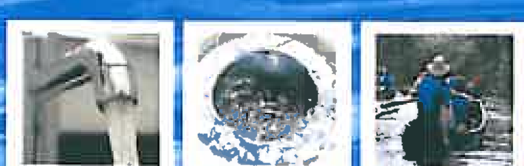
Draft Capital Efficiency Plan™

Wayland, Massachusetts

TATA & HOWARD INCORPORATED



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Section 1
Executive Summary

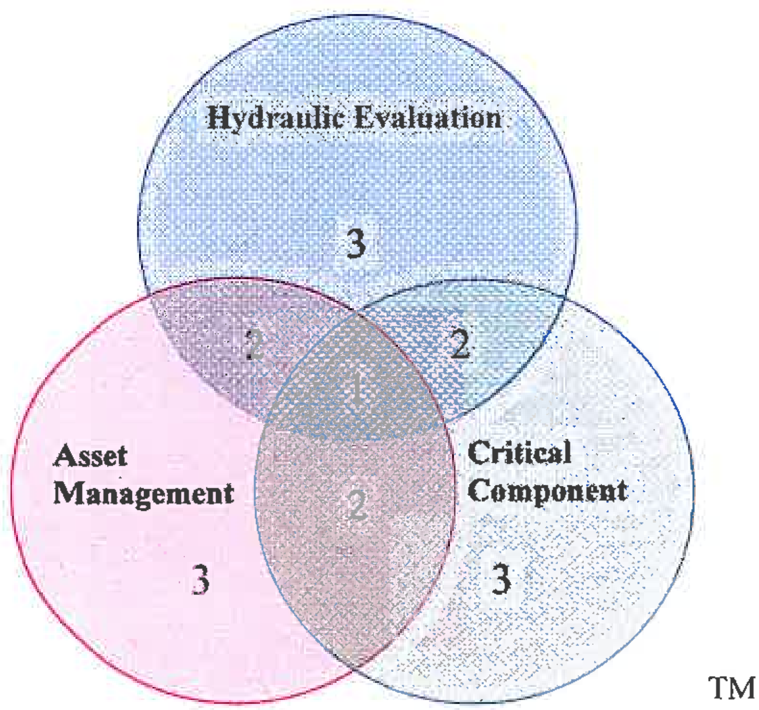
Introduction

Tata & Howard, Inc. was retained by the Town of Wayland to generate a Capital Efficiency Plan™ for the Town's water system. The purpose of the study is to identify areas of the water distribution system in need of rehabilitation, repair or replacement and prioritize improvements to make the most efficient use of the Town's capital budget. The study evaluates the existing water infrastructure including water transmission and distribution piping and appurtenances, water storage tanks, pumping stations and water supply and chemical feed facilities.

The Three Circle Approach

The Capital Efficiency Plan™ evaluated the water distribution system using Tata & Howard's Three Circle approach. The Three Circle Approach consists of the following evaluation criteria:

- System hydraulic evaluation,
- Critical component assessment,
- Asset management considerations.



Each circle represents a unique set of evaluation criteria for each water system category. System deficiencies are identified within each category and then compared. Any deficiency that falls into more than one circle is given higher priority than one that does not. Using the Three Circle Approach, we are able to identify recommended improvements that will result in the most benefit to the system. In addition, the Three Circle Approach allows us to identify situations where an improvement of a deficiency in one circle will eliminate a deficiency in another circle. By integrating all three categories, the infrastructure improvement decision-making process and overall "capital efficiency" is optimized.

Tasks in this study included the following:

- Updated the existing water distribution system model to include infrastructure improvements since the completion of the 2000 Water Distribution System Update.
- Conducted half-day workshop with the Water Department staff to review operations and maintenance practices, break history and other pertinent information.
- Reviewed previously completed reports and available data pertaining to the condition of the existing system.
- Conducted an inventory of the existing assets that comprise the water system that will identify the general condition, age, service history and useful life of each asset.
- Incorporated applicable pipe and pump curve information into WaterGEMS model.
- Reviewed recommended hydraulic improvements from the Tata & Howard Water Distribution System Update and previous water reports, as well as potential improvements resulting from asset management and redundancy component considerations.
- Created a pipe rating system to identify areas needing rehabilitation or replacement. Use the rating system to create a prioritized plan of recommended improvements for a five and ten year period.

Based on the Three Circle Approach, a prioritized recommended improvements plan was compiled. Improvements were separated into three phases. Phase I represents the most needed improvements based on hydraulic needs, location in the distribution system and the operating and physical conditions of the water main. In general, these include water mains that fall into all three circles. These improvements will strengthen the transmission grid, eliminate potential asset management concerns, as well as provide reduncancy. Engineering judgment is used to determine if any improvement that falls in only one or two circles should be considered a Phase I Improvement. Phase II Improvements include areas that fall into at least two of the circles and also strengthen the transmission grid, eliminate potential asset management concerns, as well as provide redundancy. Phase III Improvements include areas that fall into one of the circles. These improvements generally will benefit a localized area, and include areas of hydraulic inadequacy, redundancy concerns or a water main that has a high asset management score.

Consideration of Risk

The definition of risk is the product of probability and consequence. The probability of failure of smaller diameter mains, that is, less than 12-inches in diameter is more likely to occur than larger diameter mains. In the Wayland system, approximately 88 percent of all of the existing mains are less than 12-inches in diameter and there are no water mains that are truly considered large diameter (24-inch and 30-inch mains). Large diameter mains typically have a lower probability of failure than smaller diameter mains, not only because there are comparatively fewer miles of them, but also because they are less likely to fail from corrosion due to having a much greater pipe wall thickness. Large diameter mains are also less likely to fail from bending forces compared to smaller diameter mains. However, failure of larger diameter mains may have greater consequences than smaller mains particularly if they are located in urban areas where damage from flooding is typically greater. On the other hand, the direct costs and societal costs of large diameter main failures that occur in rural areas may not be as great as smaller diameter main failures that occur in urban areas. The risk of operating a water system that has hydraulic deficiencies is apparent. The number of individual deficiencies increases the probability and the type of deficiency (e.g. ISO requirement) increases the consequences. This Capital Efficiency Plan™ inherently examines the risk of pipe failure by combining consideration of the probability of failure through the asset management analysis and the consequences of failure through the critical component and hydraulic deficiency analysis.

Section 2
Existing Water System

Distribution System

The Wayland Water Department (WWD) was formed by an act of the legislature in 1878. Since that time, the water system has expanded throughout the Town and currently provides water service to 95 percent of the Town's population. The current system is comprised of approximately 100 miles of water main with pipe diameters ranging from 4 to 16 inches. Figure No. 2-1 shows a breakdown of the water main sizes of the existing water system. Approximately 1 percent of the system is 16-inch diameter pipe, 9 percent is 12-inch diameter pipe, 7 percent is 10-inch diameter pipe, 48 percent is 8-inch diameter pipe, 33 percent is 6-inch diameter pipe, and 2 percent is less than 6-inch diameter pipe.

The existing water mains are constructed of various materials including unlined and cement lined cast iron, asbestos cement and ductile iron. Figure No. 2-2 shows a breakdown of water main material. There is approximately 12 percent ductile water main, which was installed after 1970. Approximately 67 percent of the system is comprised of unlined cast iron, approximately 20 percent is cement lined cast iron and the remaining one percent is asbestos cement. Further discussion of material characteristics is provided in Section 5.

Water Storage Facilities

The distribution system includes two water storage facilities both located on Reeves Hill. The first tank is a 0.5 million gallon riveted steel reservoir constructed in 1927. The tank is 76.5 feet in diameter. The tank interior was rehabilitated in 2004. The second tank is a 2.0 million gallon precast concrete structure constructed in 1958 with a diameter of 150 feet. The overflow elevation of both tanks is 359 feet.

Water Supply Sources

The water system has 8 groundwater supply sources. The wells are all located in the Concord River basin and include Baldwin Pond Well Nos. 1, 2 & 3; Campbell Well; Chamberlain Well; Meadowview Well; and Happy Hollow Well Nos. 1 & 2.

The water system has three interconnections with the Town of Weston and one interconnection with the Town of Lincoln. The Weston interconnections are located at the Weston border at the intersection of Plain Road and Route 30, and at the Weston Border on Buckskin Road, and at Route 20. The Lincoln interconnection is located at the Lincoln border on Route 126. The interconnections are used only as emergency connections and only the Plain Road/Route 30 connection with Weston is equipped with a meter.

Baldwin Pond Wells

The Baldwin Pond Wells are located in the northwestern section of the distribution system between Old Sudbury Road and Glezen Lane. The wells consist of three gravel-packed wells. The three wells are connected to the distribution system through two

Figure No. 2-1
Water Main Size Distribution
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Wayland, Massachusetts

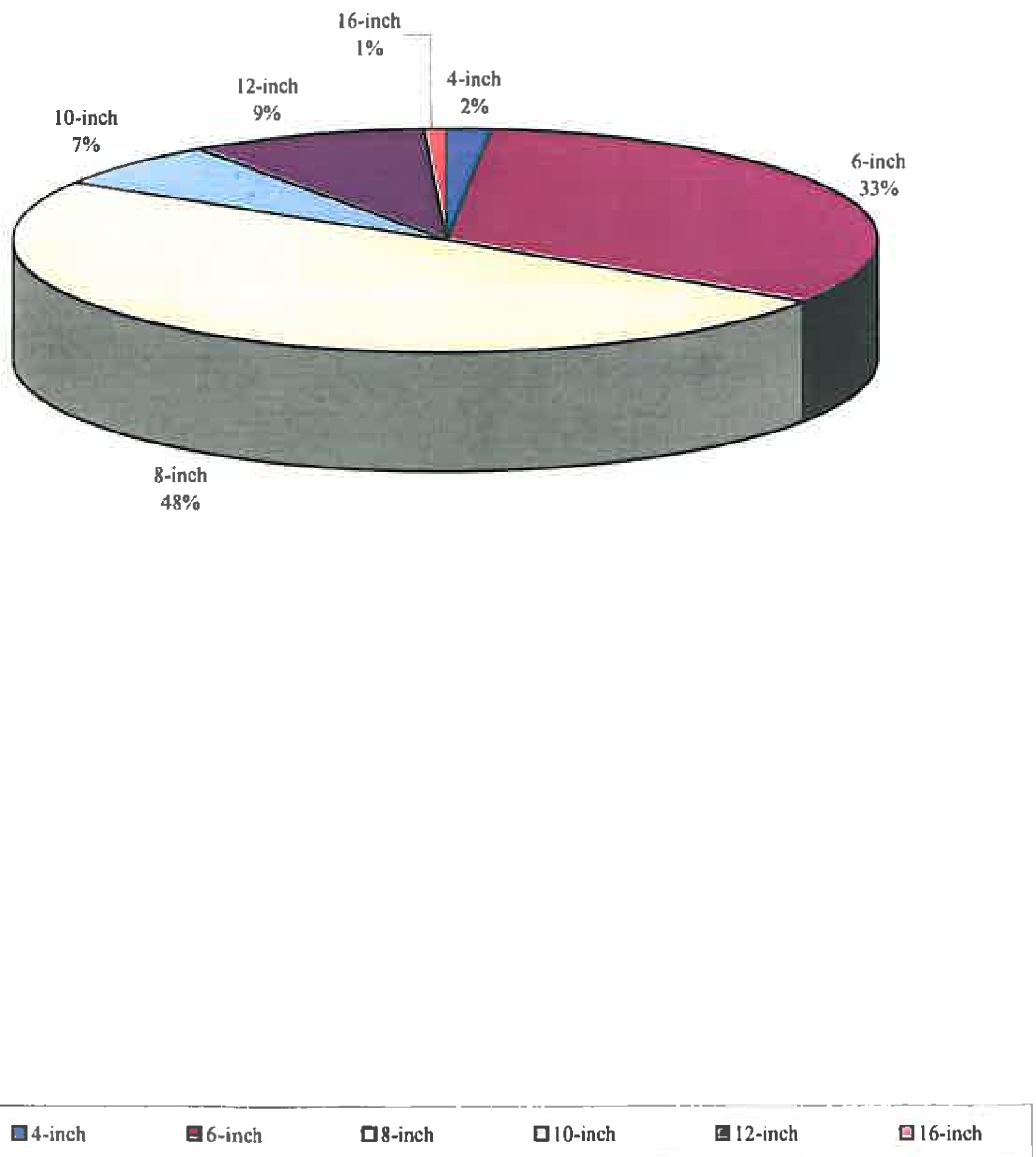

Figure No. 2-2
Water Main Material Distribution
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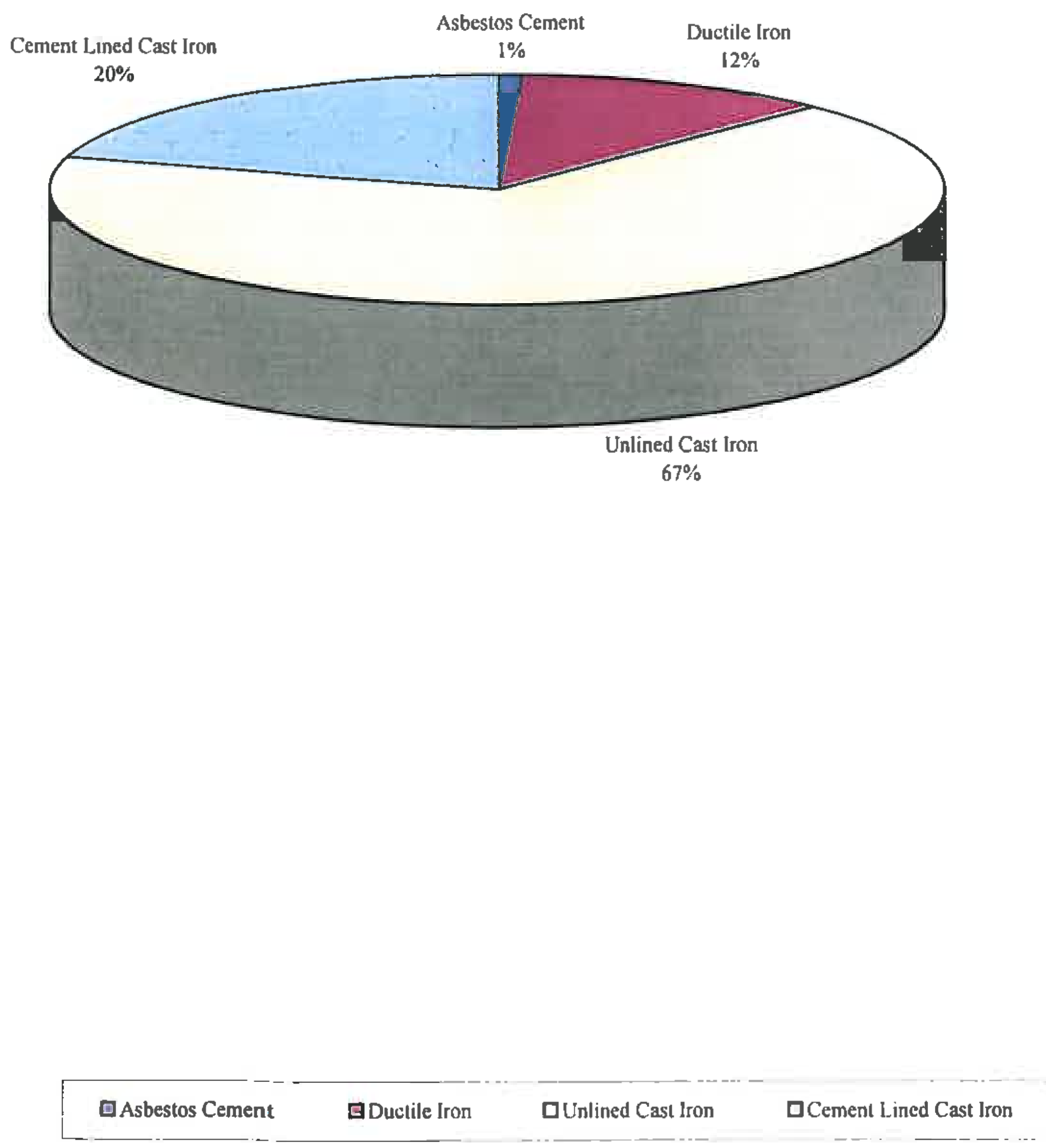
Wayland, Massachusetts



8-inch diameter water mains. The first connects to a 10-inch diameter water main located on Old Sudbury Road and the second connects to a 12-inch diameter water main located on Glezen Lane. Currently two of the wells are not used because of high levels of iron and manganese. A new treatment facility is planned to treat all three wells for iron and manganese.

Well No. 1 was originally an 18-inch diameter well approximately 48 feet deep. A replacement 12-inch by 18-inch gravel packed well approximately 52 feet deep was installed in 2001. Well No. 1 is currently used as a sampling location only due to high levels of iron and manganese.

Well No. 2 is a 48-inch by 24-inch gravel packed well approximately 54 feet deep located just east of Well No. 1. The well is equipped with a 50 HP submersible turbine pump. Well No. 2 is currently offline due to high levels of iron and manganese.

Well No. 3 is located directly east from Well No. 2. It is a 24-inch diameter well approximately 53 feet in depth. The well is equipped with a 75 HP vertical turbine pump. Currently Well No. 3 is the only well in use at the Baldwin Pond site.

<u>Campbell Well</u>

The Campbell Well is located in the north western section of the distribution system off Campbell Road. The well is connected to the distribution system through a 12-inch diameter water main that connects to a 12-inch main on Campbell Road. The well is a 48-inch by 24-inch gravel packed well approximately 57 feet deep. The well is equipped with a 60 HP vertical turbine pump.

<u>Chamberlain Well</u>

The Chamberlain Well is located in the north western section of the distribution system off Moore Road. The well is connected to the distribution system through a 12-inch diameter water main that connects to an 8-inch main on Moore Road. The well is a 24-inch by 48-inch gravel packed well approximately 63.5 feet deep. The well is equipped with a 75 HP constant speed vertical pump.

<u>Meadowview Well</u>

The Meadowview Well is located in the south western section of the distribution system off Meadowview Road. The well is connected to the distribution system through an 8-inch diameter water main that connects to an 8-inch water main on Meadowview Road. The well is a 24-inch by 48-inch gravel packed well approximately 62 feet deep. The well is equipped with a 50 HP submersible turbine pump. The well is currently offline due to high levels of manganese.

<u>Happy Hollow Wells</u>

The Happy Hollow Wells are located in the south western section of the distribution system off Old Connecticut Path. The two wells are connected to the distribution system through a 12-inch diameter water main that connects to 10-inch and 12-inch diameter water mains.

Well No. 1 is a 24-inch by 48-inch gravel packed well approximately 42 feet deep. The well is equipped with a 40 HP constant feed vertical turbine pump

Well No. 2 is a 24-inch by 48-inch gravel packed well approximately 47 feet deep. The well is equipped with a 75 HP vertical turbine pump.

<u>Pump Stations</u>
The Reeves Hill Booster Pump Station was constructed in 1973 adjacent to the Reeves Hill Storage tanks. The pump station contains five pumps and a natural gas standby generator. There are two domestic hydroconstant pumps set at 150 gallons per minute (gpm), a fire pump capable of 450 gpm and two small capacity jockey pumps.

There are also two private pump stations that serve individual developments. The Turkey Hill Pump station serves Turkey Hill Road, Fox Hollow Road, Christina Road, Daybreak Road and Essex Road. There is an additional private pump station that serves the development off Rice Road, which includes Magnolia Drive, Dahlia Drive, Wisteria Way and Bayberry Lane. These private pump stations were not evaluated in this study.

<u>Supervisory Control and Data Acquisition System (SCADA)</u>
Each of the wells, tanks, and the pump station are connected to the SCADA system. The SCADA system was not evaluated in this study.

<u>Water Quality</u>
Chemical injection facilities were installed at each well site in 1999. The chemicals include potassium hydroxide for corrosion control, sodium hypochlorite for disinfection and sodium fluoride for aiding in the prevention of tooth decay. The chemical tanks for Baldwin Pond Wells No. 1 and 2 and for Meadowview Well are currently empty because they are offline. Some of the sources have issues with iron and manganese. The Meadowview well is offline due to high manganese and Baldwin Pond Wells No. 1 and 2 are offline due to iron and manganese. There are some areas in the distribution system that have residual iron and manganese from the well water deposited on the pipe walls resulting in red or black water customer complaints. Also, there are many red and or brown water complaints each year as a result of the build-up of iron tuberculation in the interior of the large amount of unlined cast iron mains in the distribution system.

<u>Previous System Studies</u>
A Water Distribution System Update was completed by Tata & Howard in 2003. The study provided updates to the Town's water distribution system map and computer model. Also, recommendations were made to meet previously identified Insurance Service Office (ISO) fire flow requirements. Water main improvements were developed and preliminary design plans of the proposed improvements were completed for the Dudley Pond Area.

Section 3
Hydraulic Evaluation

General

In the 2003 Water Distribution System Update, Tata & Howard used a hydraulic model to evaluate the Wayland Water Distribution System and as a basis for recommending water distribution system improvements. At the time of the study, a hydraulic computer model was created using Cybernet, which utilized AutoCad Version 14 for its mapping component. The model has since been upgraded to "WaterGEMS" software. Cybernet and WaterGEMS allow the user to conduct hydraulic simulations using KY Pipe algorithms. As part of the System Update, the hydraulic model was updated from the previous 1994 model, and was verified based on fire flow testing and information pertaining to the sources and storage facilities provided by the WWD. Once the model was verified, hypothetical conditions such as fire flow demands were simulated in the model to provide the opportunity to identify system deficiencies and to develop necessary improvements. As part of the Capital Efficiency Plan™, the model was updated to include improvements to the system since 2003.

