Preliminary Engineering Report
Related to
Water System Capital Improvements Plan

for the

Boothbay Region Water District

June 11, 2018

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June 11, 2018
#37622

Mr. Jon Ziegra, Manager
Boothbay Region Water District
84 Adams Pond Road
Boothbay, ME 04

RE: Preliminary Engineering Report
Water System Capital Improvements Plan

Dear Jon:

This Water System Capital Improvements Plan is intended to provide you with a roadmap for system planning and improvements over the next 10 to 20 years. This is a DRAFT copy of this report for your review and comment. Please review this report and let us know if you have any questions, comments, suggestions, etc. We anticipate meeting with you after you have had a chance to review, working together to finalize the priorities and the Capital Improvements Plan.

If you have any questions please do not hesitate to contact us.

Sincerely,
Dirigo Engineering

Mr. Timothy D. Sawtelle, P.E. President	Mr. James M. Lord, P.E. Engineer

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I. INTRODUCTION

The Boothbay Region Water District (BBRWD) provides year-round water service to approximately 5,000 people in the Towns of Boothbay, Boothbay Harbor, and Southport, Maine. In the summer the number of people served increases dramatically. Over the last 20 years the BBRWD has completed several system improvements and expanded its year-round service area. Some of the more significant projects have included the following:

- Added Knickerbocker Lake as a seasonal source
- Constructed the Kenniston Hill storage tank
- Demolished the East Boothbay storage tank
- Upgraded the water main trunk-line serving East Boothbay
- Absorbed the Southport water system and expanded year-round service to Southport
- Constructed the Thompson Tank in Southport
- Upgraded the Commercial Street water main in Boothbay Harbor
- Completed treatment plant upgrades, modernizations, and modifications
- Upgraded the SCADA system
- Replaced and upgraded several water mains throughout the distribution system
- Completed several watershed protection projects
- Rehabilitated the Adams Pond dam
- The BBRWD is also in the design phase of a new maintenance garage that is expected to be constructed in 2018 or 2019.

The BBRWD has completed all of the major capital improvements projects recommended in the 2009 Water System Master Plan and is now focused on planning for the next 10 to 20 years. This Capital Improvements Plan is intended to provide the BBRWD with a roadmap for system improvements over that period.

II. EXECUTIVE SUMMARY

A. Major Challenges

The District faces many challenges in the coming years. Below is a brief summary of some of the more critical challenges on the horizon.

- Continued increases in seasonal demand – There has been significant development in recent years within the BBRWD service area. This brings increased year-round and seasonal residents as well as visitors, which has increased peak seasonal demands. If this trend continues the capacity of the supply, treatment and storage systems will become a major concern.

- Limitations of source water supplies – The BBRWD supply consists of 2 surface water sources, both considered Water Bodies Most at Risk by Maine DEP. They have this designation because they are surface water supplies as well as being susceptible to development causing water quality degradation. In addition, Maine State Route 27 runs very near Adams Pond for its entire length, which exposes the pond to contamination. There are no other practical source water options within a reasonable distance to the service area, so protecting these sources is critical to the sustainability of the BBRWD. In addition to being at risk, the ponds have marginal capacity. The two ponds together have a yield of approximately 1.65 MGD to 2.5 MGD, but Knickerbocker is limited by permit to only 51.5 MG annual withdrawal. The average demand through much of the summer exceeds the sustainable yield of Adams Pond, and as the peak demand season lengthens, the ability to supply water will be challenged, especially during dry years.

- Potential climate change impacts– The University of Maine Climate Institute reports that since 1895 the average annual temperature in Maine has risen 3°F, and they project that temperatures will continue to rise but at a faster rate as ocean water temperatures rise. The US EPA developed the Climate Resilience Evaluation & Awareness Tool (CREAT) that models potential climate changes for specific locations. One potential predicted by this model is that by the year 2060 the average annual temperature in Maine will increase another 6°F. They also report that in the year 2000 the heat index was equal to or exceeded 95°F for 3.4 days. They predict that number to increase to 11.2 days by 2050. They also report that the warm season (when the mean monthly temperate across Main is above 32°F) increased from 32 weeks in 1895 to 34 weeks in 2014 and is projected to increase to 36 weeks over the next 50 years.

  Extreme weather events have also increased in frequency over the last 50 years, which includes droughts. The increase in temperatures could lead to an increase in droughts, which is a significant concern for the BBRWD. During peak summer demand, the existing sources are already strained, and extended or recurring droughts could impact the District's ability to meet peak demands in the future.

The good news, though, is that the average annual precipitation has also increased approximately 6" since 1895. Some models predict this will continue to increase, which would improve the District's ability to serve in the long term.

- Treatment capacity during peak demand periods & contingency – The treatment plant filters each have a reported capacity of approximately 1 MGD. This is more than adequate during the winter months with a single filter online. The treatment plant also has sufficient capacity to meet peak demands during the summer months when everything is operating properly. However, if one of the filters were to fail for any reason during the peak summer season, the District could struggle to meet demand.

- Limited service life of electrical, mechanical and control systems – The electrical, mechanical and control related systems of the treatment plant typically have a short service life compared to the building and piping systems. Many of the smaller components (chemical feed pumps, online monitors, controls components, PLCs, etc.) have service lives of 20 years of less and many of the large components (waste pumps, finish water pumps, raw water pumps, etc.) have a design life of 25 years. Therefore, an ongoing strategic plan to maintain, replace and modernize these components will help to extend the life of the treatment system and help to avoid service interruptions.

- Storage during peak demand periods – The BBRWD has adequate storage for the winter season, but marginal storage during peak summer months. As the peak summer season gets longer, seasonal customers and area visitors increase, and the potential for drought conditions increase, available storage becomes more critical.

- Piping system deficiencies – The majority of the distribution system has a very strong backbone with ample flow. However, some areas, such as East Boothbay, are limited to only one primary trunk line. Strategic pipe extensions and loops will strengthen the systems reliability by providing redundant flow paths and eliminate dead ends. In addition, the frequency of leaks and breaks is increasing in the older cast iron pipes in the system.

B. Overview of Major Improvements & Priorities

The following is an overview and summary of the major improvements needed in the near future and the District's priorities.

1. Source Water Protection – The District should prioritize working with the Town of Boothbay to enact stricter shoreland regulation that help protect the watersheds of the source waters. The District should expand education and outreach programs related to responsible development and protection of the watersheds. The District should perform emergency response training with local police and fire for hazardous spills that occur in the watershed. The District should provide improved access to the source ponds for monitoring. The District should expand monitoring to feeder streams.
2. Improving Capacity – The District should begin expanding to the north with the ultimate goal of connecting to the Wiscasset Water System for additional supply. The District should maintain the East Boothbay Wells in a state where they could be activated if needed.
3. Improve Distribution Flow – The District should construct a new water main along Ocean Point Road from Route 27 to Bradley road to improve flow to East Boothbay and to better balance the flow throughout the system during fire flow events in East Boothbay. The District should continue to upgrade and replace old undersized mains and complete loops that improve flow in the general area of the loop.
4. Facilities – The District should complete the following items in the near future:
    a. Backup power at the Pinkham and Kenniston tanks
    b. Clean and inspect the clearwell
    c. Complete steel rehabilitation of the clarifiers/filters
    d. Improved access to the piping gallery
    e. Pump renewal/replacement
    f. Adding a 3rd pump to the Kenniston booster pump station
    g. Adding a 2nd pump to the Knickerbocker pump station
    h. Re-routing the 3Ø power to the Kenniston booster station from Adams Pond Road
    i. Replace the air compressor for the filter bed air scour

III. STUDY AREA

A. Communities Served

The Boothbay Region Water District currently serves residential, commercial, irrigation and fire service customers in Boothbay, Boothbay Harbor, and Southport, Maine as shown in Figure 1 below.

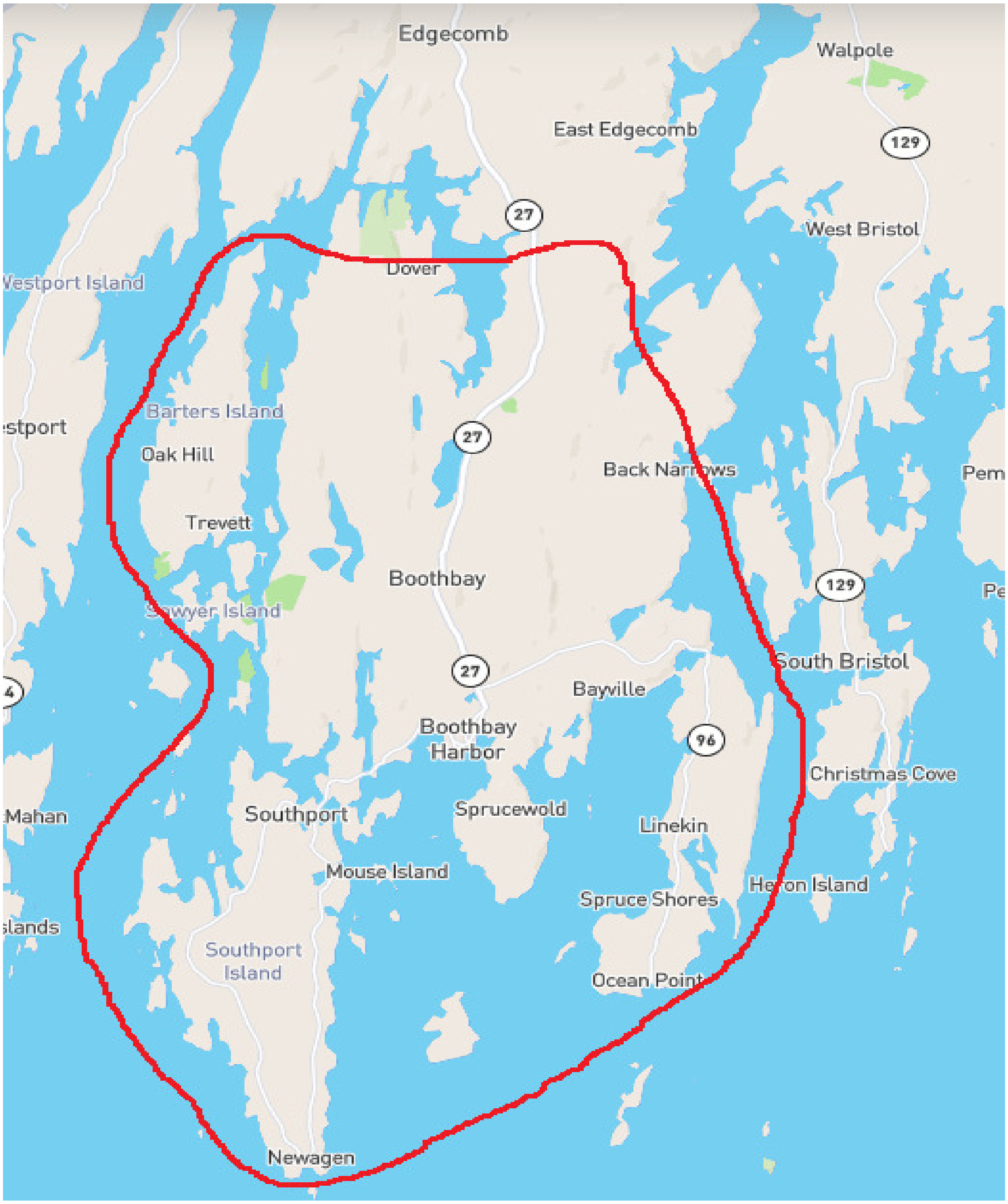


Figure 1 – Service Area Map

The town of Edgecomb is certainly within reach and considered highly probable for growth in the coming years. In addition, Wiscasset is only a relatively short distance from Edgecomb, which if linked, could provide water during peak demand, reducing the withdrawal from the surface water supplies during dry periods. Figure 2 below provides a regional map showing the nearby communities.

