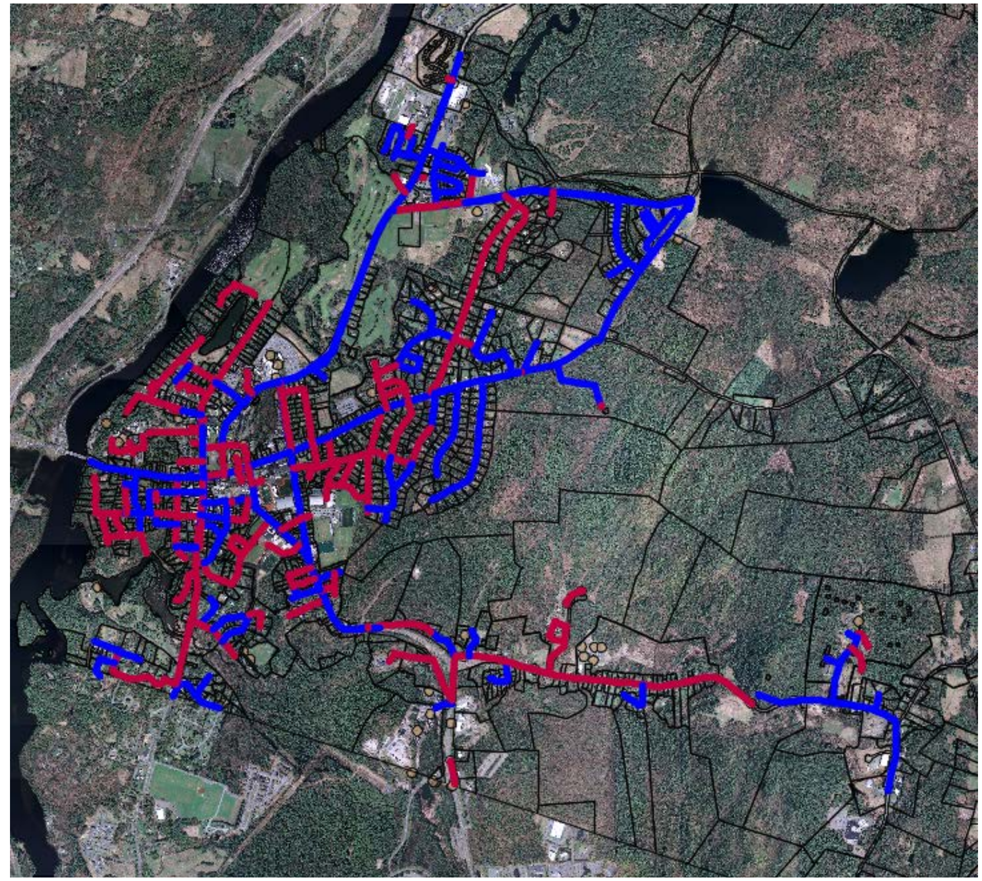
TOWN of HANOVER

HANOVER, NEW HAMPSHIRE 03755
P.O. BOX 483 603/643-4123

HANOVER WATER SYSTEM CAPITAL REPLACEMENT PLAN

2023



Red poor condition, blue good condition

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Introduction

After many years of poor water quality, declining fire protection and main failures Hanover Water Works Company invested in two substantial projects to improve the system. The first project (2001) addressed post treatment storage, fire flow and transmission main improvements on Park, College, Wheelock, Lebanon, Prospect, Maple, West and Allen Streets. The second project (2006) was aimed at the treatment of water quality entering the system and included a water treatment facility and additional post treatment storage. Both projects used NH DES State Revolving Fund (DWSRF) Loans and have/had a term of 20 years each. While these projects addressed fire protection in the main trunk lines and the water quality entering the system, mains in neighborhoods were not addressed. Neighborhood sections make up a majority of water quality complaints and system failures.

