AGENDA

Wednesday

November 9, 2016

TOWN OF EASTHAM
AGENDA
BOARD OF SELECTMEN WORK SESSION
WEDNESDAY, November 9, 2016
3:00 p.m.

Location: Timothy Smith Room

DISCUSSION:

A) Library Project Punch List – Neil Andres, DPW Superintendent

B) Eastham Wastewater Management Plan Technical Memos No. 3 and 4 – Jane Crowley,
Health Agent

C) Minutes:

September 19, 2016	Regular Meeting
September 19, 2016	Executive Session
October 3, 2016	Regular Meeting
October 3, 2016	Executive Session
October 5, 2016	Work Meeting
October 5, 2016	Executive Session
October 17, 2016	Regular Meeting
October17, 2016	Executive Session
October 19, 2016	Work Session
October 19, 2016	Executive Session

EXECUTIVE SESSION: To discuss collective bargaining strategy, and strategy with respect to potential litigation regarding the Library and litigation regarding landfill pollution and the Chairman declares, an open meeting may have a detrimental effect on the bargaining or litigating position of the public body.

Upcoming Meetings

November 21, 2016	*5:00 p.m.*	*Earl Mountain Room*	*Regular Session*
December 5, 2016	*5:00p.m.*	*Earle Mountain Room*	*Regular Session*
December 7, 2016	*3:00 p.m.*	*Timothy Smith Room*	*Work Session*

The listing of matters includes those reasonably anticipated by the Chair that may be discussed at the meeting. Not all items listed may in fact be discussed and other items not listed may be brought up for discussion to the extent permitted by law.

This meeting will be video recorded and broadcast over Local Access Channel 18 and through the Town website at www.eastham-ma.gov

TECHNICAL MEMORANDUM NO. 3

October 17, 2016

To	Town of Eastham		
Copy to	Jane Crowley		
From	Jessica P. Janney J. Jefferson Gregg, P.E., BCEE	Tel	774-470-1636 774-470-1640
Subject	Eastham Wastewater Management Plan Initial Hybrid Approach for Salt Pond	Job No.	8618665

1. INTRODUCTION AND SCOPE

The Town of Eastham is working to continue its wastewater planning for its impacted estuaries. The purpose of this technical memorandum is to develop an initial hybrid nitrogen management approach for Salt Pond based on the findings of Technical Memorandum 1 and 2 and using available Cape Cod Commission planning tools developed as part of the Cape Cod Area Wide Water Quality Management Plan Update (208 Plan).

The Cape Cod Commission has finalized their 208 Plan and it has been approved by USEPA. This document identifies many nitrogen management and planning components that can be used as part of a municipal wastewater planning process, such as Eastham's, including:

- Identification of Waste Management Agencies (WMA) that will work to share responsibility to meet the nitrogen TMDLs for coastal estuaries.
- Development of Watershed Reports for each watershed wholly or partially within Town boundaries.
- Expanded innovative and alternative nitrogen management approaches and technologies.
- New wastewater management evaluation tools to estimate existing and future wastewater flows and nitrogen loading as well as alternative wastewater nitrogen management scenarios.
- The requirement to complete a Targeted Watershed Management Plan (TWMP) for estuaries and their watersheds that exceed established nitrogen TMDLs.
- Revised regulatory procedures to streamline the review process when TWMP is properly completed.
- Recommendations to MassDEP to develop a watershed permitting program to allow nitrogen removal credits for traditional as well as non-traditional management techniques to meet a nitrogen TMDL.
- County support to develop individual TWMPs.

The next steps of Eastham's wastewater management planning project will utilize many of these components.

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New wastewater management evaluation tools developed by the Cape Cod Commission include what is commonly referred to in this technical memorandum as "WatershedMVP" which is an abbreviated name for Watershed Multi-Variant Planner. This is an online tool where existing and future water and wastewater flows and loads can be extracted based on Town, watershed or sub-watershed lines or by polygons drawn by the user. The WatershedMVP tool was used during the development of this Technical Memorandum when examining estimated wastewater flows and nitrogen loads within the watershed of interest and in the scenario runs developed as part of the hybrid evaluations as discussed in Technical Memorandums No. 1 and 2 (TM-1, TM-2).

2. TECHNOLOGY EVALUATION METHODOLOGY

In this phase of this project, hybrid evaluations are developed for Salt Pond in order to examine the feasibility and cost-effectiveness of incorporating the non-traditional mitigation measures identified in this memorandum into an alternative management plan. The hybrid evaluation methodology for Salt Pond using the CCC tools, with an estimate of cost and assessment of feasibility is identified below.

The Town has expressed interest in incorporating the following technologies into this hybrid evaluation:

- Permeable Reactive Barrier downstream of the Town's landfill.
- Shellfish aquaculture/propagation.
- Improvements to the Salt Pond Visitor Center (Cape Cod National Seashore) onsite wastewater treatment system.
- Stormwater reductions from Route 6/MassDOT.
- Fertilizer reductions.
- Traditional infrastructure to address excess nitrogen not managed through other methods.

As part of the hybrid evaluations, other non-traditional technologies identified in TM-2 may be considered as part of the "toolbox" and incorporated as needed if a feasible solution cannot be reached with the technologies identified above.

The hybrid evaluations are conducted using the following approach:

- Develop scenarios which incorporate components of the traditional and non-traditional technologies the Town is interested in pursuing, through discussions with Town Staff.
- Use the CCC Tracker model and WatershedMVP tools to determine the quantity and combination of different technologies that can be used in order meet the nutrient reduction goals.
- Develop cost estimates for each scenario run under the hybrid evaluations.
- Determine potential sites for traditional and non-traditional technologies for each scenario.
- Present side by side comparison of:
  - Traditional approaches/bookends (CCC 208)
  - Non-traditional bookends (CCC 208)

- Hybrid approach #1 (limited traditional infrastructure)
- Hybrid approach #2 (non-traditional with traditional infrastructure within Eastham)

3. DATA

3.1 Technical Memorandum No. 1 Loading

Table 1 summarizes the estimated nitrogen removal loads based on the wastewater flow estimates discussed in TM-1. The Table presents a range of nitrogen loads based on various water use/wastewater generation estimates for Salt Pond. These are as follows:

- The estimated **minimum** nitrogen load is based on a wastewater generation of 122 gpd per single family residence which is calculated as 90 percent of the water use developed for the Eastham's municipal water system.
- The estimated **maximum** is based on the CCC 208 Planning tool which applied a Cape-wide average water use value to Eastham. The 90 percent wastewater generation rate of 164 gpd.
- The middle value, identified as the "Excess Septic Wastewater Load" is the attenuated load for the CCC Tracker model which is based on the targets listed in MEP.

The evaluations developed in this technical memorandum take into consideration the MEP values (middle value) as further discussed below.

Table 1 Project Focus Area Estimated Removals for Existing and Future Nitrogen Loads using a Phased Approach

Estimated MEP % Removal	Sub-watershed	Estimated Minimum Wastewater Load to Remove (kg/yr)[1]	Estimated Excess Septic Wastewater Load to Remove (kg/yr)[2]	Estimated Maximum Wastewater Load to Remove (kg/yr)[1][5]
100%	**Salt Pond Total**	**1,350**	**1,560**	**1,860**
	Salt Pond	1,000	1,282	1,280
	Ministers Pond[3]	350	253	580
	Schoolhouse Pond[3]	-	6	-
	Depot Pond[4]	-	20	-

Notes:

(1) "Estimated Minimum Wastewater Load to Remove" and "Estimated Maximum Wastewater Load to Remove" are from GHD TM-1 Table 11.

(2) "Estimated Excess Septic Wastewater Load to Remove" is the attenuated load from CCC Tracker model based on the targets listed in the Massachusetts Estuaries Project, Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System, Towns of Orleans and Eastham, MA, Final Report, December 2012.

(3) WatershedMVP identifies Schoolhouse Pond as Minister's Pond South and is therefore included in the Ministers Pond total from GHD TM-1 Table 11.

(4) As discussed in GHD TM-1, a small percentage (less than 2% of the total nitrogen load) of Depot Pond contributes to Salt Pond and was not included in the evaluation.

(5) Wastewater flow and nitrogen load values did not appear to be included in WatershedMVP for the CCNS Salt Pond Visitor Center and the Eastham Elementary School.

3.2 CCC Tracker Model and WatershedMVP Tool

Bookend and hybrid evaluations are conducted using the CCC Tracker model. Nitrogen removal targets for each sub-watershed in Tracker are based on the targets listed in the Massachusetts Estuary Project (MEP). The Tracker model uses nutrient removal assumptions for a defined set of technologies to model the potential effectiveness of a technology (or combination of technologies) in an area of interest. The Tracker is organized in a way that allows the user to input data into the technology categories to determine how the improvement reduces the septic wastewater load to achieve the goal net reduction. Salt Pond has a MEP septic removal target of 100% with an associated 1,560 kg/yr septic wastewater load.

Traditional technologies can also be evaluated in the WatershedMVP (208 planning tool) to aid in determining the water quality improvement within the watershed. The 208 planning tool has estimated wastewater loads assigned to parcels in the Salt Pond subwatershed and by selecting parcels using this program, the estimated load in any selected area for improvement can be calculated. However it should be noted that WatershedMVP uses higher values for water use and wastewater generation (shown as the third column in Table 1) than the MEP does which is the foundation of the Tracker model. WatershedMVP is also

limited in its ability to "model" technology effectiveness. At the time of this evaluation, it is only designed to demonstrate nitrogen loading improvement in areas where traditional technologies are selected.

3.3 CCNS WWTF Data

The Salt Pond Visitor Center is the main visitor facility to the Cape Cod National Seashore (CCNS) and is located on federal land within the boundaries of the Town of Eastham. The Salt Pond Visitor Center has an on-site sewage treatment and disposal system which was retrofitted with an Orenco AdvanTex Treatment System in 2004. The AdvanTex® system is a textile filter technology which provides greater surface area than sand or gravel, allowing greater volumes of wastewater treatment in less space. Typically an AdvanTex® system produces high quality effluent (5 mg/L BOD and TSS) and can utilize drip irrigation for effluent disposal. The system at the Visitor Center has is designed for a maximum monthly peak flow 3,880 gallons per day (gpd) (120,300 gallons per month) and has a design flow of 7,760 gpd (200% of average daily flow).

Effluent reporting data is not available for the Salt Pond Visitor Center site due the system's size being under 10,000 gpd and therefore does not require a groundwater discharge permit (GWDP) with MassDEP. At this time the treatment performance and operation of the system is not known.

3.4 Site Identification

Site identification is an important component of wastewater planning and is needed to determine feasible properties for traditional technologies such as advanced wastewater treatment and disposal and also for non-traditional technologies and approaches for nitrogen removal that also require land like permeable reactive barriers (PRBs) and stormwater systems.

When considering traditional wastewater infrastructure, costs generally increase as the distance from the collection area to the treatment site increase. Therefore it is recommended that potential publicly owned parcels, right-of-ways and vacant parcels that may be available for purchase within the Salt Pond subwatershed be identified. It is also important to the note that the municipal water supply system must be considered in wastewater planning in terms of where water storage tanks and drinking water supply wells are being sited and various wellhead protection areas or water resource protection areas are located to ensure there are no conflicts (including the delineation of future Zone II areas). Identifying areas for siting of non-traditional technologies, such as a PRB is also important to the overall feasibility of the plan.

As part of the Final Interim Needs Assessment and Alternatives Screening Analysis Report completed for the Town of Eastham in 2009, an analysis was performed for potential sites for wastewater treatment and treated water recharge facilities. In determining potential treated water recharge sites within Eastham, many factors were considered including:

- Whether the site is located within an estuarine recharge area;
- Does a TMDL exist for the estuary
- Is the site town owned; and
- If groundwater studies were favorable for public water supply.

The 2009 Needs Assessment and Alternatives Screening Analysis Report also incorporated screening factors for municipal water supply; as sites that were ranked as being "highly favorable" for drinking water supply were then screened out for potential treated wastewater recharge site. Since then the Town of Eastham has proceeded with the design and construction of municipal water and those sites identified for well sites are removed from the analysis below in Table 2.

Table 2 Evaluation and Ranking of Site for Potential Wastewater Treatment and/or Recharge

Potential Site (common name)	Government Owned (Municipal or Federal)	MEP Watershed Location	TMDL for Watershed	NHESP Habitat[1]	Zone I[2]	Groundwater Protection Overlay District[2]	IPWA[2]	General Distance from Collection Area	2009 Ranking	2016 Ranking
Roach Property	Yes	Wellfleet Harbor	In Progress	No	No	Partially	No	Outside Watershed	1	4
Eastham Elementary School	Yes	Nauset Harbor	In Progress	Partially	No	No	Yes	Inside Watershed	3	1
Eastham Senior Center/Council on Aging	Yes	N/A	N/A	No	No	Yes	Yes	Outside Watershed	2	3
Nursery School/Day Care									4	
Eastham Town Hall Area	Yes	Nauset Harbor	In Progress	Yes	No	No	Yes	Inside Watershed	N/A	2
CCNS Salt Pond Visitor Center	Yes	Nauset Harbor	In Progress	Yes	No	No	Partially	Inside Watershed	N/A	1

Notes:

(1) NHESP Habitat = Massachusetts Natural Heritage and Endangered Species Program estimated habitats of rare wildlife.

(2) These are drinking water protection areas, Zone I = the 400' protective radius required around a public water supply; Groundwater Protection Overlay District = Eastham zoned district for groundwater protection under the Groundwater Protection District Bylaw; IPWA = for public water systems using wells or wellfields that lack a MassDEP approved Zone II.