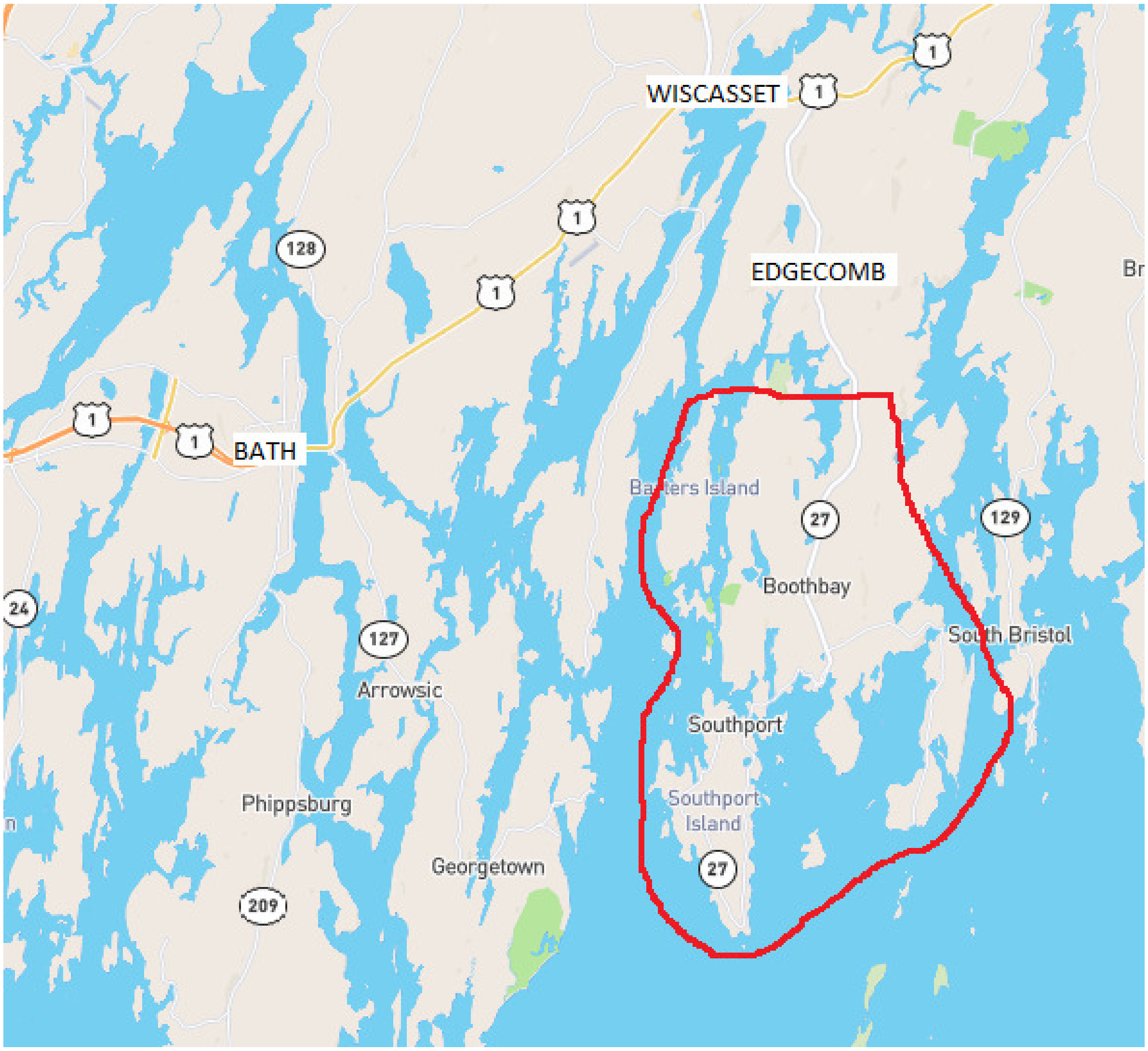


Figure 2 - Regional Area Map

The Boothbay Region Water District is also part of the Five Rivers Regional Water Council, which has studied the potential of connecting all water systems in the region for emergency supplies, improved overall reliability, and potentially reduced costs.

B. Community History, Population

Boothbay, Boothbay Harbor, and Southport were originally all part of the Town of Townsend, which was incorporated in 1730. In 1764 Boothbay, which at the time also included the area that is now Boothbay Harbor, set off from Townsend and incorporated. In 1842 The Town of Southport was incorporated. In 1889 Boothbay Harbor set off from Boothbay and was incorporated. A primary factor in the set off was that the Boothbay

Harbor Water District had been developed to provide domestic water and fire protection to the commercial and industrial businesses, which were primarily in what is now Boothbay Harbor, and residents and farmers in the rural parts of Boothbay did not favor sharing in the cost of that public water system. Separate independent public water systems were then also developed in Southport and East Boothbay, which is part of the Town of Boothbay.

Since then the Boothbay Harbor Water District was renamed the Boothbay Region Water District (BBRWD) and the BBRWD has since absorbed both the Southport and the East Boothbay water systems and now serve all 3 communities.

Table 1 below provides recent population information for the current service area as well as the abutting Town of Edgecomb. This data suggests a relatively consistent year-round population. The data was obtained from the US Census Bureau.

TABLE 1 – POPULATION DATA

Census Year	Boothbay	Boothbay Harbor	Southport	Edgecomb
2000	2,960	2,334	684	1,090
2010	3,120	2,165	606	1,249
2015	3,095	1,855	630	1,102

C. Seasonal Impacts

The BBRWD customer base includes a significant number of summer seasonal services (approximately 62% of all mains are seasonal mains). In addition, the entire region experiences a high influx of visitors in the summer months. As such, the District's typical daily demand changes drastically with the seasons. The average daily demand during off peak seasons (winter & spring) is approximately 500,000 gpd, which includes 100,000 gpd wasted through "bleeders". (Bleeders are used to maintain a disinfectant residual in the piping and storage facilities by forcing water turnover.) During peak summer months the average daily demand increases to 900,000 gpd.

It is likely that seasonal impacts will increase over the years for the following reasons:

- Average temperatures are increasing
- Warm periods are getting longer
- Local development will bring more and more visitors and extend further into the "shoulder seasons"

IV. WATER SYSTEM FACILITIES

A. EXISTING SOURCES

Raw water sources with sufficient quantity and reasonable quality are limited on the Cape Newagen Peninsula. Groundwater in the region does not have the quantity to support peak demands and is typically high in iron and manganese, so the BBRWD uses the only two viable surface water sources: Adams Pond and Knickerbocker Lakes (Knickerbocker Lakes is comprised of two connected water bodies). Adams Pond is the primary water source and Knickerbocker Lakes is a supplemental seasonal source for peak demand in the summer months.

Figure 3 – Source Water Location Map

The Maine Department of Environmental Protection (DEP) lists both Adams Pond and Knickerbocker Lakes as Water Bodies Most at Risk to new development in Chapter 502 of the Maine Stormwater Law. The criteria for being qualified as a water body most at risk are as follows:

(1) A public water supply; or

(2) Identified by the department as being in violation of class GPA water quality standards or as particularly sensitive to eutrophication based on

(a) Current water quality,
(b) Potential for internal recycling of phosphorus,
(c) Potential as a cold-water fishery,
(d) Volume and flushing rate, or
(e) Projected growth rate in the watershed.

The BBRWD has worked diligently to protect these watersheds. Watershed protection efforts have included shoreland stabilization, culvert upgrades, erosion repair and site stability projects. The BBRWD has also worked with the Town of Boothbay and Maine DOT to limit chemical treatment along the roadways within the watersheds.

It is critical to the sustainability of the BBRWD to protect both watersheds and continue prioritizing watershed protection projects. Below is a listing of watershed protection efforts the BBRWD should prioritize:

- Community awareness and outreach – Educating local residents, visitors, developers and even school children will help the long-term success of watershed protection. The District should budget a reasonable amount annually for continued education and awareness campaigns. The BBRWD should also hold joint training with the local fire and police departments for managing accidents and pills within the watershed of the public sources.
- Work toward tighter ordinances and regulation within source water watersheds – Work with the Town of Boothbay to develop a Public Source Water Watershed District that requires the following:
    - Stricter stormwater treatment requirements for all new development
    - Connection to public sewer where possible
    - Stricter onsite wastewater treatment design and monitoring where public sewer is not possible
    - Limited development of new impervious areas
    - Etc.
- Continue identifying and restoring eroded areas within the watersheds
- Continued water quality monitoring of ponds and streams – Improved permanent access to the sources would greatly improve the ability to collect data on a regular basis and provide improved safety for the staff collecting the data. Expanding water quality monitoring within the watersheds to streams and drainage ways would also be beneficial in identifying the sources of negative impacts.
- Land acquisition – The best way to avoid problems is to control the land, however, due to the high cost of land, land acquisition typically only yields moderate gains. The BBRWD should identify critical sites in direction connection to the watersheds (along the ponds and feeder streams) and work toward acquisition when the costs are appropriate.

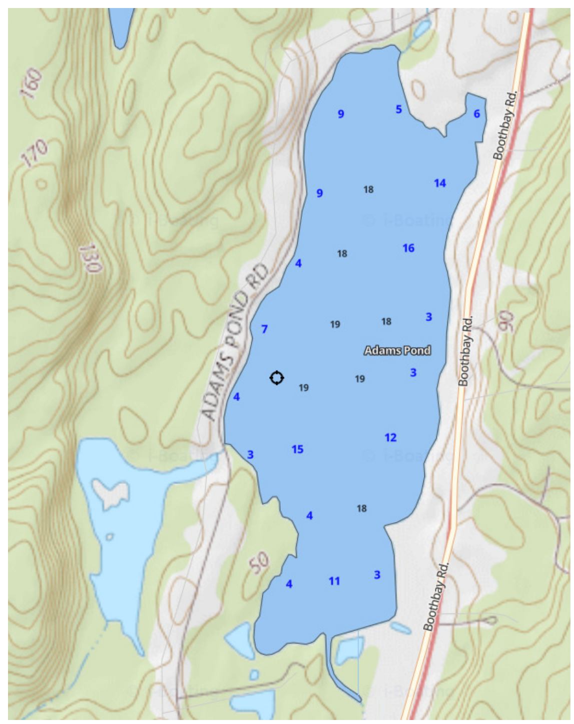
B. ADDITIONAL SUPPLY

As mentioned above raw water sources with sufficient quantity and reasonable quality are limited on the Cape Newagen Peninsula. As development continues the BBRWD will eventually need to pursue additional or supplemental sources of water. Groundwater from the existing wells in East Boothbay or from other locations on the peninsula could help to supplement the existing supply. The groundwater sources will likely require treatment for iron and manganese and also require additional pumping and treatment facilities. System operations will be complicated with several facilities but there will be a corresponding improvement redundancy.

In the coming decades it might be necessary for the BBRWD to obtain additional supply from north of the peninsula. A connection to the regional/ interconnected water systems along the Route 1 corridor might be necessary. As pipes are extended north in the future it would be advisable to size them for potential service as a transmission main (12” to 16” inside diameter).

ADAMS POND

1. Source Water



Adams Pond has the following physical attributes:

- Surface area is approx. 78 acres
- Average depth is approx. 12’
- Maximum depth is approx. 22’
- Perimeter of approx. 2.1 miles
- Watershed is approx. 1.5 sq. miles

Prior reports state Adams Pond has an estimated safe yield of 0.65 to 0.96 million gallons per day. The water level in Adams Pond is controlled by the concrete dam on the north end of the pond. The dam was rehabilitated in 2009. A removable splash board allows the BBRWD to hold an additional 0.75’ of water in the pond (approximately 19 million gallons).

Adams Pond is located immediately west of State Route 27, which is the primary route to Boothbay, Boothbay Harbor, and Southport. Route 27 is directly in the watershed of Adams Pond and it has considerable traffic, especially during peak summer season. This leaves the pond vulnerable to contamination. Vehicular accidents along this stretch of roadway could cause oil, fuel, radiator coolant, etc. to discharge into the watershed and eventually reach the pond. The BBRWD should have spill containment and counter measures readily available at all times. The BBRWD should educate local fire and police departments and conduct joint trainings along this stretch to help protect the water source in the event of a spill.

2. Intake & Raw Water Pumping Station

The intake was constructed in 1994. The intake has a stainless steel screen and an 18" HDPE gravity intake pipe that conveys raw water by gravity to the raw water pumping station located at the edge of Adams Pond. The intake screen is supported by a concrete platform and elevated approximately 5' off of the pond bottom. Much of the intake pipe is buried under the pond substrate. The intake has a reported capacity of 1,800 gpm.

The intake is in reasonable condition with no reported concerns. The BBRWD cleans the screen monthly by scouring it with compressed air. A 2" HDPE subaqueous air line delivers compressed air to the screen.