Background

The Hanover water transmission and distribution system is made up of four different types of pipes; Cast Iron (CI), Asbestos Cement (AC), copper (CU), one section of Galvanized (Galv) and Ductile Iron (DI). Cast Iron pipes make up the majority of the system. Asbestos Cement is limited to the transmission main between reservoirs three and two and Copper and Galvanized are limited to a few short sections of 1" and 2" pipe. The remaining pipe is Ductile Iron. Water services (not included in the totals) are generally copper, some brass, polyethylene and short sections of lead (goose necks).

Pipe Type	**symbol**	**length**	**percent**
Asbestos Cement	AC	9,000	4.6%
Cast Iron	CI	130,736	66.4%
Copper	CU	1,022	0.5%
Ductile Iron	DI	55,979	28.4%
Galvanized Iron	GALV	99	0.1%
Total		196,836	

Approximately 44% of the pipe in the system is over 70 years old cast iron. Pipe manufactured prior to WWII was pit cast iron, after WWII was spin cast iron and after the early 1970's all pipes that were installed are ductile iron.

Period Installed	Feet	percent	Age
prior to 1922	31,706	17%	100+
Prior to 1945	61.549	33%	77+
Prior to 1952	82,926	44%	70
after 1952	104,910	54%	<70

Cast iron water mains have been in continuous service throughout the country for more than 100 years. Ductile iron, which is used in newer installations, contains alloys of several metals, which tends to reduce brittleness of the pipe. Both materials are typically lined to protect the metal from the water. Linings are typically cement mortar and/or bituminous seal coat.

The longevity of pipes is roughly comparable to the people they serve. The general rule of thumb for the life expectancy of water system pipes is approximately 70 years before corrosion creates the need for replacement or rehabilitation. However, under the right flow, pressure, water quality and soil conditions water mains can last hundreds of years. There are cases of cast iron pipe that has been in continual service since the 1600's. The oldest cast iron pipe in the United States is in Allentown Pennsylvania and was installed in 1816. While much of Hanover's pipes are much newer the larger transmission mains (20,155') date back to the beginning of the water system in 1893. Many of these large transmission mains (>10") have very little corrosion or history of failures, although some sections have been cleaned and lined to extend their life and improve hydraulic capacities.

Prioritization

In the 2016 capital replacement plan, the town chose to prioritize pipe replacements by analyzing sections to determine impacts on loss of service, maintenance costs and water quality. In general, the main trunk lines are in excellent shape requiring only routine maintenance (flushing, exercising valves). The majority of water quality and failure issues are in areas of low flow, i.e. neighborhoods. The assessment is broken into two categories, hydraulic and structural. Hydraulic assessment measured the interior conditions while the structural method measured both internal and external pipe conditions. In 2021, a new prioritization element rose to the top with the new requirements set by the Federal government on communities to eliminate all lead lines, and components in the distribution system from the source to the house. The guidelines are still being laid out as how to address this and the timelines in which they need to be completed, with a plan to eliminate lead is required to be completed by November of 2024. Hanover does not have any record of lead services line. However, there are numerous services which have goose necks (flexible connection between mains and customers services) which are known to be lead when the service line is brass. The town is fortunate to be ahead of one of the toughest components from the mandate as it has already identified the locations of where the lead is in the system but again is still awaiting guidance on the complete requirements of the plan. One requirement which may be difficult to complete is when any lead is found in a service line the entire service must be replaced to the house including the customers portion in private property.

Hydraulic Assessment

During semi-annual flushing, flows and pressure drops were measured to determine pipe hydraulic capacities which are indications of the smoothness and deposits in pipe interiors. As a pipe ages, corrosion and deposition occur forming nodules of iron and manganese which restrict the flow of water. Under higher flow conditions, such as during flushing and in the main lines, these deposits as less able to occur. Prior to 2006 the water supply was unfiltered and iron removal was not addressed. Since 2006 the water stability has been managed including, microfiltration, coating of the interior of pipes with poly-orthophosphate, and alkalinity adjustment using Sodium Bicarbonate (baking soda).

Corrosion causes gradual decay and deterioration of pipes, both internally and externally. It can reduce the life of a pipe by eating away at the wall thickness. Under certain conditions, decay can cause the pipe to fail in as short as five years. Corrosion can also result in encrustation inside the pipe, reducing the carrying capacity of the pipe to a point that little or no flow is possible.

