WASTEWATER COLLECTION & TREATMENT FACILITY FEASIBILITY STUDY

for the

TOWN OF BOWDOINHAM, MAINE

JUNE 2019

WRIGHT-PIERCE

Engineering a Better Environment

TOWN OF BOWDOINHAM, MAINE

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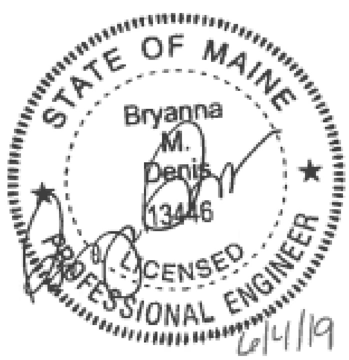

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TOWN OF BOWDOINHAM, MAINE

WASTEWATER FEASIBILITY STUDY

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SECTION 1
INTRODUCTION

The Town of Bowdoinham currently relies on individual treatment and subsurface disposal systems located on each lot for wastewater treatment. In the 1970's and 1980's, Wright-Pierce completed two studies to evaluate the feasibility and cost of installing a centralized collection and treatment system for domestic wastewater, with the more recent study recommending that the Town continue with individual on lot systems due to cost. More recently, small lot sizes and inadequate soils in the Village I District have resulted in limited options for property owners as individual disposal systems age and fail. In addition, the Town and the Community Development Advisory Committee (CDAC) have indicated that limited wastewater collection and treatment solutions may be preventing economic development in the village area. Therefore, the downtown village area has been identified by Town officials and the CDAC for a wastewater collection and treatment feasibility study to outline planning level costs and options to potentially sewer a portion of the Village I District that consists of the smallest lots with the most population density.

This planning level feasibility study can be used by Town officials to determine whether further investigation and/or design of wastewater treatment collection and treatment systems should be considered in the Village area. As part of this study, Wright-Pierce completed the following:

- Meet with Town officials for input on the number and location of lots to consider for sewer collection;
- Meet with Town officials to obtain water flow data, lot type, and use;
- Conduct preliminary test pits on Town-owned property to identify soil features to help understand feasibility and prepare planning level cost estimates;
- Develop a GIS figure illustrating the proposed collection system and possible location of treatment and disposal system;
- Contact the ME Department of Environmental Protection for input on effluent discharge requirements and parameters;
- Develop planning level total project capital cost and expected O&M costs;
- Comment on likely funding scenarios, sewer user fees and capital reserve accounts;

- Summarize the above analysis and findings in a draft report to Town officials and CDAC; and
- Meet with Town officials and CDAC to go over report comments, and to update the report as necessary.

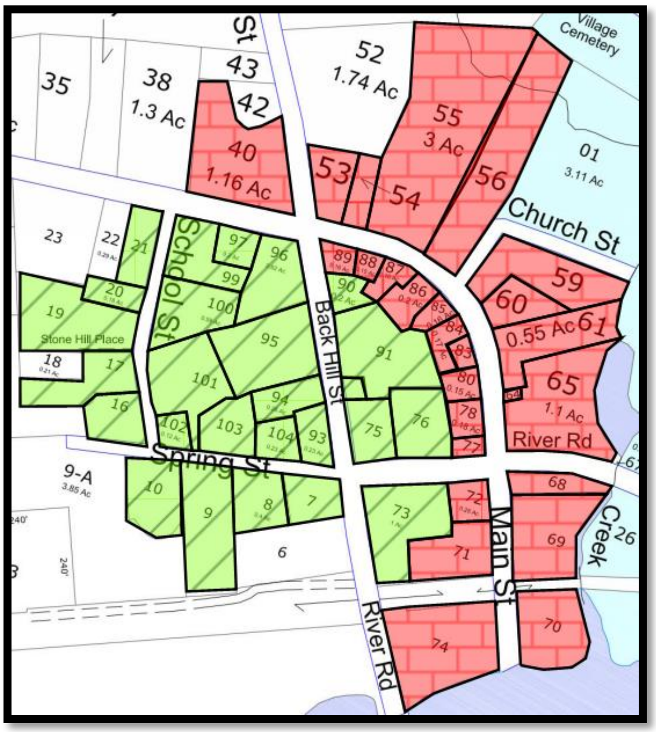
SECTION 2
EXISTING CONDITIONS

2.1 STUDY AREA

The Town and CDAC established the targeted areas for sewage collection as shown in Figure 2-1. The lots within the two targeted areas comprise of 55 total parcels as follows:

- Target Area 1: 27 parcels along Main Street from the Cathance River north to the intersection with Main Street and School Street. These lots are colored pink with brick hatch in Figure 2-1.
- Target Area 2: 28 additional parcels consisting of lots along School Street, Spring Street and Back Hill Road. These lots are colored green with diagonal hatch in Figure 2-1.

FIGURE 2-1
TARGET SEWERED AREAS



For the purpose of this report, the two Target Areas are not exclusive. It is anticipated that the following options be considered based upon available funds and Town needs:

- Sewer Target Area 1 only;
- Sewer Target Areas 1+2 together;

- Phased approach where Target Area 1 is sewered first, and Target Area 2 is added later.

The parcels in the two study areas were grouped into use categories for evaluating flow data as summarized in Table 2-1. The parcels are further divided into various use categories for single family homes, multi-family homes, and commercial spaces (restaurants, retail, and office spaces, etc.). There are also several Town owned lots including public parks, parking areas, a public restroom, the Town Hall and religious or other organizational building such as churches and masonic lodges.

