flow (usually measured from ground surface or top of well casing).
Time-of-day Demand Curve:	A curve which describes changes in the quantities of water used by customers at different times of the day.
Total Dynamic Head:	The total energy that a pump must overcome to deliver a given flow rate including suction lift, discharge, and friction loses (usually expressed in feet of water).
Unaccounted-For Water:	The difference between the total volume of water pumped and the volume of water sold (expressed as gallons or as a percentage of total pumpage).
Water Demand:	The amount of water required by a water user or users at a specific point or area within a water distribution system.
Water Distribution Main:	A water main which primarily extends water services and fire protection to an area.
Water Distribution System:	A facility usually consisting of a network of piping which is designed to distribute water from a given water supply to specific water users.
Water Supply System:	Facilities designed to collect and furnish a controlled supply of water for consumption or other water needs.
Water Transmission Main:	A large water main (generally 10-inch or larger) which is used to convey water between a water system's supply/storage facilities and service area.

APPENDIX B

LIST OF ABBREVIATIONS

APPENDIX B

LIST OF ABBREVIATIONS

AWWA	American Water Works Association
CTH	County Trunk Highway
DNR	Wisconsin Department of Natural Resources
fps	Feet per Second
ft	Feet
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
gpm	Gallons per Minute
gpm/ft	Gallons per Minute per Foot
HADC	Hartford Area Development Corporation
HGL	Hydraulic Grade Line
Hp	Horsepower
ISO	Insurance Services Office
ITS	Interzone Transfer Station
LLPZ	Low Level Pressure Zone
MG	Million Gallons
MGD	Million Gallons per Day
MGY	Million Gallons per Year
PPZ	Primary Pressure Zone
PSC	Public Service Commission
psi	Pounds per Square Inch
rpm	Revolutions per Minute
SCADA	Supervisory Control and Data Acquisition
SEWRPC	Southeast Wisconsin Regional Planning Commission
STH	State Trunk Highway
TDH	Total Dynamic Head
USGS	U.S. Geological Survey
USH	U.S. Highway
WDOA	Wisconsin Department of Administration

APPENDIX C

ISO REPORT

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November 25, 2013

The Honorable Joseph Dautermann, Mayor
Hartford
109 N Main Street
Hartford, WI 53027

RE: Hartford, Dodge and Washington Counties, WI
Public Protection Classification: 3
Effective Date: March 1, 2014

Dear Mayor Dautermann:

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

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

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

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

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

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

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

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

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

Sincerely,

Dominic Santanna

Dominic Santanna
(800) 444-4554 Option 2

jj

Encl.

cc: Chief Paul Stephans, Hartford Fire Department
Mr. Brian Rhodes, Director, Hartford Water Department
Ms. Jill Raffay, Supervisor, Washington County Communications Center
Ms. Patrica Ninman, Supervisor, Dodge County Communications Center
Sergeant Leon Ruder, Director, City of Watertown Communications Center
Lieutenant Scott MacFarlan, Supervisor, Hartford Communications Center

Public Protection Classification Summary Report

Hartford

WISCONSIN

Prepared by

Insurance Services Office, Inc.
4B Eves Drive, Suite 200
P.O. Box 961
Marlton, New Jersey 08053-3112
(856) 985-5600

November 2013

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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™) number is assigned to the community. The surveys are conducted whenever it appears that there is a possibility of a classification change. As such, the PPC program provides important, up-to-date information about fire protection services throughout the country.

The Fire Suppression Rating Schedule (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 Public Protection Classification, 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 classification.

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 is substantially lower than in a community with a poor PPC, 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 Public Protection Classification – 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 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 48,000 fire protection areas across the United States using its Fire Suppression Rating Schedule (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 number. In order for a community to obtain a classification better then 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

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.

Public Protection Classification Number

The PPC number 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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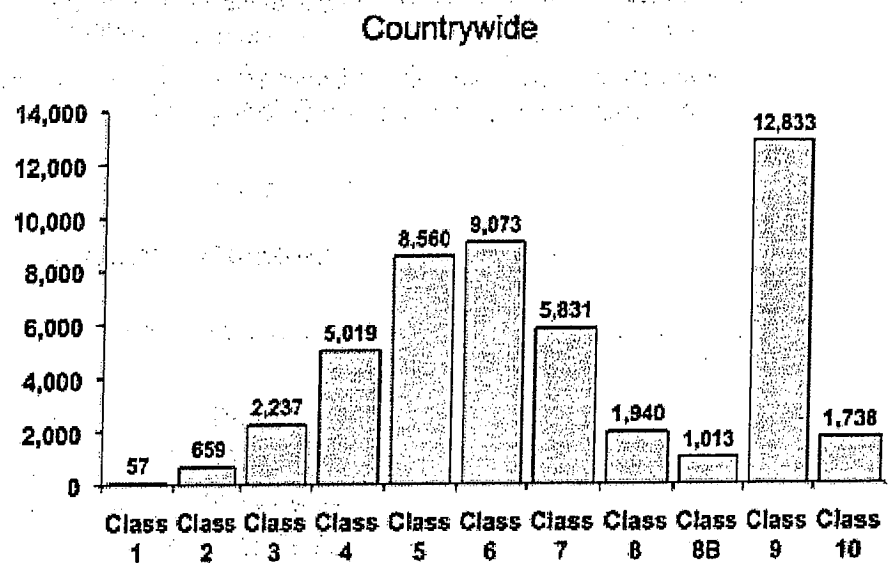
Distribution of Public Protection Classification Numbers

The 2013 published countrywide distribution of communities by the Public Protection Classification number 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.

ISO Public Protection 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 PPC questions. 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 ISO's Public Protection Classification 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 ISO Public Protection Classification, 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 Fire Suppression Rating Schedule 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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Public Protection Classification

ISO concluded its review of the fire suppression features being provided for Hartford. The resulting community classification is **Class 03**.

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., 6/9), the following applies:

- The first class (e.g., "6" in a 6/9) 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.
- Class 8B or class 9 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.
- Specific properties with a Needed Fire Flow in excess of 3,500 gpm are evaluated separately and assigned an individual classification.

Summary Evaluation Analysis

FSRS Feature	Earned Credit	Credit Available
Emergency Communications		
414. Credit for Emergency Reporting	**1.80**	3
422. Credit for Telecommunicators	**2.40**	4
432. Credit for Dispatch Circuits	**1.80**	3
440. Credit for Receiving and Handling Fire Alarms	**6.00**	**10**
Fire Department		
513. Credit for Engine Companies	**5.87**	6
523. Credit for Reserve Pumpers	**0.45**	0.50
532. Credit for Pump Capacity	**3.00**	3
549. Credit for Ladder Service	**2.76**	4
553. Credit for Reserve Ladder and Service Trucks	**0.11**	0.50
561. Credit for Deployment Analysis	**7.02**	10
571. Credit for Company Personnel	**5.21**	15
581. Credit for Training	**3.12**	9
730. Credit for Operational Considerations	**2.00**	2
590. Credit for Fire Department	**29.54**	**50**
Water Supply		
616. Credit for Supply System	**28.81**	30
621. Credit for Hydrants	**2.97**	3
631. Credit for Inspection and Flow Testing	**7.00**	7
640. Credit for Water Supply	**38.78**	**40**
Divergence	**-7.57**	–
1050. Community Risk Reduction	**5.19**	**5.50**
Total Credit	**71.94**	**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	**1.80**	3
422. Credit for Telecommunicators	**2.40**	4
432. Credit for Dispatch Circuits	**1.80**	3
Item 440. Credit for Emergency Communications:	**6.00**	**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.

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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	10.00	25
3. Computer Aided Dispatch Basic CAD (5 points); CAD with Management Information System (5 points); CAD with Interoperability (5 points)	5.00	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.	0.00	15
Review of Emergency Reporting total:	60.00	100

Item 422- Credit for Telecommunicators (4 points)

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

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

Item 420. Telecommunicators (CTC)	Earned Credit	Credit Available
A1. Alarm Receipt (AR) Receipt of alarms shall meet the requirements in accordance with the criteria of NFPA 1221	20.00	20
A2. Alarm Processing (AP) Processing of alarms shall meet the requirements in accordance with the criteria of NFPA 1221	20.00	20
B. Emergency Dispatch Protocols (EDP) Telecommunicators have emergency dispatch protocols (EDP) containing questions and a decision-support process to facilitate correct call categorization and prioritization.	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.	10.00	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	10.00	20
Review of Telecommunicators total:	60.00	100

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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)" = 1.80 points

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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	**5.87**	6
523. Credit for Reserve Pumpers	**0.45**	0.5
532. Credit for Pumper Capacity	**3.00**	3
549. Credit for Ladder Service	**2.76**	4
553. Credit for Reserve Ladder and Service Trucks	**0.11**	0.5
561. Credit for Deployment Analysis	**7.02**	10
571. Credit for Company Personnel	**5.21**	15
581. Credit for Training	**3.12**	9
581. Credit for Operational Considerations	**2.00**	2
Item 590. Credit for Fire Department:	**29.54**	**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.