Evaluation Criteria

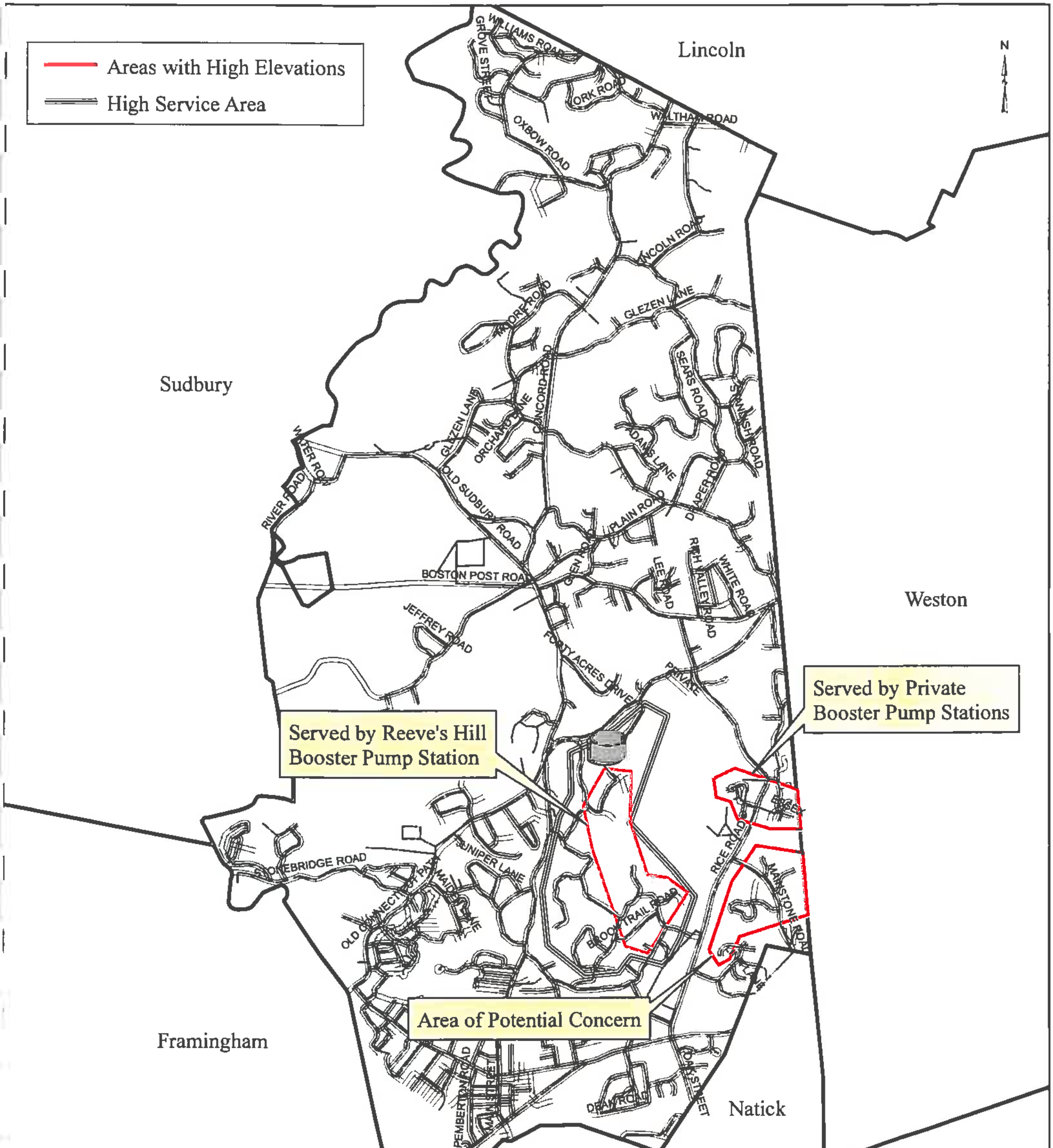
The Hydraulics facet of the Three Circle approach evaluates the system's ability to provide adequate system pressure during varying demand conditions.

In general, a minimum pressure of 35 pounds per square inch (psi) at ground level is required during average day, maximum day and peak hour demand conditions. During fire flow conditions, a minimum pressure of 20 psi is required at ground level throughout the system. Areas served by the distribution system with elevations greater than 265 feet may experience pressures below 35 psi during average day, maximum day and peak hour demand conditions. The limits of the high elevations in Town are included in Figure No. 3-1. Of the three high elevations areas, two are served by the either the Reeves Hill Booster Pump Station or private booster pump stations. The areas around Mainstone Road and Wayland Hills Road do not have a booster pump station. These areas have the potential for low pressures, especially during large fire flow events. A booster pump station may be considered for this area, or individual pumps at the homes were there are low pressure concerns.

In order to evaluate the system's ability to meet a minimum pressure of 35 psi during average day, maximum day and peak hour demand conditions or a minimum pressure of 20 psi during fire flow conditions, the following hydraulic simulations were run in the model.

Insurance Services Office (ISO) Fire Flow Requirements

The required fire flow in any community is established by the ISO. The ISO determines a theoretical flow rate needed to combat a major fire at a specific location; taking into account the building structure, floor area, the building contents, and the availability of



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Areas with High Elevations

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

3-1

fire suppression systems. In general, the flows required for proper fire protection are based on maintaining a residual pressure of 20 pounds per square inch (psi). This residual pressure is considered necessary to maintain a positive pressure on the suction side of a fire department pumper truck with an allowance for frictional losses in the hydrant and fire hose. The estimated needed fire flows, as determined by the ISO, were simulated on the computer model. ISO testing results from 1982 and 1997 were used as part of the last distribution system study. In areas where the available fire flow did not meet the ISO needed fire flow, recommended improvements were developed to satisfy the ISO requirement.

Basic Fire Flows Requirements

According to ISO, the minimum recommended fire flow in residential areas where homes are between 31 feet and 100 feet apart is approximately 750 gpm. Based on a review of the system, Wayland falls within this category. An estimated fire flow of 750 gpm at all nodes was simulated on the computer model. Some areas of the system could not meet the minimum recommended fire flow. These areas were considered hydraulically deficient and improvements were developed to meet the recommended fire flow.

Hydraulic Recommendations

In general, the recommendations presented in the 2003 update were divided into two components. The first component presented phased improvements in the vicinity of the Dudley Pond area. The second component identified system-wide improvements that were intended to strengthen the transmission capabilities of the system and mitigate estimated ISO fire flow deficiencies.

Since the completion of the 2003 update, the Town has completed a portion of the recommended improvements. These include work on Indian Road and the Massasoit Path Loop and Plain Road. The remaining improvements from the 2003 update were reevaluated in this study. The remaining recommendations should be completed by the WDD to meet transmission needs, mitigate ISO fire flow deficiencies and improve areas which currently do not meet the recommended residential fire flow of 750 gpm.

ISO Fire Flow Improvements

1. An estimated needed fire flow of 2,000 gpm is required at the Wayland High School. In order to meet this requirement, a new 16-inch diameter main is recommended to replace an existing 8-inch main on Old Connecticut Path from the tank driveway entrance west to Shaw Drive. In addition, a 12-inch diameter main is recommended on Old Connecticut Path from Cochituate Road to the Happy Hollow Wells. In addition to meeting the 2,000 gpm flow at Wayland High School, these new mains would improve the transmission capability of the system, and allow the ISO fire flow requirement of 2,500 gpm at Pequot Road and Happy Hollow Road to also be met. This improvement will provide an important transmission loop and mitigate several fire flow deficiencies in this portion of the distribution system.

2. An estimated needed fire flow of 1,500 gpm is required at the intersection of Edgewood Street and West Palm Street. This location is currently serviced by a 6-inch diameter main on Old Connecticut Path. In order to meet the estimated needed fire flow, we recommend that a new 12-inch main be constructed on Old Connecticut Path extending from Maiden Lane to West Plain Street.

3. ISO estimated needed fire flows of 3,000 and 2,000 gpm were estimated on West Main Street at the intersection with Main Street and at the intersection of Main Street and Bent Avenue, respectively. Currently there are 6-inch diameter mains on a portion of Cochituate Road and School Street. These mains represent a portion of the main transmission route from the tanks to the downtown area. A 12-inch diameter main is recommended on Cochituate Road from Old Connecticut Path to Hurland road and on School Street from Cochituate Road to Loker Street. Also, in its current condition, the 10-inch diameter main on West Plain Street does not have the inherent capacity to meet the fire flow requirements. Cleaning and lining the 10-inch main would improve the transmission capacity of the main and improve flows in the southern portion of the distribution system. Prior to implementing this improvement, we recommend that pipe coupons be taken from the 10-inch main to confirm the poor interior condition of the main.

4. An ISO estimated needed fire flow of 2,250 gpm is required at the intersection of East Plain and Commonwealth Road. In order for the system to meet the estimated needed fire flow, a new 12-inch diameter main is recommended on East Plain Street from Main Street to Commonwealth Avenue and on Commonwealth Avenue from East Plain Street to the Town line. Implementation of the improvement will provide the inherent capacity to meet the estimated needed fire flow, and complete a transmission loop in the southern portion of the distribution system.

5. An ISO estimated needed fire flow of 2,500 gpm is required at the intersection of Main Street and Damon Street. In order for the system to meet the estimated needed fire flow, a new 12-inch diameter main is recommended on Main Street extending from West Plain Street to Commonwealth Road. This improvement will provide the inherent capacity to meet the estimated needed fire flow and improve flows to this commercial area of Town.

6. An estimated needed fire flow of 2,500 gpm is required on Boston Post Road at the intersection with White Street. This commercial area of Town is currently serviced by an older 6-inch diameter main which is heavily tuberculated. In order for the system to meet the estimated needed fire flow, a new 12-inch main is recommended on Pinebrook Road from Old Connecticut Path to Boston Post Road and on Boston Post Road from Pinebrook Road to Plain Road. This improvement will provide the inherent capacity to meet the estimated needed fire flow and provide a transmission loop from the storage tanks to Plain Road.

7. A new 8-inch diameter main is recommended on Loker Street from Hobbs Road to Thompson Street. This improvement will allow the low service area adjacent to the high service area to be fed by an 8-inch diameter main rather than a 6-inch main. In addition, fire flows to these neighborhoods would be improved.

8. An estimated ISO fire flow of 3,000 gpm is required at the school located off Rice Road. In order to meet the estimated fire flow requirement, a new 12-inch main is recommended on Rice Road from Thompson Street to Woodridge Road and from Mainstone Road to Wisteria Way. Also, a new 12-inch main is recommended on Thompson Street and the 6-inch main that serves the facility should be replaced with a 12-inch main.

<u>Residential Fire Flow Improvements</u>

9. Currently there is no fire protection on Bradford Street, Shawmut Avenue and Pleasant Street. Bradford Street and Shawmut Avenue have 4-inch mains. The WWD has expressed concern over this area because of the inadequate fire protection capability and the poor condition of the water mains. It is recommended that an 8-inch water main with hydrants be installed on each of these streets to improve flows to these areas.

10. The existing 6-inch diameter water main on Lincoln Road does not have the inherent capacity to provide the estimated needed residential fire flow requirement. In order to meet the estimated needed fire flow and improve the carrying capacity of the main, a new 8-inch diameter main is recommended on Waltham Road and Lincoln Road from Waltham Road to Hazelbrook Lane. Also, the existing 6-inch diameter main on Hazelbrook Lane would result in a bottleneck once improvements are implemented. A new 8-inch diameter water main is recommended on Hazelbrook Lane from Lincoln Road to Glezen Lane to eliminate this hydraulic restriction.

11. River Road is currently serviced by 4-inch and 6-inch diameter mains extending off of Old Sudbury Road. Based on the fire flow test conducted in this area, less than 200 gpm of flow is available at 20 psi. In order to mitigate the fire flow deficiency in this area, it is recommended that the Town replace the smaller diameter mains with a new 8-inch diameter main. This improvement is especially important if development of the area occurs in the future.

12. The existing 6-inch diameter main on Concord Road is a bottleneck connecting the 10-inch on Old Sudbury Road to an 8-inch main on Plain Road. In order to improve the transmission from the tanks to the northern portion of the system, a new 12-inch diameter main on Concord Road is recommended. The new 12-inch main on Concord Road will improve the carrying capacity of the main and eliminate a bottleneck in the system.

13. Currently Riverview Circle, Overlook Road, Oak Hill Road and Meadowview Road cannot meet a 750 gpm residential fire flow because the Meadowview Well is currently not in use. We recommend cleaning and lining the existing mains on these streets as wells as Stonebridge Road to meet the residential fire flow requirement.

14. Currently the system cannot meet a 750 gpm residential fire flow on the 8-inch portion of Glezen Lane near the Town line nor can it meet it on Flosom Pond road and Autumn Lane off of Glesen Lane. An 8-inch main is recommended on Glezen Lane from Concord Road to the existing 8-inch main just before Autumn Lane. This improvement will allow this area to meet the residential fire flow requirement.

15. Currently Rich Valley Road, Lundy Lane, White Road, Sylvan Way and Hayward Road cannot meet a 750 gpm residential fire flow. An 8-inch main is recommended on each of these streets. This improvement will allow this area to meet the residential fire flow requirement.

16. There are other areas of the system that cannot meet a 750 gpm residential fire flow due to main size. Table No. 3-1 identifies the remaining mains that should be replaced with 8-inch diameter mains to meet the residential fire flow requirement.

Table No. 3-1
Water Main Replacements
Capital Efficiency Plan™
Wayland, Massachusetts

	Location	Existing Diameter
1.	Off of Lincoln Road 1,500 feet south of Waltham Road	6-inch
2.	Off of Moore Road near the intersection with Glezen Lane	4-inch
3.	Nob Hill Road	4-inch
4.	Westway Road	6-inch
5.	Blossom Lane	6-inch
7.	Whispering Lane	6-inch
8.	Apache Trail	6-inch
9.	Coltsway	6-inch
10.	Hillside Drive and Pickwick Way	6-inch
11.	Smokey Hill Road	6-inch
12.	Peck Avenue	6-inch
13.	Doran Road	4-inch
14.	Mathews Drive	4-inch

Section 4
Critical Component Assessment

General

The critical component assessment includes identification of critical areas served, critical water mains and the need for redundant mains. As part of the critical component assessment, an analysis was performed in order to evaluate the impact of potential water main failures on the water distribution system.

Evaluation Criteria

Critical areas served are locations in the distribution system that require continual water supply for public health, welfare or financial reasons. Examples of critical service areas include hospitals, nursing homes, schools, and business districts. All water mains within 1,000 feet of a critical area are considered a critical component. Because water storage tanks and sources provide water and maintain pressure to critical service areas, tanks and primary sources are also considered critical areas. Therefore, any water main within 1,000 feet of a water storage tank or primary source is considered a critical component. Also, the system allows access to neighboring water supplies. The Wayland system has three interconnections, one with Lincoln and two with Weston. The interconnection with Weston on Plain Road/Route 30 is the only one WWD considers critical because it is an emergency source.

Critical water mains are those mains that are sole transmission from a source or tank. In addition, main transmission lines that do not have a redundant main are considered critical. The evaluation included a review of the water mains leading into and out of the critical areas and the transmission grid, hydraulic modeling and discussions with WWD personnel. WWD personnel also identified water mains that appear to be problematic at this time which would present a large inconvenience or issue if a break were to occur.

Critical Components

Critical areas served, critical supply mains and redundant mains were evaluated in the water distribution system based on the criteria described above. The following provides a listing of the areas that are considered critical components. A map of the critical components is included in Appendix B.

Critical Areas Served

According to WWD personnel, there are no major medial facilities or large factories that act as critical customers, but there are a few nursing homes and assisted living facilities that could be considered critical. Therefore, critical areas would include these facilities as well as schools, water storage tanks, booster pump stations and water supply sources. Sixteen critical areas were identified in the water system and are listed in Table No. 4-1.

Table No. 4-1
Critical Service Areas
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	Critical Area	Location
1.	The Children's Way	41 Cochituate Road
2.	Claypit Hill School	Adams Lane
3.	Happy Hollow School	63 Pequot Road
4.	Loker School	47 Loker Street
5.	Wayland High School	264 Old Connecticut Path
6.	Wayland Middle School	201 Main Street
7.	Kathryn Barton Nursing Home	373 Commonwealth Road
8.	Sunrise Assisted Living of Wayland	285 Commonwealth Road
9.	Wayland Nursing and Rehab Center	188 Commonwealth Road
10.	Baldwin Pond Wells	Old Sudbury Road
11.	Campbell Well	Campbell Road
12.	Chamberlain Well	Off Moore Road
13.	Happy Hollow Wells	Off Old Connecticut Path at HS
14.	Meadowview Well	Meadowview Road
15.	Reeves Hill Water Storage Tanks and Booster Pump Station	Forrest Hill Road
16.	Interconnection with Westin	Plain Road/Route 30

Critical Water Mains

Critical mains were identified based on a review of the distribution system model and discussions with WWD personnel. A critical main was identified on Oak Street. There is a bridge on Oak Street between Timber Lane and Hearthstone Circle that goes over the Massachusetts Turnpike. The water main on the bridge is not insulated. This main could be susceptible to breaks caused by pipes freezing and its location would make cleanup and repairs difficult. Another critical main is the 16-inch water main on Old Connecticut Path which is the primary water main out of the two water storage tanks. If something were to happen to this water main, the tanks could be isolated from the system.

Section 5
Asset Management Considerations

General

The Wayland water distribution system has been in operation since 1878. The existing system includes approximately 100 miles of water main varying in size and material. A number of factors including age, material, diameter, break history, soil conditions and water quality affect the decision to replace or rehabilitate a water main. Using an Asset Management approach, each water main in the system was assigned a numerical grading based on these factors. The gradings were then used to establish a prioritized schedule for water main replacement or rehabilitation.

Data Collection

Information was obtained through meetings with Wayland Water Department personnel and review of town records including old maps, tie cards, invoices and annual reports. Because record drawings did not exist, water main ages and materials were estimated based on construction records and personnel field experience.

Evaluation Criteria

In order to prioritize water main replacement or rehabilitation, a water main grading system was established. The grading system used the water main characteristics such as age, material, break history, water quality, diameter size and soil characteristics to assign point values to each pipe in the system. Each category was assigned a grading between zero and 100 with zero being the most favorable and 100 being the worst case within the category. Each category was then given a weighted percentage, which represents priorities within the system. It is the WWD's discretion to adjust the weight based on system performance and condition. Our recommendation was that a maximum of 30 percent be given to any one category. The grading was then multiplied by the weight. The weighted grading for each performance criteria will be utilized to determine the overall grading per pipe. Those pipes with the highest grade were considered most in need of replacement or rehabilitation.

In order to establish a rating system specific to the system, discussions with the Wayland Water Department were incorporated. The WWD has stated that water quality issues are their largest concern at this time. The discolored water quality issue is likely related to the well water residual iron and manganese remaining in the pipes and/or from deterioration of the interior of unlined cast iron water mains themselves. This was taken into account when developing the rating system. The grading system is shown in Table 5-1 and discussed in detail later in this section.

Age/Material

The water industry in the United States followed certain trends over the last century. The installation date of a water main correlates with a specific pipe material that was used during that time as shown on Table No. 5-2. For example, until about the year 1958,

Table 5-1
Asset Management Grading System
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Wayland, Massachusetts

Weight	Performance Criteria	Rating	Weighted Rating
15%	Break History		
	History of Breaks	100	15
	No History of Breaks	0	0
20%	Material		
	Unlined Cast Iron	100	20
	Asbestos Cement	50	10
	Cement Lined Cast Iron	30	6
	Ductile Iron	5	1
20%	Installation Date		
	Pre 1920	100	20
	1920-1932	90	18
	1933-1939	50	10
	1940-1954	40	8
	1955-1969	20	4
	1970-1979	10	2
	1980-1989	5	1
	1990-1999	2	0.4
	2000-2007	0	0
25%	Water Quality		
	Water quality problems	100	25
	No water quality problems	0	0
15%	Diameter		
	4-inch water main	100	15
	6-inch water main	90	13.5
	8-inch water main	50	7.5
	10-inch water main	15	2.25
	12-inch water main	10	1.5
	16-inch water main	5	0.75
5%	Soils		
	Identified as poor soils	100	5
	Wetlands	80	4
	Gravel, sand	0	0

Table No. 5-2
Pipe Material by Installation Year
Capital Efficiency Plan™
Wayland, Massachusetts

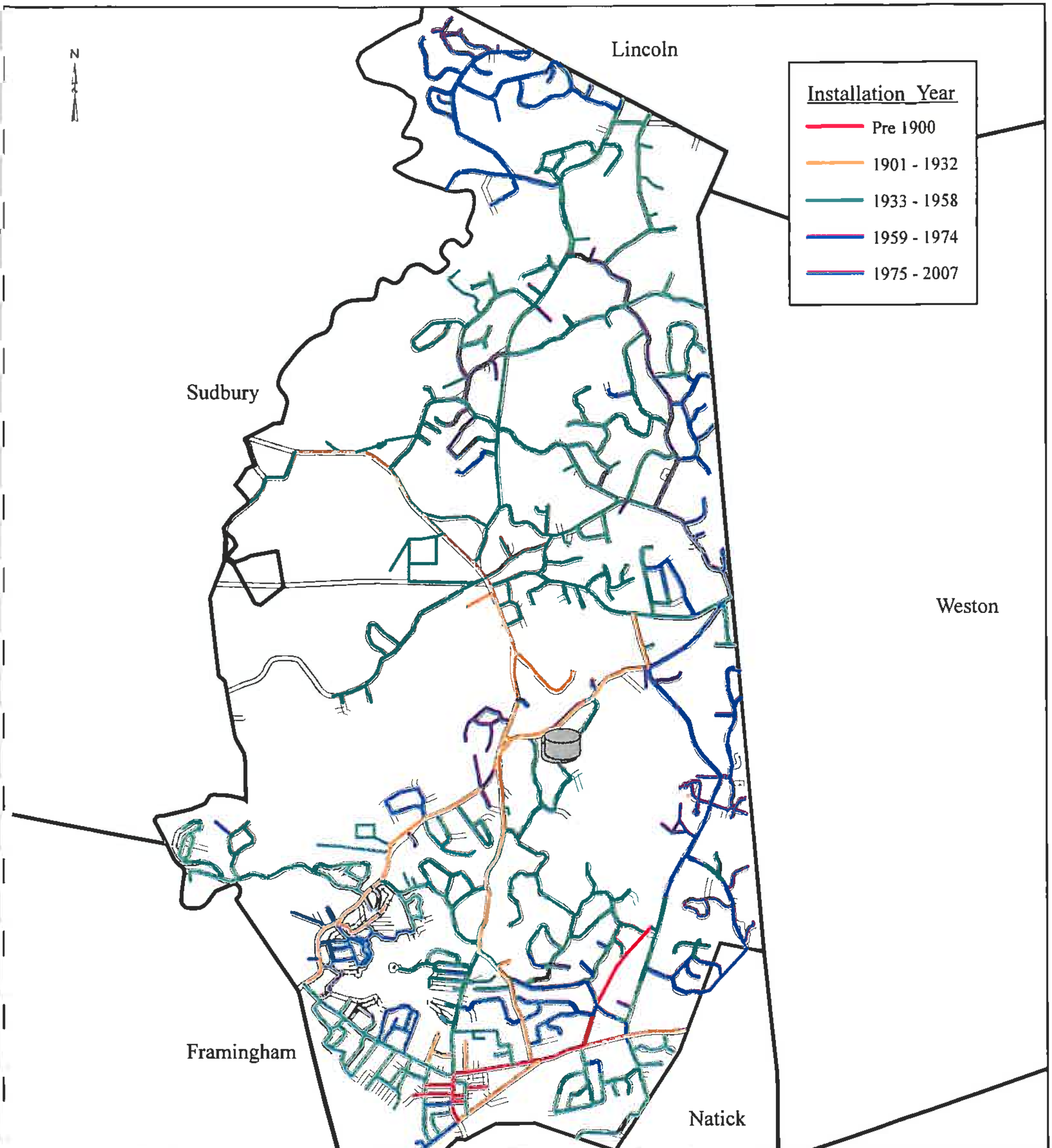
Length (ft)	Material				
Installation Year	Asbestos Cement	Cement Lined Cast Iron	Ductile Iron	Unlined Cast Iron	Grand Total
Pre 1920				13,776	13,776
1920 - 1932				56,068	56,068
1933 - 1939				84,480	84,480
1940 - 1954	2,083			163,270	165,353
1955 - 1969	2,287	86,192	154	41,228	129,861
1970 - 1979		23,516	8,251		31,767
1980 - 1989			14,569		14,569
1990 - 1999			13,328		13,328
Grand Total	4,370	109,708	63,136	358,822	536,036

unlined cast iron water mains were the predominant pipe material installed in water systems. Factory cement lined cast iron mains were manufactured from the late 1950's to the mid 1970s, when pipe manufactures switched primarily to factory cement lined ductile iron pipe.