Table 2 identifies the properties and how they ranked according to the screening factors listed in the Table. Initial evaluation indicates that Eastham Elementary School and the CCNS Salt Pond Visitor Center are the most favorable sites based on the criteria listed in Table 2. In ranking sites, an attribute considered positive (Government Owned or outside of a Groundwater Protection District for example) was assigned a "1" and with attributes considered negative (within a NHESP Mapped Habitat Area for example) was assigned a "0." The exception to this ranking was for the "General Distance from Collection Area" column in which a "2" was assigned if the site was near/within the watershed and a "0" if the site was considered a great distance from the watershed. However, when ranking the sites, all were comparable based on this general evaluation and didn't vary greatly in the overall ranking.

Table 3 below identifies the traditional and non-traditional technology types being considered and the preliminary identification of potential sites where those technologies might be implemented. More information, discussions, and investigations are needed to determine the feasibility of these sites for the Town. Figure 1 provides a visual on where the sites are located in comparison to the Salt Pond Watershed.

Table 3 Potential Siting for Various Technology Types

Technology Type	Potential Site (Common Name)
Centralized Treatment and Recharge	Proposed Orleans WWTF CCNS Salt Pond Visitor Center Eastham Elementary School Eastham Senior Center / Council on Aging Eastham Nursery School / Day Care Eastham Town Hall Area
PRB	CCNS Salt Pond Visitor Center
Shellfish	Salt Pond
Fertilizer	Salt Pond Watershed (Board of Health Regulation – Town-wide)
Stormwater Improvements	Route 6 / CCNS Salt Pond Visitor Center

The largest available government owned parcels for siting of advanced wastewater treatment in the Salt Pond subwatershed appear to be the CCNS Salt Pond Visitor Center and the Eastham Elementary School.

4. INITIAL EVALUATIONS – BOOKEND AND HYBRID

The evaluations discussed in this section include bookend evaluations and hybrid approaches.

The bookend evaluations are those developed by the Cape Cod Commission as part of their 208 Planning process which consider either an all traditional technology approach (sewering) or an all non-traditional technology approach (combinations of technologies besides sewers that the CCC thought appropriate for the location).

The two hybrid evaluations developed specifically as part of this project include two scenarios, each with a combination of both traditional and non-traditional technologies. This evaluation is intended to be at a similar

level of detail as the initial work performed by the CCC and present the possible combinations of nitrogen mitigation approaches for Eastham so they can be incorporated into the 208 Plan Watershed Reports. Further detailed investigations are needed to properly assess the scenarios, determine site suitability and determine the most feasible solution.

For the purposes of the following initial evaluations, the Tracker model includes the following "sub-subwatersheds" for the Salt Pond subwatershed: Salt Pond, Minister's Pond, Schoolhouse Pond and Depot Pond.

4.1. All Traditional

4.1.1 Eastham Treatment and Recharge

4.1.1.1 Bookend Evaluation

This bookend evaluation is based on the entire Nauset Harbor watershed and although it includes Salt Pond as a subwatershed, the approach is not focused on Salt Pond. The bookend evaluation developed by the CCC for traditional technologies or "gray infrastructure" as it is referred to in the Tracker model, includes export of treated wastewater outside of the Salt Pond watershed. The bookend shows the goal net reduction being met for Nauset Harbor with 81% load removal at Salt Pond. It is important to understand that this estimated percent removal is a component of reaching the TMDL for the entire watershed system. Upon GHD's evaluation it is also noted the bookend evaluation includes an error where the load being treated for Minister's Pond is larger than the existing load. This error affects the 81% estimated removal percentage and portrays it as artificially low. The following Table 4 below presents this information.

4.1.1.2 Recharge Outside of Watershed

This scenario is similar to the CCC Bookend Evaluation in which wastewater is collected in the Salt Pond area and recharged outside (exported) out of the watershed. This option corrects for the error in the bookend evaluation for Minister's Pond and reflects a 95% estimated load removal percentage. The following Table 4 presents this information.

4.1.1.3 Recharge Inside of Watershed

This scenario includes the collection of wastewater within the Salt Pond watershed and recharge of the treated water inside of the watershed it was collected from. This option includes an estimated 100% estimated load removal and an assumed 3% nitrogen load recharge into the watershed (which assumes a 97% treatment efficiency). Table 4 presents this information.

4.1.1.4 Recharge Inside of Watershed with Fertilizer/Stormwater Reduction

This scenario includes the collection of wastewater within the Salt Pond watershed and recharge of the treated water inside of the watershed it was collected from. This option includes an estimated 100% estimated load removal and assumes 3% of the nitrogen load is being recharged back into the watershed after treatment. This option also includes a 20% fertilizer/stormwater reduction in order to meet the 100% removal goal. Table 4 presents this information.

Table 4 Estimated Eastham Centralized Treatment and Recharge Options

Salt Pond				
Tracker Model Category	Bookend Evaluation[1]	Recharge Outside of Watershed	Recharge Inside of Watershed[2]	Recharge Inside of Watershed with Fertilizer / Stormwater Reduction[2]
MEP Septic Target	100%	100%	100%	100%
Septic Wastewater Load (kg/yr)	1,560	1,560	1,560	1,560
Excess Septic (to be removed) (kg/yr)	1,560	1,560	1,560	1,560
Estimated Load Removal % (required)	81%	95%	100%	100%
Estimated Fert/SW Reduction % (assumed)	0%	0%	0%	20%
Goal Net Reduction	0	0	0	0
Load Removed (kg/yr)	1,603	1,560	1,513	1,566
Remaining Excess (kg/yr)	- 43	0	47	- 6

Notes:

(1) The bookend evaluation shows an error where 1,013 kg/yr of wastewater load is identified for treatment for in-shed disposal in Minister's Pond which only has an existing unattenuated septic load of 866 kg/yr. This is why a "Recharge Outside of Watershed" evaluation was completed adjusting the 1,013 kg/yr to 866 kg/yr.

(2) Assumes 3% of treated nitrogen load being recharged.

Table 4 presents four traditional scenarios for evaluation in Salt Pond. The "remaining excess" row is the final excess septic load that needs to be removed as a result of the scenario being proposed. As shown in Table 4 the following scenarios could achieve the target nitrogen removal based on the CCC's 208 Plan Tracker model:

- Recharge Outside of the Watershed - 95% load removal of wastewater
- Recharge Inside of the Watershed with Fertilizer/Stormwater Reduction (20%) – 100% load removal of wastewater

Figure 2 shows the estimated achievable traditional options.

4.2. All Non-Traditional

4.2.1 Bookend Evaluation

CCC has developed several non-traditional bookend solutions for Nauset Harbor (which includes Town Cove and Salt Pond) based on the vast number of choices one could make in using non-traditional solutions. However these evaluations are based on the entire Nauset Harbor watershed and include impacts from both Eastham and Orleans as they relate to the Nauset System.

The Tracker model calculates the quantities (linear feet, areas, number of properties served, number of systems, etc.) of different technologies needed to meet a nutrient mitigation goal. The quantities can be input to the 208 Map Viewer (which was also developed by CCC) to determine proposed locations for the technologies. Further studies would be needed to determine the optimal locations for these technologies based on variables that are not included in the 208 Map Viewer, such as site suitability and public acceptance.

The bookends are simply guides established to provide starting points for communities as they approach the development of hybrid solutions (combination of traditional and non-traditional approaches). The bookends for Nauset Harbor are not particularly useful to our analysis of Salt Pond because it is a large-scale watershed approach. Therefore, non-traditional approaches for Salt Pond will be evaluated as part of the hybrid evaluations below.

4.3. Hybrid 1 Evaluation

The Hybrid 1 evaluation includes the main non-traditional elements of a permeable reactive barrier (PRB), aquaculture/shellfish propagation, stormwater and fertilizer reduction credits and the traditional component of upgrading the CCNS on-site wastewater treatment system to a higher level treatment facility. The components of this hybrid are discussed in greater detail below and shown in Figure 3.

4.3.1 Permeable Reactive Barrier

A permeable reactive barrier (PRB) is an in-situ treatment zone designed to intercept nitrogen enriched groundwater and is installed within the aquifer. Through the use of a carbon source, microbes in the groundwater uptake the nitrogen, denitrifying the groundwater. As part of a previous grant application (which was not funded) that was submitted to the USEPA, the CCNS Salt Pond Visitor Center was identified as a proposed PRB location and approximately 2,300 linear feet of PRB was estimated. This location is upgradient of Salt Pond and downgradient of the Town's landfill and could provide a dual benefit.

As part of this hybrid evaluation, there are certain assumptions identified with PRB installation as a non-traditional technology. According to the CCC 208 Plan, PRB's have a 75%-95% nitrogen removal efficiency, therefore a conservative estimate of 75% was used as part of this hybrid evaluation. In addition, the CCC assumes a depth of 40 feet with 20 foot spacing between injection wells. The assumptions are important as they are tied to the cost indices developed for the PRB in the Tracker model.

As discussed previously, the CCC 208 planning tools provide a broad-brush approach to wastewater planning. Siting a PRB requires additional engineering and understanding of the site conditions. Typically investigation of the groundwater flow and characteristics would be accomplished through monitoring well installation and sampling, and soil borings. A PRB is ideally sited where it will make the largest impact on the

nitrogen reduction therefore investigations of where and to what depth and concentration the nutrient plume is critical. Detailed investigations outside the scope of this project will be needed to determine the feasibility and location of the PRB. Through the Town's previous groundwater investigation work to characterize the groundwater flow in the vicinity of the landfill, there is an indication that groundwater flows in a southeasterly direction towards Minister's Pond/School House Pond and Salt Pond.

The Town was recently notified that they received a District Local Technical Assistance (DLTA) grant with assistance from the Cape Cod Commission for PRB investigation work. This grant funding will complement the Town's efforts in investigating this non-traditional technology for their wastewater management. As part of these efforts a limited site characterization study was initiated and the results were put into a technical memorandum for the Town's use in future efforts.

4.3.2 Shellfish

The use of shellfish propagation as a means of nitrogen management was discussed with the Town's Natural Resource Officer/Harbormaster. The Natural Resource Officer/Harbormaster noted the following about Salt Pond and its current shellfish program:

- Salt Pond has a lower salinity (compared to Town Cove) with quahogs mostly present.
- There are mechanisms and existing beds that would support greater shellfish populations in Salt Pond, however a reef would not be recommended because Salt Pond is anoxic in the middle.
- Current general propagation practices of the Town include purchasing and planting of about 500 bushels of quahogs as part of the contaminated shellfish relay program permitted through the Division of Marine Fisheries.
  - growing out 2- to 4-mm shellfish "seed" in June, this is about 300,000 quahogs in Salt Pond. By early October/November they have grown to the size of nickels and quarters.
  - growing out 3/4-inch shellfish "seed" in April, this is about 25,000 oysters for Salt Pond. By November they are ready for harvesting in the Salt Pond River.
- Salt Pond is "approved" by the Commonwealth of Massachusetts and open 365 days a year unless impacted by a red tide.
- Salt Pond has no active aquaculture grants.
- In the event the Town would like to increase shellfish as part of their wastewater planning, the Department would need the staff to increase.
- The Town does not have knowledge of square footage, what shellfish are living there, and what the bottom could support. The Town may need to do a shellfish survey or evaluation as a pilot project to gain some of this understanding.

Through the use of GIS, the Town estimates Salt Pond itself to be approximately 18.7 acres in size and 21.7 acres in size including the inlet/river.

As part of this hybrid analysis, there are certain assumptions identified with shellfish as a non-traditional technology. It is estimated that one acre can support 150,000 – 400,000 shellfish; in this analysis, a

conservative estimate of 200,000 shellfish is used. One unit of shellfish is estimated to remove 0.5% nitrogen assuming natural density. This approach has been used in Mashpee and applied to Eastham as another method to estimate shellfish areas needed. The following Table 5 presents this information.

Assumptions as part of the Tracker presented a less conservative estimate based on the assumption of approximately 250 kg/yr/acre removal. These estimates were developed based on one of the following two methods:

- Mashpee approach which is based on Mashpee harvest weights
- CCC 208 Plan

There are many limitations and risks when considering shellfish propagation which would need to be evaluated prior to use like:

- Available area
- Salinity
- Closure areas
- Disease
- Predation
- Algae blooms
- Ocean acidification, etc.

Table 5 Salt Pond Estimated Nitrogen Removals with Shellfish

Shellfish Type	Nitrogen Removed (kg/yr)	# of Additional Shellfish Needed	Area Needed Using Tracker (acres)	Area Needed Using Mashpee Approach (acres)
Quahogs	730	2.5 million	2.9	12.2(1)
Oysters	730	1.5 million	2.9	7.3(2)

Notes:

(1) Littleneck quahogs at 60 g. N.

(2) Oysters at 100 g. N.

Calculations indicate that possibly up to 15 acres are needed to remove 900 kg/yr of nitrogen using quahogs or 9 acres are needed to remove 900 kg/yr of nitrogen using oysters. A combination of quahogs and oysters is also an option for the Town. It is noted that this level of propagation is a significantly larger effort than what the Town currently propagates for. It is undetermined at this time if Salt Pond could support this level of propagation without a shellfish survey or similar investigation. Due to the highly variable nature of this nitrogen removal approach, this would require a pilot scale test possibly up to 4 acres in area to see the effectiveness.

4.3.3 Fertilizer and Stormwater Reduction

The Town of Eastham voted to adopt a Board of Health regulation on the content and application of fertilizer to turf on November 20, 2014. This regulation incorporates current Best Management Practices, which are deemed essential in this effort to protect the public health and aid in achieving compliance with the Total Maximum Daily Loads (TMDL) for the Town's water resources prescribed the Commonwealth of Massachusetts while allowing reasonable use of fertilizers for the enhancement of turf quality.

In the Tracker model a 20% reduction was input into the model for both fertilizer and stormwater reduction. This 20% reduction estimates a combined 51 kg/yr removal as shown below in Table 6.

Table 6 Salt Pond Nitrogen Loads for Fertilizer and Stormwater and Estimated Reduction Credit

Controllable Nitrogen Source	MEP Nitrogen Loads by Input (kg/yr)[1]	CCC Tracker Credit (kg/yr)[2]
Fertilizer and Stormwater	292	51

Notes:

(1) From CCC Tracker Model.