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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: **3 engine companies**

a) **1 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) **2 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 **3 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)" = 5.87 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)" = 0.45 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 **1 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)" = 2.76 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)" = 0.11 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)" = 7.02 points

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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 **0.00 on-duty personnel** and an average of **25.00 on-call personnel** responding on first alarm structure fires.

Item 571 "Credit for Company Personnel (CCP)" = 5.21 points

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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 month in structure fire related subjects as outlined in NFPA 1001.	0.00	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.	7.81	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.	6.00	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.	3.33	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.	2.50	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.	2.00	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.	6.00	12

Item 580 "Credit for Training (CT)" = 3.12 points

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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	28.81	30
621. Credit for Hydrants	2.97	3
631. Credit for Inspection and Flow Testing	7.00	7
Item 640. Credit for Water Supply:	38.78	40

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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)" = 28.81 points

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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 909 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	897
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	12
E./F. Flush Type, Cistern, or Suction Point	0

Item 621 "Credit for Hydrants (CH)" = 2.97 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 = -7.57

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)	**2.12**	2.2
1033. Credit for Public Fire Safety Education (CFSE)	**2.09**	2.2
1044. Credit for Fire Investigation Programs (CIP)	**0.98**	1.1
Item 1050. Credit for Community Risk Reduction	**5.19**	**5.50**

Item 1025 – Credit for Fire Prevention Code 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.	4.50	6
Fire Prevention Programs (PCP) Evaluation of fire prevention programs.	16.00	2
Review of Fire Prevention Code and Enforcement (CPCE) total:	2.12	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.	28.00	30
Review of Public Safety Education Programs (CFSE) total:	2.09	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.	3.90	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 Prevention Code and Enforcement (CPCE) total:	0.98	20

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Summary of Public Protection Classification Review

Completed by ISO

for

Hartford

FSRS Item	Earned Credit	Credit Available
Emergency Reporting		
414. Credit for Emergency Reporting	1.80	3
422. Credit for Telecommunicators	2.40	4
432. Credit for Dispatch Circuits	1.80	3
440. Credit for Receiving and Handling Fire Alarms	6.00	10
Fire Department		
513. Credit for Engine Companies	5.87	6
523. Credit for Reserve Pumpers	0.45	0.5
532. Credit for Pumper Capacity	3.00	3
549. Credit for Ladder Service	2.76	4
553. Credit for Reserve Ladder and Service Trucks	0.11	0.5
561. Credit for Deployment Analysis	7.02	10
571. Credit for Company Personnel	5.21	15
581. Credit for Training	3.12	9
730. Credit for Operational Considerations	2.00	2
590. Credit for Fire Department	29.54	50
Water Supply		
616. Credit for Supply System	28.81	30
621. Credit for Hydrants	2.97	3
631. Credit for Inspection and Flow Testing	7.00	7
640. Credit for Water Supply	38.78	40
Divergence	-7.57	--
1050. Community Risk Reduction	5.19	5.50
Total Credit	71.94	105.5

Final Community Classification = 03

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INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Hartford

County Dodge, Washington State WISCONSIN (48) Witnessed by: Insurance Services Office Date: Oct 8, 2013

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM $Q=(29.83(C(d^2)p^{0.5}))$ INDIVIDUAL HYDRANTS			TOTAL	PRESSURE PSI STATIC	RESID.	FLOW -AT 20 PSI NEEDED **	AVAIL.	REMARKS***	MODEL TYPE
1.0		Cleveland & Wacker	Hartford Water Department, Main	1180	0	0	1180	62	50	1000	2300		
1.1		Cleveland & Wacker	Hartford Water Department, Main	1180	0	0	1180	62	50	4500	2300		
10.0		Steelcraft & Sumner	Hartford Water Department, Main	1140	0	0	1140	79	43	3000	1500		
11.0		Hoffman & Sumner	Hartford Water Department, Main	1300	0	0	1300	65	62	3500	5600		
12		Hilldale & Sumner	Hartford Water Department, Main	1300	0	0	1300	65	62	2000	5600		
13.0		Monroe & Grand	Hartford Water Department, Main	1290	0	0	1290	71	60	3000	3000		
14		Jefferson & Main	Hartford Water Department, Main	1340	0	0	1340	72	65	3500	4000		
15.1		Cedar & Lincoln	Hartford Water Department, Main	1340	0	0	1340	72	65	5000	4000		
15.2		Cedar & Lincoln	Hartford Water Department, Main	1340	0	0	1340	72	65	4500	4000		
16		Willow & Fairview	Hartford Water Department, Main	1100	0	0	1100	60	45	1000	1900		
17.0		North Main North of Sumner	Hartford Water Department, Main	1400	0	0	1400	80	75	2000	5400		
17.1		North Main North of Sumner	Hartford Water Department, Main	1400	0	0	1400	80	75	4000	5400		
18.0		W State East of N Wacker	Hartford Water Department, Main	1230	0	0	1230	64	55	1750	2900		
18.1		W State East of N Wacker	Hartford Water Department, Main	1230	0	0	1230	64	55	4500	2900		
19		Independence N of Liberty	Hartford Water Department, Main	1290	0	0	1290	70	60	1750	3100		
19.1		Independence N of Liberty	Hartford Water Department, Main	1290	0	0	1290	70	60	4000	3100		

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

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

*Comm = Commercial; Res = Residential.

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

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

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Hartford

County Dodge, Washington State WISCONSIN (48) Witnessed by: Insurance Services Office Date: Oct 8, 2013

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM INDIVIDUAL HYDRANTS			TOTAL	PRESSURE PSI STATIC	RESID.	FLOW -AT 20 PSI NEEDED **	AVAIL.	REMARKS***	MODEL TYPE
2.0		Grant W of Sumner	Hartford Water Department, Main	1490	0	0	1490	90	80	3000	4300		
20		Grant W of Sumner	Hartford Water Department, Main	1500	0	0	1500	90	80	1250	4300		
20.1		Grant W of Sumner	Hartford Water Department, Main	1500	0	0	1500	90	80	4000	4300		
3.0		Wisconsin & Rural	Hartford Water Department, Main	1440	0	0	1440	86	75	3000	3800		
3.1		Wisconsin & Rural	Hartford Water Department, Main	1440	0	0	1440	86	75	7000	3800		
4.0		Cedar & Sumner	Hartford Water Department, Main	1460	0	0	1460	86	77	2000	4300		
5.0		Rte 60 @ Helgerson	Hartford Water Department, Main	1150	0	0	1150	50	45	2000	3000		
6.0		Park & Mill	Hartford Water Department, Main	1420	0	0	1420	80	73	3000	4500		
7.0		Union & 7th	Hartford Water Department, Main	1430	0	0	1430	80	70	3000	3800		
8.0		6th & Highland	Hartford Water Department, Main	1230	0	0	1230	60	55	2500	3800		
8.1		6th & Highland	Hartford Water Department, Main	1230	0	0	1230	60	55	4000	3800		
9		Riverbend E of Wilson	Hartford Water Department, Main	1240	0	0	1240	66	55	3000	2700		

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

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

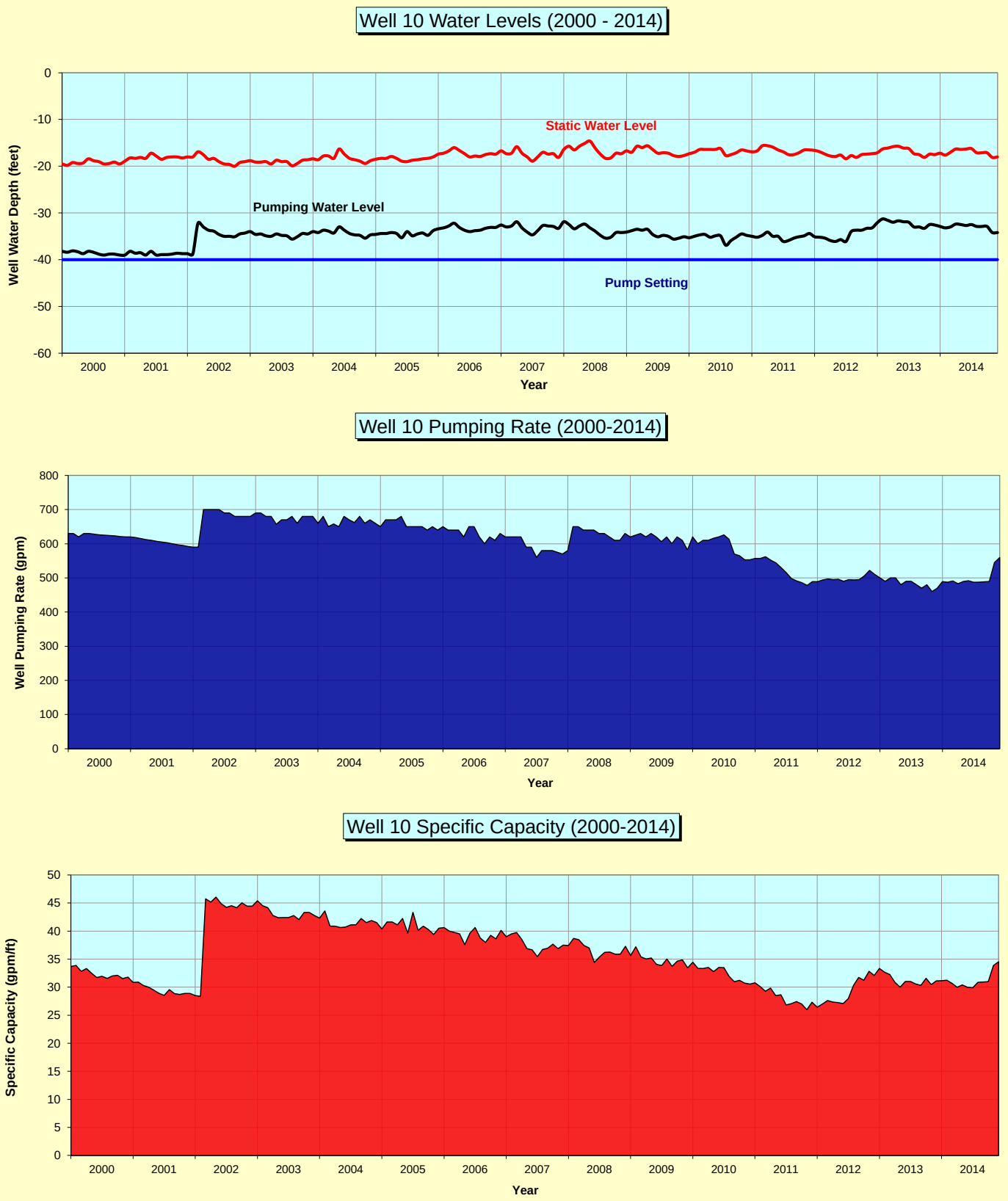
*Comm = Commercial; Res = Residential.

