



To: Jerry Potamis, P.E., Falmouth Wastewater Superintendent
CWMP Review Committee

From: Nathan C. Weeks, P.E.

Date: October 20, 2010

Re: Assistance to CWMP Review Committee
Technical Memorandum No. 7 (TM-7)
Evaluation and Summary of Committee's Preferred Option
S&W File No.: 8612163
Document No.: 71045.13

This memorandum is prepared to summarize the evaluations completed by the Comprehensive Wastewater Management Plan (CWMP) Review Committee and summarize cost and non-monetary components of the Preferred Option as identified by the Committee.

BACKGROUND ON FALMOUTH'S CWMP PROJECT

The Town of Falmouth initiated a Comprehensive Wastewater Management Planning Project for its South Coastal Watersheds to Little Pond, Great Pond, Green Pond, Bournes Pond, Eel Pond, and Waquoit Bay Watersheds in early 2007. The location map for this Planning Area is illustrated on Figure 1. As part of this planning effort, the following documents have been prepared to date:

- Needs Assessment Report, October 2007 – Documenting the needs of this area with a focus on nitrogen management.
- Alternatives Screening Analysis Report, November 2007 – Documenting approaches to address the needs as identified in the Needs Assessment Report.
- Environmental Notification Form Document, December 17, 2007 (This document summarizes the main findings of the Needs Assessment Report and Alternatives Screening Analysis Report to initiate the Massachusetts Executive Office of Energy and Environmental Affairs Massachusetts Environmental Policy Act (MEPA) review process as well as the Cape Cod Commission Development of Regional Impact review process).
- Draft Comprehensive Wastewater Management Plan and Draft Environmental Impact Report (CWMP/ DEIR) and Notice of Project Change, December 2009 – Outlining the selection process for addressing the wastewater needs for this part of Falmouth and the recommended alternative.



All of these documents are located on the Town's Wastewater Department website at www.falmouthmass.us/depart.php?depkey=wastewater as well as at the CWMP Project Site at www.falmouthwastewaterprojects.org with additional background information.

These documents have summarized the need to remove existing and future wastewater nitrogen loadings to meet the nitrogen Total Maximum Daily Load (TMDL) limits. Figures 2 and 3 illustrate the existing and future wastewater nitrogen removals needed to meet the TMDLs.

In February 2010, the Town's Board of Selectmen formed a CWMP Review Committee to review the Draft CWMP/DEIR. That committee has met several times and has requested additional cost development and technical evaluations as detailed in the Project Scope in Appendix A.

This Project Scope has produced six (6) technical memoranda on specific topics as listed below:

- Technical memorandum No. 1 (TM-1): Development of Cost Summaries for five (5) Additional Alternative Wastewater Management Scenarios.
- Technical memorandum No. 2 (TM-2): Subsurface Investigations and Groundwater Modeling for the five (5) Additional Scenarios.
- Technical Memorandum No. 3 (TM-3): West Falmouth Harbor and Scranton Avenue Sewer implementation Costs.
- Technical Memorandum No. 4 (TM-4): Options for Project Phasing.
- Technical Memorandum No. 5 (TM-5): Federal and State Funding Opportunities.
- Technical Memorandum No. 6 (TM-6): Cost and Non-Monetary Comparison for Centralized vs. Cluster-System Wastewater Management for Seacoast Shores Peninsula.

Technical Memoranda Nos. 1 and 2 investigated five (5) Alternative Wastewater Management Scenarios as listed below:

- **Scenario 3C** was the preferred scenario of the December 2009 Draft CWMP/DEIR and includes the following components:
 - Advanced treatment at the Massachusetts Military Reservation (MMR) Site with a treatment performance of less than 1 milligram per liter (mg/L) Total Organic Carbon and 1 mg/L Total Nitrogen (TN) on average.
 - Recharge of the treated water through injection wells placed in the Route 151 right-of-way (ROW) to distribute the recharge to the planning area watersheds.



- ▶ **Scenario 3D** which includes the following components:
 - Enhanced Nitrogen Removal treatment with treatment performance of 3 mg/L Total Nitrogen on average at the MMR Site.
 - Discharge of the treated water at an outfall to the Cape Cod Canal.
- ▶ **Scenario 2A Modified** which includes the following components:
 - Enhanced Nitrogen Removal treatment at the Falmouth Country Club (FCC) Site.
 - Subsurface recharge at the following sites:
 - Western portion of Falmouth Country Club Site (Site 2B)
 - Southwest portion of Allen Property (Site 4)
 - Dupee Ball Field Property (Site 5)
- ▶ **Scenario 1A Modified** which includes the following components:
 - Advanced treatment at Blacksmith Shop Road (BSR) WWTF Site to meet a treatment performance of 2 mg/L Total Nitrogen on average and less than 3 mg/L Total Organic Carbon.
 - Recharge of the treated water through injection wells placed at the northern edge of the BSR WWTF Site (Site 7) and at the Land Swap Parcel (Site 10) located north of the BSR WWTF Site.
- ▶ **Scenario 1D** which includes the following components:
 - Enhanced Nitrogen Removal treatment at the BSR WWTF.
 - Discharge of the treated water at an outfall to Vineyard Sound at Nobska Point.

All of these scenarios included wastewater collection from the original Phase 1 and Phase 2 sewer areas as indicated in Figure 3.

These five scenarios are described in detail in TM-1 and 2 with summaries of advantages and disadvantages and with cost summaries. The potential treatment and recharge sites which are part of the scenarios are illustrated on Figure 4.

