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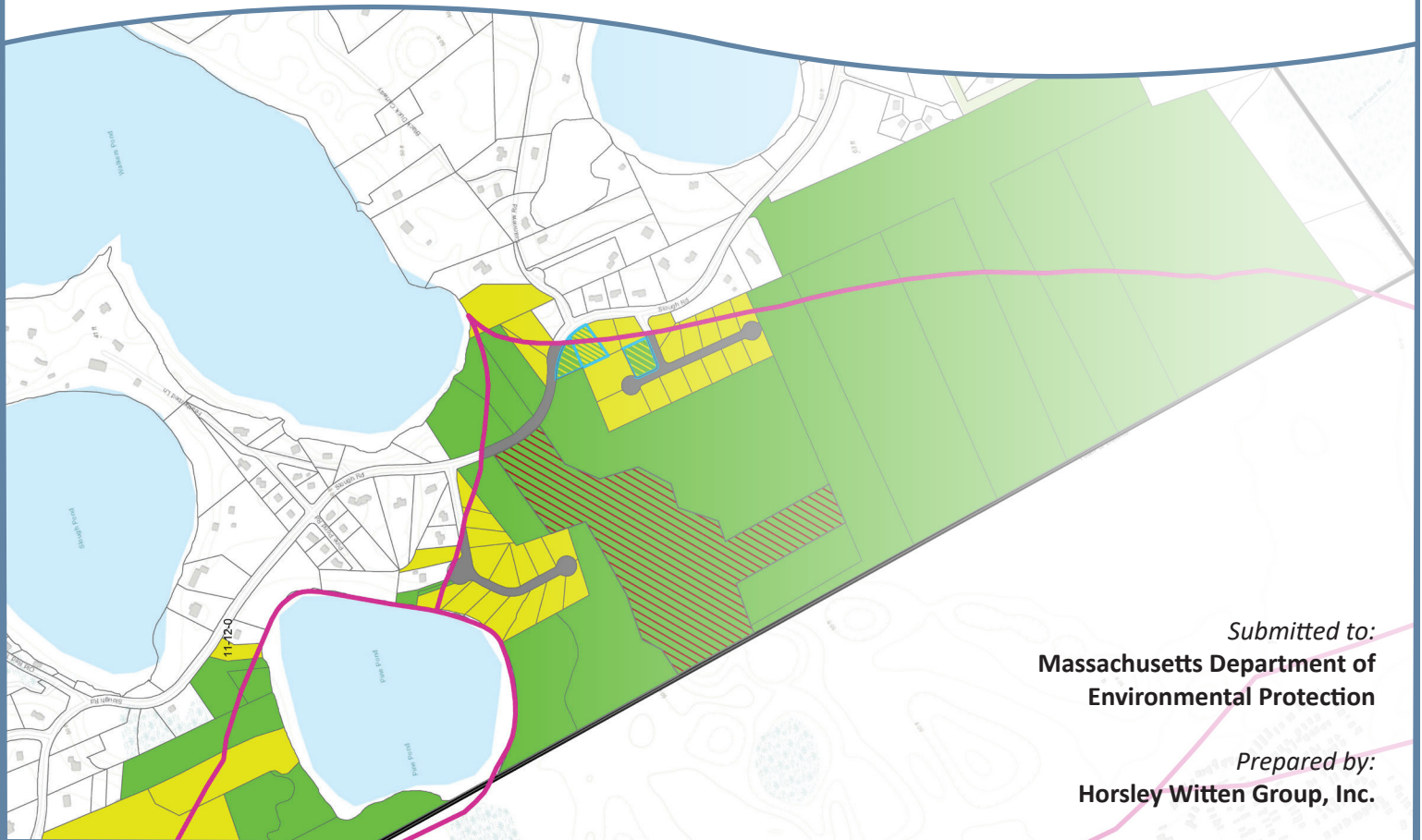
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De Minimis Nitrogen Load Exemption Application - Swan Pond River Watershed

Brewster, MA

April 10, 2024



Submitted to:
Massachusetts Department of
Environmental Protection

Prepared by:
Horsley Witten Group, Inc.

