Tighe&Bond

WATER STORAGE
Basis of Design Report

Prepared For:

Dunstable Water Department
Town of Dunstable, MA

December, 2014

5 Recommendations

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Section 1 Introduction

Tighe & Bond is providing the Dunstable Water Department with this Basis of Design Report related to the replacement of the two existing hydro-pneumatic tanks at Pond Street. The existing tanks are twin 4,000 gallon steel tanks that are partially buried. These tanks are over 50 years old and maintain pressure in the distribution system between approximately 55 to 66 pounds per square inch (psi). They do not provide adequate fire protection due to a lack of storage volume. The tanks and associated piping and controls have experienced several malfunctions within the last several years. This has resulted in flooding of the below-ground concrete structure in which the tanks are partially exposed. The Water Department received a recent cost estimate of approximately $150,000 to repair these tanks.

The Water Department has been considering replacing these tanks in-place as well as installing new tanks at an alternate location. A preliminary cost opinion determined that the cost to construct duplicate dual hydro-pneumatic tanks at the Salmon Brook Wells site would be approximately $500,000. Tighe & Bond visited the site to inspect the existing conditions and assess the feasibility of constructing a duplicate dual hydro-pneumatic tanks facility at this location. The existing gravel access road is narrow and contains steep grades. The entire site is surrounded by wetlands and is within the 100-foot Buffer Zone. The access road will need to be improved in order to permit delivery of large tanks and/or structures to the site. Improvements may include widening the road, clearing trees, and modifying the grades. Existing buried utilities (electric and water) could also be impacted by this work, and may need to be replaced or relocated. The original cost estimate did not include road improvements or permitting requirements.

Given the high cost of replacing the hydro-pneumatic tanks along with the realization that this investment would still not provide adequate water storage, the Board of Water Commissioners requested that Tighe & Bond complete this Basis of Design Report to explore alternative storage solutions. This report examined many different sites in Town for locating a new storage facility, and also evaluated alternative styles of tanks. The results of our analysis along with our recommendations are provided in the following sections.

Section 2 Existing Water System

The Town of Dunstable operates a public water supply with 102 service connections serving a residential population of approximately 234 people. The majority of these service connections are residential with a few municipal and commercial properties. According to the 2010 census, the population of the Town is 3,179. Approximately 7 percent of the Town is connected to the water system. The average water demand in 2013 was 23,333 gallons per day (gpd).

2.1 Water Supply and Treatment

The Water Department obtains its water supply from two gravel packed wells located off of Main Street near the intersection of Depot Street.

Well No. 1 is located about 200 feet from Salmon Brook. The Salmon Brook Gravel Packed Well (DEP #2081000-02G) was constructed in 1984, and has a capacity of 250 gallons per minute (gpm), or 360,000 gpd. It is approximately 86 feet deep with a 20 foot screen.

Well No. 2 (DEP #2081000-03G) is located in close proximity to Well No. 1. It was activated on December 12th, 2006. This well was constructed to ensure redundancy in the water supply system. Due to the pump size installed, it also has a capacity of 250 gpm (360,000 gpd), though the approved yield of the well is 1,048 gpm (1,510,000 gpd). This well is a 16-inch by 12-inch by 10-inch gravel packed well, and was constructed to a depth of 88 feet deep. There is a 120 slot 10-inch diameter stainless steel screen from 68 to 73 feet and a 180 slot 10-inch diameter stainless steel screen from 73 to 88 feet. A bentonite seal exists at a depth of 7 to 25 feet. Radon was observed in the water from this well although it was below the existing regulatory limit.

Salmon Brook Wells Site

The untreated water from the wells has a pH of approximately 6.3 and is corrosive to pipes. DWD currently adds potassium hydroxide (KOH) to the water to increase the pH. The KOH feed system consists of a 1,500-gallon bulk tank, a 45-gallon day tank with a secondary containment area, two (2) wall-mounted positive displacement chemical feed metering pumps, a calibration column, and a pH analyzer for continuous monitoring of the pH. Each chemical feed metering pump is equipped with a four function valve, a check valve to prevent backflow and siphoning, and a pressure relief valve. The chemical addition process cannot be activated until the well pump motor is energized and the pH of the finished water is within acceptable limits. The treatment system is equipped with a high/low pH alarm. All pumps shut down on alarm and require a manual reset and restart of the facility. The chemical metering pumps inject at a constant rate rather than the preferred flow-paced method. Emergency shower/eye wash, protective clothing, and eye wear are provided at all facilities. Raw and treated sample taps are also available at each facility for sampling.

The well site has a propane-powered standby generator that is automatically engaged in the event of a power failure. The water system is equipped with a wireless alarm system configured for monitoring all operational aspects of the distribution system as well as notifying designated DWD personnel should emergency conditions occur. The DWD conducts scheduled testing of all critical controls and alarms associated with the over-feed and under-feed of chemicals as identified in Chapter 6.1.3.6 of the Massachusetts Department of Environmental Protection's (MassDEP) guidelines.

2.2 Distribution System and Storage

The water distribution system consists of approximately 3.6 miles of water main of varying sizes and material, two hydro-pneumatic pressure tanks, and 102 water service connections. The services consist of 93 residential, 4 industrial/commercial, and 5 municipal connections. In 2010, 23 residential water meters were replaced. A map of the water distribution system is shown in Figure 2-1.

Water pressure is maintained by two (2) below ground 4,000 gallon hydro-pneumatic tanks that are located in the Pond Street structure shown in the photograph below. The water system is a single pressure zone. The operation of well pumps is controlled automatically by a pressure switch associated with the hydro-pneumatic tanks.

An ongoing concern is the adequacy of the water system to provide fire protection. The hydro-pneumatic tank facility is an integral part of the water system and it contains a number of aged components. However, it provides very little storage, which is not adequate for fire protection for the distribution system. The Water Department has considered taking action to renovate the hydro-pneumatic tanks as an intermediate step for water storage, but there is concern with the age of the equipment.

Existing Pond Street Hydro-Pneumatic Tanks Building (Tanks Partially Exposed in Basement)

The majority of the distribution system is comprised of 12-inch water main, but many sections still contain 4-inch, 6-inch, or 8-inch cast iron or asbestos cement (AC) pipe, also referred to as transite pipe. The 4-inch and 6-inch water mains are not considered adequate for providing high flows when utilized as a transmission main. The distribution system configuration consists of a main transmission main along Route 113 and Main Street with dead-end branches coming off to various side streets including Pleasant Street, Pond Street, Highland Street, Hillcrest Street, and Lowell Street. An inventory of the distribution system water mains including location, lengths, size, age and material is shown in Table 2-1.

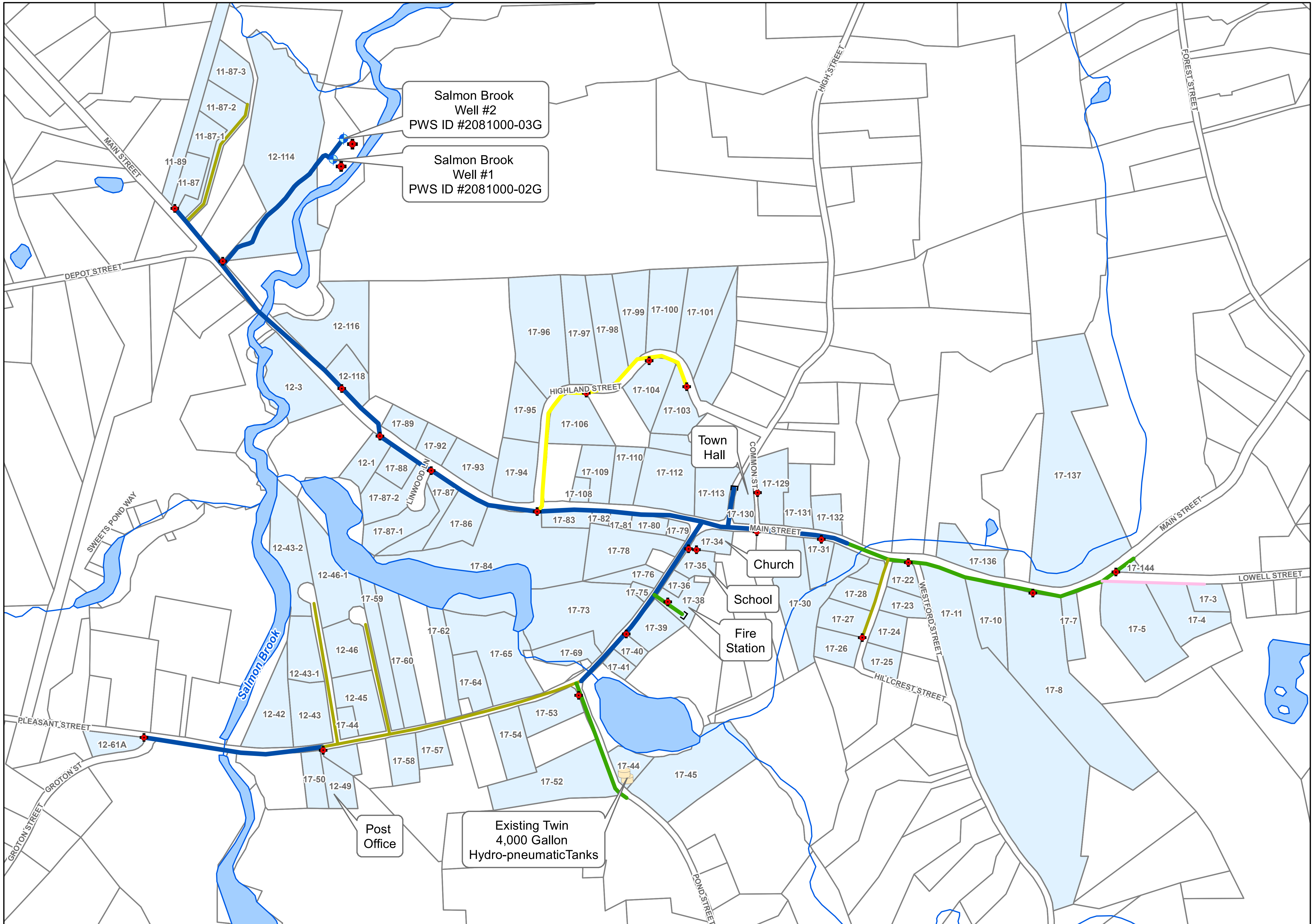

FIGURE 2-1 WATER DISTRIBUTION SYSTEM MAP

LEGEND

- Cap
- Hydrant
- Existing Well
- Tank

Main

- 12"
- 8"
- 6"
- 4"
- 2"
- Water Body
- Parcels
- Water Customers

LOCUS MAP

NEW HAMPSHIRE

PEPPERELL

GROTON

TYNGSBOROUGH

N

1:7,200

1 in = 600 ft

0 200 400 800

Feet

NOTES

1. Based on MassGIS Level 3 Parcel Data Updated October 2013.

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

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Tighe&Bond
Consulting Engineers
Environmental Specialists

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TABLE 2-1
Water Main Inventory

Street	Limits	Length (feet)	Diameter (in)	Material	Year Installed
Main Street	Depot Street to 300 feet west of Hillcrest Street	5,230	12	Ductile Iron	1983
Main Street	300 feet west of Hillcrest Street to Lowell Street	2,000	6	Unknown	Unknown
Lowell Street	Main Street to 700 feet east of Main Street	700	2	Unknown	Unknown
Highland Street	Main Street to 600 feet west of High Street	1,840	8	Unknown	Unknown
Common Driveway off Main Street West of Wells	Near Depot Street to 500 feet northeast of Main Street	900	4	Unknown	Unknown
Pump Station Access Driveway	Main Street to Pump Station	1,220	12	Ductile Iron	1983
Pleasant Street	Main Street to Pond Street	1,280	12	Ductile Iron	1983
Pleasant Street	Pond Street to 1,800 feet west of Pond Street near the Post Office	1,800	4	Unknown	Unknown
Pleasant Street	Near Post Office to Groton Street	1,190	12	Ductile Iron	2001
Pond Street	Pleasant Street to 800 feet southeast of Pleasant Street	880	6	Unknown	Unknown
Hillcrest Street	Main Street to 600 feet south of Main Street	530	4	Unknown	Unknown
Common Driveway	Western Driveway off of Pleasant Street	930	4	Unknown	Unknown
Common Driveway	Eastern Driveway off of Pleasant Street	730	4	Unknown	Unknown
	Total Length	**19,230**	**(3.65 miles)**		

Note: Lengths are approximate and based on GIS mapping

Approximately 46 percent of the water distribution system is comprised of 12-inch water mains. Approximately 44 percent of the distribution system is comprised of 2-inch, 4-inch, or 6-inch water mains, which is generally insufficient for fire flow. Table 2-2 provides a summary of the distribution system by pipe size.

TABLE 2-2
Distribution System by Size

Pipe Size (in)	Length (ft)	Miles	Percent
12	8,920	1.69	46.4%
8	1,840	0.35	9.6%
6	2,880	0.55	15.0%
4	4,890	0.93	25.4%
2	700	0.13	3.6%
TOTALS	**19,230**	**3.65**	**100.0%**

Section 3 Water Distribution System Improvements

Water mains in three locations within the existing distribution system have previously been identified as hydraulic restrictions and are recommended to be replaced. A forth reach on Hillcrest has also been noted to be undersized and have had problems. These areas are described in the following sections and are shown on Figure 3-1, Water Distribution System Upgrade Recommendations. Cost opinions for each are provided in Section 3.4.

3.1 Recommendation No. 1 – Main Street

An existing 6-inch water main of unknown material and age is located in an approximately 2,000 foot length of Main Street (part of Route 113), beginning 300 feet west of Hillcrest Street and extending to Lowell Street. It is recommended that this water main be replaced with a new 12-inch ductile iron (DI) water main that will improve the hydraulic conditions in the eastern area of the distribution system. Route 113 is owned by the State of Massachusetts and maintained by the Town of Dunstable. There is evidence of rock adjacent to this roadway as observed by several stone walls.

In September 2014, the Town of Dunstable issued a Request for Proposals to engineering firms to design the reconstruction of a 1,200 foot section of Main Street, beginning 300 feet west on Hillcrest Street to 900 feet east of Hillcrest Street. While the water main replacement limits extend approximately 800 feet further, it would be advantageous for the Water Department to replace this water main prior to the road reconstruction project or as part of the project. Resurfacing costs would likely be less if it is planned under the Highway project. In addition, once roads are repaved there is typically a 5 year moratorium on cutting into the road.

Main Street facing east near Hillcrest Street

3.2 Recommendation No. 2 – Pleasant Street

The existing 4-inch water main of unknown material on a 1,800 foot long section of Pleasant Street from Pond Street to the Post Office is undersized and should be replaced. This water main should be replaced with a new 12-inch ductile iron water main that will improve the hydraulic conditions and flow in the western area of the distribution system.