SUMMARY OF CWMP REVIEW COMMITTEE FINDINGS AND IDENTIFICATION OF PREFERRED OPTION (SCENARIO 1E)

The CWMP Review Committee has reviewed the CWMP Reports as well as the six (6) Technical Memoranda identified previously; they have met many times to discuss the details of the Project; and they have had three (3) public meetings for receiving public comments. The Review Committee Findings Document dated September 7, 2010 summarized their findings to date. This document is



attached as Appendix B and the key findings are briefly listed below with the same numbering used in the document:

1. The Draft CWMP Documents represent an excellent compilation of a broad spectrum of data and opportunities for wastewater management in Falmouth.
2. The Committee requested additional information that was provided by the Technical Memoranda.
3. The Committee does not share the conclusion of the December 2009 Draft CWMP/DEIR that the MMR Site is the preferred option, with recharge in injection wells along Route 151.
- 4 – 6. The Preferred Option identified by the Committee includes:
 - Treatment at the Blacksmith Shop Road (BSR) WWTF to take advantage of existing treatment capacity at the facility and room to expand treatment facilities, and the economy of scale associated with construction and operation of only one major WWTF in Falmouth.
 - Discharge of additional flow outside the West Falmouth Harbor Watershed using the following sites/technologies:
 - Land Swap Parcel (Site 10) with sand infiltration beds.
 - Parcel at northern edge of BSR WWTF (Site 7) with sand infiltration beds.
 - Dupee Ball Field property (Site 4) with subsurface leaching.
 - Allen Property (Site 5) with sand infiltration beds.
 - Western portion of Falmouth Country Club Site (Site 2B) with subsurface leaching.
 - Eastern portion of Falmouth Country Club Site (Sites A1 and B) with sand infiltration beds.
 - Suggested flow for recharge with the sand infiltration beds was 2.0 mgd.
 - Suggested flow for recharge with subsurface leaching was 1.0 mgd.
 - Ocean outfall at Nobska Point should continue to be considered as an option.
7. Sewer expansion in the Phase 1 and 2 area should start with the Little Pond watershed area and proceed to the east in several construction stages. Massachusetts Estuaries Project model runs should be used to help define sewer extensions.
8. Potential demonstration projects were proposed for the following alternative nitrogen management concepts:
 - Pond inlet widening at Bournes, Little, and Perch Ponds with possible dredging.
 - Use of alternative toilets (composting, incinerating, or urine diversion).



- Nitrogen uptake in the estuaries with oyster farming.
 - Cluster wastewater/permeable reactive barrier system.
 - Road runoff management.
 - Fertilizer control.
 - Tail ponds installed at the south ends of the cranberry bogs.
 - Ecological treatment systems.
 - Well injection treated water recharge at the BSR WWTF Site.
9. The Committee does not see the urgency for sewer extension to the Falmouth Heights area outside the Little Pond watershed; in the southerly part of Scranton Avenue; or in the West Falmouth Harbor watershed. The Falmouth Heights area was included in the original Phase 1 and 2 areas. The Scranton Avenue and West Falmouth Harbor Sewer Service Areas were identified for sewerage in the 2001 Wastewater Facilities Plan and currently have MassDEP approval and flow allocation as part of the 2001 Plan.
10. The Phase 1 and 2 sewer area should extend from the Little Pond watershed to the eastern side of the Seapit Peninsula. Areas east of the Seapit Peninsula (referenced as the Waquoit East Area) should become part of the Phase 3 area (the Phase 3 area is the portion of Town that may need nitrogen mitigation in the future, north and east of the Phase 1 and 2 areas). The revised Phase 1 and 2 areas are illustrated in Figure 5.
11. The Committee believes that cluster systems are probable for the Phase 3 area, but not for the Phase 1 and 2 areas. The Committee also believes that the demonstration strategies listed in item 8 could bring new information to the Town.
12. A new standing committee should be formed to assist with the project in the future.
13. The treatment and recharge facilities should be expanded in a modular approach.
14. The Findings Document presented a “Hypothetical” Project Budget for the Phase 1 and 2 Project Areas as summarized in Table 1. This table has also been revised to provide the following clarifications:
- The values are all rounded to two significant digits.
 - The collection system cost was reduced because it included \$11,000,000 for grinder pumps, and that allowance had already been provided in the “Right-of-Way Laterals” component.
 - The treatment system cost was increased to correct a typographical error.
 - The “Reduction for Falmouth Heights” cost was reduced because it double counted the contingency, and fiscal, legal and engineering factors.
 - The contingency, and fiscal, legal, and engineering costs were reduced to account for a lower subtotal.



TABLE 1
Committee Project Budget Estimate

COMPONENT	COST (\$)
Construction Costs	
Collection System ^{1, 2}	200,000,000
Treatment System ³	17,000,000
Recharge System	<u>32,000,000</u>
Subtotal	249,000,000
Reduction for Falmouth Heights ⁴	-13,000,000
Reduction for Waquoit East	<u>-35,000,000</u>
Subtotal	201,000,000
Contingency (25%) ⁶	50,000,000
Fiscal, Legal, and Engineering (25%) ⁶	50,000,000
Total Project Costs⁵	300,000,000
Notes:	
1). These initial collection system costs include the Falmouth Heights and Waquoit East Areas.	
2). This cost was presented in the Findings Document as \$212,000,000 because it included \$11,000,000 for grinder pumps. That allowance had already been accounted in the Right-of-Way laterals component.	
3). This cost was presented in the Findings Document as \$16,200,000 which was a typographical error as compared to the components that were summed.	
4). This cost was presented in the Findings Document as \$19,000,000 which is \$12,600,000 with an additional 50% for contingencies and fiscal/legal/engineering. The 50% was added later in the Findings Document Budget.	
5). Costs rounded to two significant digits except total construction costs to reduce rounding error.	
6). This cost was originally \$52,000,000 due to a higher subtotal.	