TABLE 2-1
TARGET AREAS LAND USE

Type	No. of Lots
Target Area 1	
Single Family 0 – 2 bedroom	2
Single Family 3 bedroom	1
Single Family 4 bedrooms or greater	8
Multi-Family	2
Commercial – Restaurant	1
Commercial – Retail	2
Commercial – Office	1
Commercial – Other	3
Municipal – Mixed Use	2
Public Park / Recreation / Parking[1]	3
Religious / Other Organization	2
Subtotal	*27*
Target Area 2	
Single Family 0 – 2 bedroom	5
Single Family 3 bedroom	7
Single Family 4 bedrooms or greater	7
Multi-Family	3
Commercial – Other	1
Municipal – Mixed Use	2
Public Park / Recreation / Parking[1]	2
Religious / Other Organization	1
Subtotal	*28*
Total	**55**

Notes: 1. Based upon discussions with Town staff, there were five Town owned lots with no flow assigned (i.e. park, parking lot, records/storage building, information/ signage, etc.). Town staff indicated these lots are not anticipated to ever have water or sewer needs.

As outlined in Table 2-1, the 55 lots within the targeted areas of Bowdoinham Village are approximately 62% residential, 15% commercial, 16% municipal/public and 5% religious/other use. There is currently one restaurant in Target Area 1.

2.2 WASTEWATER FLOWS AND LOADS

Public water usage data was provided by the Town for 2018. The water use data, the International Plumbing Code, and anecdotal information from the Town Manager and Town Planner about current and potential uses for various parcels and building were used to develop projected wastewater flows outlined in Table 2-2.

TABLE 2-2
WASTEWATER FLOW PROJECTIONS

	Area 1	**Area 2**	**Areas 1 + 2**
Wastewater Flows[1,2]	8,140 gpd	8,250 gpd	16,390 gpd
Infiltration and Inflow[3]	1,630 gpd	1,780 gpd	3,410 gpd
Total Flow	9,770 gpd	10,030 gpd	19,800 gpd

Notes:
1. A peaking factor of 3.0 was applied to current water data information to estimate design wastewater flow where applicable.
2. Where water data appeared to be erroneous or artificially low (i.e. a 4-bedroom house with a yearly average water use of 15 gpd [resulting in a design flow of 45 gpd with peaking factor] or where the house is currently empty), the Plumbing Code was used to project flows based upon number of bedrooms. This adjustment to flows resulted in a net peaking factor of 4.0 overall.
3. Infiltration and Inflow was estimated to be equal to 500 gpd/inch-mile

Wastewater loading to the system is expected to be typical mix-use wastewater with the majority of the wastewater flows residential in nature. There are a small number of commercial wastewater flows, including office and retail spaces, that would generally have BOD, TSS and nutrient loadings similar to residential wastewater. There are no manufacturing or industrial facilities currently operating in the study area with non-typical wastewater flows or loads. There is one restaurant in town, which is expected to have 2-3 times higher wastewater loading than residential wastewater. However, since most of the wastewater flow in the target areas is residential in nature, typical mixed-use wastewater strength values will be used. For the purposes of this report, the following wastewater characteristics were used:

- Biochemical Oxygen Demand (BOD_5): 250 mg/L
- Total Suspended Solids (TSS): 220 mg/L
- Total Nitrogen (TN): 40 mg/L

