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Mill Pond Study

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To:
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From:
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Date:
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Memo

Subject: Orleans Nitrogen Management in Mill Pond Sub-Watershed: Collection System Connected to Satellite WWTF

The Town of Orleans (Town) has identified ten options for reduction of nitrogen load in the Mill Pond sub-watershed (shown in Figure 1) to improve water quality in this sub-watershed.

This memorandum addresses the option to construct a collection system and a satellite wastewater treatment facility (WWTF) and effluent disposal system to reduce the septic nitrogen load contributions to Mill Pond.

Description

This option involves constructing a collection system and a satellite WWTF and effluent disposal system within the Mill Pond sub-watershed. Based on preliminary layout review, the collection system would include gravity pipes, possibly low pressure pipes, a pump station, and a force main that discharges at the new satellite WWTF.

To understand the relative reduction in nitrogen load, three scenarios have been evaluated, and are described below. Figure 1 shows the infrastructure needed and parcels associated with each scenario. Note that subsequent scenarios are inclusive of prior scenarios. The pump station, force main, WWTF, and effluent disposal are assumed to be required for all scenarios. Contributing parcels identified in the figure are identified based on assumed location of septic systems relative to the estimated area contributing to Mill Pond water quality.

Scenario 1.

Parcels located along Great Oak Road, Brick Hill Road, and Dunlukin Lane within the Mill Pond/Pochet North Study Area as defined in the Amended Comprehensive Wastewater Management Plan (ACWMP). This scenario represents establishment of the central collection and conveyance pipe for the area and is included as a representative minimum establishment of sewer in the Mill Pond watershed. Figure 1 highlights contributing parcels with blue shading.

Scenario 2.

Parcels included in Scenario 1, plus those along Westwood Drive, Rose Path, Blueberry Lane, Dylan Way, Colony Drive, East Circle Drive, Harbor View Lane, Harbor View East, and Little Cove Lane. These are roads within the Mill Pond/Pochet North Study Area. This scenario represents an expansion of sewers to match those identified in the ACWMP that benefit Mill Pond. Figure 1 highlights the additional contributing parcels with red shading.

Scenario 3.

Parcels included in Scenario 2, plus those along Brick Hill Road, Beginners Lane and Safe Harbor Lane.

The additional roads complete buildout of the sewer system within the Mill Pond contribution area defined during evaluation of permeable reactive barriers (PRBs). This scenario represents sewering the parcels that would benefit Mill Pond that are proximate to the existing sewer system. Figure 1 highlights the additional contributing parcels with purple shading.

It is assumed that the new WWTF and effluent disposal system would be located within the Mill Pond subwatershed. To locate these facilities outside of the subwatershed would entail significant infrastructure capital costs and relatively high operational and maintenance costs for the extended conveyance system and associated pumping. As described in this memorandum, the costs for this alternative are anticipated to be the highest of the evaluated Mill Pond Study alternatives and locating facilities outside of the subwatershed would only drive the capital and long-term costs up.

Selection of the treatment facility type and technology is left to a future stage of evaluation. It should be noted that size of the facility and associated effluent flow rate will impact permitting requirements. Typically, municipal flow facilities discharging less than 10,000 gallons per day (gpd) do not require a groundwater discharge permit, though a permit may be required for less flow in nitrogen sensitive areas (https://www.mass.gov/guides/groundwater-discharge-permits-frequently-asked-questions).

Effluent disposal for the existing WWTF is via a system of wick wells that allow deep infiltration within a relatively small footprint. Infiltration basins are also commonly used for groundwater discharge. Preliminary research shows that this area has been mapped with soil type deltaic deposits, which are typically sand and gravel and have high infiltration rates. However there is evidence this area may have been a lake in the past, which means there could be fine-grained (clay and silt) layers that could impact infiltration rates negatively, affect selection of the disposal approach, and/or necessitate increased costs to establish a viable long-term disposal method. Selection of the disposal approach and associated size is left to a future stage of evaluation and based on detailed geotechnical investigations. These investigations and evaluations may show that ground discharge of effluent may not be viable.

The satellite WWTF and effluent disposal system are preliminarily located as shown in Figure 1 based on the undeveloped status of the parcel, the size of the potentially acquirable portion of the parcel, and offset distances from suspected wetlands and Mill Pond itself.

