Section 10

Wastewater Scenarios Assessment

10.1 Purpose and Scope

The wastewater needs assessment presented in Section 8 of this Comprehensive Wastewater Management Plan divided the Town into discrete areas for evaluation and identified potential areas that need improved methods of wastewater treatment and recharge to meet current and future community development needs and nitrogen Total Maximum Daily Loads. The main objective of the needs assessment was to assess the wastewater needs of each area of Harwich, based on available data, and to prioritize those areas according to their level of need. This section discusses wastewater scenarios developed to address the identified areas of need.

10.2 Massachusetts Estuaries Project Impact

The degradation of Harwich's estuaries and bays is the main reason that the Town is changing its approach to wastewater management. The Town understands that the environmental and financial impacts of good water quality in a resort community like Harwich are of paramount importance. Harwich's goal of maintaining a high quality of life for its residents and restoring its already degraded harbors and estuaries requires a systematic tool capable of evaluating each resource. The Massachusetts Estuaries Project (MEP) provides that tool. The outcome is a determination of where nutrient reductions are needed to preserve or restore long-term ecological health.

As described previously, Harwich has five embayments included in the MEP: Allen Harbor, Wychmere Harbor, Saquatucket Harbor, the Herring River, and the Pleasant Bay. The Herring River watershed is shared with the Towns of Brewster, Dennis and Harwich. The Pleasant Bay watershed is shared with the Towns of Chatham, Harwich, Orleans and Brewster. The other three embayment watersheds are located within Harwich. The combined Allen, Wychmere and Saquatucket Harbor report was completed in June 2010. The Pleasant Bay report was completed in May 2006 with memo updates in June and October of 2010 that revised the land use, water use and natural attenuation in Muddy Creek and evaluated the water quality impacts of the addition of a 24 ft culvert in the Muddy Creek inlet. The Draft Herring River report was completed in April 2012.

The MEP results and required nitrogen load reductions are discussed in more detail in Section 6. The results of these evaluations were used by the Town in developing the wastewater scenarios presented in this section. To achieve the required buildout nitrogen load reductions in the five embayments, the following approximate reductions in septic load were used, as shown in Table 10-1.

Table 10-1
Required Attenuated Nitrogen Load Reduction in MEP Watersheds

Watershed	Buildout Nitrogen Load Reduction Required
Allen Harbor	78%
Wychmere Harbor	100%
Saquatucket Harbor	58%
Pleasant Bay	65%
Herring River	25% (original assumption) , revised to 58%

*Saquatucket Harbor and Muddy Creek Loads Include Enhanced Attenuation

Values in RED indicate that the value is must be reduced to achieve the TMDL.

While the Title 5 areas of concern and desired development in village centers are of particular concern for the Town of Harwich, the need to meet the nitrogen reduction requirements established in the MEP is the main driving factor in the decision making process. Therefore, the primary focus of the wastewater scenarios developed is to reduce nitrogen in the sensitive watersheds.

10.3 Wastewater Management Scenarios

The Town developed several wastewater management scenarios that consider the five best effluent recharge sites, the MEP nitrogen removal requirements, and natural nitrogen attenuation. Initially, baseline scenarios were developed. The baseline wastewater scenarios consider the possibility of removing wastewater from a particular watershed and transporting that wastewater outside of the watershed and into an area that is not nitrogen sensitive (i.e., not subject to MEP analysis or a TMDL). The two baseline scenarios (one with and one without enhanced nitrogen attenuation) are not realistic wastewater scenarios because they offer no solutions for treating and recharging the wastewater flows. They are useful however, because they establish a baseline that defines the minimum amount of sewering required to meet the TMDL requirements in a given watershed. The baseline scenarios do not consider any requirements other than the minimum TMDL nitrogen removal requirements. The baseline attenuation scenario goes one step further and assumes the simultaneous implementation of two town projects that would enhance natural attenuation of nitrogen; one in the Cold Brook and one for increased tidal flushing in the Muddy Creek. The successful completion of both of these projects will result in a reduced amount of sewering required to meet established TMDL requirements.

Based on the positive results of the comparison between the baseline option and the baseline option with attenuation, all of the scenarios discussed in the CWMP (1A through 8A) utilize enhanced nitrogen attenuation along with various strategies for effluent recharge throughout the Town. These scenarios are considered to be implementable scenarios (unlike the baseline scenarios) and two or three of them will be carried forward for detailed analysis. Note that Scenarios 1A to 8A presented in this section do not include all of the village centers and board of health areas of Title 5 concern, since the scenarios were developed for comparative purposes only. Those additional areas are assumed to be common to all scenarios. Once the comparative evaluations are complete, the final wastewater scenarios will be carried into the later phases of the CWMP and will be revised to include the village centers and the areas of Title 5 concern outside of nitrogen sensitive areas.

10.3.1 Nitrogen Balancing Methodology

Nitrogen balancing is an important consideration as implementable wastewater scenarios are developed. Since it is difficult to remove all of the nitrogen from treated wastewater, care must be taken to recharge treated effluent to a watershed that is capable of receiving the resulting nitrogen load without exceeding the MEP nitrogen requirements.

In the simplest of scenarios, it may be possible to remove wastewater flow and send the treated effluent to another watershed that is not nitrogen sensitive. In these scenarios, the nitrogen balance is a simple subtraction of the nitrogen removed, for a net nitrogen reduction. Unfortunately, it is not always possible to send treated effluent into a watershed that is not nitrogen sensitive. In these cases, the wastewater removed by sewering can be counted as a reduction, but the remaining nitrogen after treatment in the effluent recharge must be counted as a nitrogen addition. The amount of nitrogen removed and recharged to a watershed must be balanced so that the net removal meets the MEP reduction requirements.

Since septic system effluent is estimated to have a concentration of 26 ppm of nitrogen (23.63ppm if converted from water use to wastewater), the average household will contribute approximately 6.2 kg/year of nitrogen (63,000 gallons (typical) per year of water use flow x 26 mg/l of nitrogen x 3.785 liters per gallon/1,000,000 mg/kg). If the wastewater were treated to 5 mg/l of nitrogen and recharged to the same watershed, the post-treatment contribution of nitrogen from this household would be 1.2 kg/year for a net decrease of 6.2 – 1.2 = 5.0 kg/ year. By today's standards, even with the most advanced wastewater treatment, wastewater effluent will have some nitrogen remaining and must be accounted for in the overall management strategy. Figure 10-1, below, illustrates this point. In this example, ten homes in the nitrogen limited watershed are connected to the wastewater treatment facility and an estimated 62 kg/ year of nitrogen is removed from the watershed. In the wastewater treatment facility, 50 kg/ year of nitrogen is removed and 12 kg/year remain. This remaining load of 12 kg/ year is recharged back into the watershed in the effluent.

Thus, when developing the overall wastewater scenario, the removal of nitrogen from a watershed to meet the TMDL must also consider the addition of nitrogen added in any effluent to be recharged in a given watershed by removing more than the baseline amount. This has been considered in developing the scenarios.

If the MEP TMDL requirement for nitrogen removal was 50kg/year, then this example would satisfy the requirement.

Nitrogen balancing can be also be utilized for scenarios that remove wastewater from one watershed and recharge to another watershed.

In another example, 20 households are sewered within the watershed and treated effluent from 62 households (20 from within the watershed and 42 from outside) is recharged in the same watershed. Figure 10-2 illustrates this point. In this example, 20 households in the nitrogen limited watershed are connected to the wastewater treatment facility and an estimated 124 kg/ year of nitrogen is removed from the nitrogen sensitive watershed. Another 42 homes from outside the watershed are also connected to the wastewater facility and contribute 260 kg/year to the facility. In the wastewater treatment facility, 334 kg/ year of nitrogen is removed and 50 kg/year remain. This remaining load of 50 kg/ year is recharged back into the watershed in the effluent. This example illustrates how an additional ten households sewered in the MEP sensitive watershed allow for an additional 42 households from other watersheds to be managed within the nitrogen limited watershed without changing the nitrogen balance in the nitrogen limited watershed.

Figure 10-1
Nitrogen Balance for a Typical Nitrogen Limited Watershed: 10 Households

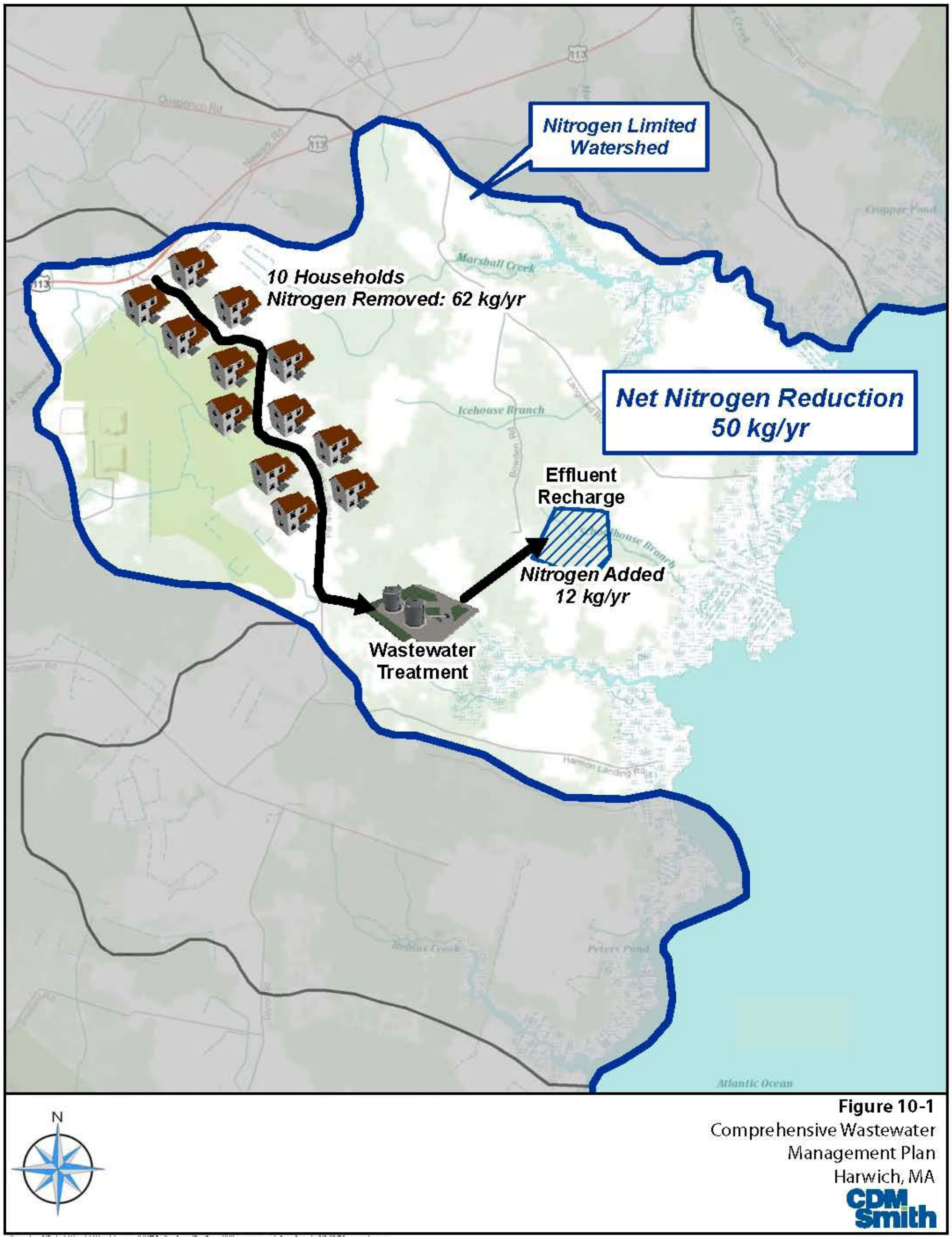
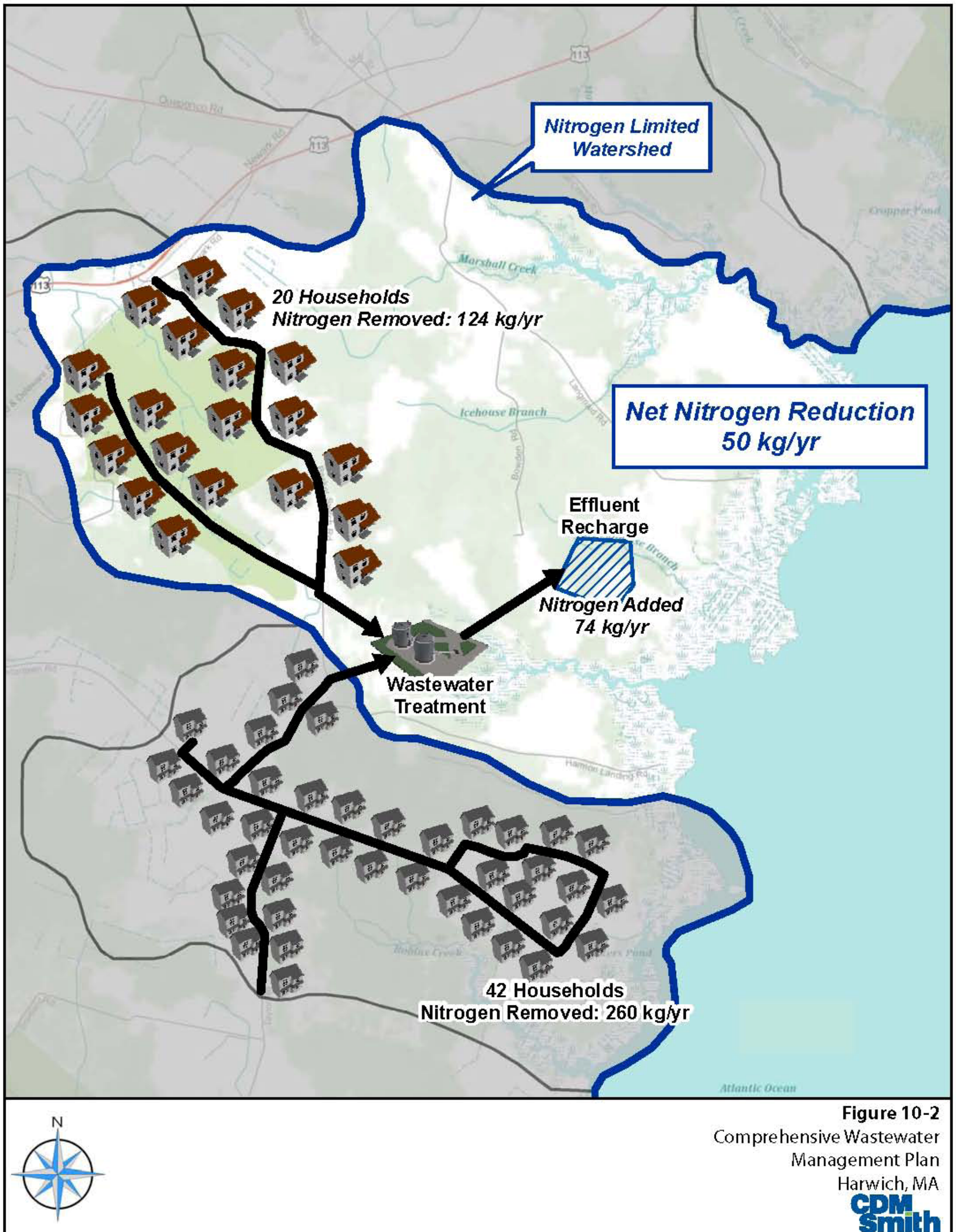


Figure 10-2
Nitrogen Balance for a Typical Nitrogen Limited Watershed: Multiple Watersheds



The result is a net nitrogen reduction of 50 kg/year of nitrogen in the nitrogen limited watershed. From a nitrogen balancing point of view, this watershed is considered to be identical to the example presented in Figure 10-1. This example illustrates how the balance of nitrogen can be used when deciding how to meet the MEP established TMDL requirements and the needs of the community while working within the constraints of the effluent recharge sites, both within and outside of nitrogen sensitive watersheds.

