Town of Southborough

Town of Southborough · Incorporated July 6, 1727 · Massachusetts

DEPARTMENT OF PUBLIC WORKS

147 CORDAVILLE ROAD • SOUTHBOROUGH, MASSACHUSETTS 01772-1802 • (508) 485-1210 • FAX (508) 229-4444

- The following preliminary/draft Water System Storage Tank Report is still in draft form.
- The findings in this report are being presented at the Public Works Planning Board's December 13, 2016 meeting, at 7pm at Cordaville Hall, 9 Cordaville Road.
- The PWPB intends on having a discussion with the Town's Water System Design Engineer and the public at their December 13th meeting.
- The final report will include items, ideas and public comment from the meeting.
- This will be the first of several meetings to discuss the Town's water system.

REPORT
Pare Project No. 08146.18

WATER SYSTEM STORAGE TANK EVALUATION

Southborough, Massachusetts

PREPARED FOR:

Town of Southborough
Department of Public Works
85 Cordaville Road
Southborough, MA

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DECEMBER 2016

PARE
CORPORATION

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INTRODUCTION

As requested, Pare Corporation (Pare) has performed an evaluation of a new water storage tank in the Town of Southborough's High Service Area (HSA). It has been previously identified that Southborough has an insufficient amount of storage for fire protection and emergency conditions. This deficiency was identified in a report prepared by H2O Engineering in early 2007, and confirmed by Pare in our original tank siting analysis performed later that same year, and reaffirmed in the Town's 2009 Water System Master Plan. This evaluation builds upon and is a continuation of the previous system studies listed above. While the need for additional storage has been an issue for many years, it has become even more critical with the prospect of the proposed Park Central development. The Park Central development could significantly increase system demand, and includes certain land areas that are too high to be served by the existing system storage tanks. In addition, the owner of Park Central expressed a willingness to provide the Town with a parcel for a new water storage tank. As a result, the Town thought it was a good opportunity to reinvigorate the evaluation and design of new system storage and evaluate whether or not the Park Central property is the best location for that storage.

The following sections include the methodology for Pare's study, the findings of our evaluation, and our conclusions based on those findings.

System Overview

The Town of Southborough (Town) owns and operates a water distribution system that serves a population of approximately 9,350 people. While the Town is primarily residential in nature, some dense commercial development exists along the Boston Worcester Turnpike (Rt. 9). Of the Town's current population, approximately 93 percent is connected to the distribution system. Over the last 3 years, system-wide consumption averaged approximately 1 million gallons per day (MGD) and increased to approximately 2.8 MGD in the summer. The Town's current sole source of supply is the Massachusetts Water Resource Authority (MWRA) via 2 connections to the Hultman Aqueduct, 1 connection to the Metrowest Water Supply Tunnel, and 1 direct connection to the John J. Carroll Water Treatment Plant. Existing customers are served by 3 water storage tanks, 2 pump stations, and 86 miles of transmission and distribution piping.

The system is operated as 2 distinct pressure zones, referred to as the High Service Area (HSA) and the Low Service Area (LSA). The boundary between the HSA and LSA runs generally north-south along Rt. 85 from the Marlborough town line to I-90. From I-90, the boundary runs roughly east-west from Rt. 85 to the Westborough town line. The eastern half of Town and locations south of I-90 are in the LSA. The remaining area north of I-90 and west of Rt. 85 is in the HSA (refer to Sheet 1 of 12 in the Appendix). The Town of Southborough's water system has 4 pressure-reducing valves (PRVs) designed to transfer water from the HSA to the LSA during times of peak water demand.

The LSA encompasses approximately 55 percent of the overall Town by area, and 60 percent of the population. The LSA operates at a hydraulic grade line (HGL) of approximately 493 feet mean sea level (MSL) and is served by the Hosmer Pump Station and the Oak Hill and Clear Hill storage tanks.

The HSA encompasses approximately 45 percent of the overall Town by area, and 40 percent of the population. The HSA operates at an HGL of approximately 515 feet MSL and is served by the Boland Pump Station and the Tara Road storage tank.

The Town of Southborough's water distribution system is made up of approximately 86 miles of water main, ranging in size from 6-inches to 12-inches in diameter.

The Town of Southborough has 3 water storage tanks, the Tara Road Tank (Fiddler's Green), the Oak Hill Tank, and the Clear Hill (Overlook) Tank. The Tara Road Tank is located in the HSA, while the Oak Hill Tank and the Clear Hill Tank are both located in the LSA. The following table describes the 3 water storage tanks.

TABLE 1: Southborough System Storage Tanks

	Tara Road (Fiddler's Green)	Clear Hill	Oak Hill
Nominal Size	1.300 MG	0.460 MG	0.275 MG
Diameter	67 ft	40 ft	25 ft
Base Elevation	467 ft	451 ft	418 ft
Overflow Elevation	515.0 ft	493.3 ft	492.7 ft
Operating Range	503.0 to 510.0 ft	482.0 to 488.0 ft	482.0 to 488.0 ft
Style	Standpipe	Standpipe	Standpipe
Year Built	1960	1930	1930
Location	Tara Road	Overlook Drive	Oak Hill Road

High Service Area System History

It is Pare's understanding, based on our review of past studies of the system, that the Southborough system was originally designed to serve areas of Town that have a ground surface elevation below 400 feet MSL. Originally, the system was designed and operated as 1 pressure gradient (i.e., no separate pressure zones) with an HGL of approximately 493 feet MSL, which is the overflow of the Oak Hill and Clear Hill tanks. The Tara Road tank was built in 1960, and has an overflow of 515 feet MSL. However, until 1988, the Tara Road tank was only ever filled to an elevation of approximately 493 feet MSL, which kept the entire system at 1 pressure gradient, or 1 pressure zone. The HSA was established in 1988, which effectively divided the Town into 2 pressure zones. The HSA raised the HGL of the western half of Town to 515 feet MSL, raising pressure by approximately 10 pound per square inch (psi), which was done to better serve areas that experienced low pressures due to higher ground surface elevations.

System Pressure

The Massachusetts Department of Environmental Protection Guidelines for Public Water System state that the normal working pressure in the distribution system should be approximately 60 – 80 psi and not less than 35 psi, and that all service connections shall have a minimum residual water pressure at street level of at least 20 psi under all design conditions of flow. Sheet 1 of 12 in the Appendix illustrates system pressures during a maximum day condition. When the Tara Road tank is full, customers above elevation 434 will experience pressures below 35 psi. These customers are generally located in the area immediately surrounding the Tara Road tank site.

System Storage

The distribution system currently has 1.30 MG of storage capacity in the HSA. The effective volume of storage, or usable storage, is defined by the American Water Works Association (AWWA) as the volume of water stored above an elevation that would provide a minimum allowable pressure under peak hour or maximum day demands during normal operating conditions. For this evaluation, effective storage was considered the volume of water above an elevation that would provide a minimum pressure of 20 psi to the highest customer.

Pare took the elevation of the highest service connection at the street level and added 46 feet (i.e., 20 psi x 2.31) to establish the minimum effective water level in the Tara Road tank. In the HSA, the highest service connection is approximately 450 feet MSL. Based on this service connection, the lowest water elevation in the Tara Road tank that can provide all customers with 20 psi is approximately 496 feet MSL. Therefore, the total effective storage volume in the HSA is about 0.50 MG (out of a total of 1.30 MG). The water stored in the tank below elevation 496 feet MSL (0.80 MG) would be considered ineffective, or unusable. This means that only the top 19 feet (38 percent) of the Tara Road tank is considered usable – if the water level falls below this level, customers will start to experience unacceptably low pressure (i.e., below 20 psi).

As stated in previous reports on system storage, there is no set requirement for how much storage a system must have to operate; it is typically considered prudent to size storage for normal use (equalization), fire flow events, and emergency conditions. Each system, depending on its size and the adequacy of its supply pumps, will determine how much storage is necessary to satisfy these requirements. For this evaluation, Pare calculated the required storage for the HSA as described below. Please note that as a planning tool, Pare utilized projected demand information for a scenario in the future when the Town is built out to its maximum density based on current zoning. This was done to make sure that future storage is sized appropriately for current and future system demand.

Equalization storage: Equalization storage is the amount of water required to meet demands in excess of the production capability. Currently, Southborough's production capacity is greater than the system's maximum day demand. Therefore, the amount of storage required for normal use should be at least enough to meet demands above maximum day demand up to peak hour demands (which is generally the system's highest short-term demand scenario). Based on the water use patterns in the system, which were last evaluated as part of the 2009 Master Plan, the volume of equalization storage required to meet peak hour demands is approximately 15 percent of maximum day demand. The build-out maximum day demand in the HSA is projected to be approximately 1.8 million gallons (MG), and therefore equalization storage should be approximately 270,000 gallons (1,800,000 gallons x 0.15).

Fire storage: The quantity of distribution system storage necessary for fire protection is based on the fire flow requirements established by the Insurance Services Office (ISO). The required fire storage volume is determined by multiplying the required flow duration (in minutes) by the maximum fire flow (in gallon per minute) in the service area. Based on ISO's report dated March 1990, the highest required fire flow in the HSA is near the Trottier School and is 3,000 gpm. As referenced in AWWA M31 Distribution System Requirements for Fire Protection, the required flow duration for a required fire flow of 3,000 gpm is 3 hours (180 minutes), which results in a required storage volume in the HSA of 540,000 gallons.