(2) Calculation performed in the CCC provided Nauset Harbor Tracker by inserting a percentage in the "Fert/Storm Removal Reduction" column.

4.3.4 Upgrade CCNS On-Site Treatment

It is recommended that the Town Health Department continue to work with the CCNS on developing monitoring data to determine if improvements can be made to the existing AdvanTex® system. Upgrades would be a benefit to the hybrid model and would aid the estuary system by treating the wastewater prior to discharge (assuming treatment to 3 mg/L of nitrogen) unlike the other non-traditional components which are working to remediate an existing problem without source reduction. If this upgrade is feasible to the CCNS, discussions between the CCNS and Eastham on treating a larger flow by adding users to the system could be explored.

It is recommended that some level of sampling be done this summer to establish influent and effluent nitrogen concentrations. A simple program that might allow the Town to gain a better understanding of the performance and potential impact on the Nauset Estuary would be to collect the following:

- Influent flow, BOD, ammonia, TN, Phosphorus
- Effluent flow, BOD, TSS, TKN, Nitrite-N, Nitrate-N, TN, Phosphorus,

Collecting these samples at a minimum of quarterly and up to weekly/monthly depending on the parameter and daily flow information would be essential to determine the systems impact on Salt Pond and the Nauset Estuary. Barnstable County Department of Health may be a resource for this sampling.

4.4. Hybrid 2 Evaluation

The Hybrid 2 evaluation has the same technology components as the Hybrid 1 evaluation but includes advanced wastewater treatment at a proposed facility in Eastham. The components of this hybrid are discussed in greater detail below. Based on the outputs of the Tracker model, a PRB and shellfish component is estimated to still be required based on the assumptions of the PRB siting area.

4.4.1 Eastham WWTF

For the purpose of this evaluation, this component of the Hybrid 2 evaluation includes a WWTF within Eastham's Salt Pond subwatershed. Several sites were preliminarily evaluated as shown in Table 2. For the purposes of this evaluation, the Eastham Elementary School site is proposed as a potential site for advanced wastewater treatment within the Salt Pond subwatershed. Figure 3 illustrates an estimated collection area using the CCC's 208 planning tool. This sewer service area includes approximately 180 parcels, of which 93% are single family residential. The estimated nitrogen load from the planning tool provides a value of 850 kg/yr. It should be noted that the CCC's 208 planning tool does not appear to capture the school nitrogen load as there is no value assigned to that parcel in the model. Including the school as part of the service area would likely increase the value of the nitrogen load collected and treated and therefore could reduce the load requirements of the other hybrid components.

4.4.2 Permeable Reactive Barrier

As discussed in Hybrid 1 Evaluation, a permeable reactive barrier (PRB) is an in-situ treatment zone designed to intercept nitrogen enriched groundwater and is installed within the aquifer. Through the use of a carbon source, microbes in the groundwater uptake the nitrogen, denitrifying the groundwater.

As part of this Hybrid 2 Evaluation, the same assumptions identified by the CCC in Hybrid 1 are carried forward here. Based on the siting area upgradient of the CCNS Salt Pond Visitor Center and a PRB length of 2,300 linear feet assumed in Hybrid 1; a shellfish or other non-traditional component may need to be included to meet the target reduction.

4.4.3 Shellfish

The use of shellfish propagation as a means of nitrogen management is also likely required in the Hybrid 2 scenario. The combination of the Eastham WWTF, PRB, stormwater and fertilizer reduction leaves a scenario that does not entirely meet the septic target reduction. However, the amount of shellfish estimated is reduced by an order of magnitude compared to the Hybrid 1 evaluation as shown in the following Table 7.

As part of this Hybrid 2 analysis, there are certain assumptions identified with shellfish as a non-traditional technology that carry forward from Hybrid 1. It is estimated that one acre can support 150,000 – 400,000 shellfish, in this analysis, a conservative estimate of 200,000 shellfish is used. One unit of shellfish can remove 0.5% nitrogen assuming natural density. This approach has been used in Mashpee and applied to Eastham as another method to estimate shellfish areas needed.

Using the Tracker program this might result in greater performance and a reduced area as shown in Table 7.

Table 7 Salt Pond Estimated Nitrogen Removals with Shellfish

Shellfish Type	Nitrogen Removed (kg/yr)	# of Shellfish Needed	Area Needed using Tracker (acres)	Area Needed using Mashpee Approach (acres)
Quahogs	100	340,000	< 1	1.7(1)
Oysters	100	200,000	< 1	1(2)

Notes:

(1) Littleneck quahogs at 60 g. N.

(2) Oysters at 100 g. N.

Table 7 calculations indicate that 1.7 acres are needed to remove 100 kg/yr of nitrogen using quahogs or 1 acre is needed to remove 100 kg/yr of nitrogen using oysters. A combination of quahogs and oysters is also an option for the Town. Due to the highly variable nature of this nitrogen removal approach, this would require a pilot scale test possibly up to 1 acre in area to see the effectiveness.

4.4.4 Fertilizer and Stormwater Reduction

This reduction is the same as for Hybrid 1. In the Tracker model a 20% reduction was input into the model for both fertilizer and stormwater reduction. This 20% reduction estimates a combined 51 kg/yr removal as shown in Table 6.

4.5. Estimated Costs and Comparisons

As a feature of the CCC 208 planning tools; costs are built into the Tracker for non-traditional technologies and into the WatershedMVP mapping tool for traditional technologies. There are assumptions built into the CCC costs in order to provide a tool in comparison to towns. GHD has not validated these costs as part of this analysis. At the time this technical memorandum was developed, the WatershedMVP tool was not functioning and costs for the traditional technologies were not able to be generated from this source.

Table 8 Salt Pond Estimated Cost Comparisons

Technology	Traditional Scenarios		Hybrid Scenarios	
	Recharge Outside Watershed[1]	Recharge Inside Watershed with Fertilizer/Stormwater Reductions[1]	Hybrid 1 Evaluation[2]	Hybrid 2 Evaluation[1][2]
Estimated Capital Costs	$24 million	$25.3 million	$10.6 - $11.3 million[3]	$21.2 - $21.3 million[3]
O&M	$340,000	$356,000	$116,000 - $167,000[4]	$157,000 - $165,000[4]
Total 20-Year Cost (5% Interest)	$28.2 million	$30.5 million	$13.5 - $18.1 million	$34.1 – 34.5 million

Notes:

(1) Costs were developed from the $50,000 per property with new community/municipal wastewater treatment estimate identified in the 2009 Plan Evaluation Report and adjusted for an August 2016 ENR of 10385.65.

(2) The range in costs is due to the range in acreage of shellfish that may be needed.

(3) The Tracker does not provide an "Estimated Capital Cost" for Fertilizer Management or Stormwater Mitigation.

(4) The Tracker only provides an O&M cost for aquaculture, for the other non-traditional technologies listed in the Hybrid 1 and 2 Evaluations the O&M costs are part of the capital costs.

It is important to note that costs may not factor in all aspects of the Town's true cost. If the Town were to aggressively expand their shellfish propagation program as part of their nitrogen management approach, staff and resources would also need to be budgeted for.

5. SUMMARY AND NEXT STEPS

The following Table 9 is a summary of the scenarios developed for Salt Pond and Table 10 is a summary of the scenario estimated load reductions. For the purpose of this memorandum and the Cape Cod Commission Watershed Report for Nauset Harbor, the following traditional and hybrid scenarios were presented.

Table 9 Salt Pond Summary of Scenarios

Technology	Traditional Scenarios		Hybrid Scenarios	
	Recharge Outside Watershed	Recharge Inside Watershed with Fertilizer/Stormwater Reductions	Hybrid 1 Evaluation	Hybrid 2 Evaluation
Fertilizer and Stormwater Reductions	0%	20%	20%	20%
Wastewater Collection and Treatment	95%	100%	0%	180 Properties
Permeable Reactive Barrier	--	--	2,300 linear feet	2,300 linear feet
Shellfish/Aquaculture	--	--	2.9 – 12.2 acres	< 1 – 1.7 acres
Enhanced I/A Systems	--	--	Upgrade of CCNS On-site treatment system	--

The development of the scenarios in Table 9 should be considered preliminary planning for the Town and can be used as a basis for discussion on how to proceed with planning and additional studies and whether another combination of technologies could be evaluated.

The following Table 10 is an estimated load reduction summary table for the scenarios presented above.

Table 10 Salt Pond Estimated Load Reduction Summary

Removals (kg/yr)	Traditional Scenarios		Hybrid Scenarios	
	Recharge Outside Watershed	Recharge Inside Watershed with Fertilizer/Stormwater Reductions	Hybrid 1 Evaluation	Hybrid 2 Evaluation[2]
Fertilizer and Stormwater Reductions	0	51	51	51
Wastewater Collection and Treatment	1,560	1,516	0[1]	655
Permeable Reactive Barrier	0	0	780	780
Shellfish/Aquaculture	0	0	730	< 1 – 1.7 acres
I/A Systems	0	0	0	0
Total Removal	1,560	1,566	1,561	1,560
Goal	0	0	0	0
Balance	0	-6	-1	0

Notes:

(1) The estimated load reduction is zero for the potential upgrade of the CCNS Salt Pond Visitor Center on-site wastewater system because there is no data available on the current loads. If this value was known and this scenario was selected, other removal technologies could be adjusted to account for the removal credit with the upgrade.

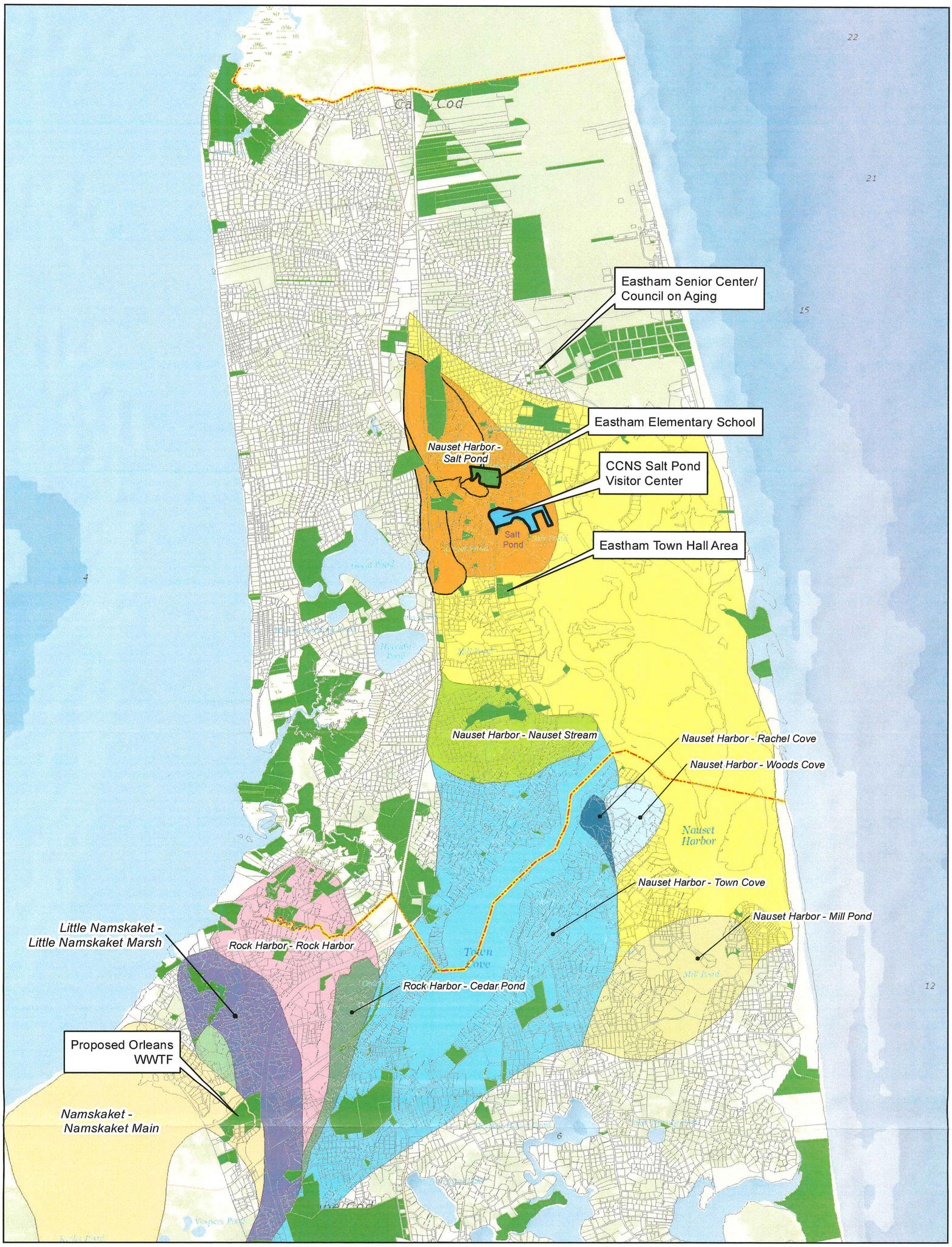
(2) This scenario includes a portion of Nauset Marsh that is sewered which is outside of the Salt Pond watershed. This scenario involves a trade-off between Nauset Marsh and Salt Pond which allows the nitrogen load reductions to be reached for Salt Pond.

Recommended next steps for the Town include applying for grant opportunities for further investigation of a PRB site in the Salt Pond Watershed and for a shellfish survey in Salt Pond. The Town of Eastham should also continue the discussion with the CCNS Salt Pond Visitor staff on how they may be able to collaborate on future projects.