A future Mixed Use Development (MUD) is being discussed within Town near the Post Office area. Should this development occur, this improvement will most likely be needed in order to provide adequate water service.

3.3 Recommendation No. 3 – Lowell Street

The existing water main on Lowell Street is a 2-inch pipe of unknown material. This pipe begins at Main Street and extends east for approximately 700 feet. It appears that this pipe was installed to provide water service to only a few properties along Lowell Street. Although this pipe is considered undersized and should be replaced with a new 12-inch water main, it is not a high priority project. Replacing this pipe should be included in any future water main extension along Lowell Street.

Lowell Street facing east near Main Street

3.4 Recommendation No. 4 – Hillcrest Street

The existing 4-inch water main of unknown material on a 530 foot long section of Hillcrest Street from Main Street to just prior to the ninety degree bend in the road is undersized and should be replaced. The water main dead ends at this point, although the road continues and outlets to Westford Street.

3.5 Water Main Improvements Cost Opinion

The following cost opinions were developed for the four recommended improvements to the water distribution system.

TABLE 3-1
Opinion of Probable Construction Cost - Water Main Improvements

Location	Limits	Existing Pipe Size (in)	Proposed Pipe Size (in)	Length (ft)	Unit Price(1)	Cost
Main Street	300 feet west of Hillcrest Street to Lowell Street	6	12	2,000	$210	$420,000
Pleasant Street	Pond Street to 1,800 feet west of Pond Street near the Post Office	4	12	1,800	$210	$378,000
Lowell Street	Main Street to 700 feet east of Main Street	2	12	700	$210	$147,000
Hillcrest Street	Main Street to 530 feet south	4	8	530	$200	$106,000
	TOTALS			**5,030**		**$1,051,000**

(1) Unit prices include design, permitting, construction, and a 20% contingency in 2014 dollars. Unit price also includes temporary and permanent trench repair paving only.

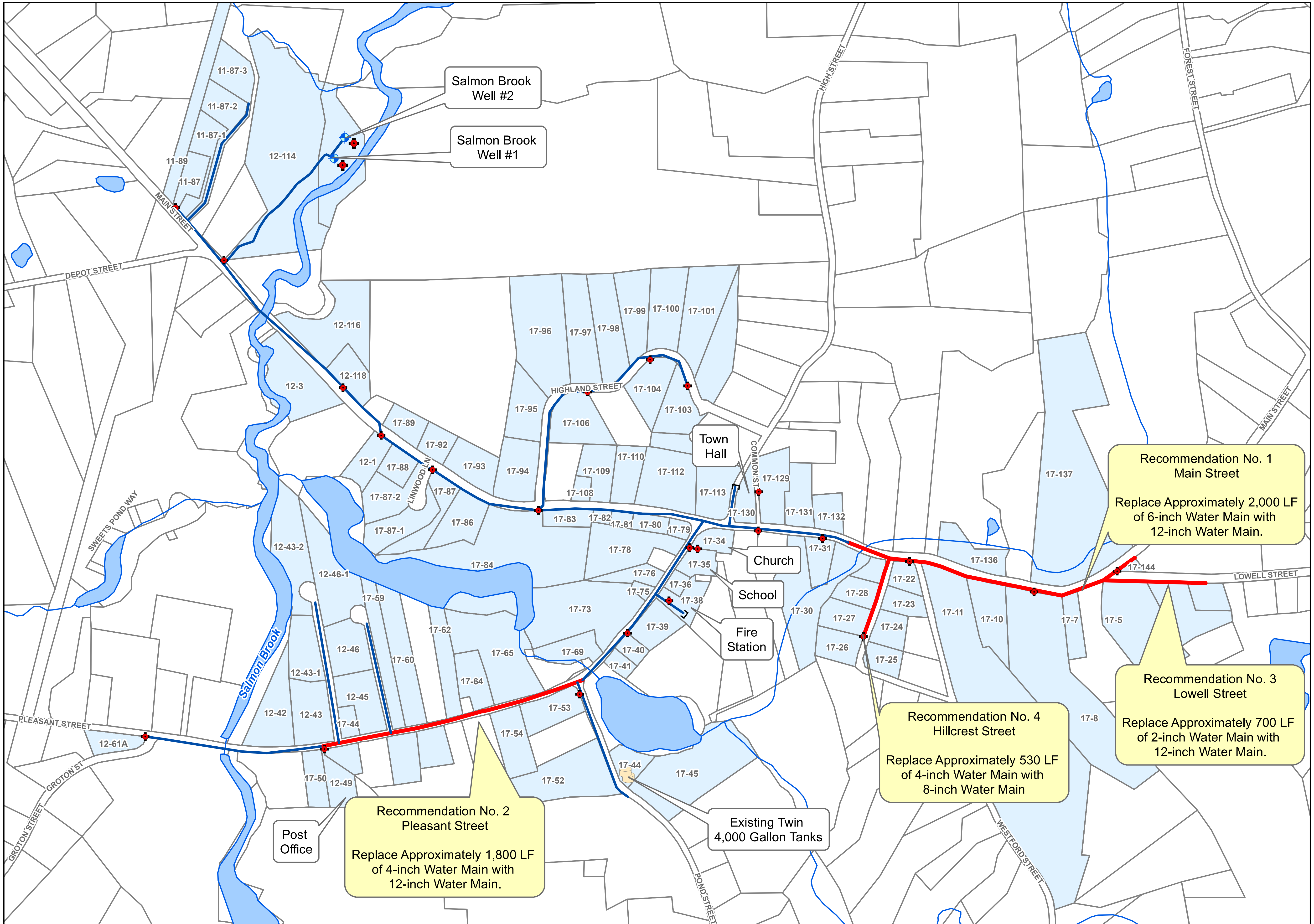


FIGURE 3-1 WATER DISTRIBUTION SYSTEM UPGRADE RECOMMENDATIONS

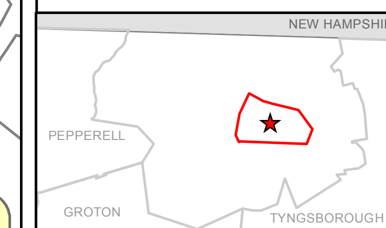
LEGEND

- Cap
- Existing Well
- Tank
- Hydrant

Main

- Water Main
- Water Main Recommended for Replacement
- Water Body
- Parcels
- Water Customers

LOCUS MAP



N

1:7,200

1 in = 600 ft

0 200 400 800

Feet

NOTES

1. Based on MassGIS Level 3 Parcel Data Updated October 2013.

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3.6 Water Main Flushing

Water main flushing removes corrosion buildup in the pipes, and improves water quality delivered to the individual service connections. Regular flushing can ultimately increase the life of the pipe. Typical maintenance of distribution systems incorporates two methods of water main flushing, conventional flushing and unidirectional flushing. Conventional flushing involves opening hydrants in selected areas, which draws water from all of the nearby connected pipelines, and discharging onto the ground surface. Unidirectional flushing involves closing valves to direct the flow along one isolated section of pipe instead of allowing flow from all pipes. This increases the velocity and generally provides a better scouring of the buildup inside the pipe. Unidirectional flushing involves a much higher effort to plan due to the need for a hydraulic computer model and design of a flushing plan. Conventional flushing typically does not require the assistance of a computer model, but should be implemented with a basic sequence plan of areas to be flushed.

Other water main pipeline maintenance options include pigging, mechanical cleaning, and chemical cleaning. These options are significantly more expensive, but allow for longer times between maintenance. Table 3-2 provides a general comparison of water system maintenance methods.

TABLE 3-2
Comparison of Distribution System Maintenance Methods[1]

Technique	Objectives	Estimated Total Cost ($/mile)	Estimated Frequency (years)
Uni-Directional Flow	Bulk water, loose deposits, cohesive deposits	$5,000 – first time $3,000 – repeat	0.5 – 3
Pigging	Loose deposits, cohesive deposits, adhered deposits, and hard scale	$85,000 – $111,000	≥ 10
Mechanical Cleaning		$422,400 – $517,440	≥ 20

(1) Source: Opflow, Volume 36, Number 8 – August 2012

Section 4
Water Storage Tank Evaluation

The Dunstable Water Department currently provides inadequate storage volume for its customers. A properly sized water storage tank would provide consistent water system pressure, provide adequate storage to meet the daily demands, and provide storage for fire protection. Tighe & Bond evaluated several different alternative storage tank styles and locations that would meet the needs of the Water Department. The following sections describe the results of our evaluations.

4.1 Storage Needs

In order to estimate the storage requirements for the water distribution system, we evaluated historical water usage as well as estimated future demands and fire protection requirements of the water system.

4.1.1 Pumping Records

Ten years of annual pumping records from the Salmon Brook Well Nos. 1 and 2 were reviewed. The historical water usage of the Water Department from 2004 to 2013 as reported on DEP's Annual Statistical Report is summarized on Table 4-1 and shown on Figure 4-1.

TABLE 4-1
Historical Water Pumpage

Year	Salmon Brook Well No. 1 2081000-02G (Gallons)	Salmon Brook Well No. 2 2081000-03G (Gallons)	Total Volume Pumped (Gallons)	Average Daily Demand (gpd)	Maximum Daily Demand(1) (gpd)
2004	14,365,300		14,365,300	39,357	118,071
2005	18,050,900		18,050,900	49,455	148,364
2006	17,023,740		17,023,740	46,640	139,921
2007	11,478,460		11,478,460	31,448	94,344
2008	5,512,500	5,512,500	11,025,000	30,205	90,616
2009	5,021,890	5,021,890	10,043,780	27,517	82,552
2010	4,828,050	4,828,050	9,656,100	26,455	79,365
2011	3,430,100	3,430,100	6,860,200	18,795	56,385
2012	3,954,460	3,954,460	7,908,920	21,668	65,005
2013	4,258,300	4,258,300	8,516,600	23,333	69,999

(1) Maximum daily demand was not reported; demand was estimated by multiplying the average daily demand by 3.0

FIGURE 4-1
Historical Water Pumpage

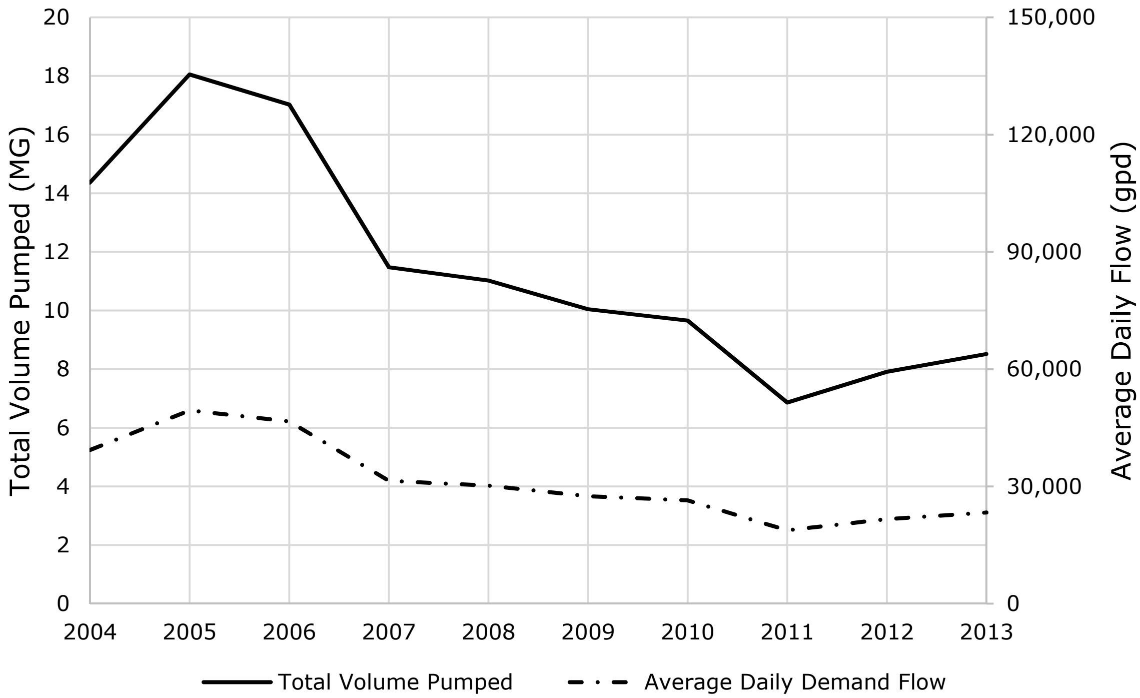


Table 4-1 and Figure 4-1 demonstrate that there has been a reduction in water usage over the past decade. The average daily flow over the last ten years is approximately 30,000 gallons per day.

4.1.2 Future Demand

Future demand on the water system is impacted by new developments in the area, expansion of the distribution system, and town planning and zoning methodology.

There are currently two potential large projects in Town that are in the planning stages and could connect to the distribution system:

- A multi-use district (MUD) of commercial and residential property off of Pleasant Street near the Post Office.
- Development of an age restricted community on Lowell Street near Main Street.

Potential water demands of these projects have not been provided, so they have not been included in our demand estimates. If the developments do move forward, they could impact the design of the new storage tank. Before the design of a new storage tank proceeds, the Town should confirm the likelihood of these projects being developed in the near future.

4.1.3 Fire Flow Storage Calculations

Fire flow requirements are provided by the National Fire Protection Association (NFPA) and by the Insurance Services Office (ISO). Towns are not required to provide fire flow to residents. However, fire flow requirements established by the NFPA should be satisfied where fire protection is provided. Based on ISO recommendations, the maximum fire flow that a community water system is expected to provide is 3,500 gpm for 3 hours, or 630,000 gallons. If there are individual commercial or industrial customers within that service area with fire flow needs that exceed this requirement, these customers must rely on alternative methods (e.g., sprinkler systems) to satisfy their additional fire flow needs. Fire flow requirements for the water system were determined from the ISO parameters of fire protection. For residential areas with one- and two-family dwellings, ISO determines the needed fire flows by considering the distance between buildings per Table 4-2.

TABLE 4-2
ISO Fire Flow Parameters

Distance Between Buildings (ft)	Needed Fire Flow (gpm)
> 100	500
31 to 100	750
11 to 30	1,000
≤ 10	1,500

The Town of Dunstable is a rural setting, and buildings are generally not located in close proximity to each other. We used a fire flow requirement of 750 gpm for estimating the storage requirements.