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

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

APPENDIX D

WELL PERFORMANCE DATA



SHORT ELLIOTT HENDRICKSON

FIGURE C-1

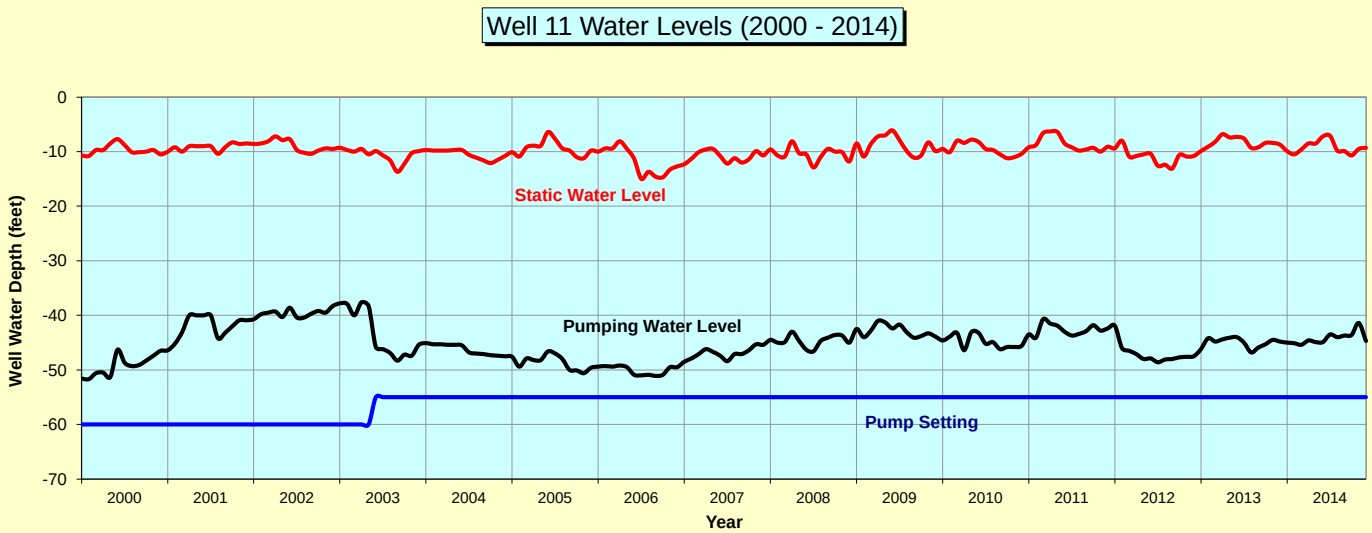
HISTORICAL PERFORMANCE: WELL 10

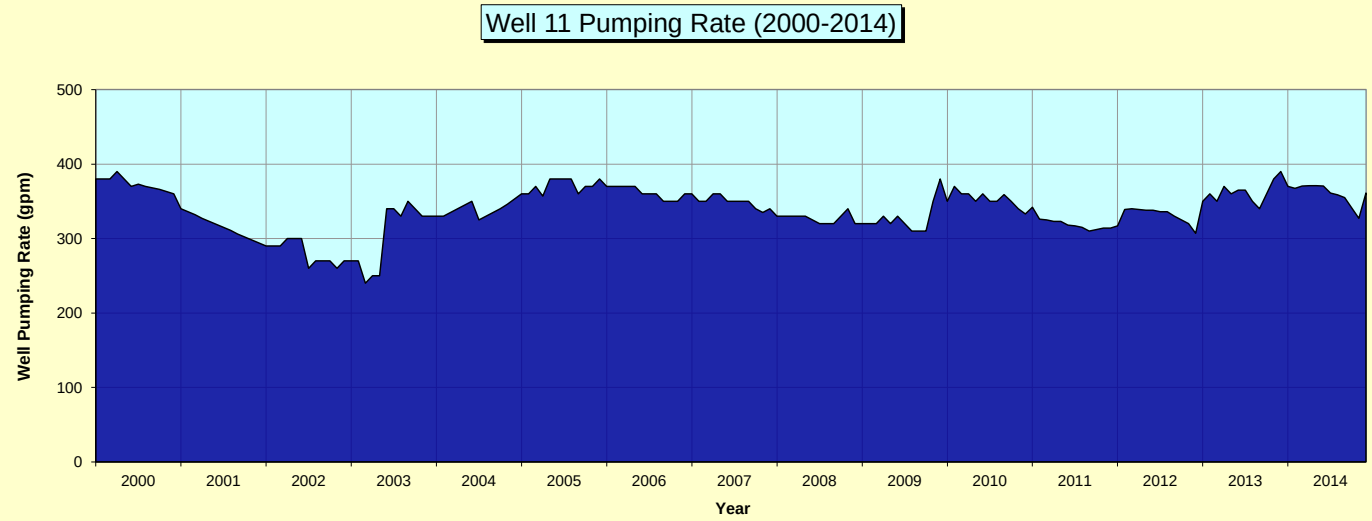
HARTFORD WATER UTILITY

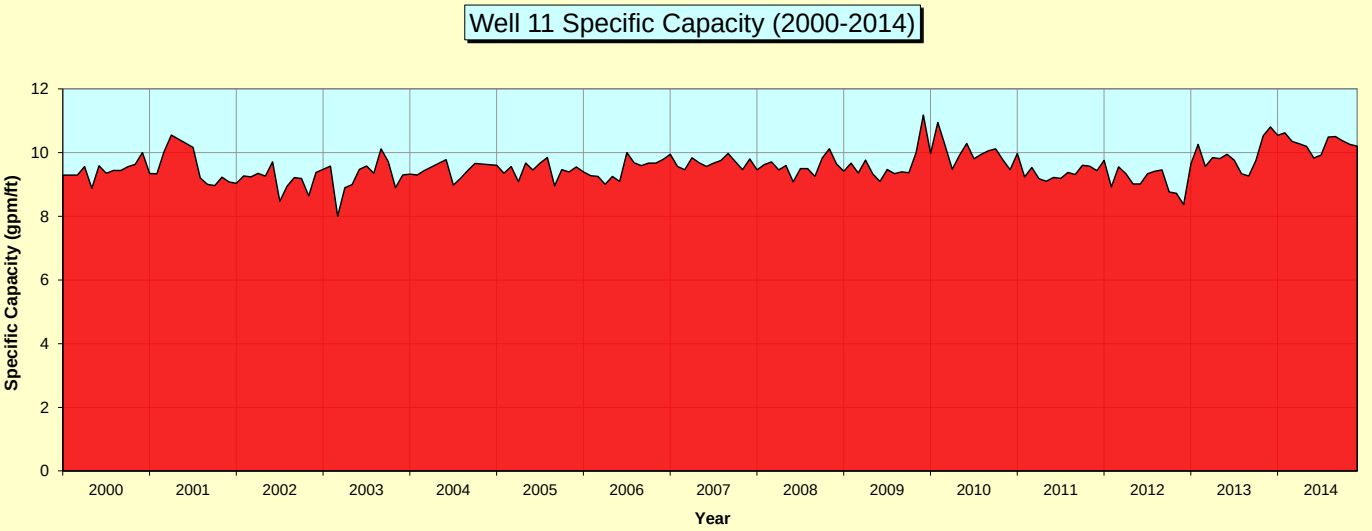
CITY OF HARTFORD, WISCONSIN

DECEMBER 2014

HARTU 123623







SHORT ELLIOTT HENDRICKSON

FIGURE C-2

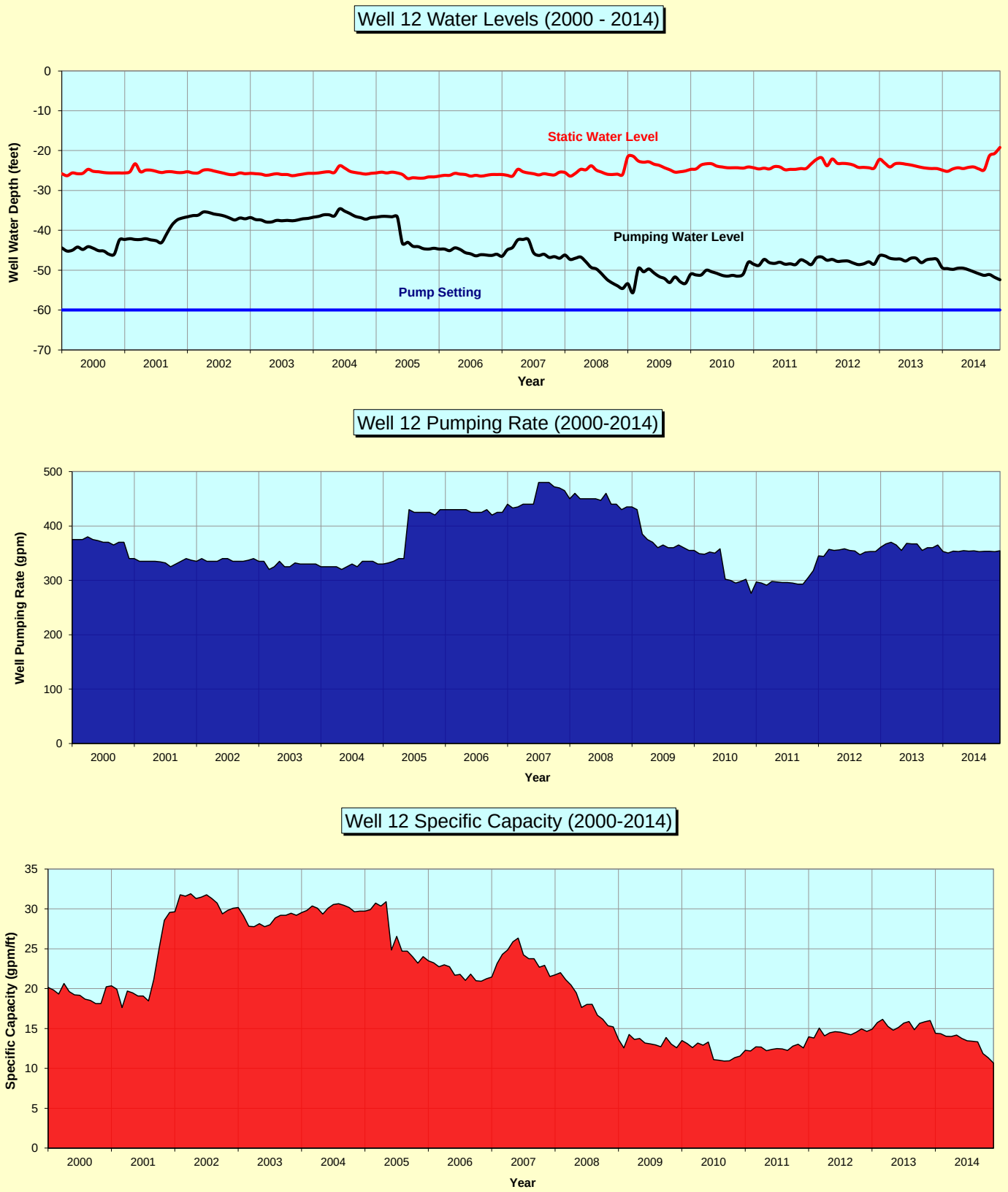
HISTORICAL PERFORMANCE: WELL 11

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

DECEMBER 2014

HARTU 123623



SHORT ELLIOTT HENDRICKSON

SEH

FIGURE C-3

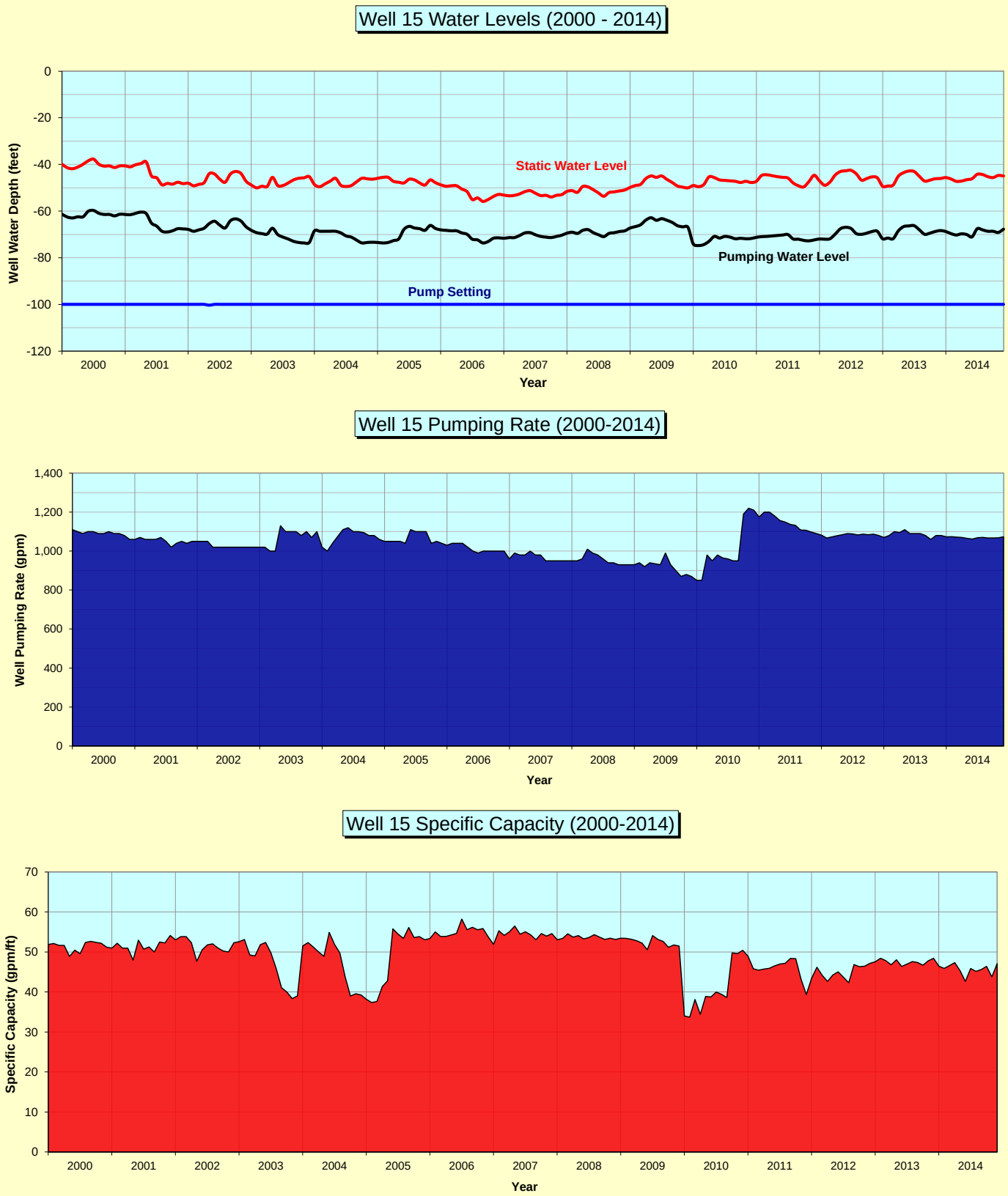
HISTORICAL PERFORMANCE: WELL 12

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

DECEMBER 2014

HARTU 123623



SHORT ELLIOTT HENDRICKSON

SEH

FIGURE C-4

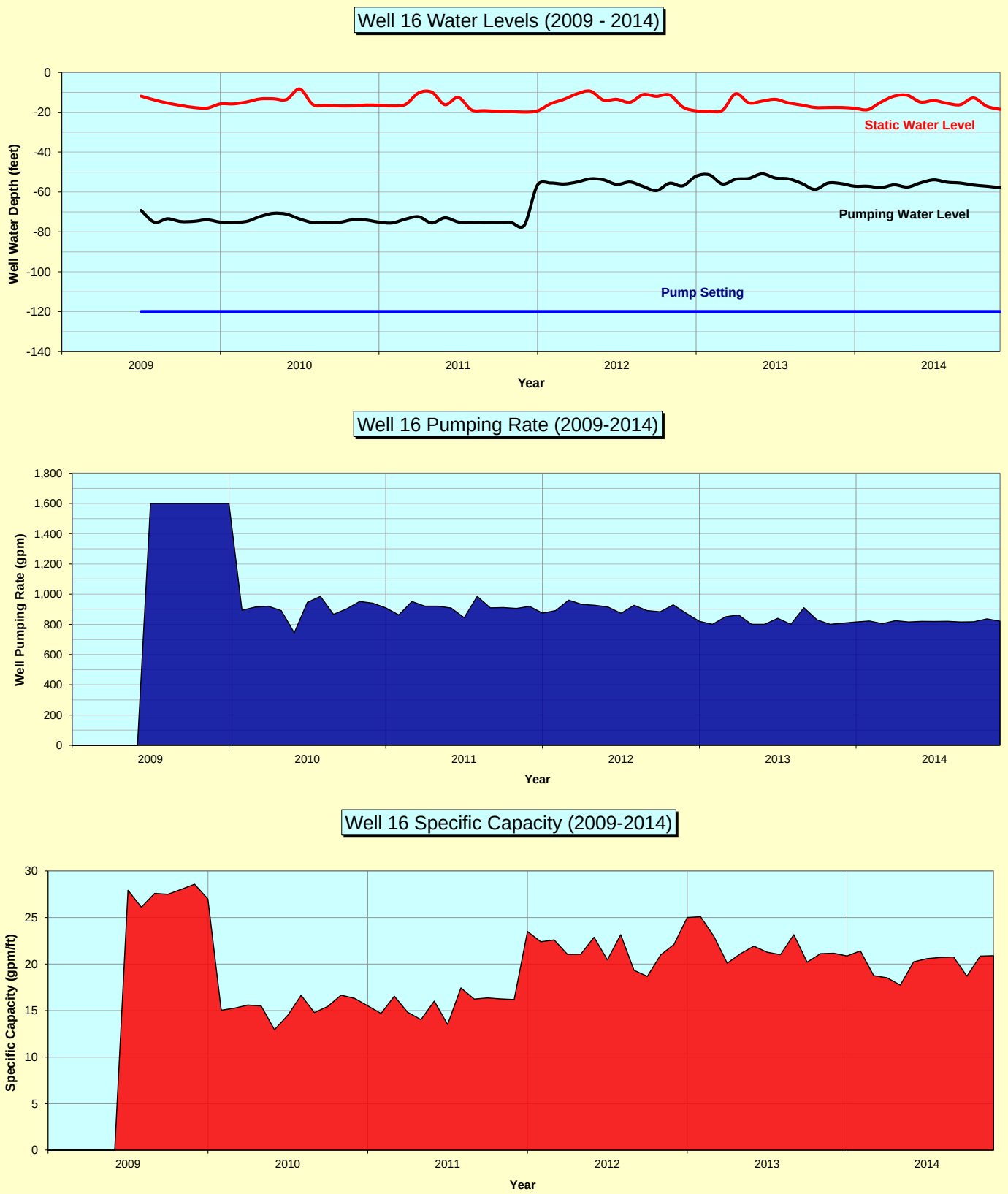
HISTORICAL PERFORMANCE: WELL 15

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

DECEMBER 2014

HARTU 123623



SHORT ELLIOTT HENDRICKSON

FIGURE C-5

HISTORICAL PERFORMANCE: WELL 16

HARTFORD WATER UTILITY

CITY OF HARTFORD, WISCONSIN

DECEMBER 2014

HARTU 123623

APPENDIX E

PRESSURE-FLOW FIELD TEST RESULTS

FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-1 **Date & Time:** 08/07/13 11:46 AM **Area:** Low Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Goodland Road, 1st Hyd. S. of Railroad (1-303)