Cast iron water mains consist of two types: pit cast and sand spun (a.k.a. centrifugally cast). Pit cast mains were manufactured from the 1800's up until approximately 1930, while sand spun mains were manufactured between 1930 and 1976. Pit cast mains with diameters between 4-inch and 12-inch do not have a uniform wall thickness and may have "air inclusions" as a result of the manufacturing process. This reduces the overall strength of the main, which makes it more prone to leaks and breaks. Although sand spun mains have a uniform wall thickness, the overall wall thickness was thinner than the pit cast mains. The uniformity and improved iron purity provided added strength, however, the thin wall thickness made it more susceptible to corrosion and breaks. Pit cast mains 16-inch diameter and larger have very thick pipe walls and are generally stronger than the thinner walled spun cast mains. Prior to about the year 1958, cast iron mains were unlined, which increased the potential for internal corrosion. The year 1958 is also when rubber gasket joints were introduced. Prior to this date joint material was either jute (rope type material) packed in place with lead or a lead-sulfur compound, also known as "leadite" or "hydrotite." Leadite type joints expand at a different rate than iron due to temperature changes. This can result in longitudinal split main breaks at the pipe bell. Sulfur in the leadite can promote bacteriological corrosion that can lead to circumferential breaks at the spigot end of the pipe. Therefore, the grading score is higher for water mains manufactured before 1958 as opposed to water mains manufactured after this time. After 1958, factory lined cast iron was manufactured and installed up until about 1970. Cement lining provides increased protection against internal corrosion. Unlined cast iron water mains make up approximately 67 percent of the Wayland water system.

Between the 1930's and 1970's, the water industry also utilized asbestos cement (AC) pipe for their expanding water systems. An advantage of AC pipe is that it resisted tuberculation build up, resulting in less system head loss. However, depending on the water quality, the structural integrity of AC mains can deteriorate over time, thereby becoming sensitive to pressure fluctuations and/or nearby construction activities. In addition, external influences such as soil type and high groundwater can corrode AC mains, thus reducing the strength further. Only one percent of the system consists of AC water mains and according to personnel these mains have not had many failures and are not a cause of concern at this time.

Approximately 10 percent of the system is cement lined ductile iron water main. This material was introduced in the United States in 1950's, however, was not widely used until the 1970's. According to the Ductile Iron Pipe Research Association (DIPRA), ductile iron pipe retains all of cast iron's qualities such as machinability and corrosion resistance, but also provides additional strength, toughness, and ductility. However, ductile iron pipe typically has a much thinner pipe wall and may not have the overall



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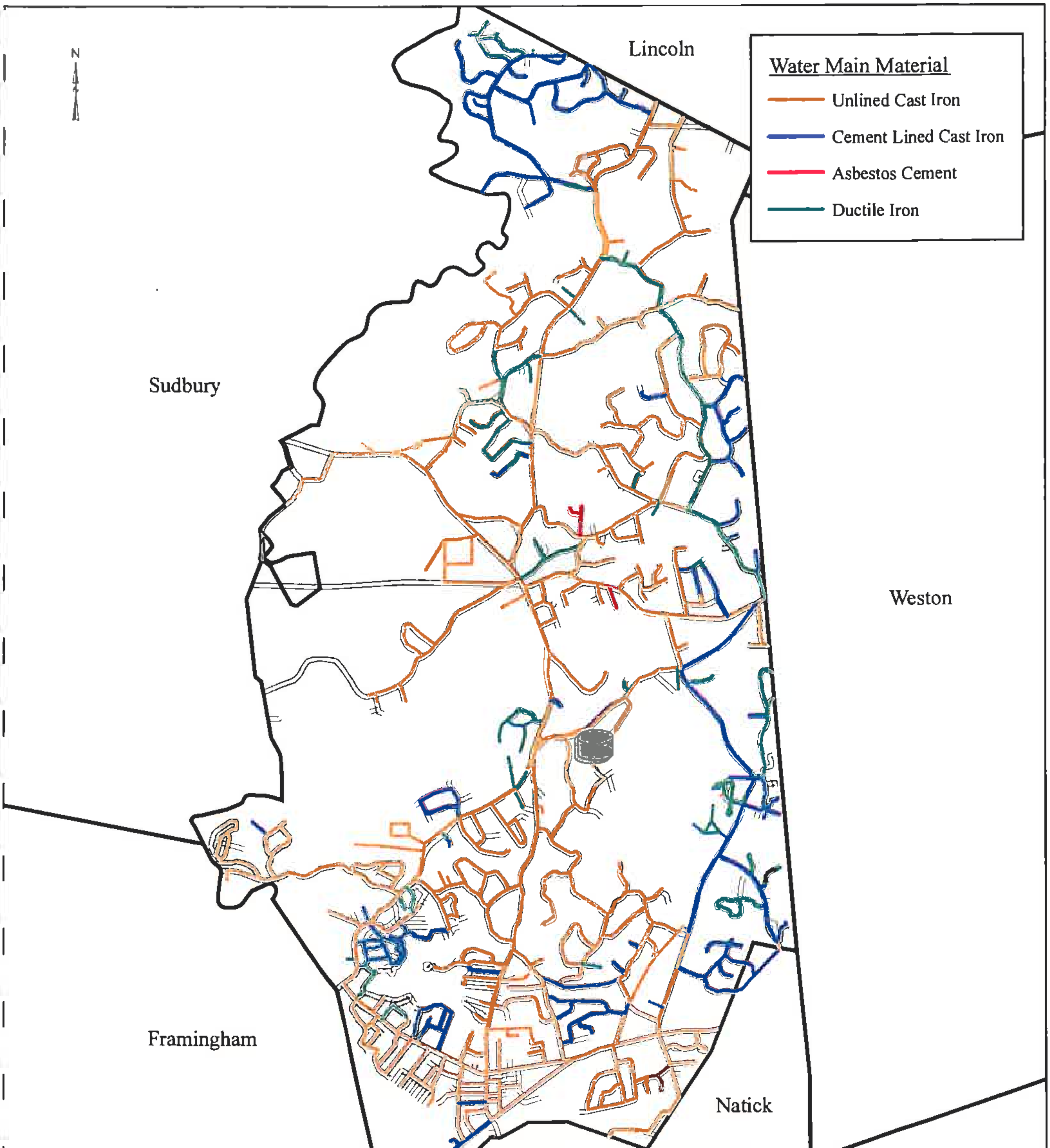
Date: April 2009 Scale: 1:48000

Water Main Installation Year

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-1



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Water Main Material

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-2

useful life as cast iron pipe due to external corrosion unless it is wrapped in polyethylene encasement.

In general, the oldest water mains in the system received a high rating of 100, while the newest received a rating of zero. A ratings decrease occurs after 1932, which reflects the switch in Wayland from a surface water source to groundwater sources. Surface water in this area of the country is typically more corrosive to the interior of water mains than groundwater and this is reflected in the rating decrease. Another significant rating decease can be seen in the materials score around 1958, which reflects the introduction of factory lining. Figures No. 5-1 and 5-2 present the installation year of the water mains and the materials, respectively.

Diameter

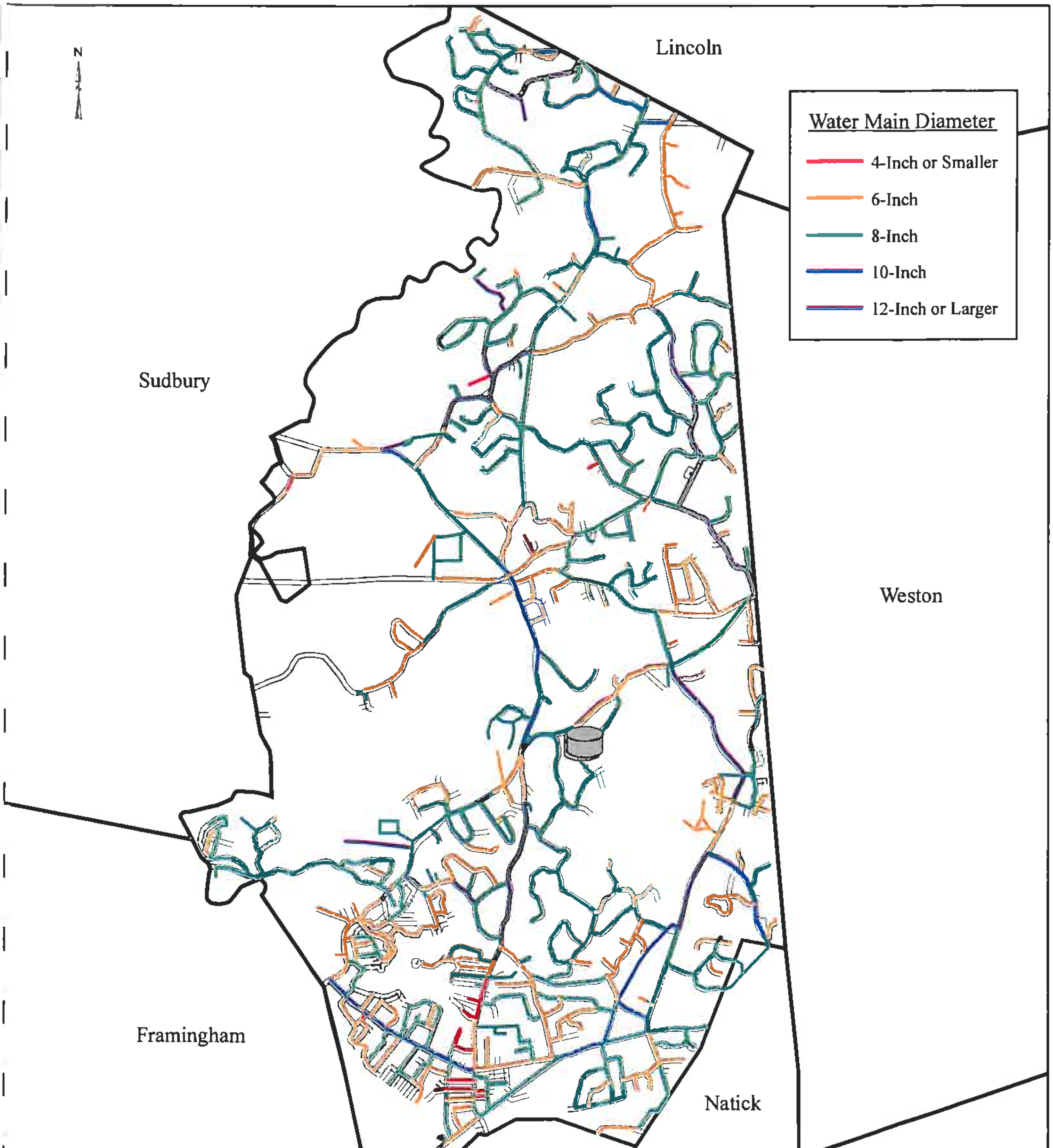
The Wayland water distribution system consists of approximately 100 miles of water mains ranging in diameter from four to sixteen inches. In general, as the diameter of a pipe increases, the strength increases. In most cases, failure occurs in the form of ring cracks. This is the result of bending forces on the pipe. Pipes that are 6-inch in diameter are more likely to deflect or bend than a larger diameter main. Pipes that are 8-inch in diameter are less likely to break from bending forces due to their increased wall thickness and increased moment of inertia. Pipes that are 16-inches in diameter and larger have significantly thicker walls than 12-inch diameter pipe and smaller. In addition to superior bending resistance, they also are much more resistant to failure from pipe wall corrosion.

The rating system for the diameter of the water mains follows the concept that 4-inch diameter water mains are not as strong as sixteen-inch diameter water mains. Therefore, a rating of 100 was given to 4-inch diameter water mains and a rating of five was given to the 16-inch diameter water mains. Table No. 5-1 shows a significant drop in the rating score between a 6-inch diameter water main (90) and 8-inch diameter water main (50). This is due to superior bending resistance.

An 8-inch diameter water main has proven to have nearly twice the bending strength of a 6-inch diameter water main. In general, 8-inch diameter water mains are stronger and less likely to break than 6-inch diameter pipes. Mains which are 4-inch diameter or less should be replaced with at least an 8-inch diameter main because an 8-inch diameter main has a 77 percent greater carrying capacity than a 6 inch main resulting in lower headloss and water velocities during fire flow events. Figure No. 5-3 presents the various diameters throughout the distribution system.

Break History

Based on conversations with staff and Water Department records, the water system experiences an average of approximately eight to ten breaks per year. In relation to the total miles of water main in the system, this equates to approximately eight breaks per 100 miles per year. In comparison to the national average of 25 breaks per 100 miles per year, the Wayland water system is in good condition.



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Water Main Diameter

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-3

Each water main break costs the water Town time and labor. They also cause disruption to the public and water consumers. At some point, it becomes more efficient to replace the main than to continue repairing it. Based on discussions with WWD staff, there are several areas in the system that have experienced breaks. These areas are given a rating of 100 while areas with no known breaks received a rating of zero. Figure No. 5-4 presents areas with a history of breaks.

Pressures

Approximately 50 percent of the Wayland water system has a pressure above 80 psi. Plumbing code states that water heaters can be affected when pressures exceed 80 psi. Pressures above 100 psi can result in increased water use from fixtures and also increased leakage throughout the distribution system. Approximately four percent of the system experiences pressures above 100 psi. Massachusetts Department of Environmental Protection Guidelines and Policies for Public Water Systems states that normal working pressures should be approximately 60 psi and not less than 35 psi. Areas with pressures exceeding 125 psi are required to have pressure reducing valves on the water mains. These areas are more susceptible to water main breaks. In addition, main failures in areas of higher pressure typically cause more disruption, and result in more costly repairs for damages. Because none of the system has pressure above 125 psi, a pressure criteria was not considered in the asset management rating. Figure No. 5-5 presents static pressure ranges in the system as summarized below.

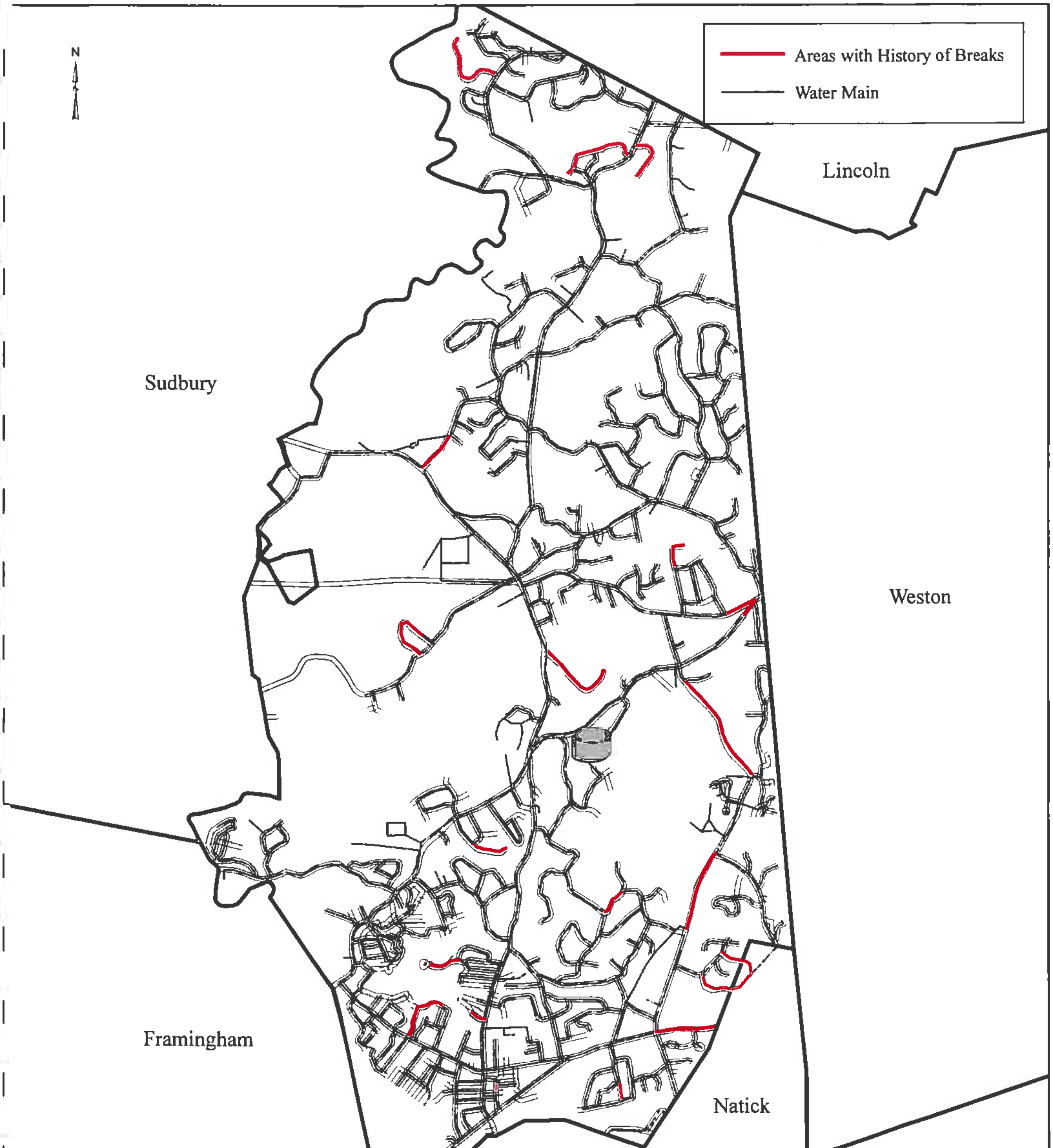
Pressure Range	Percentage in System
Less than 80 psi	50
80 – 100 psi	46
100 – 125 psi	4
Greater than 125 psi	0

Soils

Water main degradation can occur both internally and externally. Factors that increase the rate of external corrosion include high groundwater, clay soils, potentially contaminated soils, soils with low calcium carbonate, or soils with high acidity or sulphate. Wetland areas have greater potential to cause external corrosion of water main than other soil conditions. As shown on Figure No. 5-6, wetland areas are scattered throughout Wayland. Areas where the water system and the wetlands coincide were considered areas of potential exterior corrosion. There were also areas identified to have a high groundwater level or known corrosive soils based on soil conditions observed during main repairs. These areas were given the highest rating (100) because they were known areas of potential corrosion. Areas identified as wetlands through soils maps were given a rating of 80. All other pipe was assigned a rating of zero.

Water Quality

Based on discussions with the Wayland Water Department, there are some areas of the system with water quality concerns. The Meadowview Well produces high concentrations of manganese. As a result, this well is no longer used, but there is residual manganese in the pipes in this area of the system that cause black water complaints.