**De Minimis Nitrogen Load Exemption Application
Swan Pond River Watershed
Brewster, MA**

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**De Minimis Nitrogen Load Exemption Application
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Introduction

On behalf of the Town of Brewster, the Horsley Witten Group, Inc. (HW) is submitting this application for a *De Minimis* Nitrogen Load Exemption for the Town's portion of the Swan Pond River watershed (Figure 1). This application is being submitted according to the requirements provided in the Massachusetts Watershed Permit Regulations (314 CMR 21.12). The regulations allow this exemption if the Town can document that the baseline and updated nitrogen loads for the Town's portion of the watershed do not exceed 3% of the total controllable, attenuated nitrogen load for the entire Swan Pond River watershed (314 CMR 12.12(2)).

This assessment is based on the Massachusetts Estuaries Program (MEP) Report for the Swan Pond River watershed prepared by the University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST, October 2012). This report documents the nitrogen loading factors used to calculate the nitrogen load from various sources in the watershed and provides the total baseline nitrogen load at the time of the report.

This application has been prepared as part of the Town's Integrated Water Resource Management Plan (IWRMP, HW, 2013) which is summarized below. Information on the specific Swan Pond River subwatersheds located in Brewster and their associated attenuation rates is then discussed. This is followed by a summary of the extent of development and the associated nitrogen loads for three scenarios:

- Baseline nitrogen load at the time of the MEP report (2012),
- The updated nitrogen load as of September 2023, and
- The nitrogen load associated with buildout conditions in the Town's portion of the watershed.

The information provided below demonstrates that the baseline nitrogen load for Brewster's portion of the Swan Pond River watershed is 0.65% of the total controllable load. The updated nitrogen load and the buildout controllable nitrogen load are 0.53% and 0.56% of the total controllable load respectively. These are both lower than the baseline load and significantly below the 3% exemption threshold.

Brewster's Integrated Water Resource Plan

Brewster completed its IWRMP in 2013 and it described the water quality issues associated with drinking water, coastal estuaries, and freshwater ponds. This plan was submitted to the Massachusetts Department of Environmental Protection (DEP) for review; however, DEP did not complete the review as there were no proposed actions that required a state permit to implement. Since then, the Town has worked to implement the recommendations in the report which include:

- Coordination with Chatham, Harwich, and Orleans on the Pleasant Bay watershed permit, including analysis of options to meet the Town's obligations for nitrogen removal in its portion of the watershed. This includes changes in fertilizer applications at the town-owned Captains Golf Course, which has achieved more than 50% of the nitrogen reduction goal the Town needs to meet for Pleasant Bay. It also involves development of a plan to meet the remaining nitrogen reduction goals including those associated with future, buildout development, potentially using a neighborhood wastewater system, innovative/alternative septic treatment systems or a nitrogen trade with another town.
- Ongoing projects to evaluate freshwater ponds and develop plans to protect and restore their water quality.
- Passage of a new stormwater management regulation to minimize water quality impacts to the Town's water resources.
- Upgrades to stormwater treatment facilities at town-owned landings on freshwater ponds and parking areas adjacent to town beaches.
- Updates to the Town's Water Quality Review bylaw which currently limits nutrient loading in Zone II wellhead protection areas and the Pleasant Bay watershed.

This information is provided to document the Town's water resource planning work for estuaries and for the Town's other important water resources as required in the Watershed Permit Regulations (314 CMR 21.2(a)).

Overview of Swan Pond River Watershed

The Swan Pond River is located along the western border of the Town of Dennis. It originates at Swan Pond and flows south into Nantucket Sound (Figure 1). The watershed is predominantly in Dennis with small areas located in Harwich along the western boundary of the watershed and in Brewster on the northern portion of the watershed. The land area in Brewster encompasses 162 acres or 6.8 % of the overall watershed (2,379 acres). The portion of the watershed in Brewster is located at the northern end of the overall watershed.

According to the SMAST Report, Brewster's land is located in three of the subwatersheds that comprise the overall Swan Pond River watershed. They are the Pine Pond, the NW Dennis Wells and the Swan Pond subwatersheds. Information on each subwatershed is provided below, including how nitrogen loads in Brewster's portion of them is reduced by attenuation and by how these watersheds also contribute a portion of their load to other watersheds, such that not all of it flows to the Swan Pond River.