RESIDUAL HYDRANT(S)		
Location(s):	R1	Constitution Ave. & Goodland Rd. (1-302)
	R2	Independence Ave, Innovation Way

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (Primary Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

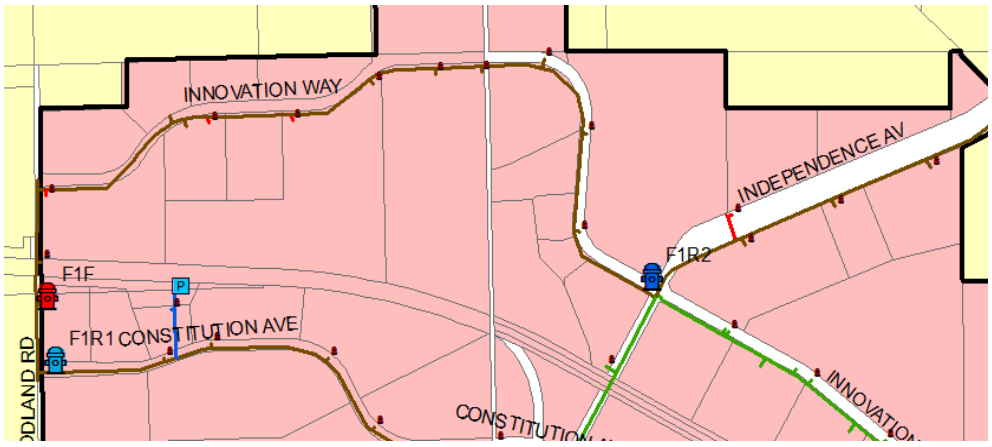
Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	55 psi	55 psi	45 psi
Residual 2	55 psi	55 psi	46 psi
1269	65 psi	65 psi	65 psi
1270	46 psi	44 psi	43 psi
1329	77 psi	76 psi	76 psi
1330	70 psi	70 psi	70 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4	34 psi	2,201 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K	19.1	By Pass Valve	
#11		300K	18.9		
#12		500K	21.4	#1	
#15		750K	21.3	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



Remarks:

P:\FJ\H\HARTU\123623\9-survey\Field Tests\ET

FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-3 **Date & Time:** 08/07/13 12:55 PM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Falcon Dr. & Nighthawk Dr.

RESIDUAL HYDRANT(S)		
Location(s):	R1	Redtail Dr. & Nighthawk Dr.
	R2	N Wacker Dr. & Oriole Dr.

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	57 psi	58 psi	50 psi
Residual 2	44 psi	45 psi	40 psi
1269	65 psi	67 psi	61 psi
1270	44 psi	44 psi	44 psi
1329	76 psi	76 psi	75 psi
1330	70 psi	70 psi	69 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4	35 psi	2,234 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K	19.3	By Pass Valve	