The Raw Water Pump Station, also constructed in 1994, is a concrete and masonry structure with a finish floor elevation of 54.5'. The station has a rectangular cast-in-place concrete wetwell below the building with a bottom elevation of 21'. Raw water enters the wetwell by gravity. The raw water from Knickerbocker is also piped into this wetwell. When Knickerbocker is supplying water, the District shuts off flow from Adams Pond by closing a sluice gate on the inlet from Adams Pond inside the wetwell.

Raw water is pumped to the treatment plant by two (2) 30 HP vertical turbine suction lift pumps manufactured by SimFlo Pumps, Inc. The design flow rate for each pump is 700 gpm. Both pumps are equipped with newer Toshiba variable frequency drives (VFDs). The pumps run one at a time and are manually alternated monthly. The BBRWD had the raw water pumps inspected and testing in March of 2017 by Weston & Sampson. Raw water pump #1 (RW#1) performance was found to be 21% below the design curve at full speed and RW#2 was found to run 23% below the design curve at full speed. RW#2 was also noisy with vibrations.

Dirigo Engineering recommends the BBRWD follow the recommendations of Weston & Sampson and service RW pump #2.

To pump from Knickerbocker, the District activates the Knickerbocker pump station through the SCADA system. They then shut the Adams Pond sluice gate. Once activated, the Knickerbocker pump station pumps continuously using a VFD to provide constant pressure. A pneumatically actuated DeZurick plug valve in the wetwell controls the flow into the wetwell to maintain a specific water level. This flow control valve was installed in 2006.

The air compressor, which is used to clean the intake screen, also supports the Knickerbocker Lakes supply pneumatic plug valve. The compressor is a 3 HP Quincy QT-3. The compressor does NOT have a dryer and during warm summer operations, moisture is generated in the compressed air, which can lead to problems in the pneumatic actuator. The District should upgrade the air compressor by adding a dryer, or air cooler.

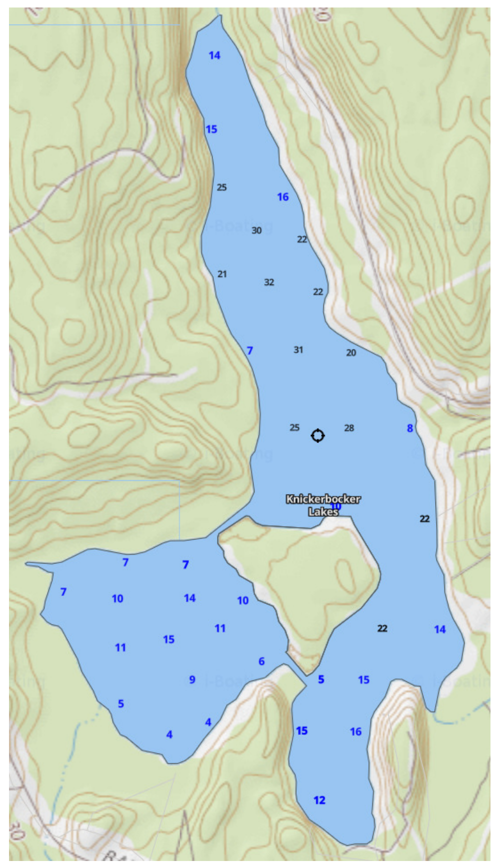
The BBRWD also injects sodium bicarbonate in the raw water pumping station to allow for reaction time and mixing prior to reaching the treatment plant. The function of the sodium bicarbonate is alkalinity adjustment in the raw water. The District purchases granular sodium bicarbonate and mixes it to an 8% solution in a 200-gallon day tank. The day tank is inside a concrete containment area with a capacity of holding 150 gallons, which is slightly below the capacity of the day tank.

3. Transmission

A 12” DI raw water transmission main conveys water from the raw water pumping station to the treatment plant. In the raw water pumping station, the discharge pipes leave the pumps and drop down into a sub-floor valve vault. Each discharge line has a 12” check valve and a 12” gate valve before connecting into the single transmission main to the plant. There are no known issues in the transmission main.

KNICKERBOCKER LAKES

1. Source Water



Knickerbocker Lakes are the summer seasonal supply for the BBRWD. The lakes (2 interconnected water bodies) have the following physical attributes:

- Surface area of approximately 109 acres
- Average depth of 15’
- Maximum depth of 32’
- Perimeter of approximately 3.6 miles
- Watershed of approx. 1.6 sq. miles

Prior reports indicate that the Knickerbocker Lakes have an estimated safe yield of 1.0 to 1.6 million gallons per day. But the BBRWD is only permitted to withdraw 51.5 million gallons annually.

The BBRWD constructed an intake and pump station in 2006 and began extracting water in 2008. Knickerbocker Lakes are critical to the BBRWD and the entire region. They are relied upon heavily during peak summer months to help meet the growing demand. However, this is a waterbody most at risk to development and, though the majority of the watershed is forested, there are some larger developments in its watershed. There is also a large-scale development currently working through the permitting process for parking, on-site waste4wrer disposal and stormwater treatment. As mentioned earlier the BBRWD has worked to encourage responsible development that treats runoff to 100% and connects any new wastewater services to the public sewer system.

2. Intake & Pumping Station

The intake is located approximately 50’ off shore and is comprised of 16” HDPE pipe and a stainless steel Intake screen with a capacity of 1,400 gpm.

Raw water is lifted from the intake by a single 75 HP vacuum primed pump. The pump station is housed inside a wood framed building on the eastern shore of Knickerbocker Lakes. The facility is equipped with backup power provided by a 165 KW Cummings propane fired generator. Flow is metered through a Krohne magnetic flow meter inside the building. The intake does not have a check valve or foot valve and drains after each pumping cycle.

The station is in good condition and currently meets the needs of the system. However, Dirigo Engineering recommends a second pump be added to provide mechanical redundancy.

3. Transmission Main

The raw water is pumped to the Adams Pond treatment plant through a 12” HDPE transmission main that is approximately 5,500’ long. This main was constructed in 1991 when the District initially planned to begin using Knickerbocker Lakes as a supplemental source. However, funding for the intake and pumping station was not available at that time.

The transmission main runs “cross country” and was constructed with limited cover for summer use only. The transmission main is drained every fall. There are no reported issues with the transmission main.

EAST BOOTHBAY WELLS

1. Source Water

The BBRWD still has two (2) groundwater wells in East Boothbay. These wells are inactive but the majority of the facilities are still in place. The wells are high in iron & manganese. Below is a brief description of the wells.

- Well #1 – 18” diameter gravel packed well with an approximate depth of 37’ and a reported yield of 100,000 gpd.
- Well #6 – 10” diameter bedrock well with an approximate depth of 120’ and a reported yield of 100,000 gpd.

These wells would require significant upgrading to integrate into the system. However, 200,000 gpd is a good amount of water and during severe drought conditions, could be extremely beneficial to still have available.

C. TREATMENT

In 1994 the BBRWD constructed a new treatment plant on the south west end of Adams Pond. The treatment process includes clarification, filtration and chemical treatment. The general plant flow is as outlined below:

1. Raw water from the raw water pumping station enters the piping gallery on north end of building, sodium bi-carbonate is added at the raw water pump station for pH adjustment and alkalinity
2. Aluminum Sulfate (Alum) is added for coagulation prior to clarification & filtration
3. The raw water is metered as it enters the clarifiers
4. Water flows up through the media clarifiers and then down through the mixed media filters
5. Sodium hypochlorite is injected as the water enters the clearwell for the primary (free chlorine) disinfection
6. The clearwell volume provides contact time for free chlorine disinfection
7. Filtered water is pumped to the distribution system after it received additional chemical treatment as described below:
    a. Sodium silicate for corrosion control
    b. Sodium hydroxide for pH adjustment
    c. Sodium fluoride for fluoridation purposes
    d. Ammonium sulfate for conversion of free chlorine to chloramines for a system residual with lower disinfection by-products formation and taste/odor improvement
8. Finished water is metered as it is pumped to the distribution system

Backwash Procedures

The clarifiers are cleaned by a controlled flushing procedure with air and water. The filters are cleaned with controlled backwash procedures using air and water. Flushing is accomplished with raw water and filter backwash is accomplished with filtered water pumped from the clearwell. Flush and backwash discharge is directed to a backwash water storage tank located immediately outside the north end of the building.

Backwash water is mixed in the holding tank with a circulating pump system prior to decanting and discharge to the sewer system.

Included in the appendix is a Process Flow Diagram for the treatment works. Below is a description, conditional assessment and our recommendations for improvements.

PIPING GALLERY

The piping gallery is a large underground cast-in-place concrete vault below the treatment plant clarifier and filter room. The piping gallery houses the following piping, equipment and processes:

- Raw water and finish water piping
- Finish water mag-meter
- Chemical injection (all injection corporations/quills were replaced in 2016)
- Plant water meter (2" Sensus turbo meter recently replaced) and RPZ units
- Backwash mixing and waste pumps

There are two (2) access hatches to the piping gallery but only one (1) has a permanent wall mounted ladder down to the vault. There is an E-Stop type "Help" bottom on the floor at the base of the ladder that would signal an alarm.

The primary issues/concerns with the piping gallery include the following:

- limited ingress/egress
- Marginal ventilation
- Only a single safety alarm button
- Portable ladders are needed to reach chemical injection ports and finish water meter on overhead piping

Ingress/egress into the piping gallery is by a single fixed ladder. Ideally access to the gallery would be by a standard stairwell, however space is very limited. The District should consider converting the ladder to a ship style ladder for improved safety and adding a second point of ingress/egress at a minimum. In addition, there are multiple chemical lines and chemical injection taps in the piping gallery. Gas detection equipment and additional manual "Help buttons" spaced throughout the gallery would be an improvement with a minor expense.

CLARIFIERS/FILTERS & BACKWASH SYSTEMS

The BBRWD filtration system is a two unit direct filtration system. The system includes two parallel Trident High Rate Up-flow Clarification/ Filtration units. Each unit includes a painted steel tank housing an up-flow clarifier and mixed media filter. The clarifier/filter units each having a daily capacity of 1 million gallons per day. The 2 units are located beside each other and function in parallel. The filter beds are mixed media filters comprised of anthracite and layers of sand.

In 2017 the District had the clarifier beds analyzed and were reported to be in good condition. The media is also in good condition. The District adds new media annually because the backwash process reduces media over time. The District also inspected the structural steel in each unit and found the floors in each until to be corroded with heavy pitting and delamination of the coatings. The corrosion of the steel was black in appearance, suggesting severe oxidation. They also found some other steel components had failed at bolt holes. The District made repairs and re-coated the repaired areas only. The stainless steel underdrain appeared in good condition. The District should plan to have each unit completely rehabilitated with steel repairs and a complete coating replacement.

To aid the clarification/filtration process, the District injects aluminum sulfate, a coagulant, upstream of the clarifiers/filters in the piping gallery. sodium bi-carbonate is added at the raw water pump station for pH adjustment and alkalinity.

Air scour is utilized to assist in backwashing the filters. Air is supplied by an Ingersoll Rand air compressor. This compressor was installed in 1994 and is loud and inefficient. The District has installed a noise control curtain around the compressor, which resides in the filter room. The compressor also supplies air for the pneumatic valves and is equipped with a dryer. The compressor is also equipped with a dual motor setup, and the motors alternate automatically. The compressor is equipped with low pressure and low oil alarms. Dirigo Engineering recommends the BBRWD replace the blower and controls with modern equipment.

The filters are backwashed 1 to 2 times daily in the summer months and approximately once every two days in the winter months depending on production rates. Each backwash event uses 12,200 gallons. Backwash water is sent to the backwash holding tanks and then pumped to the Boothbay Harbor Sanitary District WWTP. The District pumps up to 45,000 gpd of backwash water waste to the Sanitary District. The District keeps the backwash water mixed in the holding tank using a recirculating pumping system.

The backwash holding tank level is monitored by an ultrasonic level indicator (Milltronics) that also controls the waste pumps. To overcome the backpressure in the check valve and force main piping, both pumps need to run for a few minutes and then 1 pump can be de-activated. The pumps and check valves should be upgraded and replaced.