This budget was presented in the Findings Document as the “Hypothetical Project Budget” pending engineering review. The original total cost was 310,200,000 before the revisions were made as discussed above.

A primary purpose of this Technical Memorandum is to investigate the components of this budget so that it can be re-verified and used in a revised Draft CWMP/DEIR. As noted above (notes 2 through 6), slight modifications have been made on the accounting of the table to reconcile the cost estimates.



REVIEW OF COMMITTEE PROJECT BUDGET WITH CONSIDERATIONS FOR ADJUSTMENTS AND NEXT STEPS

Estimated Flows for New Preferred Option Scenario 1E.

The Preferred Option is labeled as Scenario 1E based on previous scenario labeling. The “1” is for the BSR WWTF which is Site 1; and the E is the next available letter after Scenario 1D.

This scenario is illustrated on Figure 6 with the revised sewer service areas A through E. These areas have been revised to delete the Falmouth Heights and Waquoit East areas from the Phase 1 and 2 sewer area. As a result, Sewer Service Areas B and E are smaller; and Sewer Service Area F (as identified in TM-1, and the December 2009 Draft CWMP/DEIR) has been deleted.

Projected future flows for this scenario are summarized in Table 2 with explanations in the notes at the end of the table.

(continued)



TABLE 2
Projected Future Flows for Scenario 1E

SOURCE	WASTEWATER FLOW (MGD ¹)	FUTURE SEWER UNITS ²
Existing WWTF ³	0.38	N/A
Infilling for Existing Collection Area ⁴	0.09	530
Sewer Service Area A ⁵	0.08	470
Sewer Service Area B ⁶	0.40	2,350
Sewer Service Area C ⁷	0.22	1,290
Sewer Service Area D ⁷	0.30	1,760
Sewer Service Area E ⁸	0.23	1,350
Allowance for I/I ⁹	<u>0.37</u>	<u>N/A</u>
Total	2.1	7,750

Notes:

- 1) Million gallons per day rounded to two significant digits.
- 2) Based on Future Wastewater Flow for the Phase 1 and 2 sewershed areas divided by 170 gpd/residential property similar to Table 4-3 in the Draft CWMP/DEIR (rounded to the nearest 10).
- 3) From the October 2007 Needs Assessment Report.
- 4) From the 2001 WWFP/FEIR.
- 5) Based on water consumption evaluations dated September 2010 and projections to 2035.
- 6) Based on projections in Table 4-3 in the December 2009 Draft CWMP/DEIR and reductions for the Falmouth Heights area outside the Little Pond Watershed.
- 7) From Table 4-3 in the December 2009 Draft CWMP/DEIR.
- 8) Based on projection in Table 4-3 and reductions for the properties east of Seapit Peninsula that were removed from this service area.
- 9) Estimated at 30% of the Planning Area flow as discussed in the Needs Assessment Report.

This analysis indicates a larger number of Future Sewer Units or “EDU” as identified in the Findings Document. This is due to accounting for Future Sewer Units as part of infilling in the existing collection area. This analysis also indicates the need to recharge less wastewater flow than the projected 3.0 mgd identified in the Findings Document.

Considerations on Proposed Recharge Sites.

Sand infiltration beds have been proposed for Sites 7, 10, 5, A1, and B as illustrated on Figure 4. This type of recharge had been considered for areas A1 and B but not for Sites 7, 10, and 5. Table 3 summarizes information about each site and its estimated capacity.



TABLE 3
Sand Infiltration Bed Site Summary

SITE⁴	ESTIMATED MAXIMUM BED AREA¹ (ACRE)	ESTIMATED DESIGN INFILTRATION RATE (GPD/SF²)	ESTIMATED MAXIMUM CAPACITY (MGD³)
7	5.4	5	1.2
10	10	5	2.2
5	12.6	7	3.8
B	4.9	7	1.5
A1	6.6	7	2.0

Notes:

- 1) Assumes reasonable buffers to adjoining properties. This is typically 100-feet to an adjacent parcel with special considerations for buffers to other Town-owned parcels, and provides a 10% allowance for internal berms.
- 2) Gallons per day per square foot.
- 3) Million gallons per day.
- 4) The sites are listed with respect to their distance from the BSR WWTF Site (Site 7 is closest and Site A1 is furthest).

The following considerations are provided for these sites and estimates:

- The design infiltration rates for Sites 7 and 10 are estimated at 5 gpd/sf due to these sites being located in the moraine. Soil conditions for these sites should be similar to conditions at the BSR WWTF infiltration beds which appear to have similar rates now that the WWTF has been upgraded. A hydraulic load test at the existing WWTF could be used as a way to quantify the capacity of those beds and to estimate the capacity of proposed beds at Sites 7 and 10.
- The design load rates of 7 gpd/sf for Sites 5, B, and A1 is based on a hydraulic load test completed at the FCC Site and subsequent correspondence with MassDEP.
- Sites 7 and 10 are outside watersheds with nitrogen Total maximum Daily Loads (TMDLs), therefore, nitrogen removal to 3 mg/L TN on average (as currently designed at the BSR WWTF) is more than the 5 to 7 mg/L TN on average that would typically be required for this area. Groundwater modeling completed for these two sites using well injection technology indicated that some of the recharged water was projected to flow through fresh surface waters (Wing Pond and Herring Brook) which may be sensitive to phosphorus additions. Additional groundwater modeling will be needed for these sites for the revised technology used and the revised flows. Phosphorus removal needs to be considered for recharges that flow through fresh surface waters to minimize impacts to the system.