#11	380	300K	17.4		
#12	380	500K	20.2	#1	650
#15		750K	21.1	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map

Remarks: Low Tower Alarm
Tawk Level Low Alarm set 16'

P:\FJ\H\HARTU\123623\9-survey\Field Tests\ET

FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-4 **Date & Time:** 08/07/13 1:13 PM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Woodruff Way & Foxtail Dr.

RESIDUAL HYDRANT(S)		
Location(s):	R1	Foxtail Dr. 1st west of flowing
	R2	Mulberry & Cleveland

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

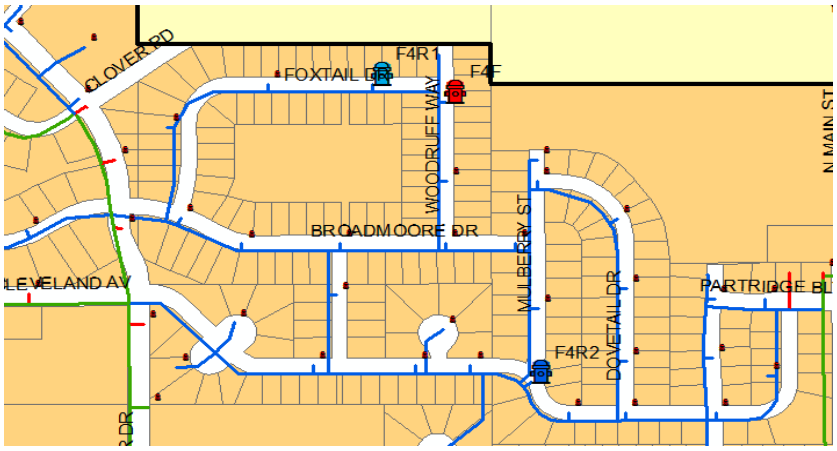
Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	55 psi	54 psi	43 psi
Residual 2	59 psi	58 psi	53 psi
1269	67 psi	68 psi	63 psi
1270	44 psi	44 psi	44 psi
1329	78 psi	80 psi	76 psi
1330	71 psi	70 psi	70 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure (psi)	Flow (gpm)
F1 - Nozzle 1	DIF	4	30 psi	2,068 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K	18.7	By Pass Valve	
#11	340	300K	19.1		
#12	340	500K	19.3	#1	
#15		750K	21.0	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



Remarks:

P:\FJ\H\HARTU\123623\9-survey\Field Tests\ET

FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-5 **Date & Time:** 08/07/13 1:40 PM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Yosemite Ave. & Yellowstone Dr.