ISO recommends the following durations for estimating fire flow storage requirements:

- Less than 3,000 gpm: 2 hour duration
- 3,000 to 3,500 gpm: 3 hour duration
- Greater than 3,500 gpm: 4 hour duration

The estimated minimum fire flow storage requirement is estimated to be 90,000 gallons as shown below:

Projected Fire Storage (gal) = Fire Flow (gpm) * Duration (min)

Projected Fire Storage = 750 gpm * 120 min [2 hours] = 90,000 gallons

4.1.4 Pressure Requirements

The total dynamic head (TDH) for the existing 250 gpm submersible Well Pump No. 2 is 170 feet, according to the original design documents by Tata & Howard. This is the discharge pressure that the pump provides at the well head. Based on this TDH, we estimated the theoretical hydraulic grade line (HGL) of the distribution system to be approximately 327 feet. For this study, we used this hydraulic grade line for evaluating locations and sizes of the proposed storage tank.

4.4.5 Proposed Tank Size

Three components determine the size of a new water storage tank:

1. Equalization storage
2. Fire protection storage
3. Emergency storage

Equalization storage should meet the demand variations of the system, and should be approximately 25% of the maximum daily demand. Maximum day demand is not reported on the DEP Annual Statistical Reports, so it was estimated to be 90,000 gallons per day. Equalization storage requirements are estimated to be 22,500 gallons. Emergency storage is typically equivalent to the average daily demand, which is estimated to be approximately 30,000 gallons. Therefore, we estimate the minimum total usable storage volume for the new tank to be 142,500 gallons.

We recommend that the Water Department construct a new water storage tank with a usable volume of 200,000 gallons. This will provide the Water Department with sufficient capacity to meet existing demands and provide some additional capacity for growth of the water system and community.

4.2 Storage Tank Types

Municipal water storage tanks are typically constructed of concrete, steel, or glass-fused to steel. Each material has advantages and disadvantages, as well as cost considerations. Descriptions of different tank styles are provided in the following sections.

4.2.1 Hydro-pneumatic Tanks

Hydro-pneumatic tanks are used to pressurize a closed piping system. The Water Department utilizes two 4,000 gallon hydro-pneumatic storage tanks located in a below ground structure at Pond Street. The tanks consist of a steel shell tank with an internal bladder separating two areas of the tank interior. As water is drawn out of the tank air pressure on the bladder maintains water pressure in the system. Pressure switches on the tanks can be used to operate the well pumps.

4.2.2 Precast/Prestressed Concrete Tanks

Concrete tanks are constructed of a monolithic concrete floor, with wall and roof panels formed and cast onsite. The concrete tank is designed from specific parameters for each site concerning dead, seismic, and wind loads.

Prestressed concrete tanks allow reduced wall thickness by adding high strength tensile wire or strand in addition to minimum conventional reinforcing steel. A picture of a prestressed concrete tank is shown on the right. In these types of tanks, the walls are horizontally prestressed, either by wire or cable wrapping externally or by internal strands or tendons within the wall. In some tanks without a steel shell diaphragm, vertically prestressed walls are provided as well. Most of these tanks are less than 5 million gallons (MG) but can be as large as 40 MG. To provide industry standards for prestressed tanks, the American Water Works Association (AWWA) has provided two different standards. The AWWA D110 Standard, "Wire and Strand-Wound, Circular, Prestressed Concrete Water Tanks", and AWWA D115 Standard, "Circular Prestressed Concrete Water Tanks with Circumferential Tendons" was created to provide the industry with acceptable minimum design requirements. In these tanks, a concrete core wall of either cast-in-place concrete, shotcrete, or precast concrete is prestressed with high strength wire or strands prior to filling to counteract the content's hydraulic forces.

Wall and dome panels are cast on the ground and lifted into position with heavy equipment. Newer tanks use a full height steel diaphragm in each wall panel for reinforcement and to provide a watertight structure. Previously, multiple steel sheets were joined together in each wall panel to achieve the diaphragm for the full tank height. This procedure has led to cracking along the horizontal steel plate joints. This problem has been corrected by the use of the full height steel diaphragms in the wall panels, which do not have horizontal joints. Another option is for the wall to be formed and cast in place. This can result in a large vertical concrete pour which is not ideal for concrete placing, vibrating, and finishing. Based on these potential issues, there are constraints to the height and diameter of prestressed concrete tanks.

Historically, the early prestressed concrete designs have functioned reliably and have seen only minor, repairable concerns over the life of the structure. Some concrete tanks have been in service for over 50 years.

Advantages

- Minimal maintenance required
- Cathodic protection not required
- Designed for ice conditions
- Can be backfilled
- Advances in design process (using full height steel diaphragm) yields a more durable tank
- Some structural rehabilitation can be performed without removing the tank from service

Disadvantages

- Generally higher capital cost when compare to similar size welded steel or bolted steel tank.
- Limited to maximum height of approximately 80 feet
- Concrete spalling on exterior may expose prestressing wire
- Concrete is porous, allowing potential discoloration from mold and mildew

Summary

Wire-wound prestressed concrete tanks are rugged, durable tanks designed to last a long time in all environments. The steel diaphragm of the tank provides the watertightness of a welded steel tank, while the concrete provides corrosion protection without the need of regular maintenance.

4.2.3 Welded Steel Tanks

Welded steel tanks are designed from specific parameters for each individual site concerning dead, seismic, and wind loads. Panels are manufactured offsite, shop primed, and welded together on site to form the watertight tank. After welding, blasting, and cleaning, the interiors and exteriors of the tanks are coated with an ANSI/NSF 61 approved paint. Steel tanks can last a long time provided that the coating system is sound, preventing the underlying steel from corroding.

Steel tanks have been designed and constructed in the United States for over a century. The majority of these tanks are under 5 MG with a considerable number between 5 and 10 MG. There are steel tanks still in service that have been in service for than 100 years. The majority of tanks have performed well, without any noted leakage, if the surface coating is maintained. Welded steel tanks are made of steel plates that are comprised of welded wall sections, floor segments, and roof segments. The roof segments are commonly supported on rafters, beams, and girders which are then column supported. The larger the diameter, the more roof framing and column members needed, which adds to the initial and future coating surface areas. Typical concerns with steel tanks include the ability to adequately coat surfaces between the roof and rafter supports and the overall quality control of painting the tank in the field. A significant feature of steels tanks is the thin shell base plates which offer structural flexibility compared to a concrete base slab. Should column settlement be uneven, steel tank bases are less prone to leakage. Concrete base slabs must be carefully jointed and reinforced to approach the flexibility of steel plate bases. Steel tanks are faster to construct than prestressed concrete tanks. However, steel tanks cannot be buried or be in contact with soil.

To maximize the benefit of a coating system, the experience of the painting contractor and paint inspector is critical. Proper preparation, base coat and top coat application, and testing of the coating system is required to achieve a coat with minimal holidays, which are pinholes in the coating system. Furthermore, it is important to stripe coat seams and welds, as this is a location where corrosion typically occurs.

Recently, paint manufacturers were required to remove volatile organic compounds (VOCs) from their paint products. Newer paint systems can include a zinc-based primer, which theoretically acts as a sacrificial anode to prevent steel corrosion. Costs of painting have escalated in recent years due largely to strict occupational procedures to protect worker health, the environment, and stray particulates during application.

Advantages

- Structural problems are readily evident by staining and rust, and corrective measures are easy to perform
- Not susceptible to structural vandalism
- Designed and constructed to meet ASME Boiler and Pressure Vessel Code resulting in a watertight structure
- Structurally designed for ice conditions
- Can be custom painted

Disadvantages

- High maintenance cost of repainting, which is required at regular intervals to maintain corrosion protection (typically every 15 to 20 years)
- Cathodic protection may be required
- Ice can damage interior coatings, accelerating internal corrosion
- Cannot be backfilled

Summary

Steel tanks are rugged, versatile tanks that have a long service life. Steel tanks are utilized in all climates where watertight, and even vapor tight, storage is needed. The primary disadvantage of steel tanks is the maintenance expense associated with the coating system. Maintenance may be required after 7 to 10 years. Complete recoating of the interior and exterior coatings is usually required after approximately 15 to 20 years. This is a large expense that tends to make steel tanks cost prohibitive when compared to other alternative style tanks.

4.2.4 Glass-Fused-to-Steel Bolted Tanks

The steel plates for glass-fused tanks are coated with a protective, inert material that inhibits rusting and corrosion of the steel plates. The glass coating is applied as a mineral slurry and then baked in a high temperature kiln. The molten glass reacts with the steel surface to form a system that is chemically and mechanically bonded.

Panels are manufactured and coated in a factory setting, and then delivered to sites to be bolted together. The tanks can be factory-engineered for the customer, and can include site-specific tank designs, options, and accessories.

Modern tanks have stainless steel panel edges, as panel edges are historically problematic regarding corrosion. Sealant is applied to the interior and exterior of the tank at the overlap seam between panels where they are bolted together, as well as at the bolt holes.

Advantages

- Generally lower capital cost when compared to similar size concrete and welded steel tanks.
- Designed to be maintenance free without the need of recoating
- Single panels can be replaced if necessary due to failure or vandalism
- Lightweight aluminum self-supporting geodesic dome roofs do not require internal supports
- Faster construction time due to a top-down method that requires minimal equipment and can be constructed in all types of weather

Disadvantages

- Panels are bolted together which significantly increases the potential for leaks
- Structural damage can be caused by ice when water turnover is not adequate or ice prevention systems are not provided
- Glass coating can be damaged by impact vandalism, which can cause delamination of glass on the tank interior
- Lifespan of glass-fused tanks are not definitive since tanks have only been used in the waterworks industry since the 1970's
- Cathodic protection is required for full warranty
- Cannot be backfilled

Summary

Glass-lined bolted steel tanks have been used in the waterworks industry since the 1970s. This style of tank is used for potable water, wastewater, landfill leachate, and industrial water storage. The original design had a defect that caused glass delamination from the steel plate at the plate edge. This defect has since been corrected with a stainless steel coating of the edge. However sealant is still used on all joints within the tank interior.

The glass lining is NSF 61 approved, and in the absence of defects, provides a long lasting coating. Damage to panels by projectiles can cause delamination of the glass on both the inside and outside surface, damage can be repaired with a field applied sealant. Field repairs however are not as well bonded to the steel as the factory applied glass coating.

Tank appurtenances such as vents, hatches, and manways are constructed of hot-dipped galvanized steel. This is an area where regular maintenance will be required. Regular maintenance items include the appurtenances as well as replacing sealant on a 15 year interval.

4.2.5 Elevated Tanks

Four styles of storage tanks that can provide water storage in an elevated manner are:

1. Pedestal Spheroid Tanks ("golf-ball-on-a-tee" design)
2. Fluted Column Tanks (also known by the trade name Hydropillar)

3. Composite Elevated Storage Tanks
4. Glass-Fused-to-Steel Bolted Composite Elevated Storage Tanks

Elevated storage tanks allow all of the stored water volume to be located above a specific elevation. These tanks are useful where multiple tanks provide storage within the same pressure zone and topography does not allow for ground based storage. Elevated storage tanks are beneficial in areas of flat terrain.

Pedestal Spheroid Tanks

Pedestal spheroids are a type of welded steel elevated storage tank, and are typically used for small storage volumes, less than 500,000 gallons. These tanks have a characteristic spheroid shape where the water is stored. Pedestal spheroids can either be supported on an all-steel column or a concrete column. The tank portion is an all-steel, all-welded structure. The design of the supporting column is site specific to provide resistance to wind, dead loads, and seismic consideration. The seismic requirements may prevent the design of a small diameter all-steel column.

Advantages

- Welded steel construction allows year-round construction, as compared to concrete construction, depending on supporting column design
- Enclosed interior access to tank
- Multiple tank vendors are capable of fabricating the tank
- Design and construction is governed by a long-established AWWA standard

Disadvantages

- All-steel column requires internal and external maintenance painting
- All-steel column is in compression, requiring extra bracing and support

Fluted Column Tanks

Fluted column tanks consist of a steel tank supported on a large-diameter steel column. The style derives its name from the ruffled appearance of the steel column, which provides the structural support of the suspended water storage tank. Fluted columns are all-steel, all-welded structures, with good resistance to earthquake, wind, and dead loads.

Advantages

- Welded steel construction allows year-round construction, as compared to concrete construction

- Enclosed interior access to tank, piping, valves, and instrumentation equipment
- Multiple tank vendors are capable of fabricating the tank
- Design and construction is governed by a long-established AWWA standard

Disadvantages

- All-steel column requires internal and external maintenance painting
- All-steel column is in compression, requiring extra bracing and support
- Steel tank bowl causes condensation accumulation on the inside of the column, requiring a condensation ceiling and drain, or gravel floor within the column

Composite Elevated Tanks

Composite elevated tanks consist of a welded steel tank supported on a cast-in-place concrete column. The column is formed and cast in place resulting in a ring. Successive rings are cast in place on top of each other to build the concrete support column for the welded steel tank. This type of tank eliminates the steel supporting column, which reduces the amount of steel requiring long term maintenance. The concrete pedestal may require periodic maintenance depending on the climate that the tank is located in.

Advantages

- Less steel area to maintain as compared to fluted column style tanks.
- Steel bowl rests on a concrete slab, preventing the accumulation of condensation on the underside of the bowl.
- Enclosed interior access to tank, piping, valves, and instrumentation equipment.
- Multiple tank vendors are capable of constructing this style tank.

Disadvantages

- Concrete support structure cannot be constructed in cold weather.
- Tank manufactures have various form heights, with the majority being 4-foot high forms, which can result in numerous horizontal cold joints and variation in concrete aesthetic appearance.

Glass-Fused-to-Steel Bolted Composite Tanks

Glass-fused steel tanks are similar to welded steel composite elevated tanks, except the tank is constructed from glass-fused steel panels.

Advantages

- Designed to be low maintenance

- Single panels can be replaced if necessary due to failure or vandalism
- Lightweight aluminum geodesic roofs require no center pole support

Disadvantages

- Panels are bolted together which significantly increases the potential for leaks
- Structural damage caused by ice when water turnover is not adequate or ice prevention systems are not provided
- Glass coating may be damaged by impact vandalism, but panels can be replaced or repaired with sealant
- Lifespan of glass-fused tanks are not definitive since tanks have only been utilized since the 1970's
- Cathodic protection required

4.3 Tank Location Analysis

An analysis of the land within the Town of Dunstable was performed to determine the potential location of a new water storage tank. This analysis used available mapping information such as aerial images, parcel and road boundaries, and elevation contours to determine the potential location. Our analysis yielded 25 potential sites for further evaluation. A figure was developed and is attached as Appendix A. The search area was limited to all properties within a distance of one mile from the endpoints of the existing water distribution system. We determined that any sites beyond this distance would be too cost prohibitive to develop. Sites located within one-half mile of the water distribution system were preferred. Sites that were selected were based on the following criteria:

- Ownership
- Elevation
- Distance from the existing distribution system
- Existing site usage
- Access to roadways
- Size of property

All 25 potential sites were then ranked based on the criteria shown on Table 4-3.