Because of its flexibility and durability, lead was once used in the construction of service lines (this was not the case in Hanover) and interior plumbing. Its longevity is due to its low corrosion rate and its resistance to encrustation. Hanover Water Works once used lead service "goose necks" at the connection to the water main itself. This practice appears to have been limited to a few streets. We believe we still have approximately 100 lead gooseneck services in this system. Lead goose necks are not the greatest potential source of lead in the Hanover system. Prior to 1986 lead was used in solder, and as late as 2011 in the casting of brass fittings in particular premium faucets and even in water meters. Fortunately, the use of stabilizing additives (poly-orthophosphate and sodium bicarbonate) prevents the leaching of metals including lead, copper and iron. The lack of stabilizing chemicals is the main contributor to the high lead leaching into the drinking water of the Flint Michigan system. Additionally, many of the older pipes (installed prior to 1950) used oakum and lead to seal joints. The oakum sealed the flow of water and lead was used to keep the oakum in place. These joints are still in place in many of the older lines. Fortunately lead is not in contact with the water and will not have to be removed.

Structural Assessment

Structural conditions of mains are affected by internal and external factors. Internal corrosion is directly related to water quality. Prior to 2006 the water was not filtered and received disinfection and fluoridation only. External corrosion is related to soil conditions. Much of Hanover soils are lacustrine (lake deposits) in nature, relatively tight, acidic, with little groundwater movement in the surface layers. Pipe bedding is required for all pipe systems to ensure adequate support and to limit pipe movement. Many of the failures of pipes installed after 1952 have been due to improper bedding and improper compaction during installation.

External Corrosion

The best indication that the outside of a pipe will corrode is soil resistivity, which can be measured with the four-point meter (measures the average resistivity of soil at the pipeline). If soils resistivity is greater than 5,000 ohms/cm (measure of electrical resistance per centimeter), serious corrosion is unlikely, and ductile iron or steel pipe could be used. If resistivity is less than 500 ohms/cm, the potential for corrosion is greater. In these cases, non-metallic pipe such as asbestos cement, HDPE, or PVC piping should be used. Most of Hanover's soils are between 500 – 5,000 ohms/cm with the exception of one area near the intersection of South Main Street and Brook Road and a section of Great Hollow Road. Corrosion in these may be due to the proximity of the electrical substation for the pipe on South Main Street and the proximity of mucky peat deposits adjacent to Great Hollow Road. Other areas where stray electrical current has been observed to affect pipes are the interconnection of water services and mains where electrical services, which are required to be grounded to water services by NEC code have a short. By and large external corrosion is not an issue in Hanover, except for the areas mentioned.

Internal Corrosion

By reviewing historical reports of breaks/failures it is possible to determine the likelihood of future failures. The majorities of failures (91.4%) are cast iron and galvanized pipes installed prior to 1980. There are only 3 ductile iron pipe sections that have failed. Two failures were caused by improper fitting connections, and the third section is Low Road (WL0249) which has the highest failure rate of any pipe in the system, with 11 since 2003. The cause of these failures is the absence of proper bedding (see below).

ID	Location	Date of Break
WL0249	Low Rd	9/19/2003
WL0249	Low Rd	10/14/2003
WL0249	Low Rd	2/6/2004
WL0249	Low Rd	10/28/2004
WL0249	Low Rd	2/21/2007
WL0249	Low Rd	5/29/2008
WL0249	Low Rd	7/13/2008
WL0249	Low Rd	10/7/2009

WL0249	Low Rd	1/23/2013
WL0249	Low Rd	1/27/2015
Wl0249	Low Rd	1/19/2023

The largest internal corrosion factor is how long the pipe has been exposed to water, i.e. pipe age. In particular pipes installed between 1907 and 1966 account for 84% of all pipe failures. The second factor is detention time of the water within a section of pipe. A majority of these pipes are in neighborhood areas where pipe velocities are below 0.003 feet per second (fps). A typical neighborhood street takes up to 2 days to replace the water (turn over) within that section of pipe, while main lines average velocities between 1 – 2 fps and turn over every few minutes.