Emergency Storage: Finally, a system should have adequate emergency storage to prevent serious disruptions in service in the event of a water main break or other emergency situation. In this case, Pare assumed 20 percent of an average day would be adequate for emergency volume to initiate emergency response. Therefore, the recommended emergency storage in the HSA is approximately 160,000 gallons. In the event that all effective storage was depleted, the Town would have to rely on the ineffective storage, which may result in system pressure dropping below 20 psi for some customers.

As defined above, the total effective volume of storage recommended in the HSA is the sum of the required equalization storage, fire storage, and emergency storage, which is approximately 970,000 gallons (270,000 + 540,000 + 160,000). The total deficit in recommended effective storage is approximately 0.47 MG (0.97 – 0.50). That is to say, to achieve the total volume of effective storage recommended in the HSA, the Town would have to add approximately 0.47 MG of effective storage.

System Available Fire Flow

The available fire flow in a water system is defined as the maximum amount of flow available at a hydrant while maintaining a minimum residual pressure of 20 psi in the system. Pare utilized the Town of Southborough's computerized hydraulic model developed as part of the 2009 Master Plan to estimate the available fire flow. Refer to Sheet 2 of 12 in the Appendix for system-wide available fire flows.

The 2009 Master Plan identified certain areas of Town that had deficient fire flow ratings, which is to say these areas of Town did not have as much available fire flow as required by ISO. The required fire flows that were identified as deficient in the 2009 Master Plan are identified in Table 2.

TABLE 2: Fire Flow Analysis (High Service Area)

	Location	Needed Fire Flow based on ISO Requirements	Available Fire Flow	
			Based on ISO's Flow Tests	**Based on Computer Modeling**
1.	Neary School (near Trottier School)	3,000 gpm	1,900 gpm	2,300 gpm
2.	Mary E. Finn School	2,250 gpm	1,500 gpm	2,400 gpm
3.	Highland Street @ Parkerville Road	1,500 gpm	1,200 gpm	2,360 gpm

The Southborough DPW has completed multiple distribution system improvements since the 2009 Master Plan, which include the following:

- Upgrades to the Boland Pumping Station to increase water supply to the HSA;
- Upgrades to the 4 system PRVs to move water from the HSA to the LSA;
- Water main upgrades on Parkerville Road to address the fire flow deficiency at the Finn School;

- Supervisory control and data acquisition (SCADA) system upgrades to improve real-time system operation and response to system emergencies; and
- Water main upgrades at 2 locations on Rt. 9 to improve dependability of system piping.

As in the 2009 Master Plan and previous studies completed, the recommendation for additional storage in the HSA and improved fire flow to the Trottier School area is still an outstanding concern.

METHODOLOGY

In 2007, a tank siting analysis was completed in which 25 potential tank sites were evaluated. Only 6 of those 25 sites had adequate ground surface elevations where pumping would not be required. At the time, 3 of those 6 sites were considered cost-effective sites for a new tank. Those 3 sites included the existing Tara Road tank site, the Town-owned parcel located off of Deerfoot Road (Fairview Hill), and the Flatly property (now part of the proposed Park Central development). When evaluating new tank alternatives as part of this study, Pare only considered those 3 tank sites.

Pare, in conjunction with the Town and the Public Works Planning Board, developed and evaluated 5 options for a new HSA tank. Each option was evaluated for its ability to address the system's most critical needs (i.e., increase effective storage and increase available fire flow). Pare utilized the Town's computerized hydraulic model to evaluate each option and its impact on system pressure and available fire flow.

Each option was also evaluated against other important criteria, such as their impact on system pressure, their potential impact on water quality, and their impact on system redundancy. Redundancy is important because it allows one tank to come out of service for maintenance and repairs without significant disruptions to water service. Pressure is a complex criterion because, as is the case in Southborough, it can be difficult to increase areas with low pressure without over-pressurizing areas with high pressure. Water quality comes into consideration when evaluating overall storage volume. Too much water in storage can lead to an increase in system water age, and ultimately poor water quality.

Finally, for each option, Pare developed an opinion of probable construction cost, and estimated how much each option would cost in terms of the dollars spent for each gallon of effective (usable) storage gained.

Please note that Pare utilized readily and publically available mapping information when evaluating tank sizes and locations. In some cases, elevation information utilized by Pare for this study is only accurate to within ±5 feet. As such, the tank sizes described below should be considered preliminary and may change based on actual ground surface elevations established during the final design of the tank.

Option 1: Replace the existing 1.3 MG Tara Road tank with a larger 2.5 MG tank; while maintaining the existing HGL of 515 feet MSL in the HSA.

Option 1A: Keep the existing Tara Road tank in service and build a second tank in the HSA on the Fairview Hill site. The new tank would be 1.5 MG and have an overflow elevation of 515 feet MSL, the same as the existing Tara Road tank.

Option 1B: Keep the existing Tara Road tank in service and build a second tank in the HSA on the Fairview Hill site. The new tank would be 1.5 MG and have an overflow elevation of 515 feet MSL, the same as the existing Tara Road tank. This option would also include a new water main connecting Fairview Drive and Deerfoot Road.

Option 2: Replace the existing Tara Road tank with a taller tank that would increase pressure in the HSA by approximately 17 psi. This new taller tank would have an overflow elevation of approximately 555 feet MSL and would be approximately 1.3 MG. Because of the increase in system pressure, certain areas of the HSA would have to be moved into the LSA to avoid over-pressurizing those customers. As a result, the demand in the HSA would go down, resulting in the need for slightly less effective storage, approximately 0.86 MG.

Option 3: Build a new taller tank on the Park Central property. This tank would be approximately 0.75 MG and would have an overflow elevation of approximately 590 feet MSL. This new tank would be the basis for a new pressure zone in the system, referred to as the Extra High Service Area (EHSA). Under this option, the Tara Road tank would remain in service, but certain areas of the HSA would be converted to the new EHSA and served from the new taller tank. This option would require the installation of a new booster pump station to move water from the HSA to the EHSA.

Advantages/Disadvantages Discussion

The following section summarizes the relative advantages and disadvantages of each option based on their relative impact to effective storage volume, system pressures, available fire flow, and system redundancy. Pare's opinion of probable construction cost for each option is provided as well.

Option 1 (2.5 MG replacement tank at Tara Road)

- Advantages
  - This option would increase the overall storage volume in the HSA, and specifically would add an additional 0.5 MG of effective storage, which would result in the recommended total effective storage volume of 0.97 MG.
- Disadvantages
  - This option would not result in an increase in pressure in areas that have relatively low pressure (refer to Sheet 3 of 12 in the Appendix).
  - This option would not improve fire flow in the HSA (refer to Sheet 4 of 12 in the Appendix).
  - This option would add an additional 0.78 MG of ineffective storage in the HSA, which could create water quality issues.
  - This option will not provide for any new redundancy in storage.

Pare's opinion of probable construction cost for this option is **$4.4 M.**

Option 1A (New 1.5 MG tank at Fairview Hill)

- Advantages
  - This option would increase the overall storage volume in the HSA, and specifically would add an additional 0.48 MG of effective storage, resulting in a total of 0.98 MG of effective storage.
  - This option would improve fire flow to some areas of the HSA (refer to Sheet 6 of 12 in the Appendix), particularly in the area of the Trottier School.
  - This option would create significant redundancy in HSA storage.

- Disadvantages
  - This option would not increase pressure in the HSA; however, some customers may experience more stable pressure than they experience currently (refer to Sheet 5 of 12 in the Appendix).
  - This option would create an additional 1 MG of ineffective storage.

Pare's opinion of probable construction costs for this option is **$3.9 M.**

Option 1B (New 1.5 MG tank at Fairview Hill with new connection to Deerfoot Road)

- Advantages
  - This option would increase the overall storage volume in the HSA, and would specifically add 0.48 MG of effective storage, increasing the effective storage to 0.98 MG.
  - This option would improve fire flow to some areas of the HSA (Refer to Sheet 8 of 12 in the Appendix), particularly the area around the Trottier School. This option would also improve fire flows above and beyond the improvements realized as part of Option 1A.
  - This option would create significant redundancy in storage.
- Disadvantages
  - This option would not increase pressure in the HSA; however, some customers may experience more stable pressure (Refer to Sheet 7 of 12 in the Appendix).
  - This option would add an additional 1 MG of ineffective storage to the HSA.
  - This option is more costly than Option 1A.

Pare's opinion of probable construction cost for this option is **$4.8 M.**

Option 2 (1.3 MG replacement ground storage tank at Tara Road)

- Advantages
  - This results in adequate equalization and fire storage as recommended above.
  - This option would increase pressure to areas in the HSA that currently experience relatively low pressure, providing everybody a minimum of 35 psi during normal operating conditions (refer to Sheet 4 of 12 in the Appendix).
  - This option would increase fire flow in the HSA (refer to Sheet 10 of 12 in the Appendix).
  - Effective storage volume would increase from 38% of overall storage to 67%.

- Disadvantages
  - This option would increase pressure too much for some customers that already get high pressure (refer to Sheet 9 of 12 in the Appendix).
  - To mitigate excessively high pressures, this option would necessitate a modification to the zone boundary between the HSA and the LSA. This option would require relocating the 4 existing PRV zone valves, which adds cost to this option. Even with the relocation of the PRVs, some areas would experience pressure in excess of 120 psi.
  - As a result of the zone boundary modification, this option would increase the size of the LSA, which would add demand on the Hosmer Pump Station.
  - While fire flow would be improved in some areas of the HSA, the area around the Trottier School would still have less than 3,000 gpm of available fire flow.
  - This option would do nothing to improve system redundancy in the HSA.