Pine Pond

Pine Pond is located entirely in Brewster, along the border with the Town of Dennis (Figure 2). Pine Pond has good water quality as described in Appendix A. This is due in part to the limited number of septic systems within 300 feet of the upgradient side where groundwater flows towards the pond. The watershed to the pond is located in Brewster and Dennis. The Brewster portion comprises 41.7 acres. Groundwater and associated nitrogen load flow from the

watershed into Pine Pond. The flow through the pond reduces the overall load that can migrate to Swan Pond River through a process known as attenuation. According to the SMAST report, 50% of the nitrogen that originates in the Pine Pond subwatershed is attenuated in the pond, meaning only half of the nitrogen load flows into areas downgradient of the pond. As required under the watershed permit regulations, the attenuated load is used to evaluate the percentage of the nitrogen contribution from the Town's portion of the watershed. In addition, according to the SMAST report, 59% of the attenuated nitrogen load from the Pine Pond subwatershed enters the NW Dennis Wells subwatershed which then flows to both the Swan Pond River and Bass River watersheds as discussed below. The remaining 41% flows to the northeast towards Walkers Pond which then drains to Upper and Lower Mill Ponds before entering Stony Brook and flowing into Cape Cod Bay. This means that only 29.5% of the overall nitrogen load that originates in the Pine Pond subwatershed flows south with a portion of it entering the Swan Pond River estuary.

NW Dennis Wells Subwatershed

This subwatershed encompasses the land area from which groundwater flows to a series of public supply wells located in Dennis. The groundwater and associated nitrogen load in this subwatershed then migrates to both the Bass River and Swan Pond watersheds. The SMAST report documents that 70% of the overall nitrogen load that originates in the NW Dennis Wells subwatershed (or upgradient subwatersheds) flows into the Bass River watershed. Thirty percent of the load migrates to the Swan Pond River watershed. Therefore, the nitrogen loading impact from Brewster's portion of this subwatershed is reduced by 70%.

In summary, only 30% of the nitrogen load that originates in or migrates through the NW Dennis Wells subwatershed remains in the Swan Pond River Watershed. As discussed above, the nitrogen load from Pine Pond is reduced to 29.5% of the total load that originates in this subwatershed before it enters the NW Dennis Wells Subwatershed where the load is again reduced by 70%. These load reduction factors are factored into the nitrogen loading calculations used to document the controllable nitrogen load that originates in Brewster and flows to the Swan Pond River.

Swan Pond Subwatershed

A portion of one parcel in Brewster is also located in the portion of the Swan Pond subwatershed where the travel time through groundwater to Swan Pond is greater than ten years. It is labeled Swan Pond GT 10 in Figure 1. This parcel was undeveloped at the time of the initial SMAST report. Since then, the Town has protected this parcel to prohibit any future development. A portion of a second parcel is also located in this subwatershed, but it attributed to the NW Dennis Wells subwatershed in the SMAST report.

***De Minimis* Nitrogen Load Calculations for Pine Pond, NW Dennis Wells, and Swan Pond GT10 Subwatersheds**

The information documenting the fact that the overall, controllable nitrogen load from Brewster's portion of the Swan Pond River watershed is less than 3% is provided below. A

summary of the land use in Brewster is provided first, showing the level of development at the time of the Swan Pond River SMAST report. This is followed by an updated land use summary for 2023, used to calculate the updated nitrogen load as required by the regulations. An overview of the potential buildout development for Brewster is also provided.

The nitrogen loading calculations are then described, providing a summary of the nitrogen load factors related to each Brewster land use and the overall load by land use in each subwatershed. These loads are then adjusted based on the appropriate attenuation rate for Pine Pond and the percentages by which the load from the Pine Pond and NW Dennis Wells subwatersheds is split such that part flows to the Swan Pond River and part flows to another watershed. The final loads are used to calculate the percentage of the overall load to Swan Pond River that originates in Brewster.

Land Use Assessment

Brewster's baseline land use in the Pine Pond, NW Dennis Wells and Swan Pond GT 10 subwatersheds at the time of the SMAST report is shown on Figure 2. This figure also shows the changes in land use from the 2012 SMAST report to 2023 that were used to calculate the updated nitrogen load for these subwatersheds. Overall, the land use consists of residential properties, protected open space, a former cranberry bog, a religious facility, paved roadways, and undeveloped parcels that could potentially have a house built on them in the future. The land use data for the baseline conditions was taken from the SMAST spreadsheets used to calculate the overall Swan Pond River watershed nitrogen load, which were provided to HW by SMAST. This data, and the updated information of the 2023 and buildout development scenarios are summarized in a separate excel file that documents the land use assessment and nitrogen loading calculations used for this assessment (Swan Pond River Exemption Calculationss.xlsx).