The use of conventional wastewater treatment and its ability to remove between 80 and 90 percent of the incoming nitrogen in a wastewater gives the Town several options when planning a wastewater solution.

10.3.2 Nitrogen Loading Spreadsheets

To create the wastewater scenarios, CDM Smith developed detailed nitrogen loading spreadsheets that closely approximate the nitrogen loading model used in the MEP reports. The spreadsheets are based on the septic component of nitrogen loading and, as a result, focus strictly on reductions from the wastewater component of the total nitrogen load. The much smaller percentage of nitrogen components from stormwater and fertilizer sources will be managed through a separate program under other aspects of this CWMP.

The nitrogen loading spreadsheets are a tool that allows planners to develop wastewater scenarios using a systematic approach. The spreadsheets display all of the subwatersheds within an estuarine system. They also present all of the fresh water bodies (ponds and streams) that are modeled with natural attenuation. Since the spreadsheets are divided into subwatersheds and their potential for natural nitrogen attenuation, they allow planners to create sewersheds with a primary focus on the areas that will not receive any natural attenuation. By doing this, the Town can minimize the areas that require wastewater collection and maximize cost savings to the Town.

The nitrogen loading spreadsheets also allow the Town to reevaluate “what if” scenarios that are raised throughout the planning process. Table 10-2 below shows an example of a nitrogen loading spreadsheet for the Saquatucket Harbor watershed. While there are many behind-the-scenes calculations in the spreadsheets, the table shows some of the complexities that are involved in the overall nitrogen model including natural attenuation factors, nitrogen removal from sewering and the ability to follow the path of septic system effluent through each subwatershed until it reaches the embayment. Copies of the other spreadsheets are included in Appendix C.

From Table 10-2, it becomes clear that several factors can affect how nitrogen travels through a watershed. The MEP model attempts to simulate the most important factors and determine what the nitrogen concentrations will be throughout the watershed. These spreadsheets account for flow in and out of the watershed, natural attenuation (from ponds and streams), enhanced attenuation (from projects such as bog / wetlands restoration), wastewater treatment to various levels of treatment, and the removal of the nitrogen load from a particular watershed as a result of conventional sewering. The spreadsheet is a tool that helps consider all of these factors together in one logical place. The end result is a very powerful planning tool that is the basis for several of the decisions discussed in this CWMP.

Table 10-2
Example Nitrogen Loading Spreadsheet for Saquatucket Harbor

Build-out												
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal		Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)
Grass Pond	13	1152	903	100%	1152	903	43%		515	50%	257	
Banks St Bogs LT10	12	2284	1941		2284	1941	10%		1747		1747	
Banks St Bogs GT10	11	322	175		322	175	1%		173		173	
Recharge to Upper Muddy Creek Watershed 13												
							Removed Septic (kg/yr)		Recharge Septic (kg/yr)			
Cold Spring Brook Recharge							1877					
John Joseph Recharge							0					
E. Saq Stream Recharge							989					
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							5084					
Recharge at what Concentration.				5 mg/l					978	50%	488.8076923	
Banks St Bogs Total					**3758**	**3019**	**19%**		**2435**	**35%**	**1733**	
Paddocks Pond	14	898	648	100%	898	648	2%		635	50%	318	
Cold Spring Brook LT10	10	2825	2064		2825	2064	62%		784		784	
Cold Spring Brook GT10	9	1178	861		1178	861	0%		861		861	
Cold Spring Brook Total					**8659**	**6592**	**28%**		**4715**	**35%**	**2402**	
	Enhanced Attenuation										-978	**3.902**
Black Pond	5	18	6	14%	2	1	0%		1	50%	0	
John Joseph Pond GT10	6	109	89		109	89	0%		89		89	
John Joseph Pond LT10	7	500	335		500	335	0%		335		335	
John Joseph Pond Total		627	430	27%	164	114	0%		114	74%	30	
Chatham Road WELLS	8	1004	667	80%	803	534	0%		534		534	
Saq Harbor LT10N	15	1166	1009		1166	1009	98%		20		20	
E. Saquatucket Stream Total					**2133**	**1657**	**60%**		**668**	**15%**	**496**	**1.359**
Harbor LT10S	16	1113	1012		1113	1012	100%		0		0	0.000
Harbor Total					**11905**	**9261**			**5383**		**1920**	**5.261**
Treated Load						**3878**	**42%**					

CDM Smith
0324-0650-03-11

There are several paths that septic effluent can take as it moves through the groundwater in the watershed. As an example, a drop of septic system effluent generated in the Grass Pond Subwatershed # 13 (MEP report designation) would be attenuated by 50 percent due to the presence of the freshwater pond. Then it would move to the Bank Street Bogs in Subwatershed 12 where it would receive an additional 35 percent attenuation. From Subwatershed 12, the effluent would enter Subwatershed 10 and receive an additional 35 percent attenuation through the Cold Brook. Finally the effluent would enter watershed 16 and eventually discharge to the Saquatucket Harbor. Thus, a 100 kilogram load of nitrogen discharged to the Grass Pond Subwatershed in the Saquatucket watershed would be reduced to 21 kg (100kg x 0.50 x 0.65 X 0.65) of nitrogen as it entered the Harbor. The flowchart below illustrates this. Since the attenuation component is cumulative, it would be most efficient to sewer the highest density areas closest to the embayments since the farthest reaches in the watersheds have the highest potential for natural nitrogen attenuation if freshwater ponds are in the flow path. Figure 10-3 shows the path of groundwater in the Saquatucket Harbor watershed and the natural attenuation that occurs in the subwatersheds.

Flowchart of Natural Attenuation Pathway

Grass Pond
Subwatershed # 13
50 % Attenuation
100 kg TN Reduced to 50 Kg TN

⇩

Bank Street Bogs
Subwatershed # 12
35 % Attenuation
50 kg TN Reduced to 33 kg TN

⇩

Cold Brook
Subwatershed # 10
35 % Attenuation
33 kg TN Reduced to 21 kg TN

⇩

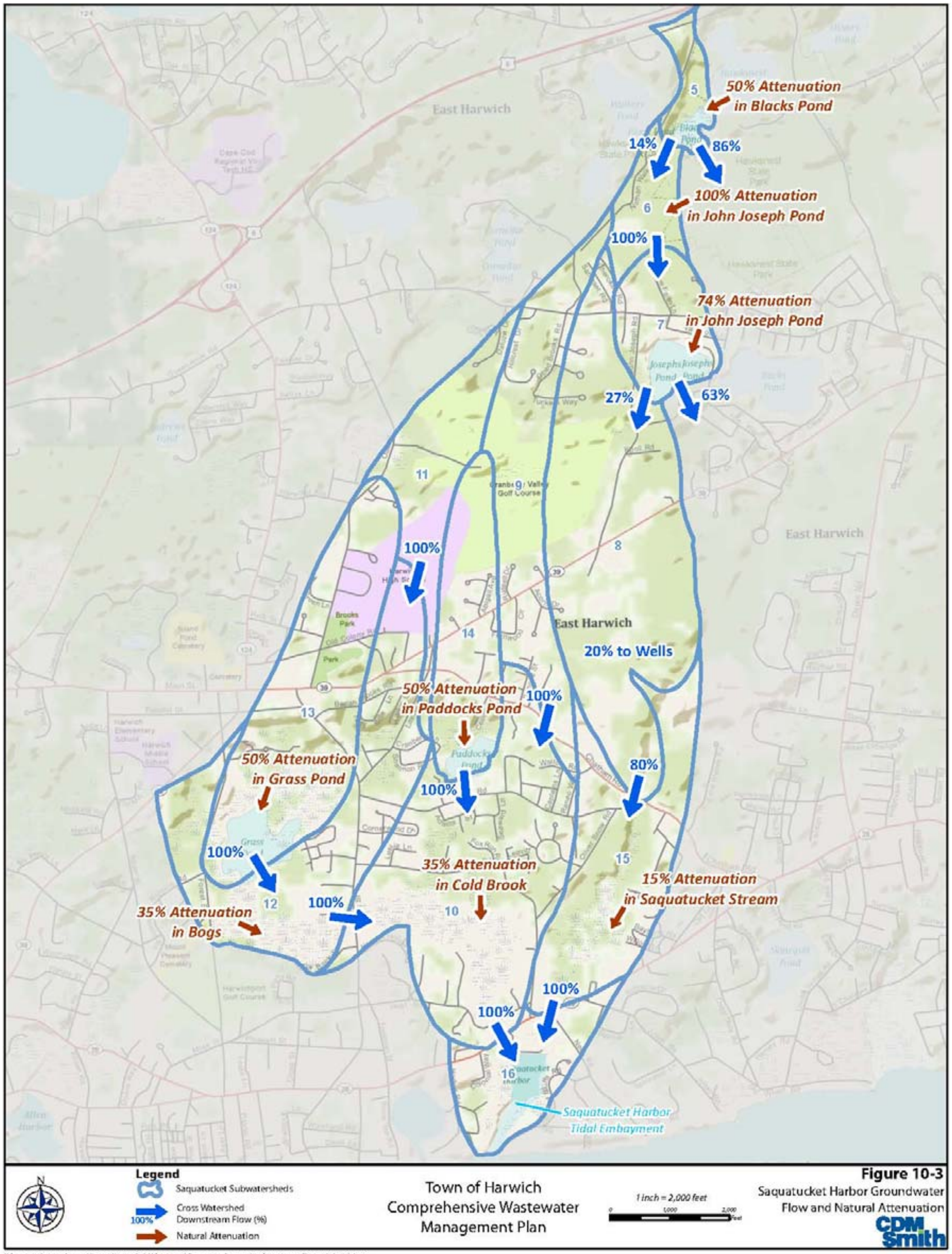
Saquatucket Harbor
Subwatershed # 16
No Attenuation
21 kg TN (No Reduction)

⇩

21 kg TN Discharged to Saquatucket Harbor

(79 Kilograms Naturally Attenuated)

Figure 10-3
Saquatucket Harbor Groundwater Flow and Natural Attenuation



10.3.3 GIS Data Obtained from the MEP Data Disks

Once the nitrogen loading spreadsheets were completed, GIS was utilized to graphically create wastewater service areas that matched nitrogen load reductions required in the MEP reports. Data disks from the MEP contain useful information that is quickly loaded into the GIS database used throughout this CWMP. The MEP data contains parcel boundary data, water use data for the years 2004 to 2007, build-out data, and the estimated annual nitrogen load from each parcel. A powerful feature of the GIS is that it has the capability of calculating an estimated annual nitrogen load for any parcel, street or user-defined wastewater service area and displaying it graphically. With this tool, sewer service areas were developed that match the nitrogen reductions required in the MEP reports. The result is the scenarios presented below that will meet the minimum requirements for nutrient reduction.

10.3.4 Baseline Scenario

A baseline scenario was created that satisfies the minimum MEP established TMDL requirements for nitrogen removal in the five MEP watersheds in Harwich. Only the Allen, Wychmere, Saquatucket and Pleasant Bay MEP reports were complete during this initial scenario screening process. The Herring River MEP report was not complete and, therefore, the actual nitrogen removal requirements were estimated. Due to the extensive presence of freshwater wetlands in the Herring River watershed, it is believed that this watershed may only need a small amount of nitrogen reduction. The presence of freshwater wetlands indicates that a significant amount of natural attenuation may be present in the upper Herring River and as a result, less wastewater management is expected. For the purpose of developing these initial scenarios, it was estimated that the Herring River watershed required about 25 percent present septic nitrogen removal. When the MEP results were available, the actual amount of nitrogen removal required In the Herring River was revised to 58%. The 25 percent assumption is utilized in this section, but the revision to 58 percent is incorporated in Section 12 where the highest rated wastewater scenarios are further evaluated. This is further discussed in Section 10.3.9.

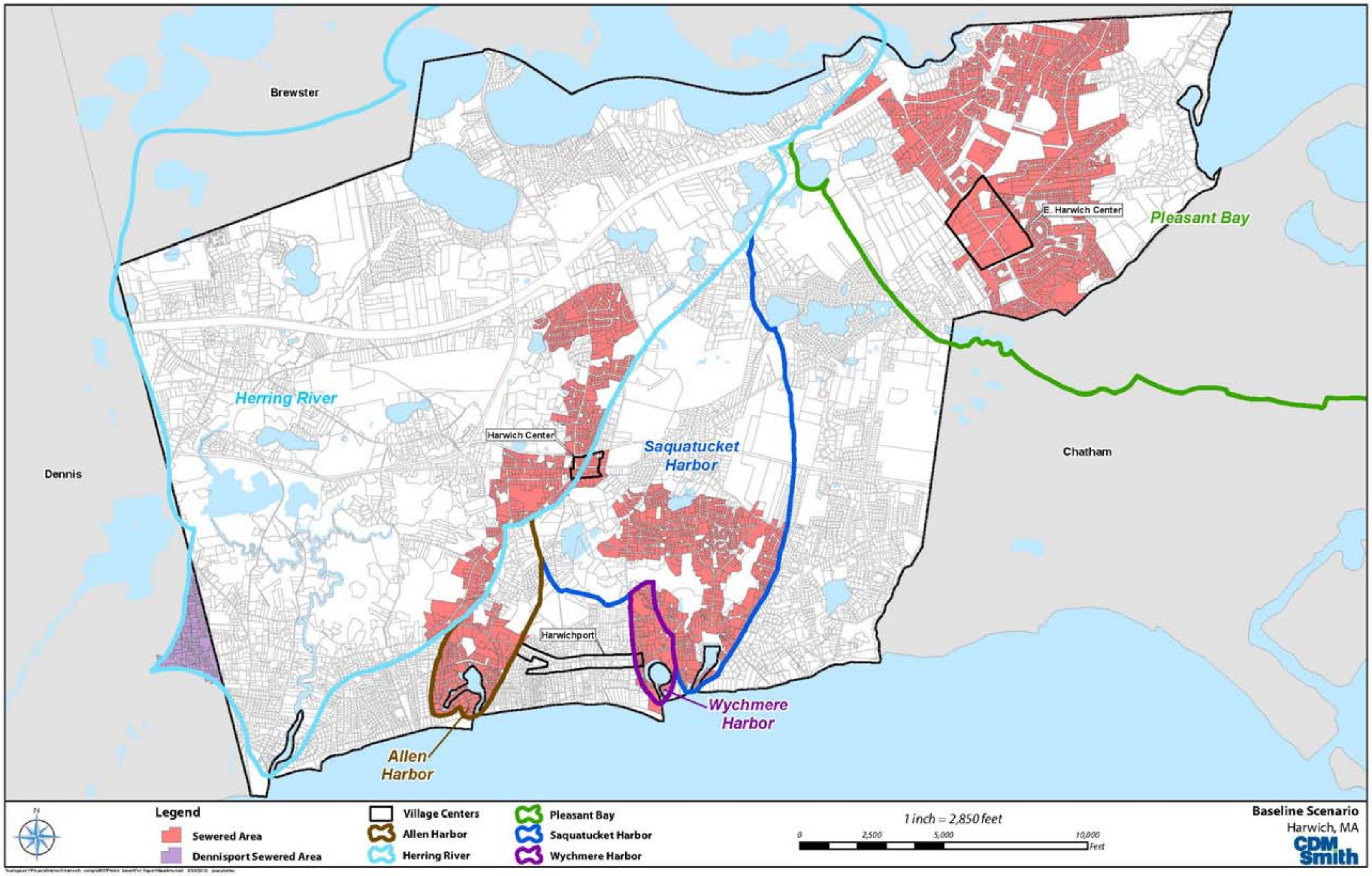
Figure 10-4 shows the baseline scenario. The lots that are colored in red represent the minimum areas that must be sewered to meet the required TMDL nitrogen removals per the MEP. As stated earlier, the Baseline Scenario does not account for effluent recharge and assumes all septic nitrogen removed will be recharged outside of nitrogen-sensitive watersheds.