6. REFERENCES

1. Cape Cod Commission, Cape Cod Area Wide Water Quality Management Plan Update, June 2015 and associated wastewater management tools.
2. Technical Memorandum No. 1 – Update to Wastewater and Nitrogen Management Needs Assessment; GHD Inc; February 10, 2015.
3. Technical Memorandum No. 2 – Update to Wastewater and Nitrogen Management Alternatives Screening Analysis; GHD Inc; February 10, 2015.
4. Final Interim Needs Assessment & Alternatives Screening Analysis Report; GHD Inc. (Stearns & Wheler, LLC); March 2009.
5. Town of Eastham, Massachusetts Fertilizer Bylaw, Approved 11/2014, http://www.eastham-ma.gov/Public_Documents/EasthamMA_Health/FertalizerRegulation/.
6. Town of Eastham, Massachusetts, Watersheds: Lower Cape, Nauset Harbor Watershed Report for Salt Pond and Town Cove – Eastham Focus; June 2016 (submitted to the Cape Cod Commission).
7. Town of Mashpee Sewer Commission; Final Recommended Plan / Final Environmental Impact Report; GHD Inc; May 2015.

Figures



LEGEND

Parcel Boundary	Municipal Owned Parcel	Town Line	Federal Property
Little Namskaket - Little Namskaket Creek	Nauset Harbor - Mill Pond	Nauset Harbor - Rachel Cove	Nauset Harbor - Woods Cove
Little Namskaket - Little Namskaket Marsh	Nauset Harbor - Nauset Marsh	Nauset Harbor - Salt Pond	Rock Harbor - Cedar Pond
Namskaket - Namskaket Main	Nauset Harbor - Nauset Stream	Nauset Harbor - Town Cove	Rock Harbor - Rock Harbor

Paper Size ANSI B

0 1,550 3,100 6,200 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001

N

GHD

TOWN OF EASTHAM, MA
Technical Memorandum #3 - Salt Pond

Job Number 86-18665
Revision A
Date 28 Sep 2016

Potential Locations for Various Technologies

Figure 1

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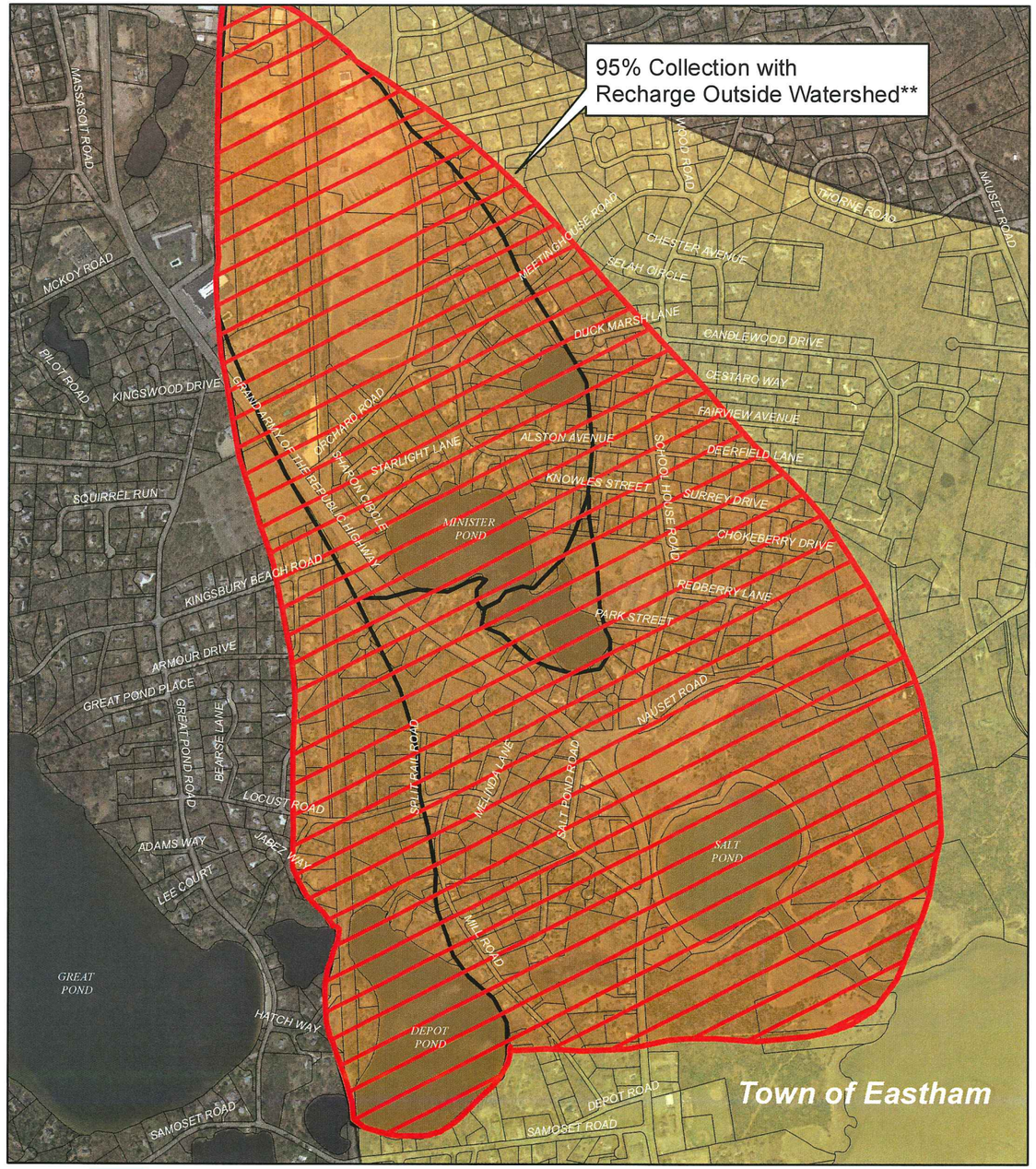
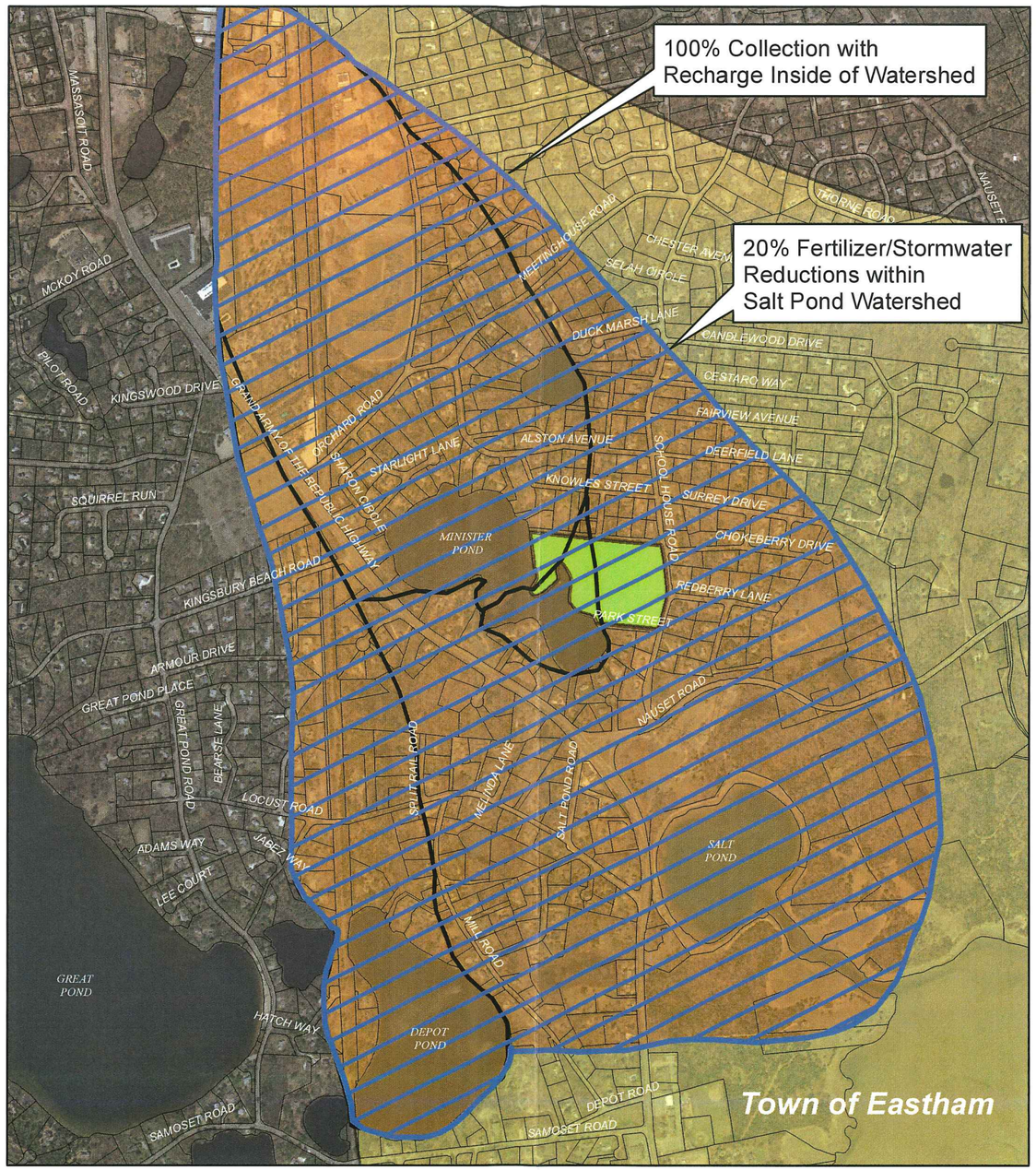
1545 Iyannough Road, Hyannis Massachusetts 02601 USA **T** 1 508 362 5680 **F** 1 508 362 5684 **E** hyamail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jjobrien





Legend

95% Wastewater Collection

100% Wastewater Collection

Eastham Elementary School (Potential Discharge Site)

Paper Size ANSI B

0 500 1,000 2,000 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

N

** Note: Figure is for preliminary planning purposes only and does not represent actual collection areas. Refer to Figure 1 for sites outside of Salt Pond Watershed

TOWN OF EASTHAM, MA
Technical Memorandum #3 - Salt Pond

Traditional Scenario Evaluations

Job Number	86-18665
Revision	A
Date	26 Sep 2016

Figure 2

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TECHNICAL MEMORANDUM NO. 4

October 17, 2016

To	Town of Eastham		
Copy to	Jane Crowley		
From	Jessica P. Janney J. Jefferson Gregg, P.E., BCEE	Tel	774-470-1636 774-470-1640
Subject	Eastham Wastewater Management Plan Initial Hybrid Approach for Town Cove	Job No.	8618665

1. INTRODUCTION AND SCOPE

The Town of Eastham is working to continue its wastewater planning for impacted estuaries. The purpose of this technical memorandum is to develop an initial hybrid approach for Town Cove based on the findings of Technical Memorandum 1 and 2 and using available Cape Cod Commission planning tools developed as part of the Cape Cod Area Wide Water Quality Management Plan Update (208 Plan).

The Cape Cod Commission has finalized their 208 Plan and it has been approved by USEPA. This document identifies many nitrogen management and planning components that can be used as part of a municipal wastewater planning process, such as Eastham's, including:

- Identification of Waste Management Agencies (WMA) that will work to share responsibility to meet the nitrogen TMDLs for coastal estuaries.
- Development of Watershed Reports for each watershed wholly or partially within Town boundaries.
- Expanded innovative and alternative nitrogen management approaches and technologies.
- New wastewater management evaluation tools to estimate existing and future wastewater flows and nitrogen loading as well as alternative wastewater nitrogen management scenarios.
- The requirement to complete a Targeted Watershed Management Plan (TWMP) for estuaries and their watersheds that exceed established nitrogen TMDLs.
- Revised regulatory procedures to streamline the review process when TWMP is properly completed.
- Recommendations to MassDEP to develop a watershed permitting program to allow nitrogen removal credits for traditional as well as non-traditional management techniques to meet a nitrogen TMDL.
- County support to develop individual TWMPs.

The next steps of Eastham's wastewater management planning project will utilize many of these components.

New wastewater management evaluation tools developed by the Cape Cod Commission include what is commonly referred to in this technical memorandum as "WatershedMVP" which is an abbreviated name for

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Watershed Multi-Variant Planner. This is an online tool where existing and future water and wastewater flows and loads can be extracted based on Town, watershed or sub-watershed lines or by polygons drawn by the user. The WatershedMVP tool was used during the development of this Technical Memorandum when examining estimated wastewater flows and nitrogen loads within the watershed of interest and in the scenario runs developed as part of the hybrid evaluations as discussed in Technical Memorandums No. 1 and 2 (TM-1, TM-2).

2. TECHNOLOGY EVALUATION METHODOLOGY

In this phase of this project, hybrid evaluations are developed for Town Cove in order to determine the feasibility and cost-effectiveness of incorporating the non-traditional mitigation measures identified in this memorandum into an alternative management plan. A hybrid evaluation methodology for Town Cove using the CCC tools, with an estimate of cost and assessment of feasibility is identified below.

The Town has expressed interest in incorporating the following non-traditional technologies into this hybrid evaluation:

- Shellfish aquaculture/propagation.
- Stormwater reductions.
- Fertilizer reductions.
- Traditional infrastructure to address excess nitrogen not managed through other methods.

As part of the hybrid evaluations, other non-traditional technologies identified in Technical Memorandum No. 2 may be considered as part of the "toolbox" and incorporated as needed if a feasible solution cannot be reached with the technologies identified above.