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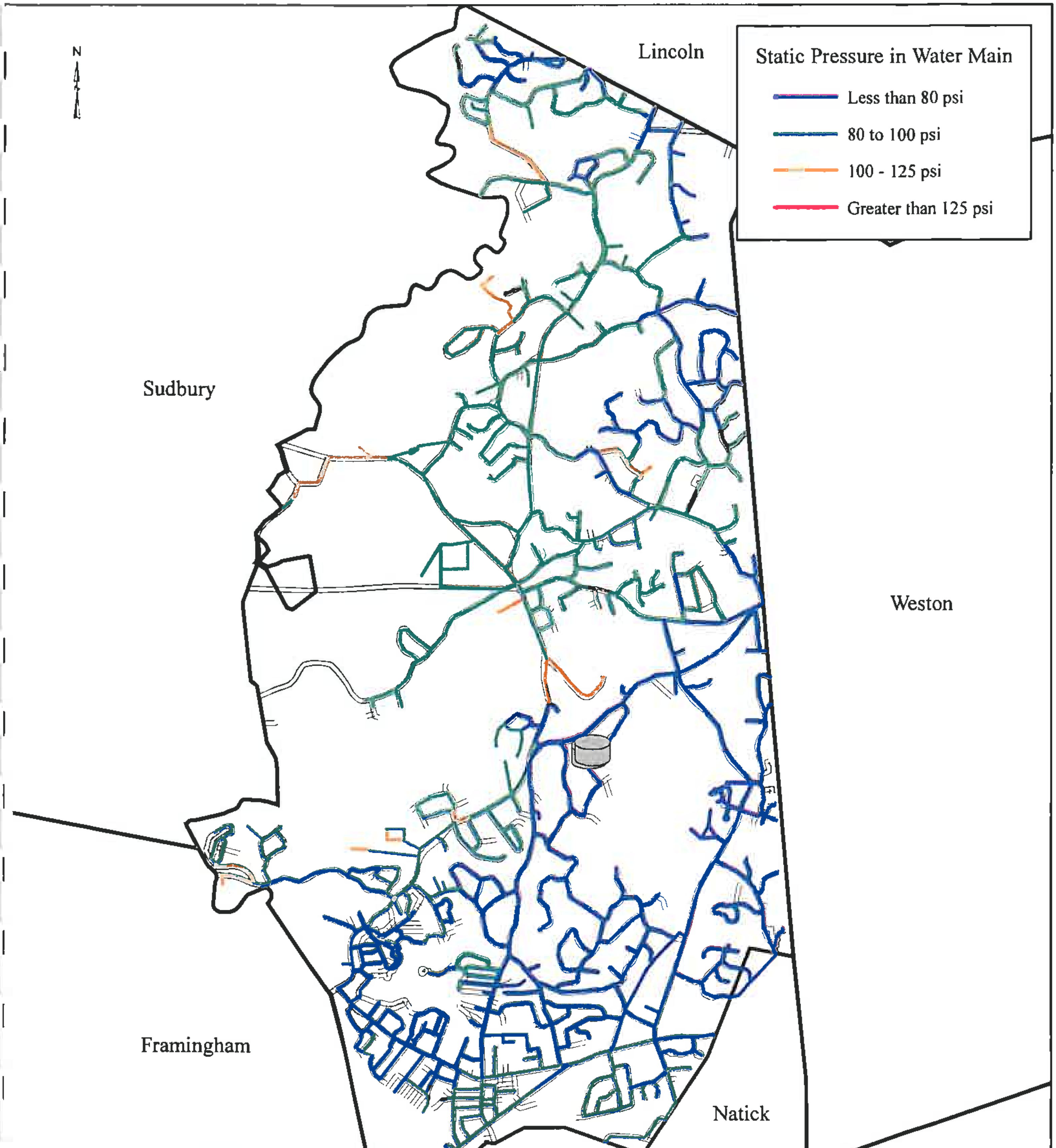
Areas with History of Breaks

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-4



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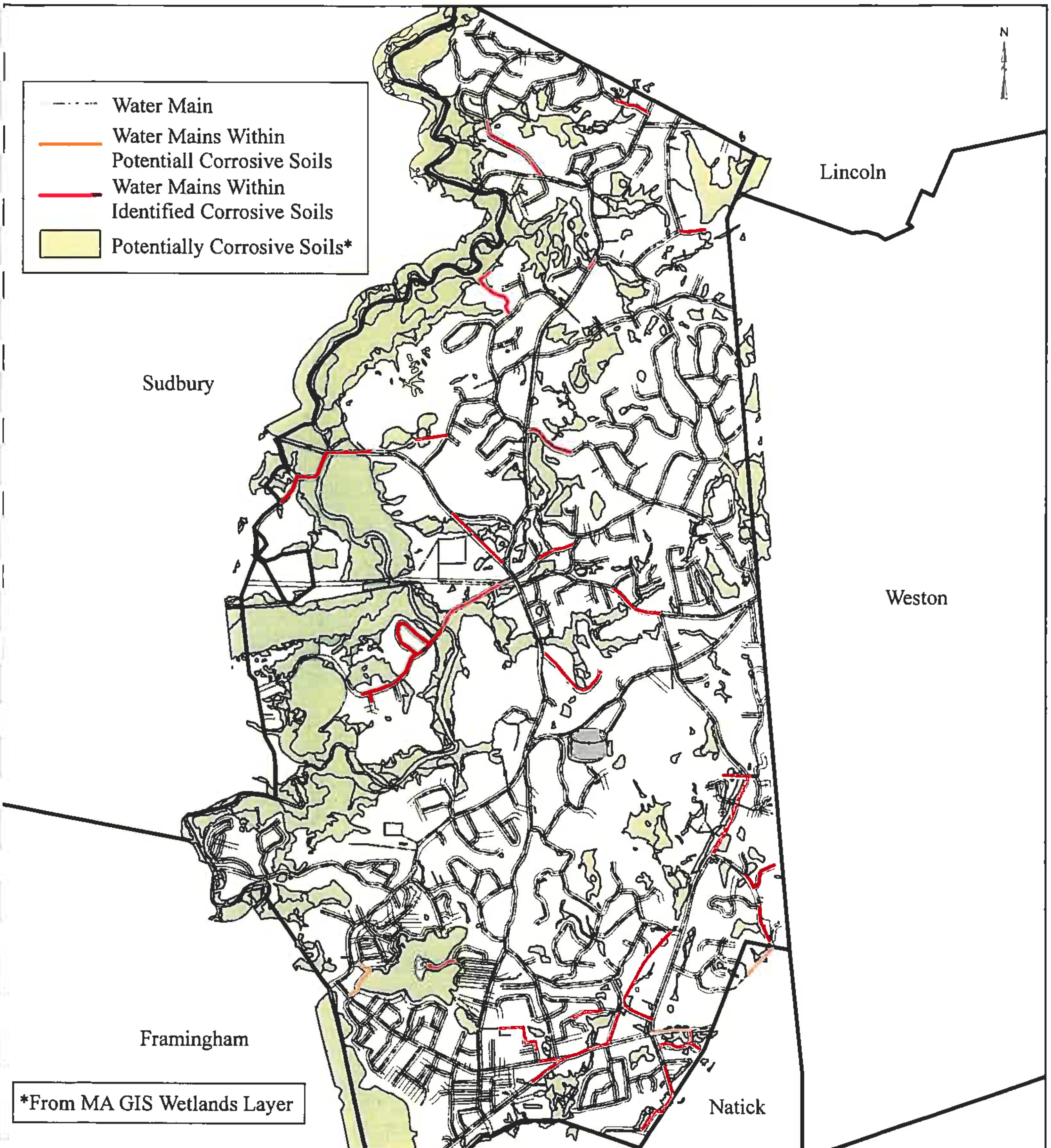
Static Pressure in Water Main

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-5



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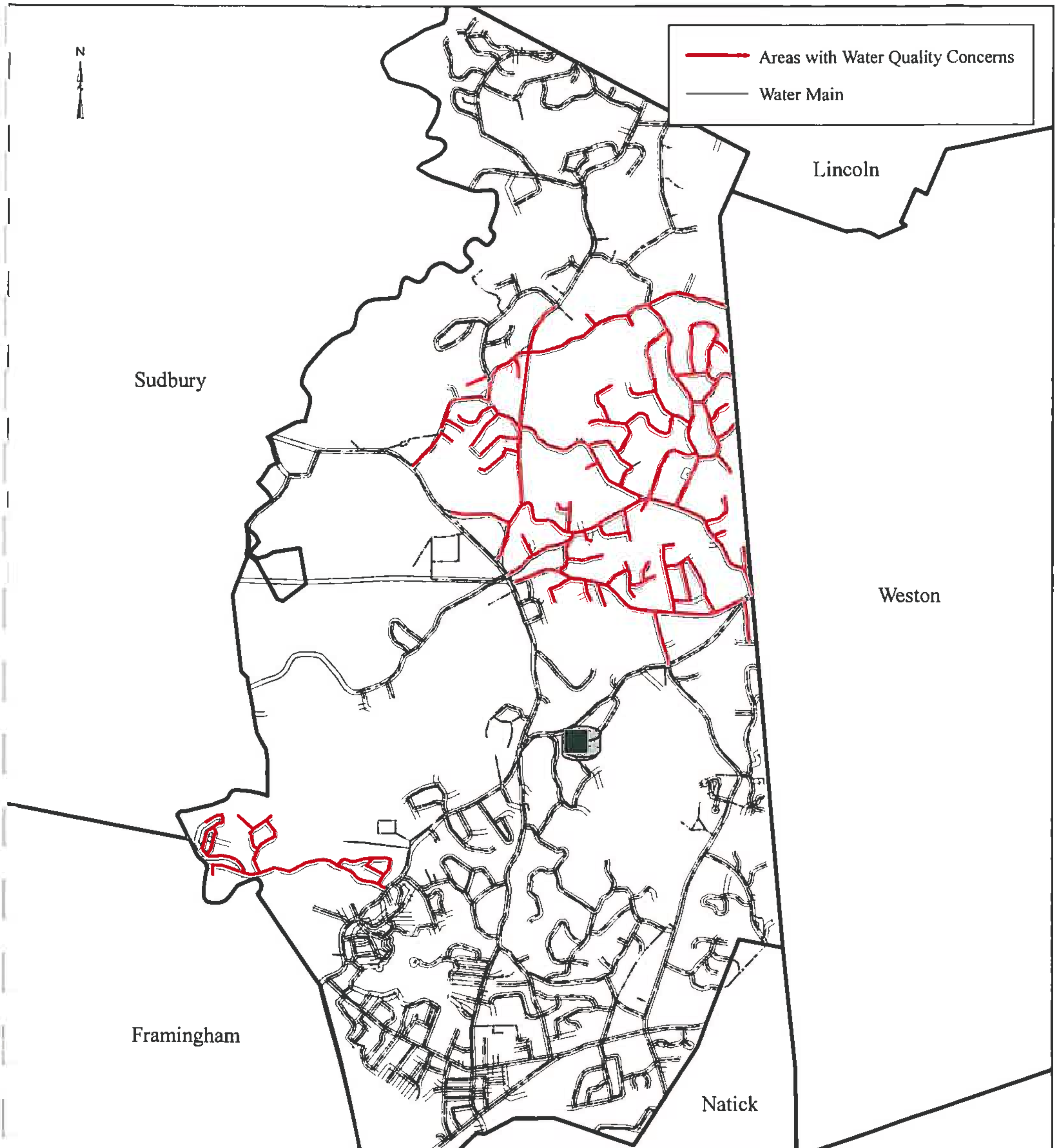
Potentially Corrosive Soils

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-6



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Areas with Water Quality Concerns

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-7

Also, there have been numerous brown water complaints over the years in the north-eastern portion of Town. Much of the water main in this area is unlined cast iron, which is most likely in poor condition and resulting in increased iron in the water. Finally, Baldwin Pond Wells No. 1 and 2 are currently not used due to high iron and manganese levels. The proposed Baldwin Pond Water Treatment Facility should alleviate this problem and allow for these wells to be used again. Figure No. 5-7 represents the areas with water quality concerns.

Asset Management Areas of Concern

Based on the asset Management ratings, there are several areas of concern in the system. Water mains with a total rating between zero and 29 are considered good to excellent. Areas with a total rating between 30 and 59 are considered good to fair, and areas with a total rating greater than 60 are considered poor to fair. Water mains considered poor to fair are included in Table No. 5-3. Asset management ratings are presented graphically in Appendix C.

Table No. 5-3
Asset Management Areas of Concern
Capital Efficiency Plan™
Wayland, Massachusetts

Location	Rating
Poor to Fair	
Boston Post Road from Cochituate Road to Westway Road	63/84
Rich Valley Road	67/82
Pinebrook Road	71
Concord Road from Old Sudbury Road to Moore Road	63/69
Bow Road	69
Plain Road from Concord Road to Claypitt Hill Road	63/69
Glezen Lane from Concord Road to the Town Line	61/67
Pear Tree Lane	67
Folsom Pond Road	67
Jericho Lane	67
Training Field Road from Concord Road to Pheasant Run	61/67
Bennett Road	67
Lee Road	61/67
Hayward Road from Rich Valley Road to Sylvan Way	67
Westway Road	67
Shore Drive and Riverview Circle	61/67
Oak Hill Road	61/67
Meadowview Road	61/67
Claypitt Hill Road from concord Road to Plain Road	61/66
Forty Acres Drive	66
Commonwealth Avenue from Oak Street to Town Line	61/65

Table No. 5-3 (Continued)
Asset Management Areas of Concern
Capital Efficiency Plan™
Wayland, Massachusetts

Location	Rating
Jeffrey Road	64
Dudley Road from Bayfield Road to end	64
Mellen Lane	63
Lingly Lane	63
Farmcrest Lane	63
Plainview	63
Glen Road from Boston Post Road to Millbrook Road	63
Michael Road	63
Holbrook Road	63
Saddle Lane	61
Barley Lane	61
Springhill road	61
Glover Road	61
Wheelock Road	61
Stonebridge Road	61
Overlook Road	61

Section 6
Above Ground Facilities

General

As discussed in Section 2, the water system includes eight wells located at five locations, two above ground water storage tanks and a booster pump station. In addition, each well has chemical storage and injection facilities. All facilities are connected to the Town's SCADA system. In November 2007, Tata & Howard conducted a site visit of the wells, tanks and pump station to take inventory and evaluate the condition of each structure and associated equipment.

Evaluation Criteria

The above ground facilities in the system were evaluated based on installation date, expected life span and current condition. The installation date was determined based on conversations with Wayland Water Department staff, inspection and rehabilitation reports and invoices from suppliers. The life span was estimated based on AWWA papers and standard water works practices. An inspection of each facility was conducted to determine if the estimated life span of a particular piece of equipment should be adjusted based on its current condition.

Condition of Above Ground Facilities

The results of the evaluation of the above ground facilities are discussed below.

Baldwin Pond Wells

The Baldwin Pond Wells consists of three wells, a control building and an operations building. The control building was built in 1927 and turned into the current pump station in 1962. The building houses the chemical storage for Wells No. 1 and 2, the master venturi meter, emergency generator and the motor control center for all three wells. The building walls are in good condition, but the roof is missing shingles. The generator is the original generator from 1962. Wells No. 1 and 2 are currently offline, therefore, the chemical storage tanks at this location are empty.

Well No. 1 was replaced in 2001 and is located in the original concrete vault. Well No. 1 is currently offline due to high iron and manganese levels and is used as a sampling location only.

Well No. 2 was installed in 1944. The current pump was installed in 1993 and the pump motor was replaced in 2003. The pump and motor are located in the original concrete vault. The well was inspected in 2007 and found to be in good condition. Well No. 2 is currently offline due to high iron and manganese levels.

Well No. 3 was installed in 1955 and is located in a concrete building with a concrete slab roof installed in 1998. The pump and pump motor were replaced in 1993. The well was redeveloped in 1998. The 2007 well inspection report recommends the pump be pulled and inspected. Chemical storage and injection was added to the building in 1999.

A summary of the installation year and expected life span of each piece of equipment at the Baldwin Pond Wells is included in Table No. 6-1. A new Water Treatment Facility has been designed for this location. Construction of the new facility would include a 1. mgd treatment facility with a new building and add an addition to the existing garage. Also, the Well No. 1 vault will be replaced and a new pump installed. Modifications made to Well No. 3 will include a new pump and motor. Also, a new generator will be installed in the treatment facility building to operate all three wells during a power failure.

Table No. 6-1
Baldwin Pond Wells
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Control Building			
Building	1927	100	2027
Roof	1927	20	2027
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014
Master venturi	1962	50	2012
Generator	1962	50	2012
Motor control center	1999	25	2024
Well No. 1 (not in use except for sampling)			
Well pump	1992	50	2042
Pump motor	1992	25	2019
Vault	1938	100	2038
Well No. 2 (not in use)			
Well pump	1993	50	2043
Pump motor	2003	25	2028
Vault	1944	100	2044
Well No. 3			
Well pump	1993	50	2044
Pump motor	1993	25	2019
Building	1998	100	2098
Concrete roof	1998	50	2048
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014
Magnetic meter	1998	25	2023

Campbell Well

The Campbell Well and station was originally installed in 1965. The station is a concrete building with a concrete slab roof. It is the original building and roof from 1965. An addition was added to the building in 1999 for the chemical storage and injection. Both portions of the building are in good condition. A new pump and pump motor were installed in 1994. The 2007 well inspection report recommends the well be cleaned and redeveloped.

A summary of the installation year and expected life span of each piece of equipment at the Campbell Well is included in Table No. 6-2.

Table No. 6-2
Campbell Well Equipment
Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Station building	1965	100	2065
Concrete roof	1965	50	2015
Well pump	1994	50	2044
Pump motor	1994	25	2019
Motor control center	1999	25	2024
Master venturi	1993	50	2043
Chemical storage building	1999	50	2049
Concrete roof	1999	30	2029
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

Chamberlain Well

The Chamberlain Well and station was constructed in 1991. The well station houses all the original equipment including a direct drive generator that runs the pump only. A motor control center was installed in 1999 with chemical storage and feed equipment. The station is in good condition, but the direct drive generator is of minimal benefit because it will run only the pump and not the chemical feed equipment if there is a power outage. The 2007 well inspection report requests information on the well and pump.

A summary of the installation year and expected life span of each piece of equipment at the Chamberlain Well is included in Table No. 6-3.

Table No. 6-3
Chamberlain Well
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Well pump	1991	50	2041
Pump motor	1991	25	2016
Building	1991	100	2091
Concrete roof	1991	50	2041
Direct drive generator	1991	25	2015
Motor control center	1999	25	2024
Master venturi	1991	50	2041
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

Happy Hollow Wells

Happy Hollow Well No. 1 was originally installed in 1949 in a concrete building with a concrete slab roof. The well was cleaned and redeveloped in 2003. It is unknown if the pump and pump motor has been replaced since they were installed, and no repairs have been made to the roof or building since construction. Chemical storage and feed equipment were added in 1999 along with a new motor control center for Wells 1 and 2. There is a master venturi located in a pit outside of the building. The exact location is currently unknown. The 2007 well inspection report recommends that the well be cleaned and redeveloped.

Happy Hollow Well No. 2 was originally installed in 1951 in a concrete building with a concrete slab roof. The pump motor was rebuilt in 2006, but it is unknown if the pump has been replaced. No repairs have been made to the roof or building since construction. The 2007 well inspection report claims that the well and pump appear to be in good condition.

A new building was constructed near the Well No. 1 building for chemical storage in 1999. All of the chemicals for Well No. 2 are stored here, along with some of the chemicals for Well No. 1. Chemical injection occurs in a manhole outside of the building.

A summary of the installation year and expected life span of each piece of equipment at the Happy Hollow Wells is included in Table No. 6-4.

Table No. 6-4
Happy Hollow Wells
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Well No. 1			
Building	1949	100	2027
Concrete roof	1949	50	1999
Well pump	Unknown	-	-
Pump motor	Unknown	-	-
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014
Master venturi	Unknown	-	-
Motor control center	1999	25	2024
Well No. 2			
Building	1951	100	2051
Concrete roof	1951	50	2001
Well pump	Unknown	50	2001
Pump motor	2006	25	2019
Magnetic meter	1999	25	2024
Chemical storage building			
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

Meadowview Well

The Meadowview well pit was originally installed in 1970. The well was cleaned and redeveloped in 2001 and the pump and motor were replaced in 1993. Two concrete buildings were constructed in 1999 for chemical injection and storage. One building houses the potassium hydroxide tank and the other building houses the rest of the chemical storage, the chemical injection equipment, motor control center and the magnetic meter. The chemical tanks are all empty and the well is not in use due to high manganese concentrations. The 2007 well inspection report requests information on the pump.

A summary of the installation year and expected life span of each piece of equipment at the Meadowview Well is included in Table No. 6-5.

Table No. 6-5
Meadowview Well
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Well pit	1970	100	2070
Well pump	1993	50	2043
Pump motor	1993	25	2018
Buildings	1999	100	2099
Concrete roofs	1999	50	2049
Motor control center	1999	25	2024
Magnetic meter	Unknown		
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

Reeves Hill Pump Station

The Reeves Hill Booster Pump Station was installed in 1973 at the same site as the two water storage tanks. The building is a concrete building with a concrete slab roof. There is one fire pump and two domestic pumps inside the station. There is also natural gas generator inside of the building. The pump station was rehabilitated in 1999, when an EFI skid was installed. The domestic pumps were replaced again in 2006.

A summary of the installation year and expected life span of the equipment in the Reeves Hill booster pump station is included in Table No. 6-6.

Table No. 6-6
Reeves Hill Booster Pump Station
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Domestic booster pumps	2006	25	2031
High capacity pump	1999	25	2024
Building	1973	100	2073
Concrete roof	1973	50	2023
Generator	1973	25	1998

Reeves Hill Water Storage Tanks

The Reeves Hill Water Storage Tank No. 1 is a steel standpipe constructed in 1927. The tank interior and exterior were repainted in 1985. The interior of the tank was again painted in 2004. The exterior of the tank is in very poor condition with severe pitting at the base. The tank was inspected in 2006.

The Reeves Hill Water Storage Tank No. 2 is a prestressed concrete tank constructed in 1958. This tank was cleaned in 2002. The tank was inspected in 2006 and was considered to be in very good condition. The Wayland Water Department is planning to power wash the tank in the summer of 2008.

Section 7
Recommendations and Conclusions

General

The following summarizes the findings of the study and presents a prioritized plan for recommended improvements and associated costs. The prioritization of improvements allows for construction of the necessary improvements over an extended period of time as funds allow.

Costs for main replacements are based on the October 2007 Engineering News Record (ENR) construction cost index for Boston, MA of 9188.63, and include a 25 percent allowance for engineering and contingencies. Costs for cleaning and lining are based on bid prices and include a 10 percent allowance for engineering and contingencies. Estimates do not include costs for land acquisition, easements or legal fees.

The capital improvement projects considered by this study will provide a direct benefit to the overall level of service to the Wayland customers, reduce operation and maintenance cost by reducing the frequency of water main failures and the damage they cause, as well as improve fire protection to the homeowners and businesses in the Town.

The Water Research Association's (formerly the American Water Works Research Foundation) study on "Cost of Infrastructure Failure," which was completed in 2002, found that in addition to "direct costs" paid by water utility ratepayers for water main failures, there are also "societal costs," which are paid by the public. Examples of the direct costs include outside contractor costs, engineering costs, police assistance, fire department assistance, electrical, telephone and gas utility damage costs, landscaping restoration costs and laboratory costs. Examples of societal costs included the cost of traffic impacts, business customer outage impacts, public health impacts (including loss of life), property damage not covered by direct costs, and the cost of reduced fire fighting capability during the failure event.

The Connecticut Water Planning Council Advisory Group completed its "Final Report of the Water Infrastructure Workgroup" in September 2007. The Water Infrastructure Workgroup included representation from Connecticut water utilities, the Connecticut Department of Health Services (DPH) and the Connecticut Department of Public Utility Control (DPUC). Regarding water main replacements, the report states "...replacing one percent of a system each year (a 100 year replacement cycle) is a reasonable guideline based on industry experience and analysis". For the Wayland distribution system, this would equate to approximately 5,300 linear feet of water main replacement each year as a guideline. The report also discusses main replacement policies which may include a minimum main size of "8-inches for those systems providing fire protection".