In all of the scenario figures, the Herring River Watershed area known as Dennisport in the Town of Dennis is assumed to be sewered, treated and recharged within that small area. This area is colored in purple in the scenarios.

10.3.5 Enhanced Natural Attenuation Options

Natural attenuation of nitrogen is part of a natural freshwater system, and the Allen, Saquatucket and Pleasant Bay systems all have some degree of natural attenuation associated with them. In the Allen Harbor watershed, the Allen Harbor stream has a 30 percent nitrogen attenuation associated with it. In the Saquatucket Harbor watershed, attenuation occurs in several ponds and streams including the Cold Brook. The Pleasant Bay system has natural attenuation in several ponds as well as the Muddy Creek system. For the purposes of the wastewater scenarios, the existing natural attenuation factors that are accounted for in the model are considered the baseline conditions because they approximate actual field conditions as reported by the MEP. This is existing natural attenuation and has been accounted for in the baseline scenario presented above.

Figure 10-4
Baseline Scenario (No Attenuation)



The Town, however, also has the ability to initiate two projects that will enhance the existing natural attenuation in the Saquatucket Harbor watershed and tidal flushing in Muddy Creek in the Pleasant Bay watershed. The end result of implementing these projects is a reduction in the total amount of sewering required in the Saquatucket Harbor and Pleasant Bay watersheds while still meeting the MEP established TMDL requirements for nitrogen removal.

To see the effects of these two projects, the Town moved forward and created a new baseline scenario that utilizes the Saquatucket natural attenuation project in the Cold Brook and the Pleasant Bay tidal flushing project in Muddy Creek. The result is the Baseline Attenuation scenario which directly compares the potential impacts of the two projects. This scenario is described below.

Saquatucket Harbor Natural Attenuation Project

The June 2010 final Linked Watershed Embayment Model presented in the MEP report for the Allen, Wychmere and Saquatucket Embayment Systems presents an alternative scenario that changes the attenuation rate in the Bank Street Bogs (Cold Brook) from 35 percent to 50 percent. Table IX-3 on Page 157 of the report presents the overall change to the watershed loads resulting from this alternative. For the Town to implement this project, additional study is needed, but the MEP modelers generally agree that the Bank Street Bogs (Cold Brook) can be enhanced to increase the residence time of freshwater flowing through the system by creating depositional basins (ponds) after determining specific sites within the bog system to increase the nitrogen removal. This modification is expected to result in the 50 percent attenuation.

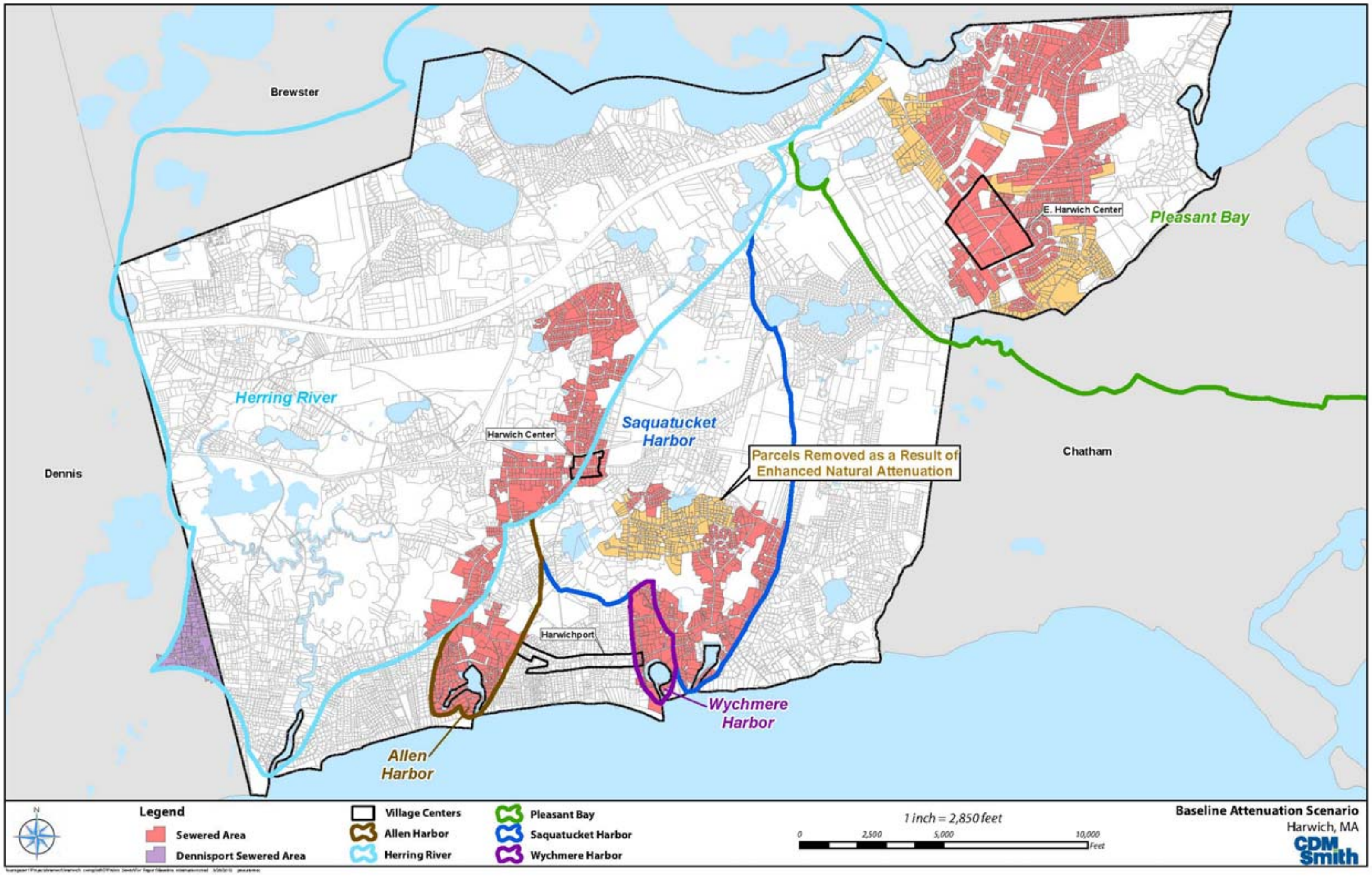
Pleasant Bay Natural Attenuation Project (Muddy Creek increased tidal flushing)

An October 5, 2010 MEP technical memorandum evaluates the water quality impacts of the addition of a 24-foot wide culvert in the Muddy Creek inlet. This technical memorandum presents an alternative scenario to the May 2006 final Linked Watershed Embayment Model for the Pleasant Bay system and presents an alternative scenario that reduces the threshold nitrogen concentrations in the upper and lower Muddy Creek sub-embayments as a result of increased flushing. For the Town to implement this project, the much smaller existing culvert would need to be increased in size to at least 24 feet. For this CWMP, the Pleasant Bay system was modeled with the understanding that the current inlet to the Muddy Creek would be expanded to increase flushing by utilizing a larger, 24-foot culvert. The modeling that was performed for the Pleasant Bay system showed that replacing the existing inlet to Muddy Creek with a 24-foot culvert has little effect on the nitrogen levels throughout the Pleasant Bay System, but the wider culvert results in a 20% drop in the difference between the existing conditions modeled nitrogen concentration and the threshold concentration at the Lower Muddy Creek check station. Additional nitrogen reductions are still required in the Muddy Creek watershed to meet the threshold concentration in Lower Muddy Creek, but the magnitude is reduced through the installation of the wider culvert.

10.3.6 Baseline Attenuation Scenario

Similar to the baseline scenario, the baseline attenuation scenario satisfies the minimum MEP requirements for nitrogen removal in the five MEP watersheds in Harwich, but it utilizes the enhanced natural attenuation in the Saquatucket Harbor and Pleasant Bay systems described above. Specifically, the attenuation rate in the Bank Street Bogs is changed from 35 to 50 percent for the build-out nitrogen loading conditions in the Saquatucket Harbor watershed, and in the Pleasant Bay watershed, the addition of a 24-foot wide culvert at the outlet of Muddy Creek is estimated to reduce the target nitrogen concentration at the Lower Muddy Creek check water quality station (PBA-05). Figure 10-5 illustrates the Baseline Attenuation Scenario.

Figure 10-5
Baseline Scenario (With Attenuation)



Based on the results of the baseline attenuation, the amount of sewering required is significantly decreased in the Saquatucket Harbor and the Pleasant Bay watersheds. The parcels highlighted in red show the parcels that would need to be sewered in order to meet the MEP requirements. The parcels colored in tan show the parcels that have been removed (do not need to be sewered) compared to the original Baseline Scenario.

10.3.7 Justification for Attenuation Scenarios (1A to 8A)

A preliminary cost evaluation of both of these enhanced attenuation options was conducted and it was concluded that the projects would be beneficial since the amount of sewering would be significantly reduced as a result of each project and the cost of these projects is a one-time capital expenditure, with minimal future operations and maintenance costs. Specifically, 470 fewer lots would require sewering with the enhanced natural attenuation offered by these two projects, approximately 230 in the Pleasant Bay watershed and approximately 240 in the Saquatucket Harbor watershed. With an estimated collection system cost of $25,000 per property for sewering, the total cost savings is $11.8 million. This savings does not even include the capital cost savings for construction of a transport system, a treatment facility, effluent recharge and the long term operation and maintenance of the entire system. Since the two proposed attenuation projects are expected to be around $3 million each or $6 million total, the cost savings are significant. Table 10-3 below shows the comparison.

Due to this significant cost savings, only the scenarios that incorporate the two natural attenuation projects will be evaluated further in this report.

Table 10-3
Cost Comparison Between Baseline and Baseline Attenuation, Collection System Only

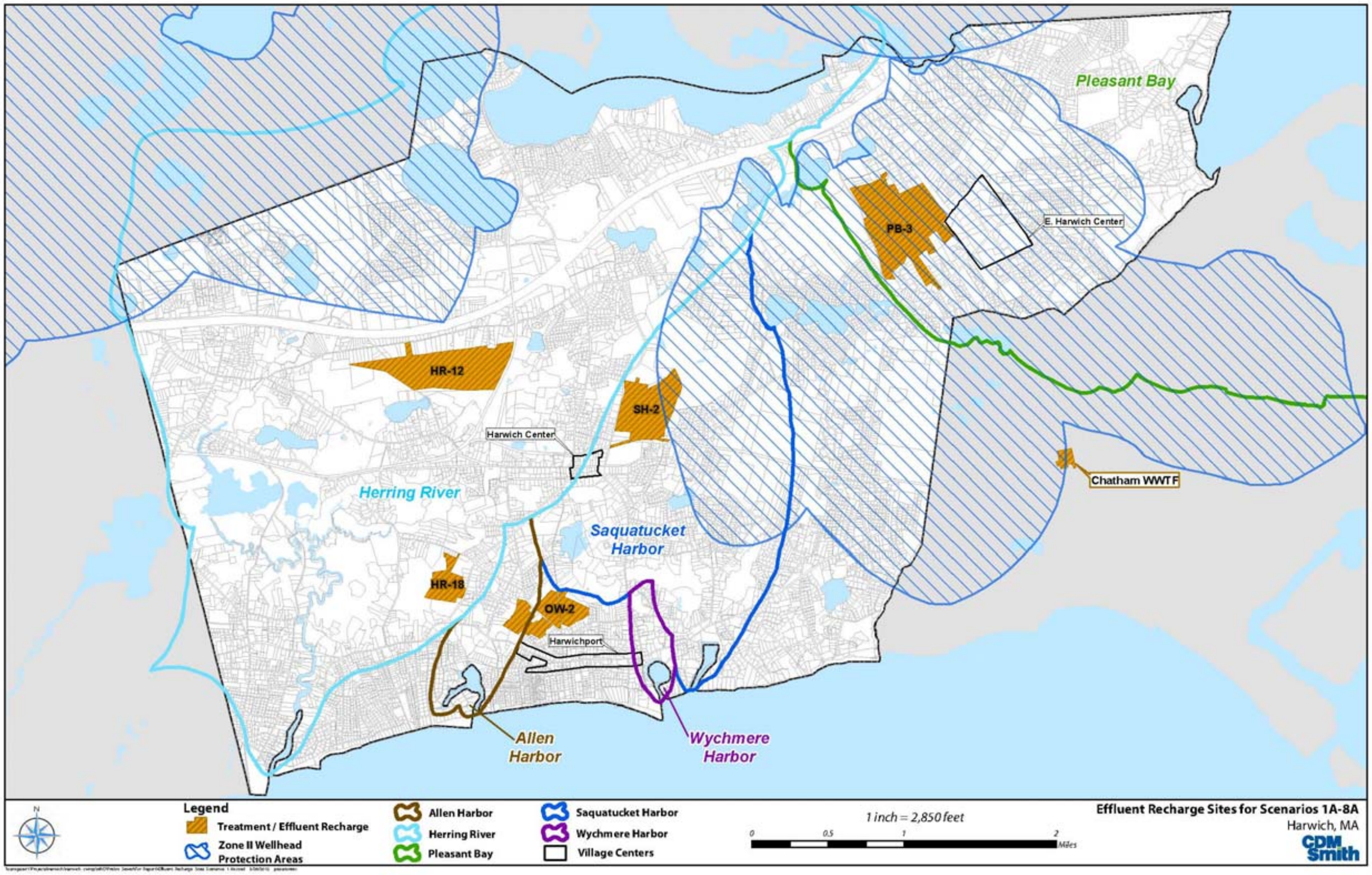
Scenario	# Of Parcels	Collection System Cost at 25K/lot
Baseline - No Attenuation	2,911	$72,775,000
Baseline With Attenuation	2,438	$60,950,000
Potential Cost Savings - Collection System Only	473	$11,825,000

10.3.8 Effluent Recharge Sites

As stated earlier, the baseline scenarios do not account for any effluent recharge in the watersheds and simply assume that treated wastewater is sent somewhere outside of the nitrogen sensitive watershed. A baseline scenario would be considered a viable scenario if the Town had an acceptable candidate recharge site outside of the five MEP watersheds. Unfortunately, there is no acceptable candidate site identified outside of these watersheds, so several in-watershed options are considered.

As described in Section 9, the site screening analysis was initiated as a way to identify the best candidate sites for effluent recharge in Harwich. While the main focus was for effluent recharge sites, they were also considered to be acceptable wastewater treatment facility sites. This analysis was used to narrow down the final sites to be used in the wastewater scenarios. The eight wastewater scenarios (1A to 8A) presented below utilize four different effluent sites that were considered to be the best candidate sites based on the analysis in Section 9. (Note: HR-18 is only being considered as a treatment facility site) Figure 10-6, below shows the location of those sites. It also shows what MEP watershed the site is located in and whether they are within a Zone II area to a municipal well.

Figure 10-6
Effluent Recharge Sites for Scenarios 1A – 8A



The sites are as follows:

HR-12: This site is controlled by the Harwich Division of Highways and Maintenance. Only a portion of the site is being considered for recharge which consists of a heavily wooded 20-acre section to the east where potential infiltration basins could be located. To the west of the site is the Town's capped former landfill, and in the middle of the site, the Town is mining soil material for town projects. The site is located in the Herring River Watershed about a 1,000 lf upgradient of some cranberry bogs in the upper reaches of the eastern branch of the Herring River known as Coy Brook. A portion of the site is identified as a Priority Habitat area. This site is located outside any Zone II areas and is considered to be an excellent candidate site and is being considered by the Town in every scenario excluding the ocean outfall scenario.