The hybrid evaluations are conducted using the following approach:

- Develop scenarios which incorporate components of the traditional and non-traditional technologies the Town is interested in pursuing, through discussions with Town Staff.
- Use the CCC Tracker model and WatershedMVP tools to determine the quantity and combination of different technologies that can be used in order meet the nutrient reduction goals.
- Develop cost estimates for each scenario run under the hybrid evaluations.
- Determine potential sites for traditional and non-traditional technologies for each scenario.
- Present side by side comparison of:
    - Traditional approaches/bookends (CCC 208)
    - Non-traditional bookends (CCC 208)
    - Hybrid approach #1A and #1B (with I/A systems)
    - Hybrid approach #2A and #2B (with sewer collection system)

3. DATA

3.1 Technical Memorandum No. 1 Loading

Table 1 summarizes the estimated nitrogen removal loads based on the wastewater flow estimates discussed in TM-1. The Table presents a range of nitrogen loads based on various water use/wastewater generation estimates for Town Cove. These are as follows:

- The estimated **minimum** nitrogen load is based on a wastewater generation of 122 gpd per single family residence which is calculated as 90 percent of the water use developed for the Eastham's municipal water system.
- The estimated **maximum** is based on the CCC 208 Planning tool which applied a Cape-wide average water use value to Eastham. The 90 percent wastewater generation rate of 164 gpd.
- The middle value, identified as the "Excess Septic Wastewater Load" is the attenuated load for the CCC Tracker model which is based on the targets listed in MEP.

The evaluations developed in this technical memorandum take into consideration the MEP values (middle value) as further discussed below.

Table 1 Project Focus Area Estimated Removals for Existing and Future Nitrogen Loads using a Phased Approach

Estimated MEP % Removal	Sub-watershed	Estimated Minimum Wastewater Load to Remove (kg/yr)[1]	Estimated Excess Septic Wastewater Load to Remove (kg/yr)[2]	Estimated Maximum Wastewater Load to Remove (kg/yr)[1]
75%	**Town Cove Total**	**1,840**	**2,182**	**2,720**
	Town Cove	*1,280*	*1,435*	*1,880*
	Mary Chase Gauge[3]	*490*	-	*740*
	Nauset Stream	*80*	*747*	*110*

Notes:

(1) "Estimated Minimum Wastewater Load to Remove" and "Estimated Maximum Wastewater Load to Remove" are from GHD Technical Memorandum No. 1 Table 11.

(2) "Estimated Excess Septic Wastewater Load to Remove" is the attenuated load from CCC Tracker model based on the targets listed in the Massachusetts Estuaries Project, Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System, Towns of Orleans and Eastham, MA, Final Report, December 2012. This value includes a 25% contribution responsibility for Eastham for the Town Cove value as identified in Appendix 8C of the 208 Plan Update (Mary Chase Gauge and Nauset Stream are both 100% contribution responsibility for Eastham).

(3) Mary Chase Gauge load is included in the Nauset Stream value for the "Estimated Excess Septic Wastewater Load to Remove" column.

3.2 CCC Tracker Model and Watershed MVP Tool

Bookend and hybrid evaluations are conducted using the CCC Tracker model. Nitrogen removal targets for each sub-watershed in Tracker are based on the targets listed in the Massachusetts Estuary Project (MEP). The Tracker model uses nutrient removal assumptions for a defined set of technologies to model the potential effectiveness of a technology (or combination of technologies) in an area of interest. The tracker is organized in a way that allows the user to input data into the technology categories to determine how the improvement reduces the septic wastewater load to achieve the goal net reduction. Town Cove has a MEP septic removal target of 75% with an associated 5,739 kg/yr septic wastewater load (for the entire watershed). It is important to note that according to Appendix 8C of the 208 Plan Update, Eastham is designated as being 25% responsible for the loading (and therefore load reductions) which adjust the 5,739 to approximately 1,435 kg/yr. Nauset Stream (including Mary Chase Gauge) also has a MEP septic removal target of 75% with an associated 747 kg/yr septic wastewater load and does not share this load with an contributing towns.

Traditional technologies can also be evaluated in the Watershed MVP (208 planning tool) to aid in determining the water quality improvement within the watershed. The 208 planning tool has estimated wastewater loads assigned to parcels in the Town Cove/Nauset Stream subwatersheds and by selecting parcels using this program, the estimated load in any selected area for improvement can be calculated. However it should be noted that Watershed MVP uses higher values for water use and wastewater generation (shown as the third column in Table 1) than the MEP does which is the foundation of the Tracker model. Watershed MVP is also limited in its ability to "model" technology effectiveness. At the time of this evaluation, it is only designed to demonstrate nitrogen loading improvement in areas where traditional technologies are selected.

3.3 Site Identification

Site identification is an important component of wastewater planning and is needed to determine feasible properties for traditional technologies such as advanced wastewater treatment and disposal and also for non-traditional technologies and approaches for nitrogen removal that also require land like stormwater systems.

When considering traditional wastewater infrastructure, costs generally increase as the distance from the collection area to the treatment area increase. Potential public parcels within the Town Cove subwatershed were not easily identified and therefore public parcels in the Salt Pond subwatershed or Nauset Marsh subwatershed may be a better option for the Town. It is also important to the note that the municipal water supply system planning should be incorporated in terms of where tanks and wells are being sited to ensure there are no conflicts (including the delineation of future Zone II areas).

As part of the Final Interim Needs Assessment and Alternatives Screening Analysis Report completed for the Town of Eastham in 2009, an analysis was performed for potential sites for wastewater treatment and treated water recharge facilities. In determining potential treated water recharge sites within Eastham, many factors were considered including:

- whether the site is located within an estuarine recharge area;
- does a TMDL exist for the estuary;

- is the site town owned; and
- if groundwater studies are favorable for public water supply.

This information is included as part of the site identification discussion in Technical Memorandum No. 3 for Salt Pond.

Table 2 below identifies the traditional and non-traditional technology types being considered and preliminary identification of potential sites where those technologies might be implemented. More information, discussions, and investigations are needed to determine the feasibility of these sites for the Town. Figure 1 provides a visual on where the sites are located in comparison to the Town Cove Watershed.

Table 2 Potential Siting for Various Technology Types

Technology Type	Potential Site (Common Name)
Centralized Treatment and Recharge	Proposed Orleans WWTF
	CCNS Salt Pond Visitor Center
	Eastham Elementary School
	Eastham Senior Center / Council on Aging
	Eastham Nursery School / Day Care
	Eastham Town Hall Area
Shellfish	Town Cove
Fertilizer	Town Cove Watershed (Board of Health Regulation – Town-wide)
Stormwater Improvements	To be evaluated

The largest available government owned parcels for siting of advanced wastewater treatment appear to be outside of the Town Cove subwatershed in the Salt Pond subwatershed. They are the CCNS Salt Pond Visitor Center and the Eastham Elementary School. In addition, the Eastham Town Hall Area located in the Nauset Marsh subwatershed is another potential site for treatment facilities and is located between the Salt Pond and Town Cove subwatersheds.

4. INITIAL EVALUATIONS – BOOKEND AND HYBRID

The evaluations discussed in this section include bookend evaluations and hybrid approaches.

The bookend evaluations are those developed by the Cape Cod Commission as part of their 208 Planning process which consider either an all traditional technology approach (sewering) or an all non-traditional

technology approach (combinations of technologies besides sewers that the CCC thought appropriate for the location).

The four hybrid evaluations developed specifically as part of this project include variable scenarios, each with a combination of both traditional and non-traditional technologies. This evaluation is intended to be at a similar level of detail as the initial work performed by the CCC and present the combinations of nitrogen mitigations approaches for Eastham so they can be incorporated into the 208 Plan Watershed Reports. Further detailed investigations are needed to properly assess the scenarios, determine site suitability and determine the most feasible solution.

For the purposes of the following initial evaluations, the Tracker models includes the following "subwatersheds" for the Town Cove subwatershed: Town Cove, Mary Chase Gauge and Nauset Stream.

5.1 All Traditional

a. Orleans connection

Connection to the proposed Orleans WWTF at the Tri-Town Facility site is dependent on many factors including whether excess design capacity will be available for Eastham wastewater, whether a mutual agreement between the Towns can be developed, cost, and engineering constraints. Geographically, the Town Cove portion of Eastham is located nearest the site originally proposed for the Orleans WWTF. At this time it is unclear that this even remains a viable option based on the change in approach Orleans has made in their planning process as they look to update their approved plan and identify new and smaller WWTF sites to address their community's needs.

b. Eastham treatment and recharge

i. Bookend Evaluation

This bookend evaluation is based on the entire Nauset Harbor watershed and although it includes Town Cove as a subwatershed, the approach is not focused on Town Cove. The bookend developed by the CCC for traditional technologies or "gray infrastructure" as it is referred to in the Tracker model, includes recharging of treated wastewater inside of the Town Cove watershed (including the subwatersheds of Nauset Stream and Mary Chase Gauge). The bookend shows the goal net reduction being met for Nauset Harbor with 81% load removal at Town Cove. It is important to understand that this estimated percent removal is a component of reaching the TMDL for the entire watershed system and that this load includes the contributing Towns of Orleans, Eastham and Brewster. Table 3 below shows this information.

ii. Recharge outside of watershed with fertilizer/stormwater reduction

This scenario includes the collection of Eastham's estimated wastewater within the Town Cove watershed (including subwatersheds of Nauset Stream and Mary Chase Gauge) and recharge of the treated water outside of the watershed. This option includes an estimated 28% load removal from the Town Cove subwatershed and an assumed 3% nitrogen load recharge outside of the watershed after treatment. This

option also includes a 20% fertilizer/stormwater reduction for all subwatersheds of Town Cove (including Nauset Stream and Mary Chase Gauge). Table 3 below presents this information.

Table 3 Estimated Eastham Centralized Treatment and Recharge Options for Town Cove

Tracker Model Category	Bookend Evaluation (Town Cove Total: Eastham, Orleans and Brewster)[1]	Orleans WWTF Connection / Recharge Outside of Watershed with Fertilizer/Stormwater Reduction[2] (Eastham's Contribution to Town Cove)
MEP Septic Target	75%	75%
Septic Wastewater Load (kg/yr)	8,648	2,909
Excess Septic (to be removed) [3] (kg/yr)	6,486	2,182
Estimated Load Removal % (required)	81%	28%
Estimated Fert/SW Reduction % (assumed)	0%	20%
Goal Net Reduction	2,182	2,182
Load Removed (kg/yr)	2,146	2,226
Remaining Excess (kg/yr)	36	-44

Notes:

(1) This Bookend Evaluation is for all of Town Cove and includes load from all contributing towns (Eastham, Orleans and Brewster).

(2) This traditional scenario factors in Eastham's 25% contribution responsibility for Town Cove only and 100% contribution responsibility for Nauset Stream (including Mary Chase Gauge). Percent contributions are from the CCC 208 Plan Update Appendix 8C.

(3) 75% of Septic Wastewater Load (kg/yr)

Table 3 presents the bookend evaluation done for the greater Nauset Harbor system and a second traditional scenario based on collecting an estimated 28% of the load in the Town Cove subwatershed in combination with fertilizer/stormwater reduction to achieve the target nitrogen removal based on the CCC's 208 Plan Tracker model. There are currently no identified wastewater treatment or recharge sites in the Town Cove watershed for traditional wastewater treatment. Wastewater treatment is identified as either connection to the proposed Orleans WWTF or at an in Eastham option outside of the Town Cove watershed.

The purpose of this traditional scenario is to provide a preliminary assessment of what degree of sewering may be required to meet wastewater nitrogen removal limits, actual collection areas have not been identified. Any sewering done in the upper reaches of the Town Cove subwatershed should be evaluated in

combination with what is done with the Salt Pond subwatershed. Figure 2 shows the estimated achievable traditional option.

5.2 All Non-Traditional

a. Bookend Evaluation

CCC has developed several non-traditional bookend solutions for Nauset Harbor (which includes Town Cove and Salt Pond) based on the vast number of choices one could make in using non-traditional solutions. However these evaluations are based on the entire Nauset Harbor watershed and include impacts from both Eastham and Orleans as they relate to the Nauset System.

The Tracker model calculates the quantities (linear feet, areas, number of properties served, number of systems, etc.) of different technologies needed to meet a nutrient mitigation goal. The quantities can be input to the 208 Map Viewer (which was also developed by CCC) to determine proposed locations for the technologies. Further studies would be needed to determine the optimal locations for these technologies based on variables that are not included in the 208 Map Viewer, such as site suitability and public acceptance.

The bookends are simply guides established to provide starting points for communities as they approach the development of hybrid solutions (combination of traditional and non-traditional approaches). Non-traditional approaches will be evaluated as part of the hybrid evaluations below.

5.3 Hybrid 1A Evaluation

The Hybrid 1A evaluation includes the main non-traditional elements of aquaculture/shellfish propagation, stormwater and fertilizer reduction credits and the traditional component of I/A systems. The components of this hybrid are discussed in greater detail below and shown in Figure 3.

a. Shellfish

The use of shellfish propagation as a means of nitrogen management was discussed with the Town's Natural Resource Officer/Harbormaster. The Natural Resource Officer/Harbormaster noted the following about Town Cove and their current shellfish program:

- Town Cove has a higher salinity (compared to Salt Pond) and has various shellfish species with the exception of naturally occurring oysters. Oysters are propagated and there are several aquaculture grants with oysters.
- There are mechanisms that would support greater shellfish populations in Town Cove including the ability to handle reefs or propagation.
- In Town Cove (and Salt Pond), the Town participates in a contaminated shellfish relay permitted through the Division of Marine Fisheries. The Town purchases quahogs from draggers in Fall River where the bacteria counts are high. Cost is about $10-$15/bushel and the shellfish are 95% mature (1-inch size hinge). The quahogs are then planted and

the area is closed for four months. The State then comes in and tests the tissue for safety and approves opening the area for taking of shellfish.

- In Town Cove there are six active aquaculture grant sites; five are located in Eastham and one is located in Orleans.
- Town Cove is "approved" by the Commonwealth of Massachusetts and open 365 days a year unless impacted by a red tide with the exception of Mary Chase Creek which is closed year-round.
- In the event the Town would like to increase shellfish as part of their wastewater planning, the Department would need the staff to increase.
- The Town does not have knowledge of square footage, what shellfish are living there, and what the bottom could support. The Town may need to do a shellfish survey or evaluation as a pilot project to gain some of this understanding.