SECTION 3

OPTIONS FOR WASTEWATER COLLECTION & TREATMENT

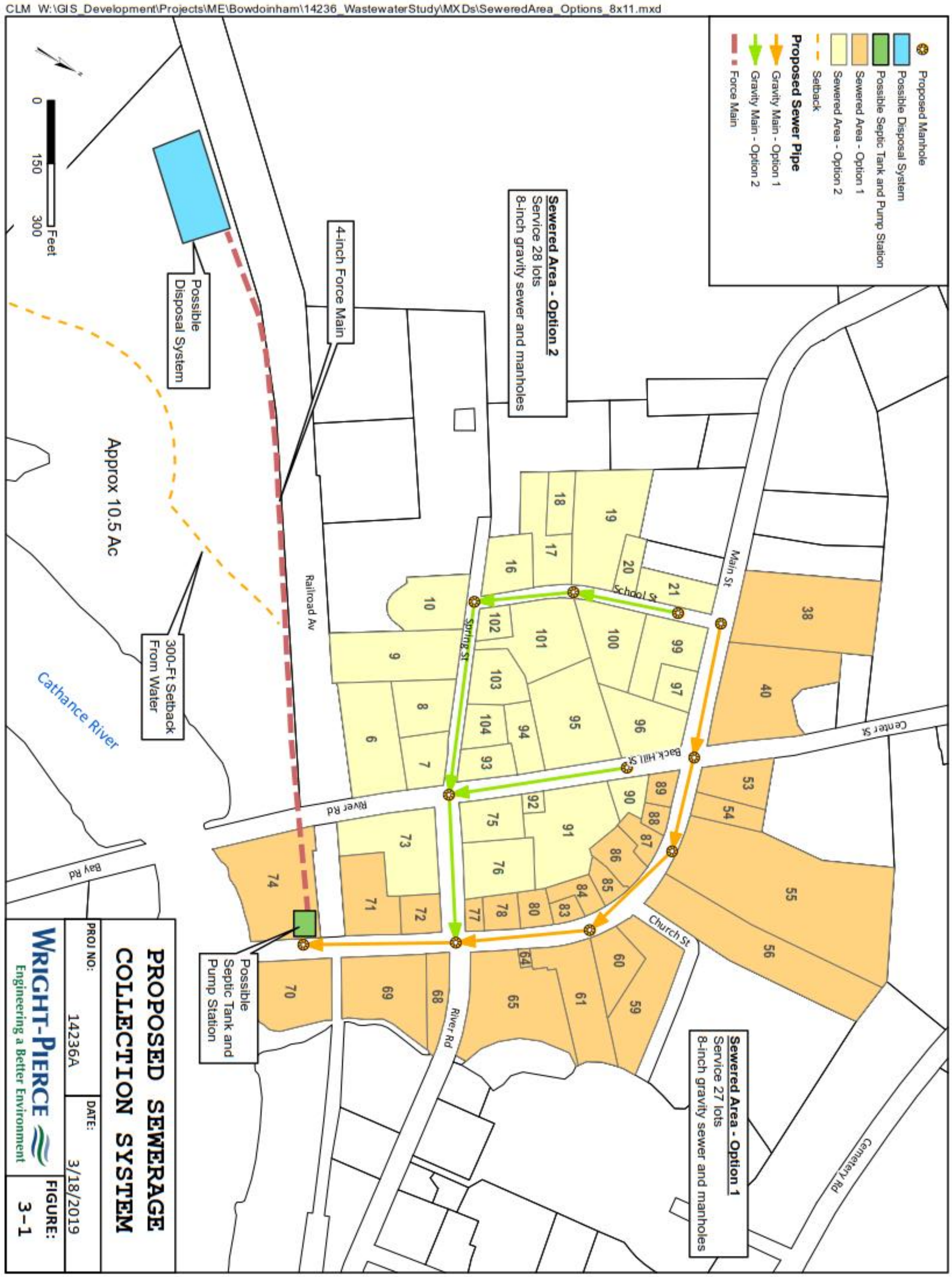
3.1 PROPOSED SEWERAGE COLLECTION SYSTEM

Based upon the target areas defined in Section 2, the collection of sewerage from the lots would require the following lengths of 8-inch PVC gravity sewer pipe. Figure 3-1 shows a possible sewerage collection and disposal system for Target Areas 1 and 2.

	Area 1	**Area 2**	**Areas 1 + 2**
Total Length of Gravity sewer	1,520 feet	1,750 feet	3,270 feet

Manhole locations shown in Figure 3-1 are approximate and would be determined based upon site specific information including land topography/changes in slope, bends in the road right-of-way, and an overall distance of around 300 feet between manholes to accommodate future maintenance/cleaning. As shown in Figure 3-1, one 1,520 feet long gravity sewer line extending down Main Street would serve all the lots within Target Area 1.

To sewer Target Area 2, an additional 1,750 feet of 8-inch PVC gravity sewer pipe would be required. Note that for the purposes of this report, it was assumed that Target Area 2 would not be sewered without including Target Area 1. If the Town wishes to sewer Target Area 2 alone or in a phased approach, 365 feet of gravity sewer would be required in addition to the length noted above for Target Area 2.


CLM W:\GIS_Development\Projects\ME\Bowdoinham\14236_WastewaterStudy\MXDs\SeweredArea_Options_8x11.mxd
Proposed Manhole
Possible Disposal System
Possible Septic Tank and Pump Station
Sewered Area - Option 1
Sewered Area - Option 2
Setback
Proposed Sewer Pipe
Gravity Main - Option 1
Gravity Main - Option 2
Force Main
Sewered Area - Option 2
Service 28 lots
8-inch gravity sewer and manholes
Sewered Area - Option 1
Service 27 lots
8-inch gravity sewer and manholes
4-inch Force Main
Possible Disposal System
Approx 10.5 Ac
300-Ft Setback From Water
Cathance River
Possible Septic Tank and Pump Station
Main St
School St
Spring St
Railroad Av
Center St
Back Hill St
River Rd
Bay Rd
Church St
Cemetery Rd
0
150
300
Feet
PROPOSED SEWERAGE COLLECTION SYSTEM
PROJ NO: 14236A
DATE: 3/18/2019
FIGURE: 3-1
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3.2 TREATMENT & DISPOSAL SYSTEM OPTIONS

There are several methods for wastewater treatment and disposal for small community sewer systems as follows:

1. Collection and pre-treatment in a septic tank with subsurface disposal at a suitable location using:
   a. Typical stone bed;
   b. Proprietary leaching devices (i.e. concrete chambers, plastic chambers, etc.); or
   c. Drip dispersal systems.
2. Collection and advanced treatment system/unit (i.e. Amphidrome, BioClere, Sand Filter, etc.) with wastewater disposal as follows:
   a. Subsurface disposal outlined in 1a, b and c above; or
   b. Surface water discharge to the Cathance River.

3.3 REQUIREMENTS FOR WASTEWATER DISPOSAL

3.3.1 Subsurface Disposal

Subsurface disposal systems are required to be licensed through the State of Maine Department of Health and Human Services (DHHS). DHHS would require that any subsurface disposal system design include a hydrogeological study and groundwater mounding analysis (completed during a later design phase) to determine the soil and groundwater characteristics and to estimate the permeability of the soil. The permeability of the soil would be used to size the leaching bed area correctly, assuring that the effluent is correctly distributed to the soil maximizing treatment and preventing effluent from breaking out at the surface. A state hydrogeologist would need to approve the hydrogeological study before the licensure process is finalized.

Typically, the State only requires pre-treatment (i.e. septic tank) prior to discharge to the disposal field. Preliminary treatment provides 40-50% removal of biochemical oxygen demand (BOD_5); 50-70% removal of total suspended solids (TSS); and 20-30% removal of total nitrogen (TN).

At the anticipated design loadings specified in Section 2.2 result in the effluent loadings shown in Table 3-1 below.

TABLE 3-1: PRETREATMENT REMOVAL RATES

Influent Loading	Removal Range[1]	Calculated Effluent to Subsurface Disposal Loading
250 mg/l BOD_5	40-50%	125-150 mg/l BOD_5
220 mg/l TSS	50-70%	66-110 mg/l TSS
40 mg/l TN	20-30%	28-32 mg/l TN

Notes: 1. Pretreatment removal rates as documented in the State of Maine Subsurface Wastewater Disposal Rules.

Based upon discussions with the State of Maine DEP, effluent to the subsurface disposal system is now required to meet a total nitrogen limit of 10 mg/l. As outlined in Table 3-1, pretreatment cannot meet this limit alone, therefore, installation of a septic tank (primary treatment) with subsurface disposal was eliminated from further consideration. The collected wastewater will require some type of advanced treatment to achieve a total nitrogen limit in the effluent of less than or equal to 10 mg/l TN.