- ▶ Sites 5, B and A1 are in watersheds that have TMDLs (Great Pond and Bournes Pond watersheds) or in the Waquoit West Watershed that is expected to have nitrogen limitations. Recharges at these locations are expected to need additional sewerage in the watershed to meet a TMDL at the end of the Phase 3 period. Also, these sites could drain through fresh surface waters; therefore, phosphorus removal may be required similar to Sites 7 and 10.
- ▶ All of these sites are undisturbed, wooded sites. Significant land clearing would be needed and will need to be considered in a revised environmental impact analysis.

Subsurface leaching facilities have been proposed for Sites 4 and 2B and the following considerations are provided:

- ▶ Site 2B would be the preferred site because it is a large (relatively) flat golf course that was purchased for wastewater management purposes. It is also in the Upper Green Pond watershed which would have available nitrogen assimilation capacity as part of the Phase 1 and 2 sewer extension. TM-1 identified approximately 12.5 kilograms per day (kg/d) of assimilative capacity which would equate to an average annual flow of 1.1 mgd of recharge at 3 mg/L. If sewers were extended into the upper portion of the Green Pond watershed to encompass the FCC Site, the assimilative capacity would increase to approximately 19.3 kg/d which equates to 1.7 mgd of recharge.
- ▶ Site 4 was evaluated as part of TM-2 and the main findings are listed below:
 - The site is located in the Great Pond watershed which has a nitrogen TMDL; and a recharge at Site 4 would require additional sewerage in the upper part of this watershed to meet the TMDL as part of Phase 3.
 - The parking lot and a wooded area south of the ball fields was considered for leaching facilities with an approximate area of 3.7 acres (allowing for 100 foot buffers for the wooded area) which would equate to 0.4 mgd maximum capacity at 2.5 gpd/sf. An additional 0.4 mgd capacity could be obtained if the leaching facilities were installed under the ball fields.
- ▶ Phosphorus loading could be an issue for recharge at these sites. The results of groundwater modeling of these sites indicates that most of the recharge at Site 4 flows through the Coonamessett River; and most of the flow from Site 2B flows through the cranberry bogs north of Green Pond. The need for phosphorus removal would need to be determined in a revised Draft CWMP/DEIR. The cranberry bogs may not be as sensitive to phosphorus as the Coonamessett River.



The most appropriate sites to develop for recharge as part of the Phase 1 and 2 implementation would be Sites 7, 10, and 2B with a total estimated average annual capacity of 3.4 mgd. This capacity is based on potential sand infiltration bed area at Sites 7 and 10; and nitrogen limitations for Site 2B and the Green Pond watershed.

It is expected that the existing recharge at the BSR WWTF (0.38 identified in Table 2) would continue but may be increased based on limited sewer extension around West Falmouth Harbor or with more detailed water quality modeling for West Falmouth Harbor (discussed in TM-3). If this recharge flow is maintained and the total treatment flow at the BSR WWTF increases to 2.1 mgd as identified in Table 2; then 1.7 mgd additional capacity is needed outside the West Falmouth Harbor watershed. This could be met with new infiltration facilities at Sites 7 and 10; and infiltration at Site 2B would not be needed.

Also, Sites 7 and 10 are favorable because they use sand infiltration beds which have higher design loading rates than subsurface leaching; they are easier to maintain; and they are less expensive to construct. Unit construction costs of \$2.1/gpd for sand infiltration beds and \$12.4/gpd for subsurface leaching facilities are used in following cost summaries for these two types of facilities. These costs are based on recent construction of these types of facilities for Falmouth and indicate a large savings with sand infiltration beds.

Treated water transport to these sites would be provided by a pump station at the BSR WWTF and forcemain to Sites 7, 10, and ultimately to Site 2B. The distance to Site 10 is approximately 1.7 miles and the additional distance to Site 2B is 3.2 miles for a total distance of 4.9 miles. Most of the forcemain would be in the road layout except for the portion from the BSR WWTF to Site 7 at Research Road.

Cost Summaries for Preferred Option Scenario 1E.

The Phase 1 and 2 costs for Scenario 1E are summarized in Table 4. It is noted that the costs of Table 4 are slightly higher than the costs in Table 1. This is due to more refined costs for the collection, treatment, and recharge systems.

The costs are summarized again in the following Table 5 which is presented in the same format as the costs in TM-1 to allow comparison with the costs developed for Scenarios 3C, 3D, 2A, 1A, and 1D evaluated in TM-1. It is noted that Scenario 1E is different than the previous scenarios for the following main reasons:

TABLE 4	
Summary of Costs for Scenario 1E	
Treatment at Blacksmith Shop Road (BSR) WWTF with	
SBR and Denite-Filter and	
Recharge of 2.0 mgd at Sites 7 and 10 with Sand Infiltration Beds	
Recharge of 1.0 mgd at Site 2B with Subsurface Leaching	
Cost Component	Phase 1 and 2
Capital Costs	
<i>Collection System</i>	\$170,000,000
Major PS and FM	\$37,000,000
Peninsular Main Lines and Pump Stations	\$35,000,000
Right-of-Way Laterals, Pump Stations, and Collection Lines (Note 5)	\$93,000,000
Allowance for Land Purchase	\$1,000,000
<i>Treatment Site and Systems</i>	\$15,000,000
Site Development	\$5,500,000
WW Treatment Systems	\$8,100,000
Sludge Management System	\$1,800,000
<i>Treated water Recharge</i>	\$25,000,000
Pump Station and Treated Water Force Main to Sites 7 and 10	\$3,400,000
Sand Infiltration Facilities at Sites 7 and 10 (2 mgd)	\$4,200,000
Force Main Extension to Site 2B	\$4,500,000
Subsurface Leaching Facilities at Site 2B (1 mgd)	\$12,000,000
Allowance for Land Purchase	\$1,000,000
Total Construction Costs	\$210,000,000
Contingency (25%)	\$53,000,000
Fiscal, Legal and Engineering (25%)	\$53,000,000
Total Capital Costs (Notes 1-3)	\$320,000,000
Cost Component	Phase 1 and 2
O&M Annual Costs (Note 4)	
Electrical Costs	
Collection System Lift Stations	\$260,000
Treatment Site	\$260,000
WWTF operations & repairs	\$340,000
Collection system operations & repairs	\$1,400,000
Sludge Disposal	\$320,000
Treated Water Discharge System	\$50,000
Marine Water Quality Monitoring Allowance	\$100,000
Total O&M Costs per year	\$2,700,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)	
Present Worth of O&M Costs	\$34,000,000
Total Present Worth Costs	\$350,000,000
General Notes:	
1. All costs are rounded to two significant digits except Total Construction Costs which are rounded to the nearest \$1 million to reduce rounding error.	
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660), and will needed to be adjusted for inflation in the future.	
3. These costs do not include house connection costs observed at \$2,000 to \$5,000 per connection at the New Silver Beach Project.	
4. These O&M costs represent the incremental increase to existing O&M Costs to allow a comparison of Present Worth Costs of other Scenarios as completed in TM-1. The Revised CWMP will need to integrate current and projected costs of the existing operations	
5. Contains an allowance for grinder pumps	



- The Phase 1 and 2 sewer area has decreased due to the Falmouth Heights and Waquoit East areas being removed.
- Scenario 1E makes use of excess treatment capacity at the BSR Site because that capacity is no longer allocated to the West Falmouth Harbor and Scranton Avenue sewer areas planned in the 2001 WWFP.
- Scenario 1E utilizes relatively inexpensive recharge capacity at Sites 7 and 10 using sand infiltration beds.

(continued)



TABLE 5

Summary of Phase 1 and 2 Costs for Preferred Option Scenario 1E⁽¹⁾

CAPITAL COST ITEM	COST (MILLION \$)
Capital Cost Summary	
▶ Land purchase costs ⁽²⁾	2
▶ Construction costs	208
▶ Construction contingency (25%)	53
▶ Fiscal, legal & engineering (25%)	53
Total⁽³⁾	320
Capital Costs Categorized for Possible Cost Distribution	
▶ 100% support by property tax	
- Land Purchase ⁽²⁾	2
- Fiscal, legal & engineering	53
- Major PS and forcemain construction and contingency	46
- Treatment and recharge construction and contingency	50
▶ 50/50 support by property tax/betterments	
- Peninsular main lines and pump station and contingency ⁽²⁾	44
▶ 100% support by betterments	
- All other laterals, lines, and pump station in road ROW and contingency	120
Total⁽³⁾	320
OPERATION & MAINTENANCE (O&M) COST ITEM	(MILLION \$/YEAR)
Treatment and recharge systems	
▶ Electricity	0.26
▶ Treatment operations/repairs	0.34
▶ Recharge operations/repairs	0.05
▶ Sludge disposal	0.32
Collection system	
▶ Electricity	0.26
▶ Operations/repairs	1.4
Marine water quality monitoring	0.1
Total⁽³⁾	2.7
HOUSE CONNECTION COST	(MILLION \$)
Payment by Property Owners for House Connections ⁽⁴⁾	39
Notes: <ol style="list-style-type: none"> 1. Scenario 1E for Phase 1 and 2 Implementation includes the following components/concepts: <ol style="list-style-type: none"> a. Wastewater collection from a smaller Phase 1 and 2 area that doesn't include Falmouth Heights and Waquoit East. b. Wastewater treatment at the BSR WWTF with enhanced nitrogen removal (similar to existing treatment) and phosphorus removal. c. Treated water recharge at the BSR Site (at current flows), and development of new infiltration facilities at Sites 7, 10, and 2B. 2. An allowance of \$2M is provided. It is noted that Sites 7 and 10 are not yet Town-owned and some land purchase and easements may occur for pump stations in the collection system. 3. All costs rounded to 2 significant digits except construction costs to reduce rounding error. Costs are referenced to January 2010 (Engineering News Record Index 8660) and will need to be modified in the future for inflation. 4. Based on 7,750 future connections and \$5,000 per connection. (See Table 2) 	



Also, it is noted that the O&M costs in Tables 4 and 5 are the incremental increase to the O&M costs that are currently being incurred for the existing collection and treatment systems. The total estimated O&M costs at the end of the Phase 1 and 2 periods will need to add in the existing BSR WWTF O&M costs. Typically, when a wastewater treatment facility is upgraded, the CWMP presents an estimate of the first year O&M costs which provides guidance to the Town for budgeting purposes. This approach should be used in the revised Draft CWMP/DEIR.

