Nutrient Source Identification Report

Saugus River (Nitrogen and Phosphorus)
Pillings Pond (Phosphorus)

Town of Lynnfield, Massachusetts

June 30, 2022

Prepared For:

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Nutrient Source Identification Report – Town of Lynnfield

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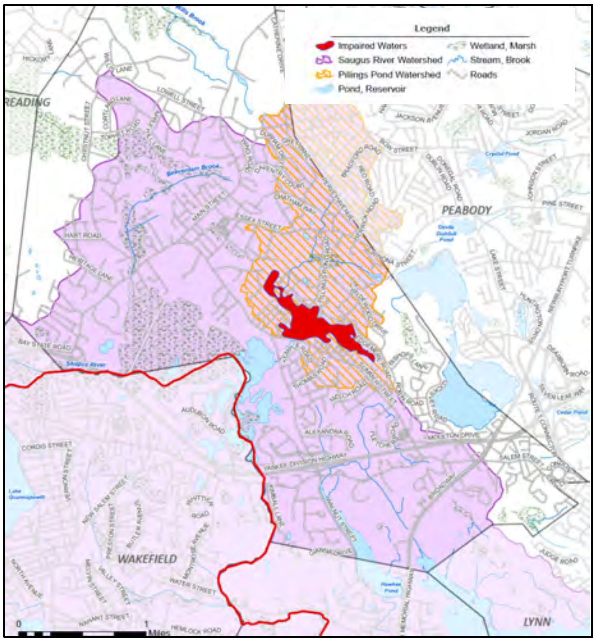
Under the Environmental Protection Agency's (EPA's) 2016 National Pollutant Discharge and Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit, regulated communities that discharge to certain water quality limited waters are required to meet additional requirements as outlined in Appendix H of the MS4 Permit. The Town of Lynnfield must address the discharge of nitrogen and phosphorus from its MS4 to the Saugus River and the discharge of phosphorus to Pillings Pond.



Nutrient Impaired Waterbodies in Lynnfield, MA

As part of these requirements, Lynnfield must develop a Nutrient Source Identification Report within four years of the effective date of the permit (*by June 30, 2022*). The overall goal of this plan is to determine specific areas of the MS4 that may be contributing higher concentrations of nutrients to the impaired watersheds.

Nutrient Source Identification Report Requirements

This Nutrient Source Identification Report includes the following elements as required under the MS4 Permit:

1. Calculation of the MS4 area draining to the water quality limited segment and its tributaries ("Nitrogen and Phosphorus Source Areas"). Drainage areas were delineated for each MS4 outfall.
2. All screening and monitoring results for outfalls in the Source Areas.
3. Calculation of the impervious area and directly connected impervious area (DCIA) for each catchment in the Source Areas.
4. Identification, delineation and prioritization of potential catchments with high nutrient loading.
5. Identification of potential retrofit opportunities or opportunities for the installation of structural BMPs during redevelopment including the removal of impervious area. This focuses on municipally-owned parcels.

A summary of the assessment findings is provided in the table below.

Summary of Nutrient Source Identification Report Findings for the Saugus River and Pillings Pond

Nutrient Source Identification Report Requirement	Saugus River *Nitrogen and Phosphorus Impairments*	Pillings Pond *Phosphorus Impairment*
Impaired Watershed in Urbanized Area (UA)	4,270 acres	868 acres
Total Number of Outfalls in Impaired Watershed in UA	192(#)	46(#)
Catchment Area for MS4 Outfalls (Source Area) Impervious Area DCIA	1,618 acres 382 acres 9 acres	394 acres 96 acres 2 acres
Priority Outfalls Identified in Source Areas	Outfall 51-3 Outfall 65-1 Outfall 28-2	Outfall 28-2 Outfall 33-6 Outfall 28-4
Total Load from Outfalls in Source Area	781 lbs P/year 7,054 lbs N/year	195 lbs P/year
Nutrient Reduction from Existing BMPs	18 lbs P/year 183 lbs N/year	8.6 lbs P/year
Reduction from Potential Retrofits	2.2 lbs P/year 15.5 lbs N/year	0.45 lbs P/year

Next Steps

Within five years of the permit effective date (by June 30, 2023), a listing of planned structural BMPs and a plan and schedule for implementation must be developed. One structural BMP, targeting a high phosphorus load area and one structural BMP targeting a high nitrogen load area, must be designed and installed as a demonstration project within six years of the permit effective date (by June 30, 2024). One demonstration BMP that targets phosphorus and nitrogen removal within the Pillings Pond watershed will satisfy the demonstration BMP requirement for both watersheds since Pillings Pond ultimately discharges to the Saugus River. The remainder of the structural BMPs must be installed in accordance with the developed schedule.

Next steps to be completed by June 30, 2023 include:

1. Evaluate high-ranking outfall catchment areas for additional BMP opportunities. Include review of existing street right-of-ways, outfalls, and municipal properties that have not yet been assessed, such as undeveloped municipal properties, where opportunities may exist to treat stormwater runoff from the MS4.
2. Evaluate the schedule for planned infrastructure, resurfacing or redevelopment activity planned for any municipal properties where potential retrofits were proposed.

3. Evaluate the engineering and regulatory feasibility of redevelopment or retrofit BMPs.
4. Develop a schedule for implementation of retrofits considering the above criteria.

Next steps to be completed by June 30, 2024 include:

4. Install a demonstration BMP, targeting a high phosphorus and nitrogen load area within the Pillings Pond watershed.

The remaining proposed BMPs shall be implemented in accordance with the developed schedule (item 3 above).

1 MS4 Permit Impaired Waters Requirement

Under the EPA's 2016 NPDES MS4 Permit, regulated communities that discharge to certain water quality limited waters are required to meet additional requirements as outlined in Appendices F and H of the MS4 Permit. Water quality limited waters are any waterbodies that do not meet applicable water quality standards, including waterbodies listed in Categories 4a and 5 on the Massachusetts Integrated List of Waters, also known as the "303(d) List." These impaired waters fall into one of two categories as described in Section 2.2 of the 2016 MS4 Permit (as amended):

- Impaired waters with an approved Total Maximum Daily Load (TMDL) (subject to requirements in Appendix F of the MS4 Permit); or
- Impaired waters without an approved TMDL (subject to requirements in Appendix H of the MS4 Permit).

The Town of Lynnfield must address the discharge of nitrogen and phosphorus from its MS4 to the Saugus River and the discharge of phosphorus to Pillings Pond (Figure 1). These requirements include the development of a Phosphorus and Nitrogen Source Identification Report for the contributing MS4 area to the Saugus River and a Phosphorus Source Identification report for the contributing MS4 area to Pillings Pond within four years of the effective date of the permit (*by June 30, 2022*). The Report must include:

1. Calculation of the MS4 area draining to the water quality limited segment and its tributaries ("Source Area").
2. All screening and monitoring results for outfalls in the Source Areas.
3. Calculation of the impervious area and directly connected impervious area (DCIA) for each catchment in the Source Areas.
4. Identification, delineation, and prioritization of catchments in the Source Areas with high nutrient loading.
5. Identification of potential retrofit opportunities or opportunities for the installation of structural BMPs during redevelopment.

This Nutrient Source Identification Report was developed to satisfy these requirements as summarized in table below. In addition to these requirements, information regarding potential funding sources and a summary of next steps are provided at the end of this document. This document will be updated as needed as new information becomes available.