The District would also like to reduce the amount of decant discharged to the sanitary sewers to help reduce costs. Potential options include:

- Reclaim – Reclaiming decanted water and injecting it into the raw water as it enters the plant is not a recommended/desirable process for a surface water supply. This would significantly reduce the volume of water to be disposed of it but it could also reintroduce some of the removed residue (including bacteria) to the filters.
- Discharge to Adams Pond – Discharging decanted water directly to the pond is also not a recommended/desirable process. The discharged water would likely require additional treatment. A DEP/EPA discharge permit would be required.
- Land Application – During warm months the District could pump and dispose of the decant by land application. The decant could be sprayed through irrigation nozzles or discharged through perforated pipe on to the ground. The flow would be applied at a modest rate to allow it to soak into the ground and to be treated by the existing soil and vegetation in the upper areas of the drainage basin. This would also require improved settling in the holding tank and approval from the DEP. This would only be possible during warm periods but could significantly reduce waste.

CHEMICAL TREATMENT & FINISHED WATER

Following filtration, the water receives additional chemical treatment for the reasons described below and is then pumped into the distribution and storage systems.

Disinfection

The BBRWD injects sodium hypochlorite immediately downstream of the filters and prior to the clearwell for free chlorine disinfection. Then, after the water leaves the clearwell the District injects ammonium sulfate to create chloramines. (Chloramines are utilized to reduce the formation of disinfection byproducts while maintaining a residual of disinfectant longer in the distribution system.)

Chemical injection is controlled through the SCADA system and based on flow measurements obtained from mag-meters on the inlet to the filters and on the finish water main to the distribution system.

The clearwell, with a capacity of 148,000 gallons, is located below the filter room and has a series of baffles to provide for proper mixing and contact time. It is suspected that iron & manganese deposits may be present in the contact tank. The contact tank should be cleaned and inspected. This process should take place during low production times in the winter months.

Backwash water is pumped from the inlet end of the clearwell back to the filters for backwashing.

At the outlet end of the of the clearwell are two (2) finished water pumps that pump water to the distribution system. The finished water pumps are 125 HP vertical turbine pumps manufactured by SimFlo, with a design point of 1,400 gpm at 266' of total dynamic head (TDH). The pumps were inspected and tested by Weston & Sampson in February of 2017. They found finished water pump #1 (FW#1) to be performing 17% below the design curve and PS#2 to be performing 9% below the design curve. FW#1 also had vibrations that remained following balancing. FW#2 was overhauled in 2013/2014 and appeared to be in good running condition.

Dirigo recommends the BBRWD overhaul FW#1 based on Weston & Sampson's recommendations.

Finished water transmission piping is routed through the piping gallery, as noted earlier, and additional chemicals are injected for pH control, corrosion control, and dental health reasons as described below.

pH Control

Surface water sources typically have lower pH than is desirable for piping systems. The BBRWD injects sodium hydroxide to raise the pH, which improves absorption of chemicals into the water, increasing treatment efficiency.

Corrosion Control

The BBWRD injects sodium silicate to help stabilize the water and provide corrosion control. This helps reduce lead and copper from leaching into the water from customer plumbing or old piping, and also helps prevent scaling and tuberculation inside water mains.

Dental Support

The BBRWD injects sodium fluoride into the finish water to support dental health in consumers. The BBRWD does this in accordance with EPA guidelines. The BBWRD began injecting sodium fluoride into the finish water in 2004.

All chemicals are stored on site and mixed into liquid form and held in polyethylene "day tanks" prior to injection into the treatment train. All liquid solution tanks are stored inside concrete containment areas within the building. Some of these chemicals, such as sodium fluoride and sodium chloride, are extremely corrosive so these are kept in separate rooms.

CONTROLS, SCADA, & ALARMS

The BBRWD monitors and controls the water system through a series of equipment specific control panels, a main control panel, and a SCADA system. All water treatment functions at the water treatment plant, except the backwash storage tank, are integrated into the SCADA system. The District has also integrated the following remote facilities into the SCADA system:

- All water storage facilities
- Kenniston booster pump station
- Golf course booster pump station will be when it comes on-line
- All larger PRV stations
- McKown Point Road Meter Site

The SCADA screens should be updated to represent current processes and locations of processes within the system.

The BBRWD contracts with Northeast Security for all alarm notifications. However, a recent power failure/surge caused the generator ATS to fail and also caused a problem in the telephone line. This resulted in no power at the plant for water production and no alarm notification to District staff. This occurred at night, so the plant went several hours without producing drinking water.

The District should consider alternative alarming system for backup failsafe.

GENERAL BUILDING FACILTIES

The water treatment plant is a concrete and masonry building constructed in 1994. The building's major areas include the following:

- Treatment Room
- Control Room/Office
- Mechanical Room
- Electrical Room
- Generator Room
- Chemical Storage Rooms for Sodium Hypochlorite, Sodium Bicarbonate, and Ammonium Sulfate
- Maintenance garage with 4 truck bays

The building is heated with an oil-fired boiler manufactured by Burnham Commercial and installed new in 2009. The boiler is a high-pressure boiler that is inspected and serviced annually. Oil is stored in duel 375-gallon tanks inside the building and within secondary concrete containment. During the winter months typical usage is 13 to 14 gallons per day.

The control room uses baseboard heaters, while the filter room has elevated unit heaters to deliver heat.

The facility is also equipped with an air handler, which is located on the upper level within the filter room. The air handler has not functioned properly for some time. The electrical room does use this but it is turned on manually when needed. There is sufficient heat from the transformers and related equipment in the electrical room.

The facility is equipped with backup power provided by a 350 KW Kohler generator. The generator is diesel fired with fuel in the base of the generator. There is no secondary containment around the generator. The generator has approximately 900 hours of usage since it was installed in 1994. The generator has an automatic transfer switch (ATS) that automatically transitions power from the grid to local supply and back again after power is restored.

The District also has an office building situated next to the treatment plant. This office building houses management and clerical staff as well as a conference room for trustee meetings. This building is open to the public during normal hours of operation.

The District is currently in the design phase of a new maintenance garage for storage of off season equipment, materials, etc. The facility will be constructed on the Adams Pond treatment plant campus to the south of the office building. The building will be approximately 84’ x 60’ and have 4 garage bays with additional storage areas. The site planning and design will include stormwater treatment measures sized and situated to treat 100% of the runoff from the new facility and driveway areas.

D. PUMPING STATIONS

KENNISTON BOOSTER PUMP STATION

The BBRWD has two primary pressure zones as described below:

1. Low Pressure Zone (LPZ) – this is the primary pressure zone in the system. Its hydraulic grade line is determined by the water level in the Pinkham and Thompson Tanks. The overflow for both tanks is 215’. The water treatment plant finish water pumps operate to fill these tanks, when the tanks are full the pumps are shut off.
2. High Pressure Zone (HPZ) – the hydraulic grade line for this pressure zone is determined by the water level in the Kenniston Hill Tank. The overflow in this tank is 277’, which is 62 feet higher than the maximum hydraulic grade line of the LPZ.

To get water to the HPZ and the Kenniston Hill tank operating level, water is ‘boosted” by the Kenniston Hill booster pump station located at the old intake/pumping station on the south end of Adams Pond. The Kenniston Hill booster station pulls water from the LPZ piping along Adams Pond Road.

The pumping facility is housed in a newer wood framed building constructed in 2004 specifically for the purpose of the booster pump station. The pumping system is comprised of duplex 15 HP, 3Ø, single stage end-suction centrifugal booster pumps (Model 3656) manufactured by Goulds Pumps. Current pumping capacity is limited to 300 gpm per pump, which during peak summer and fire flow conditions is marginal. During winter months the BBRWD runs a single pump and its operation is set to a defined pumping rate of 140 gpm. Pumps are activated by water level in the Kenniston Hill tank and are alternated each cycle. The District should add a 3rd pump to increase peak capacity during peak summer months and fire flow conditions.

The station is equipped with backup power provided by a propane fired, 60 KW Onan Generator. The generator is equipped with an automatic transfer switch. The generator has 438 hours of usage.

The station has 3Ø electrical service from CMP that is routed off of Route 27 through the wetlands on the south end of Adams Pond. This is problematic because there is a high probably of damage to the overhead lines during wind storms, electrical storms, etc. Since this is only a service with no additional customers, it is a low priority for CMP and power outages can be lengthy. In addition, access to the electrical service line in the wetland area is difficult and requires specialized tracked equipment, which further delays repairs to the electrical service. The electrical service lines were damaged during the wind storm in October of 2017 and the station was without power for 11 days. The BBRWD should consider changing the electrical service to come off Adams Pond Road for improved access and faster repairs.

The electrical service transformer for the pump station is located on a utility pole behind the old pump building and it is engulfed in a large tree. The BBRWD should prune the tree to remove potential damages from branches.

The station does have bypass piping that allows operators to connect the high pressure zone to the low pressure zone if Pinkham tank and/or Southport tanks are offline. There are also two (2) hydrants at the site with one off each pressure zone for emergency portable pump connections.

The old pump station building at the site is currently used for storage. This building has older florescent lights that are inefficient. The BBRWD should upgrade these lights, however due to its limited usage, this is a lower priority.

GOLF COURSE BOOSTER PUMP STATION

The Golf Course booster pumping station is a new station. This station is equipped with three (3) 30 HP pumps and three (3) smaller 5 HP jockey pumps. The pumps are skid mounted with stainless steel piping. All pumps have Toshiba VFDs. The station is in a new wood framed building with backup power.

The station increases pressure to the golf course but the piping is also connected back to the distribution system on Dump Road and a new PRV station will regulate discharge pressure to match the high-pressure zone.

SPRUCE WORLD SEASONAL BOOSTER PUMP STATION

The BBRWD has a small seasonal booster pump station the serves the higher areas of Spruce World. This station is equipped with a single 2” jet pump located inside a plastic dumpster style enclosure with a wooden floor and a sheet metal cover. The pump has a VFD that drives the pump to provide constant pressure to its service area. The pressure indicated device that feeds the VFD is tapped off of the pumps discharge line at the station.

This station is not integrated into the system SCADA and there is no telemetry or alarms for this station. A new booster station inside a small building with duplex pumps and integration into the SCADA system could improve flow and reliability. The new booster station should draw water from Atlantic Avenue, which has a larger water main and better hydraulics than Lobster Cove Road. The District could also connect back to the Lobster Cove Road side with a PRV.

E. METER STATIONS

McKOWN POINT ROAD METER STATION

Prior to absorbing the Southport Water System and constructing the new Townsend Gut Crossing, the BBRWD served Southport by a single 8” HDPE water main across Townsend Gut from McKown Point Road to Decker Cove. At McKown Point Road the BBRWD had a meter and pumping station to meter water sold to Southport and to provide constant pressure as there was no active storage facility on the island. This facility is in a below grade concrete vault. The booster pumping system has been removed but the vault and the meter, a Krohne Mag-Meter, is still in place and active. The meter is used to monitor for potential leaks now. This facility is integrated into the SCADA system.

This is a confined space that is reasonable condition. There is adequate ventilation and a sump pump that is operated by floats in the station to keep equipment and controls dry. The controls are located in the vault.

F. STORAGE

WEST HARBOR TANK

The West Harbor tank is described below:

Type:	*Welded Steel*
Year of Construction:	*1963*
Dimensions:	*24.5’ diameter x 90’ tall*
Overflow Elevation:	*206’*
Nominal Capacity:	*317,000 gallons*

In 2015 the BBRWD completed the Thompson tank in Southport and the West Harbor tank was taken out of service. The tank is still in place and utilized for antenna mounting. The District receives revenue from various agencies for antennas on the top of the structure.

HARRY L. PINKHAM TANK (Formerly Mount Pisgah Tank)

The Pinkham tank supports the low pressure zone and is described below:

Type:	*Welded Steel*
Year of Construction:	*1997*
Dimensions:	*42.5' diameter x 52' tall*
Overflow Elevation:	*215'*
Nominal Capacity:	*550,000 gallons*
Inlet/Outlet:	*Common, 16"*
Mixing:	*Active - Pax*

This tank is a welded steel tank located in a Maine coastal region, which means maintaining the coating system is critical to the longevity of the tank. The tank was completely recoated in 2013/2014 and is currently in good condition.

The main power circuit breaker and other electrical/controls components are located in a below-grade concrete vault, which is a confined space. These items should be relocated above grade in a new panel or small building. The access hatch is corroded and in need of replacement.

In addition, there is no backup power at the site and the level in this tank controls finish water pumping and water production at the treatment plant. The District should add backup power to this tank site.