Pare's opinion of probable construction cost for this option is **$5.0 M.**

Option 3 (New 0.75 MG elevated tank at Park Central)

- Advantages
  - This option results in adequate equalization and fire storage by sharing water from the EHSA to the HSA.
  - Customers in the HSA that experience pressure less than 35 psi during normal operating periods would be transferred to the EHSA, and as a result would experience an increase in pressure of approximately 32 psi (refer to Sheet 11 of 12 in the Appendix).
  - This option would increase fire flow in the HSA (refer to Sheet 12 of 12 in the Appendix).
  - This option would expand the water system capacity to serve future development at higher elevations around the Park Central development.
  - The effective storage volume in the existing Tara Road tank would increase from 38% of overall storage to 70%.

- Disadvantages
  - This option would require a new booster pump station near Tara Road tank, which would add cost to the project.
  - This would require new PRVs along the EHSA/HSA boundary.

– This option would do little to improve system redundancy in the HSA.

Pare's opinion of probable construction costs for this option is **$6.2 M.**

The following table summarizes the each option relative to Pare's evaluation criteria.

TABLE 3 – TANK OPTION SUMMARY TABLE

Tank Option	Cost	Cost/gallon (usable)	Pressure	Fire Flow	Unusable Storage	Promotes System Redundancy
1	$4.4M	$8.00/gal	No Change	No Change	1.95 MG	No
1A	$3.9M	$15.00/gal	No Change	Modest Improvement	1.14 MG	Yes
1B	$4.8M	$18.46/gal	No Change	Significant Improvement	1.14 MG	Yes
2	$5.0M	$7.25/gal	Increase (18 psi)	Modest Improvement	0.51 MG	No
3	$6.2M	$4.77/gal	Increase (32 psi)	Modest Improvement	0.07 MG	No

Option Screening

To screen out the least desirable options, Pare prepared a simple comparison table of each option and the 6 evaluation criteria discussed above, which include:

- Cost;
- Cost per gallon (effective or usable);
- Impact to pressure;
- Impact to available fire flow;
- Water quality (ineffective or unusable storage); and
- Whether or not the option promotes redundancy.

Each option was rated on a scale of 1 to 5, with 5 being the most advantageous and 1 being the least advantageous. Each criteria was assigned a weight based on its relative importance to the overall importance – the weighting is on a percentage basis with all 6 criteria adding up to 100 percent. Each option's score (1 through 5) was multiplied by the weighted criteria to come up with a weighted total. The highest weighted total represents the most advantageous option, while the lowest weighted total represents the least advantageous option.

As a starting point, Pare weighted each criteria with equal value (16.7 percent), as if each criteria has the same level of importance in the decision making process. That is to say, the *total cost* of a particular option is weighted the same as the impact it would have on *fire flow* or *pressure*. It is unlikely that each of these criteria are equally important, but this represents the first trial of the screening process.

TABLE 4 – EQUAL WEIGHTED SCREENING

Tank Option	Cost	Cost/gallon (usable)	Pressure	Fire Flow	Unusable Storage	Promotes Redundancy	Weighted Total
Weighted Percentage	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	
1	4	3	1	1	1	1	1.8
1A	5	2	2	4	2.5	5	3.4
1B	3	1	3	5	2.5	5	3.3
2	2	4	4	2	4	1	2.8
3	1	5	5	3	5	1	3.3

When all the criteria are weighted equally, Option 1A, the new tank on the Fairview site, appears to be the most advantageous. It is notable that Option 3, the option that creates a new pressure zone, has a similar weighted score

For comparison, Pare varied the weighting criteria to reflect the significance of each criterion as Pare perceives them, based on our past experience with other similar tank projects. For this example, Pare increased the value of the *cost* and *available fire flow*, which tend to carry significant weight in these types of projects. Pare reduced slightly the *cost per gallon* and the impact on *system redundancy*, which are both important factors, but less so than *total cost* and *fire flow*. Finally, Pare reduced weight of *pressure impacts* and *unusable storage*, which in this case seem to be relatively minor concerns.

TABLE 5 – WEIGHTED SCREENING (1ST VARIATION)

Tank Option	Cost	Cost/gallon (usable)	Pressure	Fire Flow	Unusable Storage	Promotes Redundancy	Weighted Total
Weighted Percentage	25%	15%	10%	25%	10%	15%	
1	4	3	1	1	1	1	2.1
1A	5	2	2	4	2.5	5	3.8
1B	3	1	3	5	2.5	5	3.5
2	2	4	4	2	4	1	2.6
3	1	5	5	3	5	1	2.9

When the weighting of each criterion was changed to reflect a somewhat more typical weighting scheme, the new tank on the Fairview site appears to be the most advantageous option.

Based on feedback received during Public Works Planning Board meetings, Pare varied the weighting of the evaluation criteria to reflect different concerns of the Board. For example, the Board thought that *total cost* and *fire flow* were the most important criteria, but the *cost per gallon of usable storage* was a somewhat arbitrary criterion and therefore not necessarily worth considering. The Board also thought that *volume of unusable storage* was a relatively insignificant criterion given that none of the options result in excessive amounts of unusable storage. Based on this feedback, 2 additional screening variations were generated. The first variation increases the weight of *total cost* and reduces the weight given to *cost per gallon of usable storage*. The second increases the weight of *total cost* and *fire flow*, and reduces the weight of *unusable storage* and *cost per gallon of usable storage*.

TABLE 6 – WEIGHTED SCREENING (2ND VARIATION)

Tank Option	Cost	Cost/gallon (usable)	Pressure	Fire Flow	Unusable Storage	Promotes Redundancy	Weighted Total
Weighted Percentage	40%	0%	10%	25%	10%	15%	
1	4	3	1	1	1	1	2.2
1A	5	2	2	4	2.5	5	4.2
1B	3	1	3	5	2.5	5	3.8
2	2	4	4	2	4	1	2.3
3	1	5	5	3	5	1	2.3

TABLE 7 – WEIGHTED SCREENING (3RD VARIATION)

Tank Option	Cost	Cost/gallon (usable)	Pressure	Fire Flow	Unusable Storage	Promotes Redundancy	Weighted Total
Weighted Percentage	40%	0%	10%	35%	0%	15%	
1	4	3	1	1	1	1	2.2
1A	5	2	2	4	2.5	5	4.4
1B	3	1	3	5	2.5	5	4.0
2	2	4	4	2	4	1	2.1
3	1	5	5	3	5	1	2.1

For both these variations, the new tank on the Fairview site appears to be the most advantageous option.

Finally, Pare generated a screening variation that removed cost considerations from the screening evaluation entirely, to see if any option stands out as clear leader if cost were not an issue. For this variation, weight of the *total cost* and *cost per usable gallon* was distributed over the other criteria.

TABLE 8 – WEIGHTED SCREENING (4th VARIATION)

Tank Option	Cost	Cost/gallon (usable)	Pressure	Fire Flow	Unusable Storage	Promotes Redundancy	Weighted Total
Weighted Percentage	0%	0%	25%	40%	10%	25%	
1	4	3	1	1	1	1	1.0
1A	5	2	2	4	2.5	5	3.6
1B	3	1	3	5	2.5	5	4.3
2	2	4	4	2	4	1	2.5
3	1	5	5	3	5	1	3.2

When cost considerations are eliminated from the decision making process, the Fairview site appears to be the most advantageous; however, the option with the new water main between Fairview and Deerfoot appears to be more advantageous than the option without.