Location of the Source Identification Report Permit Requirements

MS4 Permit Requirement	Saugus River *Nitrogen and Phosphorus Impairment*	Pillings Pond *Phosphorus Impairment*
Nutrient Source Area	Section 2.2	Section 2.3
Outfall Screening and Monitoring Results	Section 3.2	Section 3.3
Calculation of Impervious Area	Section 3	Section 3
High Nutrient Loading Catchment Evaluation	Section 3.2	Section 3.3
Retrofit Opportunities	Section 4.2	Section 4.2

2 Nutrient Source Areas

As part of the 2016 MS4 Permit requirements for water quality limited waters, the Town of Lynnfield must define the MS4 area draining to the impaired waterbodies, also known as the "Source Areas." This is defined as the MS4 drainage area located within the urbanized area (UA) of Lynnfield and within the impaired watershed.

For the Town of Lynnfield, the Source Areas are defined as follows:

- "Saugus River Nutrient Source Area" to address the discharge of nitrogen and phosphorus from its MS4 to the Saugus River); and
- "Pillings Pond Phosphorus Source Area" to address the discharge of phosphorus from its MS4 to Pillings Pond.

2.1 Urbanized Area in Lynnfield, MA

Lynnfield's regulated MS4 area is defined as the MS4 located within the Town's Urbanized Areas (UAs). UAs generally constitute the largest and most dense areas of settlement in the region. The Bureau of the Census determines UAs by applying a detailed set of published UA criteria to the latest decennial census data.

The UA in the Town of Lynnfield covers the Town's entire area (approximately 6,698 acres) (Figure 2).

2.2 Saugus River Nutrient Source Area

The Saugus River is formed at the outlet of Lake Quannapowitt in Wakefield, MA. From its headwaters, the Saugus River flows approximately thirteen miles east and then south through Wakefield, Saugus, and Lynn before emptying into the Rumney Marsh/Pines River estuary at Broad Sound. Tributaries include the Mill River, Shute Brook, Strawberry Brook, and Town Line Brook. The Saugus River watershed is approximately 28,331 acres in size and includes eleven MA municipalities: Everett, Lynn, Malden, Melrose, Peabody, Reading, Revere, Saugus, Stoneham, Wakefield, and Lynnfield (Figure 3). The Town of Lynnfield is located in the northeastern corner of the watershed and covers approximately 15% of the total watershed area. The watershed overlaps 64% of the Town.

The Saugus River Nutrient Source Area is limited to the area of town discharging to the Saugus River watershed through its MS4. 4,270 acres of the Saugus River watershed are located within Lynnfield's UA. Within the 4,270 acres, stormwater from approximately 1,618 acres is directed to catch basins that discharge through one of 192 MS4 outfalls. Runoff from the other 2,652 acres within this area is not directed to the Town's MS4 (Table 1, Figure 4). This water either flows as surface runoff or is directed to a non-municipal drainage network. As MS4 maps are updated, catchment areas will be updated and expanded if necessary.

The catchment areas for the 192 outfalls within the Saugus River Nutrient Source Area will be further investigated for sources of nutrients as these areas directly discharge to the MS4 (Table 1, Figure 4).

Table 1: Saugus River Nutrient Source Area for Lynnfield, MA

Land Area used to Determine the Nutrient Source Area	Acres
Saugus River Watershed	28,331
Saugus River Watershed in Lynnfield UA	4,270
Catchment Areas for 192 Outfalls in the Urbanized Area Only	1,618
Urbanized Area Outside of Catchment Area	2,652
Saugus River Nutrient Source Area	**1,618**

2.3 Pillings Pond Phosphorus Source Area

Pillings Pond is a relatively shallow, 96-acre man-made impoundment located in the center of Lynnfield. The Pond was created in 1831 when a dam was built on Bates Brook for a grist mill. The pond outlets just north of Summer Street at Rotary Park. The Pillings Pond watershed is approximately 1,193 acres in size and extends beyond Lynnfield into Peabody. Approximately 73% of the watershed is located in Lynnfield, covering 868 acres of the Town (Figure 5). The entire Pillings Pond watershed in Lynnfield lies within the boundaries of the larger Saugus River watershed.

The Phosphorus Source Area is limited to the area of town discharging to the Pillings Pond watershed through its MS4. 868 acres of the Pillings Pond watershed are located within Lynnfield's UA. Within the 868 acres, stormwater from approximately 394 acres is directed to catch basins that discharge through one of 46 MS4 outfalls (Table 2, Figure 6). Runoff from the other 474 acres within this area is not directed to its MS4. This water either flows as surface runoff or is directed to a non-municipal drainage network. As MS4 maps are updated, catchment areas will be updated and expanded if necessary.

The catchment areas for the 46 outfalls within the Phosphorus Source Area will be further investigated for sources of phosphorus as these areas directly discharge to the MS4. The Phosphorus Source Area lies within the boundaries of the Saugus River Nutrient Source Area (Table 2, Figure 6).

Table 2: Pillings Pond Phosphorus Source Area for Lynnfield, MA

Land Area used to Determine the Phosphorus Source Area	Acres
Pillings Pond Watershed	1,193
Pillings Pond Watershed in Lynnfield UA	868
Catchment Areas for 46 Outfalls in the Urbanized Area Only	394
Urbanized Area Outside of Catchment Area	474
Pillings Pond Phosphorus Source Area	**868**

3 Nutrient Source Area Evaluations

An evaluation of the Source Areas was performed to determine the contribution of phosphorus from each outfall to Pillings Pond and the contribution of nitrogen and phosphorus from each outfall to the Saugus River and to prioritize outfalls and catchments with high nutrient loading.

3.1 Catchment Analysis

Outfall catchment areas comprising the Source Areas were evaluated for the following:

- Screening and monitoring results;
- Impervious area (IA);
- Directly connected impervious area (DCIA). DCIA is determined using the Small MS4 Permit Technical Support Document, Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachusetts Small MS4 Permit, April 2014 (Appendix A);
- Receiving water impairments;
- Distance to receiving water; and
- Annual nutrient load.

3.1.1 Illicit Discharge Screening

As part of the Town of Lynnfield's Illicit Discharge Detection and Elimination (IDDE) Program, the catchment areas to all outfalls in the town have been delineated and an outfall screening and monitoring program has been developed and implemented as described in part 2.3.4 of the 2016 MS4 Permit and in the Town of Lynnfield's IDDE Plan (June 30, 2019). Dry weather screening has been performed at all outfalls as described in Section 6 of the IDDE Plan.

The nutrient results from the dry weather screening, where available, are shown in Tables 3 and 4 at the end of the report.

3.1.2 Source Area Nutrient Loads

Annual phosphorus loads for each of the 46 outfall catchment areas for the Pillings Pond Phosphorus Source Area and the 192 outfall catchments areas in the Saugus River Nutrient Source Area were calculated in accordance with Appendix F, Attachment 3 of the 2016 MS4 Permit as follows:

1. The total drainage area (acres) to the outfall was measured.

2. The outfall catchment area was distributed into impervious and pervious subareas by land use as defined in Tables 3-1 and 3-2 in Appendix F, Attachment 3 of the 2016 MS4 Permit.
3. The nutrient load for each land use-based impervious and pervious subarea was calculated by multiplying the subarea by the appropriate nutrient load export rate provided in Tables 3-1 and 3-2 in Appendix F, Attachment 3 of the 2016 MS4 Permit.
4. The nutrient load to each outfall was determined by summing the calculated impervious and pervious subarea nutrient loads.