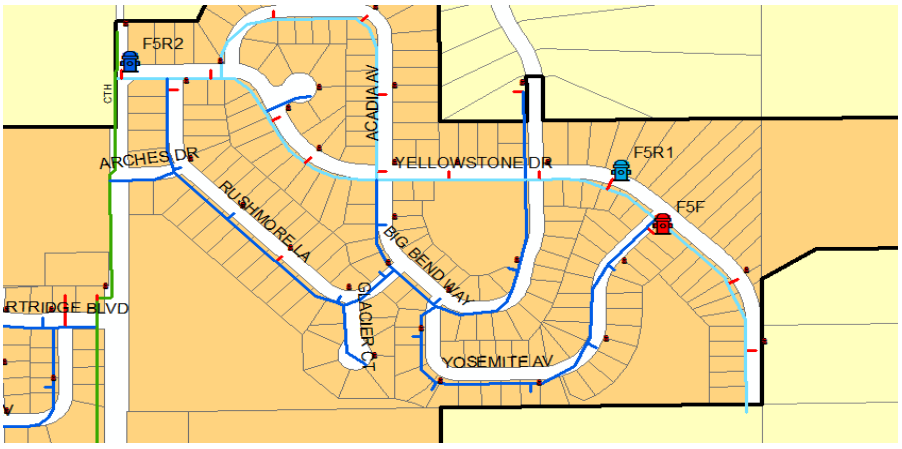
RESIDUAL HYDRANT(S)		
Location(s):	R1	Yellowstone Rd. West of Yosemite Ave
	R2	Yellowstone & Hwy K

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)	Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
	Initial	Final		F1 - Nozzle 1	DIF	4	22 psi	1,771 gpm
				F1 - Nozzle 2				
Residual 1	55 psi	56 psi	40 psi					
Residual 2	63 psi	61 psi	51 psi					
1269	66 psi	66 psi	60 psi					
1270	44 psi	44 psi	44 psi					
1329	77 psi	77 psi	74 psi					
1330	70 psi	70 psi	69 psi					

BOUNDARY CONDITIONS					
Wells	**Flow (gpm)**	**Towers (gal)**	**Water Level**	**Booster Pump**	**Status/ Flow**
#10		150K	18.0	By Pass Valve	
#11		300K	20.2		
#12		500K	18.6	#1	
#15		750K	21.0	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



Remarks: R2 experienced some wild swings during initial static condition 43-85 psi.

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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-6 **Date & Time:** 08/07/13 3:02 PM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Victor Dr. & Forest St. (337)

RESIDUAL HYDRANT(S)		
Location(s):	R1	Forest St. & Russel Ave. (325)
	R2	State St & Grant St

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	59 psi	56 psi	49 psi
Residual 2	77 psi	77 psi	73 psi
1269	65 psi	66 psi	61 psi
1270	44 psi	44 psi	44 psi
1329	77 psi	75 psi	74 psi
1330	70 psi	70 psi	69 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4	26 psi	1,925 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K	19.1	By Pass Valve	
#11		300K	18.6		
#12		500K	19.2	#1	
#15	1,070	750K	20.4	#2	
#16	800			P1	
				P2	780
				P3	
				P4	

Location Map

Remarks:

P:\FJ\H\HARTU\123623\9-survey\Field Tests\ET

FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-9 **Date & Time:** 08/07/13 11:21 AM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Goodland Road, 1st Hyd. S. of Railroad (1-303)

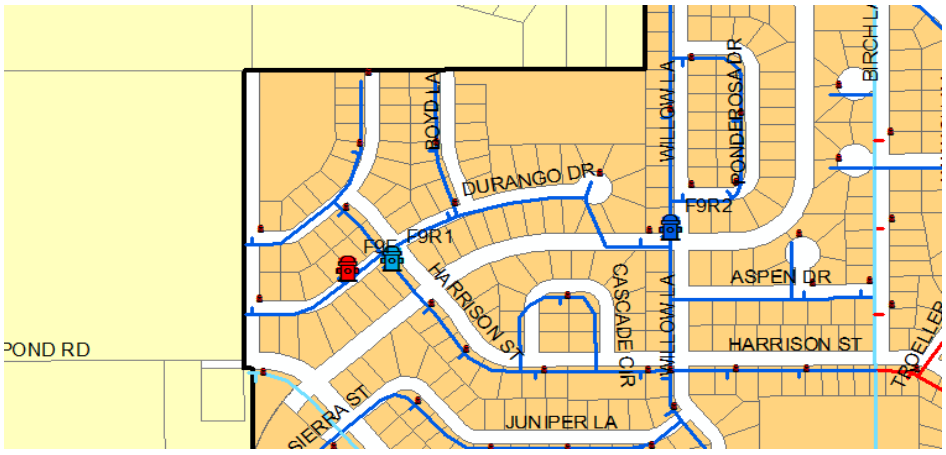
RESIDUAL HYDRANT(S)		
Location(s):	R1	Harrison and Durango
	R2	Willow and Wacker

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)	Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
	Initial	Final		F1 - Nozzle 1	DIF	4.00	25 psi	1,888 gpm
				F1 - Nozzle 2				
Residual 1	78 psi	76 psi	60 psi					
Residual 2	69 psi	69 psi	60 psi					
1269	65 psi	67 psi	63 psi					
1270	45 psi	45 psi	45 psi					
1329	77 psi	77 psi	75 psi					
1330	70 psi	70 psi	69 psi					

BOUNDARY CONDITIONS					
Wells	**Flow (gpm)**	**Towers (gal)**	**Water Level**	**Booster Pump**	**Status/ Flow**
#10		150K	19.9	By Pass Valve	
#11		300K	18.3		
#12		500K	21.0	#1	
#15		750K	21.5	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



Remarks:

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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-10 **Date & Time:** 08/07/13 2:45 PM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Washington East of Summit

RESIDUAL HYDRANT(S)		
Location(s):	R1	Summit St. & West Washington Ave.
	R2	Root & Birtch

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

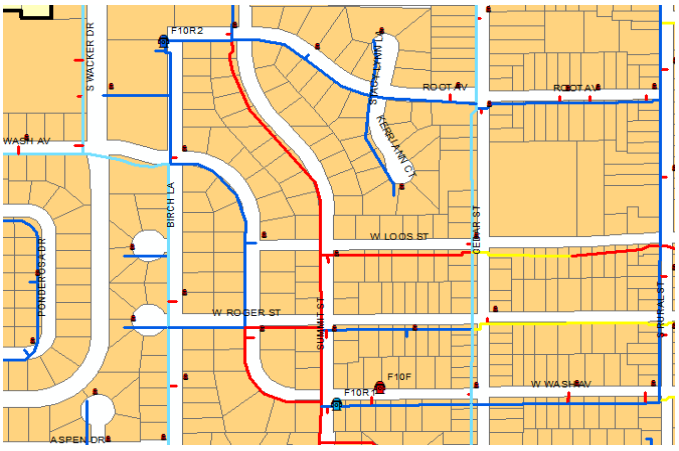
Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	56 psi	55 psi	51 psi
Residual 2	83 psi	84 psi	82 psi
1269	67 psi	66 psi	64 psi
1270	44 psi	44 psi	44 psi
1329	78 psi	75 psi	75 psi
1330	71 psi	71 psi	69 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4.00	25 psi	1,888 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K	18.7	By Pass Valve	
#11		300K	19.3		
#12		500K	18.6	#1	
#15	1,070	750K	20.6	#2	
#16	819			P1	
				P2	780
				P3	
				P4	

Location Map



Remarks: R2 switched guage - using 100-01 wike gauge.

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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-11 **Date & Time:** 08/07/13 10:58 AM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Fairview Dr. & Willow La. (446)

RESIDUAL HYDRANT(S)		
Location(s):	R1	Sunset Dr. & Willow La. (440)
	R2	Cedar South of Monroe

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

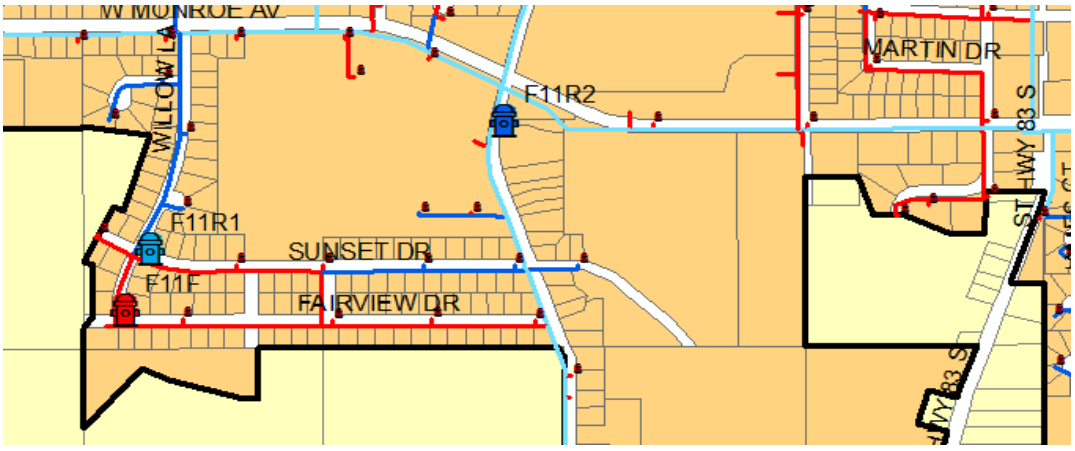
Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	56 psi	55 psi	30 psi
Residual 2	60 psi	60 psi	60 psi
1269	66 psi	66 psi	64 psi
1270	45 psi	46 psi	45 psi
1329	77 psi	77 psi	75 psi
1330	71 psi	70 psi	69 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4.00	8 psi	1,068 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K		By Pass Valve	
#11		300K	19.8		
#12		500K		#1	
#15		750K	21.7	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-12 **Date & Time:** 08/07/13 10:38 AM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Firefly across from Red Oak