The following sections evaluate these scenarios as a basis for screening to determine which alternative or alternatives are most suitable for additional consideration.

Ownership and Control

Like the implementation of the Downtown and Meetinghouse Pond sewer service areas and existing WWTF and effluent disposal, the sewer infrastructure would be owned, operated, and maintained by the Town. Easements would be needed in the case of private roads. The connection from the private properties to the Town infrastructure, including grinder pumps if necessary, would be owned by the private property owner.

Performance

Collection systems are the traditional method for managing wastewater and have proved to be reliable for consistently reducing nitrogen levels across a watershed. Conveying flows from individual properties to the satellite treatment plant prevents septic effluent from discharging directly into groundwater.

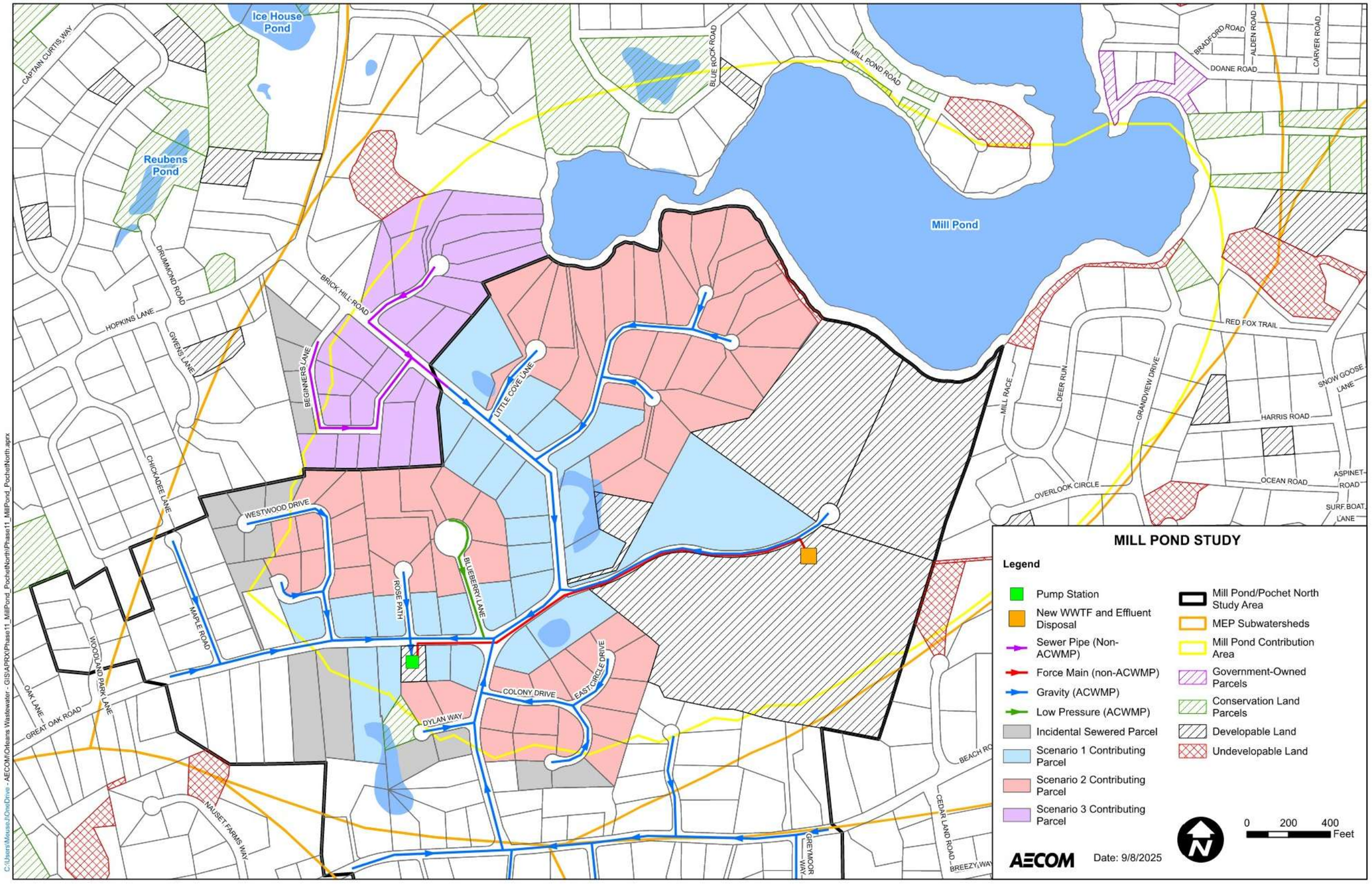

Figure 1: Assumed Contributing Parcels for Scenarios 1, 2, and 3 and Satellite WWTF and Effluent Disposal Facility

Unlike the scenario where the sewage is conveyed outside of the Mill Pond contribution area, in this scenario the effluent disposal is kept within the Mill Pond contribution area. Assuming the treatment system does not have 100% nitrogen removal, some amount of nitrogen captured within the sewered area will still make it to Mill Pond without additional measures. Table 1 summarizes nitrogen removal accounting for the re-introduction of effluent nitrogen for each scenario. This Study assumes a septic nitrogen load to the groundwater of 5.4 kg/yr/parcel. This Study assumes 10 mg/L nitrogen concentration in the effluent flow, which matches the existing groundwater discharge permit limit. Average water use per parcel is 167 gpd/parcel (231,000 L/yr/parcel); assuming 90% of water use is converted to wastewater, the average wastewater flow would be 150 gpd/parcel (207,000 L/yr/parcel). This results in an effluent nitrogen load of 2.1 kg/yr/parcel.

Table 1. Nitrogen Removal Estimates for Scenarios 1, 2, and 3

Scenario	Parcels within Contribution Area	Approx. Nitrogen Removal at Parcels(kg/yr)	Approx. Effluent Nitrogen Re-introduction (kg/yr)	Approx. Net Nitrogen Removal (kg/yr)
1	26	140	55	85
2	86	460	180	280
3	108	580	230	350