A typical advanced treatment system (Amphidrome was assumed for this study) will achieve less than or equal to 30 mg/l BOD_5, 30 mg/l TSS and 19 mg/l TN. With an additional reactor added to the Amphidrome unit, TN of less than 10 mg/l can be achieved.

3.3.2 Surface Water Disposal

Discharging wastewater to the Cathance River would be possible with a National Pollutant Discharge Elimination System (NPDES) permit. Currently the Maine Department of Environmental Protection has authorization from the US EPA to administer NPDES permits.

The Cathance River is classified by the State of Maine as a Class B waterbody. The classification of the waterbody sets typical recreational use standards and the level of effluent treatment required to discharge to that water body. Though the Town of Bowdoinham does not have a NPDES permit at this time, it is likely that the effluent requirements would be similar to the Bowdoinham

Community School's NPDES permit, which also discharges into the Cathance River. That permit requires an effluent limits as follows:

	Monthly Average	**Weekly Average**	**Daily Maximum**
BOD_5:	30 mg/L	45 mg/L	50 mg/L
TSS:	30 mg/L	45 mg/L	50 mg/L
Total Chlorine Residual:			0.3 mg/L
pH:			6.0-9.0 SU

There is currently no total nitrogen limit requirement on the Cathance River. To achieve effluent characteristics listed above, secondary treatment (also referred to as advanced treatment) is required. A standard Amphidrome system will meet the effluent requirements in this situation, though effluent disinfection will be required on a seasonal basis. During design, Maine DEP would assist with modeling the Cathance River at the discharge location to determine effluent dilution requirements.

3.4 SUBSURFACE SOIL INFORMATION

As part of this feasibility study, the Town owned, and desired, disposal lot was investigated to determine suitability for subsurface disposal. This lot is a 20-acre lot located west of River Road, bounded by the Cathance River to the south and the Railroad to the north. This 20-acre lot has about 10.5 acres of land area that is greater than 300-ft from the Cathance River that may be suitable for siting a subsurface disposal system.

Test pits were conducted on November 15, 2018 in the upland portions of the 20-acre lot. These test pits are not part of a hydrogeological study, rather, the test pits were conducted to determine general suitability of the soil, to assist in preliminary cost estimating for this study and to determine if there were any easily identifiable features that indicated subsurface disposal would not be feasible.

Based upon the test pits, the following information was determined:

- The soil type was most typically a silt loam overlying silty clay loam or silty clay and predicted to have poor permeability.
- There was no evidence of ledge.
- Evidence of seasonal high-water table was found at less than or equal to 13-inches below the surface in the areas investigated.

Loading rates for subsurface disposal to the soil will vary depending upon soil permeability, but generally range from 0.2 to 3.0 gallons per day per square foot (gpd/sf).

State of Maine Subsurface Subsurface Wastewater Disposal Rules (10-144 Chapter 241) provide sizing guidelines for determining the rate at which wastewater can be discharged to a subsurface system. These rules are considered conservative in nature and tailored for non-engineered systems which have less than 2,000 gpd design flow. The subsurface rules classify soil types into 12 different categories, each with its own sizing factor used to determine leaching bed size. Using the subsurface rules, the range of loading rates is from 0.20 gpd/sf for the worst soils (i.e. marine clays), to to 0.39 gpd/sf the best soils (i.e. stratified glacial drift). Since hydrogeological testing, percolation tests and mounding analysis's are not required for non-engineered systems, the State rules are more conservative than the range of loading rates for engineered systems mentioned previously from 0.2 to 3.0 gpd/sf.

The subsurface disposal rules do allow for a size credit associated with advanced treatment. The advanced treatment unit proposals for this study will meet less than or equal to 30 mg/l BOD_5 and TSS each (total 60 mg/l). Table 4B of the subsurface rules would allow an adjustment factor of 0.63 (63% increase) which would result in an increased loading rate range of 0.32 to 0.61 gpd/sf.

The best way to determine design loading rates for engineered systems is to conduct a hydrogeologic study, groundwater mounding analysis and percolation test, which is recommended to be completed early in design of a subsurface system and will provide actual data on the ability of the soil to accept and treat wastewater effluent flows. For the purposes of this report, a soil loading rate of 0.5 gpd/sf has been assumed for subsurface discharge of effluent from an advanced treatment system.

3.5 TREATMENT AND DISPOSAL OPTIONS EVALUATED

The Town indicated that the desired approach for wastewater treatment and disposal would include a collection and disposal system with approximate locations as shown in Figure 3-1. The treatment system would be located in the existing parking lot at the end of Main Street, south of the Railroad crossing with subsurface disposal on the 20-acre Town owned lot shown. The desired subsurface disposal area is at a higher elevation than the treatment tank, therefore, a lift station (pumping station) would be required to lift the effluent from the treatment system to the disposal field. The pumped effluent would travel through a 4-inch high-density polyethylene (HDPE) pipe approximately 2,000 LF to the disposal field location.

For the purpose of this report, advanced treatment (which includes upfront pre-treatment) with the following disposal options were evaluated as follows:

- subsurface leaching stone bed;
- subsurface drip dispersal; and
- surface Discharge to Cathance River.

3.5.1 **Pretreatment**

Pretreatment would typically consist of a septic tank(s). A septic tank provides primary treatment for wastewater by settling solids and utilizing anaerobic processes to reduce solids and organics.

As noted previously, to attain the 30/30/10 mg/l BOD_5, TSS and TN requirements, pre-treatment (septic tank) is not sufficient and advanced treatment would be required as discussed below.