The report comments on the benefits of a regular rehabilitation program, stating:

> "The benefits that accrue from rehabilitating water main on a systematic and routine bases commensurate with local need are paramount to maintaining quality

of life. Rehabilitating water main protects public health by decreasing the likelihood of main breaks, reducing leakage, and minimizing service disruptions and water quality problems. It similarly avoids unnecessary chemical and energy usage, lending additional socio-economic benefit. Finally, it can improve public safety by replacing inadequately-sized mains with larger diameter pipes that provide greater fire protection."

The Water Infrastructure Workgroup report developed a number of recommendations including best management practices. By conducting this study and proceeding with its capital improvement plan, Wayland is following the recommended best management practices set out in the report.

General Recommendations

In order to establish a comprehensive database of the condition of the system, it is recommended that the WWD create a water main failure database. Currently, the WWD maintains a spreadsheet of each break with its location and main diameter. The database should include additional properties of the failed main such as material, joint type and type of lining. In addition, the WWD should record the type of failure such as ring crack, lateral split, hole in the pipe, "punky" AC pipe failure, or joint leak. If possible, the WWD should include the apparent cause of the failure such as frost load, traffic load, direct contractor damage, settlement, water hammer, external soil corrosion or stray current. This data should then be input into the hydraulic model to allow for continual updating of a Water Main Failure Map and for identifying problem areas in the future. The water main failure database will aid the WWD in making water main replacement decisions in the future.

In addition, it is recommended that the WWD create a database of new or replacement water mains. The database should include water main diameter, material, lining, joint type, soil conditions, date of installation, and as-built schematic drawings. This data can be added to the existing database, created for this study, to maintain a comprehensive water main database.

It is recommended that prior to installation of all new ductile iron water mains, the WWD test the soils in the area of the new main to determine if the soil has high corrosion potential. If the soil is found to be potentially corrosive soil, the WWD should consider wrapping the main with polyethylene to protect against external corrosion. Wrapping is a relatively inexpensive practice that can extend the life of new ductile iron pipe. In addition, wrapping helps to protect the pipe from stray currents that may develop near the main.

Above Ground Facility Improvements

As discussed in Section 6, the system includes one booster pump station, eight wells and two water storage tanks. These facilities were evaluated and general recommendations were developed. Table No. 7-1 includes a summary of the above ground facilities recommended improvements. These improvements have not been prioritized.

The booster pump station is in good condition. It was rehabilitated in 1999, and the domestic pumps are new. The emergency generator has passed its life expectance, but appears in good condition, is tested regularly, has relatively few operating hours and a replacement is not recommended at this time.

Most of the wells appear in good condition with some minor recommended improvements. The exception would be the three wells that are not in use due to high levels of iron and manganese.

The Baldwin Pond Wells and station are in good condition, but Wells No. 1 and 2 are not in use due to high levels of iron and manganese. The Town of Wayland is currently in the process of having a 1.5 mgd treatment facility built at this site. The treatment facility would treat water from all three wells and include a new treatment building with offices. Also, as part of the project the Well No. 1 vault is to be replaced. The replacement well constructed in 2001 will be activated. Modifications planned for all three wells include new pumps and motors. A new generator will be installed to operate all three wells during a power failure. The Town began construction in the summer of 2008 with the treatment plant scheduled to go online by the end of 2009.

There are two concerns that should be addressed at each of the remaining wells. The Chamberlain Well has a propane gas heater, while the rest have electric heaters. During a power failure the electric heaters will not operate, causing the risk of pipes freezing. It is recommended that propane or natural gas heaters be installed at the Campbell Road Well, Happy Hollow Wells and the Meadowview Wells. The Baldwin Pond Wells are currently the only wells with emergency power. It is recommended that a permanent generator also be considered at the Happy Hollow Well site because this is the next largest source, and includes two wells. The purchase of an additional portable generator should also be considered and stored at the garage at Baldwin Pond for transport to the remaining wells during an emergency.

The building and equipment at the Campbell Well appears to be in good condition, but the 2007 well inspection report recommends that the well be cleaned and redeveloped. The Chamberlain Well and equipment also appears in good condition. There is a direct drive generator inside the building that is of minimal use, as it works for the pump only. During an emergency the pump can run, but the necessary chemical injection equipment cannot.

The pump installation years at both of the Happy Hollow Wells are unknown. The 2007 inspection report states that the well and pump at Happy Hollow Well No. 2 appear in good condition, and the report recommends that Happy Hollow Well No. 1 be cleaned and redeveloped. It is also recommended that the pump be inspected during any cleaning. Finally, there is a master meter that measures the flow from Well No. 1 that is located in a pit outside of the building. The WWD does not know the exact location of this pit and no records documenting inspection or testing of the venturi were found. It is recommended that the meter pit be located and the venturi be tested and evaluated.

The Meadowview Well and station appear to be in good condition. This well is currently not used because of high levels of manganese. It is recommended that the WWD consider the possibility of treatment at this location to meet future demands in the system. A pilot test report was completed using membrane ultrafiltration in 2006. Due to the current costs associated with constructing and operating an ultrafiltration plant, it is recommended that the Town review recent water quality data and available new treatment technologies to reevaluate potential treatment options.

The Reeves Hill Water Storage Tank No. 1 is in poor condition. The tank is over 80 years old, and the exterior of the tank has not been painted in over 20 years. The MassDEP sanitary survey completed in March 2007 requires the painting of the exterior of the tank. Before performing a tank painting the Town should perform a life cycle cost analysis to consider the possibility of constructing a new concrete tank either at the same location or at a second location in Town. The tank is severely rusted on the exterior, especially near the base. Painting the tank will require pit welding repairs. If left unattended the pitting at the base could result in a leaking problem in the near future.

The Reeves Hill Water Storage Tank No. 2 is in good condition. There are some areas around the base that have some coating deterioration. The WWD is planning to power wash the tank in the summer of 2008. It is recommended that they also inspect and patch the areas that have deterioration. The 2007 MassDEP sanitary survey suggests a fence be installed around the two tanks because the new telephone antenna constructed in the area results in the potential for more traffic to the area.

Due to the concerns involving the Meadowview Well and Reeves Hill Water Storage Tank No. 1, we recommend the completion of a Water Supply and Storage Evaluation to determine the adequacy of the Town's existing supply sources and water storage facilities. The evaluation would include completion of population and demand projections and appropriate water storage and supply recommendations.

Prioritization of Water Main Improvements

Based on the Three Circles Approach, a prioritized list of improvements was created. Improvements were separated into three phases. The Phase I and Phase II improvements are prioritized based on hydraulic needs, location in the distribution system and the condition of the water main. In general, the Phase I improvements include water mains that fall into all three of the circles and Phase II improvements include water mains that fall into two of the three circles. These improvements strengthen the transmission grid, eliminate potential asset management concerns and provide redundancy. Phase III improvements generally include areas that fall into one circle. These improvements include the remaining hydraulic recommendations from Section 3. Phase II improvements should be completed as funds become available and considered when reviewing road paving schedules. The hydraulically deficient areas, critical component considerations and asset management scores are combined on one Capital Efficiency Three Circles Integration Map included in Appendix E.

It should be noted that due to the nature of this Capital Efficiency Plan™, the list of improvements is extensive. This results in a high associated cost if all of the suggested improvements were constructed. The intent of the prioritization, therefore, is to serve as a guide for implementation from the most needed to the least needed improvements based on the weighted criteria established jointly by the WWD and Tata & Howard. These improvements would most logically be constructed over an extended period of time.

Table No. 7-2, at the end of this section, includes a prioritized list of Phase I improvements and the hydraulic, critical component and asset management status of each improvement. Table No. 7-3 includes the linear footage and estimated cost of each Phase I improvement. Table No. 7-4 includes a prioritized list of Phase II improvements and Table No. 7-5 includes the linear footage and estimated cost of each Phase II improvement. A recommended improvements map is included in Appendix F. It should be noted that paving schedules or highway department improvements were not evaluated as part of this study. The WWD may reprioritize the recommendations if paving or road work is scheduled on any of the roads recommended for water main improvements.

<u>Phase I Water Main Improvements</u>

1. In order to meet the ISO fire flow requirement on Boston Post Road at the intersection with White Street, a new 12-inch cement lined ductile iron main is recommended on Boston Post Road from Pinebrook Road to Westway Road and on Pinebrook Road from Boston Post Road to Old Connecticut Path. Due to the size, age, material and poor water quality, the water mains in the area have asset management scores between 61 and 64 rating the mains as poor to fair. Also, the portion of the water main on Boston Post Road is considered critical because of the interconnection with Weston located at the end of the main. The estimated probable construction cost for approximately 5,000 feet of 12-inch diameter water main is $1,140,000.

<u>Phase II Water Main Improvements</u>

2. In order to meet residential fire flows on Riverview Circle, Overlook Road, Oak Hill Road and Meadowview Road, the mains on these roads as well as Stonebridge Road should be cleaned and lined. These roads have poor to fair asset management scores of 61 to 67 based on size, age, material and poor water quality caused by residual manganese in the pipes from the Meadowview Well. These mains are also in a critical area due to their proximity to the Meadowview Well. While cleaning and lining this area it is logical to also clean and line the mains on Anthony Road, Highgate Road and Holbrook Road. These mains have high asset management scores of 57 to 61 and are considered poor to fair. The estimated probable construction cost to clean and line approximately 17,700 feet of 6-inch and 8-inch diameter mains is $1,240,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

   It is important to note that these mains would also be considered critical if the Meadowview Well is activated. Also, because it is the Meadowview Well that is contributing to the water quality issues in this area, the WWD may wish to consider cleaning and lining in this area after a treatment plant is constructed at Meadowview Well. If the water mains are cleaned and lined and then the Meadowview Well is activated without treatment, the manganese will be deposited on the cement lined pipe wall and become a problem again.

3. In order to meet residential fire flow requirements on Westway Road and Blossom Road, a new 8-inch diameter cement lined ductile iron main is recommended on Westway Road and Blossom Road. Westway Road's main has a poor to fair asset management score of 67 based on size, age, material and poor water quality. The estimated probable construction cost for approximately 1,750 feet of 8-inch diameter water main is $250,000.

4. In order to meet the ISO fire flow requirement at the Wayland High School, a new 16-inch diameter main is recommended on Old Connecticut Path from the tank driveway to Shaw Drive and a 12-inch diameter main is recommended on Old Connecticut Path from Cochituate Road to the Happy Hollow Wells. Also, these mains are in critical areas due to the proximity to the Wayland High School, the water storage tanks and the Happy Hollow Wells. The estimated probable construction cost for approximately 750 feet of 16-inch diameter water main and approximately 4,700 feet of 12-inch diameter main is $1,410,000.

5. In order to meet the ISO fire flow requirement at the intersection of Main Street and Damon Street, a new 12-inch diameter cement lined ductile iron main is recommended on Main Street extending from West Plain Street to Commonwealth Road. Also, these mains are in critical areas due to the proximity to the Wayland Nursing and Rehab Center. The estimated probable construction cost for approximately 1,500 feet of 12-inch diameter main is $380,000.

6. In order to meet the ISO fire flow requirement at the intersection of East Plain Street and Commonwealth Road, a new 12-inch diameter main is recommended on East Plain Street from Main Street to Commonwealth Avenue and on Commonwealth Avenue from East Plain Street to the Town Line. Also, these mains are in critical areas due to the proximity to the Wayland Nursing and Rehab Center, Sunrise Assisted Living of Wayland and the Kathryn Barton Nursing Home. The estimated probable construction cost for approximately 4,500 feet of 12-inch diameter main is $970,000.

7. In order to meet the ISO fire flow requirement at the Loker Elementary School, which is served off of Rice Road, a new 12-inch diameter main is recommended on Rice Road from Mainstone Road to Wisteria Way and Thompson Street to Woodridge Road, Thompson Street and the service connection to the school. Also, these mains are in critical areas due to the proximity to the Loker Elementary School. An alternative to replacing the school service connection with a 12-inch diameter main would be to extend the existing connection to Loker

Street to create a loop. The estimated probable construction cost for approximately 6,750 feet of 12-inch diameter main is $1,240,000.

8. A new 8-inch diameter cement lined ductile iron main is recommended on Loker Street from Hobbs Road to Thompson Street to allow the low service area adjacent to the high service area be fed by an 8-inch main instead of the existing 6-inch main. This main is also considered critical because of its proximity to the Loker Elementary School. The estimated probable construction cost for approximately 1,200 feet of 8-inch diameter main is $170,000.

9. In order to meet the residential fire flow requirements on the portion of Glezen Lane near the Town Line and on Autumn Lane, a new 8-inch diameter main is recommended on Glezen Lane from Concord Road to the start of the existing 8-inch main near Autumn Lane. Also, this main has a poor to fair asset management score of 67 based on size, age, material and poor water quality. The estimated probable construction cost for approximately 4,800 feet of 8-inch diameter main is $760,000.

10. The existing 6-inch diameter main on Concord Road is a bottleneck connecting the 10-inch on Old Sudbury Road to an 8-inch main on Plain Road. In order to improve the transmission from the tanks to the northern portion of the system, a new 12-inch diameter main on Concord Road is recommended. Also, this main has a poor to fair asset management score of 69 based on size, age, material and poor water quality. The new 12-inch main on Concord Road will improve the carrying capacity of the main and eliminate a bottleneck in the system. The estimated probable construction cost for approximately 2,000 feet of 12-inch diameter main is $510,000.

11. In order to meet a residential fire flow on Folsom Pond Road, a new 8-inch diameter cement lined ductile iron pipe is recommended. Also, this main has a high asset management score of 67 based on age, material and water quality. The estimated probable construction cost for 450 feet of 8-inch diameter main is $70,000.

12. In order to meet a residential fire flow on Pear Tree Lane, a new 8-inch diameter cement lined ductile iron pipe is recommended. Also, this main has a high asset management score of 67 based on age, material and water quality. The estimated probable construction cost for 350 feet of 8-inch diameter main is $50,000.

13. In order to meet a residential fire flow on the 4-inch diameter main off Moore Road near Glezen Lane, a new 8-inch diameter cement lined ductile iron pipe is recommended. Also, this main has a high asset management score of 68 based on age, material and water quality. The estimated probable construction cost for 750 feet of 8-inch diameter main is $110,000.

14. In order to meet a residential fire flow on Rich Valley Road, Hayward Road, Sylvan Way, Lundy Lane and White Road, new 8-inch diameter cement lined ductile iron pipes are recommended. Also, due to the material, size, age and poor water quality these mains have asset management scores ranging from 49 to 84. These mains are considered poor to fair. The estimated probable construction cost for 7,600 feet of 8-inch diameter main is $1,060,000.

Phase III Water Main Improvements

Phase III Improvements generally include areas that fall into one circle. A number of these mains are in areas where water quality concerns were noted by the WWD or are the remaining hydraulic recommendations from Section 3. Phase III should be completed as funds become available and considered when reviewing road paving schedules. Table No. 7-6 includes an unordered list of Phase III Improvements and the hydraulic, critical component and asset management status of each improvement. Table No. 7-7 includes the linear footage and estimated cost of each Phase III Improvement.

15. In order to meet the required ISO fire flow at the intersection of West Plain Street and Edgewood Street, a new 12-inch diameter cement lined ductile iron main is recommended on Old Connecticut Path from Maiden Lane to West Plain Street. The estimated probable construction cost for 4,300 feet of 12-inch diameter main is $1,090,000.

16. In order to meet the required ISO fire flows at the Intersection of Main Street and West Plain Street and at the intersection of Main Street and Bent Avenue, a 12-inch diameter main is recommended on Cochituate Road from Old Connecticut Path to Hurland Road and on School Street from Cochituate Road to Loker Street. Also, cleaning and lining the existing 10-inch main on West Plain Street would improve the transmission capacity of the main and improve flows in the southern portion of the system. The estimated probable construction cost for approximately 2,700 feet of 12-inch diameter water main and cleaning and lining approximately 5,300 feet of 10-inch diameter water main is $960,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

17. The existing 6-inch diameter water main on Lincoln Road does not have the inherent capacity to provide the estimated needed residential fire flow requirement. In order to meet the estimated needed fire flow and improve the carrying capacity of the main, a new 8-inch diameter main is recommended on Waltham Road and Lincoln Road from Waltham Road to Hazelbrook Lane. Also, the existing 6-inch diameter main on Hazelbrook Lane causes a bottle neck and an 8-inch diameter water main is recommended on Hazelbrook Lane from Lincoln Road to Glezen Lane. The estimated probable construction cost for approximately 8,000 feet of 8-inch diameter water main is $1,110,000.

18. The water main on Jeffrey Road has an asset management score of 64. The poor score is due to age, material and a history of breaks. It is recommended that the

existing main replaced with an 8-inch diameter cement lined ductile iron water main. The estimated probable construction cost for approximately 2,400 feet of 8-inch diameter main is $330,000.

19. The water main on Forty Acres Drive has an asset management score of 66. The poor score is due to age, material and a history of breaks. It is recommended that the existing main be replaced with an 8-inch diameter cement lined ductile iron water main. The estimated probable construction cost for approximately 2,500 feet of 8-inch diameter main is $350,000.

20. The water main on Dudley Road from Bayfield Road to the end has an asset management score of 64. The poor score is due to age, material and a history of breaks. It is recommended that the existing main be replaced with an 8-inch diameter cement lined ductile iron water main. The estimated probable construction cost for approximately 950 feet of 8-inch diameter main is $140,000.

21. The water mains on Bradford Street, Shawmut Avenue and Pleasant Street cannot meet residential fire flows. It is recommended that the mains be replaced with 8-inch diameter cement lined ductile iron mains. The estimated probable construction costs for approximately 2,850 feet of 8-inch diameter main are $400,000.

22. The portion of the water main that is under the Route 90 (Massachusetts Turnpike) overpass is considered critical by the Town because of the difficulties that would arise during a break. Due to its location repairs would be difficult and water loss onto the Turnpike would be problematic. The water main has been in place since the early 1950's without a problem and the velocity through the pipe should prevent freezing, but the Town should consider having the main inspected to see if there has been any damage due to corrosion or other means.

23. There are other areas in the system that cannot meet a 750 gpm residential fire flow requirement due to main size. The following mains should be replaced with 8-inch diameter mains. The estimated probable construction cost to replace each main is also listed.

    - 6-inch diameter main 1,500 feet south of Waltham Road on Lincoln Road ($130,000)
    - Nob Hill Road ($100,000)
    - Whispering Lane ($210,000)
    - Apache Trail ($90,000)
    - Coltsway ($100,000)
    - Hillside Drive and Pickwick Way ($430,000)
    - Smokey Hill Road ($120,000)
    - Peck Avenue ($160,000)
    - Doran Road ($60,000)
    - Mathews Drive ($70,000)

24. The water system has water quality issues in the northeastern portion of Town. This area of the system has a significant amount of unlined cast iron mains, which along with the water quality problems results in high asset management scores. Also, this area is influenced by the Baldwin Pond Wells, which has had iron and manganese issues in the past. The new treatment plant will prevent future water quality problems, but the unlined cast iron mains will likely continue to cause water quality issues. It is recommended that the following areas be cleaned and lined generally in the order listed.

The first section recommended to be cleaned and lined includes the transmission main leading from the Baldwin Pond Wells. This includes cleaning and lining the main on Glezen Lane from Old Sudbury Road to Training Field Road, Training Field Road, Saddle Lane and Bailey Lane. The estimated probable construction cost for cleaning and lining approximately 2,000 feet of 6-inch diameter water main, 1,950 feet of 8-inch diameter water main and 2,150 feet of 12-inch diameter water main is $430,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

The 8-inch diameter water main on Concord Road from Moore Road to Plain Road should be cleaned and lined. The estimated probable construction cost for cleaning and lining approximately 1,800 feet of 8-inch diameter water main is $130,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

The water main on Boston Post Road from Cochituate Road to Pinebrook Road should be cleaned and lined as well as the unlined cast iron side streets. The side streets include Glen Road, Michael Road, Bennett Road, Dangelo Road, Springhill Road, Lee Road, Wheelock Road and Glover Road. The estimated probable construction cost for cleaning and lining approximately 3,850 feet of 6-inch diameter water main and 8,400 feet of 8-inch diameter water main is $830,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

The 8-inch diameter main on Claypitt Hill Road should be cleaned and lined in its entirety. The estimated probable construction cost for cleaning and lining approximately 5,000 feet of 8-inch diameter water main is $340,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

The water mains in the area of Bow Road and Plain Road should be cleaned and lined. These mains include Bow Road, Plain Road from concord Road to Claypitt Hill Road, Farmcrest Lane and Plainview. The estimated probable construction cost for cleaning and lining approximately 4,300 feet of 6-inch diameter water main and 3,650 feet of 8-inch diameter water main is $540,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

The 8-inch portion of Glezen Lane east of Hazelbrook Lane should be cleaned and lined. The estimated probable construction cost for cleaning and lining approximately 1,950 feet of 8-inch diameter water main is $140,000. Prior to implementing this improvement, we recommend that pipe coupons be taken from the mains to confirm the poor condition of the main.

Finally, there are additional areas of unlined cast iron water mains that have a history of water quality concerns in this same area. These water mains should be reevaluated after the cleaning and lining projects have been completed and the Baldwin Pond Water Treatment Facility is online. Also, reevaluating the Town's flushing program could improve some of the water quality concerns once the treatment plant is online.