The updated land use data for 2023 was developed by comparing the 2011 SMAST land use information with the current, 2023 data available from the Town's Board of Assessors database. No new homes were built in the watershed during that timeframe. The only changes are related to the Town's acquisition and protection of three parcels for open space preservation. A conservation restriction was placed on lot 10-25-0 that prohibits any future use of fertilizers on the Sarabella Bog, eliminating a nitrogen load that was included in the baseline load (see Figure 2 for location). Two other parcels listed as developable in the SMAST baseline data (lots 9-15-0 and 8-4-0) are now owned by the Town of Brewster and have conservation restrictions prohibiting future development. These lots were both labeled as vacant land in the baseline load developed by SMAST so there is no increase in the updated or buildout load on these properties.

HW also analyzed the potential for additional development under buildout conditions. The entire watershed area in Brewster is zoned residential, with either a 100,000 square foot or 60,000 square foot minimum lot size required for each parcel. For the Pine Pond Subwatershed, all the properties are either protected open space or have an existing residence. The only exception is an existing church on the property at the northwest corner of the watershed (lot 3-

4-0). The four residential properties partially located in the northern portion of the subwatershed (Figure 2, lots 11-16-0, 12-1-0, 12-2-0, and 12-3-0) could potentially be subdivided based on the minimum lot size allowed under zoning. However, the current homes on these properties are located within the Pine Pond subwatershed and any additional homes would be built outside the watershed. For this reason, no additional development is expected in the Pine Pond Subwatershed.

For the NW Dennis Wells subwatershed, there are two residentially zoned parcels that are currently undeveloped as shown on Figure 2. These parcels are listed below with information on their development potential.

- Lot 10-18-0: This lot is owned by the Town of Brewster but there is no conservation restriction on the property. There could potentially be a house built on this property in the future.
- Lot 10-22-0: This lot could have a house built on it in the future as there are no development constraints on the property.

Overall, two of the undeveloped parcels in the NW Dennis Wells subwatershed could potentially have a new home built on them.

The one Brewster lot in the Swan Pond River watershed (Lot 8-4) was undeveloped at the time of the SMAST report. Following that, the property was permanently preserved by the Town of Brewster, so no additional development will occur on this parcel.

Finally, there is the potential for existing homes to be enlarged with one or more additional bedrooms but, based on the nitrogen loading calculations used in the SMAST report, no additional nitrogen load is assigned to this type of development. The SMAST report calculates the nitrogen load from a home based on the average water use per residence. It does not take into account the number of bedrooms on each parcel. The buildout calculations used by SMAST only involve the potential to subdivide a parcel if it can accommodate more than one home under the Town's zoning requirements.

If a house was enlarged, the nitrogen load is also limited under the Town's Water Quality Review Bylaw which requires a maximum nitrogen concentration of 5 mg/L in the mapped Zone II wellhead protection areas and the Pleasant Bay Watershed. The Pine Pond and NW Dennis Wells subwatersheds are located in mapped Zone II areas in Brewster, so development in these areas is subject to the Water Quality Review Bylaw. Therefore, if a new bedroom was added to a house, the property owner would have to prove the 5 mg/L standard would be met, and, if not, would have to install an I/A septic system or take other actions to reduce the overall load below the 5 mg/L threshold. Therefore, the potential new load from any increase in residential land use on a parcel would not likely result in an increase in the overall nitrogen load.

In summary, the land uses in Brewster's portion of the two subwatershed that are or will contribute to the controllable nitrogen load to the Swan Pond River are listed below.

	Baseline (2011)	Updated Load (2023)	Buildout
Developed Residential Lots	41	41	43
Religious Institutions	1	1	1
Cranberry Bogs	1	1	1

The major change between the baseline timeframe and the 2023 updated load timeframe is the cessation of fertilizer applications at the Sarabella bog on property owned by the Town. A conservation restriction on this parcel prohibits any future fertilizer applications. Therefore, the updated and buildout nitrogen loads are less than the baseline load documented in the SMAST report.