The total nutrient load from each of the 192 outfalls in the Saugus River Nutrient Source Area was calculated to be 781 lbs P/year and 7,054 lbs N/year (Table 3). The total phosphorus load from each of the 46 outfalls in the Pillings Pond Phosphorus Source Area was calculated to be 195 lbs P /year (Table 4). Tables detailing the catchment area land use and calculations for phosphorus loads are provided in Appendix B.

Impervious area, DCIA, and phosphorus loads calculated for each outfall are shown in Tables 3 and 4.

3.1.3 Catchment Prioritization Criteria

Based on the outfall catchment analysis, a ranking system was developed to further prioritize catchments with high nutrient loading. Each catchment was ranked first by annual phosphorus load (highest to lowest). Catchments were then sorted into five prioritization groups based on percentile (20% increments). Each prioritization group was then sorted based on whether the outfall discharges directly to an impaired waterbody and the distance from a waterbody.

The full catchment area analysis for the Saugus River Nutrient Source Area is shown in Table 3. The analysis for the Pillings Pond Phosphorus Source Area is shown in Table 4. The 46 outfalls within the Pillings Pond Source Area are also in the Saugus River Nutrient Source Area. These outfalls are noted in Table 3.

In addition to the above information, other information about the catchment areas is noted including the presence of any existing BMPs or municipally-owned properties. This information will be considered when selecting sites for potential municipal retrofits.

3.2 Saugus River Nutrient Source Area Prioritization

The 192 outfalls in the Saugus River Nutrient Source Area were grouped into one five ranking groups, with Group 1 representing the highest priority areas and Group 5 representing the areas of a lesser priority. In addition to the five groups, the top three priority catchments are identified. A summary of the prioritization groups of each outfall catchment area is shown in Table 5.

The full catchment area analysis for the Saugus River Nutrient Source Area is shown in Table 5 and Figure 4. Outfall 51-3 is the highest ranked outfall catchment area. This outfall discharges approximately one foot from the Saugus River and has a nutrient load of 16 lbs P/year and 151 lbs N/year. This outfall catchment area, along with Outfalls 65-1 and 28-2, the other top-ranked outfalls, should be prioritized for remediation (Table 3, Figure 7).

Table 5: Catchment Area Prioritization Groups for the Saugus River Nutrient Source Area

Prioritization Group	TN range (lbs N/year)	No. of Catchment Areas
Group 1	> 100 – 212.5	18
Group 2	> 50 - 100	22
Group 3	> 25 -50	51
Group 4	> 10 - 25	63
Group 5	0 - 10	38
	Total	**192**

3.3 Pillings Pond Phosphorus Source Area Prioritization

The 46 outfalls in the Pillings Pond Phosphorus Source Area were grouped into one five ranking groups, with Group 1 representing the highest priority areas and Group 5 representing the areas of a lesser priority. In addition to the five groups, the top three priority catchments are identified. A summary of the prioritization groups of each outfall catchment area is shown in Table 6.

The full catchment area analysis for the Pillings Pond Phosphorus Source Area is shown in Table 4 and Figure 8. Outfall 28-2, one of the top-ranked outfalls in the Saugus River Nutrient Source Area, is ranked the highest priority outfall for the Pillings Pond Phosphorus Source Area as it discharges almost 20 lbs P/year. Outfalls 33-6 and 28-4 are also ranked as top priority outfalls as they have a combined phosphorus load of over 37 lbs P/year. These outfalls, should be prioritized for remediation (Table 4, Figure 8).

Table 6: Catchment Area Prioritization Groups for the Pillings Pond Phosphorus Source Area

Prioritization Group	TP range (lbs P/year)	No. of Catchment Areas
Group 1	> 10 - 21	6
Group 2	> 5 – 10	4
Group 3	> 2.5 – 5	11
Group 4	> 1 – 2.5	12
Group 5	0 – 1	13
	Total	**46**

4 Potential Nutrient Reductions

An analysis of existing town-owned BMPs and an inventory of town-owned properties was performed to identify existing and potential nutrient reduction opportunities.

4.1 Existing BMPs

Nutrient removals were calculated for existing town-owned BMPs. In 2020, 14 sites with 25 structural BMPs were identified within the Saugus River Nutrient Source Area. Of those, three sites overlap the Pillings Pond Phosphorus Source Area (Table 7).

A combination of information from design plans provided by the Town (where available), GIS data, and field measurements allowed for the use of EPA's BMP Accounting and Tracking Tool (BATT) to compute pollutant removals in accordance with Attachment 3 of Appendix H of the MS4 Permit. A separate memo (BMP Pollutant Reduction Estimate Summary Memo) describes the calculation process in detail (Appendix C). In summary, the existing BMPs remove 18 lbs P/year and 183 lbs N/year (Table 7). The three sites that are within the Pillings Pond Phosphorus Source Area remove approximately 8.6 lbs P/year. The Town of Lynnfield must maintain these BMPs to ensure they are functioning properly and receive credit for the pollutant removal. The locations of each BMP are shown in Figure 9.

Table 7: Existing BMPs in the Saugus River Watershed in the Town of Lynnfield

BMP ID	Within the Pillings Pond Phosphorus Source Area[1]	Within MS4 Catchment Area[2]	BMP Location	BMP Type	Subcatchment Area (acres)	Phosphorus BMP Efficiency (%)	Nitrogen BMP Efficiency (%)	Removed Phosphorus Load (lbs P/yr)	Removed Nitrogen Load (lbs N/yr)
DPW_DS_BMP_16-1			Rourke Lane	Infiltration Trench	15.7	9.8	19.3	0.66	12.0
DPW_DS_BMP_32-1		x	Yorkshire Drive	Extended Dry Detention Pond	12.6	0.3	0.1	0.01	0.1
DPW_DS_BMP_33-1	x	x	Melody Lane	Extended Dry Detention Pond	11.0	8.9	8.2	0.59	5.4
DPW_DS_BMP_33-2	x	x	High School Infiltration System	Infiltration Trench	4.4	47.4	81.0	1.02	14.8
DPW_DS_BMP_33-2	x	x	High School Porous Pavement Near Entrance	Porous Pavement	3.4	75.0	77.0	2.56	22.3
DPW_DS_BMP_33-2	x	x	High School Porous Pavement Near Swale	Porous Pavement	2.1	75.0	77.0	1.25	10.9
DPW_DS_BMP_33-2	x	x	High School Swale/Dry Infiltration Basin	Infiltration Basin	1.1	98.8	100.0	0.20	1.8
DPW_DS_BMP_37-1		x	Middle School Infiltration Trench Near Baseball Field	Infiltration Trench	2.6	23.5	46.3	0.73	12.3
DPW_DS_BMP_37-1		x	Middle School Infiltration Trench Near Tennis Court	Infiltration Trench	3.8	17.0	33.4	0.74	12.3
DPW_DS_BMP_37-1		x	Middle School Leaching Catch Basins	Infiltration Basin	2.0	64.7	80.0	1.53	16.1
DPW_DS_BMP_37-2		x	Middle School Track Northern Basin	Bioretention	1.8	63.0	40.0	0.39	1.9
DPW_DS_BMP_37-2		x	Middle School Track Southern Basin	Bioretention	1.8	63.0	40.0	0.51	2.4
DPW_DS_BMP_38-1		x	Summer Street School	Infiltration Trench	2.7	1.9	6.0	0.03	1.0
DPW_DS_BMP_43-1		x	Elizabeth Way	Extended Dry Detention Pond	9.0	14.0	23.1	0.82	13.3