Table No. 7-1
Above Ground Facilities Recommended Improvements
Capital Efficiency Plan™
Wayland, Massachusetts

Item No.	Facility	Recommendation
1	Chamberlain, Happy Hallow and Meadowview Wells	Installation of propane or natural gas heaters
2	Happy Hollow Wells	Instllation of emergency generator
	Baldwin Pond Water Treatment Facility	Purchace of a portable emergency generator
3	Campbell Well	Clean and redevelop the well
4	Happy Hollow Well No. 1	Clean and redevelop the well
5	Happy Hollow Wells	Locate master mter pit and evaluate meter
6	Meadowview Well	Evaluate possible iron and manganese treatment alternatives
7	Reeves Hill Water Storage Tank No. 1	Interior tank painting and rehabilitation
8	Reeves Hill Water Storage Tanks No. 1 and 2	Install fence around tank perimeter
9	All sources and water storage tanks	Water Supply and Storage Evaluation

Table No. 7-2
Prioritization of Improvements - Phase I
Capital Efficiency Plan™
Wayland, Massachusetts

Item No.	Location	From	To	Hydraulically Deficient?	Critical Area?	Asset Management Rating
1	a. Boston Post Road	Pinebrook Road	Westway Road	Yes	Yes	69-84
	b. Pinebrook Road			Yes	No	61

Table No. 7-3
Estimated Improvement Costs - Phase I
Capital Efficiency Plan™
Wayland, Massachusetts

Item No.	Location	From	To	Type of Improvement	Water Main Diameter (in)	Length (lf)	Total Estimated Cost
1	a. Boston Post Road	Pinebrook Road	Westway Road	New	12	3,000	$760,000
	b. Pinebrook Road			New	12	2,000	$380,000
						Total Estimated Cost	$1,140,000

Table No. 7-4
Prioritization of Improvements - Phase II
Capital Efficiency Plan™
Wayland, Massachusetts

Item No.	Location	From	To	Hydraulically Deficient?	Critical Area?	Asset Management Rating
2	a. Stonebridge Road			Yes	Yes	61
	b. Riverview Circle			Yes	Yes	61-67
	b. Overlook Road			Yes	Yes	61
	c. Oak Hill Road			Yes	Yes	61-67
	c. Meadowview Road			Yes	Yes	61-67
	d. Highgate Road			No	No	57-63
	d. Holbrook Road			No	No	57-63
	d. Anthony Road			No	No	57-63
3	a. Westway Road			Yes	No	67
	b. Blossom Lane			Yes	No	42
4	a. Old Connecticut Path	Tank driveway	Shaw Drive	Yes	Yes	46
	b. Old Connecticut Path	Cochituate Road	Happy Hollow Wells	Yes	No	15-52
5	Main Street	West Plain Street	Commonwealth Avenue	Yes	Yes	48
6	a. East Plain Street	Main Street	Commonwealth Avenue	Yes	Yes	46-59
	b. Commonwealth Avenue	East Plain Street	Town of Natick	Yes	Yes	46-65
7	a. Rice Road	Mainstone Road	Wisteria Way	Yes	No	29
	b. Rice Road	Thompson Street	Woodridge road	Yes	Yes	30-36
	c. Thompson Street			Yes	Yes	35
	d. 6-inch service off Rice Road			Yes	Yes	15
8	Loker Street	Hobbs Road	Thompson Street	Yes	Yes	44
9	Glezen Lane	Concord Road	Start of existing 8-inch	Yes	No	67
10	Concord Road	Old Sudbury Road	Plain Road	Yes	No	69
11	Folsom Pond Raod			Yes	No	67
12	Pear Tree Lane			Yes	No	67
13	4-inch main off Moore Road	Near Glezen Lane		Yes	No	68
14	Rich Valley Road			Yes	No	67-82
	Hayward Road	Rich Valley Road	Sylvan Way	Yes	No	67
	Sylvan Way			Yes	No	49-67
	Lundy Lane			Yes	No	49
	White Road			Yes	No	49

Table No. 7-5
Estimated Improvement Costs - Phase II
Capital Efficiency Plan™
Wayland, Massachusetts

Item No.	Location	From	To	Type of Improvement	Water Main Diameter (in)	Length (lf)	Total Estimated Cost
2	a. Stonebridge Road			C & L	8	7,450	$510,000
	b. Riverview Circle			C & L	6 to 8	2,200	$150,000
	b. Overlook Road			C & L	8	950	$70,000
	c. Oak Hill Road			C & L	6 to 8	2,100	$150,000
	c. Meadowview Road			C & L	6 to 8	1,400	$100,000
	d. Highgate Road			C & L	8	1,800	$130,000
	d. Holbrook Road			C & L	6	600	$40,000
	d. Anthony Road			C & L	8	1,200	$90,000
3	a. Westway Road			New	8	1,350	$190,000
	b. Blossom Lane			New	8	400	$60,000
4	a. Old Connecticut Path	Tank driveway	Shaw Drive	New	16	750	$220,000
	b. Old Connecticut Path	Cochituate Road	Happy Hollow Wells	New	12	4,700	$1,190,000
5	Main Street	West Plain Street	Commonwealth Avenue	New	12	1,500	$380,000
6	a. East Plain Street	Main Street	Commonwealth Avenue	New	12	2,700	$510,000
	b. Commonwealth Avenue	East Plain Street	Town of Natick	New	12	1,800	$460,000
7	a. Rice Road	Mainstone Road	Wisteria Way	New	12	1,800	$340,000
	b. Rice Road	Thompson Street	Woodridge road	New	12	3,400	$640,000
	c. Thompson Street			New	12	1,100	$180,000
	d. 6-inch service off Rice Road			New	12	450	$80,000
8	Loker Street	Hobbs Road	Thompson Street	New	8	1,200	$170,000
9	Glezen Lane	Concord Road	Start of existing 8-inch	New	8	4,800	$760,000
10	Concord Road	Old Sudbury Road	Plain Road	New	12	2,000	$510,000
11	Folsom Pond Raod			New	8	450	$70,000
12	Pear Tree Lane			New	8	350	$50,000
13	4-inch main off Moore Road	Near Glezen Lane		New	8	750	$110,000
14	Rich Valley Road			New	8	2,400	$330,000
	Hayward Road	Rich Valley Road	Sylvan Way	New	8	600	$90,000
	Sylvan Way			New	8	1,800	$250,000
	Lundy Lane			New	8	800	$110,000
	White Road			New	8	2,000	$280,000
						Total Estimated Cost	$8,220,000

Table No. 7-6
Prioritization of Improvements - Phase III
Capital Efficiency Plan™
Wayland, Massachusetts

Item No.	Location	From	To	Hydraulically Deficient?	Critical Area?	Asset Management Rating
15	Old Connecticut Path	Maiden Lane	West Plain Street	Yes	No	40-52
16	a. Cochituate Road	Old Connecticut Path	Hurland Road	Yes	No	52
	b. School Street	Cochituate Road	Loker Street	Yes	No	52
	c. West Plain Street	Old Connecticut Path	Main Street	Yes	No	0
17	Lincoln Road	Waltham Road	Hazelbrook Road	Yes	No	30
	Waltham Road			Yes	No	63
	Hazelbrook Lane	Lincoln Road	Glezen Lane	Yes	No	15
18	Jeffrey Road			No	No	64
19	Forty Acres Drive			No	No	66
20	Dudley Road	Bayfield Road	End	No	No	64
21	Bradford Street			Yes	No	55
	Shawmut Avenue			Yes	No	55
	Pleasant Street			Yes	No	42
22	Rt 90 Overpass	Oak Street	Hearthstone Circle	No	Yes	41
23	a. 6-inch off Lincoln Road	1,500 feet south of Waltham Road		Yes	No	42
	b. Nob Hill Road			Yes	No	41
	c. Whispering Lane			Yes	No	17
	d. Apache Trail			Yes	No	16
	e. Coltsway			Yes	No	22
	f. Hillside Dr and Pickwick Way			Yes	No	16
	g. Smokey Hill Road			Yes	No	22
	h. Peck Avenue			Yes	No	44
	i. Doran Road			Yes	No	43
	j. Mathews Drive			Yes	No	58
24	a. Glezen Lane and Trainingfield Road			No	No	42-82
	b. Concord Road	Moore Road	Plain Road	No	No	63
	c. Boston Post Rd and Side Streets	Cochituate Road	Pinebrook Road	No	No	61-69
	d. Claypitt Hill Road			No	No	61-66
	e. Bow Road and Plain Road			No	No	63-69
	f. Glezen Lane	8-inch		No	No	61

Table No. 7-7
Estimated Improvement Costs - Phase III
Capital Efficiency Plan™
Wayland, Massachusetts

Item No.	Location	From	To	Type of Improvement	Water Main Diameter (in)	Length (lf)	Total Estimated Cost
15	Old Connecticut Path	Maiden Lane	West Plain Street	New	12	4,300	$1,090,000
16	a. Cochituate Road	Old Connecticut Path	Hurland Road	New	12	1,500	$380,000
	b. School Street	Cochituate Road	Loker Street	New	12	1,200	$200,000
	c. West Plain Street	Old Connecticut Path	Main Street	C & L	10	5,300	$380,000
17	Lincoln Road	Waltham Road	Hazelbrook Road	New	8	5,300	$730,000
	Waltham Road			New	8	1,000	$140,000
	Hazelbrook Lane	Lincoln Road	Glezen Lane	New	8	1,700	$240,000
18	Jeffrey Road			New	8	2,400	$330,000
19	Forty Acres Drive			New	8	2,500	$350,000
20	Dudley Road	Bayfield Road	End	New	8	950	$140,000
21	Bradford Street			New	8	900	$130,000
	Shawmut Avenue			New	8	1,300	$180,000
	Pleasant Street			New	8	650	$90,000
22	Rt 90 Overpass	Oak Street	Hearthstone Circle	Evaluate	8	500	N/A
23	a. 6-inch off Lincoln Road	1,500 feet south of Waltham Road		New	8	900	$130,000
	b. Nob Hill Road			New	8	700	$100,000
	c. Whispering Lane			New	8	1,500	$210,000
	d. Apache Trail			New	8	600	$90,000
	e. Coltsway			New	8	700	$100,000
	f. Hillside Dr and Pickwick Way			New	8	3,100	$430,000
	g. Smokey Hill Road			New	8	850	$120,000
	h. Peck Avenue			New	8	1,100	$160,000
	i. Doran Road			New	8	400	$60,000
	j. Mathews Drive			New	8	450	$70,000
24	a. Glezen Lane and Trainingfield			C & L	6 to 12	6100	$430,000
	b. Concord Road	Moore Road	Plain Road	C & L	8	1800	$130,000
	c. Boston Post Rd and Side	Cochituate Road	Pinebrook Road	C & L	6 to 8	12250	$830,000
	d. Claypitt Hill Road			C & L	8	5000	$340,000
	e. Bow Road and Plain Road			C & L	6 to 8	7950	$540,000
	f. Glezen Lane	8-inch		C & L	8	1950	$140,000
						Total Estimated Cost	$8,260,000

Asset Management Pipe Input Data
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Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-10	8	1936	Unlined Cast Iron	FALSE	FALSE	0	79.1
P-100	6	1936	Unlined Cast Iron	FALSE	TRUE	0	98
P-1000	6	1963	Cement Lined Cast Iron	FALSE	FALSE	0	72
P-1001	8	1963	Cement Lined Cast Iron	FALSE	FALSE	0	72
P-1003	8	1980	Ductile Iron	FALSE	FALSE	0	73.8
P-1004	8	1980	Ductile Iron	FALSE	FALSE	0	69.9
P-1005	8	1980	Ductile Iron	FALSE	FALSE	0	69.9
P-1006	8	1936	Unlined Cast Iron	FALSE	TRUE	0	88.9
P-101	6	1936	Unlined Cast Iron	FALSE	TRUE	0	98
P-102	10	1929	Unlined Cast Iron	FALSE	FALSE	2	98.2
P-104	8	1978	Cement Lined Cast Iron	FALSE	FALSE	0	49.4
P-105	10	1929	Unlined Cast Iron	FALSE	FALSE	0	99.9
P-108	6	1937	Unlined Cast Iron	FALSE	TRUE	0	94
P-109	8	1937	Unlined Cast Iron	FALSE	TRUE	0	90.9
P-11	8	1936	Unlined Cast Iron	FALSE	FALSE	0	77.3
P-110	10	1929	Unlined Cast Iron	FALSE	FALSE	0	99.8
P-111	6	1937	Unlined Cast Iron	FALSE	FALSE	0	98.8
P-112	8	1937	Unlined Cast Iron	FALSE	FALSE	2	99.8
P-113	6	1937	Unlined Cast Iron	TRUE	FALSE	2	99.8
P-114	6	1937	Unlined Cast Iron	FALSE	FALSE	2	99.8
P-115	6	1937	Unlined Cast Iron	FALSE	FALSE	2	91.1
P-117	6	1937	Unlined Cast Iron	FALSE	FALSE	0	97.6
P-118	6	1937	Unlined Cast Iron	FALSE	TRUE	0	99.8
P-12	8	1936	Unlined Cast Iron	TRUE	FALSE	0	82.3
P-120	10	1928	Unlined Cast Iron	FALSE	FALSE	0	95.4
P-121	10	1928	Unlined Cast Iron	FALSE	FALSE	0	99.6
P-122	6	1937	Unlined Cast Iron	FALSE	FALSE	0	94
P-123	6	1937	Unlined Cast Iron	FALSE	FALSE	0	95.4
P-124	6	1937	Unlined Cast Iron	FALSE	FALSE	0	97.5
P-125	8	1937	Unlined Cast Iron	FALSE	TRUE	0	97.3
P-126	8	1937	Unlined Cast Iron	FALSE	TRUE	0	101.6
P-127	8	1937	Unlined Cast Iron	FALSE	TRUE	0	84.6
P-128	6	1947	Unlined Cast Iron	FALSE	TRUE	0	97.3
P-129	6	1947	Unlined Cast Iron	FALSE	TRUE	0	101.6
P-13	8	1936	Unlined Cast Iron	FALSE	FALSE	0	82.3
P-130	6	1947	Asbestos Cement	FALSE	TRUE	0	84.6
P-132	8	1937	Unlined Cast Iron	FALSE	TRUE	2	87.5
P-133	6	1937	Unlined Cast Iron	FALSE	TRUE	0	84.5
P-134	6	1947	Unlined Cast Iron	FALSE	TRUE	0	84.5
P-137	6	1961	Cement Lined Cast Iron	FALSE	TRUE	0	89.2
P-138	6	1937	Unlined Cast Iron	FALSE	TRUE	0	67.3
P-139	12	2001	Ductile Iron	FALSE	TRUE	0	74.1
P-14	8	1936	Unlined Cast Iron	TRUE	FALSE	0	82.3
P-140	12	2001	Ductile Iron	FALSE	TRUE	0	74.5
P-141	8	1930	Unlined Cast Iron	FALSE	FALSE	0	97.3
P-142	8	1928	Unlined Cast Iron	TRUE	FALSE	2	111.6
P-143	10	1928	Unlined Cast Iron	FALSE	FALSE	0	111.6
P-144	12	1930	Unlined Cast Iron	FALSE	FALSE	0	67.9
P-145	6	1930	Unlined Cast Iron	FALSE	FALSE	0	48.1
P-146	8	1947	Unlined Cast Iron	FALSE	FALSE	0	48.1
P-149	8	1965	Cement Lined Cast Iron	FALSE	FALSE	0	64

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-15	6	1936	Unlined Cast Iron	FALSE	FALSE	0	77.5
P-150	8	1947	Unlined Cast Iron	FALSE	FALSE	0	44.2
P-153	8	1947	Unlined Cast Iron	FALSE	FALSE	0	61.3
P-154	8	1947	Unlined Cast Iron	FALSE	FALSE	0	65.3
P-155	8	1947	Unlined Cast Iron	FALSE	FALSE	0	60.6
P-157	8	1947	Unlined Cast Iron	FALSE	FALSE	0	65.4
P-159	8	1950	Unlined Cast Iron	FALSE	FALSE	0	85.3
P-160	8	1930	Unlined Cast Iron	FALSE	FALSE	0	86.6
P-161	8	1930	Unlined Cast Iron	FALSE	FALSE	0	100.2
P-162	8	1955	Unlined Cast Iron	FALSE	FALSE	0	86.6
P-163	8	1955	Unlined Cast Iron	FALSE	FALSE	0	84.9
P-164	6	1955	Unlined Cast Iron	TRUE	FALSE	0	84.9
P-165	8	1961	Cement Lined Cast Iron	FALSE	FALSE	0	100.2
P-166	6	1961	Cement Lined Cast Iron	FALSE	FALSE	0	91.5
P-167	8	1961	Cement Lined Cast Iron	FALSE	FALSE	0	93.7
P-168	12	1972	Ductile Iron	FALSE	FALSE	2	49.4
P-17	8	1936	Unlined Cast Iron	FALSE	FALSE	0	92.2
P-172	12	1961	Cement Lined Cast Iron	TRUE	FALSE	0	56.9
P-173	8	1950	Unlined Cast Iron	FALSE	TRUE	0	90.4
P-174	6	1949	Unlined Cast Iron	FALSE	TRUE	0	90.4
P-175	8	1950	Unlined Cast Iron	FALSE	TRUE	0	98.6
P-177	8	1950	Unlined Cast Iron	FALSE	TRUE	0	94.3
P-179	8	1950	Unlined Cast Iron	FALSE	TRUE	0	94.3
P-18	8	1936	Unlined Cast Iron	FALSE	FALSE	0	92.2
P-180	8	1950	Unlined Cast Iron	FALSE	TRUE	0	90.4
P-181	8	1970	Cement Lined Cast Iron	FALSE	TRUE	0	94.3
P-182	8	1948	Unlined Cast Iron	FALSE	TRUE	0	73.2
P-184	8	1950	Unlined Cast Iron	FALSE	FALSE	0	98.4
P-185	8	1930	Unlined Cast Iron	FALSE	FALSE	0	96
P-186	12	1952	Unlined Cast Iron	FALSE	FALSE	0	95.9
P-187	8	1930	Unlined Cast Iron	FALSE	FALSE	0	96
P-188	6	1930	Unlined Cast Iron	FALSE	FALSE	0	99.3
P-189	8	1957	Unlined Cast Iron	FALSE	TRUE	0	69.3
P-190	8	1957	Unlined Cast Iron	FALSE	TRUE	0	92.2
P-191	8	1957	Unlined Cast Iron	FALSE	TRUE	0	71.9
P-192	8	1948	Unlined Cast Iron	FALSE	TRUE	0	73.2
P-193	8	1957	Unlined Cast Iron	FALSE	TRUE	0	94.4
P-195	6	1952	Unlined Cast Iron	FALSE	FALSE	0	74.8
P-196	12	1953	Unlined Cast Iron	FALSE	FALSE	0	66.5
P-197	12	1953	Unlined Cast Iron	FALSE	FALSE	0	73.5
P-198	8	1953	Unlined Cast Iron	FALSE	FALSE	0	73.5
P-199	6	1951	Unlined Cast Iron	FALSE	FALSE	0	74.5
P-20	6	1965	Cement Lined Cast Iron	FALSE	FALSE	0	94.8
P-200	8	1951	Unlined Cast Iron	FALSE	FALSE	0	74.6
P-201	8	1951	Unlined Cast Iron	FALSE	FALSE	0	62.2
P-202	12	1928	Unlined Cast Iron	FALSE	FALSE	0	65.4
P-203	8	1950	Unlined Cast Iron	FALSE	FALSE	0	44.1
P-204	8	1950	Unlined Cast Iron	FALSE	FALSE	0	44.1
P-205	8	1950	Unlined Cast Iron	FALSE	FALSE	0	44.5
P-207	8	1950	Unlined Cast Iron	FALSE	FALSE	0	44.5
P-208	8	1950	Unlined Cast Iron	FALSE	FALSE	0	55.2

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-209	8	1950	Unlined Cast Iron	FALSE	FALSE	0	52.7
P-210	8	1950	Unlined Cast Iron	FALSE	FALSE	0	55.2
P-211	8	1950	Unlined Cast Iron	FALSE	FALSE	0	52.7
P-212	8	1950	Unlined Cast Iron	FALSE	FALSE	0	52.7
P-213	8	1950	Unlined Cast Iron	FALSE	FALSE	0	60.5
P-214	8	1949	Unlined Cast Iron	FALSE	FALSE	0	52.2
P-215	10	1878	Unlined Cast Iron	FALSE	FALSE	2	52.6
P-221	10	1950	Unlined Cast Iron	FALSE	FALSE	2	78.2
P-221B	10	1949	Unlined Cast Iron	FALSE	FALSE	0	73.8
P-222	6	1935	Unlined Cast Iron	FALSE	FALSE	0	78.2
P-223	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	73.9
P-224	8	1949	Unlined Cast Iron	FALSE	FALSE	0	52.2
P-224A	8	1949	Unlined Cast Iron	FALSE	FALSE	0	65.6
P-227	8	1952	Unlined Cast Iron	FALSE	FALSE	2	90.7
P-228	6	1952	Unlined Cast Iron	FALSE	FALSE	0	94.2
P-23	6	1948	Unlined Cast Iron	FALSE	FALSE	0	82.1
P-230	8	1955	Unlined Cast Iron	FALSE	FALSE	0	85.5
P-231	8	1955	Unlined Cast Iron	FALSE	FALSE	0	85.5
P-232	8	1955	Unlined Cast Iron	FALSE	FALSE	0	85.5
P-233	8	1955	Unlined Cast Iron	TRUE	FALSE	0	81.2
P-234	6	1955	Unlined Cast Iron	FALSE	FALSE	0	81.2
P-235	8	1955	Unlined Cast Iron	FALSE	FALSE	0	81.2
P-236	8	1955	Unlined Cast Iron	FALSE	FALSE	0	81.2
P-237	8	1955	Unlined Cast Iron	FALSE	FALSE	0	85.5
P-238	8	1930	Unlined Cast Iron	FALSE	FALSE	0	85.5
P-239	10	1878	Unlined Cast Iron	FALSE	FALSE	2	78.2
P-24	6	1948	Unlined Cast Iron	FALSE	FALSE	2	62.6
P-240	10	1878	Unlined Cast Iron	FALSE	FALSE	2	85.5
P-241	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	73.9
P-243	6	1930	Unlined Cast Iron	FALSE	FALSE	0	79.1
P-244	6	1930	Unlined Cast Iron	FALSE	FALSE	0	73.9
P-245	6	1930	Unlined Cast Iron	FALSE	FALSE	0	65.2
P-246	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	73.9
P-248	6	1930	Unlined Cast Iron	FALSE	FALSE	0	88.4
P-249	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	78.7
P-250	6	1930	Unlined Cast Iron	FALSE	FALSE	0	72.9
P-251	6	1939	Unlined Cast Iron	FALSE	FALSE	0	72.9
P-253	8	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-254	6	1931	Unlined Cast Iron	FALSE	FALSE	0	78.7
P-255	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	73.5
P-256	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	87
P-257	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-258	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	67.4
P-259	6	1930	Unlined Cast Iron	FALSE	FALSE	0	72.7
P-26	6	1965	Cement Lined Cast Iron	FALSE	FALSE	0	94.8
P-261	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	73.4
P-262	8	1952	Unlined Cast Iron	FALSE	FALSE	0	87.6
P-263	6	1952	Unlined Cast Iron	FALSE	FALSE	0	78.9
P-264	6	1952	Unlined Cast Iron	FALSE	FALSE	0	90.5
P-265	6	1957	Unlined Cast Iron	FALSE	FALSE	0	78.9
P-266	8	1953	Unlined Cast Iron	FALSE	FALSE	0	74.4