TABLE 4-3
Site Alternatives Ranking Criteria

Criteria	Weight	Ranking 0	1	2	3	4	5
Ownership	20%		Private				Town-owned
Elevation (feet)	20%		< 200	225	250	275	350
Existing Site Usage	5%		Structure in the way		Not in way		No structure
Access to Roadways	10%		None				Yes
Distance from Existing Distribution System (ft)	40%	> 5,000	4,000-5,000	3,000-4,000	2,000-3,000	1,000-2,000	< 1,000
Site Size	5%		< 1 acre		1.5 acres		> 2 acres

Each site was ranked for each criterion and multiplied by the weight to calculate a percentage. The weighted ranks of each criterion were then summed to determine a final ranking. The optimal score is 5.0. A completed summary of the 25 sites that were evaluated along with their ranking is shown in Table 4-4. The six highest scoring sites are listed as follows:

1. Site Y – Possible Multi-Use District (164 Pleasant Street)
2. Site X – Existing Library (588 Main Street)
3. Site W – Existing Well Site (711 Main Street)
4. Site P – Existing Tank Location (30 Pond Street)
5. Site G – Near Meetinghouse Hill Cemetery (Main Street)
6. Site Q – Goldthwaite Parcel (33 Parkhurst Road)

Tighe & Bond met with the Water Department three times in August through November 2014. From the elevations and discussions with the Water Department the following four (4) parcels where reviewed further for a new storage tank.

4.3.1 Site W – Existing Well Site (711 Main Street)

Site W is a 4-acre parcel owned by the Town of Dunstable. It is the site of the two existing Water Department wells. The site is abutted by a vacant Town-owned parcel to the west and Salmon Brook to the east. The site has access to Main Street via an established maintenance access driveway leading to the wells. This route would require approximately 400 feet of new transmission water main in order to connect the proposed storage tank south to the existing water distribution system at the wells. The existing ground elevation of the well site is approximately 157 feet.

The access driveway travels from Main Street through parcel 12-114 to reach the wells on parcel 11-88. It has a few steep hills, with the steepest gaining approximately 25 feet of elevation in 250 feet of distance for a slope of 10%. The banks of the road are very steep as well. The road would need to be improved in order for construction equipment to access the site.

This site is ranked third in the siting analysis. Due to its elevation, this site would require a ground level tank with a booster pump station to allow for adequate service pressure and fire flow. A standpipe is not a viable option as the height would be over 170 feet. The booster pumps would need to be designed to meet a minimum hydraulic grade line of 327 feet. There will be no land acquisition cost due to Town ownership of the parcel.

4.3.2 Site Q – Goldthwaite Parcel (33 Parkhurst Road)

Site Q is a 22.26-acre parcel owned by Dawn Goldthwaite. The site has access to Parkhurst Road, but this path would require more than 4,000 feet of water main extension to connect to the existing distribution system. There is an abutting parcel that is being talk about as being a multi-use district (12-49-1) owned by the Town of Dunstable that has access directly to the distribution system on Pleasant Street. A new access road and water main through this parcel would be approximately 2,000 feet long in order to connect to the existing water distribution system on Pleasant Street. Due to the Town ownership of the abutting parcel and the proximity to the existing system, this would be the preferred route.

The existing ground elevation of the Parkhurst Road site is approximately 255 feet. The site is forested and contains no structures. This site was ranked sixth in our evaluation. Its elevation would allow a standpipe to be constructed that would meet the proposed hydraulic grade line of the system. However, due to its private ownership, there will be land acquisition costs associated with obtaining the entire parcel, a portion of the parcel, and/or an easement.

4.3.3 Site X – Existing Library (588 Main Street)

Site X is the Town library parcel. The Town library is located in the northern portion of the parcel, but there is forested land in a portion of the site. The site also contains wetlands which would need to be avoided. The site has access to Main Street through the library parking lot. This route would require approximately 500 feet of water main extension to connect the proposed storage tank to the existing distribution system on Main Street. The existing ground elevation of the library site is approximately 157 feet.

This site is ranked second in the siting analysis. The site is located in the center of the existing distribution system. The elevation of the site would require a ground level tank with a booster pump station to meet the hydraulic grade line and fire flow demands. A standpipe is not a viable option at this location as the height would be at least 170 feet. As the site is Town-owned, there are no land acquisition costs.

4.3.4 Site Y – Possible Multi-Use District (164 Pleasant Street)

Site Y is the possible Multi-Use District parcel located at No. 164 Pleasant Street. The site has access to Pleasant Street near the Post Office. This route would require approximately 400 feet of water main extension to connect the proposed storage tank to the existing distribution system on Pleasant Street. The existing ground elevation of the Multi-Use District site is approximately 157 feet.

This site is ranked first in the siting analysis. The site is located in the south western end of the existing distribution system. The elevation of the site would require a ground level tank with a booster pump station to meet the hydraulic grade line and fire flow demands. A standpipe is not a viable option at this location as the height would be at least 170 feet. As the site is Town-owned, there are no land acquisition costs.

TABLE 4-4
Tank Siting Alternatives Ranking

Site	Parcel No.	Address	Owner	Owner			Site Size (acres)	Site Size			Approx. Base Elev. (feet)	Elevation			Existing Site Usage	Site Usage			Access to Roadways	Road Access			Distance from Existing System (LF)	Distance			Overall Rank
				R	W	T		R	W	T		R	W	T		R	W	T		R	W	T		R	W	T	
Y	12-49-1	164 Pleasant Street	Town of Dunstable 511 Main Street	5	20%	1.00	28.51	5	5%	0.25	157	1.00	20%	0.20	None	5	5%	0.25	Pleasant Street	5	10%	0.50	500	5	40%	2.00	**4.20**
X	17-84	Library 588 Main Street	Town of Dunstable 511 Main Street	5	20%	1.00	9.7	5	5%	0.25	157	1.00	20%	0.20	Library	3	5%	0.15	Main Street	5	10%	0.50	500	5	40%	2.00	**4.10**
W	11-88	Existing Well Site 711 Main Street	Town of Dunstable 511 Main Street	5	20%	1.00	4	5	5%	0.25	157	1.00	20%	0.20	Existing well buildings	1	5%	0.05	Main Street	5	10%	0.50	300	5	40%	2.00	**4.00**
P	17-44	Existing Tank Location 30 Pond Street	Town of Dunstable 511 Main Street	5	20%	1.00	1.5	3	5%	0.15	196	1.00	20%	0.20	Existing tank building	1	5%	0.05	Pond Street	5	10%	0.50	30	5	40%	2.00	**3.90**
G	22-31-1	Main Street Near Meetinghouse Hill Cemetery	Town of Dunstable 511 Main Street	5	20%	1.00	13.48	5	5%	0.25	255	3.50	20%	0.70	None	5	5%	0.25	Main Street	5	10%	0.50	3,250	2	40%	0.80	**3.50**
Q	18-48-2	33 Parkhurst Road	Dawn Goldthwaite 147 Pond Street	1	20%	0.20	22.26	5	5%	0.25	255	3.50	20%	0.70	None	5	5%	0.25	Through MUD to Pleasant Street	5	10%	0.50	1,800	4	40%	1.60	**3.50**
K	17-114	24 High Street	Donna Ferraguto 24 High Street	1	20%	0.20	2.03	5	5%	0.25	216	1.50	20%	0.30	House	1	5%	0.05	High Street	5	10%	0.50	350	5	40%	2.00	**3.30**
J	17-115	40 High Street	Gallant Investment Trust 2491 Marina Rd. Wadmalaw Island, SC	1	20%	0.20	2.5	5	5%	0.25	216	1.50	20%	0.30	House	1	5%	0.05	High Street	5	10%	0.50	400	5	40%	2.00	**3.30**
O	13-103	Pierce Town Forest 145 Groton Street	Town of Dunstable 511 Main Street	5	20%	1.00	131	5	5%	0.25	255	3.50	20%	0.70	None	5	5%	0.25	Groton Street	5	10%	0.50	4,000	1	40%	0.40	**3.10**
A	10-24-13	85 Sky Top Lane	Town of Dunstable 511 Main Street	5	20%	1.00	10.89	5	5%	0.25	374	5.00	20%	1.00	None	5	5%	0.25	Sky Top Lane	5	10%	0.50	11,500	0	40%	0.00	**3.00**
B	11-81	0 Mill Street	Town of Dunstable 511 Main Street	5	20%	1.00	148	5	5%	0.25	334	4.50	20%	0.90	None	5	5%	0.25	None	1	10%	0.10	6,750 7,000	0	40%	0.00	**2.50**
S	23-4	0 Forest Street	Christopher & Joyce Bertrand 489 Forest Street	1	20%	0.20	37	5	5%	0.25	314	4.50	20%	0.90	None	5	5%	0.25	Forest Street	5	10%	0.50	4,500	1	40%	0.40	**2.50**
D	16-35	254 High Street	Robert Kennedy 346 High Street	1	20%	0.20	7.2	5	5%	0.25	295	4.50	20%	0.90	None	5	5%	0.25	High Street	5	10%	0.50	4,500	1	40%	0.40	**2.50**
E	16-37	255 High Street	Susan Psaledakis PO Box 130	1	20%	0.20	7.25	5	5%	0.25	295	4.50	20%	0.90	None	5	5%	0.25	High Street	5	10%	0.50	4,500	1	40%	0.40	**2.50**
Q	18-48-2	33 Parkhurst Road	Dawn Goldthwaite 147 Pond Street	1	20%	0.20	22.26	5	5%	0.25	265	3.50	20%	0.70	None	5	5%	0.25	Parkhurst Road	5	10%	0.50	4,250	1	40%	0.40	**2.30**
H	16-18	171 High Street	David Sears PO Box 69	1	20%	0.20	25.3	5	5%	0.25	295	4.50	20%	0.90	House at entrance to parcel	1	5%	0.05	High Street	5	10%	0.50	4,000	1	40%	0.40	**2.30**
U	23-3	0 Lowell Street	Commonwealth of Mass 251 Causway St. Boston	1	20%	0.20	125.4	5	5%	0.25	374	5.00	20%	1.00	None	5	5%	0.25	Dunstable Road in Tyngsborough	5	10%	0.50	10,000	0	40%	0.00	**2.20**
V	22-1	0 Lowell Street	Joseph & Mary Elkareh 544 Merrimack St. Lowell	1	20%	0.20	25	5	5%	0.25	295	4.50	20%	0.90	None	5	5%	0.25	Dunstable Road in Tyngsborough	5	10%	0.50	7,000	0	40%	0.00	**2.10**
M	12-102	0 Depot Street	Kenneth Tully 116 Fletcher Street	1	20%	0.20	21.06	5	5%	0.25	275	4.00	20%	0.80	None	5	5%	0.25	Depot Street	5	10%	0.50	5,000	0	40%	0.00	**2.00**
C	16-36	295 High Street	Robert Kennedy 346 High Street	1	20%	0.20	69	5	5%	0.25	295	4.50	20%	0.90	Small building on eastern parcel	3	5%	0.15	High Street	5	10%	0.50	5,800	0	40%	0.00	**2.00**
I	17-123	0 High Street	George McGovern 147 Forest Street	1	20%	0.20	6	5	5%	0.25	275	4.00	20%	0.80	None	5	5%	0.25	None	1	10%	0.10	4,500	1	40%	0.40	**2.00**
F	15-42	57 French Court	Kenneth G Desilets Trustee 21 Colonial Dr. Westford	1	20%	0.20	84	5	5%	0.25	364	5.00	20%	1.00	House in western portion of parcel	1	5%	0.05	French Court	5	10%	0.50	11,000	0	40%	0.00	**2.00**
T	23-13	1 Trask Way	Gerald White 1 Trask Way	1	20%	0.20	19.76	5	5%	0.25	344	4.75	20%	0.95	House and driveway	1	5%	0.05	Trask Way/ Forest Street	5	10%	0.50	6,600	0	40%	0.00	**1.95**
L	11-18B	0 Depot Street	June Tully Marital QTIP Trust 401 Hollis Street	1	20%	0.20	16	5	5%	0.25	265	3.50	20%	0.70	None	5	5%	0.25	None	1	10%	0.10	4,000	1	40%	0.40	**1.90**
R		0 Westford Street	Lauren Chaney 36 Pleasant Street	1	20%	0.20	32	5	5%	0.25	265	3.50	20%	0.70	None	5	5%	0.25	Westford Street	5	10%	0.50	5,500	0	40%	0.00	**1.90**
N	12-103	265 Depot Street	June Tully Marital QTIP Trust 401 Hollis Street	1	20%	0.20	67	5	5%	0.25	265	3.50	20%	0.70	None	5	5%	0.25	Depot Street	5	10%	0.50	6,000	0	40%	0.00	**1.90**

LEGEND
R = Rank
W = Weight
T = Total

4.4 Alternatives Evaluation

Further analysis was completed for the tank siting alternatives and the list of priority sites was reduced to four sites. Additionally a fifth alternative documents hydro-pneumatic tank replacement. The alternatives are outlined as follows:

- Alternative No. 1 – 200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the existing well site parcel at 711 Main Street
- Alternative No. 2 – 200,000 Gallon (usable) in a Steel Standpipe on the Goldthwaite parcel at 33 Parkhurst Road
- Alternative No. 3 – 200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the possible Multi-Use District parcel at 164 Pleasant Street
- Alternative No. 4 – 200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the existing library parcel at 588 Main Street
- Alternative No. 5 - Replace hydro-pneumatic tanks in place at 30 Pond Street

4.4.1 Alternative No. 1 – Existing Well Site

Water Storage Tank: This alternative includes the construction of a 42-foot diameter by 21-foot tall ground level glass fused to steel water storage tank. The base elevation would be 157 feet. The existing well pumps will need to be modified to meet the lower head condition.

Tank Mixing System: A tank mixing system would be included to reduce water age within the tank, as well as prevent any ice formation during winter months. There are two types of tank mixing systems: passive and active. The type of system will be determined during the final design.

Booster Pump Station: Due to the ground level storage, this alternative requires a second pumping step where the water tank is drawn off of and is boosted to the required pressure as needed. This requires additional energy from a pumping perspective and adds mechanical features to the design which will wear and require maintenance and replacement over time. A backup generator is also required to facilitate pumping during a power failure. Three phase electrical power already exists at the well site, therefore a 3-phase power extension is not anticipated.

Site Work: The well site can be accessed through an access driveway off of Main Street, across from Depot Street. It is abutting a river and wetlands, but the access road travels between the wetlands, and the well buildings are located away from them. No abutters would be affected by the construction of the tank, booster pump station, or the water main extension installation. Proper precautions must be taken to avoid impacting the surrounding wetlands. The site is largely forested, with a cleared area of approximately 20,000 square feet for the wells and facilities.