As part of this hybrid analysis, there are certain assumptions identified with shellfish as a non-traditional technology. It is estimated that one acre can support 150,000 – 400,000 shellfish, in this analysis, a conservative estimate of 200,000 shellfish is used. One unit of shellfish is estimated to remove 0.5% nitrogen assuming natural density. This approach has been used in Mashpee and applied to Eastham as another method to estimate shellfish areas needed.

Assumptions as part of the Tracker presented a less conservative estimated area based on the assumption of approximately 250 kg/yr/acre removal. These estimates were developed based on one of the following two methods which are shown in Table 4 below:

- Mashpee approach which is based on Mashpee harvest weights
- CCC 208 Plan

There are many limitations and risk when considering shellfish which would need to be evaluated prior to use like:

- available area
- salinity
- closure areas
- disease
- predation
- algae blooms
- ocean acidification, etc.

Table 4 Town Cove Estimated Nitrogen Removals with Shellfish

Shellfish Type	Nitrogen Removed (kg/yr)	# of Additional Shellfish Needed	Area Needed using Tracker (acres)	Area Needed using Mashpee Approach (acres)
Quahogs	1,430	4.8 million	5.7	23.8(1)
Oysters	1,430	2.9 million	5.7	14.3(2)

Notes:

(1) Littleneck quahogs at 60 g. N.

(2) Oysters at 100 g. N.

Calculations indicate that possibly up to 23.8 acres are needed to remove 1,430 kg/yr of nitrogen using quahogs or 14.3 acres are needed to remove 1,430 kg/yr of nitrogen using oysters. It is noted that this level of propagation is a significantly larger effort than what the Town currently propagates for. It is undetermined at this time if Town Cove could support this level of propagation without a shellfish survey or similar investigation.

The Town of Eastham may want to coordinate efforts with the Town of Orleans on the preliminary investigation of increasing shellfish in Town Cove. The Town of Orleans has developed a Technical Memorandum under Task Number 3.2 – NT Demonstration Projects based on shellfish cultivation. This memo identifies the first necessary step for the Town Cove area as establishing a baseline population count in areas historically planted by the town in order to quantify the success of future propagation efforts. Once baseline populations of quahogs and other shellfish species are quantified, these areas will be propagated and then survival will be evaluated. It is recommended that the Town of Eastham also conduct a baseline population survey for the Eastham areas of Town Cove.

b. Fertilizer and Stormwater Reduction

The Town of Eastham voted to adopt a Board of Health regulation on the content and application of fertilizer to turf on November 20, 2014. This regulation incorporates current Best Management Practices, which are deemed essential in this effort to protect the public health and aid in achieving compliance with the Total Maximum Daily Loads (TMDL) for the Town's water resources prescribed the Commonwealth of Massachusetts while allowing reasonable use of fertilizers for the enhancement of turf quality.

In the Tracker model a 20% reduction was input into the model for both fertilizer and stormwater reduction. This 20% reduction estimates a combined 104 kg/yr removal as shown below in Table 5 which accounts for the full reduction credit for Nauset Stream with a reduced credit for Town Cove based on Eastham's contribution of 25% of the load.

Table 5 Town Cove (Eastham Portion) Nitrogen Loads for Fertilizer and Stormwater and Estimated Reduction Credit

Controllable Nitrogen Source	MEP Nitrogen Loads by Input (kg/yr)[1]	CCC Tracker Credit (kg/yr)[2]
Fertilizer and Stormwater	519	104

Notes:

(1) From CCC Tracker Model.

(2) Calculation performed in the CCC provided Nauset Harbor Tracker by inserting a percentage in the "Fert/Storm Removal Reduction" column and multiplying the Town Cove reduction by 25% based on a 25% contribution to the load by Eastham.

c. I/A Systems

Using the CCC Tracker model, it is estimated that approximately 130 individual I/A systems would be required in the Hybrid 1A evaluation to meet the TMDL with a treatment effluent of 19 mg/L of nitrogen. According to WateshedMVP, there are approximately 168 properties in Eastham's portion of the Town Cove subwatershed between the boundaries of Route 6 and the Town Cove shoreline and an estimated 77 percent of those properties would need to upgrade their current septic systems to I/A systems under this scenario.

5.4 Hybrid 1B Evaluation

The Hybrid 1B evaluation has the same technology components as the Hybrid 1A evaluation but includes a decreased shellfish propagation effort with an increased number of I/A systems. The components of this hybrid are discussed in greater detail below and shown in Figure 3.

a. Shellfish

Similar to the Hybrid 1A analysis, there are certain assumptions identified with shellfish as a non-traditional technology. It is estimated that one acre can support 150,000 – 400,000 shellfish, in this analysis, a conservative estimate of 200,000 shellfish is used. One unit of shellfish can remove 0.5% nitrogen assuming natural density. This approach has been used in Mashpee and applied to Eastham as another method to estimate shellfish areas needed. Using the Tracker program this might result in greater performance and reduced areas as shown in Table 6.

Table 6 Town Cove Estimated Nitrogen Removals with Shellfish

Shellfish Type	Nitrogen Removed (kg/yr)	# of Additional Shellfish Needed	Area Needed using Tracker (acres)	Area Needed using Mashpee Approach (acres)
Quahogs	280	940,000	1.1	4.7(1)
Oysters	280	560,000	1.1	2.8(2)

Notes:
(1) Littleneck quahogs at 60 g. N.
(2) Oysters at 100 g. N.

b. Fertilizer and Stormwater Reduction

The Hybrid 1B evaluation for fertilizer and stormwater reduction is the same reduction shown above in Hybrid 1A (20% combined).

c. I/A Systems

Using the CCC Tracker model, it is estimated that approximately 360 individual I/A systems would be required in the Hybrid 1B evaluation to meet the TMDL with a treatment effluent of 19 mg/L of nitrogen. There are approximately 366 properties located within the Town Cove subwatershed (not including Nauset Stream or Mary Chase Gauge) that would need to upgrade their current septic systems to I/A systems under this scenario; which for planning purposes would mean 100% of the properties within the Town Cove subwatershed would need to upgrade.

5.5 Hybrid 2A Evaluation

The Hybrid 2A evaluation includes the main non-traditional elements of aquaculture/shellfish propagation, stormwater and fertilizer reduction credits and the traditional component of wastewater collection, treatment and recharge. The components of this hybrid are discussed in greater detail below and shown in Figure 4.

a. Shellfish

Similar to the Hybrid 1A and 1B analysis, there are certain assumptions identified with shellfish as a non-traditional technology. It is estimated that one acre can support 150,000 – 400,000 shellfish, in this analysis, a conservative estimate of 200,000 shellfish is used. One unit of shellfish can remove 0.5% nitrogen assuming natural density. This approach has been used in Mashpee and applied to Eastham as another method to estimate shellfish areas needed. Using

the Tracker program this might result in greater performance and reduced areas as shown in Table 7.

Table 7 Town Cove Estimated Nitrogen Removals with Shellfish

Shellfish Type	Nitrogen Removed (kg/yr)	# of Additional Shellfish Needed	Area Needed using Tracker (acres)	Area Needed using Mashpee Approach (acres)
Quahogs	950	3.2 million	3.8	15.8(1)
Oysters	950	1.9 million	3.8	9.5(2)
Notes: (1) Littleneck quahogs at 60 g. N. (2) Oysters at 100 g. N.				

b. Fertilizer and Stormwater Reduction

The Hybrid 2A evaluation for fertilizer and stormwater reduction is the same reduction (20% combined) shown above in Hybrids 1A and 1B.

c. Collection and Treatment

Using the CCC Tracker model, it is estimated that approximately 200 properties would need to be sewered in the Hybrid 2A evaluation to meet the TMDL. There are approximately 200 properties located between Route 6 and the Town Cove shoreline within the Town Cove, Nauset Stream and Mary Chase Gauge subwatersheds that could be sewered under this scenario. This scenario includes recharge outside of the watershed but within either the Town of Eastham's boundaries or to a regional facility in Orleans and assumes 3% of the nitrogen load is being recharged outside of the watershed. Any sewering done in the upper reaches of the Town Cove subwatershed should be evaluated in combination with what is done with the Salt Pond subwatershed.

5.5 Hybrid 2B Evaluation

The Hybrid 2B evaluation includes the main non-traditional elements of aquaculture/shellfish propagation, stormwater and fertilizer reduction credits and the traditional component of wastewater collection, treatment and recharge. The components of this hybrid are discussed in greater detail below and shown in Figure 4.

a. Permeable Reactive Barrier

As discussed in TM-3, a permeable reactive barrier (PRB) is an in-situ treatment zone designed to intercept nitrogen enriched groundwater and is installed within the aquifer. Through the use of a carbon source, microbes in the groundwater uptake the nitrogen, denitrifying the groundwater. As part of a previous grant application (that was not funded) that was submitted to the USEPA, the CCNS Salt Pond Visitor Center was identified as a proposed PRB location and approximately 2,300 linear feet of PRB was estimated. This location is upgradient of Salt Pond and downgradient of the Town's landfill and could provide a dual benefit. For this scenario it is estimated that 50% of that length would be required (1,150 linear feet).

As part of this hybrid evaluation, there are certain assumptions identified with PRB installation as a non-traditional technology. According to the CCC 208 Plan, PRB's have a 75%-95% nitrogen removal efficiency, therefore a conservative estimate of 75% was used as part of this hybrid evaluation. In addition, the CCC assumes a depth of 40 feet with 20 foot spacing between injection wells. The assumptions are important as they are tied to the cost indices developed for the PRB in the Tracker model.

As discussed previously, the CCC 208 planning tools provide a broad-brush approach to wastewater planning. Siting a PRB requires additional engineering and understanding of the site conditions. Typically investigation of the groundwater flow and characteristics would be accomplished through monitoring well installation and sampling, and soil borings. A PRB is ideally sited where it will make the largest impact on the nitrogen reduction therefore investigations of where and to what depth and concentration the nutrient plume is critical. Detailed investigations outside the scope of this project will be needed to determine the feasibility and location of the PRB. Through the Town's previous groundwater investigation work to characterize the groundwater flow in the vicinity of the landfill, there is an indication that groundwater flows in a southeasterly direction towards Minister's Pond/School House Pond and Salt Pond.

b. Shellfish

Similar to the Hybrid 1A, 1B and 2A analyses, there are certain assumptions identified with shellfish as a non-traditional technology. It is estimated that one acre can support 150,000 – 400,000 shellfish, in this analysis, a conservative estimate of 200,000 shellfish is used. One unit of shellfish can remove 0.5% nitrogen assuming natural density. This approach has been used in Mashpee and applied to Eastham as another method to estimate shellfish areas needed. Using the Tracker program this might result in greater performance and reduced areas as shown in Table 8.

Table 8 Town Cove Estimated Nitrogen Removals with Shellfish

Shellfish Type	Nitrogen Removed (kg/yr)	# of Additional Shellfish Needed	Area Needed using Tracker (acres)	Area Needed using Mashpee Approach (acres)
Quahogs	540	1.8 million	2.2	9(1)
Oysters	540	1.1 million	2.2	5.4(2)

Notes:

(1) Littleneck quahogs at 60 g. N.

(2) Oysters at 100 g. N.

c. Fertilizer and Stormwater Reduction

The Hybrid 2B evaluation for fertilizer and stormwater reduction is the same reduction (20% combined) shown above in Hybrids 1A, 1B and 2A.

d. Collection and Treatment

Using the CCC Tracker model, it is estimated that approximately 490 properties would need to be sewered in Eastham in the Hybrid 2B evaluation to meet the TMDLs in the Nauset Harbor Embayment System. The general property areas are as follows:

- All of the properties within Mary Chase Gauge and Nauset Stream subwatersheds (approximately 280 properties) with recharge outside of the watershed to an in Eastham option.
- 30 properties in the Nauset Marsh subwatershed (located along Route 6) to offset removal needs from the Town Cove subwatershed
- 180 properties in the Salt Pond subwatershed (in place of the Salt Pond only hybrid approaches) identified in TM-3.

This scenario includes recharge outside of the Town Cove watershed to an in Eastham option and assumes 3% of the nitrogen load is being recharged outside of the watershed. As with Hybrid 2A, any sewering done in the upper reaches of the Town Cove subwatershed should be evaluated in combination with what is done with the Salt Pond subwatershed.

5.6 Estimated Costs and Comparisons

As a feature of the CCC 208 planning tools; costs are built into the tracker for non-traditional technologies and into the WatershedMVP mapping tool for traditional technologies. There are assumptions built into the CCC costs in order to provide a tool in comparison to towns. GHD has not validated these costs as part of

this analysis. At the time this technical memorandum was developed, the WatershedMVP tool was not functioning and costs for the traditional technologies were not able to be generated from this source.

Table 9 Town Cove Estimated Cost Comparisons

Technology	Traditional Scenario	Hybrid Scenarios			
	Orleans WWTF Connection / Recharge Outside of Watershed with Fertilizer Reductions[1]	Hybrid Evaluation 1A	Hybrid Evaluation 1B	Hybrid Evaluation 2A[1][2]	Hybrid Evaluation 2B[1][2]
Estimated Capital Costs	$22.4 million[2]	$3.3 -4.5 million[3]	$8.2 - $8.4 million[3]	$12.5 - $13.3 million[3]	$35 - $35.6 million[3]
O&M[4]	$315,000	$211,000 - $310,000	$502,000 - $521,000	$193,000 - $260,000	$433,000 - $471,000
Total 20-Year Cost (5% Interest)	$26.4 million	$8.3 million - $8.5 million	$17.1 – $17.9 million	$16.7 - $19.4 million	$42.1 - $43.7 million

Notes:

(1) Costs were developed from the $50,000 per property with new community/municipal wastewater treatment estimate identified in the 2009 Plan Evaluation Report and adjusted for an August 2016 ENR of 10385.65.

(2) The range in costs is due to the range in acreage of shellfish that may be needed.

(3)The Tracker does not provide an "Estimated Capital Cost" for Fertilizer Management or Stormwater Mitigation.