BMP ID	Within the Pillings Pond Phosphorus Source Area[1]	Within MS4 Catchment Area[2]	BMP Location	BMP Type	Subcatchment Area (acres)	Phosphorus BMP Efficiency (%)	Nitrogen BMP Efficiency (%)	Removed Phosphorus Load (lbs P/yr)	Removed Nitrogen Load (lbs N/yr)
DPW_DS_BMP_52-1	x	x	Huckleberry School Detention Tank	Extended Dry Detention Pond	3.1	12.5	15.6	0.51	5.4
DPW_DS_BMP_52-1	x	x	Huckleberry School Galleys	Infiltration Trench	2.5	62.3	86.9	2.49	29.4
DPW_DS_BMP_55-1		x	Thistle Lane	Infiltration Basin	2.7	19.7	29.1	0.40	5.4
DPW_DS_BMP_62-1		x	Senior Center Eastern Basin	Infiltration Basin	1.4	11.1	16.0	0.16	2.0
DPW_DS_BMP_62-1		x	Senior Center Southern Basin	Infiltration Basin	1.6	13.7	19.7	0.17	2.1
DPW_DS_BMP_62-1		x	Senior Center Western Basin	Infiltration Basin	0.5	36.8	53.0	0.16	2.0
DPW_DS_BMP_67-1		x	Horseshoe Drive	Wet Pond/Created Wetland	5.7	63.0	40.0	2.71	16.0
DPW_DS_BMP_72-1		x	Blue Jay Road	Extended Dry Detention Pond	34.7	0.2	0.1	0.07	0.3
DPW_DS_BMP_72-2		x	Gianna Drive Eastern Swale	Grass Swale (Conveyance)	1.8	36.0	23.1	0.26	1.3
DPW_DS_BMP_72-2		x	Gianna Drive Western Swale	Grass Swale (Conveyance)	0.7	36.0	23.1	0.17	1.0
DPW_DS_BMP_72-3		x	Mansfield Road	Wet Pond/Created Wetland	1.4	63.0	40.0	0.66	3.9
				Total	**114**	**--**	**--**	**18**	**183**

[1] BMP IDs 33-1, 33-2 and 52-1 are also located within the Pillings Pond watershed.

[2] Treatment totals include all BMPs located in outfall catchment areas. Updates will be made as GIS mapping is updated.

4.2 Municipal Retrofit Survey

Under the MS4 permit, regulated communities such as Lynnfield are required to complete an inventory and priority ranking of town-owned properties and existing stormwater infrastructure that could be retrofitted with stormwater BMPs designed to reduce the frequency, volume, and pollutant loads of stormwater discharges to the MS4. A separate memo (Municipal Property Retrofit Memo dated June 2022) describes the assessment process and the priority ranking process in detail and is included in Appendix D.

In summary, approximately 32 town-owned properties were assessed in the Fall of 2021. The potential for retrofits or the installation of new BMPs were assessed in the field and the results of these assessments, including potential BMP options, estimated phosphorus load reductions and estimated costs for all properties, where applicable, are described in detail in the Municipal Property Retrofit Memo (Appendix D). A summary of the top six identified BMP retrofit opportunities is included in Table 8.

The Lynnfield Common site has the potential to reduce over a pound of phosphorus and 13 pounds of nitrogen per year. This site is located in the Saugus River Nutrient Source Area. Two BMPs are proposed in the Pillings Pond Phosphorus Source Area. These two BMPs, rain gardens in Rotary Park and Glen Meadow Park, would address nutrient pollution in both Pillings Pond and the Saugus River.

Table 8: BMP Retrofit Priority Locations

Facility ID	Location Description	Address	Proposed BMP(s)		Pollutant Reduction		Within the Pillings Pond P Source Area	Within MS4 Catchment Area[1]
			Proposed BMP(s)	Estimated Size	TP Reduction (lbs P/yr)	TN Reduction (lbs N/yr)		
P5	Lynnfield Common	Main St	Infiltration basin	60' x 30' x 3'deep	1.74	13.32		x
P7	Rotary Park	Summer St-Lot 176	2 Rain gardens	45' x 15' x 2'deep	0.34	1.62	x	x
C2	Willow Cemetery	Summer St	2 Rain gardens	30' x 20' x 2'deep	0.32	1.54		
FD2	Fire Department and Post Office	Salem & Summer St	Infiltration basin	30' x 25' x 2'deep	1.11	8.71		
P2	Glen Meadow Park	Trickett Rd	Rain garden	30' x 15' x 2'deep	0.11	0.52	x	x
P6	Freeman Park	Main St	Rain garden	30' x 15' x 2'deep	0.11	0.52		
				Totals	**2.19**	**15.46**	**--**	**--**

Note: All proposed BMPs are located within the Saugus River watershed.

[1] Treatment totals include all proposed BMPs located in outfall catchment areas. Updates to be made as GIS mapping is updated.

5 Potential Funding Sources

The design and implementation of stormwater BMPs will be dependent on available funding. Potential funding sources may include a local stormwater utility and/or loans and grants offered at the state and federal level. A summary of potential state and federal funding sources is listed in Table 9. Additional resources can be found on the MassDEP Grant Program Directory webpage.

Table 9. Summary of Potential Funding Programs

Funding Program	Description
Planning and Implementation Programs	
MassDEP Stormwater MS4 Municipal Assistance Grant Program	The MassDEP Stormwater MS4 Municipal Assistance Grant program is available for Massachusetts municipalities, Regional Planning Agencies, stormwater coalitions, and non-profit organizations for innovative projects that will assist multiple communities in meeting the requirements of the MS4 permit. Eligible projects include assessment tools for prioritizing retrofit sites, tracking tools for regional stormwater retrofits, development of templates, formation of new regional stormwater coalitions, and other tasks that benefit multiple Massachusetts municipalities in seeking compliance with their MS4 permit.
MassDEP Clean Water State Revolving Fund	The SRF Clean Water program provides a low-cost financing method to help communities meet water quality standards. The program addresses issues such as watershed management priorities, stormwater management, and green infrastructure. SRF also supplies financial assistance to address communities with septic systems.
MassDEP Watershed Assistance Grants	Water Quality Planning and 604(b) grants are available for water quality planning purposes. Other eligible projects include development of preliminary designs and implementation plans to address water quality impairments, and the development of green infrastructure projects. MassDEP also provides funding appropriated through the USEPA under Section 319 of the Clean Water Act to support local initiatives to restore impaired waters or protect high quality waters. 319-grant funds are targeted toward implementation of completed watershed-based plans. A minimum of 40% non-federal match is required for these grants. While 319 funds may not be used to fund work that is specifically required in the MS4 permit, work in the non-regulated area of town is eligible for these funds.