RESIDUAL HYDRANT(S)		
Location(s):	R1	Red Oak North of Firefly
	R2	End of Dakota

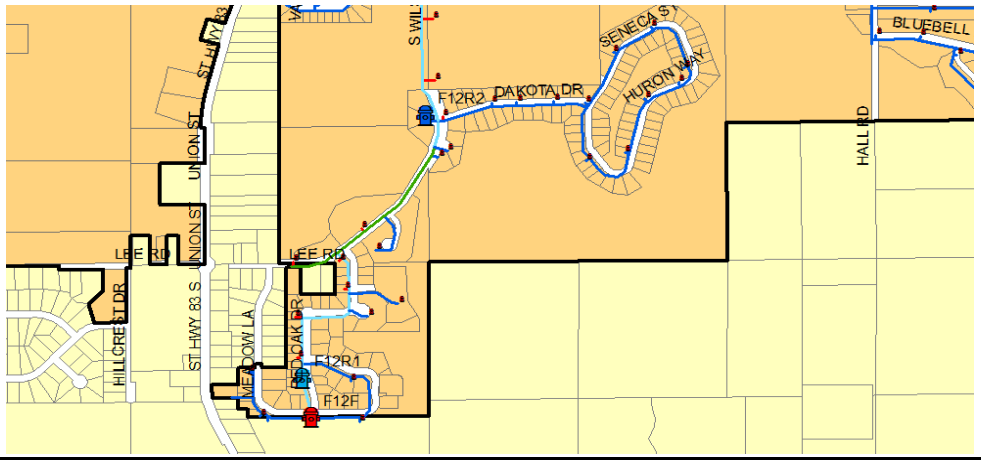
TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	60 psi	64 psi	29 psi
Residual 2	67 psi	67 psi	50 psi
1269	66 psi	66 psi	64 psi
1270	45 psi	45 psi	45 psi
1329	77 psi	77 psi	75 psi
1330	71 psi	71 psi	68 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4.00	13 psi	1,361 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS					
Wells	**Flow (gpm)**	**Towers (gal)**	**Water Level**	**Booster Pump**	**Status/ Flow**
#10		150K		By Pass Valve	
#11		300K	19.2		
#12		500K		#1	
#15		750K	21.7	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-15 **Date & Time:** 08/07/13 2:19 PM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	East Ave. & Linden Ave. (156)

RESIDUAL HYDRANT(S)		
Location(s):	R1	Linden Ave. at Curve (157)
	R2	Branch & Loos

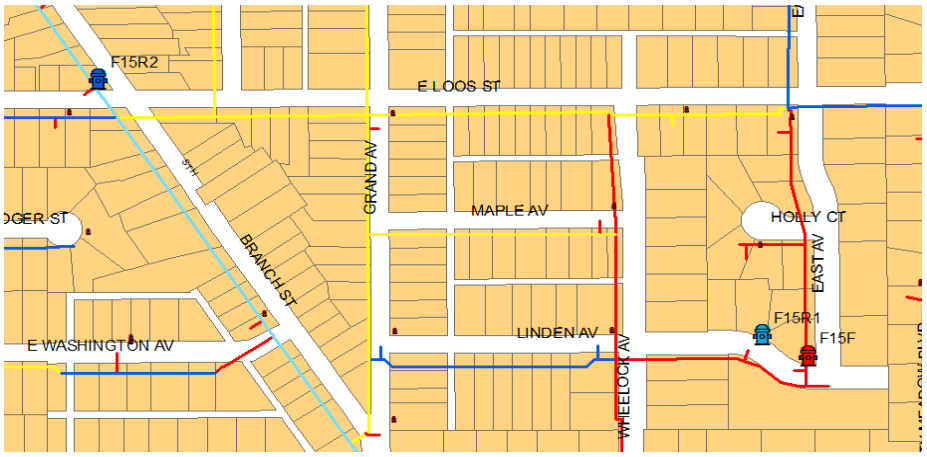
TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)	Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
	Initial	Final		F1 - Nozzle 1	DIF	4.00	28 psi	1,998 gpm
				F1 - Nozzle 2				
Residual 1	78 psi	78 psi	50 psi					
Residual 2	65 psi	65 psi	63 psi					
1269	65 psi	67 psi	66 psi					
1270	44 psi	44 psi	44 psi					
1329	77 psi	78 psi	75 psi					
1330	70 psi	71 psi	69 psi					

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K	17.9	By Pass Valve	
#11	370	300K	17.8		
#12	360	500K	18.5	#1	
#15		750K	20.6	#2	580
#16	846			P1	
				P2	780
				P3	
				P4	

Location Map



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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-18 **Date & Time:** 08/07/13 8:49 AM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Gateway & East Gate

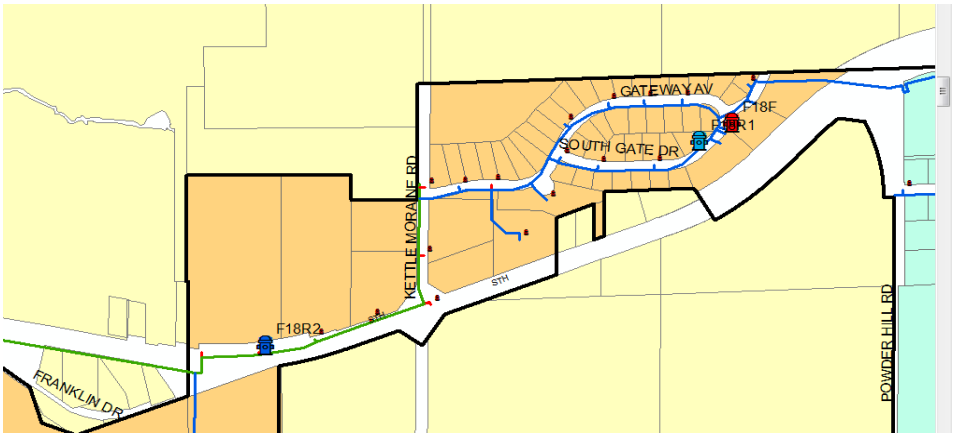
RESIDUAL HYDRANT(S)		
Location(s):	R1	South Gate West of F18F
	R2	Hwy 60 nearest Well 12

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)	Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
	Initial	Final		F1 - Nozzle 1	DIF	4.00	16 psi	1,510 gpm
				F1 - Nozzle 2				
Residual 1	64 psi	64 psi	26 psi					
Residual 2	60 psi	60 psi	27 psi					
1269	65 psi	65 psi	64 psi					
1270	44 psi	44 psi	44 psi					
1329	77 psi	75 psi	75 psi					
1330	70 psi	69 psi	69 psi					

BOUNDARY CONDITIONS					
Wells	**Flow (gpm)**	**Towers (gal)**	**Water Level**	**Booster Pump**	**Status/ Flow**
#10		150K		By Pass Valve	
#11		300K	18.2		
#12		500K		#1	
#15		750K	20.8	#2	
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-19 **Date & Time:** 08/07/13 2:00 PM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	East end Highland Ave.

RESIDUAL HYDRANT(S)		
Location(s):	R1	Between Rossman and Highland
	R2	Rossman & 4th

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

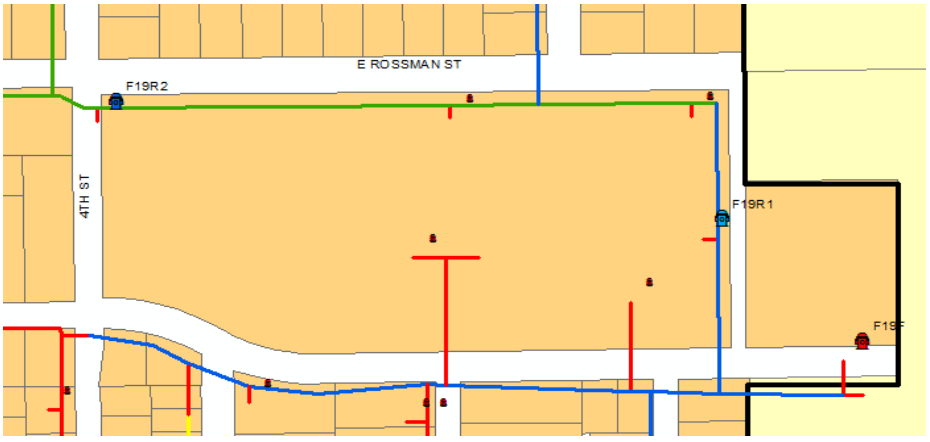
Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	60 psi	60 psi	52 psi
Residual 2	59 psi	59 psi	55 psi
1269	66 psi	65 psi	62 psi
1270	44 psi	44 psi	44 psi
1329	76 psi	77 psi	74 psi
1330	70 psi	70 psi	68 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4.00	28 psi	1,998 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K	17.7	By Pass Valve	
#11		300K	18.1		
#12		500K	18.4	#1	
#15		750K	20.8	#2	
#16	834			P1	
				P2	720
				P3	
				P4	