Another issue with this tank is that its effective capacity is significantly lower than its nominal capacity. The tank set points are as follows:

- Call for water at 40'
- Stop calling for water at 49.5'.

However, if there were a major fire or main break and the tank was to drain below 40', low pressure areas would start to develop in the system and at 30' some customers would be without water. Due to the elevation constraints and system configuration, the affective capacity of this tank is only 207,500 gallons.

KENNISTON HILL TANK

The Kenniston Hill tank supports the high pressure zone and is described below:

Type:	*Concrete*
Year of Construction:	*2004*
Dimensions:	*60' diameter x 24' tall*
Overflow:	*277'*
Nominal Capacity:	*508,000 gallons*
Inlet/Outlet:	*Common, 12" with dual ports to promote passive mixing*
Mixing:	*Passive – Tideflex*

The tank has a passive Tideflex mixing system that only works when water is entering the tank. It is intended to help reduce thermal stratification and nitrification in the tank. Low turnover during winter months contributes to ice formation and water quality degradation. The District runs a "bleeder" at the tank site in the winter to help generate turnover, which helps maintain disinfectant levels in the tank and reduce freezing. The bleeder is metered and tracked. Dirigo recommends a new active mixing system be added to this tank.

Water level in this tank controls the operation of the Kenniston Booster pump Station. However, there is no backup power at this site. Dirigo recommends backup power be installed at this site.

THOMPSON TANK (Formerly Southport Tank)

The Thompson tank supports the low pressure zone and is described below:

Type:	*Concrete*
Year of Construction:	*2015*
Dimensions:	*37' diameter x 65' tall*
Overflow:	*215'*
Nominal Capacity:	*510,000 gallons*
Inlet/Outlet:	*Common, 12"*
Mixing:	*None*

The Thompson tank was constructed in 2015 in Southport. The Tank is in good condition and provides peak and fire flow service to Southport and parts of Boothbay Harbor.

WATER STORAGE SUMMARY

The BBRWD has 3 water storage facilities with a total volume of approximately 1.5 million gallons. However, the effective storage capacity is less than 1 million gallons. Though this is adequate for winter conditions (2 days of storage) it is marginal for peak summer months (1 day of storage). However, since the District is a surface water system, and the treatment plant has the capacity to provide 2 MGD, under current conditions, the storage volume appears acceptable. However, as peak demand increases, additional storage may be needed.

G. PRESSURE ZONES

As mentioned earlier, the distribution system has two distinct pressure zones in the system; a high pressure zone and a low pressure zone. As noted in the previous section, the Kenniston Hill storage tank is in the high pressure zone and the Pinkham and Thompson tanks are in the low pressure zone.

The BBRWD uses Pressure Reducing Valves (PRVs) to link the two zones in the distribution system and optimize water flow, storage facility usage, etc. PRVs automatically reduce the higher inlet pressure to a steady lower downstream pressure no matter the flow rate. The downstream pressure can be adjusted. Pressure sensing devices on the inlet and outlet sides of the valve indicate the pressures and an adjustable pilot valve between the two sides allows for adjustments.

Below is a brief description of each PRV station in the BBRWD system.

CHAMBER OF COMMERCE PRV STATION

The BBRWD has a PRV station at the Chamber of Commerce building on the north side of the building in a small concrete vault with a wooden roof. The valve is a 12” PRV manufactured by Cla-Val Co. The PRV pilot is set so the valve is generally closed except in emergency situations when it is manually adjusted and set to the desired outlet pressure. The valve is in reasonable condition with no reported issues. The vault is a confined space, with a single ingress/egress point of an aluminum hatch on the vaults roof. In order to access the vault, operators need to bring a ladder with them. A bulkhead style access would greatly improve accessibility. However, the controls are outside of the vault on the back side in a locked enclosure. Therefore, the need to access the vault is rare. The main electrical breaker for the station is beside the vault and could be shut off by anyone. This should be protected from accidental or unauthorized operation.

EAST BOOTHBAY PRV STATION

The East Boothbay PRV station is an above grade configuration with the 12”valve manufactured by Cla-Val Co. The valve, piping and associated equipment are in an insulated enclosure on a small concrete pad. This station is located in a low area and the telemetry signal from the PRV station to the SCADA system often gets interrupted. The signal is currently routed through the Pinkham tank site to reduce interruptions but they still occur. However, this is a relativity low priority as it functions essentially flawlessly. When there are issues an alarm is sent to the plant but this is not sent to operators as it is considered a low priority.

The controls are mounted on a pressure treated wooden post in a stainless steel enclosure adjacent to the PRV enclosure. A small electric heater is located inside the PRV enclosure to maintain temperatures just above freezing. There is no backup power at the station.

CORY LAND PRV STATION

The Cory Lane PRV is an above grade configuration with a 4” PRV manufactured by Cla-Val Co. The valve and piping are in an insulated polyethylene enclosure that resembles a large rock. The station controls are mounted behind the PRV box on pressure treated wooden posts and plywood panel in a stainless steel enclosure. This PRV has been configured by the operators to help reduce stagnant water issues on the dead-end lines that would be present were it not for the PRV interconnection.

This station has issues with rodents using the enclosure as a home. In addition, the ductile iron piping needs to be painted. This is a small station and a low priority but should have the concrete pad repaired and the enclosure replaced. There is a small electric heater inside the enclosure but no backup power to the facility.

H. DISTRIBUTION PIPING

The BBRWD serves the communities of Boothbay, Boothbay Harbor, and Southport through buried year-round distribution mains and seasonal distribution surface mains. The seasonal mains account for approximately 62% of the overall system piping length. The District has replaced and upgraded some significant piping in the system in recent years and converted some major seasonal areas to year-round such as portions of Southport. Included in the appendix is a water system map showing the distribution system.

Dirigo Engineering developed a hydraulic model and performed a hydraulic analysis of the distribution system, which is included in the Appendix.

The hydraulic analysis revealed that the areas around the major trunk lines through Boothbay, Boothbay Harbor, Southport, and near East Boothbay have robust available fire flow. Included in the Appendix is a map showing the available fire flows in the mains throughout the system based on current system configuration and without the treatment plant finish water pumps running.

We also evaluated some piping upgrades that were expected to improve fire flows in certain areas where existing fire flows were less than adequate such as East Boothbay, Atlantic Avenue, etc. Of these improvements, the most significant based on hydraulic was the additional of a new 12” main on Ocean Point Road from Route 27 to Bradley Road. Other piping upgrades made improvements to the specific areas served but had little effect on the larger areas. Dirigo ran several scenarios, which are all included in the appendix.

The District also provided us with a list of water mains they felt needed upgrading based on the history of these mains, service calls, breaks, failures, limited flow, needed loops, etc. These piping upgrades are listed in the Distribution System Capital Improvements Plan included in the appendix. Some of these are minor pipe replacements on dead end runs and others were short loops, or larger upgrades. The more significant upgrades were evaluated hydraulically to assist in the prioritization of piping improvements.

Also, at the request of the District we evaluated the Spruceworld area of the system. This is an elevated area on the peninsula from Boothbay Harbor to Spruce Point. Some of this area is currently served but due to the elevation, has substandard pressure. Included in the Appendix is a brief hydraulic analysis and concept for a booster pump station.

In addition, Dirigo Engineering is also preparing a Unidirectional Flushing Plan for the distribution system, which will be provided under separate cover.

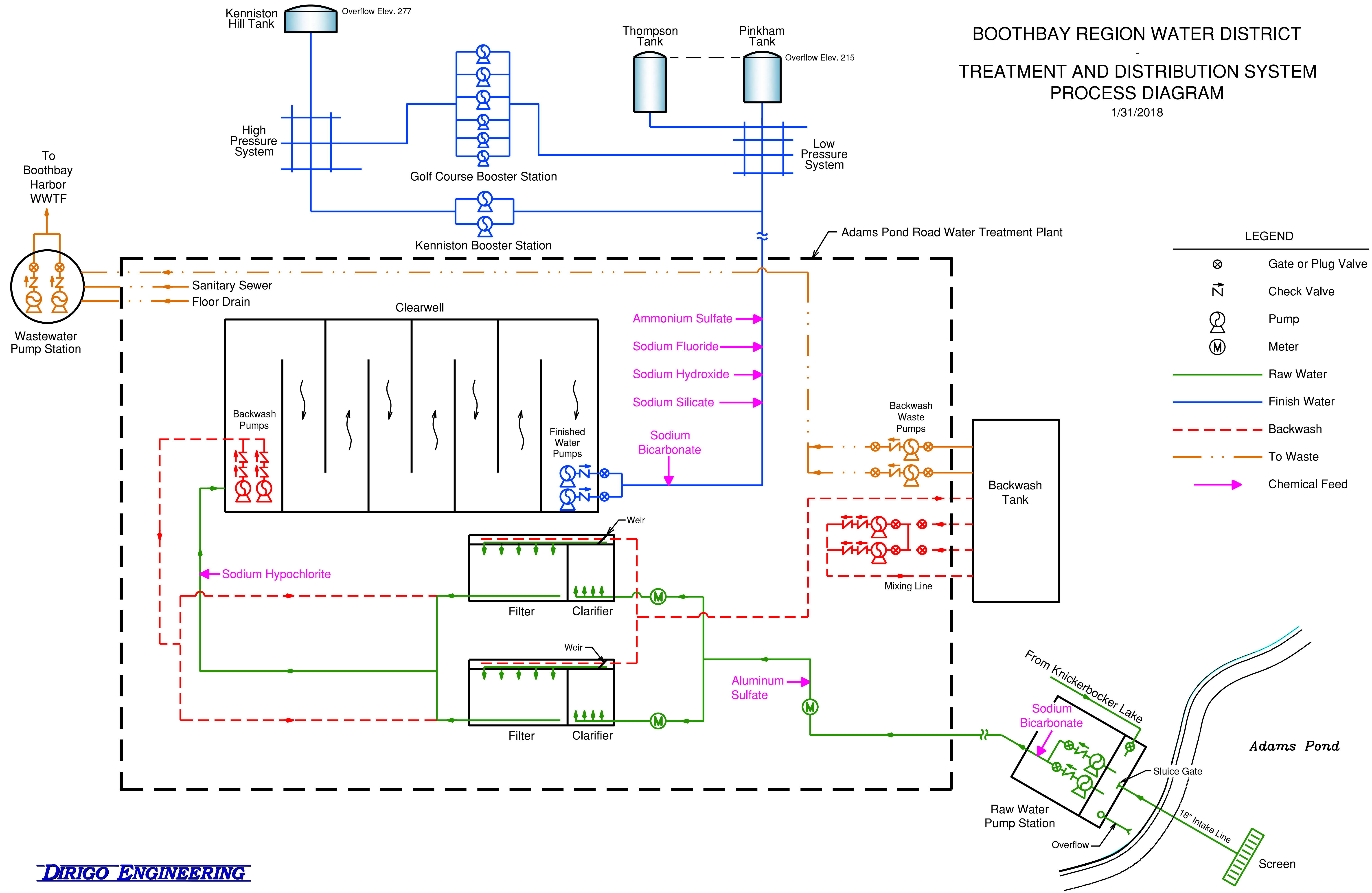
APPENDIX:

1. **Water Treatment Plant & Distribution Process Flow Diagram**
2. **Water System Map**
3. **Hydraulic Analysis**
4. **Fire Flow Map**
5. **Spruceworld Hydraulics**
6. **Source Water Protection Annual Expenses**
7. **Facilities Capital Improvements Plan**
8. **Distribution Improvements Capital Improvements Plan**