HR-18: This site is the Town-owned gardens and sheep farm at 50 Sisson Road. This site is located outside any Zone II areas and is closest to the Allen Harbor watershed. It is considered in one scenario.

OW-2: This site is composed of two privately owned parcels and includes the Harwich Port Golf Course at 51 South Street. It is close to the Allen Harbor, Saquatucket Harbor and Wychmere Harbor watersheds. This site is also located outside any Zone II areas and is considered in one scenario.

SH-2: This site is the Harwich High School parcel (now Monomoy Regional High School site). The site contains several ball fields and open spaces where subsurface recharge could be utilized or wooded areas which could be used for new ball fields. A portion of the site is identified as a Priority Habitat area but is located outside any Zone II areas. This site is considered in four scenarios.

PB-3: This site is a large privately owned gravel pit area located near East Harwich Village Center. The site is located within a Zone II area to a municipal well. Sufficient area outside mined locations appear to exist to allow infiltration basin recharge to be utilized. This site appears to be the best location in the Pleasant Bay watershed and is being considered in six scenarios.

The locations are also shown on the applicable figures for each wastewater scenario described below.

10.3.9 Wastewater Management Scenarios 1A through 8A

Based on the information presented in the previous sections, the information presented herein and discussions with the Wastewater Management Subcommittee, eight scenarios were defined and are referred to as scenarios 1A through 8A. These are the wastewater management scenarios considered to be implementable because they not only account for nitrogen reduction, but they also account for effluent recharge. All of these scenarios utilize enhanced attenuation in the Saquatucket Harbor and Pleasant Bay systems to minimize the amount of required wastewater infrastructure. The areas with enhanced attenuation have the natural ability to tolerate higher nitrogen inputs from septic system discharges without negatively affecting the environment.

As discussed earlier, the goal of the wastewater scenarios is to define several logical and implementable scenarios that can be screened down to a few preferred options to be further evaluated in detail in the CWMP.

The attenuation component in each subwatershed is cumulative. As a result, the nitrogen component in wastewater can be attenuated or reduced several times as it travels through multiple watersheds capable of attenuating nitrogen. Thus, when deciding on areas to sewer, high density areas closest to the embayment were selected first. Title 5 areas of concern and socio-economic development areas were also considered.

All of the scenarios were developed with the assumption that wastewater effluent would be treated to 5 mg/l nitrogen. This concentration was used for all scenarios except Scenario 5A and 7A. In Scenario 5A, wastewater is sent to Chatham for treatment. The Chatham wastewater facility already operates at an effluent concentration of 3 mg/l and the scenario reflects this. In Scenario 7A, the wastewater is treated to 3 mg/l to maximize the amount of I/A systems that can be used in each watershed.

Throughout the scenarios, the effluent recharge is distributed among the five recharge sites discussed above. Scenario 8A utilizes an ocean outfall rather than an effluent recharge land site. Table 10-4 below summarizes the eight scenarios and their effluent recharge locations. Treatment is assumed to occur at the recharge site location. Following, note that each scenario uses water use as a basis for comparative purposes. At this time, buildout water use is considered to be a good estimate of the wastewater flow. Water use estimates for the eight scenarios is reported as buildout water use for all watersheds except the Herring River. Water use estimates from the Herring River utilize existing water use because Herring River report was not published when this section was completed. The additional flow from the water use (typically wastewater use is estimated to be 90 percent of water use) is used to account for inflow and infiltration (I/I) estimates that must be considered with typical wastewater collection systems. The number of parcels required for sewering is also presented in this table. Table 10-4 is a detailed description and map for each of the eight scenarios.

Table 10-4
Summary of Treatment and Effluent Recharge Sites

	Herring River Watershed	Saquatucket Harbor Watershed	Pleasant Bay Watershed	Outside of an MEP Watershed	The Ocean	Number of Parcels Sewered	Scenario Water Use (Average)
Scenario	HR-12	SH-2	PB-3	OW-2	Outfall	Parcels	gpd
1A	HR	A, W, S	PB	None	None	2,992	670,000
2A	A, HR	W, S	PB	None	None	3,092	682,000
3A	A, W, S, HR, PB	None	None	None	None	3,198	697,000
4A	A, W, S, HR	None	PB	None	None	3,184	704,000
5A	A, W, S, HR	None	PB	None	None	3,094	680,000
6A	HR	W, S	PB	A	None	2,968	667,000
7A	HR and I/A	S and I/A	PB and I/A	A and I/A	None	1,643	417,000
8A	None	None	None	None	A, W, S, HR, PB	2,438	564,000

The scenarios presented in this section assume that the Herring River watershed will require about 25 percent present septic nitrogen removal. When the Draft MEP report for Herring River became available, that percentage rose to 58 percent. Since the Herring River results were published after the first draft of this section was completed, the Town decided not to update these scenarios because all eight of them would need to be revised to a similar extent and the majority of those revisions needed to realize the 58 percent removal of nitrogen involve extending the collection system and little else. Because of this and the fact that these eight scenarios are a relative assessment aimed at determining if the Town should further develop more accurate planning level costs, it was decided to keep each scenario with the 25 percent nitrogen removal assumption. It is unlikely that the overall ranking of the eight scenarios would change if the updates to the Herring River were included. Once the highest ranked scenarios are chosen, a more detailed look at planning level costs including treatment facility size, collection system size and type individual site conditions (state roads), and the need for specific infrastructure (such as pumping stations) is presented in section 12.

Scenario 1A (670,000 gpd)

Scenario 1A is presented in Figure 10-7. In this scenario, effluent recharge utilizes the HR-12, SH-2 and PB-3 sites. In this option all of the flow from sewered areas of the Herring River and the Pleasant Bay watersheds are recharged within the watershed where the flow was generated. The Saquatucket Harbor watershed receives flows from the Allen Harbor and Wychmere Harbor watersheds. The total flow for this scenario is 670,000 gpd of water use.

Scenario 2A (682,000 gpd)

Scenario 2A is presented in Figure 10-8. In this scenario effluent recharge is again located at the HR-12, SH-2 and PB-3 sites. This scenario is similar to Scenario 1A, but the flow from the Allen Harbor watershed is conveyed to the Herring River watershed. The total flow for this scenario is 682,000 gpd of water use.

Scenario 3A (697,000 gpd)

Scenario 3A is presented in Figure 10-9. In this scenario, effluent recharge utilizes only the HR-12 site. The total flow for this scenario is 697,000 gpd of water use. Thus, wastewater is collected in each watershed and conveyed to HR-12 for treatment and recharge.

Scenario 4A (702,000 gpd)

Scenario 4A is presented in Figure 10-10. In this scenario, effluent recharge utilizes only the HR-12 and PB-3 sites. Flow from the Pleasant Bay watershed is collected treated and recharged within the Pleasant Bay watershed, while the rest of the flow from the other watersheds is collected, treated and recharged to the Herring River watershed. The total flow for this scenario is 702,000 gpd of water use.

Scenario 5A (680,000 gpd)

Scenario 5A is presented in Figure 10-11. In this scenario, effluent recharge utilizes only the HR-12 and PB-3 sites. This scenario is similar to 4A, but the wastewater in this scenario is treated to 3 mg/l total nitrogen, since the flow from the Pleasant Bay watershed is collected and transported to the Chatham treatment facility. The treated effluent is then conveyed back to PB-3 for potential additional treatment (TOC removal may be required since the recharge site is in a Zone II) and recharge. The result of this additional nitrogen treatment is an overall reduction in the amount of wastewater that must be treated. The total flow for this scenario is 680,000 gpd of water use.

Figure 10-7
Scenario 1A

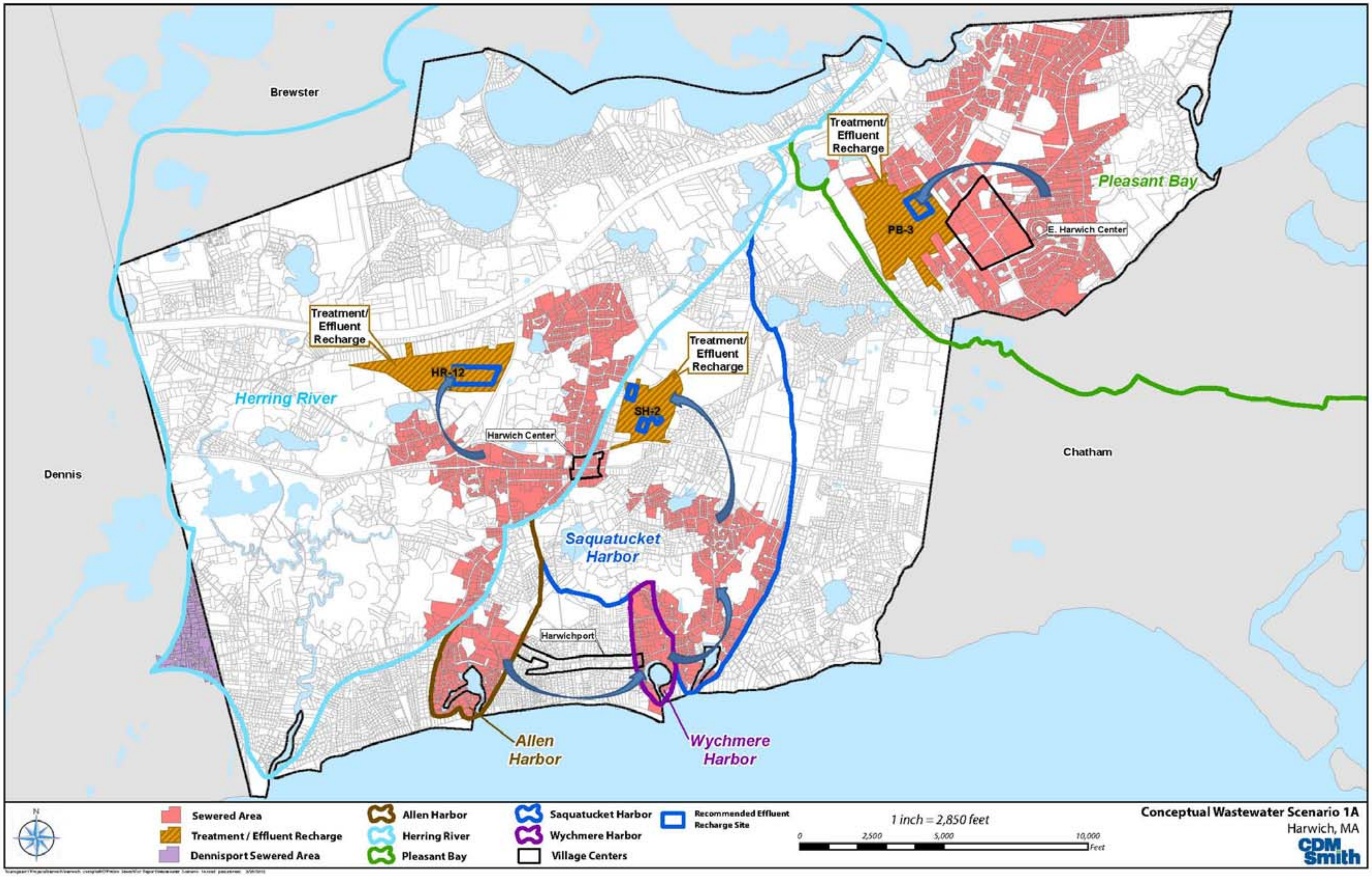


Figure 10-8
Scenario 2A

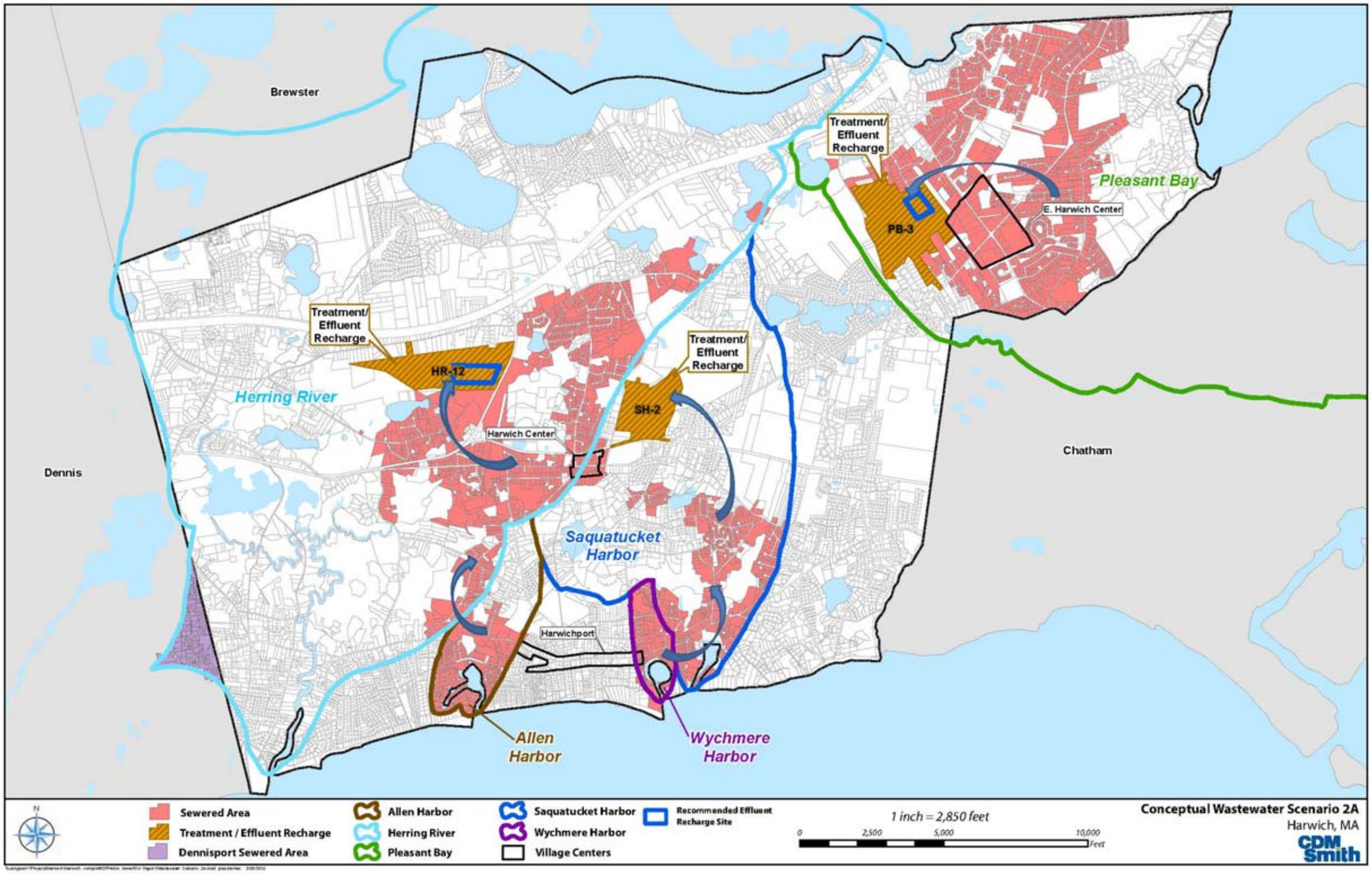
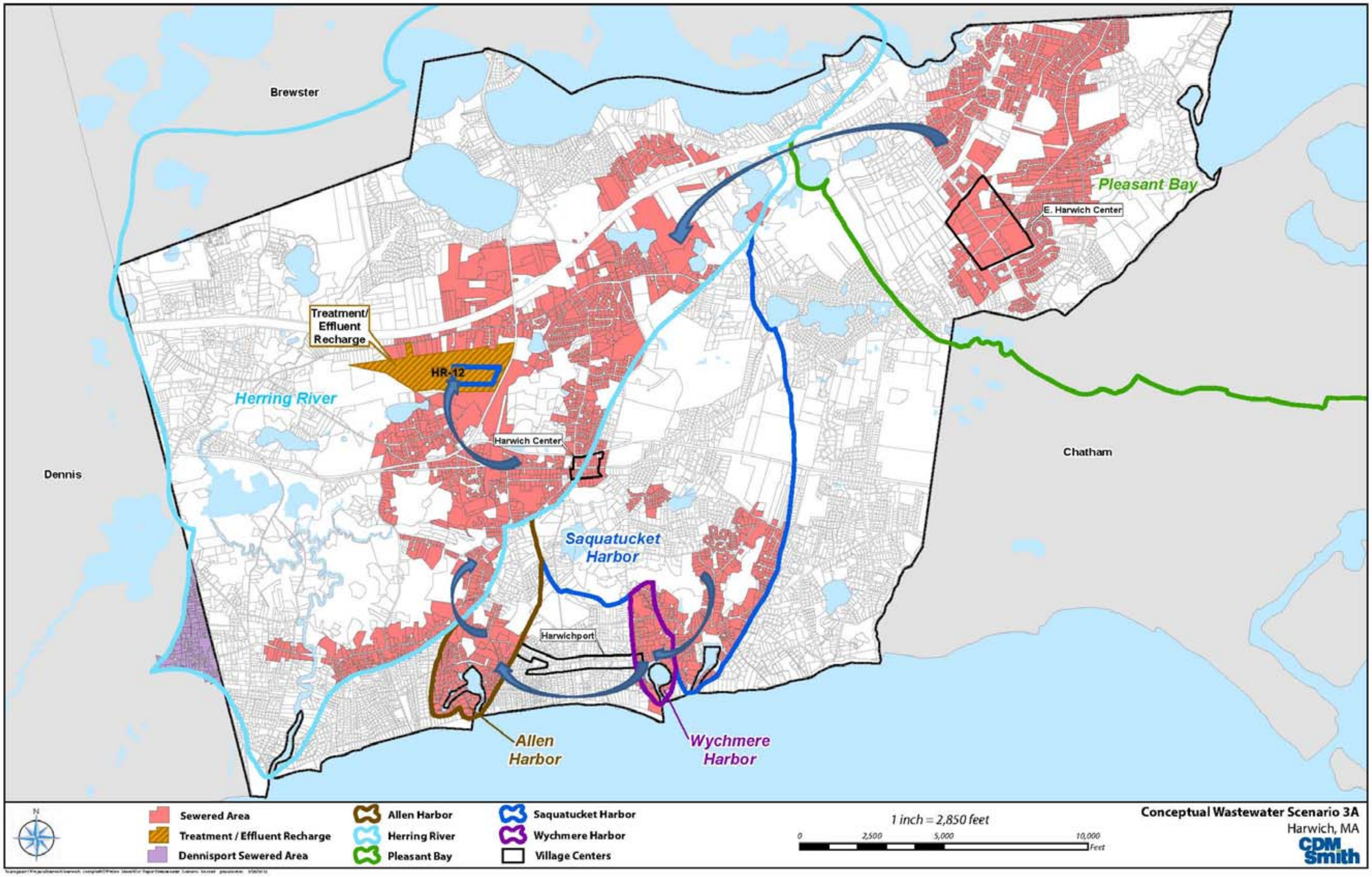