Nitrogen Loading Factors

HW used the nitrogen loading factors used in the SMAST report to calculate the controllable nitrogen load from the properties in Brewster and compare them to the total controllable nitrogen load throughout the Swan Pond River watershed. The controllable nitrogen load is defined in the watershed regulations as “the total nitrogen load from all controllable loads within the watershed that reaches the embayment or estuary (314 CMR 21.02). The controllable load therefore only includes nitrogen from wastewater discharges, fertilizer applications and runoff from impervious surfaces including roads, driveways, and roofs.

These nitrogen loading factors for these controllable loads are summarized in Table 1, and include the water use and nitrogen concentrations used to calculate wastewater loads, the fertilizer application and leaching rates for lawns, and the nitrogen concentrations and recharge rates for impervious surfaces. They also include the fertilizer application rates for the cranberry bog located within Brewster’s portion of the NW Dennis Wells subwatershed. SMAST did not include any cranberry bog areas in Brewster’s portion of the Pine Pond subwatershed. No changes in these nitrogen loading factors were made in the calculations to determine Brewster’s portion of the Swan Pond River controllable nitrogen load.

Brewster’s percentage of the overall load to Swan Pond River is based on the existing and future land uses in Brewster and the nitrogen loading factors shown on Table 2. It is also based on the total, controllable, attenuated load from the entire Swan Pond River watershed, which is 15,613 kg/year. The total controllable load for the watershed was calculated by subtracting the loads associated with natural areas and surface water bodies from the 15,956 kg/year overall load calculated by SMAST for the entire Swan Pond River watershed.

Table 1: Nitrogen Loading Factors To Calculate De Minimis Nitrogen Load		
Residential Properties		
Wastewater Load		
	Effluent Nitrogen Conc.	26.25 mg/L
	Water Use	180 gpd/house
	Consumptive Water Use Factor	90%
Lawn Fertilizer Load		
	Lawn Area per Home	5,000 sq. ft
	Fertilizer Application Rate	1.08 lbs/1,000 sq.ft
	Leaching Rate	20%
	Percentage of Properties that Use Lawn Fertilizer	50%
Building Roof Load		
	Nitrogen Concentration	0.75 mg/L
	Roof Size	1,450 sq. ft
	Recharge Rate, Impervious Surfaces	40 in/year
Driveway Load		
	Nitrogen Concentration	1.5 mg/L
	Driveway Size	1,500 sq. ft
	Recharge Rate, Impervious Surfaces	40 in/year
Cranberry Bogs		
	Fertilizer Application Rate	0.716 lbs/1,000 sq. ft.
	Leaching Rate	66%
Paved Roads		
	Nitrogen Concentration	1.5 mg/L
	Driveway Size	1,500 sq. ft
	Recharge Rate, Impervious Surfaces	40 in/year
<i>The Nitrogen Loading Factors are taken from the MEP report for the Swan Pond River Watershed (SMAST October, 2012)</i>		

Brewster's Nitrogen Load Contribution to The Swan Pond River Watershed

HW calculated Brewster's nitrogen load to the Swan Pond River watershed using the summary nitrogen loading spreadsheet developed by SMAST. Specifically, the land use input worksheet from the file titled SwanPond_MEP_SummaryDEP.xls was used. It was modified to include only the nitrogen loads from properties in Brewster for the baseline conditions, and then updated for the minor changes in land use for the updated nitrogen load and the buildout scenario. The results of the calculations are summarized in Table 2 (below) and are based on the calculations provided in the separate Excel workbook submitted with this application (Swan Pond River Exemption Calculations.xlsx).

Table 2: Summary of Nitrogen Loading Calculations for Brewster's Portion of the Swan Pond River Watershed