The target removal established for comparison purposes for this Study is 750 kg/yr. Scenarios 1, 2, and 3 would achieve 11%, 37%, and 47% of that goal, respectively. It should be noted that the Study goal was established based on the USGS/MEP Mill Pond Subwatershed, which is larger than the contributing area for Mill Pond. Therefore it is not surprising that 100% of the nitrogen removal target would not be met through sewering alone, particularly given the reintroduction of nitrogen in the effluent. Sewering can remove relatively high amounts of nitrogen compared to some other nitrogen management alternatives, depending on the number of sewered parcels. The re-introduction of nitrogen in the treated effluent stream significantly reduces the water quality benefit associated with this alternative compared to sewering and conveyance outside of the subwatershed. It is possible that nitrogen removal during treatment will achieve lower effluent concentrations or this alternative can be paired with an additional nitrogen management measure to treat the effluent; either of these would increase the water quality benefit.

Costs

This alternative has a very high capital cost and operations and maintenance cost compared to most, if not all, of the other alternatives evaluated in this Study. Capital costs are higher than the other sewer alternative due to the additional treatment facility and effluent disposal system. Operations and maintenance costs are higher than the other sewer alternative due to factors such as power, equipment maintenance and replacement, and personnel costs associated with the treatment and disposal of the wastewater.

Speed of Water Quality Improvement

The speed of water quality improvement depends on how far from the water body the nitrogen is being removed. Sewer removes the septic load at the source but does not address the legacy nitrogen, meaning that the septic nitrogen load introduced to the groundwater prior to sewering will still impact the water body. Scenario 2 is anticipated to have a shorter time than Scenario 1 to incremental water quality improvement as it includes parcels closer to the water body. The benefit associated with sewering the closest parcels to the pond could be on the order of a few years while the full benefit at Mill Pond of sewering could take decades to realize.

Predictability of Performance

Nitrogen removal through sewering is predictable at a property scale and measurable at a regional scale. Nitrogen concentration at the WWTF influent and effluent is measured and the difference is the nitrogen removed. Sewering

does not take advantage of the attenuation that occurs within a septic system which should be considered when comparing load removal.

Reliability

Sewering is considered to be a very reliable method for removal of septic nitrogen load. The performance of the system is controlled by the Town with established regulatory requirements and oversight.