Funding Program	Description
Climate Resiliency Programs	
Massachusetts Executive Office of Energy and Environmental Affairs (EEA) Municipal Vulnerability Preparedness (MVP) Grant Program	The MVP grant program provides support for cities and towns in Massachusetts to being the process of planning for climate change resiliency and implementing priority projects. The state awards communities with funding to complete vulnerability assessments and develop action-oriented resiliency plans. Communities who complete an MVP planning grant become certified as an MVP community and are eligible for MVP Action Grant funding and other opportunities.
Habitat Improvement Programs	
Massachusetts Division of Ecological Restoration (DER) Grant Programs	The Culvert Replacement Municipal Assistance Grant Program is for municipalities interested in replacing an undersized, perched, and/or degraded culvert located in an area of high ecological value. This funding is to encourage municipalities to replace aging culverts with better designed crossings that meet improved structural and environmental design standards and flood resiliency criteria. The Restoration and Revitalization Priority Projects Program selects projects that restore and protect Massachusetts rivers, wetlands, and watersheds for the benefit of people and the environment. The Priority Projects Program selects ecological and urban stream revitalization projects that present significant benefits to Massachusetts. Eligible applicants include restoration project site landowners, non-profit and/or non-governmental organizations, regional planning organizations, municipalities, and state and federal agencies. Current project focus is on cranberry bog wetland restoration, stream restoration, and urban stream and river revitalization.
NOAA Community-Based Restoration Program Partnership	Grant funding provided for stream barrier removal projects that help restore riverine ecosystems, enhance public safety and community resilience, and have clear and identifiable benefits to diadromous fish populations.
National Fish and Wildlife Foundation (NFWF) Grant Programs	NFWF Five Star and Urban Waters Restoration Program provides funds to local partnerships for wetland, forest, riparian and coastal habitat restoration, with a focus on urban waters and watersheds. Funds approximately $1,500,000 annually, with average grants between $25,000 to $35,000 and 1:1 match requirement. NFWF New England Forests and Rivers Fund dedicated to restoring and sustaining healthy forests and rivers that provide habitat for diverse native bird and freshwater fish populations in New England. Annually awards grants ranging from $50,000 to $200,000 each.

Funding Program	Description
Recreation and Trail Programs	
Fields Pond Foundation	Funds trail making and other enhancement of public access to conservation lands, land acquisitions for conservation, and establishing funds for stewardship. Funding levels: $25,000 maximum, $2,000 - $10,000 typical.
National Park Service – Rivers and Trails Program	Funds projects focused on protection of natural resources and enhancement of outdoor recreational opportunities.
Agricultural Programs	
Natural Resource Conservation Service (NRCS) Grant Programs	Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers to address natural resources concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion, and improved wildlife habitat. Conservation Stewardship Program (CSP) is the largest conservation program in the United States with a goal of enhancing natural resources and improving agricultural operations. The program helps agricultural operations build on existing conservation efforts while strengthening their operations. The program focuses on improving grazing conditions, increasing crop yields, developing wildlife habitat, and increasing resilience to weather extremes.

6 Summary and Next Steps

Summary

High priority outfalls have been identified and potential retrofits have been initially identified. A summary of the Phosphorus Source Identification Report components is provided in Table 10.

Table 10: Summary of Nutrient Source Identification Report Findings for the Saugus River and Pillings Pond

Nutrient Source Identification Report Requirement	Saugus River *Nitrogen and Phosphorus Impairments*	Pillings Pond *Phosphorus Impairment*
Impaired Watershed in Urbanized Area (UA)	4,270 acres	868 acres
Total Number of Outfalls in Impaired Watershed in UA	192(#)	46(#)
Catchment Area for MS4 Outfalls (Source Area) Impervious Area DCIA	1,618 acres 382 acres 9 acres	394 acres 96 acres 2 acres
Priority Outfalls Identified in Source Areas	Outfall 51-3 Outfall 65-1 Outfall 28-2	Outfall 28-2 Outfall 33-6 Outfall 28-4
Total BMP Load from Outfalls in Source Area	781 lbs P/year 7,054 lbs N/year	195 lbs P/year
Nutrient Reduction from Existing BMPs	18 lbs P/year 183 lbs N/year	8.6 lbs P/year
Reduction from Potential Retrofits	2.2 lbs P/year 15.5 lbs N/year	0.45 lbs P/year

Next Steps

The Town of Lynnfield should begin working towards reducing the amount of nutrients in the Source Areas. Within five years of the permit effective date (by June 30, 2023), a listing of planned structural BMPs and a plan and schedule for implementation must be developed. One structural BMP, targeting a high phosphorus load area and one structural BMP targeting a high nitrogen load area, must be designed and installed as a demonstration project within six years of the permit effective date (by June 30, 2024). One demonstration BMP that targets phosphorus and nitrogen removal within the Pillings Pond watershed will satisfy the demonstration BMP requirement for both watersheds since Pillings Pond ultimately discharges to the Saugus River. The remainder of the structural BMPs must be installed in accordance with the developed schedule.

Next steps to be completed by June 30, 2023 include:

1. Evaluate high-ranking outfall catchment areas for additional BMP opportunities. Include review of existing street right-of-ways, outfalls, and municipal properties that have not yet been assessed, such as undeveloped municipal properties, where opportunities may exist to treat stormwater runoff from the MS4.
2. Evaluate the schedule for planned infrastructure, resurfacing or redevelopment activity planned for any municipal properties where potential retrofits were proposed.
3. Evaluate the engineering and regulatory feasibility of redevelopment or retrofit BMPs.
4. Develop a schedule for implementation of retrofits considering the above criteria.

Next steps to be completed by June 30, 2024 include:

1. Install a demonstration BMP, targeting a high phosphorus load area.

The remaining proposed BMPs shall be implemented in accordance with the developed schedule (item 3 above).

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
51-3	150.7	16.3	Saugus River	1	29.4	5.13	0.56	8.5	0.14				x	x	1
65-1	101.9	12.7	Saugus River	9	17.4	5.85	0.73	6.2	0.12	0	1.39				1
28-2	185.4	19.7	Unnamed Stream	42	51.8	3.58	0.38	8.8	0.10			x			1
44-2	133.1	15.1	Pillings Pond	10	25.3	5.25	0.60	7.8	0.14					x	1
20-8	157.9	15.7	Cedar Swamp	50	43.3	3.65	0.36	4.7	0.04						1
56-6	149.7	16.5	Unnamed Stream	55	33.7	4.45	0.49	7.9	0.12					x	1
56-5	107.8	11.5	Unnamed Stream	85	22.3	4.83	0.51	5.7	0.09						1
22-1	212.5	22.4	Beaverdam Brook	248	53.8	3.95	0.42	10.2	0.13						1
33-6	196.6	21.2	Unnamed Stream	339	39.6	4.96	0.53	10.7	0.17			x			1
27-5	169.6	18.4	Beaverdam Brook	300	36.5	4.64	0.50	8.7	0.13						1
28-4	159.4	16.6	Unnamed Stream	482	37.3	4.28	0.45	7.2	0.09			x			1
38-3	138.0	14.9	Pillings Pond	174	29.0	4.76	0.51	6.1	0.08			x		x	1
36-3	123.1	13.0	Beaverdam Brook	564	30.9	3.98	0.42	5.9	0.07						1
45-1	104.6	11.4	Pillings Pond	920	22.0	4.75	0.52	6.1	0.10			x		x	1
21-5	103.8	10.7	Beaverdam Brook	911	24.5	4.24	0.44	4.4	0.05						1
32-3	101.6	13.0	Unnamed Pond	701	14.1	7.19	0.92	9.1	0.73			x			1
37-3	185.2	20.4	Saugus River	1313	46.1	4.02	0.44	8.1	0.10				x		1
68-6	108.3	13.4	Unnamed Wetland	1309	10.6	10.23	1.26	7.6	0.64					x	1
38-1	77.3	8.5	Pillings Pond	6	16.9	4.57	0.50	3.7	0.05	0.036		x		x	2
26-3	75.9	8.4	Beaverdam Brook	0	17.4	4.36	0.48	4.9	0.08						2
36-4	72.0	8.3	Beaverdam Brook	0	17.2	4.19	0.48	4.2	0.06						2