	Pine Pond Subwatershed		NW Dennis Wells Subwatershed			Swan Pond River	Total
			Including Contribution from Pine Pond			Subwatershed	
	Unattenuated Contribution (kg/yr)	Attenuated Load (kg/yr)	59% of Pine Pond Attenuated Load	Unattenuated Contribution (kg/yr)	Contribution to Swan Pond River	Unattenuated Contribution (kg/yr)	Attenuated Load (kg/yr)
Baseline Nitrogen Load		50%	59%		30%		
Wastewater	35.32	17.66	10.42	217.51	68.38	0.00	68.38
Lawn Fertilizer	2.94	1.47	0.87	17.64	5.55	0.00	5.55
Driveways and Roads	1.27	0.64	0.38	25.20	7.67	0.00	7.67
Roofs	0.62	0.31	0.18	3.70	1.16	0.00	1.16
Cranberry Bogs	0.00	0.00	0.00	63.54	19.06	0.00	19.06
Waterbodies	108.71	54.35	32.07	0.00	9.62	0.00	9.62
Natural Areas	3.29	1.65	0.97	22.00	6.89	0.25	7.14
Total Load From Brewster	152.14	76.07	44.88	349.58	118.34	0.25	118.59
Total Controllable Load	40.15	20.07	11.84	327.58	101.83	0.00	101.83
				Total Controllable Load to Swan Pond River			15,613
				Brewster's Controllable Percent Contribution			0.65%
	Pine Pond Subwatershed		NW Dennis Wells Subwatershed			Swan Pond River	Total
			Including Contribution from Pine Pond				
	Unattenuated Contribution (kg/yr)	Attenuated Load (kg/yr)	59% of Pine Pond Attenuated Load	Unattenuated Contribution (kg/yr)	Contribution to Swan Pond River	Unattenuated Contribution (kg/yr)	Attenuated Load (kg/yr)
Updated (2023) Nitrogen Load		50%	59%		30%		
Wastewater	35.32	17.66	10.42	217.51	68.38	0.00	68.38
Lawn Fertilizer	2.94	1.47	0.87	17.64	5.55	0.00	5.55
Driveways and Roads	1.27	0.64	0.38	26.48	8.06	0.00	8.06
Roofs	0.62	0.31	0.18	3.70	1.16	0.00	1.16
Cranberry Bogs	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waterbodies	108.71	54.35	32.07	0.00	9.62	0.00	9.62
Natural Areas	3.29	1.65	0.97	21.96	6.88	0.25	7.13
Total Load From Brewster	152.14	76.07	44.88	287.27	99.65	0.25	99.90
Total Controllable Load	40.15	20.07	11.84	265.32	83.15	0.00	83.15
				Total Controllable Load to Swan Pond River			15,613
				Brewster's Controllable Percent Contribution			0.53%
	Pine Pond Subwatershed		NW Dennis Wells Subwatershed			Swan Pond River	Total
			Including Contribution from Pine Pond				
	Unattenuated Contribution (kg/yr)	Attenuated Load (kg/yr)	59% of Pine Pond Attenuated Load	Unattenuated Contribution (kg/yr)	Contribution to Swan Pond River	Unattenuated Contribution (kg/yr)	Attenuated Load (kg/yr)
Buildout Nitrogen Load		50%	59%		30%		
Wastewater	35.32	17.66	10.42	229.28	71.91	0.00	71.91
Lawn Fertilizer	2.94	1.47	0.87	18.62	5.84	0.00	5.84
Driveways and Roads	1.27	0.64	0.38	29.02	8.82	0.00	8.82
Roofs	0.62	0.31	0.18	3.90	1.22	0.00	1.22
Cranberry Bogs	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waterbodies	108.71	54.35	32.07	0.00	9.62	0.00	9.62
Natural Areas	3.29	1.65	0.97	21.81	6.84	0.25	7.09
Total Load From Brewster	152.14	76.07	44.88	302.64	104.26	0.25	104.51
Total Controllable Load	40.15	20.07	11.84	280.82	87.80	0.00	87.80
				Total Controllable Load to Swan Pond River			15,613
				Brewster's Controllable Percent Contribution			0.56%

The overall, attenuated nitrogen load originating from Brewster under the baseline, 2012 land use conditions is 119 kg/N per year. This is 0.65% of the total attenuated load to the watershed. The calculations include the 50% attenuation rate associated with Pine Pond and the 59% contribution from Pine Pond to the NW Dennis Wells subwatershed. It also includes the 30% contribution of nitrogen to Swan Pond River from the NW Dennis Wells subwatershed.