Figure 10-9
Scenario 3A



Scenario 6A (667,000 gpd)

Scenario 6A is presented in Figure 10-12. In this scenario, effluent recharge utilizes all four sites. This is the only scenario that utilizes the OW-2 site, which is expected to have a limited capacity for effluent recharge. As a result, this scenario only recharges the effluent flow from the Allen Harbor watershed at this site. The total flow for this scenario is 666,000 gpd of water use.

Scenario 7A

Scenario 7A is presented in Figure 10-13. In this scenario Innovative and alternative (I/A) treatment systems are utilized in four of the five MEP watersheds. I/A Systems are not used in the Wychmere Harbor watershed since 100 percent septic nitrogen removal is required in that watershed.

The I/A systems used in this scenario are individual systems that are typically sized for individual lots rather than cluster or centralized systems capable of treating wastewater from several lots / homes or businesses. A typical I/A system is capable of treating wastewater to a nitrogen effluent standard of 19 mg/l. These systems are used in the Allen Harbor, Saquatucket Harbor, and Herring River. To minimize the wastewater collection area in the Pleasant Bay watershed, enhanced I/A systems (capable of treating to a nitrogen effluent standard of 13mg/l) are used here. While the I/A systems can remove a significant amount of nitrogen from wastewater, alone they cannot remove enough nitrogen to fully satisfy the MEP TMDL requirements in Harwich. As a result, this scenario combines a limited amount of wastewater collection and treatment and supplements it with I/A systems to achieve a nitrogen reduction that does meet the MEP TMDL requirements. For this scenario 417,000 gpd of water use must be collected and treated using a sewer system and treatment system. This alone does not meet the MEP threshold, so an additional 6,600 parcels will require some type of I/A system. Figure 10-13 shows the parcels that were chosen for conventional wastewater collection and treatment in red. The figure also shows the parcels that will receive an I/A system in green.

Scenario 8A (564,000 gpd)

Scenario 8A is the ocean outfall scenario presented in Figure 10-14. This scenario is similar to the baseline attenuation scenario because the nitrogen balancing that is required for effluent recharge within an MEP watershed is not needed. Since this scenario utilizes an ocean outfall, the wastewater is sent outside of a nitrogen sensitive watershed where it can be disregarded in terms of nitrogen balancing, similar to the baseline attenuation scenario. For this scenario, wastewater is collected, treated at the Town Gardens (HR-18) site where it is treated to 5 mg/l and then ultimately discharged to the ocean 3.5 miles off of Allen Harbor. The total flow for this scenario is 564,000 gpd of water use.

10.4 Comparative Assessment of Scenarios

The eight wastewater management scenarios were developed to address the environmental restoration and economic development goals of the Town are screened using an evaluation matrix developed to compare them with the criteria described below. A discussion of the methodology for developing preliminary cost estimates is also provided.