There are uncertainties with Scenario 1E as discussed previously in this memorandum and as listed below with consideration on how the uncertainty affects the costs:

- Phosphorus removal may be needed because the treated water recharge at Sites 7, 10, 5, 4, and 2B could recharge through fresh surface waters.
- Sites 7 and 10 may not be available or acceptable. They are not Town-owned at this point and their development may not be acceptable due to the large ground surface modifications that are required for sand infiltration beds. We have assumed that they will be acceptable. If they are not, the Town will need to use the sites further to the east for Phase 1 and 2 which would significantly modify the costs for these first two phases.
- With the assumption that Sites 7 and 10 will be acceptable, there is no need to develop the sites in the eastern part of Town (Sites 4, 5, 2B, B, and A1) with the associated pipeline until Phase 3.
- The Committee Findings Document indicates the desire for the Town to proceed with demonstration projects which could demonstrate technical feasibility for several non-wastewater or alternative nitrogen management concepts. The outcome of these projects/concepts is currently unknown; it is hoped that these items will prove feasible, and sewerage in some Phase 1 and 2 areas could be reduced. If so, this could potentially reduce the Phase 1 and 2 costs.
- The BSR WWTF and existing collection system will need repairs/improvements to address current problems and issues including:
 - Odor control at the Service Road vent.
 - Odor control at Shivericks Pond Pump Station.
 - Forcemain repair/replacement between Woods Hole and Jones Palmer pump stations.
 - Infiltration and Inflow repairs to the collection system in Woods Hole.
 - Miscellaneous improvements at the BSR WWTF to assist in operability and permit compliance.

These costs have not been estimated as part of this effort; but should be included in the revised Draft CWMP/DEIR to be more thorough.



Cost Summary for Preferred Option Scenario 1E without Subsurface Leaching Facilities at Site 2B.

As mentioned above, and indicated in Table 3, the maximum recharge capacity at Sites 7 and 10 is 3.3 mgd. If these sites are acceptable, then there would be no need to extend a treated water pipeline to Site 2B and the other potential recharge sites east of Site 10. Table 6 summarizes the costs for Scenario 1E without recharge facilities developed at Site 2B.

This modified scenario could save approximately \$30M in capital costs for the Phase 1 and 2 time period.

Considerations for Phase 3 Costs.

As discussed above, the Committee Findings Document indicates the desire for the Town to proceed with various demonstration projects which could prove feasible and reduce the need for Phase 3 nitrogen mitigation as indicated in Figure 3. It is believed that the Draft CWMP/DEIR that is submitted for State review will need to provide a concept and cost for meeting the nitrogen TMDLs in Phase 3. Based on this belief, we have estimated Phase 3 costs for meeting the nitrogen TMDLs using sewer expansions into the Phase 3 area; a further (Phase 3) expansion at the BSR Site; and treated water recharge at sites west of Site 10. These Phase 3 costs are summarized in Table 7 similar to the Phase 3 costs that were presented in TM-1 and the December 2009 Draft CWMP/DEIR. These Phase 3 costs should represent a worst case scenario unless the TMDLs become more stringent.

Comparison of Costs with Other Scenarios.

Table 8 summarizes the costs for Scenario 1E with Scenarios 3C, 3D, 2A, 1A, and 1D as discussed in TM-1.

As discussed previously, the Phase 1 and 2 areas for Scenario 1E are different than for the other scenarios; therefore, the Phase 1 and 2 costs are not an equal comparison. The total Phase 1, 2, and 3 costs are an equal comparison because they are all estimated to meet the TMDLs.

This table illustrates that Scenario 1E has the lowest cost.

TABLE 6	
Summary of Costs for Scenario 1E	
Treatment at Blacksmith Shop Road (BSR) WWTF with	
SBR and Denite-Filter and	
Recharge Only at Sites 7 and 10 with Sand Infiltration Beds	
Cost Component	Phase 1 and 2
Capital Costs	
<i>Collection System</i>	<i>\$170,000,000</i>
Major PS and FM	\$37,000,000
Peninsular Main Lines and Pump Stations	\$35,000,000
Right-of-Way Laterals, Pump Stations, and Collection Lines (Note 5)	\$93,000,000
Allowance for Land Purchase	\$1,000,000
<i>Treatment Site and Systems</i>	<i>\$15,000,000</i>
Site Development	\$5,500,000
WW Treatment Systems	\$8,100,000
Sludge Management System	\$1,800,000
<i>Treated water Recharge</i>	<i>\$8,600,000</i>
Pump Station and Treated Water Force Main to Sites 7 and 10	\$3,400,000
Sand Infiltration Facilities at Sites 7 and 10 (2.0 mgd)	\$4,200,000
Allowance for Land Purchase	\$1,000,000
Total Construction Costs	\$194,000,000
Contingency (25%)	\$49,000,000
Fiscal, Legal and Engineering (25%)	\$49,000,000
Total Capital Costs (Notes 1-3)	\$290,000,000
Cost Component	Phase 1 and 2
O&M Annual Costs (Note 4)	
Electrical Costs	
Collection System Lift Stations	\$260,000
Treatment Site	\$260,000
WWTF operations & repairs	\$340,000
Collection system operations & repairs	\$1,400,000
Sludge Disposal	\$320,000
Treated Water Discharge System	\$10,000
Marine Water Quality Monitoring Allowance	\$100,000
Total O&M Costs per year	\$2,700,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)	
Present Worth of O&M Costs	\$34,000,000
Total Present Worth Costs	\$320,000,000
General Notes:	
1. All costs are rounded to two significant digits except total construction costs which are rounded to the nearest \$1 million to reduce rounding error.	
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660), and will needed to be adjusted for inflation in the future.	
3. These costs do not include house connection costs observed at \$2,000 to \$5,000 per connection at the New Silver Beach Project.	
4. These O&M costs represent the incremental increase to existing O&M Costs to allow a comparison of Present Worth Costs of other Scenarios as completed in TM-1. The Revised CWMP will need to integrate current and projected costs of the existing operations	
5. Contains an allowance for grinder pumps	