Breaks by age of pipe

Pipe Installed	Length	Percent of System	number	Age over	Roughness
prior to 1906	2,190	5%	10	116+	77
1907 - 1946	12,333	27%	26	76 - 115	69
1947 - 1966	25,929	57%	40	56 -75	91
after 1966	4,853	11%	14	<55	135

Roughness of the interior of a pipe due to deposits is used to detemrine a pipe’s carring capacity. Roughness Factors or “Hazen Wiliam - C” vary from a high of 140 in some new pipes to 0 for a fully obstructed pipe. A “C” factor of less than 100 is a measure of poor hydraulics and provides lower fire flow capacity.   As shown below, approximately 1/3 of the water system's pipe falls into this category. Additionally, as the "C" factor decreases the water quality deteroiates as well as deposits continue to interact with water as it flows thru a pipe section.

Corrosion Roughness factor	**Feet**	**Percentage**
0-60	51,620	26.3%
60-80	8,545	4.4%
80-100	2,440	1.2%
100-110	66,330	33.8%
>110	67,300	34.3%

Replacement strategy

There are approximately 100 services in the distribution system that are believed to still be connected to the main distribution system by a lead gooseneck. There are also a number of services on private property that are brass that contain lead. As mentioned previously these are limited to a few of the streets, Rope Ferry, the Maple Street Neighborhood, North Balch, Parkway, Hovey, Buell, Brockway, Woodrow, South Main, School Street, Summer Street, Occom Ridge and Webster. Most of the gooseneck services reside on streets that were also ranked highest for replacement due to the hydraulic and structural assessment. These streets are on the top of the priority list for replacement due to the known federal mandate. There were 328 distinct pipe sections which were analyzed based on historical failures and hydraulic conditions. These sections have experienced failures and are ranked as the highest priority for replacement, followed by how critical a section of main is, i.e. the effect of failure, poor hydraulics and pipe age. There are 7 categories which are broken down by the recommended period of replacement.

Priority	replacement period (yrs)	
1	0	10
2	10	20
3	20	30
4	30	40
5	40	50
6	50+	
7	rehabilitate or don’t replace	

Also included in the replacement strategy are shorter sections, generally less than 500’ in length, which can be replaced internally by staff. The cost of staff replacement of pipe is $150-250 per linear foot (LF) of pipe ($75,000 - $125,000). The current budget provides $85,000 to allow for shorter sections to be replaced. Limiting factors are staff availability and equipment needed to replace some sections. Services where only one service may still be a lead gooseneck will also fall under this category, where the service line will be replaced from the main to the curb-stop by staff while contractors will be hired to complete service line replacements to the house. This is estimated at $10,000/service. To give an example of one of the recent in-house replacement projects is South Balch Street in which the main (500’) was replaced by town staff for a cost of $56,500. The pipe section was relatively easy to complete, did not require temporary water and was completed in conjunction with the highway department rebuilding the street so there were no repaving costs which can add $50/LF. The variation in cost is due to the amount of pavement that is affected, location (traffic impacts), ledge, number of services and if temporary water is necessary.

Contracted replacement of pipe is estimated at approximately $500/LF with the difference with internal replacement due to labor, equipment, bonding and insurance costs which are covered in our overhead. Contracted replacement has the benefit of larger equipment, more staff and more experience and the economy of scale. The material and contracted services are currently very volatile with costs nearly doubling in the last 4 years.

Funding Options

Currently the Water fund has one outstanding loan DWSRF#2 totaling $6,500,000 with an annual payment amount of $455,938, that will be paid off in FY27. The town recently paid off the DWSRF#1 loan of $4,000,000 in FY22, which had annual interest and principal payment of $304,707. The bonding capacity of the annual payment has been maintained in the operating budget.