Overall, the total baseline nitrogen load from the Pine Pond subwatershed is 40.15 kg/yr (Table 2). Because the load entering the pond is attenuated by 50%, the load is reduced to 20.7 kg/yr. Then only 59% (or 11.8 kg/yr.) of the load continues to migrate to the NW Dennis Wells subwatershed with the rest flowing to the northeast towards Cape Cod Bay. Then 30% of the load from the NW Dennis Wells subwatershed flows to the Swan Pond River. Therefore, the overall attenuated load from Pine Pond that travels to Swan Pond River is 3.5 kg/year.

The updated nitrogen load using 2023 land use data shows that Brewster's contribution is currently 100 kg/yr. or 0.53% of the total load. The reduction in nitrogen load from the baseline to the updated nitrogen load scenarios is due to the placement of a conservation restriction on the town owned parcel that contains the Sarabella cranberry bog. The restrictions include a provision that no fertilizers can be used on the bog, lowering the load from this parcel by 63.5 kg/year.

Under buildout conditions, the potential construction of two additional homes on currently undeveloped parcels could increase the nitrogen load by approximately 10 kg/yr. Therefore, taking into account the 30% contribution from the NW Dennis Wells subwatershed, the controllable buildout load from Brewster is 105 kg/yr. or 0.56% of the nitrogen load to Swan Pond River. This buildout load is still below the baseline load documented in the SMAST report because the new load is offset by the restrictions on fertilizer applications to the Sarabella cranberry bog.

Each of these scenarios documents that Brewster's contribution to the Swan Pond River watershed is significantly below the 3% threshold that must be met to receive a *De Minimis* Nitrogen Load Exemption under the state's new watershed permit regulations. Therefore, The Town of Brewster requests that DEP approve this application such that a watershed permit will not need to be filed for this watershed, and that the upgrade requirements for septic systems in this watershed included in the new Title 5 regulations (314 CMR 15.215) will be suspended.

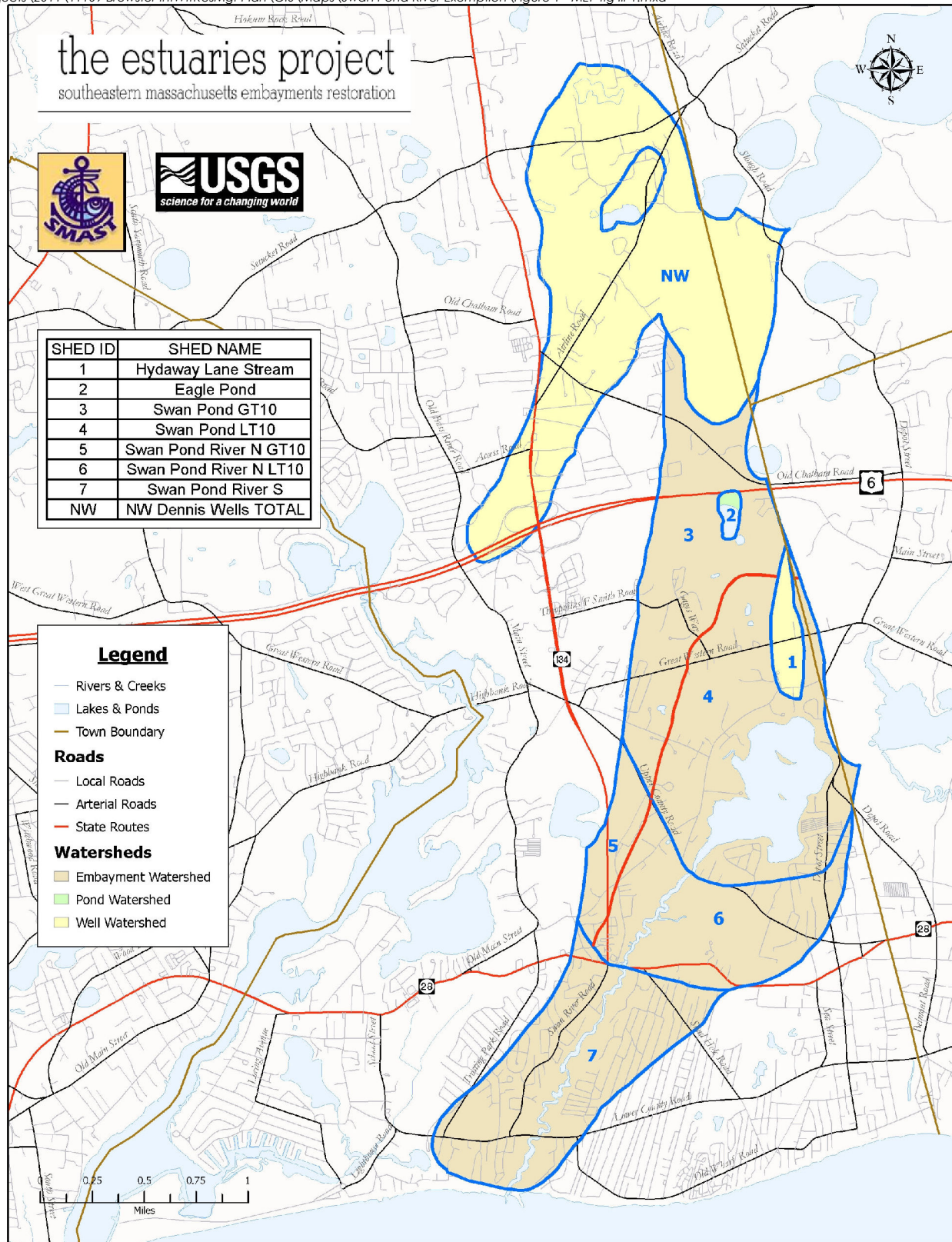
The Town will publish a notice of this exemption request in the Environmental Monitor within 28 days of when it is submitted to DEP and will meet the public notice requirements for Environmental Justice Populations as required under the regulations (314 CMR 21.12 (1)). Copies of the public notifications will be provided to DEP when they are available.