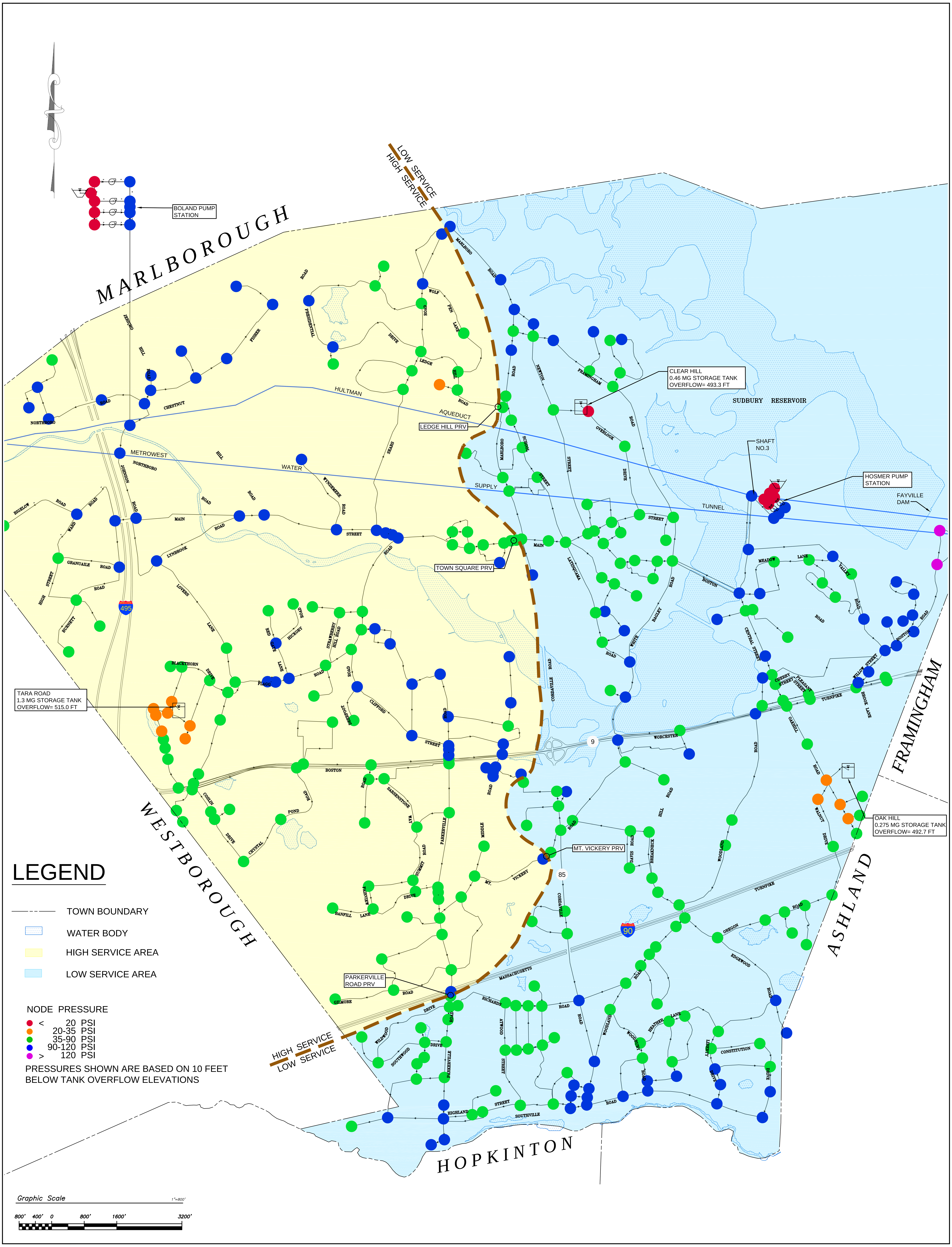
CONCLUSIONS

Based on the comparisons presented above, feedback provided by the Public Works Planning Board, and the evaluation work completed by Pare, it is apparent that Options 1A and 1B (a new tank located at the Fairview Hill site) achieve the primary objectives of this project – increasing usable storage and improving fire protection, while doing so at the lowest cost of all the options reviewed. Options 1A and 1B are also the only two options that truly create redundancy in system storage.

It is important to note that the screening process used as part of this project is relatively subjective and could vary significantly based on how each criteria is weighted. However, all five (5) of the screening variations presented above indicate that Options 1A and 1B are the most advantageous options, and therefore there seems to be compelling evidence that Option 1A, and to a lesser degree Option 1B, provide the most balance relative to cost and technical concerns.

APPENDIX A

System Pressure and Available Fire Flow Drawings



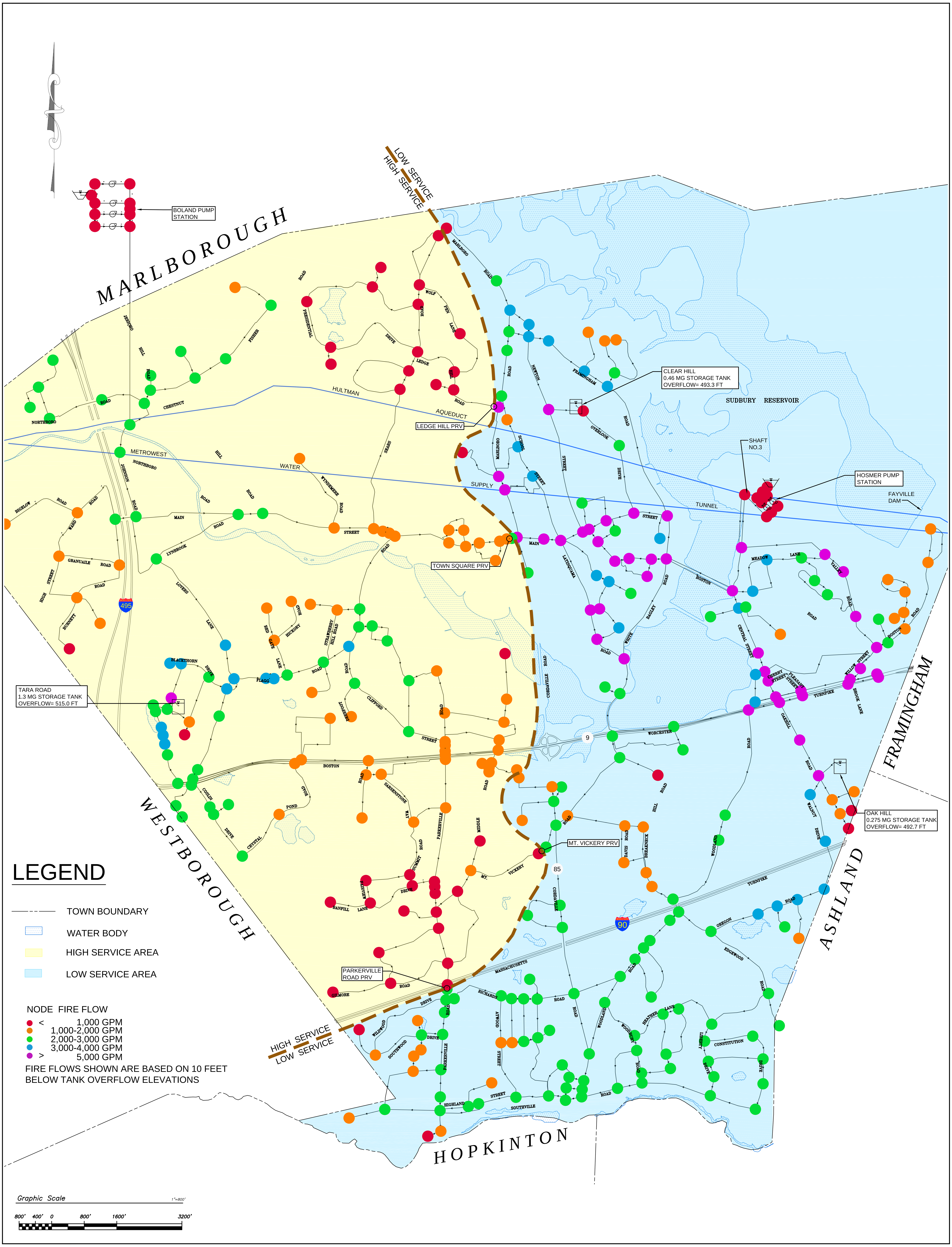
PARE CORPORATION ENGINEERS - SCIENTISTS - PLANNERS 8 BLACKSTONE VALLEY PLACE LINCOLN, RI 02865 401-334-4100	TOWN OF SOUTHBOROUGH WATER SYSTEM MASTER PLAN SOUTHBOROUGH, MASSACHUSETTS	DRAWING TITLE: MDD PRESSURE EX. CONDITIONS

REVISIONS:

PROJECT NO.:	08176.15
DATE:	NOVEMBER 2016
SCALE:	1"=800'
DESIGNED BY:	SPD
CHECKED BY:	LMG
DRAWN BY:	AKL
APPROVED BY:	TPT

DRAWING NO.:

SHEET NO. 1 OF 12



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TOWN OF SOUTHBOROUGH
WATER SYSTEM MASTER PLAN

SOUTHBOROUGH, MASSACHUSETTS

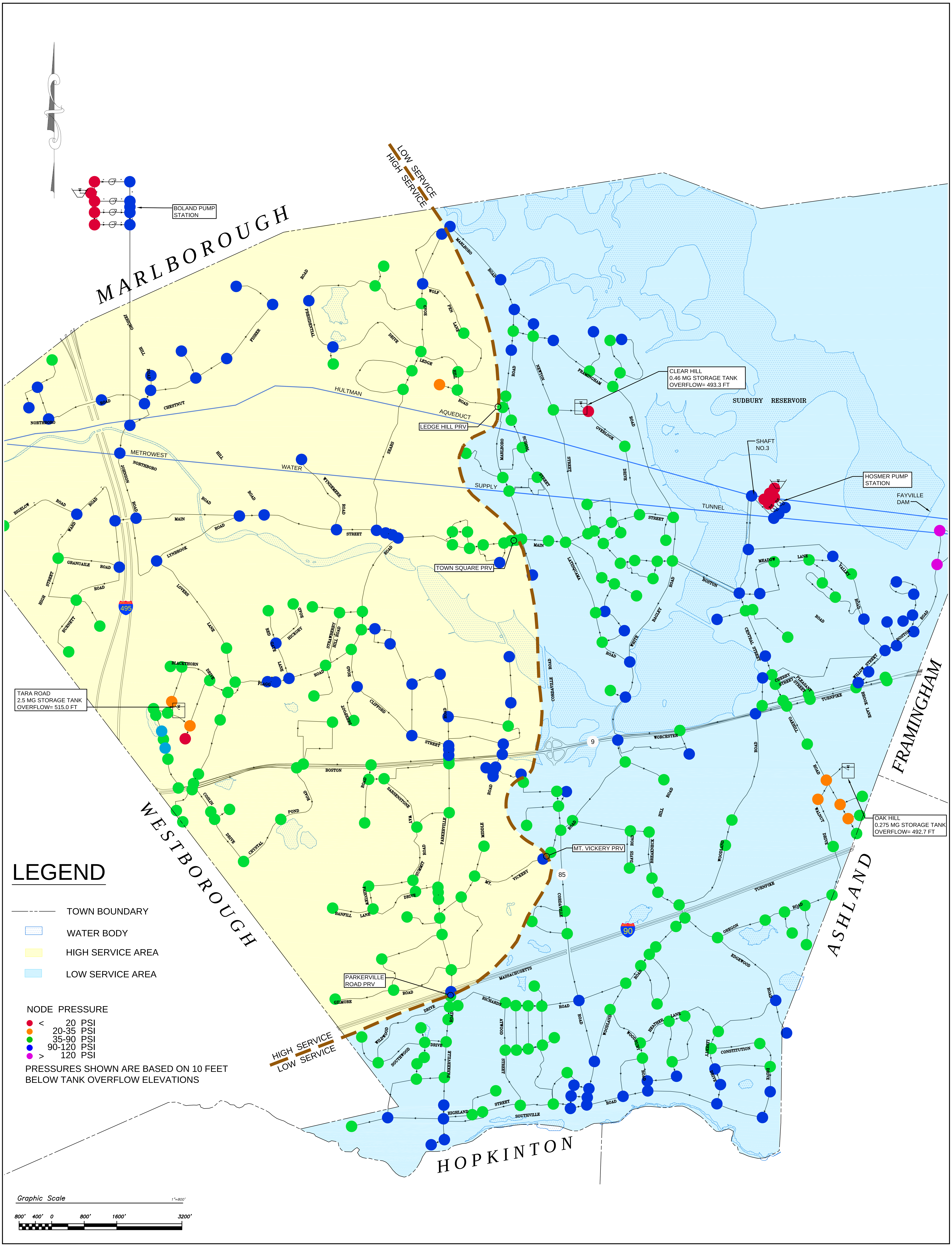
REVISIONS:		