Assuming a 20-year term and 2.56% interest (from recent NHDES project application) the replacement priorities 1, proposed projects 1-6, can be accomplished when the current loans mature with little rate impacts as follows:

Priority	year	Cost	Annual Cost	Notes
1	2024	$ 7,800,000	($354,000)	Includes Grant
2	2026	$ 6,000,000	($408,500)	
3	2042	$ 5,500,000		
4	2046	$ 5,300,000		

Additionally, in-house replacement can continue in smaller sections on an annual basis but may need additional funds to complete more complicated sections. There are also some sections of the system (Hemlock and Ledge Roads) which are near the upper hydraulic grade line of the system and would need a booster station, substantial main extension (and easements) or should be removed from the system. See Appendix B for details.

Federal funding will be available and distributed through the state by the Drinking Water State Revolving Fund, but it is unknown the amount of forgiveness that will be granted to the community from year to year. With the lead/copper ruling and grant funding it appears that funding will be based on the community's water rate vs. average income and the lead/copper grants will be applied to the service lines only. For the first round of the priority-one projects, NHDES has granted 30% forgiveness on $3.68 Million dollars of the applied loan funds and has given Hanover a $920,000 American Rescue Plan Act (ARPA) Grant as part of the package. They have also committed to grant 49% forgiveness on $1,200,000.00 of lead service lines as it relates to the proposed project.

Water Main Replacement Priorities - Appendix C

	Year Installed	Material	Diameter, in	Hanover ID	Lined	Roughness	length,ft	Estimated Cost	Lead	Project
Replacement Priority	1									
DOWNING RD	1924	CI	6	WL1275	N	60	343	$171,500	True	1
DOWNING RD	1974	CI	6	WL1257	N	60	424	$211,750	True	1
MAPLE ST	1930	CI	6	WL1283	N	60	645	$322,600	True	1
READ RD	1948	CI	6	WL1060	N	60	500	$250,200	False	1
RIVER RIDGE RD	1939	GALV	2	WL1047		80	99	$49,400	False	1
RIVER RIDGE RD	1931	CI	4	WL1046	N	60	539	$269,650	True	1
SARGENT ST	1914	CI	6	WL1483	N	60	78	$38,950	True	1
SARGENT ST	1914	CI	6	WL1484	N	60	547	$273,600	True	1
WEATHERBY RD	1939	CI	6	WL1053	N	60	321	$160,350	True	1
WEATHERBY RD	1940	CI	4	WL1123	N	60	391	$195,600	False	1
		Project Total		**$1,943,600**		Running Total		**$1,943,600**		
OCCOM RIDGE R	1913	CI	6	WL0826	N	41	600	$299,900	True	2
ROPE FERRY RD	1906	CI	6	WL0981	N	41	655	$327,500	True	2
ROPE FERRY RD	1906	CI	6	WL0877	N	41	1,151	$575,500	True	2
		Project Total		**$1,202,900**		Running Total		**$3,146,500**		
N BALCH ST	1914	CI	6	WL0565	N	60	769	$384,500	True	3
PARKWAY	1914	CI	6	WL0564	N	60	867	$433,500	True	3
		Project Total		**$818,000**		Running Total		**$3,964,500**		
BUELL ST	1936	CI	6	WL1005	N	60	808	$403,950	True	4

	Year Installed	Material	Diameter, in	Hanover ID	Lined	Roughness	length,ft	Estimated Cost	Lead	Project
HOVEY LN	1939	CI	6	WL1004	N	60	211	$105,700	True	4
HOVEY LN	1953	CI	6	WL1035	N	60	229	$114,250	False	4
HOVEY LN	1939	CI	6	WL1003	N	60	470	$234,750	False	4
HOVEY LN	1945	CI	6	WL1037	N	60	730	$365,000	True	4
		Project Total		**$1,223,650**		Running Total		**$5,188,150**		
BROCKWAY RD	1929	CI	6	WL2852	N	60	499	$249,250	True	5
WOODROW RD	1929	CI	6	WL2851	N	60	246	$122,850	True	5
		Project Total		**$372,100**		Running Total		**$5,560,250**		
BROOK RD	1950	CI	8	WL0317	N	60	501	$250,500	False	6
S MAIN ST	1932	CI	6	WL0306	N	60	167	$83,350	False	6
S MAIN ST	1893	CI	6	WL0707	N	60	224	$112,000	True	6
S MAIN ST	1932	CI	6	WL0307	N	60	348	$173,850	False	6
S MAIN ST	1933	CI	4	WL0715	N	60	556	$277,900	True	6
S MAIN ST	1932	CI	6	WL4526	N	60	966	$483,070	False	6
S MAIN ST	1932	CI	6	WL0706	N	60	1,681	$840,500	True	6
		Project Total		**$2,221,170**		Running Total		**$7,781,420**		
RIP RD	1956	CI	6	WL0144	N	60	807	$403,500	False	7
RIP RD	1955	CI	8	WL0127	N	60	1,082	$541,100	False	7
		Project Total		**$944,600**		Running Total		**$8,726,020**		
SCHOOL ST	1893	CI	6	WL0724	N	60	212	$106,100	True	8
SCHOOL ST	1893	CI	6	WL1307	N	60	488	$244,050	True	8
SCHOOL ST	1893	CI	6	WL0723	N	60	490	$244,950	True	8