Location Map



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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-20 **Date & Time:** 08/07/13 9:46 AM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Tamarack Ave. & Honeysuckle Rd. (258)

RESIDUAL HYDRANT(S)		
Location(s):	R1	Honeysuckle Rd. & Karen Court (262)
	R2	Briarwood & Hilldale

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

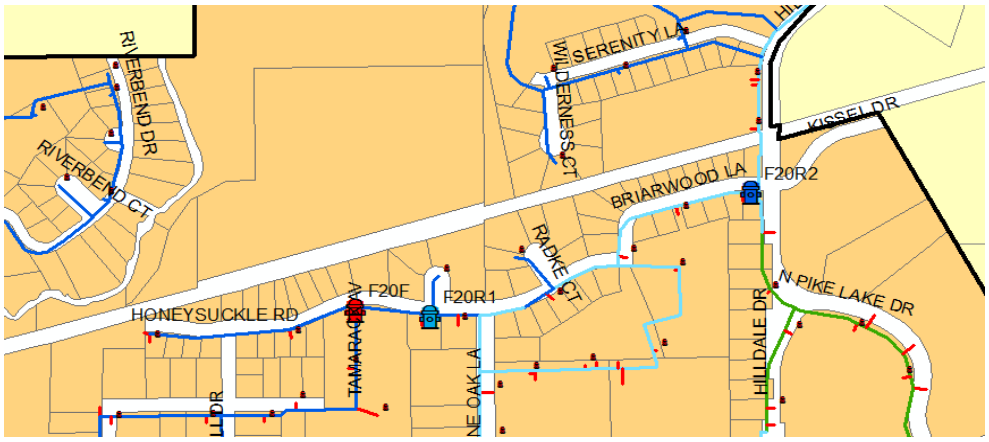
Hydrant	Static Pressure		Residual Pressure (psi)
	Initial	Final	
Residual 1	75 psi	76 psi	70 psi
Residual 2	65 psi	65 psi	63 psi
1269	66 psi	67 psi	65 psi
1270	45 psi	45 psi	45 psi
1329	77 psi	77 psi	76 psi
1330	70 psi	70 psi	69 psi

Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
F1 - Nozzle 1	DIF	4.00	35 psi	2,234 gpm
F1 - Nozzle 2				

BOUNDARY CONDITIONS

Wells	Flow (gpm)	Towers (gal)	Water Level	Booster Pump	Status/ Flow
#10		150K		By Pass Valve	
#11	360	300K	18.6		
#12	360	500K		#1	
#15		750K	21.0	#2	610
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-21 **Date & Time:** 08/07/13 9:20 AM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	On Gold Bug Court

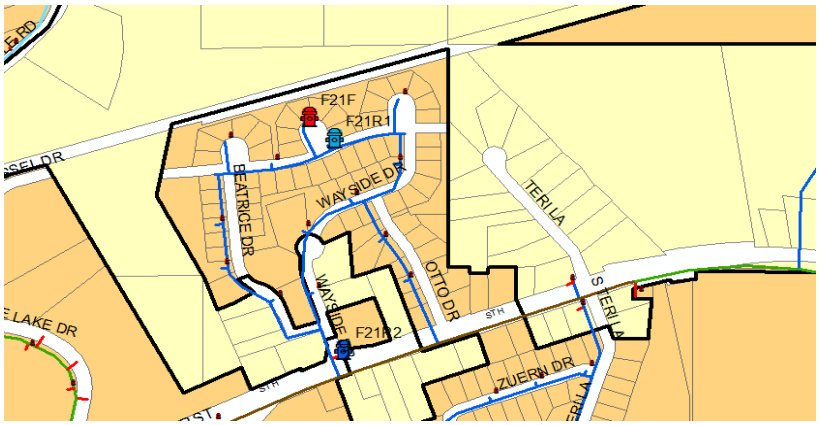
RESIDUAL HYDRANT(S)		
Location(s):	R1	Gold Bug Court & Kissel Dr.
	R2	Wayside & Hwy 60

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)	Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
	Initial	Final		F1 - Nozzle 1	DIF	4.00	24 psi	1,850 gpm
				F1 - Nozzle 2				
Residual 1	62 psi	61 psi	41 psi					
Residual 2	63 psi	63 psi	56 psi					
1269	65 psi	66 psi	64 psi					
1270	44 psi	45 psi	45 psi					
1329	76 psi	77 psi	75 psi					
1330	70 psi	70 psi	69 psi					

BOUNDARY CONDITIONS					
Wells	**Flow (gpm)**	**Towers (gal)**	**Water Level**	**Booster Pump**	**Status/ Flow**
#10		150K		By Pass Valve	
#11	380	300K	17.6		
#12	390	500K		#1	
#15		750K	20.6	#2	625
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



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FLOW AND PRESSURE TESTS
CITY OF HARTFORD, WISCONSIN

Test Number: F-22 **Date & Time:** 08/07/13 10:14 AM **Area:** Primary Pressure Zone

FLOWING HYDRANT(S)		
Location(s):	F1	Simon & Valley View (N)

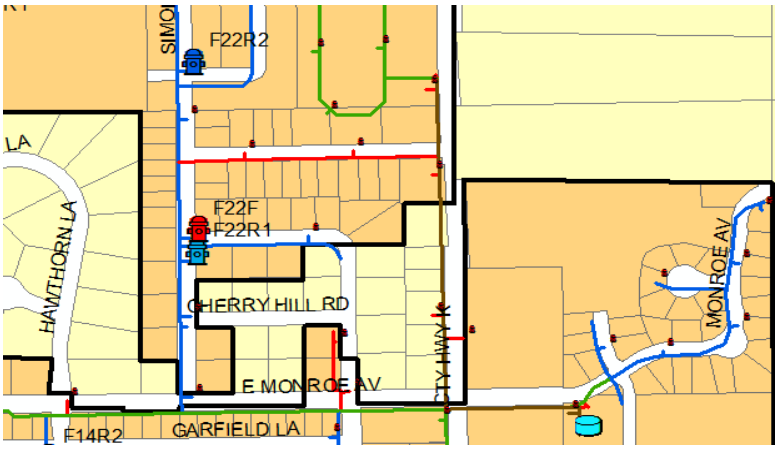
RESIDUAL HYDRANT(S)		
Location(s):	R1	Simon & Valley View (S)
	R2	Simon & Novak

TELOGS	
Telog	**Location**
1269	Airport Rd S. of Cleveland (High Zone)
1270	Airport Rd, 2nd Hyd. S. of Cleveland (Low Zone)
1329	Sumner and Wilson
1330	Monroe Ave. East of Ridge View

Hydrant	Static Pressure		Residual Pressure (psi)	Hydrant	Flow Device	Nozzle Size (in)	Velocity Pressure	Flow (gpm)
	Initial	Final		F1 - Nozzle 1	DIF	4.00	30 psi	2,068 gpm
				F1 - Nozzle 2				
Residual 1	46 psi	46 psi	41 psi					
Residual 2	47 psi	46 psi	45 psi					
1269	66 psi	66 psi	65 psi					
1270	45 psi	45 psi	45 psi					
1329	77 psi	77 psi	76 psi					
1330	70 psi	71 psi	70 psi					

BOUNDARY CONDITIONS					
Wells	**Flow (gpm)**	**Towers (gal)**	**Water Level**	**Booster Pump**	**Status/ Flow**
#10		150K		By Pass Valve	
#11	346	300K	19.7		
#12	360	500K		#1	
#15		750K	21.3	#2	610
#16	780			P1	
				P2	
				P3	
				P4	

Location Map



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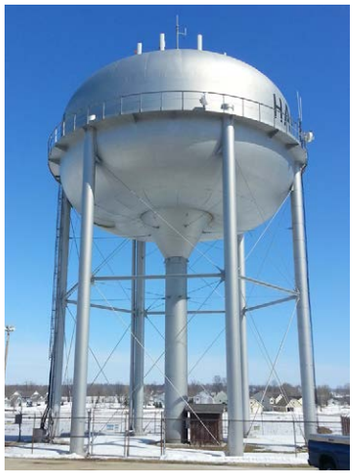

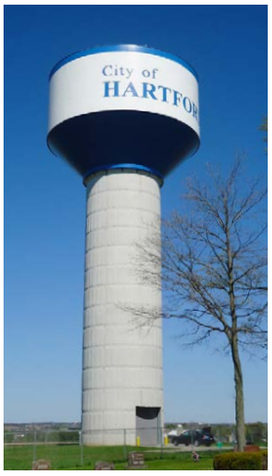

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