3.5.2 **Advanced Treatment**

Advanced treatment provides preliminary treatment and as well as a secondary level of treatment to wastewater. Instead of using settling and anaerobic processes alone like pretreatment tanks, secondary treatment is a biological process that facilitates aerobic microbial growth that converts BOD into carbon dioxide and water (and microbes that are removed before discharge) and reduces the concentration of nutrients in the wastewater. To provide secondary treatment, some type of aeration is required to provide the microbes with the oxygen needed for their biological processes and to reproduce when consuming the BOD. The biology for advanced treatment can be suspended in the liquid wastewater or attached to media. Oxygen requirements can be provided either by injecting air into the wastewater liquid using a blower/aerator (which then dissolves in the wastewater), or by contact with atmospheric air (where the biology is intermittently exposed to air and wastewater through various means).

There are several types of advanced treatment systems designed for small treatment facilities including membrane bioreactors, moving bed bioreactors, submerged attached growth bioreactors, and sequencing batch reactors to name a few. For the purposes of this initial feasibility study, the Amphidrome attached growth bioreactor manufactured by FR Mahoney was chosen for the purpose of cost. A typical Amphidrome system cross-section is shown in Figure 3-2.

FIGURE 3-2 SECTION VIEW OF TYPICAL AMPHIDROME SYSTEM[1]

Note 1: Total footprint of treatment system site can vary depending upon flow and treatment requirements, as well as space allocated for addition infrastructure to accommodate future growth. One building plus 4 to 5 underground tanks are required. Specific sizing of treatment facility site would be developed during design with input from the Town.

3.5.3 **Effluent Disposal**

Following treatment, the wastewater effluent can be disposed of in two different ways with effluent limitations as described in Sections 3.3.1 and 3.3.2.

3.5.3.1 Surface Water Effluent Disposal

Disposal to a surface water body, in this instance the Cathance River, would consist of a separate disinfection step at the end of the advanced treatment unit followed by a discharge pipe routed to the deepest part of the river channel. The effluent pipe would have diffuser holes to distribute the effluent evenly.

3.5.3.2 Subsurface Effluent Disposal

In contrast to surface water disposal, subsurface disposal would not require effluent disinfection, but it would require pumping, as the disposal bed is located at a higher elevation than the treatment system. The pumping system will consist of two pumps (one duty pump for normal operations and a second pump for redundancy in case of primary pump failure), a valve vault, and the associated force main to convey treated effluent to its disposal location. The disposal fields would be sized during design based upon percolation tests and hydrogeological investigations that would be required.

There are many different types of subsurface disposal systems including traditional stone beds or trenches, concrete or plastic chambers, drip irrigation systems, as well as numerous proprietary devices. For this report, subsurface leaching with a standard stone bed and drip dispersal were considered.

3.5.3.2.1 Subsurface Leaching with a Standard Stone Bed

This is the most common type of effluent disposal system. It involves gravity or pressure-distributed flow to a subsurface layer of gravel or crushed stone as shown in Figure 3-3.

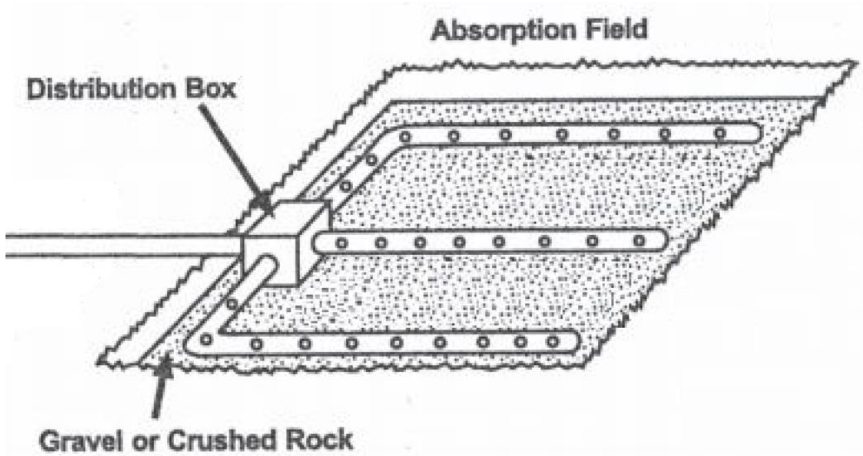

FIGURE 3-3 ISOMETRIC VIEW OF UNDERGROUND PORTION OF SUBSURFACE LEACHING SYSTEM

Because the gravel or stone layer is buried, it is difficult to remediate the bed if solids carry over from the treatment system, and the leaching field must be conservatively sized. The ground surface over the leaching system can be used for other purposes, such as athletic fields or parking lots. Possible future uses of the site need to be considered when selected the type of distribution system. Because the system is buried, only small buffer zones are needed for aesthetic reasons.

Based upon wastewater flow rates, a total square footage of disposal area can be calculated. For instance, a 10,000 gpd flow rate and a loading rate of 0.5 gpd/sf results in 20,000 sf (~1/2 acre) of disposal area. The larger 20,000 gpd flow rate for Target Areas 1 and 2 would require closer to 1 acre of disposal area. It is unclear at this time if a large enough area could be found for a standard disposal field on the 20 acre site. However, soil loading allowances can be increased (decreasing overall disposal area required) through various types of treatment and/or disposal system types (such as using concrete chambers compared with a stone bed). Therefore, during design, it may be prudent to look at options to reduce overall disposal area including proprietary leaching devices, or additional advanced treatment options prior to subsurface disposal. The decision on the type of leaching bed and area required would be made after a hydrogeological investigation and percolation tests are completed. It should also be noted that a stone bed system would most likely be a mounded system, since the seasonable high-water table was observed at only 13-inches below the surface.

3.5.3.2.2 Drip Dispersal

Drip dispersal involves a buried network of small-diameter plastic tubing with evenly-spaced "emitters" that allow effluent release to the soil when the tubing is pressurized as shown in Figure 3-4.