	Year Installed	Material	Diameter, in	Hanover ID	Lined	Roughness	length,ft	Estimated Cost	Lead	Project
		Project Total		**$595,100**		Running Total		**$9,321,120**		
WEBSTER AVE	1898	CI	8	WL0770	N	60	173	$86,350	True	9
WEBSTER AVE	1898	CI	8	WL3250	N	120	418	$208,900	True	9
WEBSTER AVE	1898	CI	8	WL0907	N	60	546	$272,800	True	9
		Project Total		**$568,050**		Running Total		**$9,889,170**		
OCCOM RIDGE R	1899	CI	6	WL0923	N	41	420	$210,200	True	10
OCCOM RIDGE R	1899	CI	6	WL0836	N	41	657	$328,350	True	10
		Project Total		**$538,550**		Running Total		**$10,427,720**		
GREENSBORO RD	1949	CI	8	WL3088	Y	70	1,066	$532,950	False	11
GREENSBORO RD	1949	CI	8	WL2863	Y	70	3,611	$1,805,500	False	11
HEMLOCK RD	1948	CI	6	WL2586	N	60	1,630	$814,950	False	11
LEBANON ST	1893	CI	6	WL1326	N	100	388	$193,850	False	11
LOW RD	1974	DI	8	WL0249	Y	140	2,125	$1,062,500	False	11
		Project Total		**$4,409,750**		Running Total		**$14,837,470**		

Average Age 89 Number of Pipe Sections 44 Avg. Roughness 63 Length 29,675

Replacement Priority 1 Estimated replacement Cost $14,837,470

	Year Installed	Material	Diameter, in	Hanover ID	Lined	Roughness	length,ft	Estimated Cost	Lead	Project
Replacement Priority 2										
OCCUM RIDGE	1913	CI	6	WL3679	N	40	423	$211,500	True	2
OCCUM RIDGE RD	1913	CI	6	WL3676	N	40	54	$27,000	True	2
OCCUM RIDGE RD	1913	CI	6	WL3680	N	40	788	$394,000	False	2