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
72-3	69.6	7.6	Hawkes Pond	12	19.5	3.57	0.39	3.7	0.05				x		2
66-4	69.6	8.3	Hawkes Brook	10	11.7	5.93	0.71	4.8	0.10					x	2
52-4	69.2	7.5	Pillings Pond	0	14.1	4.90	0.54	3.9	0.06	0.054		x	x	x	2
61-9	60.2	6.8	Unnamed Stream	42	10.8	5.58	0.63	3.4	0.19					x	2
20-3	56.6	6.1	Cedar Swamp	5	18.1	3.13	0.34	3.0	0.03						2
56-8	84.6	9.2	Hawkes Brook	94	16.1	5.25	0.57	5.0	0.09					x	2
32-8	63.7	6.8	Unnamed Wetland	141	13.0	4.92	0.52	3.1	0.05						2
21-2	60.7	6.4	Cedar Swamp	128	13.2	4.61	0.48	2.9	0.04						2
37-1a	74.3	8.8	Beaverdam Brook	475	13.9	5.37	0.64	5.6	0.36				x		2
48-2	63.3	7.8	Saugus River	364	13.9	4.56	0.56	5.2	0.10						2
33-8	58.9	6.3	Unnamed Stream	353	12.6	4.68	0.50	3.0	0.04			x			2
33-7	76.9	8.5	Unnamed Pond	571	21.8	3.53	0.39	3.6	0.04			x			2
42-1	60.1	6.6	Unnamed Pond	948	15.7	3.84	0.42	3.7	0.05						2
31-2	94.4	11.5	Unnamed Wetland	1133	16.9	5.59	0.68	7.0	0.15						2
68-5	73.2	11.4	Unnamed Wetland	1100	10.8	6.78	1.05	4.5	1.49					x	2
66-1	62.9	7.2	Hawkes Pond	1070	14.7	4.28	0.49	3.7	0.06	0	0.72				2
27-4	58.9	6.4	Beaverdam Brook	1387	14.1	4.17	0.45	3.0	0.04						2
42-2	57.7	5.9	Unnamed Pond	1472	19.0	3.03	0.31	1.4	0.01						2
41-3	54.8	6.0	Unnamed Wetland	1593	13.5	4.07	0.44	3.1	0.04						2
61-5	48.6	5.4	Unnamed Stream	8	12.3	3.95	0.44	2.4	0.03						3
61-8	45.4	5.1	Hawkes Brook	31	8.1	5.61	0.63	2.8	0.05						3

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
36-8	44.6	4.5	Beaverdam Brook	26	12.9	3.47	0.35	1.7	0.02						3
21-3	41.5	4.2	Cedar Swamp	29	10.6	3.93	0.40	1.7	0.02						3
32-1	33.9	3.8	Unnamed Wetland	9	7.1	4.77	0.54	2.0	0.03						3
66-6	32.2	3.6	Hawkes Pond	5	8.0	4.01	0.45	1.5	0.02						3
66-5	30.3	3.3	Hawkes Pond	22	6.7	4.52	0.49	1.0	0.01						3
39-3	28.1	3.0	Pillings Pond	17	6.8	4.16	0.44	1.3	0.02			x		x	3
67-2	27.2	3.1	Unnamed Stream	34	8.3	3.29	0.38	1.5	0.02						3
30-4	26.1	2.9	Beaverdam Brook	24	6.0	4.33	0.49	1.9	0.03						3
57-9	25.5	2.8	Hawkes Brook	22	5.0	5.13	0.57	1.5	0.03						3
36-7	47.2	5.3	Beaverdam Brook	55	13.2	3.57	0.40	3.2	0.05						3
21-1	41.2	4.4	Cedar Swamp	147	8.3	4.98	0.54	2.2	0.04						3
26-1	40.3	4.4	Beaverdam Brook	56	9.1	4.43	0.48	2.4	0.04						3
41-2	39.4	4.5	Unnamed Wetland	146	9.1	4.31	0.49	2.7	0.05						3
25-6	37.5	3.9	Beaverdam Brook	133	8.3	4.50	0.47	1.8	0.03						3
43-2	35.3	3.8	Saugus River	118	6.5	5.39	0.58	1.9	0.03						3
53-9	28.3	3.0	Pillings Pond	50	5.4	5.24	0.56	1.6	0.03			x			3
32-2	27.1	2.8	Unnamed Wetland	94	7.1	3.81	0.39	1.0	0.01						3
44-7	26.3	2.7	Pillings Pond	75	6.0	4.38	0.45	1.2	0.02	0.094		x			3
44-6	25.3	2.7	Pillings Pond	53	4.2	6.00	0.65	1.5	0.03			x			3
62-6b	35.5	3.8	Hawkes Brook	150	7.3	4.86	0.53	2.1	0.04						3
31-4	35.0	4.1	Unnamed Wetland	450	6.8	5.12	0.60	2.3	0.04						3

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
43-1	34.4	3.7	Saugus River	480	5.7	6.06	0.64	2.0	0.04						3
34-1	31.0	3.4	Unnamed Stream	466	7.1	4.35	0.47	1.6	0.02			x			3
62-1	30.6	3.2	Hawkes Brook	417	6.9	4.46	0.47	1.5	0.02						3
26-2	30.2	3.2	Beaverdam Brook	268	6.9	4.37	0.47	1.7	0.03						3
30-1	28.5	2.9	Beaverdam Brook	431	6.9	4.16	0.42	1.2	0.01						3
44-1	26.5	2.8	Saugus River	173	5.3	4.96	0.52	1.1	0.02						3
21-4	25.9	2.8	Cedar Swamp	357	5.9	4.42	0.47	1.3	0.02						3
30-6	25.1	3.2	Beaverdam Brook	225	14.2	1.77	0.22	1.2	0.01						3
66-8	48.9	6.0	Unnamed Stream	678	17.8	2.74	0.34	1.8	0.45						3
66-7	42.9	4.6	Unnamed Stream	852	11.1	3.86	0.42	2.0	0.02						3
57-10	42.7	4.8	Hawkes Brook	813	9.3	4.60	0.52	2.6	0.04			x			3
56-1	42.5	4.6	Saugus River	896	8.6	4.92	0.53	2.3	0.04					x	3
31-3	42.3	5.2	Unnamed Wetland	876	7.1	5.98	0.73	3.2	0.07						3
67-4	41.1	4.4	Hawkes Brook	885	7.8	5.30	0.57	2.4	0.04						3
33-5	39.8	4.4	Unnamed Stream	501	8.3	4.78	0.52	2.2	0.04			x			3
62-8	39.0	4.1	Suntaug Lake	862	7.9	4.93	0.52	2.0	0.03						3
61-4	35.4	3.8	Unnamed Stream	746	7.6	4.63	0.49	1.8	0.03						3
32-6	34.8	3.8	Unnamed Pond	797	11.8	2.95	0.32	2.0	0.02						3
67-3	27.7	3.2	Unnamed Stream	578	5.4	5.13	0.59	2.0	0.04				x		3
53-1	27.0	3.1	Pillings Pond	581	6.3	4.30	0.49	1.7	0.03			x		x	3
25-10	25.5	2.6	Beaverdam Brook	867	5.3	4.84	0.50	1.0	0.01						3