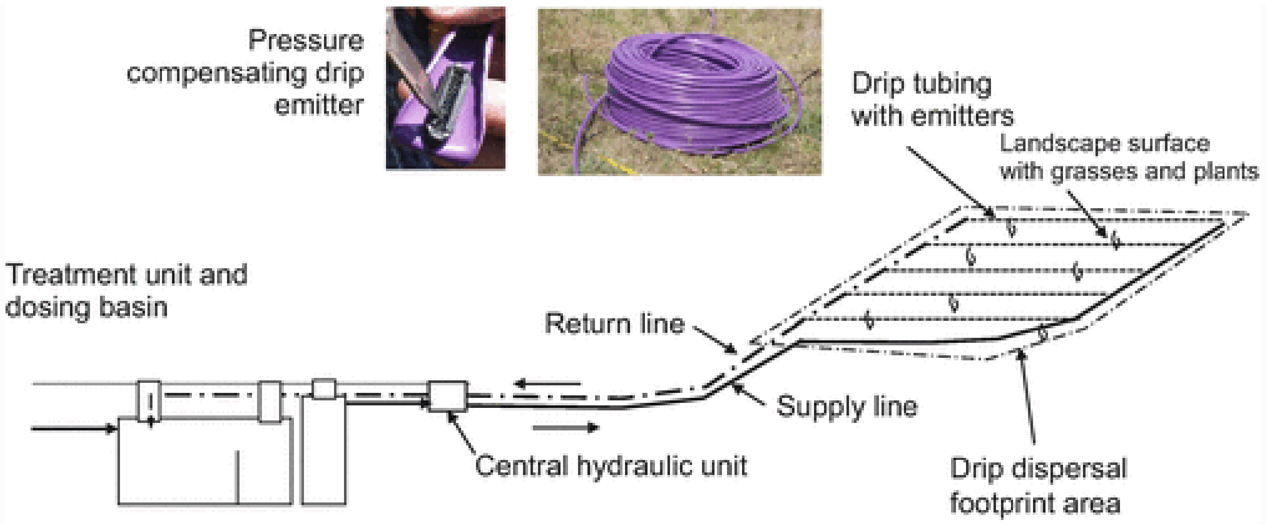

FIGURE 3-4 VIEW OF UNDERGROUND PORTION OF SUBSURFACE DRIP DISPERSAL SYSTEM

With shallow tubing burial, some of the effluent and associated nutrients are taken up by the overlying vegetation. These systems have been used in northern US conditions; the periodic release of effluent keeps the soil around the tubing from freezing.

Drip dispersal system often can be installed at lower costs than traditional subsurface systems when the tubing is "plowed-in" through existing vegetation (for example, installed in between trees in wooded areas without cutting trees), saving the cost of major excavation and crushed stone. The main benefit of a drip dispersal system is that it can be installed with very little disturbance to the surrounding area, which is ideal for use within parkland, recreational or mixed-use settings. Additionally, replacement of the system in the future if needed can be more easily accomplished.

Total length of drip dispersal pipe assuming a 0.5 gpd/sf soil loading rate would be approximately 1 foot for each gpd of flow rate, or 10,000 to 20,000 linear feet for the range of flow anticipated. Drip tubing could be installed in an excavated area bedded in sand at 1-ft on center (O.C.) spacing or plowed-into existing ground at 2-ft O.C. spacing in a manner than bests suits the site.

SECTION 4
WASTEWATER COLLECTION & TREATMENT COSTS

One of the main goals of this feasibility study was to better define the cost to the Town of Bowdoinham to construct, operate and maintain a wastewater collection and treatment system for the village area of downtown Bowdoinham. The cost of this system needs to be compared with the benefit to the system users, and to the economic prosperity of the Town as a whole.

4.1 CAPITAL COST PROJECTIONS

Capital costs are used by a municipality for planning purposes, the capital estimate is intended to reflect the full project cost to the Town. The costs to construct collection, treatment, and disposal components were developed using standard cost estimating procedures utilizing equipment quotations and unit cost information. Where appropriate, information derived from recent construction cost data, and bid openings was incorporated. Allowances were made for general contractor overhead and profit, undeveloped items, contingency, technical services, administration, and financing. These cost estimates were based on April 2019 dollars and the 20-city ENR Construction Cost Index is currently 11228 (April 2019). The following assumptions and values were used to financially evaluate the alternatives:

- Contingency – a contingency is added to the cost to account for lack of detailed design for a planning level estimate. The contingency costs are a percentage of the total construction cost associated with the project. As a project moves from planning/conceptual phase, to preliminary design, and to final design, this contingency decreases as more detail in available for unit costs.
- Legal/Administrative/Financing – The legal and administrative costs include legal, bond counsel, accounting services and interim financing associated with the project. The Maine DEP is currently offering loans through the Clean Water State Revolving Loan Fund (CWSRF) program at an interest rate of 1.5%.
- Technical and Construction Services – an allowance is included in the costs for technical engineering services associated with the project. The services include hydrogeological investigations, permitting, design, bidding, construction administration, resident inspection, and commissioning phase services.

As noted in Section 3.5, three main disposal alternatives are being evaluated. In addition to the three disposal options, there are two flow options associated with sewering Area 1 alone, or both Area 1 and 2.

The various collection, treatment and disposal alternatives are labeled as follows with costs summarized in Table 4-1.

- Alternative 1A: Advanced Treatment with Subsurface Disposal via Drip Irrigation at 10,000 gpd design flow.
- Alternative 1B: Advanced Treatment with Subsurface Disposal via Drip Irrigation at 20,000 gpd design flow.
- Alternative 2A: Advanced Treatment with Subsurface Disposal via Stone Bed at 10,000 gpd design flow.
- Alternative 2B: Advanced Treatment with Subsurface Disposal via Stone Bed at 20,000 gpd design flow.
- Alternative 3A: Advanced Treatment with Surface Disposal to Cathance River at 10,000 gpd design flow.
- Alternative 3B: Advanced Treatment with Surface Disposal to Cathance River at 20,000 gpd design flow.