APPENDIX 1 –

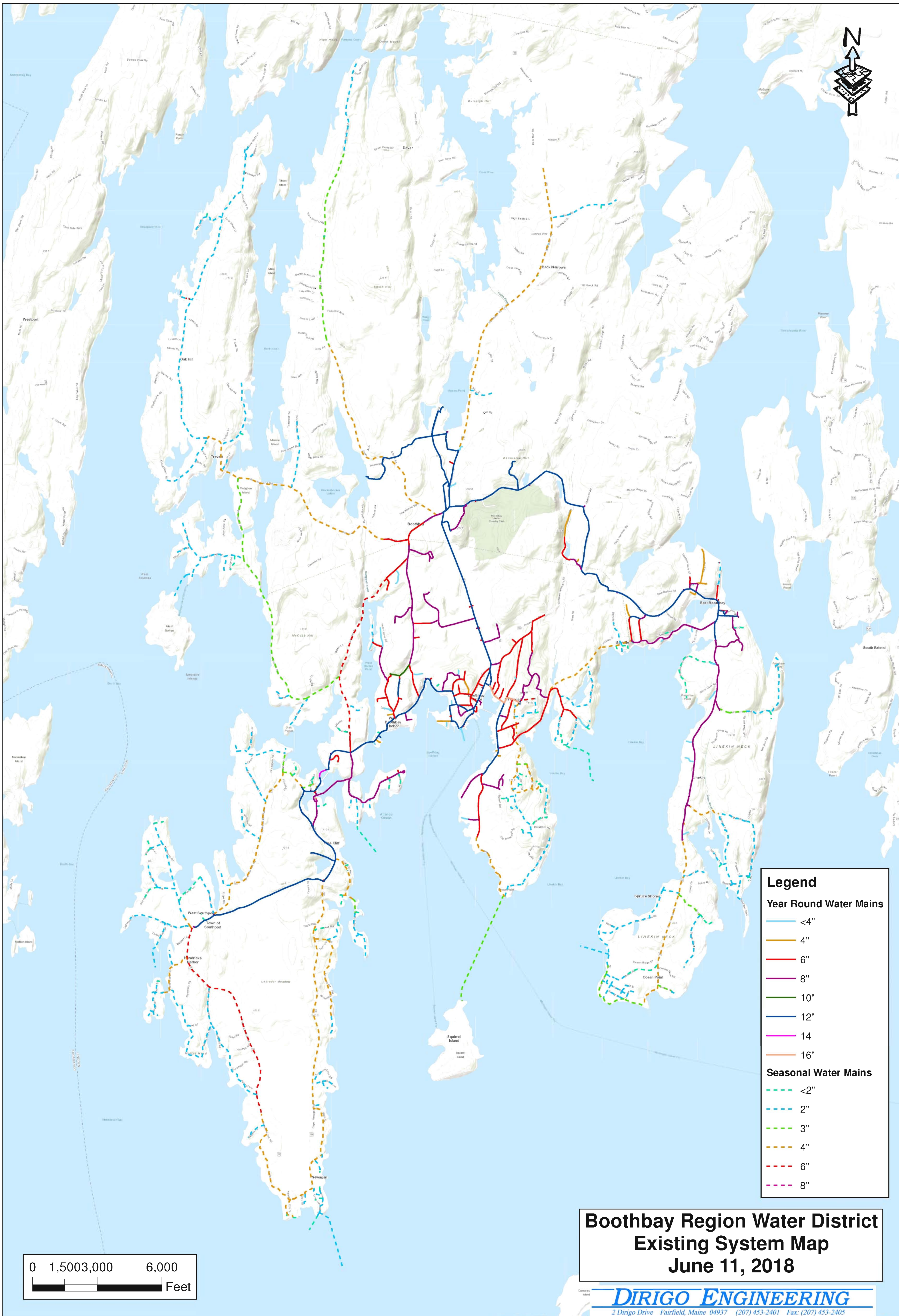
Water Treatment Plant and Distribution Process Flow Diagram

BOOTHBAY REGION WATER DISTRICT
-
TREATMENT AND DISTRIBUTION SYSTEM PROCESS DIAGRAM
1/31/2018



APPENDIX 2 –

Water System Map



N
Legend
Year Round Water Mains
<4"
4"
6"
8"
10"
12"
14
16"
Seasonal Water Mains
<2"
2"
3"
4"
6"
8"
Boothbay Region Water District
Existing System Map
June 11, 2018
DIRIGO ENGINEERING
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0 1,5003,000 6,000
Feet

APPENDIX 3 –

Hydraulic Analysis

Distribution System Analysis

A distribution system analysis was performed on the Boothbay Region Water System using Bentley WaterCAD and the WaterGEMS hydraulic evaluation engine. WaterCAD allows for a complete evaluation of flow and pressure within the system for typical existing conditions as well as for potential water system piping and pumping modifications.

The distribution system was skeletonized to make the data manageable by eliminating most small mains (2" -3" and smaller). Also, most connections that were within 50' of other connections were merged to eliminate an excessive number of very short pipes. The system as evaluated was skeletonized to 478 pipes, 432 junctions as well as the tanks, clearwell, pumps and PRVs.

The data for each evaluation would fill 20 pages with detailed flow and pressure data. This is very cumbersome. To make the output easier to understand and more meaningful we completed a summary sheet for each individual evaluation. The summary sheet shows the available fire flows at key nodes in the distribution system. The summary sheet includes a brief description of the improvements or modifications evaluated as well as a brief summary of the results.

Additional data can readily be prepared for any evaluation upon request. Also, additional specific scenarios can be evaluated if data is desired for them or for other key locations.

It should be noted that fire flows are evaluated at junctions, not hydrants. The flow available at any given location is related to the system piping, available pressure, etc. More than one hydrant will need to be utilized to achieve the higher flow as headloss through the hydrants as fittings becomes excessive.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-00-00-0
Description:	Existing System
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *	
EBB, Ocean Point Road, End of 12"	BB85	1368	gpm
EBB, School at Enterprise	BB95	1410	gpm
EBB, Post Office	BB132	1447	gpm
Ocean Point Road at Bradley	BH131	1998	gpm
Beath at Matthews	BB162	2776	gpm
Country Club Road at Golf Course	BB175	2331	gpm
Roundabout	BB180	2848	gpm
Townsend at Union	BH156	3500	gpm
Atlantic at End of Year round	BH6	484	gpm
Wall Point at Harris	BH201	494	gpm
McKown at Pooler	BH330	1287	gpm
Reed at Middle	BH244	2359	gpm
SP, Cross at end of 12" HDPE	S72	1543	gpm
Lakeside at Middle	BH257	1454	gpm

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: Very solid fireflows available along system backbones (main feeds to EBB, BBH and Southport) and in proximity of tanks. Available fireflows are not significantly different with the plant and booster pumps running except in the immediate area of the pumps. Primary benefit of pumps running during fire flow situations is a reduction in the withdrawal rate from the tanks.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-01-00-0
Description:	System Upgraded with
This Analysis Added-->>	***--new 12" main on OPR from Rt. 27 to Bradley***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1755	gpm	387
EBB, School at Enterprise	BB95	1839	gpm	429
EBB, Post Office	BB132	1916	gpm	469
Ocean Point Road at Bradley	BH131	3500	gpm	1502
Beath at Matthews	BB162	3500	gpm	724
Country Club Road at Golf Course	BB175	2394	gpm	63
Roundabout	BB180	2895	gpm	47
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	483	gpm	-1
Wall Point at Harris	BH201	494	gpm	0
McKown at Pooler	BH330	1286	gpm	-1
Reed at Middle	BH244	2362	gpm	3
SP, Cross at end of 12" HDPE	S72	1542	gpm	-1
Lakeside at Middle	BH257	1455	gpm	1

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 12" main on Ocean Point Road improves fireflows to EBB village area by about 400 gpm. Flow provided from Kenniston Reservoir is reduced which helps pressures in higher parts of system. Flow is more uniformly supplied by Pinkham and Kenniston. PIpe on OPR also provides alternative flow route to both EBB and to BBH if pipe on Route 27 were disturbed.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-02-00-0
Description:	System Upgraded with --new 12" main on OPR from Rt. 27 to Bradley and
This Analysis Added-->>	***--new 12" on Eastern Ave. and Montgomery to OPR***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1773	gpm	18
EBB, School at Enterprise	BB95	1857	gpm	18
EBB, Post Office	BB132	1935	gpm	19
Ocean Point Road at Bradley	BH131	3500	gpm	0
Beath at Matthews	BB162	3500	gpm	0
Country Club Road at Golf Course	BB175	2394	gpm	0
Roundabout	BB180	2910	gpm	15
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	483	gpm	0
Wall Point at Harris	BH201	494	gpm	0
McKown at Pooler	BH330	1288	gpm	2
Reed at Middle	BH244	2362	gpm	0
SP, Cross at end of 12" HDPE	S72	1542	gpm	0
Lakeside at Middle	BH257	1456	gpm	1

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 12" main on Eastern Avenue and Montgomery would provide redundant flow paths (loops) between OPR, Townsend, etc. Fireflows are not significantly impacted except right along the new mains.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-03-00-0
Description:	System Upgraded with --new 12" main on OPR from Rt. 27 to Bradley and --new 12" on Eastern Ave. and Montgomery to OPR
This Analysis Added-->>	***--new 8" on Oak Street***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1773	gpm	0
EBB, School at Enterprise	BB95	1858	gpm	1
EBB, Post Office	BB132	1936	gpm	1
Ocean Point Road at Bradley	BH131	3500	gpm	0
Beath at Matthews	BB162	3500	gpm	0
Country Club Road at Golf Course	BB175	2394	gpm	0
Roundabout	BB180	2910	gpm	0
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	483	gpm	0
Wall Point at Harris	BH201	494	gpm	0
McKown at Pooler	BH330	1287	gpm	-1
Reed at Middle	BH244	2367	gpm	5
SP, Cross at end of 12" HDPE	S72	1543	gpm	1
Lakeside at Middle	BH257	1456	gpm	0

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 8" main on Oak Street would replace aging 6" cast iron main. Existing firelows in this area are strong due to proximity to large backbone pipes. Fireflows are not significantly impacted by this upgrade except right along the new mains.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-04-00-0
Description:	System Upgraded with --new 12" main on OPR from Rt. 27 to Bradley and --new 12" on Eastern Ave. and Montgomery to OPR --new 8" on Oak Street
This Analysis Added-->>	***--new 8" on Lobster, Wall Pt., Barrows (start at Park)***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1773	gpm	0
EBB, School at Enterprise	BB95	1858	gpm	0
EBB, Post Office	BB132	1936	gpm	0
Ocean Point Road at Bradley	BH131	3500	gpm	0
Beath at Matthews	BB162	3500	gpm	0
Country Club Road at Golf Course	BB175	2394	gpm	0
Roundabout	BB180	2910	gpm	0
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	483	gpm	0
Wall Point at Harris	BH201	1090	gpm	596
McKown at Pooler	BH330	1287	gpm	0
Reed at Middle	BH244	2367	gpm	0
SP, Cross at end of 12" HDPE	S72	1543	gpm	0
Lakeside at Middle	BH257	1456	gpm	0

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 8" mains would replace aging 6" cast iron mains and other antiquated piping. Fireflows are not significantly impacted by this upgrade except right along the new mains.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-05-00-0
Description:	System Upgraded with --new 12" main on OPR from Rt. 27 to Bradley and --new 12" on Eastern Ave. and Montgomery to OPR --new 8" on Oak Street --new 8" on Lobster, Wall Pt., Barrows (start at Park)
This Analysis Added-->>	***--extend 12" on Atlantic to end of yearround***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1773	gpm	0
EBB, School at Enterprise	BB95	1858	gpm	0
EBB, Post Office	BB132	1936	gpm	0
Ocean Point Road at Bradley	BH131	3500	gpm	0
Beath at Matthews	BB162	3500	gpm	0
Country Club Road at Golf Course	BB175	2394	gpm	0
Roundabout	BB180	2910	gpm	0
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	2293	gpm	1810
Wall Point at Harris	BH201	1090	gpm	0
McKown at Pooler	BH330	1287	gpm	0
Reed at Middle	BH244	2367	gpm	0
SP, Cross at end of 12" HDPE	S72	1543	gpm	0
Lakeside at Middle	BH257	1456	gpm	0

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 12" mains would replace aging cast iron mains and other antiquated piping in a key developed area. Local Atlantic Avenue fireflows are significantly improved.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-06-00-0
Description:	System Upgraded with
	--new 12" main on OPR from Rt. 27 to Bradley and
	--new 12" on Eastern Ave. and Montgomery to OPR
	--new 8" on Oak Street
	--new 8" on Lobster, Wall Pt., Barrows (start at Park)
	--extend 12" on Atlantic to end of year round
This Analysis Added-->>	***--new 12" on McKown from 27 to Pooler***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1773	gpm	0
EBB, School at Enterprise	BB95	1858	gpm	0
EBB, Post Office	BB132	1936	gpm	0
Ocean Point Road at Bradley	BH131	3500	gpm	0
Beath at Matthews	BB162	3500	gpm	0
Country Club Road at Golf Course	BB175	2394	gpm	0
Roundabout	BB180	2910	gpm	0
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	2293	gpm	0
Wall Point at Harris	BH201	1090	gpm	0
McKown at Pooler	BH330	3500	gpm	2213
Reed at Middle	BH244	2368	gpm	1
SP, Cross at end of 12" HDPE	S72	1543	gpm	0
Lakeside at Middle	BH257	1457	gpm	1

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 12" mains would replace aging 6" cast iron mains and other antiquated piping. Fireflows are significantly improved along McKown Point Road.