The access road, as described in Section 4.3.1, has a few steep hills that could be dangerous for construction equipment; the slope of the largest hill is 10%. The tank site itself is relative flat, with the only potential change in elevation being a 10 foot increase from the proposed storage tank and booster pump station location to the interconnection with the existing water main. Although the well stations were built onsite, the steep access road would make construction of a storage tank challenging.

Water Main Extension: Construction of approximately 400 feet of new 12-inch DI water main would be necessary to connect the storage tank and booster pump station to the existing water main at the well site.

Water Main Replacement: The Water Department has indicted that as part of this tank project they would also like to upgrades some of the water mains in the distribution system. As such, the 4 recommendations presented in section 2 of this report are included in this alternative.

Land Acquisition: Existing well site, no land acquisition required.

Advantages of Alternative: Advantages to constructing a ground level storage tank with a booster pump station at this location includes the following:

- Minimal water main extension required to connect to the existing pipeline
- Tank could be designed to meet the Ground Water Rule, which aims to protect against microbial pathogens in drinking water supplies that utilize groundwater sources. This would require internal baffles.
- Minimum impact to abutters due to remoteness of site
- No land acquisition is required due to Town ownership
- Pumped storage facilities can provide several days storage if wells are off-line

Disadvantages of Alternative: The disadvantages of this alternative include:

- Remote site that has limited available space for construction of a new storage tank or pump station
- Existing access road is steep and narrow; road will need to be improved to permit access by construction equipment
- Wetland permitting will be required as well site is surrounded by wetlands and Salmon Brook.
- Water main break or disruption in service at the well site or along the access driveway will sever both the water supply and storage for the entire water distribution system
- Storage tank located at the end of the distribution system
- Operation and maintenance costs for the booster pump station
- Relying on mechanical pumping for to meet water demands including fire protection

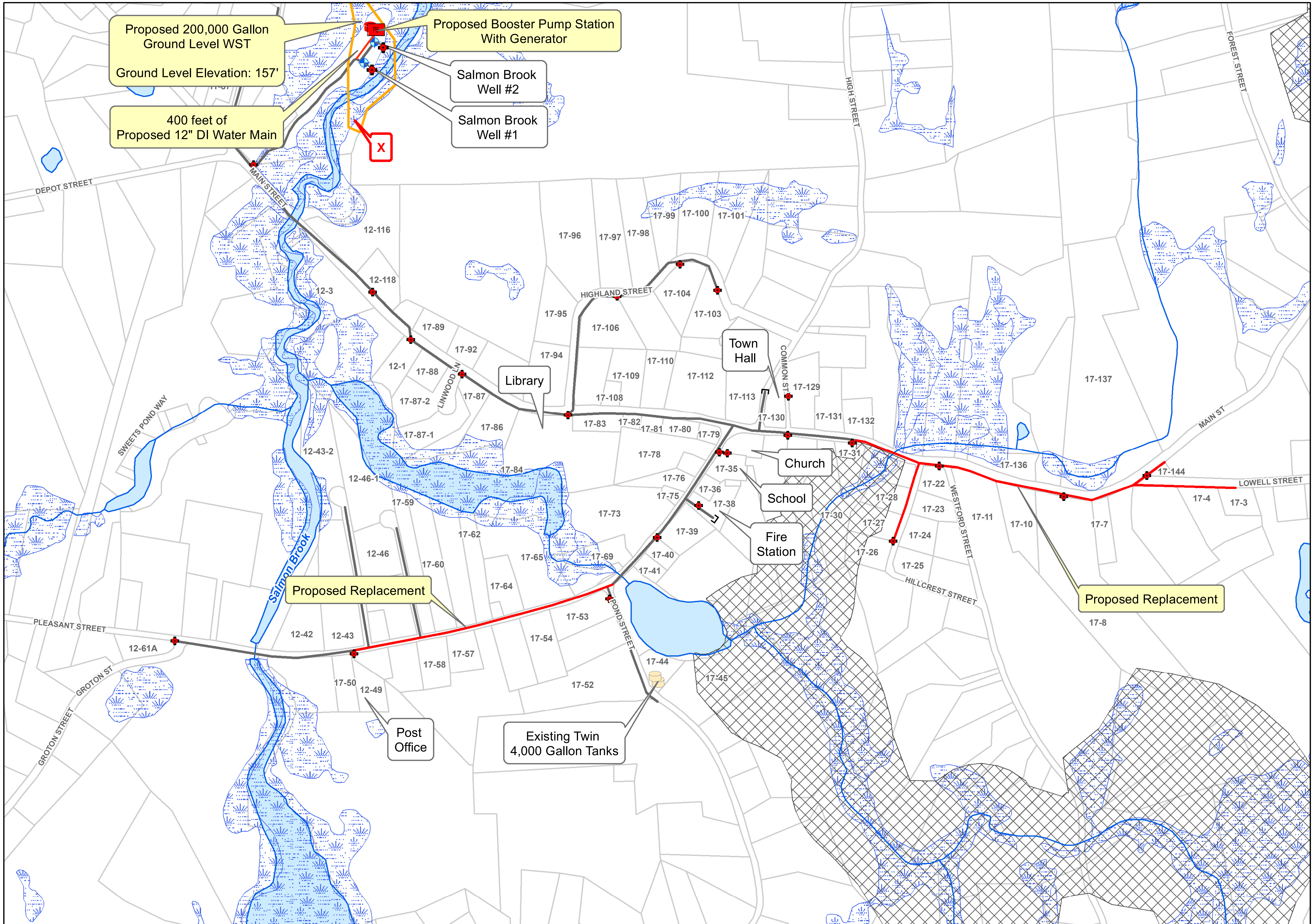
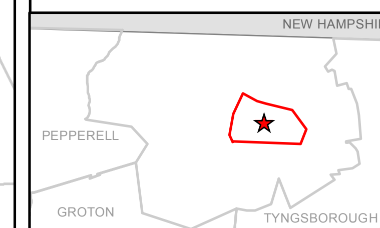


FIGURE 4-2
ALTERNATIVE 1

LEGEND

- Cap
- Hydrant
- Existing Well
- Tank
- Proposed Tank
- Proposed Pump Station
- Proposed Water Main
- Existing Main
- Inland Wetlands
- Water Body
- NHESP Priority Habitats for Rare Species
- NHESP Estimated Habitats for Rare Wildlife
- Alternative Site
- Parcels

LOCUS MAP



N

1:7,200

1 in = 600 ft

0 200 400 800

Feet

NOTES

1. Based on MassGIS Level 3 Parcel Data Updated October 2013.

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

December 2014

Tighe&Bond
Consulting Engineers
Environmental Specialists

Path: G:\GIS\MA\SiteLocus\Dunstable\Water\Fig4-2_Alt1_11x17.mxd

D-0270

4.4.2 Alternative No. 2 – Goldthwaite Parcel at 33 Parkhurst Road

Water Storage Tank: This alternative includes construction of a 36-foot diameter by 74-foot tall steel standpipe at 33 Parkhurst Road. The base elevation would be 255 feet. Although the usable volume would be 200,000 gallons, the total storage volume will be approximately 577,000 gallons.

Tank Mixing System: A tank mixing system would be needed to reduce water age within the tank, as well as prevent any ice formation during winter months. The type of system will be determined during the final design.

Site Work: The proposed standpipe site does not have a cleared access road, so one must be developed through the multi-use district from Pleasant Street to the tank site. Trees, wetlands, and cleared land are all located within the MUD. The proper precautions must be taken to avoid having a negative effect on or harming the wetlands. Minimal tree removal will be required to clear a path for the access road and an area for the standpipe.

The proposed tank location is between a low point in the MUD and a high point in Site Q. Therefore the access road would have a slope of almost 10% in places and/or hills. Some grading will be required.

The alignment for the water main and three phase power extension would depend on the development plan for the MUD District. The shortest distance – a straight line between Pleasant Street – would be ideal, however the alignment cannot interfere with future building structures in the MUD District.

While Site Q does have residential abutters, the proposed location of the standpipe is at least 700 feet away from the nearest home. The disturbance from construction of the tank should be minimal. The new water main installation could cause more issues for abutters as its alignment may take it next to residential homes near the connection on Pleasant Street.

Water Main Extension: Construction of approximately 2,000 feet of new 12-inch DI water main would be necessary to connect the standpipe to the existing water main on Pleasant Street. The cost of this extension is presented in Table 4-6. The alignment of the water main must be coordinated to be within the roadways that may be developed for the future multi-use district. It will likely not be a straight line between the standpipe and the connection point. The proposed pipeline alignment in Figure 4-3 is dependent upon the alignment of the roadways within the MUD.

Water Main Replacement: The Water Department has indicted that as part of this tank project they would also like to upgrades some of the water mains in the distribution system. As such, the 4 recommendations presented in section 2 of this report are included in this alternative.

Land Acquisition: Site Q (33 Parkhurst Road) is privately owned. According to Town records, the property is owned by Dawn Goldthwaite. The parcel is 22.26 acres and has a current assessed value of $261,200. The Town would need to acquire at least 1 acre in the northwestern portion of the parcel in order to construct the storage tank at the minimum location, as shown in Figure 4-3. The Water Department will need to complete an appraisal of the property to determine the fair market value of the entire property, and whether obtaining a small parcel or easement is feasible.

Advantages of Alternative: Advantages to constructing a standpipe at this site include the following:

- Storage tank is located close to the center of the distribution system
- Tank is constructed at a higher ground elevation and can meet the hydraulic grade line without construction of a booster pump station

Disadvantages of Alternative: Disadvantages to constructing a standpipe at this site include the following:

- Privately owned property will require land acquisition costs
- Significant site work required for access road and water main extension
- Parcel is located in a residential area on Parkhurst Road and will have abutters in close proximity
- Wetland permitting may be required due to a small area of wetland near the proposed water main alignment
- Shortest access to the site is via the potential multi-use district
- Storage tank will likely be visible to the surrounding area due to its proposed height

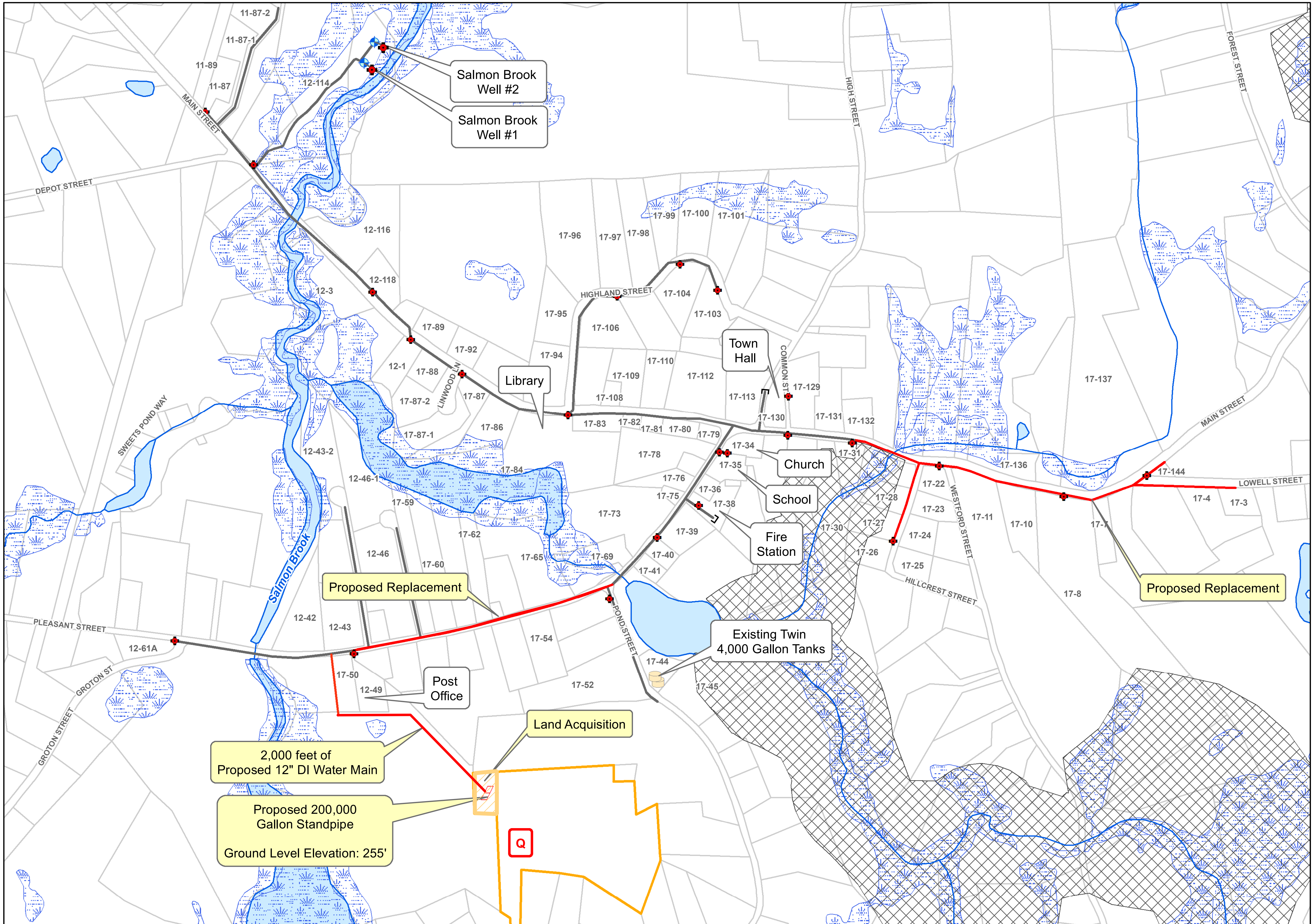
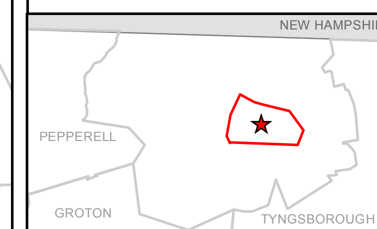


FIGURE 4-3
ALTERNATIVE 2

LEGEND

- Cap
- Hydrant
- Existing Well
- Tank
- Proposed Standpipe
- Proposed Water Main
- Existing Main
- Inland Wetlands
- Water Body
- NHESP Priority Habitats for Rare Species
- NHESP Estimated Habitats for Rare Wildlife
- Alternative Site
- Parcels

LOCUS MAP



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1:7,200
1 in = 600 ft

0 200 400 800
Feet

NOTES

1. Based on MassGIS Level 3 Parcel Data Updated October 2013.

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

December 2014

Tighe&Bond
Consulting Engineers
Environmental Specialists

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D-0270

4.4.3 Alternative No. 3 – Possible Multi-Use District Parcel

Water Storage Tank: This alternative would construct a new 42-foot diameter by 21-foot tall ground level water storage tank and pump station on the Multi-Use District parcel (Site Y). The tank and pump station could be located close to Pleasant Street, as ground elevation is not critical.