PROJECT NO.:	08176.15
DATE:	NOVEMBER 2016
SCALE:	1"=800'
DESIGNED BY:	SPD
CHECKED BY:	LMG
DRAWN BY:	AKL
APPROVED BY:	TPT

DRAWING TITLE:
FIRE FLOW
EX. CONDITIONS

DRAWING NO.:

SHEET NO. 2 OF 12



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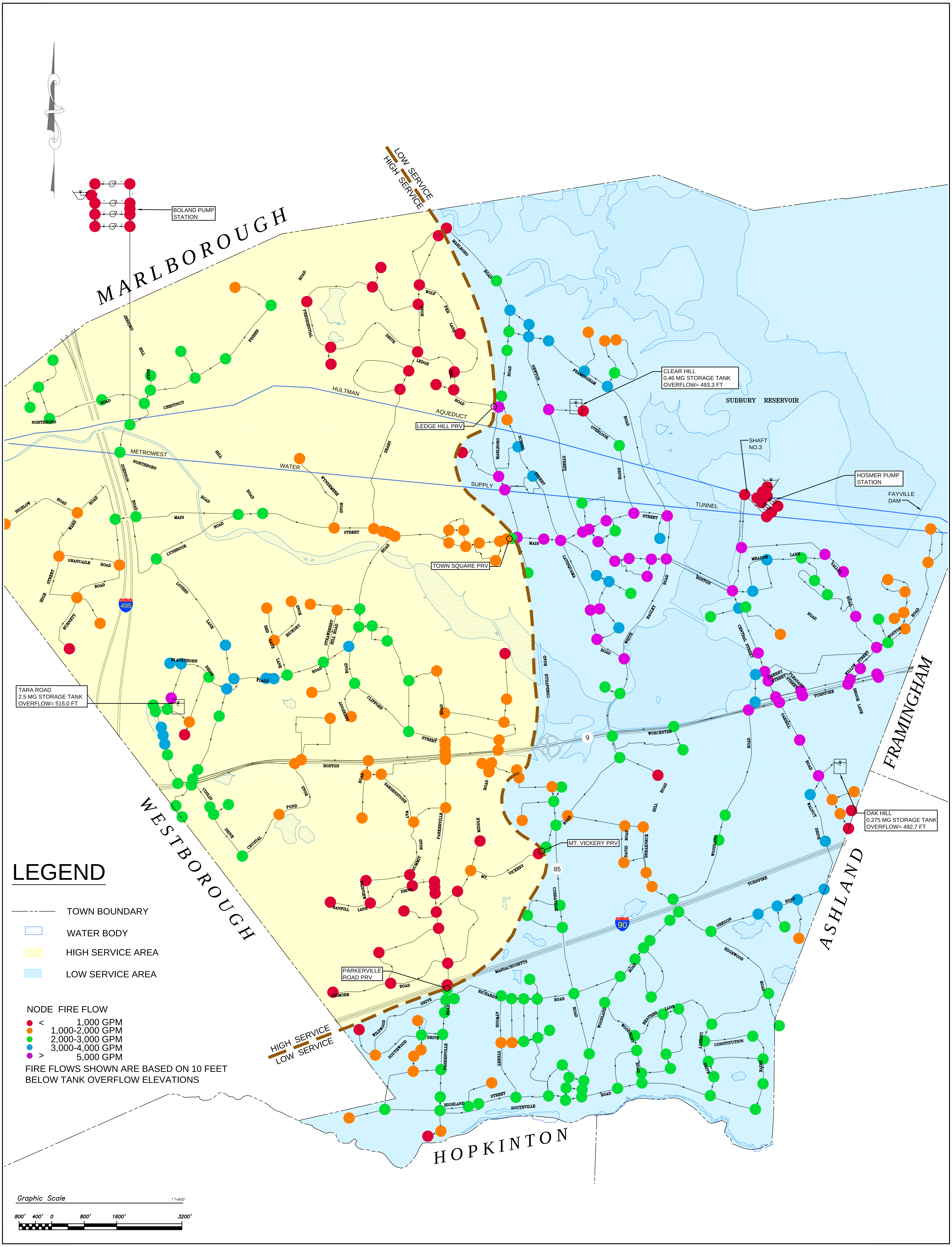
SOUTHBOROUGH, MASSACHUSETTS

REVISIONS:		
	PROJECT NO.:	08176.15
	DATE:	NOVEMBER 2016
	SCALE:	1"=800'
	DESIGNED BY:	SPD
	CHECKED BY:	LMG
	DRAWN BY:	AKL
	APPROVED BY:	TPT

DRAWING TITLE: MDD PRESSURE OPTION 1

DRAWING NO.:

SHEET NO. 3 OF 12



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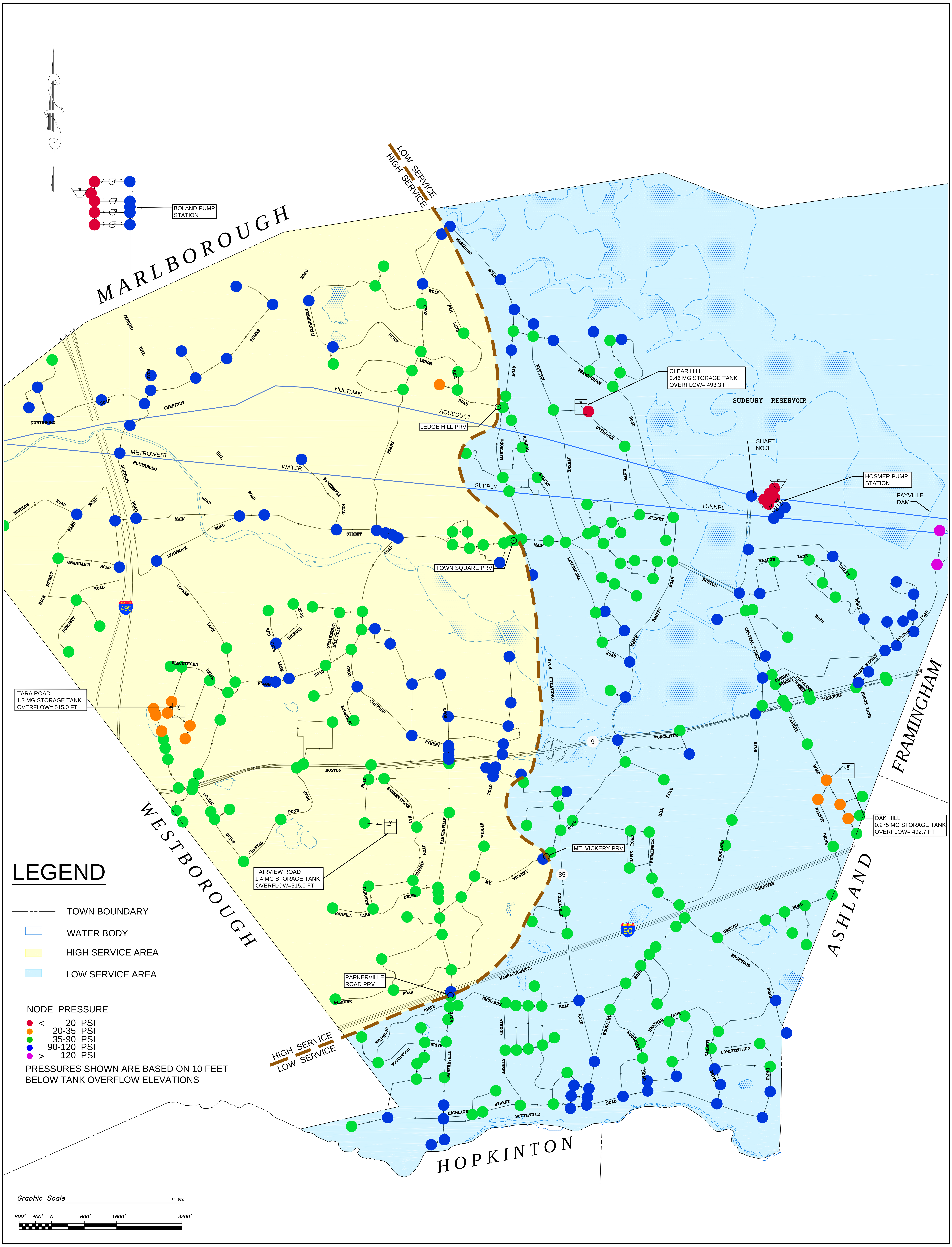
DRAWN BY:	AKL
APPROVED BY:	TPT