TABLE 7**Summary of Costs for Scenario 1E****Treatment at Blacksmith Shop Road (BSR) WWTF with****SBR and Denite-Filter and****Recharge of 2.0 mgd at Sites 7 and 10 with Sand Infiltration Beds****Recharge of 1.0 mgd at Site 2B with Subsurface Leaching**

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
Capital Costs		
<i>Collection System</i>	\$170,000,000	\$130,000,000
Major PS and FM	\$37,000,000	
Peninsular Main Lines and Pump Stations	\$35,000,000	
Right-of-Way Laterals, Pump Stations, and Collection Lines (Note 5)	\$93,000,000	
Allowance for Land Purchase	\$1,000,000	
<i>Treatment Site and Systems</i>	\$15,000,000	\$17,000,000
Site Development	\$5,500,000	
WW Treatment Systems	\$8,100,000	
Sludge Management System	\$1,800,000	
<i>Treated water Recharge</i>	\$25,000,000	\$0
Pump Station and Treated Water Force Main to Sites 7 and 10	\$3,400,000	
Sand Infiltration Facilities at Sites 7 and 10 (2 mgd)	\$4,200,000	
Force Main Extension to Site 2B	\$4,500,000	
Subsurface Leaching Facilities at Site 2B (1 mgd)	\$12,000,000	
Allowance for Land Purchase	\$1,000,000	
Total Construction Costs	\$210,000,000	\$147,000,000
Contingency (25%)	\$53,000,000	\$37,000,000
Fiscal, Legal and Engineering (25%)	\$53,000,000	\$37,000,000
Total Capital Costs (Notes 1-3)	\$320,000,000	\$220,000,000
Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
O&M Annual Costs (Note 4)		
<i>Electrical Costs</i>		
Collection System Lift Stations	\$260,000	\$190,000
Treatment Site	\$260,000	\$140,000
WWTF operations & repairs	\$340,000	\$200,000
Collection system operations & repairs	\$1,400,000	\$740,000
Sludge Disposal	\$320,000	\$210,000
Treated Water Discharge System (4)	\$50,000	\$67,000
Marine Water Quality Monitoring Allowance	\$100,000	\$0
Total O&M Costs per year	\$2,700,000	\$1,500,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)		
Present Worth of O&M Costs	\$34,000,000	\$19,000,000
Total Present Worth Costs	\$350,000,000	\$240,000,000
General Notes:		
1. All costs are rounded to two significant digits except Total Construction Costs which are rounded to the nearest \$1 million to reduce rounding error.		
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660), and will needed to be adjusted for inflation in the future.		
3. These costs do not include house connection costs observed at \$2,000 to \$5,000 per connection at the New Silver Beach Project.		
4. These O&M costs represent the incremental increase to existing O&M Costs to allow a comparison of Present Worth Costs of other Scenarios as completed in TM-1. The Revised CWMP will need to integrate current and projected costs of the existing operations		
5. Contains an allowance for grinder pumps		