Figure 10-10
Scenario 4A

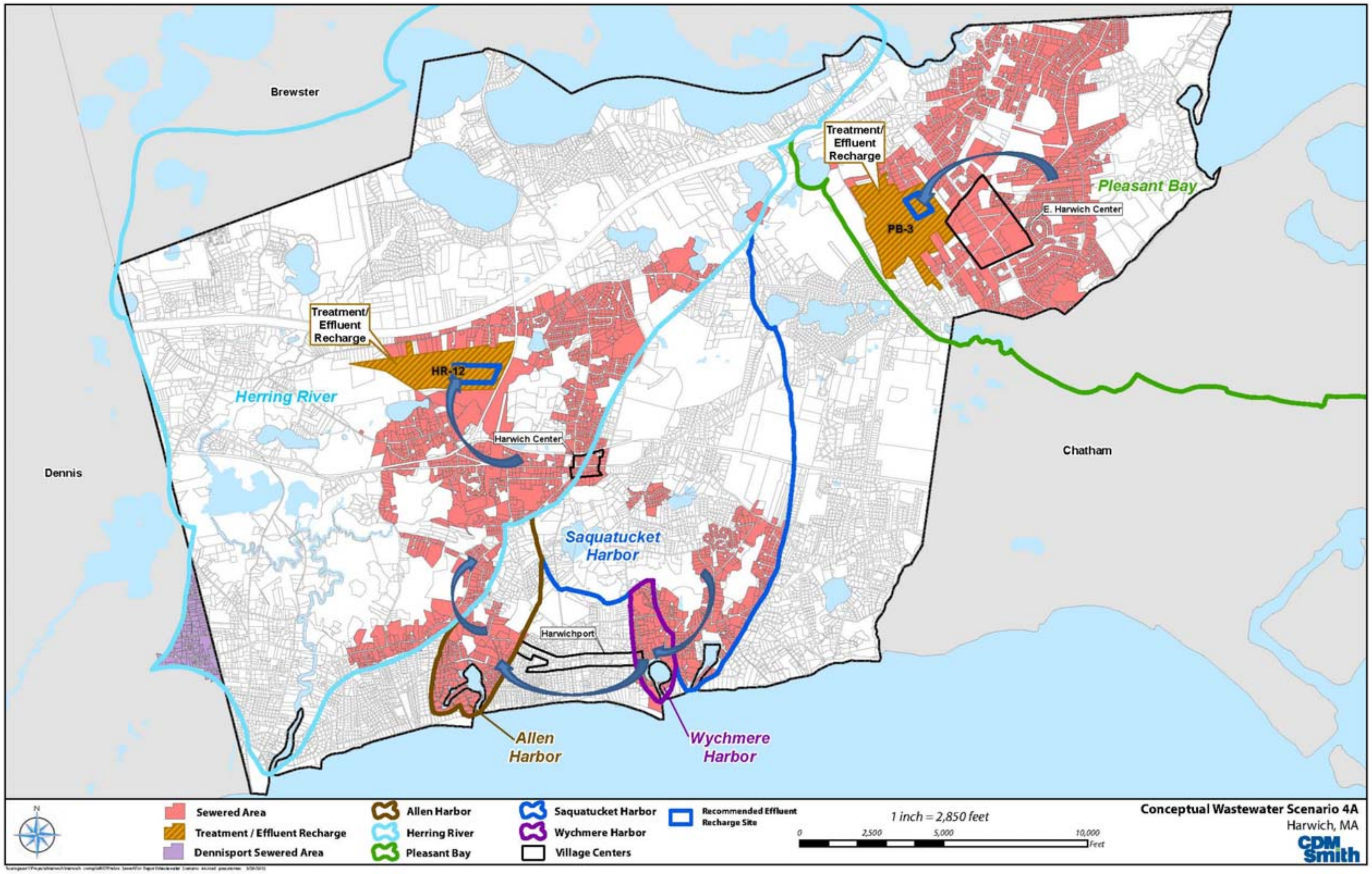


Figure 10-11
Scenario 5A

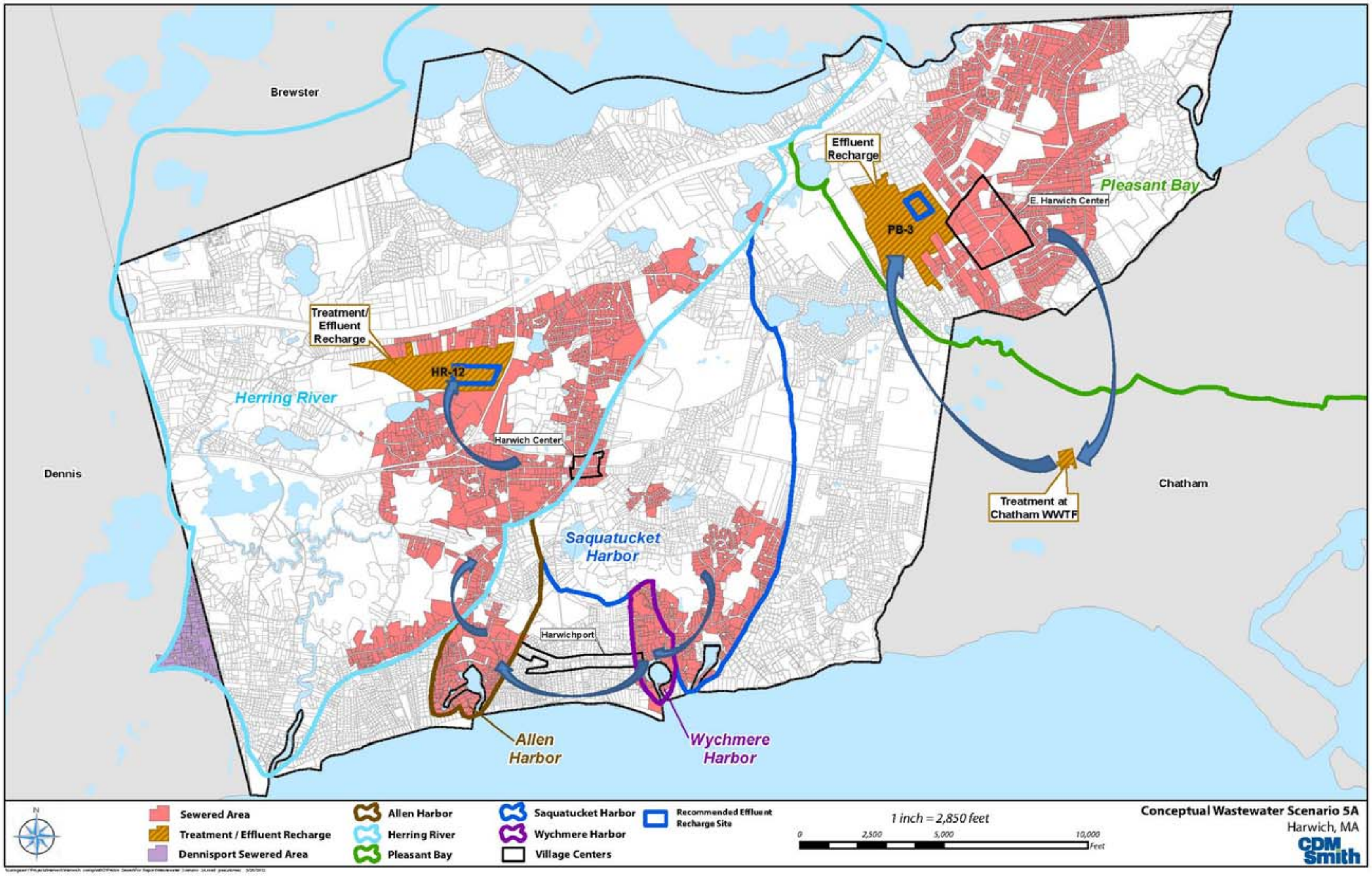


Figure 10-12
Scenario 6A

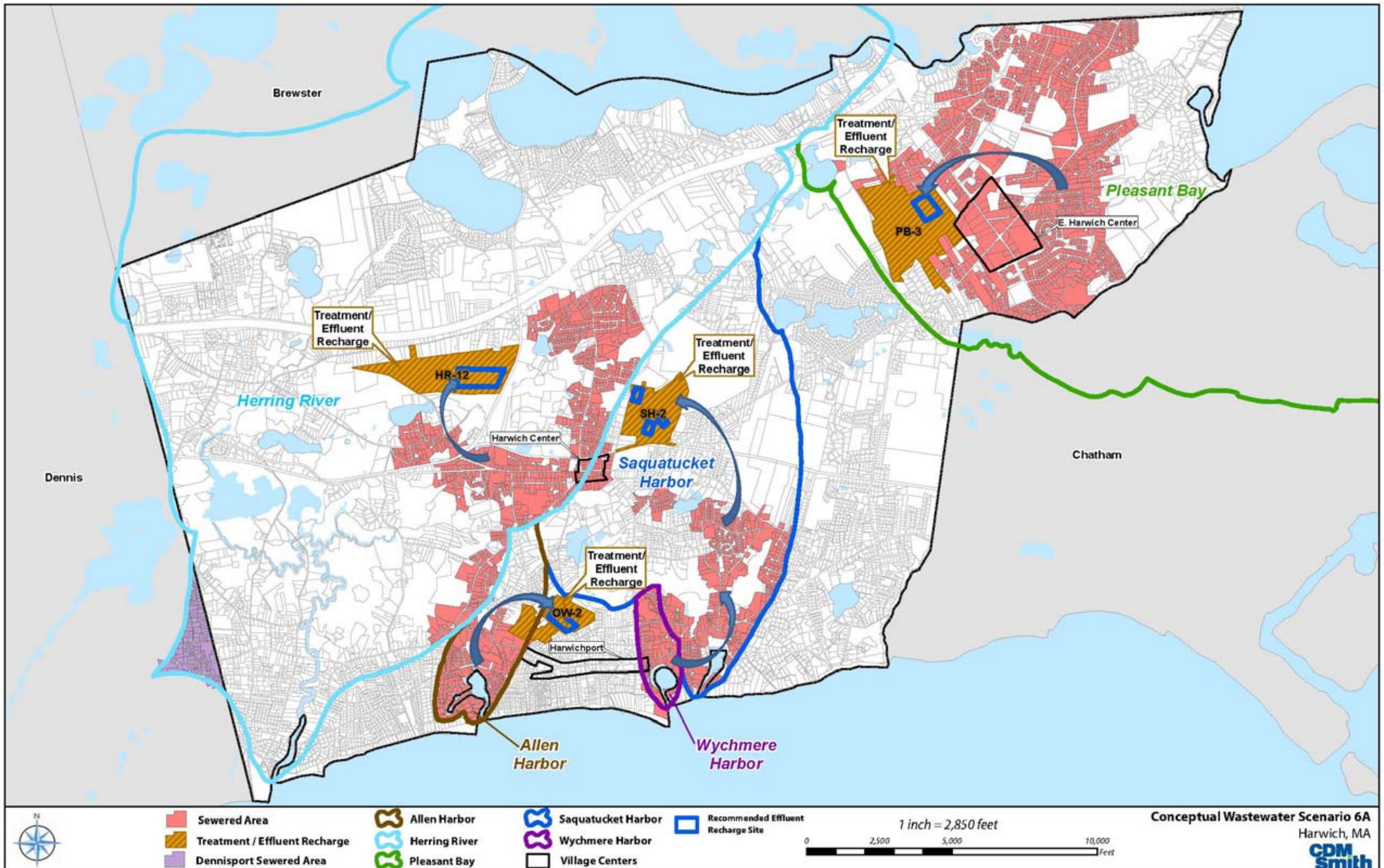


Figure 10-13
Scenario 7A

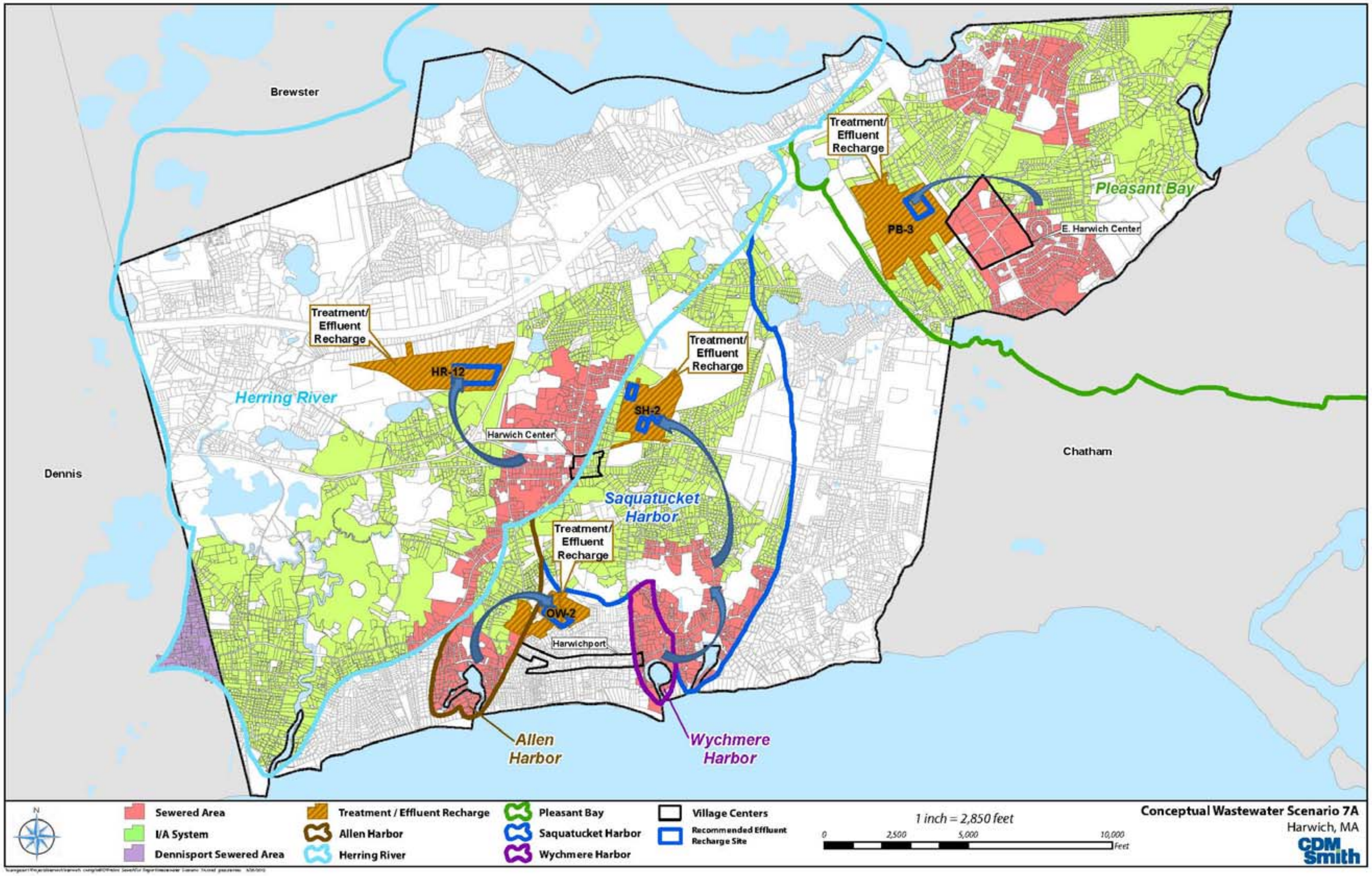
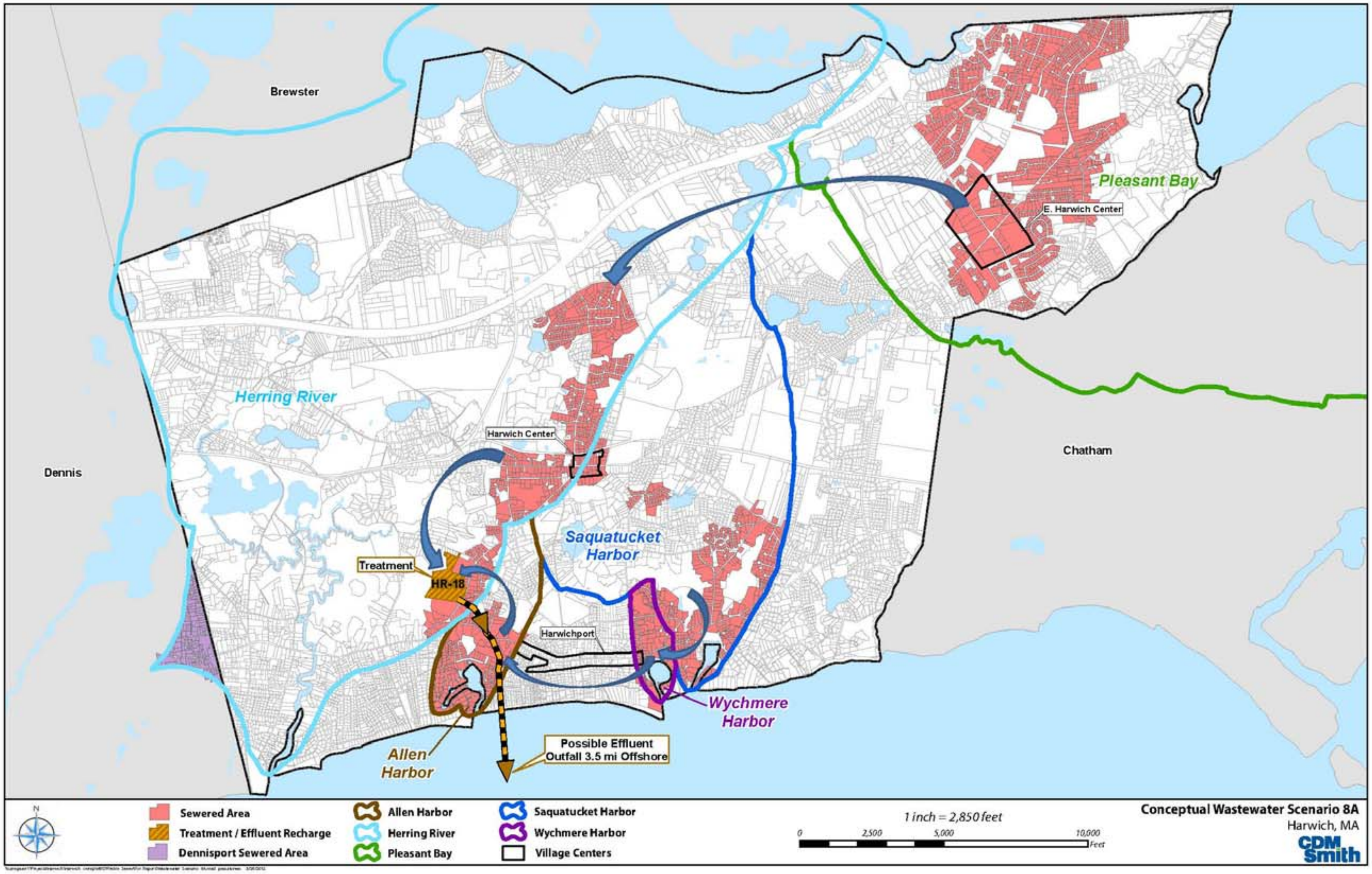


Figure 10-14
Scenario 8A



10.4.1 Cost Analysis

The comparative costs were developed using the tools presented in the Barnstable County Wastewater Cost Task Force's report entitled, "Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod, Guidance to Cape Cod Towns Undertaking Comprehensive Wastewater Management Planning" dated April 2010. Capital costs were supplemented by CDM Smith for some unit costs not readily available in the Barnstable County report.

The Barnstable County report presents cost estimating tools for individual on-site systems, cluster treatment systems (defined as up to 30 homes or 10,000 gpd), satellite systems (30 to 1,000 homes, and 10,000 to 300,000 gpd), and centralized systems which meet most or all of a town's needs. Capital costs developed using the tools include collection, conveyance, treatment, and effluent recharge. Capital costs include design, permitting and land costs. Collection and transport costs are determined using a cost curve provided in the report which is based on the lot density of proposed sewered areas. The lot density information was estimated by dividing 90 percent of the linear feet of roadways within the area tributary to each proposed treatment facility by the total number of parcels proposed for sewering. The result from that calculation is the average number of feet of collection system required per lot, which can be used to determine a capital cost for collection and transport per lot being treated.

Treatment and recharge costs are determined using a separate curve in the report based on short-term peak flows at the proposed WWTPs. A peaking factor of 2.2 was used to account for short term peak flows. Average water use for each sewered area is summarized in Table 10-5.

To supplement the Barnstable County capital cost data, CDM Smith added costs for force mains from the main pumping station for the collection area to each treatment facility location and, where applicable, force mains from the treatment facility to the recharge/outfall location. Force main costs were estimated at $175 per linear foot of force main. Ocean outfall costs were estimated at $2,500 per linear foot of outfall pipe.

O&M costs were also developed using the Barnstable County report. These costs include labor, chemicals, electricity, laboratory analysis, repairs administrative costs and sludge removal. The O&M costs are determined separately for each proposed treatment facility based on a cost curve in the report which provides the annual cost per gallon treated, using the average daily flow of the facility. Average daily flows were taken directly from the water usage for each area tributary to each treatment facility.

For the I/A scenario, both capital and O&M costs reported for similar on-site systems on Cape Cod were used to establish cost estimates. Specifically, the report describes the cost of a standard Title 5 system as $15,000 for a new home, $8,000 for an upgrade, and up to $30,000 for a mounded system. For this analysis, an I/A system is estimated to cost $15,000 for a system that can treat to 19 mg/L TN, and $20,000 for a system that can treat to 13 mg/L TN. Annual O&M costs for Title 5 systems were reported as $100 for standard Title 5 systems, $1,500 for I/A systems with limited oversight capable of achieving 19ppm of nitrogen, $2,500 for I/A systems with more appropriate oversight capable of achieving 13ppm of nitrogen, and $3,200 for I/A systems where documentation of effluent limits is required for TMDL compliance.

Equivalent annual costs were developed using the capital cost of each scenario plus the annual O&M cost. These costs are presented in section 10.4.2. Cost efficiency was then developed by dividing the equivalent annual cost by the pounds of nitrogen removed by each scenario, to arrive at an annual cost per pound of nitrogen removed.

10.4.2 Cost Results

All of the costs described above in Section 10.4.1 were tabulated into detailed spreadsheets that show several components of a wastewater system including collection, transport, treatment and effluent recharge. Detailed spreadsheets were created that tabulated all of the wastewater collection and treatment options into tables for a side by side comparison. The detailed spreadsheets are provided in Appendix C. These tables presented costs for pumping stations, force mains, linear feet of roads, water use and the number of parcels sewered. They present costs for wastewater flows (including peak flows) treatment goals, amount of treatment required, Zone II treatment considerations, effluent recharge, and O&M costs. A summary of this information is tabulated for each scenario and is presented in Tables 10-5A to 10-5D, below.

The estimated total capital cost of each option is presented along with the estimated total O&M cost for each option. For comparison of costs on an annual basis, the Equivalent Annual Cost (EAC) is also presented. The Equivalent annual cost assumes that the capital cost is based on a 20 year loan with a 2% loan rate that assumes the State Revolving Fund (SRF) is the funding mechanism for the project.

From the summary table, the equivalent annual cost of Scenario 3A is the lowest among the scenarios since it utilizes the economy of scale from a single wastewater treatment facility to accomplish the Towns' wastewater goal. However, Scenario 4A and 5A (hybrid of 4A) at this screening level cost analysis can essentially be considered equal to Scenario 3A as they are within 10 percent of each other. They utilize two treatment facilities. Scenario 7A is the most costly option since this scenario will require approximately 6,600 Innovative and Alternative septic systems which is a significant portion of the cost.

Table 10-6 presents the cost per pound of nitrogen removed for each scenario and reflect similar results to the EAC.

This table shows that each scenario must remove between 48,500 and 67,000 pounds of nitrogen every year to meet the TMDL's for total nitrogen. The differing amount of nitrogen removed in each scenario is a result of natural attenuation variations throughout the subwatersheds, the particular area chosen for wastewater collection and the nitrogen balancing that is required for each scenario that recharges effluent within a nitrogen sensitive (limited) watershed. Scenario 8A requires the least amount of nitrogen removed since this scenario recharges to the ocean and requires no effluent recharge nitrogen balancing. All other scenarios 1A to 7A recharge effluent to one or more nitrogen sensitive watersheds.

Table 10-5 A
Wastewater Scenarios Summary Table : Length of Force Mains

	Scenario							
	1A	2A	3A	4A	5A	6A	7A	8A
Length of Force Mains (feet)	32,000	26,000	47,000	29,000	36,000 + 17,000 (add.)	32,000	32,000	41,000 + 25,000 (add.)

*Force mains from treatment facilities in scenarios 5A and 8A are considered to be additional force mains. The cost for these additional force mains is included in the treatment and effluent recharge cost.