Tank Mixing System: A tank mixing system would be included to reduce water age within the tank, as well as prevent any ice formation during winter months. The type of system will be determined during the final design.

Booster Pump Station: A pump station will be utilized in this alternative to pump water from the water storage tank into the distribution system to meet demands and fire protection. A standby generator will also be required to maintain operation of the station during a power failure. Based on our site inspection, it appears that three-phase power exists on Pleasant Street near the proposed location of the tank.

Site Work: Construction of a new access road will be required to the tank and pump station site. The final location of the facilities will need to be coordinated with other planned development of the property in order to reduce the impacts of the site.

Water Main Extension: Construction of approximately 400 feet of new 12-inch DI water main would be necessary to connect the storage tank and booster pump station to the existing water main on Pleasant Street. The cost of this extension is presented in Table 4-7.

Water Main Replacement: The Water Department has indicted that as part of this tank project they would also like to upgrades some of the water mains in the distribution system. As such, the 4 recommendations presented in section 2 of this report are included in this alternative.

Land Acquisition: Site Y is owned by the Town of Dunstable. Land acquisition is not required. Use of the land for a storage facility will need approval.

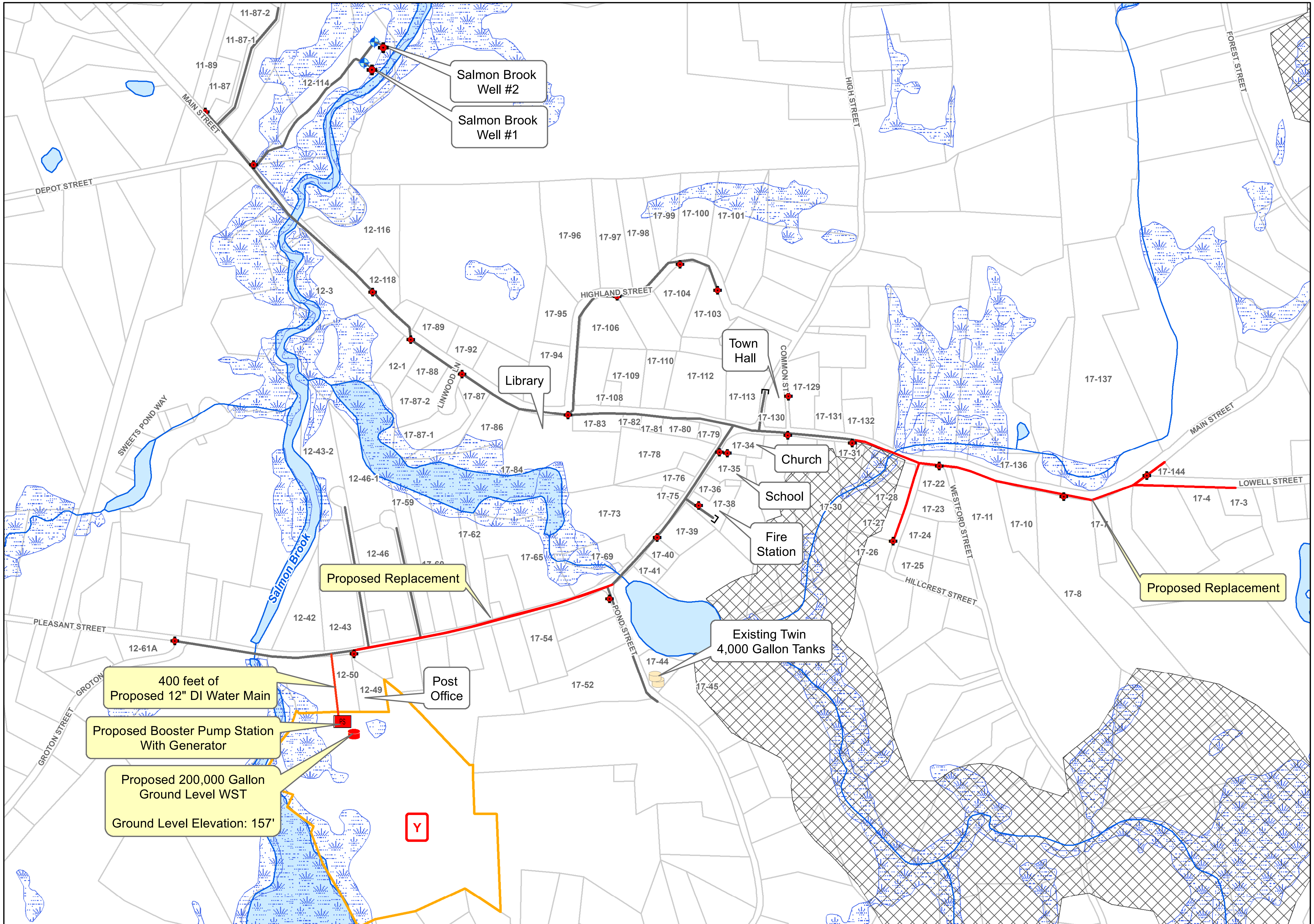
Advantages of Alternative: Advantages to constructing a pumped storage facility at this location include:

- Storage tank is located close to the center of the distribution system
- Site is Town owned
- Facilities can be located close to Pleasant Street, minimizing site work
- Pumped storage facilities can provide several days storage if wells are off-line

Disadvantages of Alternative: Disadvantages to constructing a ground level WST with a booster pump station at this site include the following:

- Water main on Pleasant Street will need to be replaced
- Potential impacts to planned multi-use district will need to be coordinated
- Operation and maintenance costs for booster pumping station
- Relying on mechanical pumping for to meet water demands including fire protection

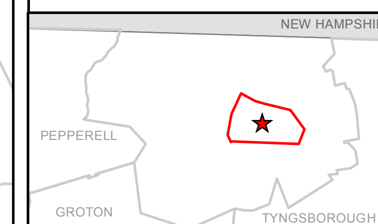
FIGURE 4-4
ALTERNATIVE 3



LEGEND

- Cap
- Hydrant
- Existing Well
- Tank
- Proposed Tank
- Proposed Pump Station
- Proposed Water Main
- Existing Main
- Inland Wetlands
- Water Body
- NHESP Priority Habitats for Rare Species
- NHESP Estimated Habitats for Rare Wildlife
- Alternative Site
- Parcels

LOCUS MAP



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1:7,200

1 in = 600 ft

0 200 400 800

Feet

NOTES

1. Based on MassGIS Level 3 Parcel Data Updated October 2013.

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

December 2014

Tighe&Bond
Consulting Engineers
Environmental Specialists

Path: G:\GIS\MA\SiteLocus\Dunstable\Water\Fig4-4_Alt3_11x17.mxd

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4.4.4 Alternative No. 4 – Existing Library parcel

Water Storage Tank: This alternative would include the construction of a 42-foot diameter by 21-foot tall ground level water storage tank. The base elevation would be 157 feet. The operating band would be from elevations 159 to 167 feet. The existing well pumps would be replaced to meet this lower head condition.

Tank Mixing System: A tank mixing system would be included to reduce water age within the tank, as well as prevent any ice formation during winter months. The type of system will be determined during the final design.

Booster Pump Station: A pump station will be utilized in this alternative to pump water from the water storage tank into the distribution system to meet demands and fire project. A standby generator will also be required to maintain operation of the station during a power failure. Three phase electrical power exists on Main Street. However it is likely that there will be utility charges to extend three phase electrical service to the booster pump station.

Site Work: The proposed site is located to the rear of the library lot. Access would be through the library parking lot off of Main Street. An access road would need to be constructed from the library parking lot and past the southern side of the library to the proposed facility, or behind the library along the edge of the property line from Main Street to the proposed site. Tree removal would be required to construct the access road, tank and booster pump station. The forested portion of the site is relatively flat slope at most. It is expected that minimal grading would be required.

There are existing wetlands exist to the south and west of the library. Construction activities adjacent to these resource areas will need to minimize the impact to the wetlands.

Water Main Extension: Construction of approximately 500 feet of new 12-inch ductile iron water main will be required to connect the tank and pump station to the existing 12-inch water main on Main Street.

Water Main Replacement: The Water Department has indicted that as part of this tank project they would also like to upgrades some of the water mains in the distribution system. As such, the 4 recommendations presented in section 2 of this report are included in this alternative.

Land Acquisition: The land is owned by the Town of Dunstable. However, construction of a pumped storage facility at this location will need approval by the Town.

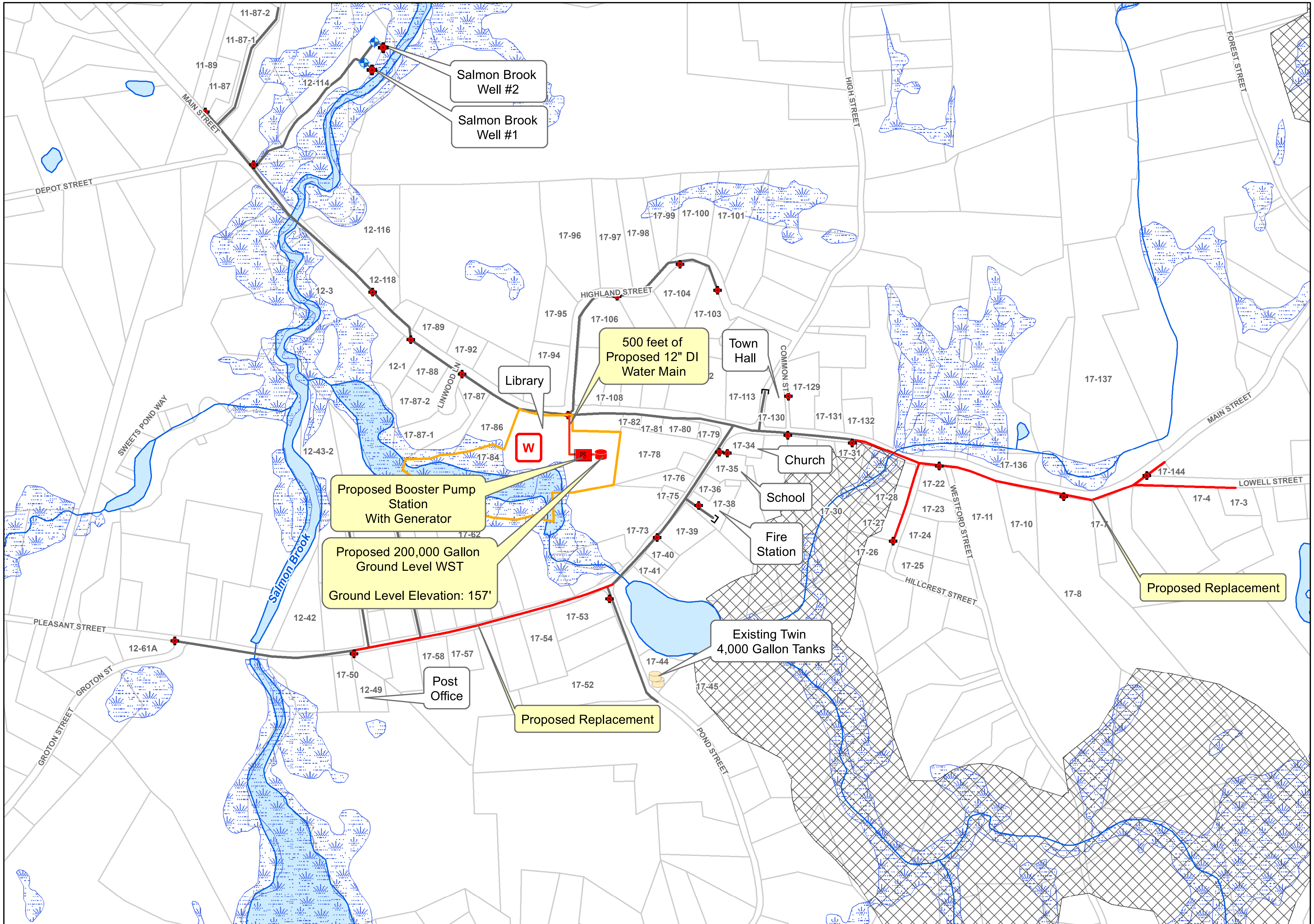
Advantages of Alternative: Advantages to constructing a pumped storage facility at this location include:

- Storage facility will be located in the center of the distribution system
- Existing distribution system is in close proximity to site and water main will not need to be replaced
- Land acquisition is not required
- Pumped storage facilities can provide several days storage if wells are off-line

Disadvantages of Alternative: Disadvantages of this alternative include:

- Site is located directly behind the Town Library in a residential area
- Town will need to approve use of land for storage facility
- Wetland permitting may be required due to close proximity of wetlands
- Operation and maintenance costs of pump station
- Relying on mechanical pumping for to meet water demands including fire protection

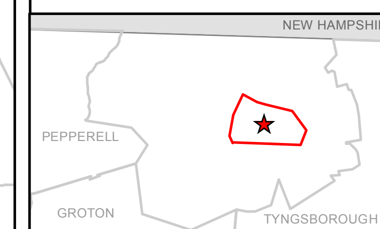
FIGURE 4-5
ALTERNATIVE 4



LEGEND

- Cap
- Hydrant
- Existing Well
- Tank
- Proposed Tank
- Proposed Pump Station
- Proposed Water Main
- Existing Main
- Inland Wetlands
- Water Body
- NHESP Priority Habitats for Rare Species
- NHESP Estimated Habitats for Rare Wildlife
- Alternative Site
- Parcels

LOCUS MAP



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1:7,200
1 in = 600 ft

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Feet

NOTES

1. Based on MassGIS Level 3 Parcel Data Updated October 2013.

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

December 2014

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Environmental Specialists

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D-0270

4.4.5 Alternative No. 5 – Replace Hydro-pneumatic Tanks

Water Storage Tank: A less expensive solution will be to replace the existing hydro-pneumatics tanks by constructing a new above-ground structure at Pond Street. This structure will house two new hydro-pneumatic tanks that will provide a total storage of 10,000 gallons. The building would be a slab-on-grade construction with dimensions approximately 25 feet wide by 40 feet long. The building would include heat and electricity but would require minimal maintenance. This facility would be designed so that if the Water Department were ever to construct a new storage facility, the hydro-pneumatic tanks could be removed and the building could be repurposed for other uses (i.e. garage or equipment storage).

Tank Mixing System: None required.

Site Work: Minimal site work will be required for this alternative as the new building would be constructed adjacent to the existing facility.