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Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
62-7	25.4	2.9	Hawkes Brook	769	7.3	3.46	0.40	1.5	0.02					x	3
25-2	35.7	3.9	Beaverdam Brook	1098	9.6	3.73	0.41	1.5	0.02						3
35-1	32.3	3.4	Unnamed Wetland	1416	7.6	4.27	0.45	1.4	0.02						3
28-3	30.1	3.2	Unnamed Stream	1244	6.8	4.46	0.47	1.4	0.02						3
37-4	29.7	3.4	Saugus River	1381	5.7	5.24	0.60	2.1	0.04						3
42-3	27.2	3.0	Beaverdam Brook	1212	9.1	2.99	0.33	1.7	0.02						3
27-3	26.4	2.8	Beaverdam Brook	1069	5.4	4.88	0.52	1.4	0.02						3
51-1	13.0	1.4	Saugus River	44	2.5	5.21	0.56	0.7	0.01						4
44-5	24.7	2.6	Pillings Pond	30	4.3	5.73	0.61	1.4	0.02			x			4
44-8	22.0	2.5	Pillings Pond	6	4.0	5.53	0.62	1.3	0.02			x			4
66-2	20.6	2.4	Hawkes Pond	10	7.7	2.67	0.32	1.1	0.01						4
39-1	19.9	2.3	Unnamed Stream	0	5.1	3.93	0.45	1.4	0.02						4
62-4	19.3	2.3	Hawkes Brook	13	1.4	13.35	1.60	1.4	0.13						4
44-4	17.2	2.0	Pillings Pond	40	5.4	3.18	0.36	0.8	0.01	0.285		x			4
20-7	17.0	1.7	Cedar Swamp	45	4.4	3.86	0.39	0.7	0.01						4
52-1	16.8	1.8	Pillings Pond	0	3.2	5.29	0.58	1.0	0.02			x			4
56-3	16.5	1.8	Unnamed Stream	25	3.0	5.52	0.61	1.0	0.02						4
72-7	15.9	1.8	Hawkes Pond	4	4.9	3.26	0.37	0.9	0.01						4
72-13	15.0	1.8	Hawkes Pond	10	4.9	3.05	0.36	0.9	0.01				x		4
66-3	15.0	1.8	Hawkes Brook	48	4.3	3.46	0.41	0.8	0.01						4
67-1	13.6	1.6	Unnamed Stream	21	3.4	4.00	0.48	0.9	0.01						4

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
45-4	13.4	1.3	Pillings Pond	48	3.4	3.88	0.39	0.5	0.01			x			4
30-5	13.2	1.6	Beaverdam Brook	37	2.5	5.25	0.63	1.0	0.06						4
45-2	13.1	1.4	Pillings Pond	0	2.7	4.92	0.51	0.6	0.01						4
62-5	12.7	1.5	Hawkes Brook	4	2.7	4.62	0.55	0.9	0.02					x	4
72-2	12.4	1.3	Hawkes Pond	7	4.5	2.74	0.29	0.2	0.00						4
56-4	12.1	1.3	Unnamed Stream	9	2.9	4.23	0.44	0.6	0.01						4
30-2	11.2	1.3	Beaverdam Brook	8	3.1	3.62	0.42	0.8	0.01						4
45-5	24.2	2.7	Pillings Pond	148	4.3	5.57	0.62	1.4	0.02			x			4
42-10	23.8	2.7	Beaverdam Brook	118	9.3	2.55	0.29	1.7	0.02						4
52-2	20.6	2.2	Pillings Pond	58	4.2	4.92	0.53	1.1	0.02			x			4
15-2	13.6	1.4	Cedar Swamp	121	3.1	4.35	0.46	0.6	0.01						4
57-5	12.5	1.3	Hawkes Brook	121	3.9	3.23	0.34	0.7	0.01					x	4
57-2	11.4	1.2	Hawkes Brook	109	2.5	4.51	0.49	0.6	0.01						4
38-2	22.4	2.4	Pillings Pond	160	5.3	4.19	0.45	1.1	0.02			x			4
40-2	20.5	2.2	Unnamed Pond	308	5.1	4.03	0.42	0.9	0.01						4
30-8	19.5	2.1	Beaverdam Brook	185	2.8	6.91	0.76	1.2	0.03						4
43-3	18.6	1.9	Saugus River	411	3.6	5.10	0.53	0.9	0.01				x		4
37-5	18.4	2.0	Saugus River	430	4.3	4.25	0.46	0.9	0.01					x	4
25-7	15.9	1.7	Beaverdam Brook	177	4.3	3.68	0.39	0.7	0.01						4
27-1	15.1	1.7	Beaverdam Brook	224	5.5	2.74	0.31	1.1	0.01						4
72-1	14.7	1.7	Unnamed Pond	402	3.4	4.31	0.48	0.9	0.02						4

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
28-1	14.1	1.4	Unnamed Stream	495	3.0	4.76	0.49	0.6	0.01						4
57-3	12.5	1.3	Hawkes Brook	230	3.6	3.49	0.35	0.4	0.00						4
62-6a	12.5	1.3	Hawkes Brook	161	3.5	3.59	0.38	0.6	0.01						4
72-10	12.4	1.4	Unnamed Wetland	383	4.4	2.81	0.31	0.7	0.01						4
26-4	11.1	1.3	Beaverdam Brook	440	3.4	3.31	0.38	0.8	0.01						4
31-1	11.0	1.3	Beaverdam Brook	471	2.8	3.94	0.47	0.9	0.02						4
61-2	10.4	1.1	Hawkes Brook	379	2.4	4.26	0.45	0.4	0.01						4
65-2	20.9	2.3	Unnamed Pond	640	4.5	4.68	0.50	0.6	0.01						4
72-12	19.1	2.3	Hawkes Pond	957	3.4	5.58	0.68	1.5	0.03						4
32-5	16.7	2.0	Unnamed Pond	754	3.3	5.13	0.62	1.2	0.02						4
56-10	15.7	1.8	Unnamed Stream	786	3.1	5.06	0.58	1.0	0.02					x	4
30-7	15.6	1.7	Beaverdam Brook	658	3.6	4.37	0.48	0.8	0.01						4
46-1	15.5	1.7	Pillings Pond	925	3.5	4.37	0.49	0.9	0.01			x			4
56-9	15.1	1.8	Unnamed Stream	861	4.8	3.16	0.37	0.8	0.01					x	4
42-9	13.2	1.5	Beaverdam Brook	519	5.1	2.58	0.29	0.9	0.01						4
42-5	12.2	1.4	Unnamed Pond	960	4.6	2.67	0.31	0.6	0.02						4
56-7	11.0	1.1	Unnamed Stream	632	2.6	4.21	0.43	0.5	0.01						4
72-14	10.6	1.3	Hawkes Pond	641	2.6	4.03	0.50	0.8	0.01				x		4
36-10	24.4	2.5	Beaverdam Brook	1329	6.8	3.57	0.37	0.9	0.03						4
23-1	23.1	2.5	Unnamed Stream	1047	5.3	4.34	0.46	1.1	0.02						4
32-7	21.5	2.4	Unnamed Pond	1104	4.7	4.54	0.50	1.2	0.02						4