Asset Management Pipe Input Data
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Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-267	12	1928	Unlined Cast Iron	FALSE	FALSE	0	62.2
P-268	12	1928	Unlined Cast Iron	FALSE	FALSE	0	74.3
P-27	8	1967	Cement Lined Cast Iron	FALSE	FALSE	0	94.8
P-270	8	1966	Cement Lined Cast Iron	FALSE	FALSE	0	69.6
P-271	8	1950	Unlined Cast Iron	FALSE	FALSE	0	60.5
P-272	8	1966	Cement Lined Cast Iron	FALSE	FALSE	0	69.5
P-274	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	65.2
P-275	8	1959	Unlined Cast Iron	FALSE	FALSE	0	73.9
P-276	6	1999	Ductile Iron	FALSE	FALSE	0	70.8
P-277	8	1987	Ductile Iron	FALSE	FALSE	1	76.3
P-278	6	1930	Unlined Cast Iron	FALSE	FALSE	0	72.5
P-279	10	1950	Unlined Cast Iron	FALSE	FALSE	0	76.3
P-28	8	1936	Unlined Cast Iron	FALSE	FALSE	2	93.3
P-280	10	1950	Unlined Cast Iron	FALSE	FALSE	0	75.5
P-281	10	1950	Unlined Cast Iron	FALSE	FALSE	0	75.3
P-283	10	1950	Unlined Cast Iron	FALSE	FALSE	0	70.2
P-284	6	1951	Unlined Cast Iron	FALSE	FALSE	0	75.5
P-285	6	1999	Ductile Iron	FALSE	FALSE	0	75.2
P-286	6	1951	Unlined Cast Iron	FALSE	FALSE	0	70.7
P-287	8	1963	Cement Lined Cast Iron	TRUE	FALSE	0	70.1
P-288	8	1963	Cement Lined Cast Iron	FALSE	FALSE	0	70.1
P-290	6	1939	Unlined Cast Iron	FALSE	FALSE	0	75.4
P-291	4	1940	Unlined Cast Iron	FALSE	FALSE	0	75.3
P-292	8	1936	Unlined Cast Iron	FALSE	FALSE	0	82.7
P-293	6	1936	Unlined Cast Iron	TRUE	FALSE	2	82.7
P-295	6	1939	Unlined Cast Iron	FALSE	FALSE	0	70.2
P-296	8	1951	Unlined Cast Iron	FALSE	FALSE	0	75
P-298	8	1952	Unlined Cast Iron	FALSE	FALSE	0	72.1
P-299	8	1963	Cement Lined Cast Iron	FALSE	FALSE	0	74.3
P-300	10	1950	Unlined Cast Iron	FALSE	FALSE	0	74.3
P-302	8	1952	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-304	8	1952	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-305	6	1952	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-306	12	1950	Unlined Cast Iron	FALSE	FALSE	0	74
P-307	12	1950	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-308	6	1930	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-309	6	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-31	8	1936	Unlined Cast Iron	FALSE	TRUE	0	91.5
P-310	10	1950	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-311	6	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-313	8	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-314	8	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-315	8	1878	Unlined Cast Iron	FALSE	FALSE	0	86.5
P-316	8	1878	Unlined Cast Iron	FALSE	FALSE	0	86.5
P-317	8	1878	Unlined Cast Iron	FALSE	FALSE	0	90.4
P-319	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	90.4
P-32	8	1952	Unlined Cast Iron	FALSE	FALSE	0	91.5
P-320	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	86.5
P-322	8	1952	Unlined Cast Iron	FALSE	FALSE	0	82.9
P-325	6	1933	Unlined Cast Iron	FALSE	FALSE	0	86.5
P-332	6	1933	Unlined Cast Iron	FALSE	FALSE	2	98.5

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-333	4	1933	Unlined Cast Iron	FALSE	FALSE	2	101.1
P-335	10	1929	Unlined Cast Iron	FALSE	FALSE	0	97.9
P-337	8	1933	Unlined Cast Iron	FALSE	FALSE	0	84.4
P-338	8	1933	Unlined Cast Iron	FALSE	FALSE	0	84.4
P-339	12	1933	Unlined Cast Iron	FALSE	FALSE	0	84.3
P-34	8	1955	Unlined Cast Iron	FALSE	TRUE	0	61.6
P-340	10	1965	Cement Lined Cast Iron	FALSE	FALSE	0	94.8
P-341	10	1936	Unlined Cast Iron	FALSE	FALSE	0	92.2
P-342	10	1950	Unlined Cast Iron	FALSE	FALSE	0	75.2
P-343	10	1932	Unlined Cast Iron	FALSE	FALSE	2	91.5
P-344	10	1950	Unlined Cast Iron	FALSE	FALSE	0	76
P-346	8	1940	Unlined Cast Iron	FALSE	TRUE	0	83.8
P-347	16	1975	Cement Lined Cast Iron	FALSE	FALSE	0	48.1
P-348	16	1975	Ductile Iron	FALSE	FALSE	0	48.1
P-349	8	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-35	8	1952	Unlined Cast Iron	FALSE	FALSE	0	96.3
P-350	8	1950	Unlined Cast Iron	FALSE	FALSE	0	74
P-352	4	1878	Unlined Cast Iron	FALSE	FALSE	0	86.5
P-353	8	1930	Unlined Cast Iron	FALSE	FALSE	0	61.3
P-354	8	1947	Unlined Cast Iron	FALSE	FALSE	0	10
P-355	16	1947	Unlined Cast Iron	FALSE	FALSE	0	10
P-356	8	1947	Unlined Cast Iron	FALSE	FALSE	0	48.1
P-357	8	1947	Unlined Cast Iron	FALSE	FALSE	0	44.2
P-358	4	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-36	8	1952	Unlined Cast Iron	FALSE	FALSE	0	84.6
P-360	8	1953	Unlined Cast Iron	FALSE	FALSE	0	74.3
P-362	8	1947	Unlined Cast Iron	FALSE	FALSE	0	65
P-366	8	1948	Unlined Cast Iron	FALSE	TRUE	0	94.4
P-367	8	1952	Unlined Cast Iron	FALSE	FALSE	0	114.9
P-368	8	1952	Unlined Cast Iron	FALSE	FALSE	2	101.9
P-369	12	1952	Unlined Cast Iron	FALSE	FALSE	2	114.9
P-37	8	1952	Unlined Cast Iron	FALSE	FALSE	0	90.6
P-372	8	1957	Unlined Cast Iron	FALSE	TRUE	0	98.8
P-373	8	1950	Unlined Cast Iron	FALSE	FALSE	0	89.1
P-374	8	1950	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-375	8	1936	Unlined Cast Iron	FALSE	TRUE	0	96
P-376	10	1929	Unlined Cast Iron	FALSE	FALSE	0	84.3
P-377	8	1950	Unlined Cast Iron	TRUE	FALSE	0	82.6
P-378	10	1929	Unlined Cast Iron	FALSE	FALSE	0	97.5
P-379	8	1955	Unlined Cast Iron	FALSE	TRUE	0	81.5
P-38	8	1952	Unlined Cast Iron	FALSE	FALSE	0	95.4
P-380	8	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-381	8	1950	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-382	8	1978	Cement Lined Cast Iron	FALSE	FALSE	2	49.4
P-38A	8	1952	Unlined Cast Iron	FALSE	FALSE	0	91.1
P-39	8	1952	Unlined Cast Iron	FALSE	FALSE	0	84.6
P-4	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	78.6
P-42	12	2001	Ductile Iron	FALSE	TRUE	0	95.4
P-43	6	1950	Unlined Cast Iron	FALSE	TRUE	0	90.5
P-441	12	1949	Unlined Cast Iron	FALSE	FALSE	0	110.2
P-442	12	1949	Unlined Cast Iron	FALSE	FALSE	0	97.3

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-45	6	1950	Unlined Cast Iron	FALSE	TRUE	0	74.3
P-450	12	1996	Ductile Iron	FALSE	TRUE	0	87.6
P-454	8	1940	Unlined Cast Iron	FALSE	TRUE	2	81.8
P-455	10	1878	Unlined Cast Iron	FALSE	FALSE	0	52.6
P-458	6	1957	Unlined Cast Iron	FALSE	TRUE	0	92.2
P-46	8	1950	Unlined Cast Iron	FALSE	TRUE	0	65.6
P-460	8	1950	Unlined Cast Iron	FALSE	FALSE	0	84.4
P-461	6	1950	Unlined Cast Iron	FALSE	FALSE	0	84.4
P-462	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	86.9
P-464	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	73.4
P-465	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-467	8	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.4
P-47	8	1950	Unlined Cast Iron	FALSE	FALSE	0	57.4
P-470	8	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-472	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-473	8	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-474	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.4
P-475	8	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.6
P-476	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.6
P-477	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-478	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	72.7
P-48	8	1950	Unlined Cast Iron	FALSE	TRUE	0	57.4
P-480	12	1950	Unlined Cast Iron	FALSE	FALSE	0	73.2
P-484	12	1950	Unlined Cast Iron	FALSE	FALSE	0	70.6
P-485	12	1950	Unlined Cast Iron	FALSE	FALSE	0	69.7
P-486	12	1950	Unlined Cast Iron	FALSE	FALSE	0	69.7
P-487	12	1950	Unlined Cast Iron	FALSE	FALSE	0	71.5
P-488	12	1950	Unlined Cast Iron	FALSE	FALSE	0	72.4
P-489	6	1936	Unlined Cast Iron	FALSE	FALSE	0	82.7
P-49	12	2001	Ductile Iron	FALSE	TRUE	0	74.3
P-490	6	1962	Cement Lined Cast Iron	FALSE	FALSE	0	81.9
P-491	6	1962	Cement Lined Cast Iron	FALSE	FALSE	0	81
P-492	6	1936	Unlined Cast Iron	FALSE	FALSE	0	81.9
P-493	8	1942	Unlined Cast Iron	FALSE	FALSE	0	72.7
P-494	8	1942	Unlined Cast Iron	FALSE	FALSE	0	70.6
P-498	8	1952	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-5	12	1962	Cement Lined Cast Iron	FALSE	FALSE	0	97.7
P-50	12	2001	Ductile Iron	FALSE	TRUE	0	69.5
P-500	6	1951	Unlined Cast Iron	FALSE	FALSE	0	71
P-501	6	1940	Unlined Cast Iron	FALSE	FALSE	0	75.3
P-51	8	1955	Unlined Cast Iron	FALSE	TRUE	0	67.7
P-511	8	1950	Unlined Cast Iron	FALSE	FALSE	0	74
P-514	8	1950	Unlined Cast Iron	FALSE	FALSE	0	98.4
P-515	8	1950	Unlined Cast Iron	FALSE	FALSE	0	100.6
P-516	8	1931	Unlined Cast Iron	FALSE	FALSE	2	79.1
P-517	8	1965	Cement Lined Cast Iron	TRUE	FALSE	0	65.8
P-519	6	1937	Unlined Cast Iron	FALSE	TRUE	0	72.4
P-520	6	1937	Unlined Cast Iron	FALSE	FALSE	0	85.8
P-522	8	1940	Unlined Cast Iron	FALSE	TRUE	0	76
P-525	8	1936	Unlined Cast Iron	FALSE	FALSE	0	78.9
P-526	8	1936	Unlined Cast Iron	TRUE	FALSE	0	78.8

Asset Management Pipe Input Data
Capital Efficiency Study
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Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-527	16	1975	Ductile Iron	FALSE	FALSE	0	61.1
P-528	6	1937	Unlined Cast Iron	TRUE	TRUE	0	67.3
P-529	12	1937	Unlined Cast Iron	FALSE	FALSE	0	65.8
P-53	12	2001	Ductile Iron	FALSE	TRUE	0	95.4
P-530	6	1878	Unlined Cast Iron	FALSE	FALSE	2	83.5
P-532	12	1930	Unlined Cast Iron	FALSE	FALSE	0	97.3
P-536	6	2004	Ductile Iron	FALSE	FALSE	0	89
P-537	6	2004	Ductile Iron	FALSE	FALSE	0	77.9
P-54	8	1955	Unlined Cast Iron	FALSE	TRUE	0	55.2
P-542	8	1957	Unlined Cast Iron	FALSE	TRUE	0	76.4
P-543	8	1957	Unlined Cast Iron	FALSE	TRUE	0	74.2
P-546	6	1961	Cement Lined Cast Iron	FALSE	TRUE	0	89.2
P-548	6	1961	Cement Lined Cast Iron	FALSE	TRUE	0	85.8
P-549	6	1947	Unlined Cast Iron	FALSE	TRUE	0	80.1
P-55	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	72
P-551	6	1952	Unlined Cast Iron	FALSE	TRUE	0	69.7
P-552	8	1960	Cement Lined Cast Iron	TRUE	FALSE	0	40.9
P-554	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	40.9
P-555	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	43.1
P-556	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	73.9
P-558	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	73.9
P-559	6	1960	Cement Lined Cast Iron	FALSE	FALSE	2	73.9
P-56	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	72
P-560	6	1960	Cement Lined Cast Iron	FALSE	FALSE	2	77.8
P-561	8	1931	Unlined Cast Iron	FALSE	FALSE	0	85.6
P-562	8	1931	Unlined Cast Iron	FALSE	FALSE	0	83.9
P-563	8	1931	Unlined Cast Iron	FALSE	FALSE	0	89.1
P-564	8	1931	Unlined Cast Iron	FALSE	FALSE	0	87.8
P-565	10	1950	Unlined Cast Iron	FALSE	FALSE	0	70.7
P-566	10	1950	Unlined Cast Iron	FALSE	FALSE	0	72
P-567	10	1950	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-568	10	1950	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-569	6	1950	Unlined Cast Iron	FALSE	TRUE	0	94.3
P-57	12	2001	Ductile Iron	FALSE	TRUE	0	72
P-570	6	1950	Unlined Cast Iron	FALSE	TRUE	0	94.3
P-571	6	1950	Unlined Cast Iron	FALSE	TRUE	0	91.3
P-572	8	1930	Unlined Cast Iron	FALSE	FALSE	0	85.3
P-574-NE`	8	1878	Unlined Cast Iron	FALSE	FALSE	0	79.1
P-575-NE`	8	2000	Ductile Iron	FALSE	TRUE	0	83.8
P-58	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	72
P-580	8	1947	Unlined Cast Iron	FALSE	FALSE	0	85.7
P-581	8	1966	Cement Lined Cast Iron	FALSE	FALSE	0	90.7
P-582	6	1995	Ductile Iron	FALSE	FALSE	0	99.8
P-583	8	1995	Ductile Iron	FALSE	FALSE	0	99.8
P-584	10	1962	Cement Lined Cast Iron	FALSE	FALSE	0	76.5
P-586	8	1995	Ductile Iron	FALSE	FALSE	0	99.8
P-59	6	1964	Cement Lined Cast Iron	FALSE	TRUE	0	95.4
P-590	10	1962	Cement Lined Cast Iron	FALSE	FALSE	0	79.5
P-591	6	1962	Cement Lined Cast Iron	FALSE	FALSE	0	79.5
P-592	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	80.8
P-594	8	1962	Cement Lined Cast Iron	FALSE	FALSE	2	103.6

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-595	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	88.5
P-596	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	88.5
P-597	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	95.8
P-598	6	1962	Cement Lined Cast Iron	FALSE	FALSE	0	95.8
P-6	12	1962	Cement Lined Cast Iron	FALSE	FALSE	0	80.8
P-60	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	95.4
P-600	8	1966	Cement Lined Cast Iron	FALSE	FALSE	0	76.5
P-601	12	1962	Cement Lined Cast Iron	FALSE	FALSE	0	90.7
P-602	12	1962	Cement Lined Cast Iron	FALSE	FALSE	0	78.6
P-603	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	78.6
P-604	10	1948	Unlined Cast Iron	FALSE	FALSE	0	77.3
P-606	6	1948	Unlined Cast Iron	FALSE	FALSE	0	82.8
P-607	6	1948	Unlined Cast Iron	FALSE	FALSE	0	75.4
P-608	6	1948	Unlined Cast Iron	FALSE	FALSE	0	75.4
P-609	6	1948	Unlined Cast Iron	FALSE	FALSE	0	80
P-61	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	95.4
P-610	6	1948	Unlined Cast Iron	FALSE	FALSE	0	70.9
P-611	6	1948	Unlined Cast Iron	FALSE	FALSE	0	70.9
P-612	8	1936	Unlined Cast Iron	FALSE	FALSE	0	93.3
P-613	8	1936	Unlined Cast Iron	FALSE	FALSE	0	86.9
P-614	8	1936	Unlined Cast Iron	FALSE	FALSE	0	86.9
P-615	8	1936	Unlined Cast Iron	FALSE	FALSE	0	88.5
P-616	8	1936	Unlined Cast Iron	FALSE	FALSE	0	94.1
P-617	6	1936	Unlined Cast Iron	FALSE	FALSE	0	94.1
P-618	6	1950	Unlined Cast Iron	FALSE	TRUE	0	74.3
P-619	6	1950	Unlined Cast Iron	FALSE	TRUE	0	82.1
P-62	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	95.4
P-620	6	1950	Unlined Cast Iron	FALSE	TRUE	0	82.1
P-621	6	1950	Unlined Cast Iron	FALSE	TRUE	0	90.5
P-622	8	1955	Unlined Cast Iron	FALSE	TRUE	0	55.2
P-623	8	1955	Unlined Cast Iron	FALSE	TRUE	0	61.2
P-624	6	1955	Unlined Cast Iron	FALSE	TRUE	0	61.2
P-625	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	61.6
P-626	8	1957	Unlined Cast Iron	FALSE	TRUE	0	76.4
P-627	8	1957	Unlined Cast Iron	FALSE	TRUE	0	72.5
P-628	6	1957	Unlined Cast Iron	FALSE	TRUE	0	72.5
P-629	12	2001	Ductile Iron	FALSE	TRUE	0	84
P-63	12	2001	Ductile Iron	FALSE	TRUE	0	77.2
P-630	12	2001	Ductile Iron	FALSE	TRUE	0	73.6
P-631	6	1960	Cement Lined Cast Iron	FALSE	TRUE	0	73.6
P-632	8	1960	Cement Lined Cast Iron	FALSE	TRUE	0	74.5
P-634	8	1936	Unlined Cast Iron	FALSE	TRUE	0	81.1
P-635	8	1936	Unlined Cast Iron	FALSE	TRUE	0	81.1
P-636	8	1936	Unlined Cast Iron	FALSE	TRUE	0	82.4
P-637	8	1936	Unlined Cast Iron	FALSE	TRUE	0	82
P-638	8	1936	Unlined Cast Iron	FALSE	TRUE	0	84.1
P-639	8	1936	Unlined Cast Iron	FALSE	TRUE	0	84.1
P-64	12	2001	Ductile Iron	FALSE	TRUE	0	95.4
P-640	6	1941	Asbestos Cement	FALSE	TRUE	0	82.9
P-641	6	1941	Asbestos Cement	FALSE	TRUE	0	82.9
P-642	6	1941	Asbestos Cement	FALSE	TRUE	0	82.9

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-643	8	1952	Unlined Cast Iron	FALSE	FALSE	0	82
P-644	8	1952	Unlined Cast Iron	FALSE	FALSE	0	81.1
P-645	6	1952	Unlined Cast Iron	FALSE	FALSE	0	81.1
P-646	12	1996	Ductile Iron	FALSE	FALSE	0	82
P-647	12	1996	Ductile Iron	FALSE	FALSE	0	86.7
P-648	4	1952	Unlined Cast Iron	FALSE	TRUE	0	93.7
P-649	12	1950	Unlined Cast Iron	FALSE	TRUE	0	87.6
P-65	8	1964	Cement Lined Cast Iron	FALSE	TRUE	0	95.4
P-650	12	1950	Unlined Cast Iron	FALSE	TRUE	0	82
P-651	8	1950	Unlined Cast Iron	FALSE	FALSE	0	82
P-652	12	1950	Unlined Cast Iron	FALSE	TRUE	0	83.3
P-654	8	1950	Unlined Cast Iron	FALSE	TRUE	0	83.4
P-655	8	1950	Unlined Cast Iron	FALSE	TRUE	0	83.1
P-657	6	1929	Unlined Cast Iron	FALSE	FALSE	0	102.4
P-658	6	1933	Unlined Cast Iron	FALSE	FALSE	2	102.9
P-66	8	1957	Unlined Cast Iron	FALSE	TRUE	0	85
P-660	6	1932	Unlined Cast Iron	FALSE	FALSE	2	102.4
P-661	10	1928	Unlined Cast Iron	FALSE	FALSE	0	99.8
P-662	10	1928	Unlined Cast Iron	FALSE	FALSE	0	99.7
P-663	6	1928	Unlined Cast Iron	FALSE	FALSE	0	101.5
P-664	6	1947	Unlined Cast Iron	FALSE	TRUE	0	78.4
P-665	6	1961	Cement Lined Cast Iron	FALSE	TRUE	0	91.8
P-666	6	1947	Unlined Cast Iron	TRUE	TRUE	0	91.8
P-667	6	1937	Unlined Cast Iron	FALSE	FALSE	0	97.5
P-668	8	1937	Unlined Cast Iron	FALSE	FALSE	0	91.5
P-669	8	1937	Unlined Cast Iron	FALSE	FALSE	0	95.8
P-67	8	1960	Cement Lined Cast Iron	FALSE	TRUE	0	78.5
P-670	8	1937	Unlined Cast Iron	FALSE	FALSE	0	97.5
P-671	8	1937	Unlined Cast Iron	FALSE	FALSE	0	97.1
P-672	8	1937	Unlined Cast Iron	FALSE	FALSE	0	95.8
P-674	8	1947	Unlined Cast Iron	FALSE	TRUE	0	95.8
P-675	8	1947	Unlined Cast Iron	FALSE	TRUE	0	95.8
P-677	8	1947	Unlined Cast Iron	FALSE	TRUE	0	95
P-678	6	1947	Unlined Cast Iron	FALSE	TRUE	0	95
P-679	8	1947	Unlined Cast Iron	FALSE	TRUE	0	97.1
P-680	8	1947	Unlined Cast Iron	FALSE	TRUE	0	96.7
P-681	6	1947	Unlined Cast Iron	FALSE	TRUE	0	96.7
P-683	8	1936	Unlined Cast Iron	FALSE	TRUE	0	93.1
P-684	8	1936	Unlined Cast Iron	FALSE	TRUE	0	93.1
P-685	8	1950	Unlined Cast Iron	FALSE	TRUE	0	62.4
P-686	8	1950	Unlined Cast Iron	FALSE	TRUE	0	71.5
P-687	6	1950	Unlined Cast Iron	FALSE	FALSE	0	71.5
P-688	8	1980	Ductile Iron	FALSE	FALSE	0	61.1
P-689	12	1972	Cement Lined Cast Iron	FALSE	FALSE	0	62.4
P-69	8	1957	Unlined Cast Iron	FALSE	TRUE	0	77.2
P-690	12	1972	Cement Lined Cast Iron	TRUE	FALSE	0	49.8
P-691	6	1980	Ductile Iron	FALSE	FALSE	0	59.8
P-692	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	79
P-693	6	1937	Unlined Cast Iron	FALSE	FALSE	2	97.6
P-694	8	1937	Unlined Cast Iron	FALSE	FALSE	2	92
P-695	8	1937	Unlined Cast Iron	FALSE	FALSE	2	89.8