(4) The Tracker only provides an O&M cost for aquaculture and I&A Systems, for the other non-traditional technologies listed in the Hybrid 1 and 2 Evaluations (and with the fertilizer reduction credit in the Traditional Scenario); the O&M costs are part of the capital costs.

It is important to note that costs may not factor in all aspects of the Town's true cost. If the Town were to aggressively expand their shellfish propagation program as part of their nitrogen management approach, staff and resources would also need to be budgeted for.

5. SUMMARY AND NEXT STEPS

The following Table 10 is a summary of the scenarios developed for Town Cove and Table 11 is a summary of the scenario estimated load reductions. For the purpose of this memorandum and the Cape Cod Commission Watershed Report for Nauset Harbor, the following scenarios were presented.

Table 10 Town Cove Summary of Scenarios

Technology	Traditional Scenarios		Hybrid Scenarios[1]			
	Orleans WWTF Connection / Recharge Outside of Watershed	Bookend Evaluation	Hybrid Evaluation 1A	Hybrid Evaluation 1B	Hybrid Evaluation 2A	Hybrid Evaluation 2B[1]
Fertilizer and Stormwater Reductions	20%	0%	20%	20%	20%	20%
Wastewater Collection and Treatment	28%	81%	0%	0%	200 Properties: TC, NS, & MCG	310 Properties: NS, MCG & NM 180 Properties: SP
Permeable Reactive Barrier	--	--	--	--	--	1,150 linear feet
Shellfish /Aquaculture	--	--	5.7 – 23.8 acres	1.1 – 4.7 acres	3.8 – 15.8 acres	2.2 – 9 acres
I/A Systems	--	--	130 Properties TC	360 Properties TC	--	--

Notes:
(1) Where TC = Town Cove, NS = Nauset Stream, MCG = Mary Chase Gauge, NM = Nauset Marsh and SP = Salt Pond

The following Table 11 is an estimated load reduction summary table for the scenarios presented above.

Table 11 Town Cove Estimated Load Reduction Summary

Removals (kg/yr)	Traditional Scenario	Hybrid Scenarios			
	Orleans WWTF Connection / Recharge Outside of Watershed with Fertilizer/Stormwater Reductions	Hybrid Evaluation 1A	Hybrid Evaluation 1B	Hybrid Evaluation 2A	Hybrid Evaluation 2B[(1)]
Fertilizer and Stormwater Reductions	104	104	104	104	155
Wastewater Collection and Treatment	2,122	0	0	1,135	2,679
Permeable Reactive Barrier	0	0	0	0	390
Shellfish/Aquaculture	0	1,430	280	950	540
I/A Systems	0	650	1,800	0	0
Total Removal	2,226	2,184	2,184	2,189	3,764
Goal	2,182	2,182	2,182	2,182	3,742
Balance	-44	-2	-2	-7	-22

Notes:

(1) This scenario includes portions of Nauset Marsh that are sewered which is a subwatershed outside of the required nitrogen reduction area. This scenario involves a trade-off between Nauset Marsh and Town Cove which allows the nitrogen load reductions to be reached for Town Cove.

The development of the scenarios in Table 10 should be considered preliminary planning for the Town and can be used as a basis for discussion on how to proceed with planning and additional studies and whether another combination of technologies could be evaluated.

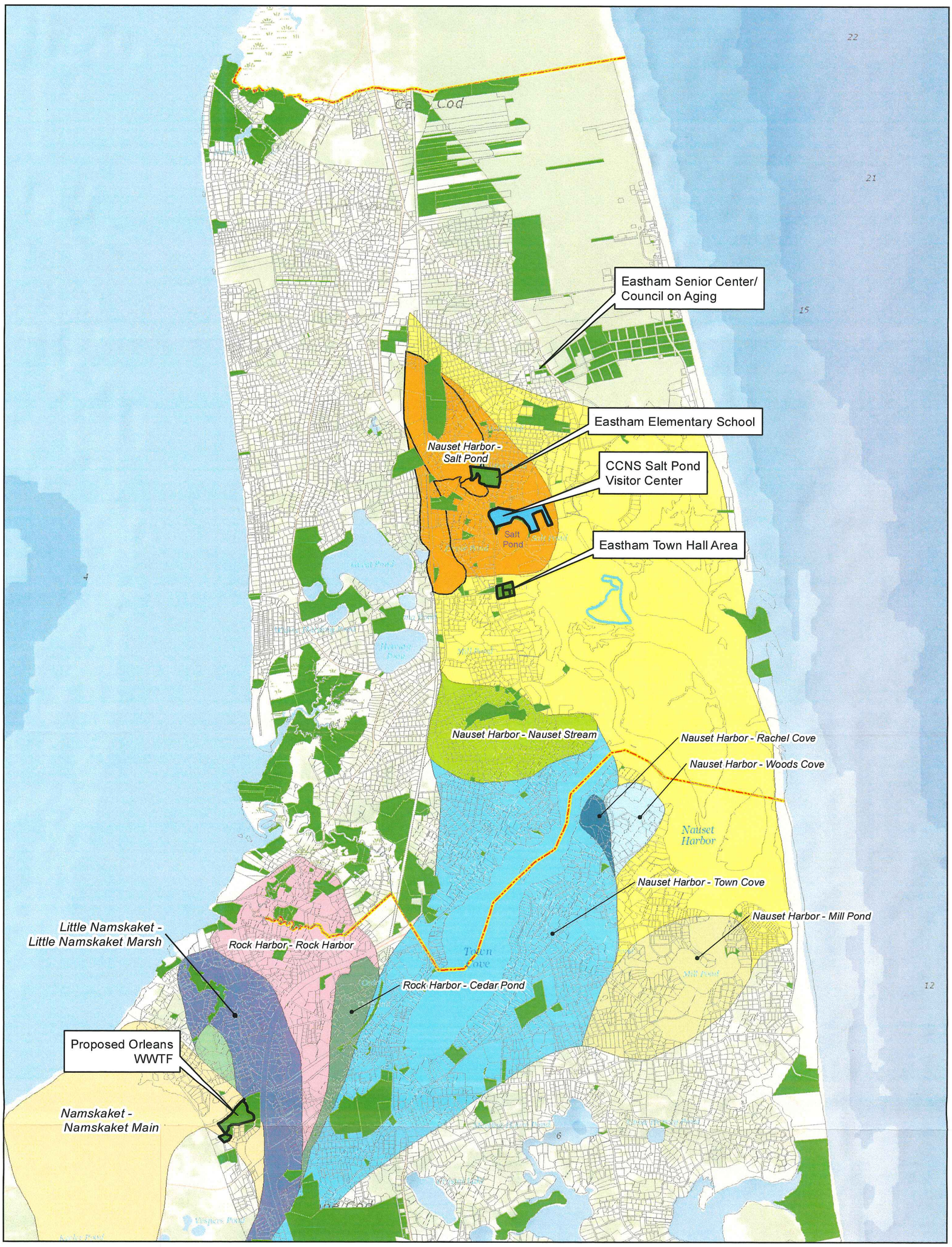
Recommended next steps for the Town include looking for grant opportunities to further their wastewater management. As discussed previously, the Town of Eastham may want to coordinate efforts with the Town of Orleans on the preliminary investigation of increasing shellfish in Town Cove. The Town of Orleans has developed a Technical Memorandum under Task Number 3.2 – NT Demonstration Projects based on shellfish cultivation. This memo identifies the first necessary step for the Town Cove area as establishing a baseline population count in areas historically planted by the town in order to quantify the success of future propagation efforts. Once baseline populations of quahogs and other shellfish species are quantified, these areas will be propagated and then survival will be evaluated. It is recommended that the Town of Eastham also conduct a baseline population survey for the Eastham areas of Town Cove.

Due to Town Cove being a shared watershed, discussions with the Town of Orleans should continue to be initiated to promote a regional approach.

6. REFERENCES

1. Cape Cod Commission, Cape Cod Area Wide Water Quality Management Plan Update, June 2015 and associated wastewater management tools.
2. Technical Memorandum No. 1 – Update to Wastewater and Nitrogen Management Needs Assessment; GHD Inc; February 10, 2015.
3. Technical Memorandum No. 2 – Update to Wastewater and Nitrogen Management Alternatives Screening Analysis; GHD Inc; February 10, 2015.
4. Final Interim Needs Assessment & Alternatives Screening Analysis Report; GHD Inc. (Stearns & Wheler, LLC); March 2009.
5. Town of Eastham, Massachusetts Fertilizer Bylaw, Approved 11/2014, http://www.eastham-ma.gov/Public_Documents/EasthamMA_Health/FertalizerRegulation/.
6. Town of Eastham, Massachusetts, Watersheds: Lower Cape, Nauset Harbor Watershed Report for Salt Pond and Town Cove – Eastham Focus; June 2016 (submitted to the Cape Cod Commission).
7. Town of Mashpee Sewer Commission; Final Recommended Plan / Final Environmental Impact Report; GHD Inc; May 2015.
8. Water Quality and Wastewater Planning, Town of Orleans, MA, Task Number 3.2 – NT Demonstration Projects, Final Technical Memorandum on Shellfish Cultivation – Preliminary Engineering Design and Work Plan for Preferred Site(s); AECOM, May 4, 2016.

Figures



LEGEND

Parcel Boundary	Municipal Owned Parcel	Town Line	Federal Property
Little Namskaket - Little Namskaket Creek	Nauset Harbor - Mill Pond	Nauset Harbor - Rachel Cove	Nauset Harbor - Woods Cove
Little Namskaket - Little Namskaket Marsh	Nauset Harbor - Nauset Marsh	Nauset Harbor - Salt Pond	Rock Harbor - Cedar Pond
Namskaket - Namskaket Main	Nauset Harbor - Nauset Stream	Nauset Harbor - Town Cove	Rock Harbor - Rock Harbor

Paper Size ANSI B

0 1,550 3,100 6,200 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001

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GHD

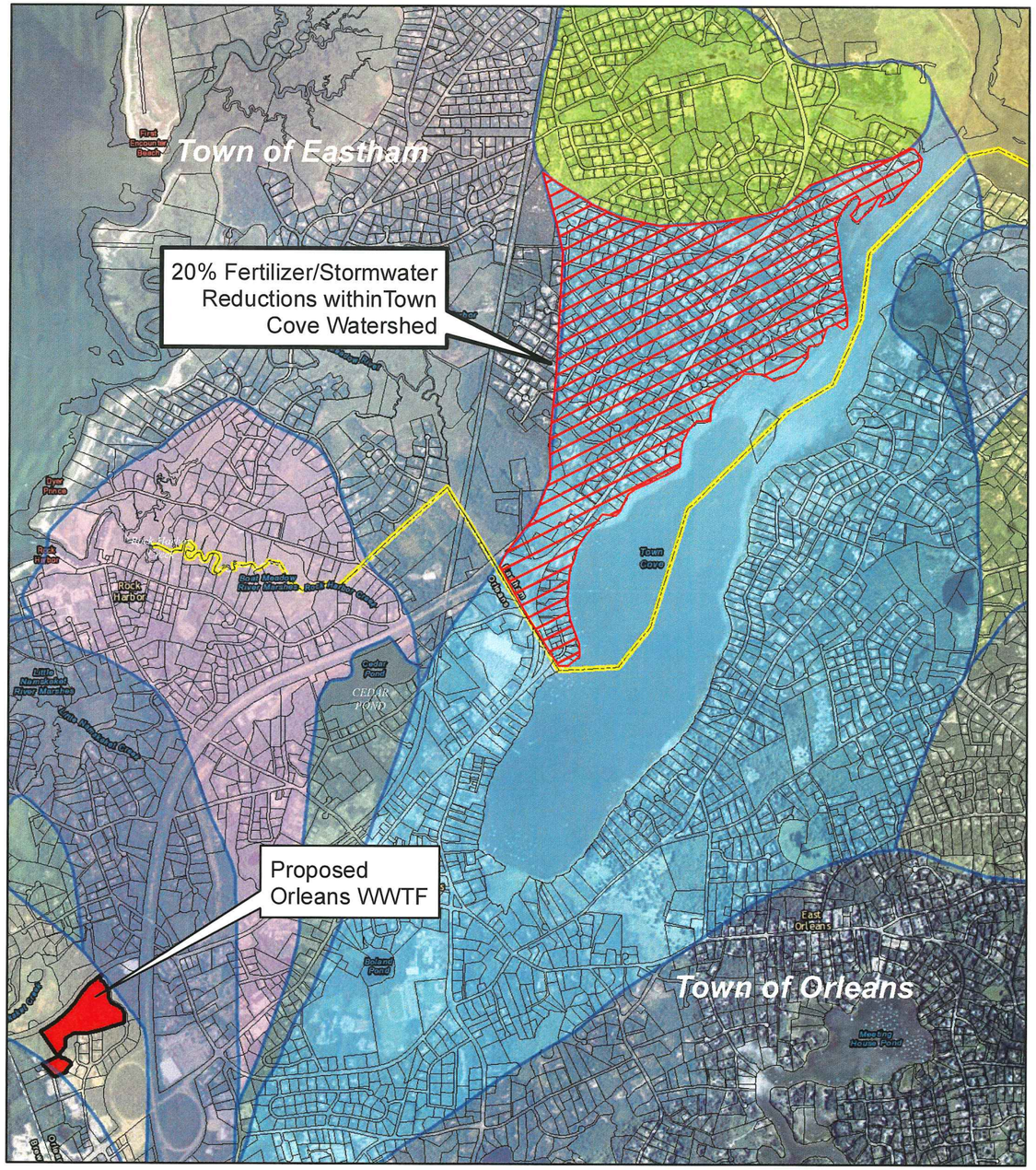
TOWN OF EASTHAM, MA
Technical Memorandum #4 - Town Cove