4.2 OPERATION AND MAINTENANCE COST PROJECTIONS

Operation and maintenance (O&M) costs for each alternative are summarized in Table 4-2 and are based on estimates for operator visits, annual expenses (regular equipment repairs, process tank pumping, electricity, etc.) to budget for the Town's yearly ongoing expenses. We have estimated the costs based on the approach taken by other communities; actual costs could be higher or lower depending upon the Town's needs.

TABLE 4-1: TOTAL PROJECT COSTS

	Alternative 1: Advanced Treatment – Drip Irrigation		Alternative 2: Advanced Treatment – Stone Bed		Alternative 3: Advanced Treatment - Surface Discharge	
	A - 10,000 gpd	B – 20,000 gpd	A - 10,000 gpd	B - 20,000 gpd	A - 10,000 gpd	B - 20,000 gpd
Collection System[1]	$552,000	$1,171,000	$552,000	$1,171,000	$552,000	$1,171,000
Treatment System	$802,000	$997,000	$802,000	$997,000	$735,000	$923,000
Disposal System	$749,000	$848,000	$945,000	$1,285,000	$348,000	$348,000
Construction Bid Price	**$2,103,000**	**$3,016,000**	**$2,299,000**	**$3,453,000**	**$1,635,000**	**$2,442,000**
Contingency	$110,000	$150,000	$110,000	$170,000	$80,000	$120,000
Other[2]	$526,000	$754,000	$575,000	$864,000	$409,000	$610,000
Subtotal	**$2,739,000**	**$3,920,000**	**$2,984,000**	**$4,487,000**	**$2,124,000**	**$3,172,000**
Financing (1.5%)	$41,000	$59,000	$45,000	$67,000	$32,000	$48,000
Total Project Cost	**$2,780,000**	**$3,979,000**	**$3,029,000**	**$4,554,000**	**$2,156,000**	**$3,220,000**

Notes:
1. Collection system cost includes gravity sewer, manholes, services to the right-of-way, and allowance for ledge. Cost for installation of services from right-of-way to each building is responsibility of the user.
2. Other includes technical services (22%), materials testing (1%), legal/administrative costs (2%).

TABLE 4-2: TOTAL O&M COSTS

	Alternative 1: Advanced Treatment – Drip Irrigation		Alternative 2: Advanced Treatment – Stone Bed		Alternative 3: Advanced Treatment – Surface Discharge	
	A - 10,000 gpd	B – 20,000 gpd	A - 10,000 gpd	B - 20,000 gpd	A - 10,000 gpd	B - 20,000 gpd
Electricity[1]	$5,000	$6,000	$6,000	$7,000	$4,000	$5,000
Chemicals[1]	$1,000	$1,500	$1,000	$1,500	$2,000	$4,000
Sludge Disposal	$2,000	$4,000	$2,000	$4,000	$2,000	$4,000
Staff/Operations[2]	$35,100	$35,100	$35,100	$35,100	$35,100	$35,100
Col. Syst. Maint.[3]	$1,200	$2,700	$1,200	$2,700	$1,200	$2,700
Maintenance & Repair[3]	$12,000	$14,400	$13,100	$16,800	$7,200	$8,900
Total O&M	**$56,100**	**$63,100**	**$58,200**	**$66,500**	**$51,300**	**$59,100**

Notes:
1. Electricity and Chemical usage cost based upon Amphidrome proposal and similar installations.
2. Staff/Operational based upon 15 hours per week, at a rate of $30/hour plus 50% overhead.
3. Maintenance and repair costs are assumed to be a fixed percentage of total treatment and disposal system equipment/materials cost.

4.3 PROJECT FUNDING AND FINANCING

This section of the report summarizes overall cost to the town per year based upon financing the overall project cost and yearly O&M costs. Traditional wastewater facilities are funded via user fees. An enterprise fund is often established to limit the use of these fees to wastewater system related costs since the system is user funded. If the cost to construct, operate and maintain a system are greater than the revenue from reasonable user fees, there are a number of possible mechanisms that can be used to stabilize user fees as discussed below.

4.3.1 Revenue

Possible sources of revenue to fund the sewer system are summarized below:

- Sewer User Rates – user rates are typically based upon actual water usage data. Rates typically include a fixed rate for a minimum amount of water usage plus an incremental rate for additional water used over the minimum amount.
- Betterment fee – betterment fees, or special assessments, can be added to the annual property tax to generate revenues that can then be used to offset the capital cost of the wastewater infrastructure investment. This fee is often justified by either an increase in property values or economic growth to stabilize taxes.
- Ready-to-serve fee – a ready-to-serve fee could be established to distribute the debt service over all the potential users within the collection service area. This fee is an acknowledgement that there are fixed costs associated with the system that must be budgeted by the Town regardless of the actual number of connected user and sewage flow rates.
- Tax Increment Financing (TIF) – TIF districts are financing mechanism in which capital improvements within the TIF district are funded through increased property tax revenues resulting from investment within the designated TIF district. This financing mechanism is often used to fund infrastructure improvements to support the TIF district.
- General Taxation – the general fund covers a full range of municipal services and is subject to competing municipal demands. Wastewater projects may be funded through general municipal taxation. This is a common method for funding capital cost of wastewater infrastructure projects that have a benefit to the Town outside of the served area.

The financial evaluation of the alternatives shows that there will be a significant gap between the revenues generated by affordable user rates and the total annual costs of the systems. The Town will need to generate additional revenues and consider other sources of revenue as described above. The Town should consider a detailed financial analysis during the early stages of system design to confirm the budgetary projections included in this study.