Water Main Extension: None required. Connect to existing water main at existing location.

Water Main Replacement: None required.

Land Acquisition: None required. Site is currently used by the Water Department.

Advantages of Alternative: Advantages to replacing the existing hydro-pneumatic tanks include the following:

- Maintains storage in the current location
- Minimum site work required
- No land acquisition costs
- Building could be reused in the future if new storage tank is constructed

Disadvantages of Alternative: Disadvantages to replacing the existing hydro-pneumatic tanks include the following:

- Does not provide sufficient storage to meet daily demands and fire protection requirements
- Wetland permitting will be required due to close proximity of existing tanks
- Significant cost to construct facility that will not provide adequate storage

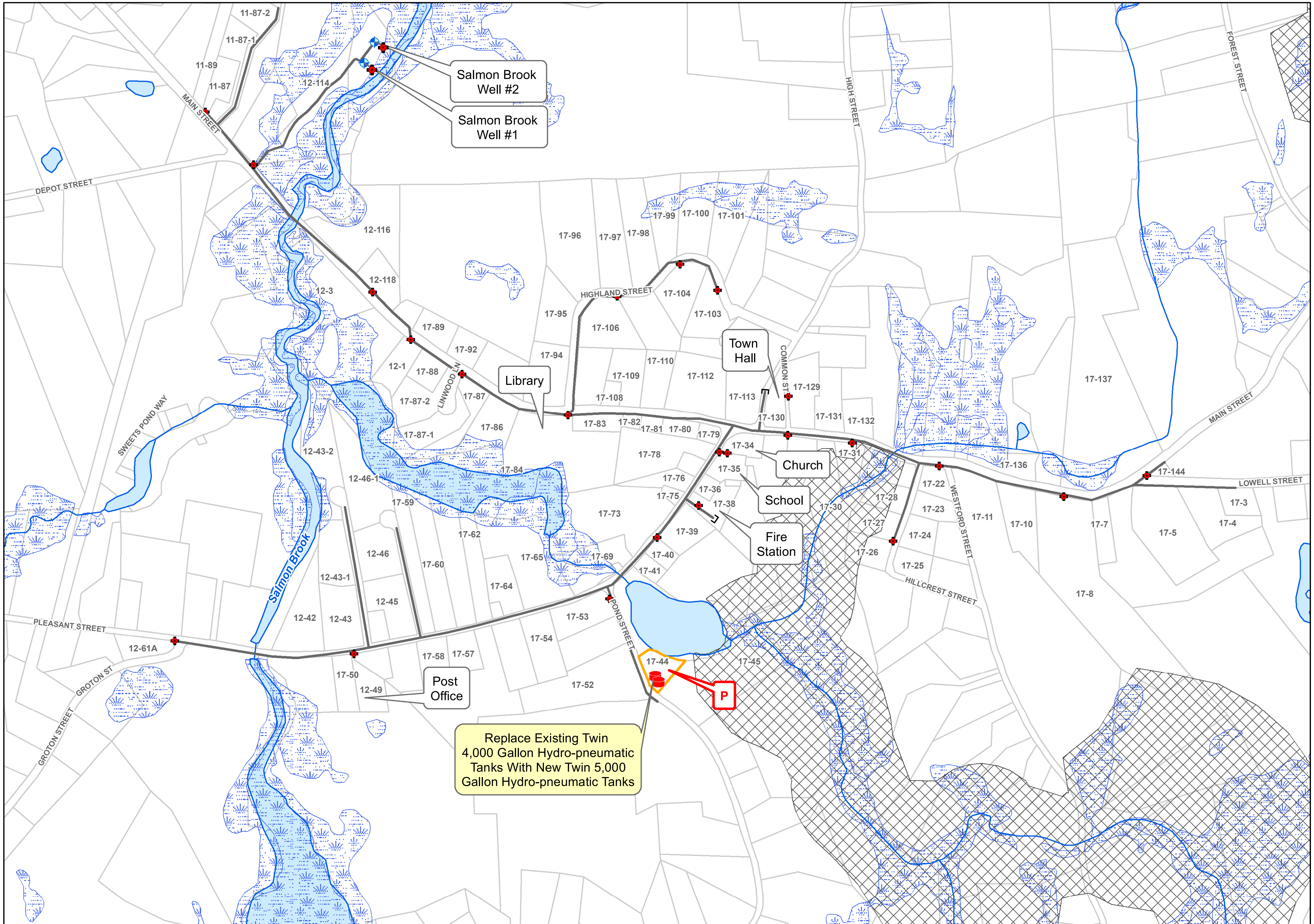
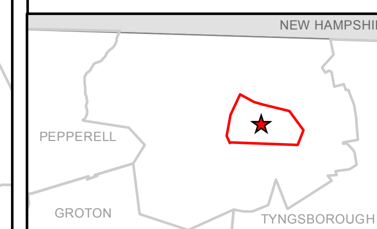


FIGURE 4-6
ALTERNATIVE 5

LEGEND

- Cap
- Hydrant
- Existing Well
- Tank
- Proposed Tank
- Existing Main
- Inland Wetlands
- Water Body
- NHESP Priority Habitats for Rare Species
- NHESP Estimated Habitats for Rare Wildlife
- Alternative Site
- Parcels

LOCUS MAP



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1:7,200

1 in = 600 ft

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Feet

NOTES

1. Based on MassGIS Level 3 Parcel Data Updated October 2013.

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

December 2014

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4.5 Alternative Cost Comparison

A summary of the costs of all 5 alternatives can be found in Table 4-5. The Basis of Design Report is meant as a comparison between alternatives. The estimates are appropriate for this stage of a project, however as a project develops there are items that will be added and items that will be subtracted based on Town preferences, bidding climate, material costs, site conditions, regulatory comments and permitting authority comments. A 20% project contingency is carried in this report which is appropriate for the planning stage of this type of project.

In addition to the capital costs each alternatives has operation and maintenance costs associated with it. All storage tanks will required routine visits and at a minimum annual inspection visits. A more thorough 5 year compressive inspection would also be recommended to be completed by a certified inspector and typical costs approximately $5,000. As a tank ages some of the ancillary components of a tank such as ladders, vents and hatches wear and break down and may need to be fixed. The Water Department should consider budgeting approximately $2,000 a year for this type of maintenance. However, little maintenance of this nature should be needed in the first few years after tank construction.

Metal tank such as welded steel require recoating after a period of time. Recoating is expensive and can be $20 to $30 per square foot of tank surface area, both external and internal to the tank. Tank coating projects are generally needed on the order of every 20 to 25 years.

For the alternatives that require a booster pump station the operation and maintenance costs would consist of the labor required to spend at the booster station, consumables such as electricity and the replacement of wear parts. The booster station would require daily visits to check on it and record daily data. The generator associated with the booster station would also require an annual maintenance visit. The combined O&M costs could be on the order of $20,000 to $25,000 a year with the majority of this being the labor cost. As the station ages additional repair costs would also be incurred.

Table 4-5 Opinion of Proable Cost - Alternatives 1 to 5

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the existing well site parcel at 711 Main Street	200,000 Gallon (usable) in a Glass Fused to Steel Standpipe on the Goldthwaite parcel at 33 Parkhurst Road	200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the possible Multi-Use District parcel at 164 Pleasant Street	200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the existing Library parcel at 588 Main Street	Replace hydro-pneumatic tanks in place at 30 Pond Street
Water Storage Tank Project Costs					
200,000 Gallon Concrete Tank with foundation	$420,000	n/a	$420,000	$420,000	n/a
200,000 Gallon (useable) Glass Fused to Steel Standpipe	n/a	$700,000	n/a	n/a	n/a
200,000 Gallon Composite Elevated Glassed Fused to Steel Tank	n/a	n/a	n/a	n/a	n/a
Tank Mixing System	$50,000	$50,000	$50,000	$50,000	n/a
Site Work (other that watermain and Access Road)	$400,000	$350,000	$300,000	$350,000	$100,000
Access Road	$0	$110,000	$75,000	$50,000	$0
Water Main Extension/Replacement not acounted for below	$60,000	$330,000	$150,000	$113,000	$0
Booster Pump Station	$500,000	n/a	$500,000	$500,000	n/a
Standby Generator	$50,000	n/a	$50,000	$50,000	n/a
Existing Well Station Modifications	$75,000	$25,000	$25,000	$25,000	n/a
Land Acquisition	n/a	TBD	n/a	n/a	n/a
New Building and Hydro-pneumatic Tanks	n/a	n/a	n/a	n/a	$350,000
Demolish Existing Hydro-pneumatic Tanks and Building	n/a	n/a	n/a	n/a	$50,000
Subtotal Tank Construction Costs	**$1,555,000**	**$1,565,000**	**$1,570,000**	**$1,558,000**	**$500,000**
Construction Contingency (20%)	$311,000	$313,000	$314,000	$311,600	$100,000
Engineering Allowance (15%)	$233,250	$234,750	$235,500	$233,700	$75,000
Total Water Storage Tank	**$2,099,250**	**$2,112,750**	**$2,119,500**	**$2,103,300**	**$675,000**
Water Main Replacement Project Costs (includes Contingency and Engineering)					
Main Street Water Main (2,000 l.f.)	$420,000	$420,000	$420,000	$420,000	n/a
Pleasant Street Water Main (1,800 l.f.)	$378,000	$378,000	$378,000	$378,000	n/a
Lowell Street Water Main (700 l.f.)	$147,000	$147,000	$147,000	$147,000	n/a
Hillcrest Street Water Main	$106,000	$106,000	$106,000	$106,000	n/a
Total Water Main Replacement Costs	**$1,051,000**	**$1,051,000**	**$1,051,000**	**$1,051,000**	**$0**
Total Project Costs	**$3,150,250**	**$3,163,750**	**$3,170,500**	**$3,154,300**	**$675,000**

Section 5 Recommendations

5.1 Summary of Costs

Table 5-1 presents a summary of the total costs for each of the alternatives considered.

Table 5-1
Summary of Cost Alternatives

Alternative No.	Description	Cost Opinion
1	200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the existing well site parcel at 711 Main Street	$3,150,250
2	200,000 Gallon (usable) in a Steel Standpipe on the Goldthwaite parcel at 33 Parkhurst Road	$3,163,750
3	200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the possible Multi-Use District parcel at 164 Pleasant Street	$3,170,500
4	200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the existing library parcel at 588 Main Street	$3,154,300
5	Replace hydro-pneumatic tanks in place at 30 Pond Street	$675,000

5.2 Recommendation

After reviewing each alternative, the cost to replace the hydro-pneumatic tanks is significantly lower than constructing a new water storage facility. However, replacing these tanks will not provide adequate water storage for the Water Department and is therefore not recommended.

Four other alternatives were considered, including constructing pumped storage facilities at three locations.

If the planned Multi-Use District proceeds in the near future, infrastructure improvements on Pleasant Street could be included as part of the development costs. In addition, construction of a storage facility at this location could be incorporated into the design of the Multi-Use District which could reduce the cost. If a new storage facility were constructed as part of this development, impacts to abutters could be minimized.

At this time, we recommend that the Water Department consider constructing Alternative 3; a 200,000 Gallon Concrete Ground Level Storage Tank and Booster Pump Station on the possible Multi-Use District parcel at 164 Pleasant Street.

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Appendix A

Tank Site Screening Plan

APPENDIX A
TANK SITE SCREENING PLAN

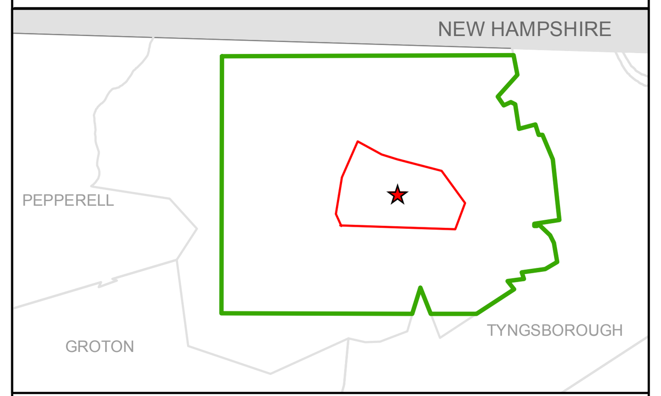
LEGEND

- Cap
- Existing Well
- Tank
- Hydrant
- Main

Contours (Elevation in Feet)

- Greater than 250 Feet
- 1 Mile Buffer
- 1/2 Mile Buffer
- Potential Tank Site
- Parcel Owned by the Town of Dunstable
- Parcels
- Town Boundary

LOCUS MAP



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1 in = 800 ft

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Feet

NOTES

1. Based on MassGIS Data - Level 3 parcel data updated October 2013 and 3m Contours updated June 2013.
2. Based on MassGIS Color Orthophotography (April 2011-2012)

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

December 2014

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Environmental Specialists

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D-0270

Appendix B

Top Five Tank Siting Alternatives Plan

APPENDIX B
TOP FIVE TANK SITING ALTERNATIVES PLAN

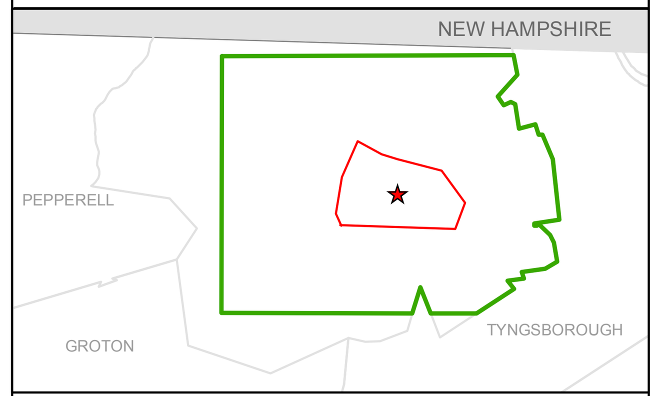
LEGEND

- Cap
- Existing Well
- Tank
- Hydrant
- Main

Contours (Elevation in Feet)

- Greater than 250 Feet
- 1/2 Mile Buffer
- 1 Mile Buffer
- Parcel Owned by the Town of Dunstable
- Parcels
- Town Boundary

LOCUS MAP



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1 in = 800 ft

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Feet

NOTES

1. Based on MassGIS Data - Level 3 parcel data updated October 2013 and 3m Contours updated June 2013.
2. Based on MassGIS Color Orthophotography (April 2011-2012)

Water Storage Basis of Design Report
Dunstable Water Department
Town of Dunstable, MA

December 2014

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Path: G:\GIS\MA\SiteLocus\Dunstable\Water\AppdxB_SitingAlts.mxd

D-0270

Appendix C

200,000-Gallon Tank Quote: Standpipe Glass-Fused-to-Steel

6010 Drott Drive
East Syracuse, NY 13057-2943
Toll Free: 800.H2O.TANK
Phone: 315.433.AQUA (2782)
Fax: 315.433.5083
Website: www.besttank.com
Email: aquastore@besttank.com

September 11, 2014

Tighe & Bond
446 Main St #23
Worcester, MA 01608
(508) 754-2201 Phone

Attention: Cassandra Stacy (clstacy@tighebond.com)

Re: **AQUASTORE®** Potable Water Ground Storage Tank
Dunstable, MA

Dear Cassandra:

Thank you for your continued interest in **AQUASTORE®** glass-fused-to-steel storage tanks. The following budget price is for the Concrete Floor, Aluminum Geodesic Dome, Potable Water Storage Tank that you are interested in. The tank is designed to AWWA D-103 allowables and manufactured to AWWA standards.