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-697	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	44.4
P-698	6	1963	Cement Lined Cast Iron	FALSE	FALSE	0	50.4
P-699	8	1960	Cement Lined Cast Iron	TRUE	FALSE	0	57.3
P-7	12	1964	Cement Lined Cast Iron	FALSE	FALSE	0	97.7
P-70	8	1957	Unlined Cast Iron	FALSE	TRUE	0	76.4
P-700	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	44.8
P-701	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	46.1
P-702	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	44.8
P-703	6	1975	Cement Lined Cast Iron	FALSE	FALSE	0	35.3
P-704	6	1975	Cement Lined Cast Iron	FALSE	FALSE	0	44.8
P-706	6	1937	Unlined Cast Iron	FALSE	FALSE	0	82.5
P-707	6	1955	Asbestos Cement	FALSE	FALSE	0	79.5
P-709	6	1955	Asbestos Cement	FALSE	FALSE	0	83.4
P-710	6	1955	Asbestos Cement	FALSE	FALSE	0	79.9
P-711	6	1955	Asbestos Cement	FALSE	FALSE	0	76.9
P-712	6	1955	Asbestos Cement	FALSE	FALSE	0	83.8
P-714	12	1928	Unlined Cast Iron	FALSE	FALSE	0	65.4
P-715	8	1947	Unlined Cast Iron	FALSE	FALSE	0	65.4
P-716	8	1935	Unlined Cast Iron	FALSE	FALSE	0	61.5
P-717	6	1930	Unlined Cast Iron	FALSE	FALSE	0	59.6
P-718	6	1930	Unlined Cast Iron	FALSE	FALSE	0	59.2
P-719	6	1935	Unlined Cast Iron	FALSE	FALSE	0	62.6
P-72	8	1957	Unlined Cast Iron	FALSE	TRUE	0	76.4
P-722	4	1942	Unlined Cast Iron	TRUE	FALSE	0	79.6
P-723	4	1950	Unlined Cast Iron	FALSE	FALSE	0	73.2
P-724	4	1950	Unlined Cast Iron	FALSE	FALSE	0	67.9
P-725	4	1942	Unlined Cast Iron	FALSE	FALSE	0	77
P-726	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	84.8
P-727	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	85.2
P-728	8	1960	Cement Lined Cast Iron	FALSE	FALSE	0	87
P-729	6	1951	Unlined Cast Iron	FALSE	FALSE	0	75
P-73	8	1955	Unlined Cast Iron	FALSE	TRUE	0	106.7
P-730	8	1930	Unlined Cast Iron	FALSE	FALSE	0	98.4
P-731	8	1930	Unlined Cast Iron	FALSE	FALSE	0	96.7
P-732	8	1986	Ductile Iron	FALSE	FALSE	0	95.8
P-733	8	1948	Unlined Cast Iron	FALSE	TRUE	0	94.3
P-734	8	1948	Unlined Cast Iron	FALSE	TRUE	0	107.3
P-735	8	1948	Unlined Cast Iron	FALSE	TRUE	0	107.3
P-736	10	1950	Unlined Cast Iron	FALSE	FALSE	0	70
P-737	10	1950	Unlined Cast Iron	FALSE	FALSE	0	70.1
P-739	6	1952	Unlined Cast Iron	FALSE	FALSE	0	82.9
P-74	8	1936	Unlined Cast Iron	FALSE	TRUE	0	98.7
P-740	6	1952	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-741	6	1952	Unlined Cast Iron	FALSE	FALSE	0	87.2
P-742	8	1942	Unlined Cast Iron	FALSE	FALSE	0	85.3
P-743	8	1936	Unlined Cast Iron	FALSE	FALSE	0	79.1
P-744	6	1948	Unlined Cast Iron	FALSE	FALSE	0	75.5
P-745	8	1955	Unlined Cast Iron	FALSE	TRUE	0	106.7
P-746	8	1955	Unlined Cast Iron	FALSE	TRUE	0	106.7
P-747	8	1955	Unlined Cast Iron	FALSE	FALSE	0	106.7
P-748	8	1952	Unlined Cast Iron	FALSE	FALSE	0	96.3

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Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-749	8	1952	Unlined Cast Iron	FALSE	FALSE	0	96.3
P-750	6	1952	Unlined Cast Iron	FALSE	FALSE	0	96.3
P-751	8	1940	Unlined Cast Iron	FALSE	TRUE	0	76
P-752	8	1940	Unlined Cast Iron	FALSE	TRUE	0	78.6
P-753	4	1957	Unlined Cast Iron	FALSE	TRUE	0	78.6
P-754	8	1970	Ductile Iron	FALSE	FALSE	0	67.1
P-756	6	1970	Ductile Iron	FALSE	FALSE	0	52.4
P-757	8	1970	Ductile Iron	FALSE	FALSE	0	52.4
P-758	8	1970	Ductile Iron	FALSE	FALSE	0	48.1
P-759	6	1970	Cement Lined Cast Iron	FALSE	FALSE	0	48.1
P-76	6	1950	Unlined Cast Iron	TRUE	TRUE	0	83.1
P-760	8	1978	Cement Lined Cast Iron	FALSE	FALSE	0	49.4
P-761	8	1978	Cement Lined Cast Iron	FALSE	FALSE	0	26.9
P-762	6	1978	Cement Lined Cast Iron	FALSE	FALSE	0	26.9
P-764	6	1978	Cement Lined Cast Iron	FALSE	FALSE	0	26.9
P-765	6	1978	Cement Lined Cast Iron	FALSE	FALSE	0	26.9
P-766	6	1978	Cement Lined Cast Iron	FALSE	FALSE	0	26.9
P-767	6	1978	Cement Lined Cast Iron	FALSE	FALSE	0	26.9
P-770	6	1988	Ductile Iron	FALSE	FALSE	0	38.3
P-771	6	1988	Ductile Iron	FALSE	FALSE	0	40
P-772	6	1988	Ductile Iron	FALSE	FALSE	0	40
P-773	10	1969	Cement Lined Cast Iron	FALSE	FALSE	2	38.3
P-774	10	1956	Unlined Cast Iron	FALSE	FALSE	0	44.4
P-775	6	1975	Cement Lined Cast Iron	FALSE	FALSE	0	44.4
P-776	10	1969	Cement Lined Cast Iron	FALSE	FALSE	0	56.9
P-778	6	1980	Ductile Iron	FALSE	FALSE	0	40
P-779	10	1969	Cement Lined Cast Iron	FALSE	FALSE	2	40
P-78	6	1980	Ductile Iron	FALSE	TRUE	0	79.1
P-780	10	1969	Cement Lined Cast Iron	FALSE	FALSE	0	35.7
P-781	8	1979	Ductile Iron	FALSE	FALSE	2	35.7
P-782	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	78.6
P-783	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	76.5
P-784	8	1962	Cement Lined Cast Iron	FALSE	FALSE	0	76.5
P-787	8	1995	Ductile Iron	FALSE	FALSE	0	89.4
P-788	10	1966	Cement Lined Cast Iron	FALSE	FALSE	0	80.6
P-789	10	1966	Cement Lined Cast Iron	FALSE	FALSE	2	97.4
P-79	8	1950	Unlined Cast Iron	FALSE	TRUE	0	89.5
P-790	6	1966	Cement Lined Cast Iron	FALSE	FALSE	0	97.4
P-791	6	1948	Unlined Cast Iron	FALSE	FALSE	0	75.5
P-792	6	1948	Unlined Cast Iron	FALSE	FALSE	0	75.5
P-793	6	1948	Unlined Cast Iron	FALSE	FALSE	0	75.5
P-794	12	1996	Ductile Iron	FALSE	TRUE	0	86.3
P-795	12	1996	Ductile Iron	FALSE	TRUE	0	88
P-796	8	1996	Ductile Iron	FALSE	TRUE	0	88
P-797	8	1936	Unlined Cast Iron	FALSE	TRUE	0	82.8
P-798	8	1936	Unlined Cast Iron	FALSE	TRUE	0	82.4
P-799	8	1936	Unlined Cast Iron	FALSE	TRUE	0	82.4
P-80	8	1936	Unlined Cast Iron	FALSE	TRUE	0	99.4
P-800	6	1952	Unlined Cast Iron	FALSE	FALSE	0	69.7
P-801	6	1952	Unlined Cast Iron	FALSE	TRUE	0	69.7
P-802	8	1952	Unlined Cast Iron	FALSE	FALSE	0	69.7

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Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-803	10	1928	Unlined Cast Iron	FALSE	FALSE	0	79
P-806	8	1980	Ductile Iron	FALSE	FALSE	0	95.4
P-808	8	1980	Ductile Iron	FALSE	FALSE	0	86.8
P-809	8	1980	Ductile Iron	FALSE	FALSE	0	86.8
P-81	8	1936	Unlined Cast Iron	FALSE	TRUE	0	99.4
P-810	8	2000	Ductile Iron	FALSE	FALSE	0	99.3
P-811	8	1931	Unlined Cast Iron	FALSE	FALSE	0	73.6
P-812	8	1931	Unlined Cast Iron	FALSE	FALSE	0	73.6
P-813	6	1930	Unlined Cast Iron	FALSE	FALSE	0	74.2
P-814	6	1930	Unlined Cast Iron	FALSE	FALSE	0	57.1
P-815	8	1930	Unlined Cast Iron	FALSE	FALSE	0	57.1
P-816	8	1963	Cement Lined Cast Iron	FALSE	FALSE	0	70.1
P-817	8	1963	Cement Lined Cast Iron	FALSE	FALSE	0	70.1
P-819	8	1950	Unlined Cast Iron	FALSE	FALSE	2	74
P-82	8	1980	Ductile Iron	FALSE	TRUE	0	87.8
P-820	8	1950	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-821	8	1950	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-822	8	1930	Unlined Cast Iron	TRUE	FALSE	1	73.8
P-823	8	1930	Unlined Cast Iron	TRUE	FALSE	0	76.9
P-824	6	1937	Unlined Cast Iron	FALSE	FALSE	0	73.8
P-825	6	1937	Unlined Cast Iron	FALSE	FALSE	0	73.8
P-826	8	1952	Unlined Cast Iron	FALSE	FALSE	2	76.9
P-827	8	1952	Unlined Cast Iron	FALSE	FALSE	2	76.9
P-828	8	1952	Unlined Cast Iron	FALSE	FALSE	2	76.9
P-829	8	1930	Unlined Cast Iron	FALSE	FALSE	0	67.7
P-83	8	1960	Cement Lined Cast Iron	FALSE	TRUE	0	89.5
P-830	8	1930	Unlined Cast Iron	FALSE	FALSE	0	75.1
P-831	10	1928	Unlined Cast Iron	FALSE	FALSE	0	73.8
P-832	10	1928	Unlined Cast Iron	FALSE	FALSE	0	82.5
P-833	8	1930	Unlined Cast Iron	FALSE	FALSE	0	75.1
P-834	6	1933	Unlined Cast Iron	FALSE	FALSE	0	102.4
P-835	8	1980	Ductile Iron	FALSE	FALSE	0	87.8
P-836	8	1936	Unlined Cast Iron	FALSE	FALSE	0	77.5
P-837	8	1936	Unlined Cast Iron	TRUE	FALSE	0	78.6
P-838	8	1936	Unlined Cast Iron	TRUE	FALSE	0	78.6
P-839	4	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-840	4	1878	Unlined Cast Iron	FALSE	FALSE	0	80.5
P-841	4	1878	Unlined Cast Iron	FALSE	FALSE	0	82.7
P-842	4	1878	Unlined Cast Iron	FALSE	FALSE	0	82.6
P-843	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	82.7
P-844	6	1960	Cement Lined Cast Iron	FALSE	FALSE	0	83.5
P-845	4	1878	Unlined Cast Iron	FALSE	FALSE	0	82.7
P-846	8	1950	Unlined Cast Iron	FALSE	FALSE	0	86.1
P-847	8	1950	Unlined Cast Iron	FALSE	FALSE	0	82.7
P-848	8	1950	Unlined Cast Iron	FALSE	FALSE	0	82.7
P-849	8	1950	Unlined Cast Iron	FALSE	FALSE	0	78.4
P-850	8	1950	Unlined Cast Iron	FALSE	FALSE	0	74.1
P-851	8	1995	Ductile Iron	FALSE	FALSE	0	76.5
P-852	8	1962	Cement Lined Cast Iron	TRUE	FALSE	0	78.6
P-853	8	1962	Cement Lined Cast Iron	TRUE	FALSE	0	99.8
P-854	8	1995	Ductile Iron	FALSE	FALSE	0	76.5

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-855	8	1995	Ductile Iron	FALSE	FALSE	0	89.4
P-856	8	1950	Unlined Cast Iron	FALSE	FALSE	2	83.1
P-857	12	1950	Unlined Cast Iron	FALSE	TRUE	0	83.8
P-858	6	1950	Unlined Cast Iron	FALSE	FALSE	0	83.8
P-860	6	1995	Ductile Iron	FALSE	TRUE	2	88.9
P-861	6	1995	Ductile Iron	FALSE	TRUE	0	96.1
P-862	4	1995	Ductile Iron	FALSE	TRUE	0	96.1
P-863	8	1960	Cement Lined Cast Iron	TRUE	FALSE	0	48.3
P-864	8	1960	Cement Lined Cast Iron	TRUE	FALSE	0	41.4
P-87	8	1936	Unlined Cast Iron	FALSE	TRUE	0	89.5
P-872	8	1960	Cement Lined Cast Iron	FALSE	FALSE	1	41.4
P-873	6	1939	Unlined Cast Iron	FALSE	FALSE	0	75.4
P-874	6	1951	Unlined Cast Iron	FALSE	FALSE	0	82
P-875	6	1951	Unlined Cast Iron	FALSE	FALSE	0	82
P-876	10	1950	Unlined Cast Iron	FALSE	FALSE	0	74.1
P-877	10	1950	Unlined Cast Iron	FALSE	FALSE	0	76.9
P-878	6	1950	Unlined Cast Iron	FALSE	FALSE	0	77
P-879	6	1950	Unlined Cast Iron	FALSE	FALSE	0	78.3
P-880	8	1929	Unlined Cast Iron	FALSE	FALSE	0	76.9
P-881	4	1929	Unlined Cast Iron	FALSE	FALSE	0	74.9
P-882	4	1929	Unlined Cast Iron	FALSE	FALSE	0	78.3
P-883	6	1953	Unlined Cast Iron	FALSE	FALSE	0	95.9
P-885	6	1953	Unlined Cast Iron	FALSE	FALSE	0	88.4
P-886	6	1953	Unlined Cast Iron	FALSE	FALSE	0	86.7
P-887	8	1953	Unlined Cast Iron	FALSE	FALSE	0	88.4
P-888	8	1953	Unlined Cast Iron	FALSE	FALSE	0	86.7
P-889	8	1950	Unlined Cast Iron	FALSE	FALSE	0	44.4
P-89	6	1964	Cement Lined Cast Iron	FALSE	TRUE	1	95.4
P-890	6	1950	Unlined Cast Iron	TRUE	FALSE	0	24.6
P-892	8	1950	Unlined Cast Iron	FALSE	FALSE	0	24.6
P-893	6	1950	Unlined Cast Iron	FALSE	FALSE	0	2.3
P-894	6	1950	Unlined Cast Iron	FALSE	FALSE	0	48.3
P-895	6	1950	Unlined Cast Iron	FALSE	FALSE	0	44.7
P-90	8	1955	Unlined Cast Iron	FALSE	TRUE	0	81.5
P-902	6	1950	Unlined Cast Iron	FALSE	FALSE	0	44.7
P-904	6	1950	Unlined Cast Iron	FALSE	FALSE	0	60.4
P-905	6	1950	Unlined Cast Iron	FALSE	FALSE	0	60.4
P-906	6	1930	Unlined Cast Iron	FALSE	FALSE	0	72.5
P-907	6	1930	Unlined Cast Iron	FALSE	FALSE	0	72.9
P-908	6	2004	Ductile Iron	FALSE	FALSE	0	72.9
P-909	6	1936	Unlined Cast Iron	FALSE	FALSE	0	88.5
P-91	8	1957	Unlined Cast Iron	FALSE	TRUE	0	98.4
P-910	6	1936	Unlined Cast Iron	FALSE	FALSE	0	86.1
P-911	6	2003	Ductile Iron	FALSE	FALSE	0	86.1
P-912	6	1962	Cement Lined Cast Iron	FALSE	FALSE	0	76.5
P-913	6	1962	Cement Lined Cast Iron	FALSE	FALSE	0	76.5
P-914	8	2003	Ductile Iron	FALSE	FALSE	0	76.5
P-918	8	2002	Ductile Iron	FALSE	FALSE	0	91.5
P-919	6	2003	Ductile Iron	FALSE	TRUE	0	98.8
P-92	12	2001	Ductile Iron	FALSE	TRUE	0	98.4
P-921	6	1928	Unlined Cast Iron	FALSE	FALSE	0	57.5

Label	Diameter (in)	Installation Year	Material	Break History	Water Quality	Corrosive Soil	Pressure (psi)
P-921	6	1930	Unlined Cast Iron	FALSE	FALSE	0	46.7
P-922	6	1928	Unlined Cast Iron	FALSE	FALSE	0	67.9
P-923	6	1930	Unlined Cast Iron	FALSE	FALSE	0	79.4
P-925	6	1930	Unlined Cast Iron	FALSE	FALSE	0	81.3
P-926	6	2003	Ductile Iron	FALSE	FALSE	0	97.3
P-927	6	2003	Ductile Iron	FALSE	FALSE	0	97.3
P-93	8	1960	Cement Lined Cast Iron	FALSE	TRUE	0	82.7
P-936	6	2003	Ductile Iron	FALSE	FALSE	0	45.5
P-94	6	1936	Unlined Cast Iron	FALSE	TRUE	0	98
P-940	6	2003	Ductile Iron	FALSE	FALSE	0	44
P-941	6	2003	Ductile Iron	FALSE	FALSE	0	44
P-943	6	2003	Ductile Iron	FALSE	FALSE	0	35
P-944	6	2003	Ductile Iron	FALSE	FALSE	0	35
P-946	6	2003	Ductile Iron	FALSE	FALSE	0	37.2
P-947	6	2003	Ductile Iron	FALSE	FALSE	0	51
P-948	6	2003	Ductile Iron	FALSE	FALSE	0	46.7
P-95	12	1936	Unlined Cast Iron	FALSE	TRUE	0	82.8
P-950	6	2003	Ductile Iron	FALSE	FALSE	0	51
P-957	8	1995	Ductile Iron	FALSE	FALSE	0	76.5
P-958	6	2003	Ductile Iron	FALSE	FALSE	0	53.6
P-959	6	2003	Ductile Iron	FALSE	FALSE	0	52.3
P-960	6	1961	Cement Lined Cast Iron	FALSE	FALSE	2	45.5
P-960	6	1950	Unlined Cast Iron	FALSE	FALSE	0	69.5
P-961	6	1961	Cement Lined Cast Iron	FALSE	FALSE	2	52.5
P-962	6	1963	Cement Lined Cast Iron	FALSE	FALSE	0	71.7
P-963	6	1950	Unlined Cast Iron	FALSE	FALSE	0	69.5
P-964	6	1950	Unlined Cast Iron	FALSE	FALSE	0	69.5
P-965	6	1965	Cement Lined Cast Iron	FALSE	FALSE	0	35.8
P-967	6	2003	Ductile Iron	FALSE	FALSE	0	52
P-967	6	1995	Ductile Iron	FALSE	FALSE	0	60.5
P-968	6	2003	Ductile Iron	FALSE	FALSE	0	52.5
P-969	6	2003	Ductile Iron	FALSE	FALSE	0	56.5
P-97	6	1936	Unlined Cast Iron	FALSE	TRUE	0	82.9
P-970	8	1957	Ductile Iron	FALSE	FALSE	0	36
P-971	6	2003	Ductile Iron	FALSE	FALSE	0	54.2
P-971	8	1957	Ductile Iron	FALSE	FALSE	0	36
P-972	6	2003	Ductile Iron	FALSE	FALSE	0	56.5
P-973	6	2003	Ductile Iron	FALSE	FALSE	0	54.2
P-974	6	2003	Ductile Iron	FALSE	FALSE	0	65.6
P-979	12	1930	Unlined Cast Iron	FALSE	FALSE	0	100.9
P-98	10	1932	Unlined Cast Iron	FALSE	FALSE	0	92.2
P-980	12	1930	Unlined Cast Iron	FALSE	FALSE	0	88.2
P-981	8	2000	Ductile Iron	FALSE	FALSE	0	88.2
P-982	6	1930	Unlined Cast Iron	FALSE	FALSE	0	61.1
P-983	6	1930	Unlined Cast Iron	FALSE	FALSE	0	50.3
P-984	6	1990	Ductile Iron	FALSE	FALSE	0	50.3
P-985	6	2003	Ductile Iron	FALSE	FALSE	0	97.3
P-986	12	2004	Ductile Iron	FALSE	FALSE	0	93.3
P-988	12	2004	Ductile Iron	FALSE	FALSE	0	88.7

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