Project Total **$632,500** Running Total **$632,500**

Average Age 103 Number of Pipe Sections 3 Avg. Roughness 40 Length 1,265

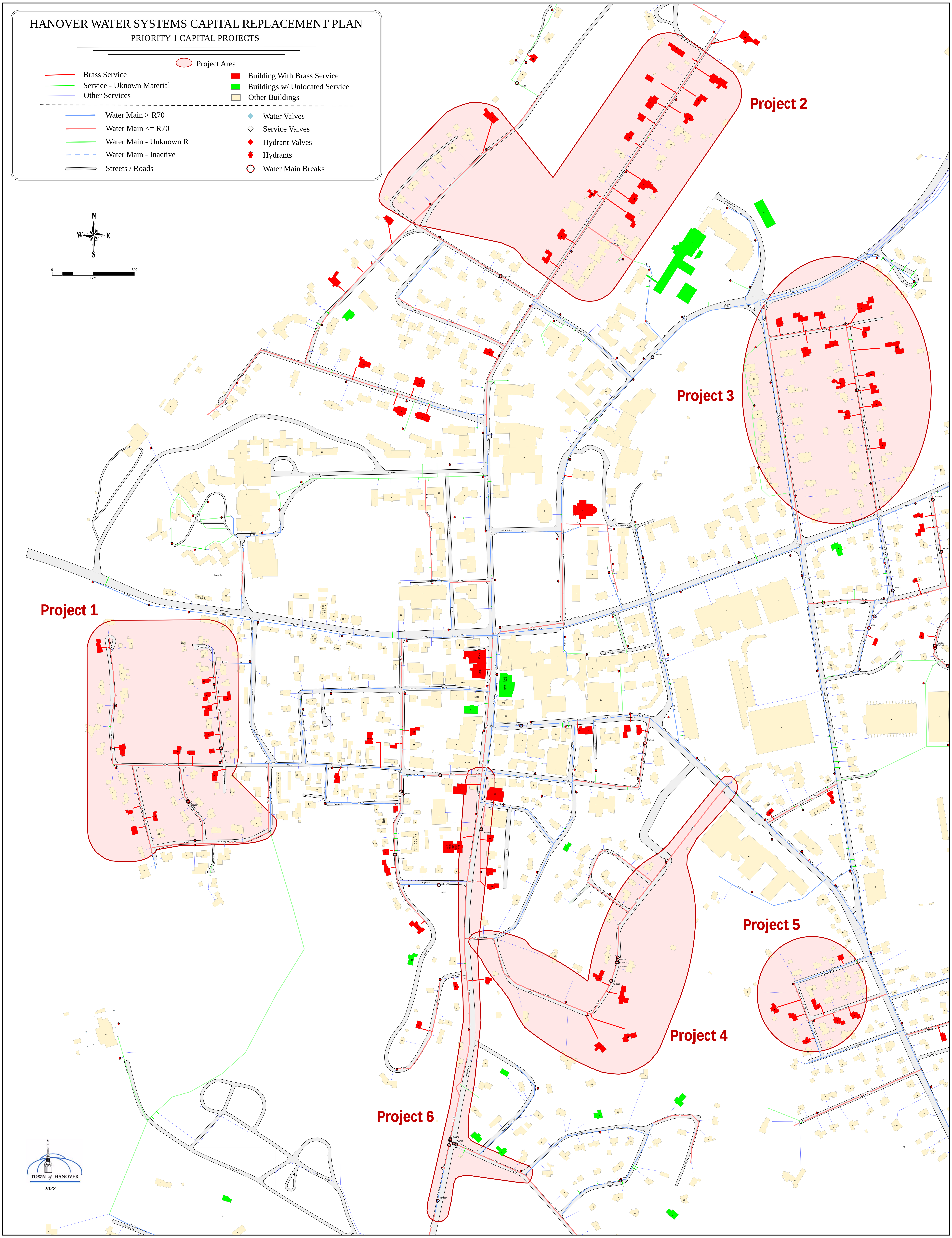
Replacement Priority 2 Estimated replacement Cost $632,500

	Year Installed	Material	Diameter, in	Hanover ID	Lined	Roughness	length,ft	Estimated Cost	Lead	Project
Replacement Priority	4									
LEDYARD LN	1939	CI	6	WL1018	N	60	60	$29,900	False	4
LEDYARD LN	1939	CI	6	WL1019	N	60	241	$120,650	False	4
LEDYARD LN	1939	CI	4	WL1020	N	60	573	$286,550	False	4

Project Total **$437,100** Running Total **$437,100**

Average Age 77 Number of Pipe Sections 3 Avg. Roughness 60 Length 874

Replacement Priority 4 Estimated replacement Cost $437,100


HANOVER WATER SYSTEMS CAPITAL REPLACEMENT PLAN
PRIORITY 1 CAPITAL PROJECTS
Project Area
Brass Service
Service - Uknown Material
Other Services
Building With Brass Service
Buildings w/ Unlocated Service
Other Buildings
Water Main > R70
Water Main <= R70
Water Main - Unknown R
Water Main - Inactive
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Water Valves
Service Valves
Hydrant Valves
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