References

Horsley Witten Group, Inc. 2013 Integrated Water Resource Management Plan, Town of Brewster, Massachusetts.

University of Massachusetts School of Marine Science and Technology, October 2012. Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Swan Pond River Embayment System. Town of Dennis, Massachusetts.

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Date: 11/29/2023

Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Figure III-1 from "Howes B., Eichner, H. Ruthven, R. Samimy, D. Schlezinger, and J. S. Ramsey (2011). Massachusetts Estuaries Project Linked Watershed-Embayment Modeling Approach to Determine Critical Nitrogen Loading Thresholds for the Swan Pond River Embayment System, Town of Dennis, MA Massachusetts Department of Environmental Protection. Boston, MA."

Appendix A Summary of Pine Pond Water Quality

As requested by DEP in their review of the initial watershed permit exemption application, the Town has prepared the following summary of the potential sources of nitrogen and phosphorus in the contributing watershed to Pine Pond, and the water quality in the Pond from testing conducted since 2001.

Pine Pond is a great pond with a maximum depth of approximately 18 feet and surface area of 24.2 acres. As shown on Figure 2 in the application there are two developed properties in the upgradient watershed where groundwater flows into the pond. The watershed boundary on one of these lots (Lot 11-12-0) is very close to the pond shore. Therefore, while the septic system on this lot may be within 300 feet of the pond, the groundwater in this area likely flows to the northeast, away from Pine Pond. Therefore, there is only one septic system within 300 feet of the upgradient side of the pond that could potentially contribute phosphorus to the pond.

Under the Pond and Lake Stewardship (PALS) program, water quality sampling has been performed between 2001-2023 and will continue in the future. For most sampling years, both spring and fall samples were collected. The sampling site has an average depth of 16-17 feet, suggesting that a full water column profile was obtained. Mean Secchi Depth during the sampling period was 4.9 meters for a % Secchi depth of 87.5%. Bottom anoxia was not observed in any sampling year. Mean fall surface chlorophyll-a was 2.7 ug/L, giving a Carlson Trophic Status Index of approximately 42, in the mesotrophic range. In addition, between 2019-2023, Pine Pond was regularly monitored for the presence of bloom-forming cyanobacteria. No samples demonstrated excess cyanobacteria biomass during this timeframe.

The mean Total Nitrogen concentration over time from the PALS data is 0.4 mg/L which is at or below the Subcoregion 84 Reference Threshold of 0.41 mg/L. Evaluating the nitrogen and phosphorus data, the mean Redfield Ratio (N:P) was 67, indicating that the pond is phosphorus limited.

Based on this monitoring data, there do not appear to be significant impacts from septic system effluent, stormwater runoff or lawn fertilizers to Pine Pond. The absence of diazotrophic cyanobacteria suggests that there are no excess biotic nitrogen contributions.