TABLE 8

Summary of Costs for All Scenarios Evaluated in Technical Memoranda 1 - 7

Cost Component	Scenario 3C ¹			Scenario 3D ²			Scenario 2A ^{3, 11}			Scenario 1A ⁴			Scenario 1D ⁵			Scenario 1E ⁶		
	Phase 1 and 2	Phase 3	Total Phases	Phase 1 and 2	Phase 3	Total Phases	Phase 1 and 2	Phase 3	Total Phases	Phase 1 and 2	Phase 3	Total Phases	Phase 1 and 2	Phase 3	Total Phases	Phase 1 and 2	Phase 3	Total Phases
Capital Costs																		
<i>Collection System</i>	\$200,000,000	\$110,000,000	\$310,000,000	\$200,000,000	\$110,000,000	\$310,000,000	\$190,000,000	\$140,000,000	\$330,000,000	\$200,000,000	\$110,000,000	\$310,000,000	\$200,000,000	\$110,000,000	\$310,000,000	\$170,000,000	\$130,000,000	\$300,000,000
<i>Treatment Site and Systems</i>	\$54,000,000	\$17,000,000	\$71,000,000	\$26,000,000	\$9,000,000	\$35,000,000	\$26,000,000	\$10,000,000	\$36,000,000	\$46,000,000	\$18,000,000	\$64,000,000	\$17,000,000	\$9,000,000	\$26,000,000	\$15,000,000	\$17,000,000	\$32,000,000
<i>Treated water Recharge</i>	\$8,000,000	\$1,500,000	\$9,500,000	\$21,000,000	\$0	\$21,000,000	\$46,000,000	\$28,000,000	\$74,000,000	\$4,400,000	\$1,400,000	\$5,800,000	\$38,000,000	\$0	\$38,000,000	\$25,000,000	\$0	\$25,000,000
Total Construction Costs	\$262,000,000	\$129,000,000	\$391,000,000	\$247,000,000	\$119,000,000	\$366,000,000	\$262,000,000	\$178,000,000	\$440,000,000	\$250,000,000	\$129,000,000	\$379,000,000	\$255,000,000	\$119,000,000	\$374,000,000	\$210,000,000	\$147,000,000	\$357,000,000
Contingency (25%)	\$66,000,000	\$32,000,000	\$98,000,000	\$62,000,000	\$30,000,000	\$92,000,000	\$66,000,000	\$45,000,000	\$111,000,000	\$63,000,000	\$32,000,000	\$95,000,000	\$64,000,000	\$30,000,000	\$94,000,000	\$53,000,000	\$37,000,000	\$90,000,000
Fiscal, Legal and Engineering (25%)	\$66,000,000	\$32,000,000	\$98,000,000	\$62,000,000	\$30,000,000	\$92,000,000	\$66,000,000	\$45,000,000	\$111,000,000	\$63,000,000	\$32,000,000	\$95,000,000	\$64,000,000	\$30,000,000	\$94,000,000	\$53,000,000	\$37,000,000	\$90,000,000
Total Capital Costs (Notes 7-9)	\$390,000,000	\$190,000,000	\$580,000,000	\$370,000,000	\$180,000,000	\$550,000,000	\$390,000,000	\$270,000,000	\$660,000,000	\$380,000,000	\$190,000,000	\$570,000,000	\$380,000,000	\$180,000,000	\$560,000,000	\$320,000,000	\$220,000,000	\$540,000,000
Total O&M Annual Costs (Note 10)	\$6,300,000	\$3,100,000	\$9,400,000	\$2,900,000	\$1,500,000	\$4,400,000	\$3,000,000	\$1,500,000	\$4,500,000	\$5,300,000	\$2,500,000	\$7,800,000	\$2,900,000	\$1,500,000	\$4,400,000	\$2,700,000	\$1,500,000	\$4,200,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)																		
Present Worth of O&M Costs	\$79,000,000	\$39,000,000	\$53,000,000	\$36,000,000	\$19,000,000	\$53,000,000	\$37,000,000	\$19,000,000	\$53,000,000	\$66,000,000	\$31,000,000	\$53,000,000	\$36,000,000	\$19,000,000	\$53,000,000	\$34,000,000	\$19,000,000	\$53,000,000
Total Present Worth Costs	\$470,000,000	\$230,000,000	\$700,000,000	\$410,000,000	\$200,000,000	\$610,000,000	\$430,000,000	\$290,000,000	\$720,000,000	\$450,000,000	\$220,000,000	\$670,000,000	\$420,000,000	\$200,000,000	\$620,000,000	\$350,000,000	\$240,000,000	\$590,000,000
General Notes:																		
1. Wastewater collection (original Phase 1 and 2 areas); treatment at Otis WWTF/MMR site with MBR, reverse osmosis, and carbon adsorption technologies; and well injection in Route 151 right-of-way (ROW)																		
2. Wastewater collection (original Phase 1 and 2 areas); treatment at Otis WWTF/MMR site with SBR and denitrification filter technologies; and ocean discharge/outfall to Cape Cod Canal.																		
3. Wastewater collection (original Phase 1 and 2 areas); treatment at Falmouth Country Club (FCC) site with SBR and denitrification filter technologies; and subsurface recharge at 3 sites west of FCC WWTF site																		
4. Wastewater collection (original Phase 1 and 2 areas); treatment at Blacksmith Shop Road (BSR) site with MBR and carbon adsorption technologies; and well injection at 2 sites north of BSR WWTF Site.																		
5. Wastewater collection (original Phase 1 and 2 areas); treatment at Blacksmith Shop Road (BSR) site with SBR and denitrification-filter technologies; and ocean discharge/outfall at Nobska Point.																		
6. Wastewater collection (revised Phase 1 and 2 areas); treatment at Blacksmith Shop Road (BSR) site with ENR and Phosphorus-removal technologies; and sand-infiltration-bed recharge at 2 sites north of BSR WWTF Site (Sites 7 and 10) and subsurface-leaching recharge at the Falmouth Country Club Site (Site 2B)																		
7. All costs are rounded to two significant digits except Total Construction Costs which are rounded to 3 significant digits to reduce rounding error																		
8. All cost are referenced to January 2010 costs (Engineering News Record Index 8660). These cost will need to be adjusted for inflation in the future. Costs for Scenarios 3C, 3D, 2A, and 1A are from Technical memorandum No 1 where they are presented in greater detail.																		
9. These costs do not include house connection costs observed at \$2,000 to \$5,000 per connection at the New Silver Beach Project.																		
10. These O&M costs represent the incremental increase to existing O&M Costs at the BSR WWTF to allow a comparison of Present Worth Costs of other Scenarios as completed in TM-1. The Revised CWMP will need to integrate current and projected costs of the existing operations.																		
11. The costs for this scenario do not include phosphorus removal facilities as tabulated in Technical Memorandum No. 1.																		



SUMMARY AND POTENTIAL NEXT STEPS

The review of the Findings Document and the Committee's "hypothetical" cost estimate for the Preferred option (Scenario 1E) indicates that this scenario appears to be feasible and is the lowest cost. Additional evaluations are needed to verify the feasibility and to fine-tune the costs including:

- Additional subsurface investigations and modeling for the recharge sites at the revised projected flows.
- Verification that the sites are available and can be used for the facilities indicated.
- Revised environmental impact analysis including phosphorus impacts to freshwater bodies.
- Marine water quality modeling for the South Coast estuaries as well as for the West Falmouth Harbor by SMAST.
- Updates to the cost tables to include existing O&M costs of the existing collection and treatment facilities and other planned (or needed) upgrades to the existing system as listed previously.
- Revisions to the Draft CWMP/DEIR to include the findings of these evaluations.
- Preparation of a Notice of Project Change to the 2001 WWFP to reduce flow allocation and sewer plans for the Scranton Avenue and West Falmouth Harbor sewer areas.

The costs that we developed are very similar to the costs developed by the Committee with minor differences.