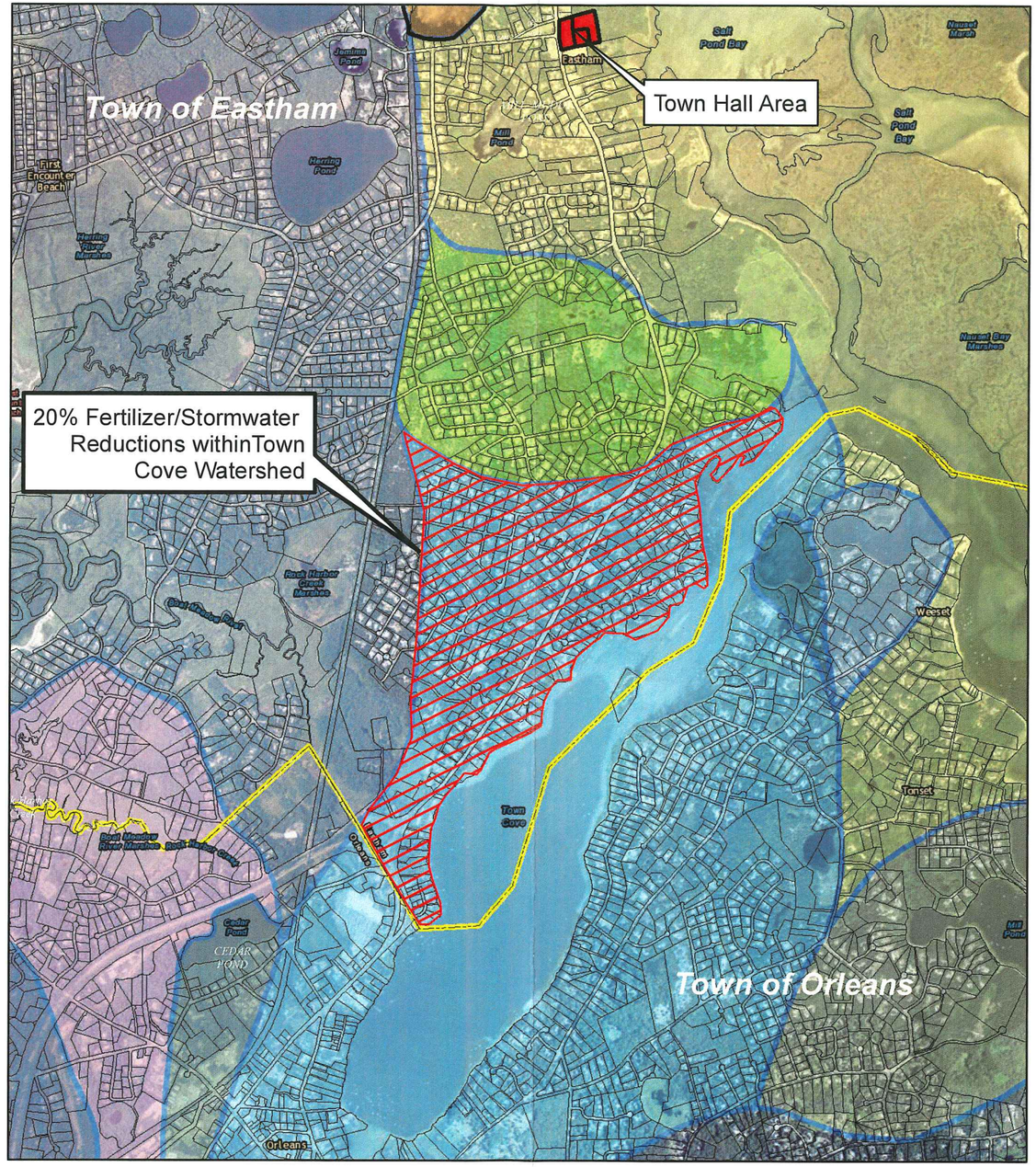
Job Number 86-18665
Revision A
Date 17 Oct 2016

Potential Locations for Various Technologies

Figure 1

1545 Iyannough Road, Hyannis Massachusetts 02601 USA T 1 508 362 5680 F 1 508 362 5684 E hyamail@ghd.com W www.ghd.com





Legend

- Potential Recharge Site
- 28% Wastewater Collection

Paper Size ANSI B

0 1,000 2,000 4,000 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

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* Note: Figure is for preliminary planning purposes only and does not represent actual collection areas.

TOWN OF EASTHAM, MA
Technical Memorandum #4 - Town Cove

Job Number	86-18665
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Date	17 Oct 2016

Traditional Scenario Evaluations

Figure 2

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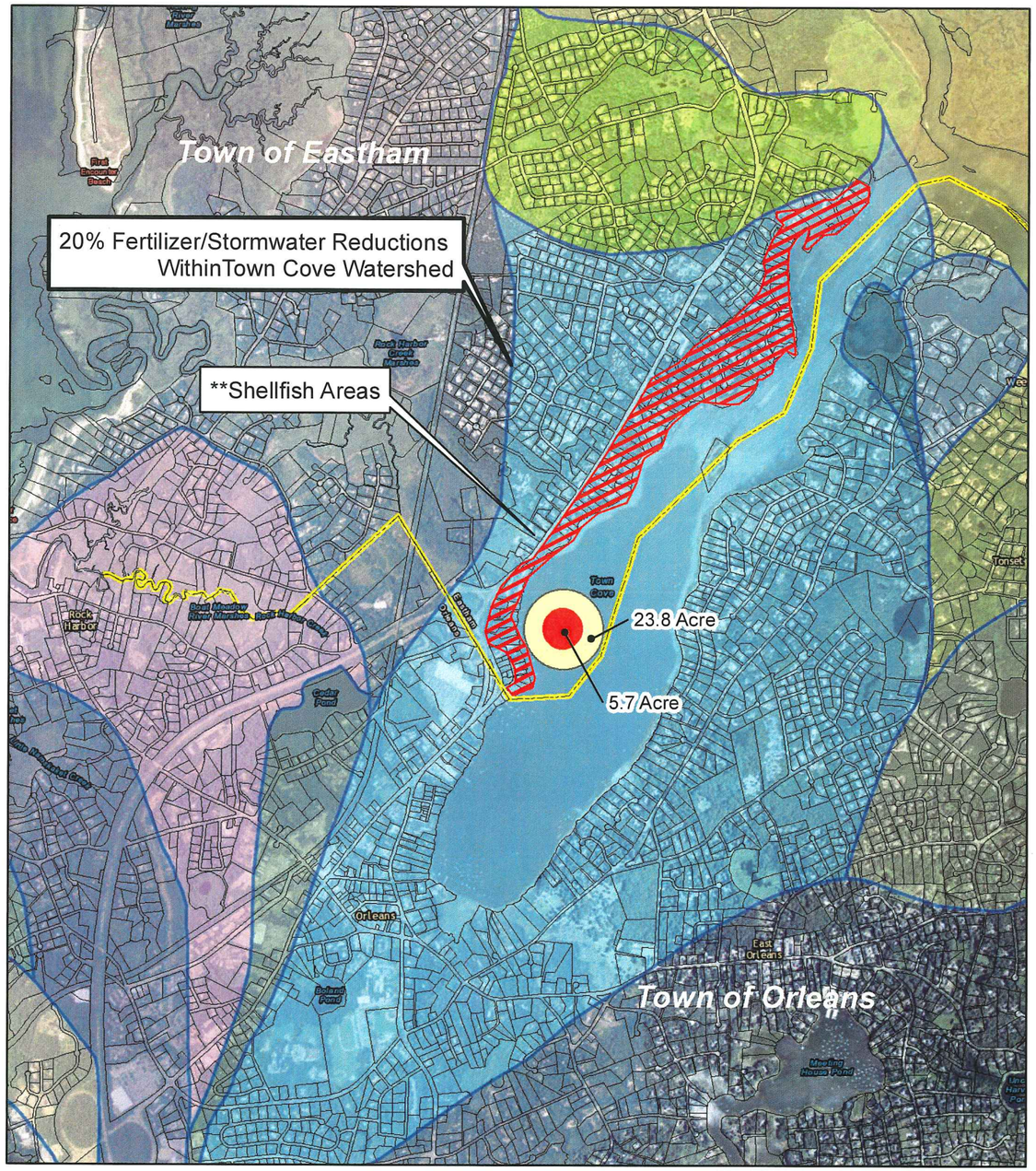
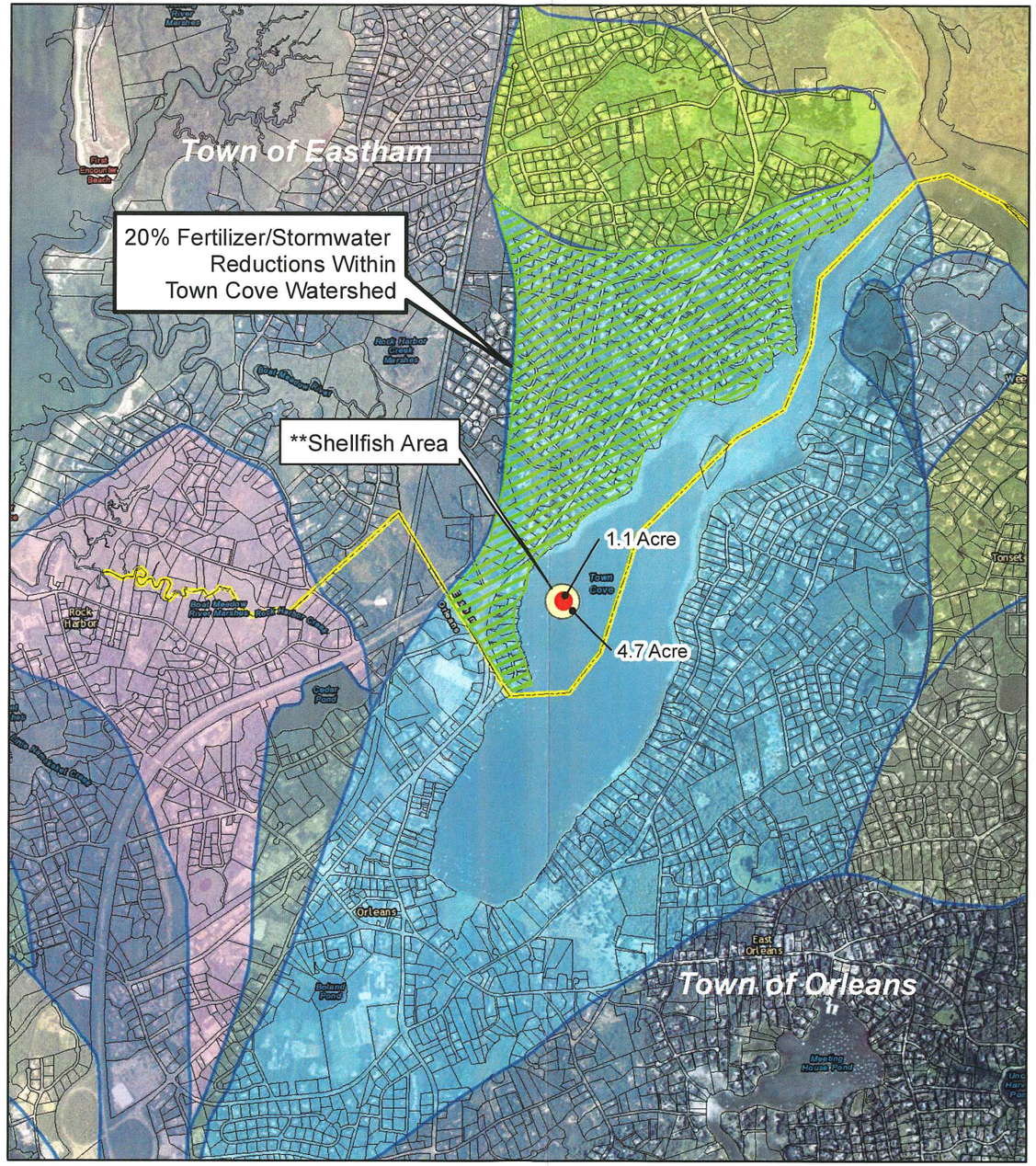


HYBRID 1A



HYBRID 1B

Legend

Up to 130 individual I/A systems

Up to 360 individual I/A systems

Paper Size ANSI B

0 1,000 2,000 4,000 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

N

* Note: Figure is for preliminary planning purposes only and does not represent actual collection areas.

**Circles do not reflect actual shellfish bed locations but serve as a representaion of the areas needed,

TOWN OF EASTHAM, MA
Technical Memorandum #4 - Town Cove

HYBRID EVALUATION SCENARIOS 1A & 1B

Job Number	86-18665
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Date	14 Oct 2016

Figure 3

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INFORMATION

MICHAEL SCHAFFER

545 Nauset Lt. Beach Road
P.O. Box 1594
North Eastham, MA 02651

November 1, 2016

Board of Selectmen
TOWN OF EASTHAM
2500 State Highway
Eastham, MA 02642

Dear Board of Selectmen,

I am writing on behalf of my neighbors on or adjacent to Nauset Light Beach Road regarding the imminent loss of access to our homes.

Just northeast of Nauset Light is the last piece of tarmac that serves 20+ properties in the Seashore District. Currently, there is less than fifty feet separating the receding ocean bluff from this road. For emergency vehicles and everyday activities, there is only one way in or out of our neighborhood. Coastal erosion will soon claim this roadway and critical access point.

The Town Administrator, DPW and Supt. Price are familiar with this matter and have very good maps to illustrate the area of concern and potential remedies. Planning ahead is part of the solution, which will involve a number of entities, approvals and the actual work.

The purpose of this letter is to urge the Board of Selectman to understand and appreciate the gravity of the problem and respond well in advance of a sudden or drastic loss. By any measure, this is one of Eastham's most unique and beautiful residential areas. All of the homeowners care deeply about its character and future.

Thank you for your consideration and we look forward to your reply.

Sincerely,

Michael Schaffer

cc. Rhonda Hodges, Elaine Damm, Lynette Tsiang, Joe Everett, Nat Santoro, Janet Sibley, Roy Kelley