4.3.2 Grants and Loans

There are several state and federal agencies from which the Town may be able to secure financial assistance in the form of grants, no-interest loans (principal forgiveness), and low-interest loans. The most likely source of funding is low-interest loans from the Clean Water State Revolving Loan Fund (CWSRF) program administered by the Maine DEP. CWSRF offers loan terms up to 30-years at an interest rate of 1.5%. Upon initial analysis, the Town of Bowdoinham does not appear to qualify for grants or loans from the US Department of Agriculture, Rural Development because it exceeds income thresholds. Additionally, Maine DEP is offering wastewater infrastructure grants from the November 2018 statewide referendum. Given the low poverty rate, low unemployment rate and high median household income in Bowdoinham, the chances of qualifying for grant funds is low considering the competitive nature of the grants. Census data does show a drop in population in the developed area of Bowdoinham, and the high user rates might be favorable for the Town. Discussions with DEP would need to occur and a more complete study prepared before applications are due in late 2019/early 2020.

4.3.3 User Rates

User rates can vary substantially across the State of Maine. Typically, larger communities can accommodate a lower user rate due to the efficiencies of cost sharing and high population density. For reference, assuming a 270 gpd user (typical 3-bedroom home), Richmond's current user fee is currently around $1,080 per year and will increase to almost $1,125 per year in October 2019. Some other communities have rates as follows:

- Cape Elizabeth: $930/year
- Portland: $690/year

- Falmouth: $500/year
- South Windham: $590/year

Total yearly costs, user rates, revenue generated, and budget gaps are summarized in Table 4-3 below.

The assumed annual sewer rate for the financial analysis included in this study was set at $1,300 per equivalent dwelling unit (EDU), the actual rate will be established by the Town. This rate is high compared to nearby communities, however, due the small sewered area, economies of scale do not apply in Bowdoinham as they do in other communities. For comparison purposes, the total number of EDUs for each alternative are based off of 270 gpd, typical of a 3-bedroom home. It should be noted that even at $1,300 per EDU, there is still a significant budget gap that would need to be met using other sources of revenue. In fact, user rates would need to be at least $2,700 per year to meet yearly financing and O&M costs under Alternative 3B.

Revenue and budget gap in Table 4-3 is divided into four categories representing the number of connected users. It is likely that not all users will connect to the collection system right away and may wait until their existing individual systems are in need of repair or replacement.

As can be seen in Table 4-3, even assuming 100% of users connect to the collection system, there is still a significant budget gap between $93,000 to $161,000 each year that would require funding from other sources. Initially, when only a small portion of the sewered area is connected, the budget gap would be much greater.

TABLE 4-3: YEARLY COST AND BUDGET GAP

	Alternative 1: Advanced Treatment - Drip Irrigation		Alternative 2: Advanced Treatment - Stone Bed		Alternative 3: Advanced Treatment - Surface Discharge	
	A - 10,000 gpd	B – 20,000 gpd	A - 10,000 gpd	B – 20,000 gpd	A - 10,000 gpd	B – 20,000 gpd
Capital Cost	$2.78M	$3.98M	$3.03M	$4.55M	$2.16M	$3.22M
Loan[1], per yr.	$116,000	$166,000	$126,000	$190,000	$86,000	$130,000
O&M, per yr.	$56,000	$63,000	$58,000	$67,000	$51,000	$59,000
Total Yearly	**$172,000**	**$229,000**	**$184,000**	**$257,000**	**$137,000**	**$188,000**
Total EDUs[2]	37	74	37	74	37	74
Cost per EDU[3]	*$4,640*	*$3,090*	*$4,970*	*$3,470*	*$3,810*	*$2,610*
Proposed User Fee	**$1,300**	**$1,300**	**$1,300**	**$1,300**	**$1,300**	**$1,300**
Revenue from Users						
25% Connected	$12,000	24,000	$12,000	24,000	$12,000	24,000
50% Connected	$24,000	48,000	$24,000	48,000	$24,000	48,000
75% Connected	$36,000	72,000	$36,000	72,000	$36,000	72,000
100% Connected	$48,000	96,000	$48,000	96,000	$48,000	96,000
Revenue Needed from Other Sources						
25% Connected	$160,000	$205,000	$172,000	$233,000	$128,000	$169,000
50% Connected	$148,000	$181,000	$160,000	$209,000	$117,000	$145,000
75% Connected	$136,000	$157,000	$148,000	$185,000	$105,000	$121,000
100% Connected	$124,000	$133,000	$136,000	$161,000	$93,000	$97,000

Notes:
1. Assumes financing of full project cost with a CWSRF 30-year loan at 1.5% interest rate.
2. Number of EDU's are based upon design flow of 10,000 gpd or 20,000 gpd divided by 270 gpd.
3. Fee required to completely fund total yearly cost assuming 100% of EDU connected.

SECTION 5
CONCLUSIONS & RECOMMENDATIONS

Based upon the findings presented within this feasibility study, the cost to provide wastewater collection and treatment to the Village area varies greatly ranging from $2.16M for a 10,000 gpd system with advanced treatment and discharge to the Cathance River up to $4.6M for a 20,000 gpd system with advanced treatment discharging to a subsurface stone bed disposal system.

As would be expected, the alternatives for treating 20,000 gpd are costlier than treating only 10,000 gpd. However, due to economies of scale with construction, the 20,000 gpd alternatives are less costly on a per lot basis than the 10,000 gpd alternatives. The least costly alternative is Alternative 3, which includes advanced treatment and surface water discharge to the Cathance River.

Based upon the high initial capital cost of providing wastewater collection and treatment in Bowdoinham, the Town may wish to take a phased approach to the selected alternative, which would involve constructing the collection system in Target Area 1, constructing the treatment facility and disposal site. The package wastewater treatment systems can be designed to expand to accommodate future increases in wastewater flow (associated with Target Area 2, or more) if desired. This would involve accommodations for future expansion being incorporated into the design by allocating space for additional treatment unit tankage and disposal field area (if applicable).

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