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June 6, 2018

Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-07-00-0
Description:	System Upgraded with
	--new 12" main on OPR from Rt. 27 to Bradley and
	--new 12" on Eastern Ave. and Montgomery to OPR
	--new 8" on Oak Street
	--new 8" on Lobster, Wall Pt., Barrows (start at Park)
	--extend 12" on Atlantic to end of year round
	--new 12" on McKown from 27 to Pooler
This Analysis Added-->>	***--new 12" and 8" loops on Pine, Bay & Summit***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1774	gpm	1
EBB, School at Enterprise	BB95	1858	gpm	0
EBB, Post Office	BB132	1937	gpm	1
Ocean Point Road at Bradley	BH131	3500	gpm	0
Beath at Matthews	BB162	3500	gpm	0
Country Club Road at Golf Course	BB175	2394	gpm	0
Roundabout	BB180	2912	gpm	2
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	2424	gpm	131
Wall Point at Harris	BH201	1095	gpm	5
McKown at Pooler	BH330	3500	gpm	0
Reed at Middle	BH244	2370	gpm	2
SP, Cross at end of 12" HDPE	S72	1543	gpm	0
Lakeside at Middle	BH257	1457	gpm	0

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 12" and mains would replace aging cast iron mains and other antiquated piping and create an improved loop around the Pinkham Tank. Fireflows are not significantly impacted by this upgrade. This upgrade provides redundant flow paths and options for the district.

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June 6, 2018
Boothbay Region Water District

Summary of WaterCAD Fireflow Analysis

Scenario Name:	BBRWD-08-00-0
Description:	System Upgraded with --new 12" main on OPR from Rt. 27 to Bradley and --new 12" on Eastern Ave. and Montgomery to OPR --new 8" on Oak Street --new 8" on Lobster, Wall Pt., Barrows (start at Park) --extend 12" on Atlantic to end of year round --new 12" on McKown from 27 to Pooler --new 12" and 8" loops on Pine, Bay & Summit
This Analysis Added-->>	***--12" Lakeview & Reed, 8" on Williams & Middle Loop***
System Base Demand:	900 gpm, Peak Domestic Daily Usage
Water Plant Pump:	Off
Kenniston Booster:	Off

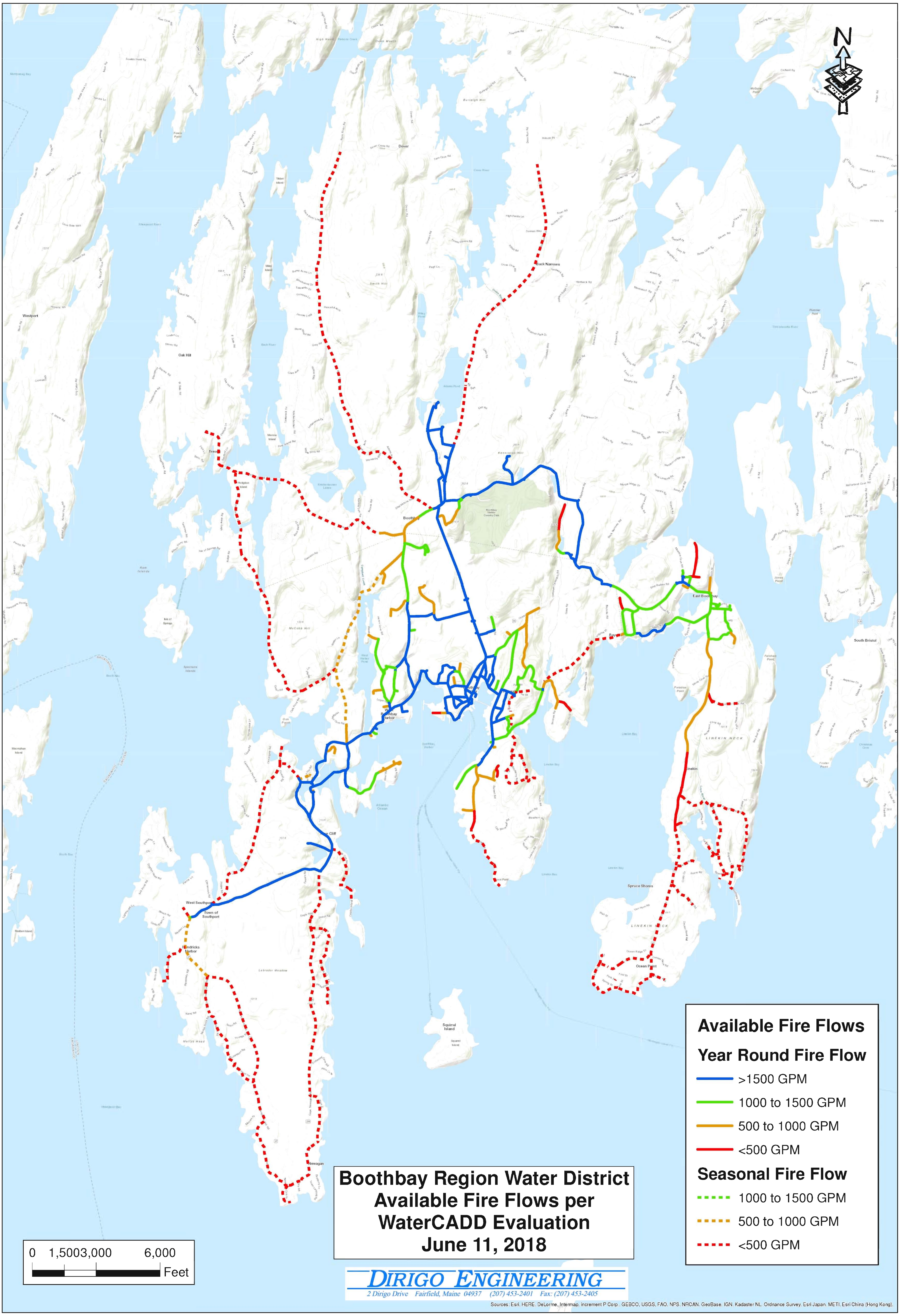
Fire Flow Location	Label	Available Fire Flow *		Increase over prior upgrades
EBB, Ocean Point Road, End of 12"	BB85	1774	gpm	0
EBB, School at Enterprise	BB95	1859	gpm	1
EBB, Post Office	BB132	1937	gpm	0
Ocean Point Road at Bradley	BH131	3500	gpm	0
Beath at Matthews	BB162	3500	gpm	0
Country Club Road at Golf Course	BB175	2394	gpm	0
Roundabout	BB180	2914	gpm	2
Townsend at Union	BH156	3500	gpm	0
Atlantic at End of Year round	BH6	2424	gpm	0
Wall Point at Harris	BH201	1095	gpm	0
McKown at Pooler	BH330	3500	gpm	0
Reed at Middle	BH244	3500	gpm	1130
SP, Cross at end of 12" HDPE	S72	1544	gpm	1
Lakeside at Middle	BH257	1481	gpm	24

* Available Fireflows indicate flows available from system piping. More than one hydrant will need to be utilized to achieve higher flows. Higher areas of the system and users beyond the flows on dead-end mains will likely experience pressures of 0 psi.

Summary: New 12" and 8" mains would replace aging cast iron mains and other antiquated piping. Loops will be formed to provide additional flow paths. Fireflows are not significantly impacted by this upgrade except right along the new mains in the immediate area of the upgrades.

APPENDIX 4 –

Fire Flow Map


Available Fire Flows
Year Round Fire Flow
>1500 GPM
1000 to 1500 GPM
500 to 1000 GPM
<500 GPM
Seasonal Fire Flow
1000 to 1500 GPM
500 to 1000 GPM
<500 GPM
Boothbay Region Water District
Available Fire Flows per
WaterCADD Evaluation
June 11, 2018
0 1,5003,000 6,000
Feet
DIRIGO ENGINEERING
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Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong)

APPENDIX 5 –

Spruceworld Hydraulics

System Hydraulic Grade Line (HGL): Approx. 210’

System HGL (low): Approx. 200’

Highest Grade in Area: Approx. 175’

Approx. customer service elevation: Approx. 180’

(Low) system HGL provides approx. 40 psi to customers below Elev. 110’

Existing booster is at 115’

Boost to 180’ + 50 psi (115’) = 300’

Boosters add 100’ = 45 psi

If 75 customers peak flow (75 x 500gpm x 4(peak)/1440 = 100 gpm

Recommend duplex booster pump of 3 to 5 HP (70-100 gpm) and a small jockey pump of 1 HP for low flow period.

Booster pump station should connect to the 12” water main on Atlantic Avenue if possible.

APPENDIX 6 –

Source Water Protection Annual Expenses

Boothbay Region Water District

Capital Improvements Plan

Source Water Protection Annual Expenses

Project	Description	Estimated Expense
Land acquisition	Purchase land when reasonable but budget annually	$10,000
Community outreach, awareness & education	Advertising, meetings, signage, etc.	$5,000
Work toward tighter ordinances	Professional fees	$2,000
Site restoration projects	Repair erosion, re-vegetation areas, culvert improvements, etc,.	$20,000
Water quality monitoring	Continued monitoring in ponds and expand to stream and upstream watershed monitoring	$5,000
Joint training with police, fire, etc.	Spill containment & countermeasures and emergency response training to spill in watershed	$5,000
	Total Preliminary Estimated Annual Budget for Source Water Protection	**$47,000**

APPENDIX 7 –

Facilities Capital Improvements Plan

Boothbay Region Water District

Capital Improvements Plan

Facilities Capital Improvements

Description	1-5 Years	5-10 Years	10-15 Years	15-20 Years
Knickerbocker Lakes Source & PS				
Construction of boat launch	$ 10,000			
Add redundant pump		$ 50,000		
Subtotal	**$ 10,000**	**$ 50,000**	**$ -**	**$ -**
Adams Pond Source & Raw Water PS				
Construction of boat launch	$ 10,000			
Add air dryer to air compressor	$ 2,500			
Replace RW pump #1 VFD		$ 7,500		
Service RW pump #2	$ 5,000		$ 5,000	
Service RW pump #1		$ 5,000		$ 5,000
Subtotal	**$ 17,500**	**$ 12,500**	**$ 5,000**	**$ 5,000**
Water Treatment Plant				
Piping Gallery				
Add exhaust fan	$ 3,500			
Convert ladder to ship style ladder	$ 10,000			
Add second ladder		$ 5,000		
Install gas detection and alarm system	$ 5,000			
Install additional "help" buttons	$ 5,000			
Place SCBA & Retrieval gear near Entrance		$ 15,000		
Subtotal	**$ 23,500**	**$ 20,000**	**$ -**	**$ -**
Clarifiers/Filters & Backwash System				
Complete rehabilitation of structural steel, repairs, welding, pit filling, recoating of both units	$ 50,000	$ 50,000		
Replace air compressor	$ 15,000			
Replace backwash wasting pumps and check valves	$ 40,000			
Integrate backwash mixing system into SCADA			$ 3,500	
Subtotal	**$ 105,000**	**$ 50,000**	**$ 3,500**	**$ -**