DRAWING TITLE:
FIRE FLOW OPTION 1

DRAWING NO.:

SHEET NO. 4 OF 12



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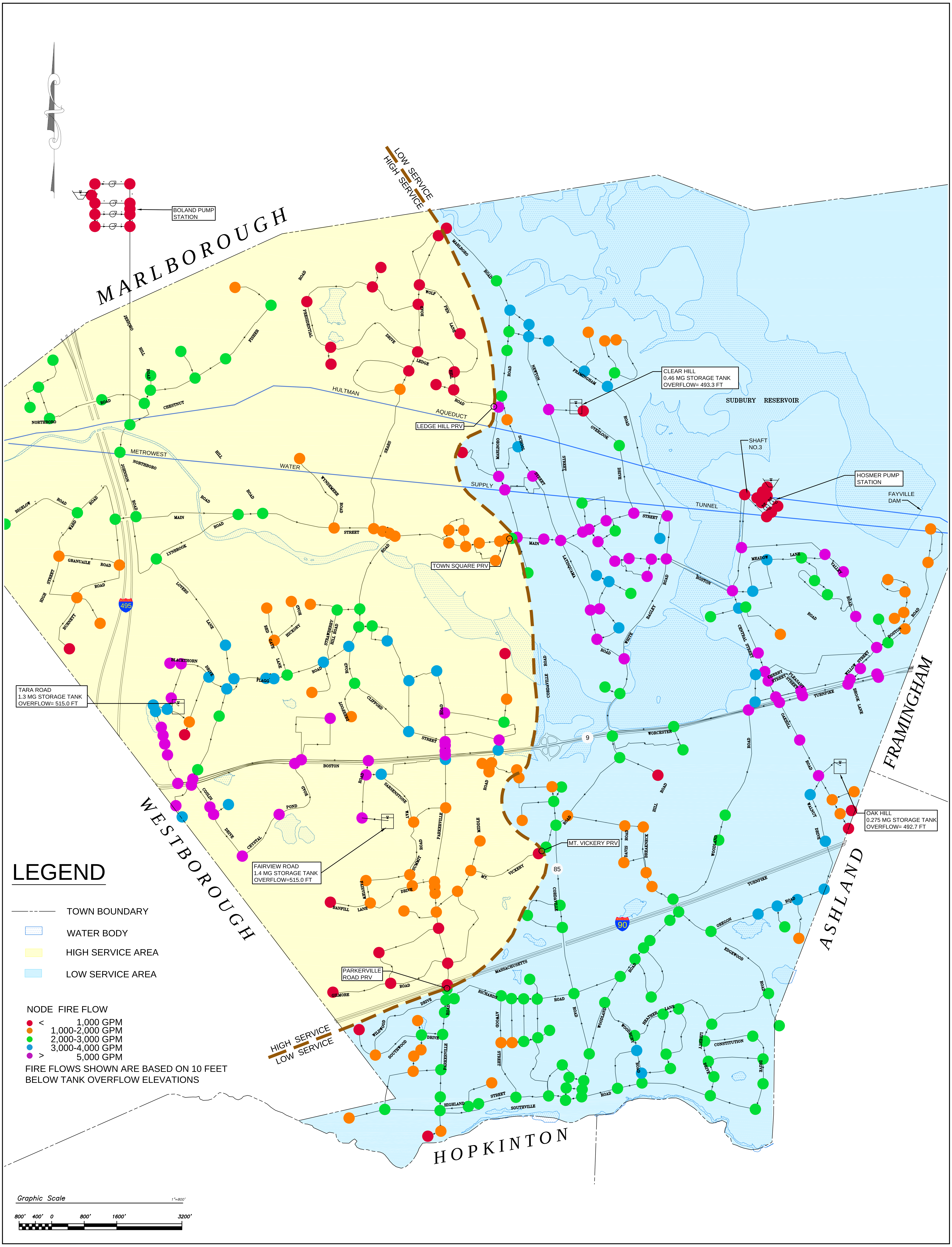
REVISIONS:		
PROJECT NO.:	08176.15	DRAWING TITLE: MDD PRESSURE OPTION 1A
DATE:	NOVEMBER 2016	
SCALE:	1"=800'	
DESIGNED BY:	SPD	DRAWING NO.:
CHECKED BY:	LMG	
DRAWN BY:	AKL	
APPROVED BY:	TPT	SHEET NO. 5 OF 12



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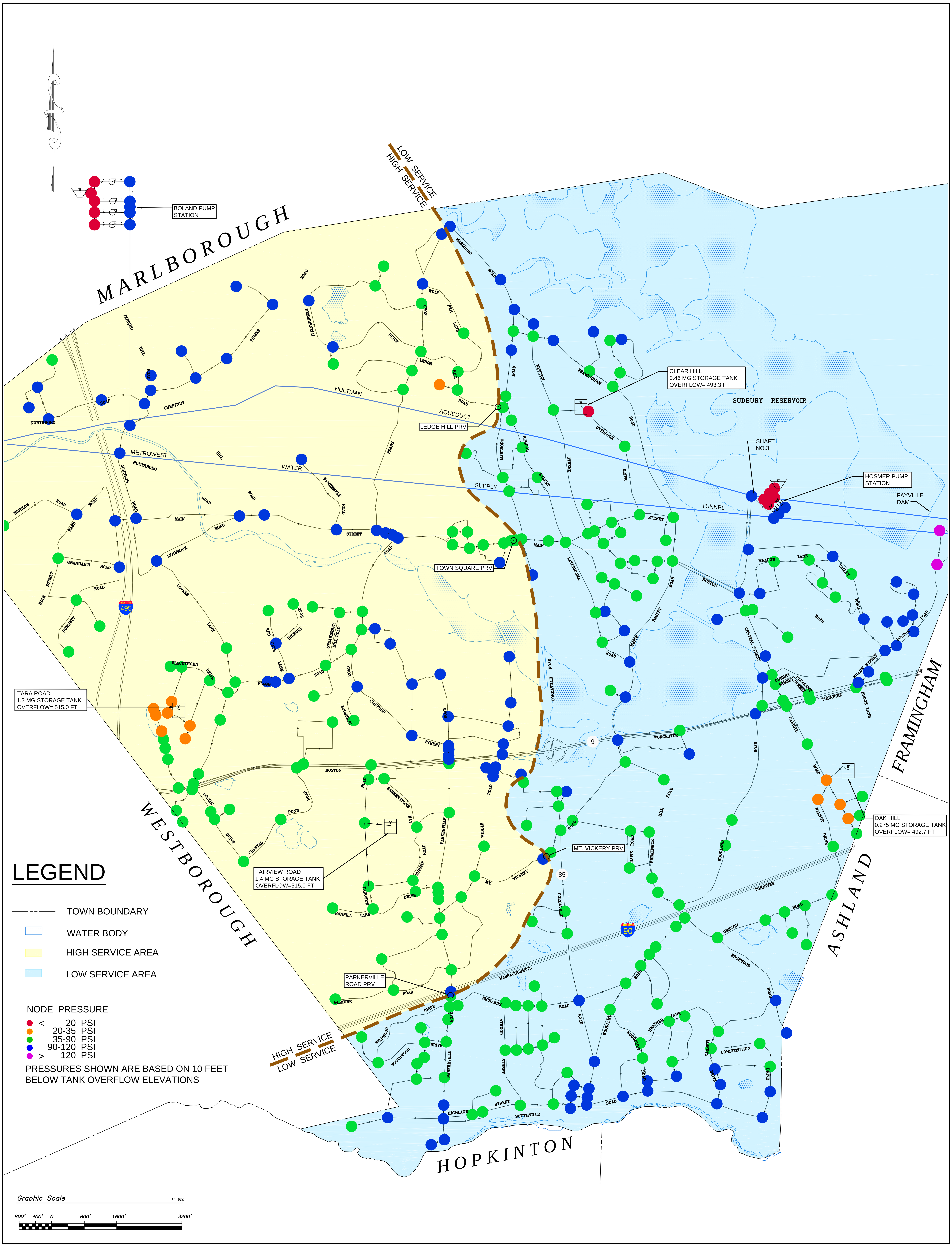
APPROVED BY:	TPT

DRAWING TITLE:
FIRE FLOW OPTION 1A

DRAWING NO.:

SHEET NO. 6 OF 12



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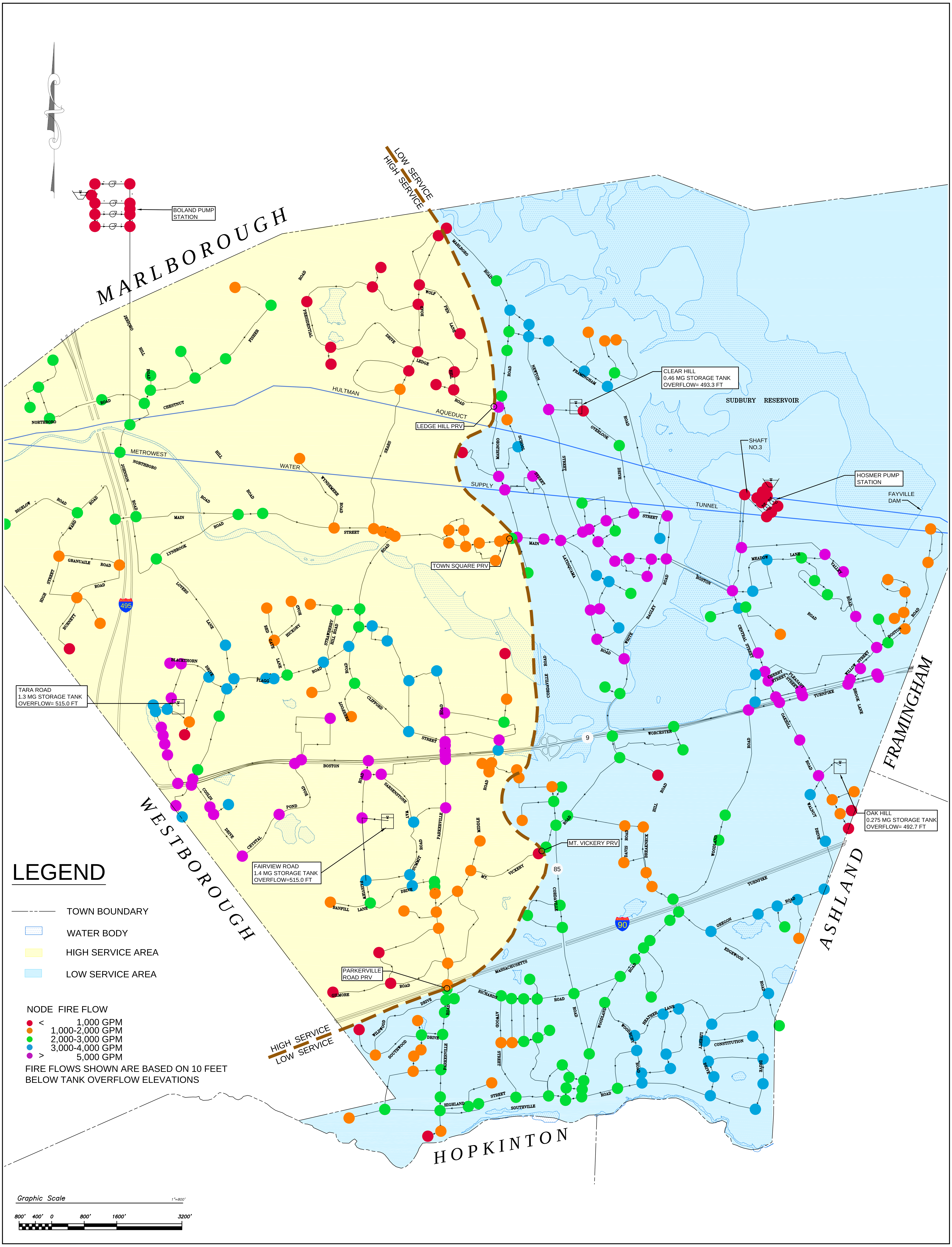
DRAWN BY:	AKL
APPROVED BY:	TPT
DRAWING TITLE:	MDD PRESSURE OPTION 1B
DRAWING NO.:	
SHEET NO.	7 OF 12



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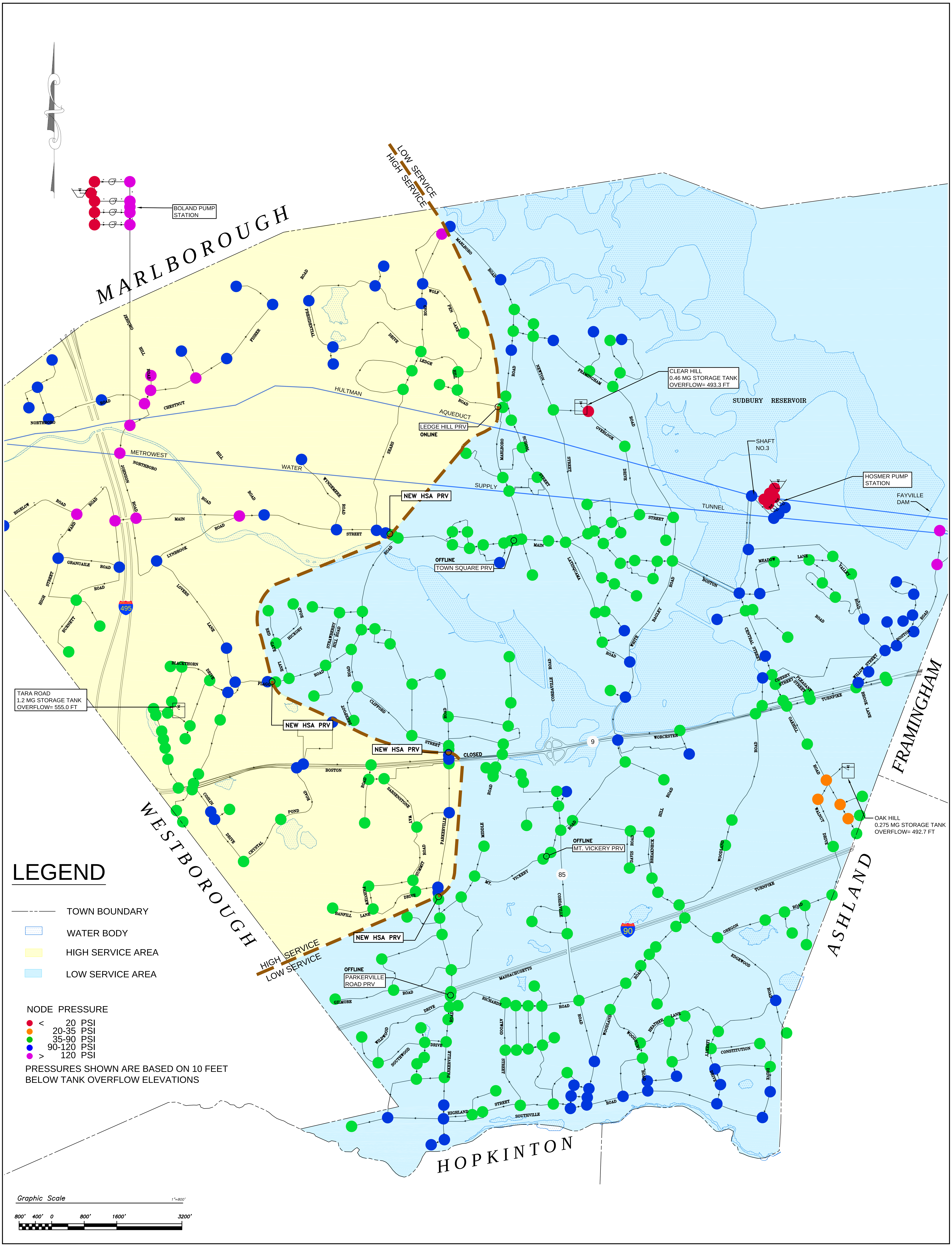
PROJECT NO.:	08176.15	DRAWING TITLE: FIRE FLOW OPTION 1B
DATE:	NOVEMBER 2016	
SCALE:	1"=800'	
DESIGNED BY:	SPD	DRAWING NO.:
CHECKED BY:	LMG	
DRAWN BY:	AKL	
APPROVED BY:	TPT	SHEET NO. 8 OF 12



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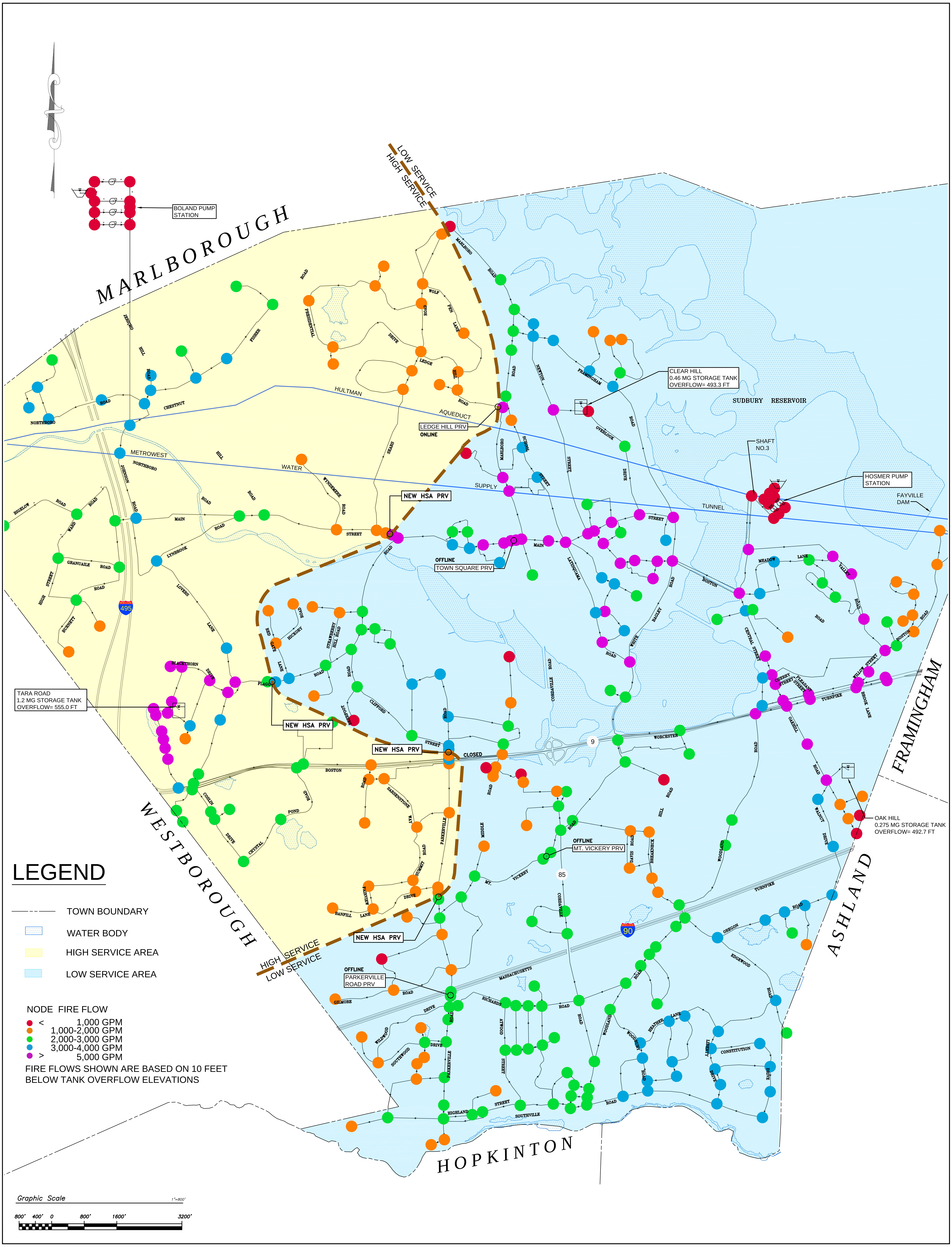
DRAWING TITLE:
MDD PRESSURE OPTION 2