Need for Large Town Capital Expenditure

The Town has committed to remove large amounts of nitrogen in the Pleasant Bay watershed under the 2018 Watershed Permit. The very high costs of that commitment mean that the Town has limited ability to undertake costly nitrogen removal projects in other watersheds, like the Nauset Harbor system. Implementation of this higher cost alternative would delay Pleasant Bay watershed progress or, if implemented in parallel with Pleasant Bay watershed sewering, place a relatively high strain on the Town's finances compared to other alternatives.

Regulatory Acceptability

Sewering and municipal treatment is a well-known approach to regulatory agencies for nutrient management. Mass DEP has permitted on the order of hundreds of satellite facilities. The Town has experience permitting sewering and treatment projects through the Downtown and Meetinghouse Pond Sewer Service Areas. Permitting steps similar to those of the Downtown project would be required. Cluster systems were included in the ACWMP but a Notice of Project Change may be required given the scale and type of project described by this alternative.

Public Acceptability

As mentioned above, sewers have been implemented in other service areas and this area has been identified as a planned sewer expansion phase. As such it is anticipated that the public would continue to support sewers in the Mill Pond subwatershed. There may be some opposition raised however if there is a perception that implementation of this alternative, with its high cost, is preventing achievement of regulatory requirements in the Pleasant Bay Watershed, preventing implementation of other Town capital priorities, or impacting the Town's financial standing and flexibility.

Flexibility in Face of Unknown TMDL and Applicability to a Phased Approach

Sewering is relatively inflexible compared to some of the other nutrient management approaches included in this Study. Once implemented it is impractical to adjust to a smaller-than-anticipated TMDL due to the installed infrastructure. Should the removal requirement be larger than anticipated the capacity of installed infrastructure may not be adequate. Pairing a sewer alternative with other nutrient management approaches requires careful planning as well. Since sewering removes all the septic load at the source, it can make downgradient management alternatives, such as PRBs, less cost-effective over time as the septic load is reduced. Other alternatives such as urine diversion systems and innovative alternative systems are in direct conflict as these alternatives also target septic nitrogen load specifically. Conversely, locating a PRB downgradient of the satellite effluent disposal could increase the cost effectiveness on a kilogram of nitrogen removed basis of the alternative as it would prevent re-introduction of nitrogen in the effluent stream.

Where sewering is implemented as a partial solution, planning both spatially and temporally is required to ensure that Town funds are spent efficiently. Consideration should be given to building additional capacity into the sewer and treatment/disposal system in case future need is identified.

Environmental Impacts

Environmental impacts include short-term construction impacts associated with infrastructure installation as well as long-term energy impacts associated with pumping and treating the wastewater. These may be more significant

than other nutrient management alternatives due to the amount and type of construction required as well as long-term facilities. Sewers have typically been installed in the streets which reduces habitat impact but would disrupt traffic flow during construction. Excavation would also be required on the properties that connect to the sewer, extending construction impacts beyond the Town's project. The introduction of a treatment facility has the potential to introduce noise and odors but these can be mitigated through technology selection and engineered solutions.

Impact on the Orleans WWTF

The existing WWTF has a finite capacity to treat and dispose of municipal wastewater. It will need to be expanded to handle the wastewater that would be collected in the current sewer master plan. Building a satellite WWTF would reduce the volume of wastewater planned at the WWTF. This alternative may not ultimately reduce the future capacity of the WWTF and it would not impact the timing of the expansion.

Ease of Implementation

The Town's experience with implementation of earlier sewer phases, particularly the Downtown project, serves as a strong blueprint for implementation of this alternative in the Mill Pond area. The Town has all the resources and experience required to implement this option in the planning, design, construction, and operational phases.

Summary of Advantages and Disadvantages

Sewering within the Mill Pond groundwater subwatershed and conveying flow to a new satellite WWTF and effluent disposal facility has these principal benefits:

- Predictable, reliable nitrogen removal; and
- Highly acceptable to public and DEP.

The principal drawbacks include:

- High cost;
- Disruptions during construction;
- Requires land purchase;
- Reduced nitrogen removal benefit compared to conveying wastewater flow to the existing WWTF; and
- Relatively long time to realize the full benefit of the alternative.