Boothbay Region Water District
Capital Improvements Plan

Description	1-5 Years	5-10 Years	10-15 Years	15-20 Years
Chemical Treatment & Finished Water Systems				
Clean & inspect clearwell	$ 20,000			
Service FW pump #1	$ 5,000			$ 5,000
Service FW pump #2			$ 5,000	
Update SCADA screens	$ 3,500			
Chemical feed system upgrades	$ 5,000	$ 10,000	$ 10,000	$ 10,000
Subtotal	**$ 33,500**	**$ 10,000**	**$ 15,000**	**$ 15,000**
General Building Facilities				
New backup alarm system for power failure at plant	$ 10,000			
Service air handler	$ 5,000			
Rehabilitate plant heating & Ventilation system				$ 50,000
Replace roof				$ 20,000
Repave site			$ 15,000	
Upgrade SCADA system			$ 50,000	
Subtotal	**$ 15,000**	**$ -**	**$ 65,000**	**$ 70,000**
Kenniston Booster PS				
trim trees along access route and around transform, power lines, etc.	$ 5,000			
Re-route power supply from Adams Pond Road		$ 30,000		
Add 3rd pump	$ 40,000			
Subtotal	**$ 45,000**	**$ 30,000**	**$ -**	**$ -**
Spruceworld Booster PS				
Construct new duplex booster pump station integrated with SCADA system				$ 100,000
Subtotal	**$ -**	**$0**	**$0**	**$ 100,000**
Harry L. Pinkham Tank				
Construct small building & relocate electrical & controls	$ 35,000			
Add backup power	$ 25,000			
Recoat Tank				$ 200,000
Subtotal	**$ 60,000**	**$ -**	**$ -**	**$ 200,000**

Boothbay Region Water District
Capital Improvements Plan

Description	1-5 Years	5-10 Years	10-15 Years	15-20 Years
Kenniston Hill Tank				
Install new active mixing system		$ 50,000		
Install backup generator	$ 25,000			
Subtotal	**$ 25,000**	**$ 50,000**	**$ -**	**$ -**
Chamber of Commerce PRV Station				
Install locking system on main power breaker	$ 1,500			
Improve access with bulkhead style entrance			$ 10,000	
Subtotal	**$ 1,500**	**$ -**	**$ 10,000**	**$ -**
East Boothbay PRV Station				
Improve telemetry route			$ 10,000	
Install backup power receptacle		$ 5,000		
Subtotal	**$ -**	**$ 5,000**	**$ 10,000**	**$ -**
Cory Lane PRV Station				
Re-coat piping, replace concrete pad and insulated enclosure	$ 5,000			
Install backup power receptacle		$ 5,000		
Subtotal	**$ 5,000**	**$ 5,000**	**$ -**	**$ -**
Total Estimated CIP for Plant and Stations	**$ 341,000**	**$ 232,500**	**$ 108,500**	**$ 390,000**

APPENDIX 8 –

Distribution Improvements Capital Improvements Plan

Boothbay Region Water District

Capital Improvements Plan

Distribution Piping Projects

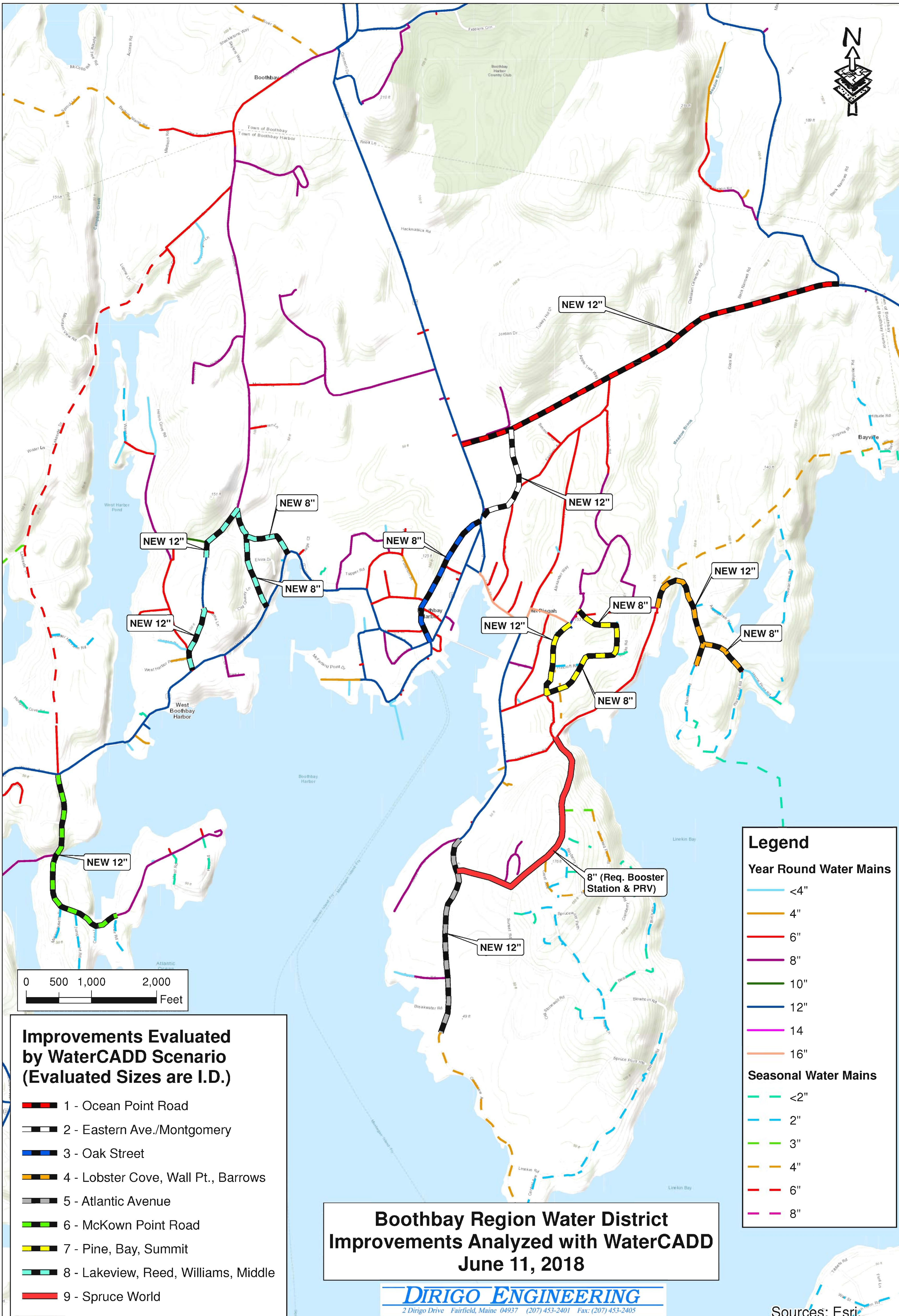
Projects to be Contracted Out

Priority	Project Description	Reasons for upgrade	Upgrade Description	Length	Unit Cost	Cost Est.
1	Ocean Point Rd. (Route 96 from Townsend to Bradley Rd.)	Gives redundancy to EBB by creating a critical loop, improves fire flow and helps maintain system pressure during peak events	Install new 12" ID water main	6,300	$300	$1,890,000
2	Lobster cove Rd. (Park St. to Wall Point) & Wall Point to Apalachee Rd.	Many main breaks in recent years	Replace existing 6" with new 12" & 8"	2,500	$275	$687,500
3	McKown Pt. (Western Ave. to Blake boatyard)	Many main breaks and potential for ongoing leaks	Replace existing 8" with new 12"	3,100	$275	$852,500
4	Oak Street-Smith St. to Bank square	100 year old infrastructure needs upgrading	Replace existing 6" CI with new 8"	2,300	$275	$632,500
5	Eastern Ave. (Townsend to Montgomery)	8" AC recently discovered needs upgrading	Replace existing 8" Ac/ 67" CI with new 12"	750	$275	$206,250
6	Atlantic Ave. (Roads End to Grandview)	100 year old infrastructure needs upgrading	Replace existing 6" CI with new 12"	3,200	$275	$880,000
7	Eastern Ave. (Montgomery to Route 96)	Old 6" CI needs upgrading and improved redundancy	Replace existing 6" CI with new 12"	750	$275	$206,250
8	Summit Rd. (Bay St. to Pinkham Trans. Main)	Redundancy and seasonal line upgrade	Replace seasonal line with new 12"	1,200	$275	$330,000
9	Pine St., Bay St. to Summit Loop	Complete year-round loop	Replace seasonal lines with new 8"	2,500	$275	$687,500
10	Reed Rd. (Middle Rd. to Route 27 less the section completed previously)	Replace old 6" CI pipe and complete 12" loop. (this includes 2 sections: 1 near West Harbor Tank cross country main and the other from Andrea Ln. to Western Ave.)	Replace old 6" CI with new 12"	1,700	$275	$467,500
11	Montgomery Rd.	Completes Loop	Install new 8"	900	$275	$247,500
12	West St. (Oak St. to Howard St.)	100 year old infrastructure needs upgrading	Replace existing 6" CI with new 8"	850	$275	$233,750
1	Lakeside Dr. from Town Center to Western Ave.	Upgrade critical loop to year round loop	Install new 12"	13,100	$300	$3,930,000
			Subtotal	**19,750**	**Subtotal**	**$9,361,250**

Boothbay Region Water District
Capital Improvements Plan
Distribution Piping Projects

Projects to be Completed by BBRWD Staff

Priority	Project Description	Reasons for upgrade	Upgrade Description	Length	Unit Cost	Cost Est.
1	Anderson Rd. to Rice Rd.	Manifolded 3/4" lines feeding a 4" HDPE main/flow issues	Install new 6"	500	$200	$100,000
2	Logan Rd. (Barlow Hill Rd.)	1" Copper- undersized/freezes frequently	Install new 6" + hyd.	500	$200	$100,000
3	Mariner Way	1" Copper line/shallow-freezes frequently/possibly leaking	Install new 6" + hyd.	400	$200	$80,000
4	Middle Rd. (Western Ave. to Williams St.)	Old 1 1/2" galvanized/not looped/needs correcting	Install new 8"	750	$200	$150,000
5	Willams Rd. (Reed Rd. to Western Ave.)	Old poorly installed 6" CI with multiple Breaks	Install new 8"	1,600	$200	$320,000
6	Farnham Point to Dan Alley	Old dead-ended 8" CI main/needs hydrant for flushing	Install new 8" + Hyd.	550	$200	$110,000
7	Roads End, south end	Lots of rocks discovered in main/need hydrant moved to end of main	Install new 6" + hyd.	500	$200	$100,000
8	Factory Cove	Shallow/Freezes frequently - bleeder installed annually	Install new 6" + hyd.	300	$200	$60,000
9	Heron Cove	2" blue brute/undersized	Install new 6" + hyd.	500	$200	$100,000
10	Breakwater/Pinkham Cove	Spaghetti lines all undersized/no real main	Install new 6" + 2 hyd.	1,050	$200	$210,000
11	Commercial St. Ext and Eames Rd.	Old 4" cast iron undersized on commercial-2" galv on Eames Rd.	Install new 8" & 6" + Hyd.	810	$200	$162,000
12	Tupper Rd. (Fullerton to Perkins)	No main exist/ long spaghetti services/needs correcting	Install new 6"	500	$200	$100,000
13	West side of Presley Dr. + x-country to Roberts	Many main breaks/shallow/possibly reused cast iron	Install new 8" (unless potential to upgade x-country, then use 12")	1,100	$200	$220,000
14	House # 159 to 169 on Route 96	2" or 4" HDPE line running behind houses/requires four new taps	Tap main on Ocean Point Rd., new service	4	$1,500	$6,000
15	Fullerton St. (Barter Rd to Western Ave)	Old AC pipe/needs upgrading	Install new 8"	800	$200	$160,000
16	Hahn Rd.	No yearround main/undersized seasonal main	Install new 6" + hyd.	500	$200	$100,000
			Total In-House Projects	**10,364**		**$2,078,000**



NEW 12"
NEW 12"
NEW 8"
NEW 12"
NEW 8"
NEW 8"
NEW 12"
NEW 12"
NEW 8"
NEW 12"
NEW 8"
NEW 8"
NEW 12"
8" (Req. Booster Station & PRV)
NEW 12"
West Boothbay Harbor
Boothbay Harbor
Bayville
0 500 1,000 2,000 Feet
Improvements Evaluated by WaterCADD Scenario (Evaluated Sizes are I.D.)
1 - Ocean Point Road
2 - Eastern Ave./Montgomery
3 - Oak Street
4 - Lobster Cove, Wall Pt., Barrows
5 - Atlantic Avenue
6 - McKown Point Road
7 - Pine, Bay, Summit
8 - Lakeview, Reed, Williams, Middle
9 - Spruce World
Legend
Year Round Water Mains
<4"
4"
6"
8"
10"
12"
14"
16"
Seasonal Water Mains
<2"
2"
3"
4"
6"
8"
Boothbay Region Water District
Improvements Analyzed with WaterCADD
June 11, 2018
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Sources: Esri,