Design parameters for budget purposes are: Seismic based on category IV. Estimated soil bearing capacity of 4,000 PSF – Soil Site Class C, AWWA wind design and 65 PSF ground snow load.

- **NOTE: Foundation prices are ESTIMATES. Accurate soil bearing capacity, frost depth and any other pertinent information would be required to determine the exact design and costs of the foundation.**

- **The tank below provides approximately 7,770 gallons per foot or 209,700 gallons total in the noted 27-feet of elevation between 300 and 327 feet. The tank below is slightly taller, to utilize standard economical sizing, and will provide useable capacity above 300 feet (28'-3") of approximately 219,500 gallons.**

Model	Nominal Capacity (Gallons)	Actual Capacity w/Freeboard	Freeboard (Inches) Provided	Diameter (Feet)	Height (Feet)	Tank Price Only *(No Foundation)*	TOTAL PRICE Tank *(with Foundation)*
36 74	576,900	569,100	12"	36.37'	74.25'	$540,000	$680,000

NOT INCLUDED: Any and all site work** (including but not limited to) access roads, site preparation, excavation, backfill, backfill materials, rock or organic material removal, compaction/compaction testing), all site pipe (material and installation). Also **NOT** included: Lightning protection, mixing systems, fencing, any electrical, name sheets and water/disposal for tank testing. **Any permits, state or local sales and use taxes and bonds are not included.

The following items are included in the budget numbers:

- Forest Green Glass-Fused-To-Steel Shell Assembly with "**Edge Coating™**"
- Aluminum Geodesic Dome Roof Assembly with Gravity Vent and Safety Cable
- Concrete Floor, Foundation and Design (See Foundation Note)
- OSHA Compliant Exterior Ladder, Cage, Platform Assembly and Lockable Ladder Device
- (1) Standard Roof and (1) 24-inch Bottom Manway
- Aluminum Overflow Piping and Weir Box
- Exterior Protective Caps

continued on Page 2

- Sacrificial Anode Cathodic Protection System
- Tank Installation, Testing and Freight to Jobsite

The price in this quotation is valid for 30 days and based on Open Shop, Prevailing wage labor. If you have any questions, please do not hesitate to call. We would be glad to provide project specific specifications and drawings for **AQUASTORE®** tanks as needed. Thank you for the opportunity to offer budget prices for your consideration. We look forward to working with you as this project develops.

Respectfully,

Statewide Aquastore, Inc.

Harry J. Hagan
New England Regional Sales Manager
Office: 315-433-2782
Cell: 617-834-3985

cc: AMK; CLL; BCG file 4238

Appendix D

200,000-Gallon Tank Quote: Ground-Level Glass-Fused-to-Steel

6010 Drott Drive
East Syracuse, NY 13057-2943
Toll Free: 800.H2O.TANK
Phone: 315.433.AQUA (2782)
Fax: 315.433.5083
Website: www.besttank.com
Email: aquastore@besttank.com

September 5, 2014

Tighe & Bond
446 Main St #23
Worcester, MA 01608
(508) 754-2201 Phone

Attention: Cassandra Stacy (clstacy@tighebond.com)

Re: **AQUASTORE®** Potable Water Ground Storage Tanks
Dunstable, MA

Dear Cassandra:

Thank you for your continued interest in **AQUASTORE®** glass-fused-to-steel storage tanks. The following budget prices are for the concrete floor, potable water storage tanks that you are interested in. The tank is designed to AWWA D-103 allowables and manufactured to AWWA standards.

Design parameters for budget purposes are: Seismic based on category IV. Estimated soil bearing capacity of 4,000 PSF – Soil Site Class C, AWWA wind design and 65 PSF ground snow load.

- **NOTE: Foundation prices are ESTIMATES. Accurate soil bearing capacity, frost depth and any other pertinent information would be required to determine the exact design and costs of the foundation.**

Model	**Nominal Capacity (Gallons)**	**Actual Capacity w/Freeboard**	**Freeboard (Inches) Provided**	**Diameter (Feet)**	**Height (Feet)**	**Tank Price Only *(No Foundation)***	**TOTAL PRICE Tank *(with Foundation)***
20 97	218,800	216,600	12”	19.58’	97.16’	$340,000	$410,000
42 21 **Expandable to 40ft**	219,200	208,900	12”	41.96’	21.20’	$225,000	$285,000

- Model 42 21 tank can be expanded at a later date to a 40 ft (39.53’) overall sidewall height.
- The Nominal capacity of the expanded tank is 408,900 gallons and the usable capacity at 38.53’ liquid depth, is 398,500 gallons.
- Materials for the tank expansion will be quoted at a time when the expansion is imminent and are not included in this proposal.
- The above budget includes the additional design requirements to the tank/foundation that will allow for the future expansion to take place.

NOT INCLUDED: Any and all site work *(including but not limited to) access roads, site preparation, excavation, backfill, backfill materials, rock or organic material removal, compaction/compaction testing), all site pipe (material and installation). Also* ***NOT*** *included: Lightning protection, mixing systems, fencing, any electrical, name sheets and water/disposal for tank testing.* ***Any permits, state or local sales and use taxes and bonds are not included.***

The following items are included in the budget numbers:

- Cobalt Blue Glass-Fused-To-Steel Shell Assembly with “**Edge Coating™**”
- Aluminum Geodesic Dome Roof Assembly with Gravity Vent and Safety Cable **(Model 42 21 Only)**
- Glass-Fused-To-Steel Knuckle Roof Assembly with Gravity Vent & Walkway **(Model 20 97 Only)**
- Concrete Floor, Foundation and Design (See Foundation Note)
- OSHA Compliant Exterior Ladder, Cage, Platform Assembly and Lockable Ladder Device

continued on Page 2

- (1) Standard Roof and (1) 24-inch Bottom Manway
- Aluminum Overflow Piping and Weir Box
- Exterior Protective Caps
- Sacrificial Anode Cathodic Protection System
- Tank Installation, Testing and Freight to Jobsite

The price in this quotation is valid for 30 days and based on Open Shop, Prevailing wage labor. If you have any questions, please do not hesitate to call. We would be glad to provide project specific specifications and drawings for **AQUASTORE®** tanks as needed. Thank you for the opportunity to offer budget prices for your consideration. We look forward to working with you as this project develops.

Respectfully,

Statewide Aquastore, Inc.

Harry J. Hagan

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cc: AMK; CLL; EH file 4238

Appendix E

200,000-Gallon Tank Quote: Ground-Level Concrete

DYK and Natgun
Generations Strong

11 Teal Road, Wakefield, MA 01880 | 781.246.1133 | Fax 781.224.5163

November 14, 2014

Ms. Cassandra L. Stacy
Tighe & Bond
446 Main Street
Worcester, MA 01608

Reference: Updated Tank Pricing
Dunstable, Massachusetts

Dear Cassandra:

Thank you again for your inquiry regarding the proposed water storage tank in Dunstable. This letter provides confirmation of the proposed 300,000 gallon water storage tank as well as the alternative for the 200,000 gallon storage tank as requested this past week.

Based on 2015 construction costs, suitable budget-estimating figures for wire-wound, precast, prestressed concrete water storage tanks are as follows:

200,000 gallon tank with approximate dimensions of 41.25' diameter x 20' side water depth, with freestanding concrete dome roof:	$395,000.00
300,000 gallon tank with approximate dimensions of 50' diameter x 20' side water depth, with freestanding concrete dome roof:	$460,000.00

The above tanks are designed and constructed in accordance with AWWA standard D110, Type III, precast concrete walls with steel diaphragm, wire prestressing, and freestanding concrete dome roof.

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The budget-estimating figures include the basic tank complete with freestanding concrete dome roof, concrete floor and foundation, roof access hatch, vent, inlet/outlet pipe and overflow pipe. They do not include site work, access road, additional tank accessories or additional tank piping. Local, state, and federal taxes, if applicable, are not included in the above price. As noted, we suggest a contingency for additional safety and security accessories in the amount of $20-25,000.00. That would cover the additional cost for an exterior ladder with cage, roof safety railings, a security vent, etc. Please note the final cost for additional security and safety accessories will be based on the specific hardware selected.

As noted the tank pricing does not include site work.

To assist in developing the contract documents DN Tanks can provide you with the following information:

- Preliminary design drawings and calculations in electronic format
- Complete performance specification in electronic format
- Geotechnical requirements for wire-wound concrete tanks and geotechnical report review
- Value engineering from our Engineering and Estimating departments
- Site layout and estimated site work cost from our Estimating Department
- Review of preliminary drawings and specifications to provide updated tank and site work budget estimates

Thank you for the opportunity to be of service. Please feel free to contact me if you have any questions or if I can be of any further assistance.

Very truly yours,

DN TANKS

Christopher C Hodgson

Christopher C. Hodgson
Regional Manager

Appendix F

Booster Pump Station Quote

Cassandra,

Attached you will find a “Typical” drawing with approximate size and layout. Based on the correspondence we have received to date the station would include the following equipment:

One(1) Jockey Pump – 5 HP Operating at 35 GPM @ 170’ TDH
Two(2) Domestic Pumps – 10 HP operating at 100 GPM @ 170’ TDH
Two(2) High Flow Pumps – 75 HP operating at 750 GPM @170’ TDH.
One(1) 8” Mag Meter
One(1) 3” Mag Meter
One(1) 12” Altitude Valve
Isolation and check valves sized as shown.
Bare Variable Frequency drive for each pump
Control Panel with Allen Bradley PLC
Building to have Metal Siding.
Roof to be rubber membrane sloped ½” per foot.
If a more architectural look is required, we will need additional information to provide an additional cost.

The Level 1 Response for the station as show and described is $450,000 - $500,000. Please see description of Level 1 Response below.

LEVEL ONE RESPONSE

Initial inquiries will be responded to as “Level One. ”   Level One will be based upon the limited information we are initially provided.   Our response will include a preliminary scope summary and may also reference a prior project or plan view of similar scope.   The pricing provided with a Level One response is only our “Best Guess” with the limited information we are initially provided.

A price range will be provided with Level One. The range will vary depending upon the degree of uncertainty.   The range only includes anticipated variations in the EFI selling price due to unknowns.

Level One pricing is a guess.   It is NOT “EFI Budget” quality. Level One pricing MUST be upgraded to “Level Two” before using Level Two pricing for project funding purposes.

Dustin Diedrich
Project Manager
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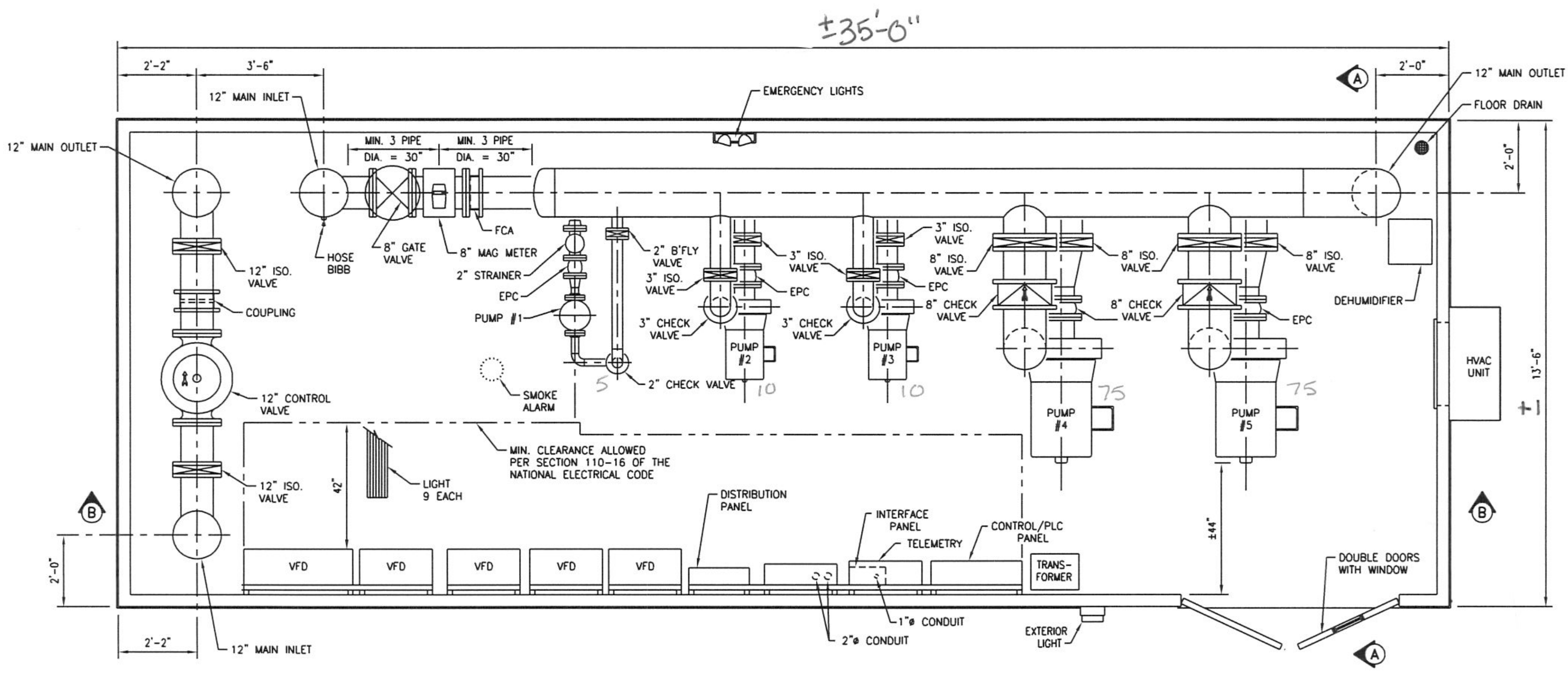
Not Shown
3" Low Flow Mag Meter
6" Pressure Relief Valve



PLAN

N.T.S.

Example Drawing
Dunstable, MA