DRAWING NO.:

SHEET NO. 9 OF 12



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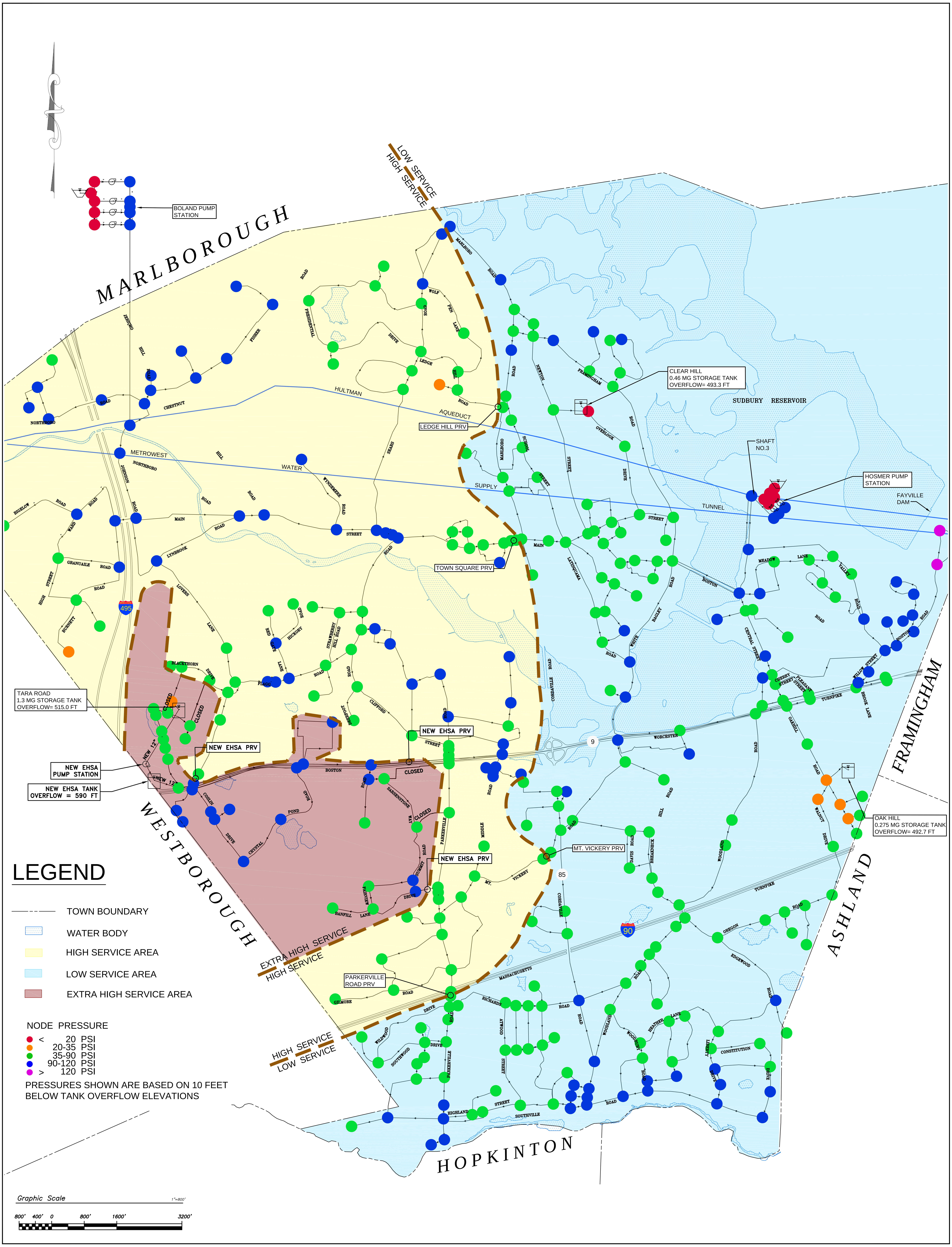
DRAWING TITLE:
FIRE FLOW OPTION 2

DRAWING NO.:

SHEET NO. 10 OF 12



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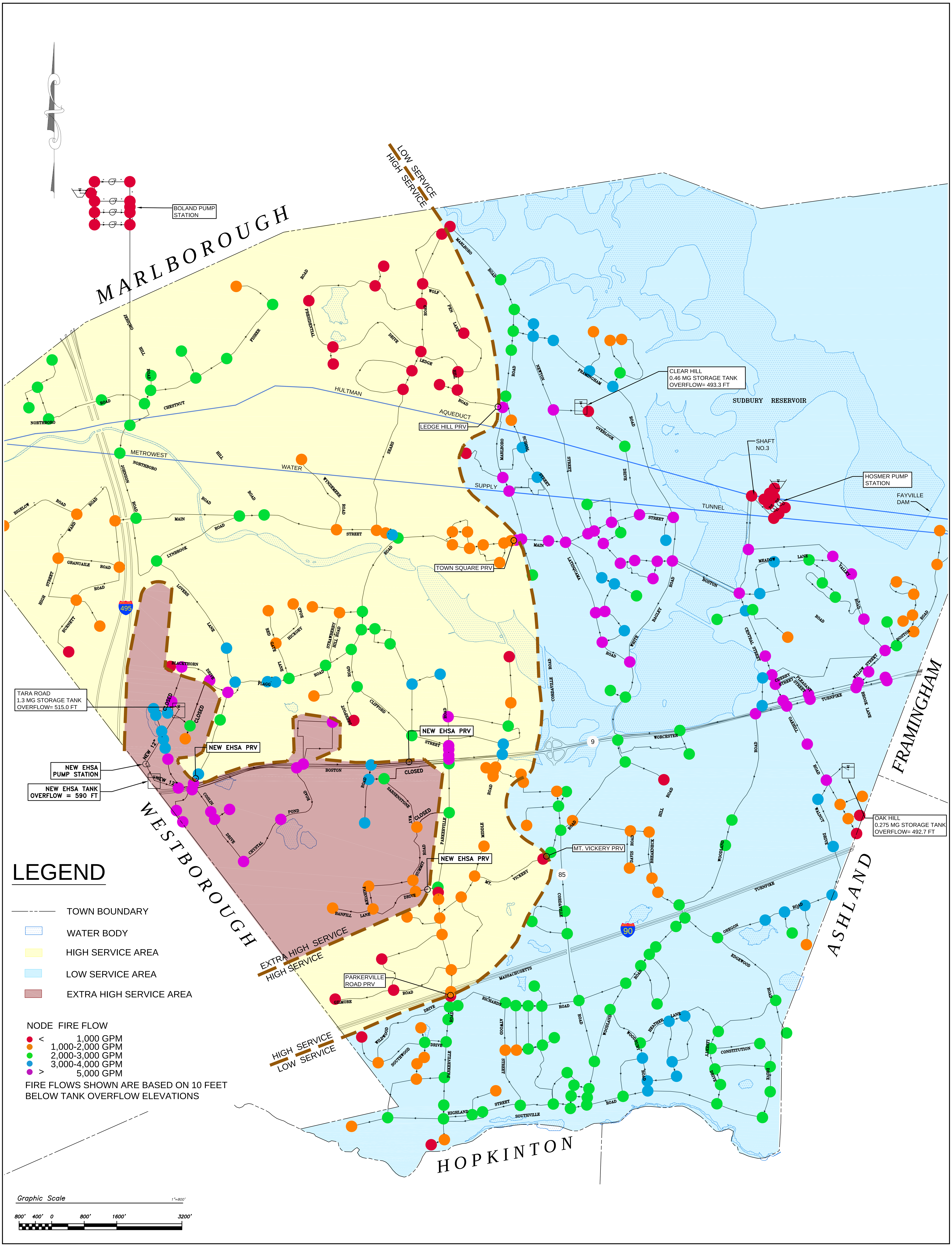
DRAWN BY:	AKL
APPROVED BY:	TPT

DRAWING TITLE:
MDD PRESSURE OPTION 3

DRAWING NO.:

SHEET NO. 11 OF 12



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APPROVED BY:	TPT

DRAWING TITLE:
FIRE FLOW OPTION 3

DRAWING NO.:

SHEET NO. 12 OF 12