Table 10-5 B
Wastewater Scenarios Summary Table : Collection and Treatment Costs

	Scenario							
	1A	2A	3A	4A	5A	6A	7A	8A
Total Transport/Collection System Cost	$78,500,000	$82,300,000	$95,600,000	$86,800,000	$86,000,000	$78,100,000	$51,700,000	$73,300,000
Treatment and Effluent Recharge Cost	$42,400,000	$41,900,000	$28,100,000	$36,700,000	$37,000,000	$45,700,000	$139,100,000	$92,300,000
Total Capital Cost	***120,900,000***	***124,100,000***	***123,700,000***	***123,500,000***	***123,100,000***	***123,800,000***	***190,800,000***	***165,700,000***

Table 10-5 C
Wastewater Scenarios Summary Table : Total O&M Costs

	Scenario							
	1A	2A	3A	4A	5A	6A	7A	8A
Total O&M Cost	$4,000,000	$3,700,000	$2,200,000	$3,300,000	$2,700,000	$4,200,000	$14,200,000	$2,100,000

Table 10-5 D
Wastewater Scenarios Summary Table : Equivalent Annual Cost (includes Collection treatment and O&M Costs)

	Scenario							
	1A	2A	3A	4A	5A	6A	7A	8A
Equivalent Annual Cost (EAC) - 20 years @2% -	$11,300,000	$11,300,000	$9,800,000	$10,800,000	$10,200,000	$11,800,000	$25,900,000	$12,200,000

Table 10-6
Wastewater Scenarios Cost Per Pound of Nitrogen Removed

	Scenario							
	1A	2A	3A	4A	5A	6A	7A	8A
Pounds of Nitrogen Removed	57,000	59,000	67,000	62,000	60,000	55,000	58,000	48,500
Cost Per Pound of Nitrogen Removed (EAC)	$199	$192	$146	$175	$170	$215	$447	$252

10.4.3 Evaluation Criteria

To distinguish between these scenarios, a detailed evaluation matrix was developed. The following evaluation criteria were selected for analysis and divided into four major categories:

- Relative Costs
  - Capital costs
  - O&M costs
  - Cost efficiency
- Technical Criteria
  - Complexity of transport
  - Reliability
  - Effluent recharge issues
  - Future recharge capacity
- Institutional Criteria
  - Phasing
  - Regional opportunities
  - Regulatory considerations
  - Land ownership
- Environmental Criteria
  - Effluent recharge impacts
  - Water balance considerations
  - Sensitive receptors
  - Construction impacts

All criteria were ranked on a scale of 1 to 5, with 1 being the most favorable and 5 being the least favorable. The definition and ranking approach for each criterion is described below.

Each individual criterion was weighted individually by the Wastewater Management Subcommittee to reflect the preferences in Harwich. The relative costs category is weighted more heavily in this analysis since project costs are usually a deciding factor in determining whether or not a project can be implemented.

Relative Costs (50 Percent Weight)

Capital Costs: The cost of each alternative was estimated based on the Barnstable County Report discussed above. This tool enables communities to assess the relative planning-level costs of various alternatives to use in the scenario screening process. Capital costs were supplemented by CDM Smith for some unit costs not readily available in the Barnstable County report. The cost estimates developed using this tool are described in Section 10.4.1 and are presented in 2009 dollars. More detailed cost estimates will be established during later phases of the CWMP for the selected scenarios. Capital costs include collection, transport, treatment and effluent recharge and were ranked as follows:

Rating	Range
1	<$120 million
2	$120 – 125 million
3	$125 – 130 million
4	$130 – 135 million
5	>$135 million

Ratings for each Scenario:

Scenario	Rating	Explanation
1A	2	as project construction cost is estimated to be about $121 million
2A	2	as project construction cost is estimated to be about $124 million
3A	2	as project construction cost is estimated to be about $124 million
4A	2	as project construction cost is estimated to be about $124 million
5A	2	as project construction cost is estimated to be about $123 million
6A	2	as project construction cost is estimated to be about $124 million
7A	5	as project construction cost is estimated to be about $191 million
8A	5	as project construction cost is estimated to be about $166 million

Operations and Maintenance Costs: The operation and maintenance (O&M) costs of each alternative were also developed using the Barnstable County report, and were supplemented as needed by CDM Smith. O&M costs are shown on an average annual basis at 2009 dollars and were ranked as follows:

Rating	Range
1	< $ 2.5 million
2	$2.5 – 3.0 million
3	$3.0 – 3.5 million
4	$3.5 – 4.0 million
5	> $ 4.0 million

Ratings for each Scenario:

Scenario	Rating	Explanation
1A	4	as annual O&M cost is estimated to be about $4.0 million
2A	4	as annual O&M cost is estimated to be about $3.7 million
3A	1	as annual O&M cost is estimated to be about $2.2 million
4A	3	as annual O&M cost is estimated to be about $3.3 million
5A	2	as annual O&M cost is estimated to be about $2.7 million
6A	5	as annual O&M cost is estimated to be about $4.2 million
7A	5	as annual O&M cost is estimated to be about $14.2 million
8A	1	as annual O&M cost is estimated to be about $2.1 million

Cost Efficiency: The cost efficiency is the Equivalent Annual Cost (EAC) of the system over a 20 year life cycle. The EAC calculated using the 20-year life cycle at an interest payment rate of two percent plus the annual O&M cost gives a good estimate of the annual cost for the system by accounting for loan payments and O&M costs. The cost efficiency was then ranked as follows:

Rating	Range
1	< $ 10.0 million
2	$10 – 10.5 million
3	$10.5 – 11 million
4	$11 – 11.5 million
5	> $ 11.5 million

Ratings for each Scenario:

Scenario	Rating	Explanation
1A	4	as the Equivalent Annual Cost is estimated at $11.3 Million
2A	4	as the Equivalent Annual Cost is estimated at $11.3 Million
3A	1	as the Equivalent Annual Cost is estimated at $9.8 Million
4A	3	as the Equivalent Annual Cost is estimated at $10.8 Million
5A	2	as the Equivalent Annual Cost is estimated at $10.2 Million
6A	5	as the Equivalent Annual Cost is estimated at $11.8 Million
7A	5	as the Equivalent Annual Cost is estimated at $25.9 Million
8A	5	as the Equivalent Annual Cost is estimated at $12.2 Million

Technical Criteria (18 Percent Weight)

Complexity of Transport System: The various scenarios involve collecting wastewater from sewer service areas and conveying the collected wastewater via pumping stations and forcemains to a treatment facility and effluent recharge area. The number of major pumping stations required to convey collected wastewater to the treatment facility and effluent recharge sites is a consideration as this will have short-term construction impacts and long-term operation and maintenance impacts. The complexity of each scenario's transport system was evaluated by considering the total length of forcemains required to convey wastewater to the treatment facility sites and effluent to the recharge sites (including outfall pipes) to arrive at the following rankings:

Rating	Range
1	requires 30,000 lf or less of forcemains
2	requires greater than 30,000 lf up to 40,000 lf of forcemains
3	requires greater than 40,000 lf up to 50,000 lf of forcemains
4	requires greater than 50,000 lf up to 60,000 lf of forcemains
5	requires greater than 60,000 lf of forcemains

Ratings for each Scenario:

Scenario	Rating	Explanation
1A	2	as this scenario has about 32,000 lf of forcemains
2A	1	as this scenario has about 26,000 lf of forcemains
3A	3	as this scenario has about 47,000 lf of forcemains
4A	1	as this scenario has about 29,000 lf of forcemains
5A	4	as this scenario has about 36,000 lf of forcemains and 17,000 lf of FM to and from Chatham (53,000 lf total)
6A	2	as this scenario has about 32,000 lf of forcemains
7A	2	as this scenario has about 32,000 lf of forcemains
8A	5	as this scenario has about 41,000 lf of forcemains and 25,000 lf of outfall pipe (66,000 lf total)

Reliability Issues: Reliability issues explore the likelihood that permitted treatment facility effluent limits can be reliably met throughout the year. More stringent permit limits will reduce the potential reliability of a system. Multiple facilities will also reduce the overall reliability due to increased complexity of maintaining several different size facilities at once. Thus, reliability criterion consider three overall factors and includes the permit level of Total Nitrogen (TN) that must be obtained, the requirement for Total Organic Carbon (TOC) removal in drinking water Zone II effluent recharge areas, and the overall number of wastewater treatment facilities utilized in a given scenario. These criteria are used in the following rankings:

Rating	*Range*
1	Wastewater treatment to 5mg/l TN, one treatment facility, ocean outfall recharge
2	Wastewater treatment to 5mg/l TN, one treatment facility, land recharge
3	Wastewater treatment to 5mg/l TN, two to three treatment facilities, land recharge, additional TOC removal required for a Zone II area.
4	Wastewater treatment to 3mg/l TN, two to three treatment facilities, land recharge, additional TOC removal required for a Zone II area.
5	Wastewater treatment to 3mg/l or 5 mg/l TN, four treatment facilities, land recharge, additional TOC removal required for a Zone II area.

Ratings for each Scenario:

Scenario	*Rating*	*Explanation*
1A	3	as this scenario has treatment to 5 mg/l TN, three treatment facilities, land recharge in a Zone II with TOC removal
2A	3	as this scenario has treatment to 5 mg/l TN, three treatment facilities, land recharge in a Zone II with TOC removal
3A	2	as this scenario has treatment to 5 mg/l TN, one treatment facility and land recharge
4A	3	as this scenario has treatment to 5 mg/l TN, two treatment facilities and land recharge in a Zone II with TOC removal
5A	4	as this scenario has treatment to 3 mg/l TN two treatment facilities, land recharge in a Zone II with TOC removal
6A	5	as this scenario has treatment to 5mg/l TN, four treatment facilities, land recharge in a Zone II with TOC removal
7A	5	as this scenario has treatment to 3 mg/l TN, four treatment facilities, and land recharge in a Zone II with TOC removal
8A	1	as this scenario has treatment to 5 mg/l TN, one treatment facility and ocean outfall recharge

Effluent Recharge Issues: Effluent recharge issues from a technical perspective include the required hydrogeologic investigations and groundwater discharge requirements to approve each recharge site. Technical considerations are anticipated to relate directly to the number of effluent recharge sites, whether the site is located inside or outside of a Zone II drinking water supply and whether the site can utilize open infiltration basins or requires use of subsurface leaching areas or an ocean outfall. Based on those criteria the following rankings were defined as follows:

Rating	*Range*
1	One effluent recharge site utilizing open infiltration basins
2	Two or three effluent recharge sites utilizing open infiltration basins and one site within a Zone II area
3	Two or three effluent recharge sites with some requiring subsurface leaching areas and one site in a Zone II area
4	Four effluent recharge sites with some requiring subsurface leaching areas and one site in a Zone II area
5	An ocean outfall utilized for effluent recharge

Ratings for each Scenario:

Scenario	*Rating*	*Explanation*
1A	3	as this scenario utilizes three sites with one in a Zone II and one requiring subsurface recharge
2A	3	as this scenario utilizes three sites with one in a Zone II and one requiring subsurface recharge
3A	1	as this scenario utilizes one site outside of a Zone II and with open infiltrations basins
4A	2	as this scenario utilizes two sites with one in a Zone II and one with open infiltrations basins
5A	2	as this scenario utilizes two sites with one in a Zone II and one with open infiltrations basins
6A	4	as this scenario utilizes four sites with one in a Zone II and two requiring subsurface recharge
7A	4	as this scenario utilizes four sites with one in a Zone II and two requiring subsurface recharge
8A	5	as this scenario utilizes an ocean outfall

Future Recharge Capacity: The Future Recharge capacity describes the ability to recharge additional effluent if the Town decided to expand its wastewater system and sewer additional areas in the future. This criterion looks at each wastewater scenario and considers the potential recharge capacity of the effluent recharge sites. For this analysis the ocean outfall is assumed to have significant capacity for expansion. The ratings for each scenario are listed below.

Rating	*Range*
1	Utilizes an ocean outfall with significant capacity
2	Utilizes more than three effluent recharge sites
3	Utilizes HR-12, PB-3, and SH-2. Expansion of capacity at SH-2 is less likely
4	Utilizes HR-12 and PB-3 which have the most capacity of the land based recharge options Preliminary results indicate that additional recharge flow at these sites may be possible and could allow for future growth of a wastewater system
5	Utilizes only one site for effluent recharge

Ratings for each Scenario:

Scenario	*Rating*	*Explanation*
1A	3	as this scenario utilizes three sites: HR-12, SH-2 and PB-3
2A	3	as this scenario utilizes three sites: HR-12, SH-2 and PB-3
3A	5	as this scenario utilizes one site: HR-12
4A	4	as this scenario utilizes two sites : HR-12 and PB-3
5A	4	as this scenario utilizes two sites : HR-12 and PB-3
6A	2	as this scenario utilizes four sites : HR-12, SH-2, PB-3, and OW-2
7A	2	as this scenario utilizes four sites : HR-12, SH-2, PB-3, and OW-2
8A	1	as this scenario utilizes an ocean outfall

Institutional Criteria (16 Percent Weight)

Phasing: The scenarios vary in their ability to be divided into suitable implementation phases and the associated ability to meet TMDL nitrogen reduction goals without creating temporary increases in nitrogen sensitive areas due to removal from one watershed and recharge in another. Also the ability to meet the Town's planning goals in addressing village center developments which will require sewers is factored in. The timeline to permit a given scenario was considered (ocean outfall not currently allowed by law). The availability of a logical phasing strategy for each scenario was compared and ranked as follows:

Rating	*Range*
1	Straightforward and logical phasing strategy is apparent since three or more wastewater facilities exist with distinct wastewater service areas
2	Straightforward and logical phasing strategy is apparent since two wastewater facilities exist with distinct wastewater service areas
3	Straightforward and logical phasing strategy is less apparent since one wastewater facility exists to service all wastewater service areas
4	Phasing strategy is more difficult since four wastewater facilities exists along with several I/A systems. Permitting the I/A systems to meet TMDL permit compliance will require additional regulatory efforts
5	Ocean outfall is not currently allowed by law under the Ocean Sanctuaries Act

Ratings for each Scenario:

Scenario	*Rating*	*Explanation*
1A	1	as this scenario utilizes three treatment facilities and effluent recharge sites that can be phased for each area to be addressed
2A	1	as this scenario utilizes three treatment facilities and effluent recharge sites that can be phased for each area to be addressed
3A	3	as this scenario relies on phasing one facility which can lead to construction sequencing issues and initial year operational issues due to the large variability in flows over time
4A	2	as this scenario relies on two treatment and effluent recharge sites
5A	2 a	s this scenario relies on two treatment and effluent recharge sites
6A	1	as this scenario utilizes four treatment facilities and effluent recharge sites that can be phased for each area to be addressed
7A	4	as this scenario relies on multiple treatment facilities and recharge sites and utilizes on-site innovative alternative treatment systems
8A	5	as this scenario relies on phasing one facility which can lead to construction sequencing issues and initial year operational issues due to the large variability in flows over time and the utilization of an ocean outfall for effluent disposal

Regional Opportunities: Due to economies of scale, regional wastewater management solutions can be more cost effective if treatment and effluent recharge can be done together. At this time, all of the wastewater scenarios consider a small area in Dennisport (which is part of the Herring River watershed) as part of the wastewater solution, but Harwich is considering expanded regional opportunities with the neighboring communities of Chatham, Dennis and Brewster. The availability of regional opportunities associated with each scenario is ranked as follows:

Rating	*Range*
1	Includes potential for a regional solution with Brewster, Chatham or Dennis
2	Includes potential for a regional solution with both Dennis and Chatham
3	Includes potential for a regional solution with Dennis utilizing an Ocean Outfall
4	Includes potential for a regional solution with Dennis, Chatham and Brewster
5	Regional solutions do not appear feasible

Ratings for each Scenario:

Scenario	*Rating*	*Explanation*
1A	2	as PB-3 allows for discussions with Chatham and HR-12 allows for discussions with Dennis
2A	2	as PB-3 allows for discussions with Chatham and HR-12 allows for discussions with Dennis
3A	1	as HR-12 is the only treatment and effluent recharge site and allows for discussions with Dennis
4A	2	as PB-3 allows for discussions with Chatham and HR-12 allows for discussions with Dennis
5A	2	as PB-3 utilizes facilities at Chatham and HR-12 allows for discussions with Dennis
6A	2	as PB-3 allows for discussions with Chatham and HR-12 allows for discussions with Dennis
7A	5	as economy of scale is lost at multiple small decentralized facilities due to use of I/A systems
8A	3	as discussions with Dennis may be beneficial to help pursue the use of an ocean outfall

Regulatory Considerations: Regulatory considerations include the permitting required to both construct and operate the proposed facilities, which can depend on their locations, the number of facilities proposed, and the proximity to areas requiring additional regulatory review such as coastal zones, flood plains, sensitive habitats, etc. Regulatory considerations were ranked as follows:

Rating	Range
1	Few regulatory hurdles anticipated for one treatment facility with effluent recharge
2	Some regulatory hurdles anticipated for one to two treatment facilities and one to two effluent recharge locations with effluent recharge for one facility in a Zone II
3	Additional regulatory hurdles anticipated for three to four treatment facilities and three to four effluent recharge locations with effluent recharge for one facility in a Zone II
4	Several regulatory hurdles anticipated for three to four treatment facilities and three to four effluent recharge locations with effluent recharge for one facility in a Zone II and the use of several hundred I/A systems
5	Significant regulatory hurdle because the ocean outfall option is not allowed under the Ocean Sanctuaries Act

Ratings for each scenario:

Scenario	Rating	Explanation
1A	3	as three treatment facilities and three effluent recharge sites including one in a Zone II will need to be permitted
2A	3	as three treatment facilities and three effluent recharge sites including one in a Zone II will need to be permitted
3A	1	as this relies on only one treatment facility and one effluent recharge site
4A	2	as two treatment facilities and two effluent recharge sites including one in a Zone II will need to be permitted
5A	2	as two treatment facilities and two effluent recharge sites including one in a Zone II will need to be permitted
6A	3	as four treatment facilities and four effluent recharge sites including one in a Zone II will need to be permitted
7A	4	as four treatment facilities and three effluent recharge sites including one in a Zone II will need to be permitted along with permitting I/A systems
8A	5	as this scenario relies on use of an ocean outfall which is not allowed under current Ocean Sanctuaries Act regulations

Land Ownership: Implementation of a wastewater management alternative is most feasible and cost effective when all infrastructure is located on town-owned land, and land acquisition is not necessary. Municipal town-owned land is preferred over school department or conservation town-owned lands. Therefore, the alternatives were ranked based on the need for land acquisition as follows:

Rating	*Range*
1	All major transport, treatment, and recharge sites can be accommodated on existing municipal town-owned land
2	Most major transport, treatment, and recharge sites can be accommodated on existing town-owned land or one to two parcels owned by other town or private entities
3	Most major transport, treatment, and recharge sites can be accommodated on existing town-owned land with one parcel designated as school property and one to two privately owned parcels
4	Most major transport, treatment, and recharge sites can be accommodated on existing town-owned land with one parcel designated as school property or two privately owned parcels along with several hundred permitted I/A systems recharging effluent on private property
5	This scenario utilizes the Town property for treatment, and the ocean outfall for effluent recharge

Ratings for each scenario:

Scenario	*Rating*	*Explanation*
1A	3	as scenario relies on acquisition of privately owned site PB-3, and the SH-2 school site to implement
2A	3	as scenario relies on acquisition of privately owned site PB-3 , and the SH-2 school site to implement
3A	1	as scenario relies on use of only municipal, town owned lands to implement
4A	2	as scenario relies on acquisition of privately owned site PB-3 to implement
5A	2	as scenario relies on acquisition of privately owned site PB-3 to implement and an agreement with Chatham for use of their treatment facility
6A	3	as scenario relies on acquisition of privately owned sites PB-3, OW-2 and the SH-2 school site to implement to implement
7A	4	as scenario relies on acquisition of privately owned sites PB-3, OW-2 and the SH-2 school site to implement. Includes the use of I/A systems on privately owned sites
8A	5	as site utilizes ocean outfall for effluent disposal and will require use of federal waters

Environmental Criteria (16 Percent Weight)

Effluent Recharge Impacts: Each scenario has one or more effluent recharge areas proposed. The potential challenges resulting from recharge in those locations include recharge into nitrogen sensitive watersheds and resultant mounding from recharge into areas with known high groundwater. The potential impacts from effluent recharge were ranked as follows:

Rating	*Range*
1	Impacts from recharge anticipated to be minimal due to the use of an ocean outfall for effluent recharge
2	Impacts from recharge anticipated to be minimal due to moderate to excellent depth to groundwater
3	Impacts from shallow depth to groundwater are anticipated to me moderate to surrounding areas but can be mitigated
4	Impacts at multiple recharge sites are anticipated and will require greater mitigation due to shallow depth to groundwater
5	Impacts at multiple recharge sites are anticipated and will require greater mitigation due to shallow depth to groundwater at several sites

Ratings for each scenario:

Scenario	*Rating*	*Explanation*
1A	2	as this scenario utilizes HR-12 and SH-2 which have moderate depth to groundwater and PB-3 which has excellent depth to groundwater
2A	2	as this scenario utilizes HR-12 and SH-2 which have moderate depth to groundwater and PB-3 which has excellent depth to groundwater
3A	3	as this scenario utilizes HR-12 which has moderate depth to groundwater
4A	2	as this scenario utilizes HR-12 which has moderate depth to groundwater and PB-3 which has excellent depth to groundwater
5A	2	as this scenario utilizes HR-12 which has moderate depth to groundwater and PB-3 which has excellent depth to groundwater
6A	4	as this scenario utilizes HR-12 and SH-2 which have moderate depth to groundwater, PB-3 which has excellent depth to groundwater and OW-2 which has shallow depth to groundwater
7A	4	as this scenario utilizes HR-12 and SH-2 which have moderate depth to groundwater, PB-3 which has excellent depth to groundwater and OW-2 which has shallow depth to groundwater
8A	1	as this scenario utilizes an ocean outfall for effluent disposal

Water Balance Considerations: Preserving a water balance between the many watersheds in Harwich may be a consideration if any of the existing sub-basins are perceived to be stressed from a water management perspective. The water balance criterion was ranked as follows:

Rating	Range
1	Scenario maintains water balance in all locations
2	Scenario maintains water balance to most locations, and transfers flow only from one watershed
3	Scenario maintains water balance in some locations but transfers water from two basins to other locations
4	Scenario transfers water to the greatest extent (three or more basins) to other watersheds
5	Scenario transfers water to the ocean

Ratings for each scenario:

Scenario	Rating	Explanation
1A	3	as this scenario recharges effluent within three watersheds
2A	3	as this scenario recharges effluent within three watersheds
3A	4	as this scenario collects all wastewater and recharges the effluent to only one watershed
4A	4	as this scenario recharges effluent within two watersheds
5A	4	as this scenario recharges effluent within watersheds
6A	2	as this scenario recharges effluent within four watersheds
7A	2	as this scenario recharges effluent locally and within four watersheds
8A	5	as this scenario collects all wastewater and disposes of the effluent to the ocean

Sensitive Receptors: The presence of sensitive receptors (e.g., schools, residents, natural resources, etc.) in the vicinity of proposed treatment and effluent recharge system locations or other areas which could have significant construction or other perceived impacts must be considered. The potential impacts to sensitive receptors of each scenario were ranked as follows:

Rating	*Range*
1	No sensitive receptors located within 500-ft of the vicinity of the proposed treatment facilities
2	Limited sensitive receptors located within 500-ft of the vicinity of the proposed treatment facilities and mitigation available to minimize impacts
3	Several sensitive receptors located within 500-ft of the vicinity of the proposed treatment facilities requiring more mitigation
4	Several sensitive receptors located within 500-ft of the vicinity of the proposed treatment facilities that are likely to limit the construction of a wastewater facility
5	The utilization of an ocean outfall discharges effluent to a sensitive receptor as defined by the Ocean Sanctuaries Act

Ratings for each scenario:

Scenario	*Rating*	*Explanation*
1A	3	as scenario includes site SH-2 which has receptors (schools) within 500-lf and PB-3 which may have receptors close to 500-lf. This scenario also utilizes site HR-12 which is well buffered but has reported natural heritage species which have a special concern and threatened status.
2A	3	as scenario includes site SH-2 which has receptors (schools) within 500-lf and PB-3 which may have receptors close to 500-lf. This Scenario utilizes site HR-12 which is well buffered but has reported natural heritage species which have a special concern and threatened status.
3A	2	as scenario utilizes site HR-12 which is well buffered but has reported natural heritage species which have a special concern and threatened status.
4A	3	as scenario includes PB-3 which may have receptors close to 500-lf and HR-12 which is well buffered but has reported natural heritage species which have a special concern and threatened status.
5A	3	as scenario includes PB-3 which may have receptors close to 500-lf and HR-12 which is well buffered but has reported natural heritage species which have a special concern and threatened status.
6A	4	as scenario includes sites SH-2 (schools) and OW-2 with several receptors within 500-lf and PB-3 which may have receptors close to 500-lf. This scenario utilizes site HR-12 which is well buffered but has reported natural heritage species which have a special concern and threatened status.
7A	4	as scenario includes sites SH-2 (schools) and OW-2 with several receptors within 500-lf and PB-3 which may have receptors close to 500-lf. This scenario utilizes site HR-12 which is well buffered but has reported natural heritage species which have a special concern and threatened status.
8A	5	as scenario includes site HR-18 which has receptors within 500-lf. This site is within wetlands, is coded as conservation land and is within a Priority Habitat of Rare Species zone. The presence of the ocean outfall means that the effluent will be sent to a sensitive receptor.

Construction Impacts: Each scenario will involve some level of construction impacts. Scenarios anticipated to require deeper construction, more time consuming construction, more challenging construction methods (e.g., trenchless technologies or complex dewatering systems), or work in more challenging areas (e.g., major roads, wetland areas, etc.) are ranked less favorably due to the higher likelihood of impacts to surrounding areas than those for which construction is anticipated to be straightforward. The construction impacts were ranked as follows:

Rating	Range
1	Construction is anticipated to be relatively straightforward and impacts limited by mitigation and utilize one treatment facility and effluent recharge facility.
2	Construction is anticipated to be more complex with a higher likelihood of impacts and utilize two facilities for treatment and effluent recharge.
3	Construction is anticipated to be more complex with a higher likelihood of impacts and utilize three facilities for treatment and effluent recharge.
4	Construction is anticipated to be more complex with a higher likelihood of impacts and utilize four facilities for treatment and effluent recharge.
5	Construction is anticipated to be very complex or have impacts needing more significant mitigation

Ratings for each scenario:

Scenario	Rating	Explanation
1A	3	as this scenario requires three treatment facilities
2A	3	as this scenario requires three treatment facilities
3A	1	as this scenario requires one treatment facility
4A	2	as this scenario requires two treatment facilities
5A	3	as this scenario requires two treatment facilities
6A	4	as this scenario requires four treatment facilities
7A	5	as this scenario requires four treatment facilities and about 6,600 I/A on-site systems
8A	5	as this scenario requires one treatment facility, but the Ocean Outfall will contribute to significant construction impacts

10.4.4 Matrix Results

All of the factors described above in Section 10.4.3 were tabulated below into a matrix which shows the rank for each evaluation criterion and respective assigned weight. The evaluation criteria are presented in Table 10-7. Each criterion is ranked from 1 to 5. Each criterion was weighted based on preference for that particular category. At this time the relative costs are weighted higher than the other criteria because the Wastewater Management Subcommittee believes that the cost of the system will be a significant deciding factor in the outcome of the recommended wastewater plan. The end result is a matrix that ranks each of the eight options with a low score of 145 and a high score of

402. In this matrix, the low score of 145 is given to Scenario 3A and the high score of 402 is given to Scenario 7A. This is similar to the results in Table 10-6 and is not unexpected since the weighting factor is highest for the relative costs.

Table 10-7
Wastewater Scenarios Matrix

Evaluation of Alternatives - Harwich CWMP Wastewater Scenarios									
Evaluation Criteria	*Criteria Weight*	*1A*	*2A*	*3A*	*4A*	*5A*	*6A*	*7A*	*8A*
RELATIVE COSTS									
Capital Costs	15	2	2	2	2	2	2	5	5
O&M Costs	15	4	4	1	3	2	5	5	1
Cost Efficiency (EAC)	20	4	4	1	3	2	5	5	5
TECHNICAL CRITERIA									
Complexity of Transport	4	2	1	3	1	4	2	2	5
Reliability	4	3	3	2	3	4	5	5	1
Effluent Recharge Issues	4	3	3	1	2	2	4	4	5
Future Recharge Capacity	6	3	3	5	4	4	2	2	1
INSTITUTIONAL CRITERIA									
Phasing	4	1	1	3	2	2	1	4	5
Regional Opportunities	4	2	2	1	2	2	2	5	3
Regulatory Considerations	4	3	3	1	2	2	3	4	5
Land Ownership	4	3	3	1	2	2	3	4	5
ENVIRONMENTAL CRITERIA									
Effluent Recharge Impacts	4	2	2	3	2	2	4	4	1
Water Balance Considerations	4	3	3	4	4	4	2	2	5
Sensitive Receptors	4	3	3	2	3	3	4	4	5
Construction Impacts	4	3	3	1	2	3	4	5	5
TOTAL WITH WEIGHTING	*100*	270	266	145	223	204	321	402	366

The Wastewater Management Subcommittee raised the concern about whether another scenario should be evaluated that relied upon the utilization of several 100,000gpd treatment and recharge facilities. In theory, this could help with phasing and potentially allow for standard modular treatment facilities. Scenario 6A is the closest scenario to this additional option as it utilizes four treatment facilities and associated recharge sites. On an equivalent annual cost basis, scenario 6A is 20 percent more costly than scenario 3A which is the least costly. Scenario 6A is also 100 to 150 points higher than the best rated scenarios in the evaluation matrix, thus adding more small scale treatment facilities to another scenario would only make that option less competitive and that is prior to locating additional acceptable effluent recharge sites.

All of the scenarios presented in this section assume that the Herring River watershed required a 25 septic nitrogen removal. The scenarios were developed before the Draft MEP report for Herring River became available and revised that percentage to 58 percent. The Town decided not to update these scenarios because all eight of them would require similar revisions to realize the 58 percent removal of nitrogen. Since these eight scenarios are a relative assessment aimed at determining if the Town should further develop more accurate planning level costs, it was decided to keep each scenario with the original 25 percent nitrogen removal assumption in The Herring River. It is unlikely that the overall ranking of the eight scenarios would change if the nitrogen removal revisions to the Herring River were included.

10.5 Recommended Scenarios for Further Analysis

Wastewater Management Subcommittee discussed the evaluation results and recommended that Scenarios 3A, 4A and 5A be brought forward and evaluated in more detail since they are the best scenarios in terms of the relative costs, technical, institutional, and environmental criteria. Scenarios 4A and 5A are essentially the same with scenario 5A utilizing a regional treatment facility at the Chatham Water Pollution Control Facility. These three scenarios will be evaluated in greater detail in Section 12 of this CWMP and will include planning level detailed costs for treatment facility size and type, collection system size and type, individual site conditions (including considerations for state roads), and the need for specific infrastructure (such as pumping stations). These three scenarios will also include an update to the nitrogen removal requirement in the Herring River for TMDL compliance.