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
27-7	20.5	2.6	Beaverdam Brook	1270	9.2	2.23	0.28	0.8	0.00						4
36-2	19.5	2.1	Unnamed Wetland	1874	3.8	5.19	0.56	1.0	0.02						4
42-11	16.1	1.8	Unnamed Pond	1383	3.1	5.12	0.57	1.0	0.02						4
68-1	15.8	1.6	Unnamed Wetland	1191	4.3	3.68	0.38	0.6	0.01						4
35-2	15.2	1.7	Unnamed Wetland	1013	2.6	5.88	0.64	0.9	0.02						4
27-2	13.1	1.3	Beaverdam Brook	1631	3.3	3.92	0.40	0.5	0.01						4
37-6	12.6	1.4	Saugus River	1185	1.1	11.00	1.25	1.0	0.03					x	4
51-2	2.2	0.2	Saugus River	8	0.5	4.17	0.42	0.1	0.00						5
57-7	8.6	0.9	Hawkes Brook	0	1.8	4.66	0.50	0.4	0.01						5
72-4	8.4	1.0	Hawkes Pond	9	2.5	3.29	0.38	0.5	0.01				x		5
39-4	7.0	0.8	Unnamed Wetland	45	2.2	3.13	0.38	0.5	0.01						5
72-11	6.7	0.7	Hawkes Pond	8	2.2	2.97	0.33	0.4	0.00				x		5
28-7	6.2	0.7	Unnamed Stream	11	1.3	4.95	0.55	0.4	0.01						5
40-1	5.6	0.6	Unnamed Pond	3	1.2	4.80	0.55	0.4	0.01						5
45-6	5.0	0.5	Pillings Pond	13	1.0	4.83	0.51	0.3	0.00			x			5
33-3a	4.9	0.6	Unnamed Stream	38	0.8	6.15	0.74	0.4	0.01						5
52-3	4.4	0.5	Pillings Pond	28	0.8	5.29	0.59	0.3	0.00			x			5
39-8	2.2	0.3	Unnamed Pond	17	1.0	2.27	0.25	0.1	0.00						5
72-6	1.2	0.2	Hawkes Pond	11	0.1	8.15	1.04	0.1	0.01						5
52-5	9.0	1.0	Pillings Pond	112	1.5	5.94	0.64	0.5	0.01			x			5
39-5	8.8	1.0	Unnamed Wetland	107	1.7	5.33	0.59	0.5	0.01						5
40-3	8.8	1.0	Unnamed Stream	135	1.7	5.21	0.61	0.6	0.01						5
62-2	8.7	1.0	Hawkes Brook	96	1.5	5.67	0.65	0.6	0.01						5

Table 3: Catchment Area Analysis for Outfalls in the Saugus River Nutrient Source Area

Catchment ID	TN Load (lbs N/year)	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TN Load per acre (lbs/acre/yr)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Nitrogen (mg/L) *if sample was taken*	Within the Pillings Pond P Source Area	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
30-3	6.9	0.8	Beaverdam Brook	120	2.0	3.47	0.40	0.5	0.01						5
33-2	6.5	0.8	Unnamed Pond	64	2.3	2.86	0.36	0.5	0.01						5
28-6	5.6	0.7	Unnamed Stream	83	1.1	5.35	0.64	0.4	0.01						5
42-8	4.8	0.7	Beaverdam Brook	89	0.7	6.73	0.94	0.4	0.03						5
45-3	4.4	0.5	Pillings Pond	51	0.9	5.15	0.56	0.2	0.00			x			5
72-15	3.4	0.4	Hawkes Pond	112	0.9	3.82	0.50	0.3	0.00				x		5
37-2	8.2	1.0	Beaverdam Brook	259	1.9	4.29	0.50	0.6	0.01						5
62-10	8.0	1.0	Hawkes Brook	261	1.4	5.56	0.67	0.6	0.04						5
61-3	7.4	0.9	Hawkes Brook	491	3.2	2.29	0.27	0.3	0.00						5
39-7	6.7	0.8	Unnamed Stream	193	1.8	3.62	0.43	0.5	0.01						5
57-8	3.9	0.5	Hawkes Brook	366	0.5	7.19	0.87	0.3	0.01						5
43-4	3.8	0.4	Saugus River	349	0.6	6.02	0.67	0.2	0.01				x		5
25-5	3.4	0.4	Beaverdam Brook	152	1.2	2.82	0.34	0.3	0.00						5
62-9	1.4	0.2	Hawkes Brook	230	1.2	1.16	0.20	0.1	0.00						5
68-3	8.4	1.0	Unnamed Wetland	833	5.2	1.60	0.20	0.2	0.00						5
26-5	7.8	0.9	Beaverdam Brook	619	1.7	4.50	0.50	0.5	0.01						5
42-6	6.3	0.9	Unnamed Pond	612	1.2	5.27	0.72	0.5	0.03						5
61-1	5.9	0.6	Hawkes Brook	576	1.4	4.28	0.45	0.3	0.00						5
37-7	3.8	0.4	Saugus River	739	0.9	4.08	0.47	0.2	0.00					x	5
INT-3	9.8	1.0			2.4	4.15	0.44	0.5	0.01						5
INT-4	5.2	0.6			1.4	3.80	0.41	0.3	0.00						5
36-9	3.4	0.3	Beaverdam Brook	1115	1.0	3.51	0.34	0.1	0.00						5
Total	**7054**	**781**			**1618**			**382**	**9**						

Table 4: Catchment Area Analysis for Outfalls in the Pillings Pond Phosphorus Source Area

Catchment ID	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
28-2	19.66	Unnamed Stream	42	51.8	0.38	8.8	0.10				1
33-6	21.17	Unnamed Stream	339	39.6	0.53	10.7	0.17				1
28-4	16.58	Unnamed Stream	482	37.3	0.45	7.2	0.09				1
38-3	14.93	Pillings Pond	174	29.0	0.51	6.1	0.08			x	1
32-3	12.98	Unnamed Pond	701	14.1	0.92	9.1	0.73			x	1
45-1	11.44	Pillings Pond	920	22.0	0.52	6.1	0.10			x	1
38-1	8.45	Pillings Pond	6	16.9	0.50	3.7	0.05	0.036		x	2
52-4	7.55	Pillings Pond	0	14.1	0.54	3.9	0.06	0.054	x	x	2
33-8	6.28	Unnamed Stream	353	12.6	0.50	3.0	0.04		x		2
33-7	8.53	Unnamed Pond	571	21.8	0.39	3.6	0.04				2
39-3	3.00	Pillings Pond	17	6.8	0.44	1.3	0.02			x	3
44-5	2.61	Pillings Pond	30	4.3	0.61	1.4	0.02				3
53-9	3.04	Pillings Pond	50	5.4	0.56	1.6	0.03				3
44-6	2.75	Pillings Pond	53	4.2	0.65	1.5	0.03				3
44-7	2.71	Pillings Pond	75	6.0	0.45	1.2	0.02	0.094			3
45-5	2.69	Pillings Pond	148	4.3	0.62	1.4	0.02				3
34-1	3.38	Unnamed Stream	466	7.1	0.47	1.6	0.02				3
57-10	4.79	Hawkes Brook	813	9.3	0.52	2.6	0.04				3
33-5	4.37	Unnamed Stream	501	8.3	0.52	2.2	0.04				3
53-1	3.06	Pillings Pond	581	6.3	0.49	1.7	0.03			x	3
28-3	3.16	Unnamed Stream	1244	6.8	0.47	1.4	0.02				3
44-8	2.49	Pillings Pond	6	4.0	0.62	1.3	0.02				4
44-4	1.95	Pillings Pond	40	5.4	0.36	0.8	0.01	0.285			4

Table 4: Catchment Area Analysis for Outfalls in the Pillings Pond Phosphorus Source Area

Catchment ID	TP Load (lbs P/year)	Receiving Water	Distance to Receiving Water (ft)	Catchment Area (Acres)	TP Load per acre (lbs/acre/yr)	Impervious Area in Catchment (acres)	DCIA in Catchment (acres)	Phosphorus (mg/L) *if sample was taken*	Existing BMP in Catchment	Municipal Properties in Catchment	Prioritization Group
52-1	1.83	Pillings Pond	0	3.2	0.58	1.0	0.02				4
45-4	1.35	Pillings Pond	48	3.4	0.39	0.5	0.01				4
39-1	2.29	Unnamed Stream	0	5.1	0.45	1.4	0.02				4
40-3	1.02	Unnamed Stream	135	1.7	0.61	0.6	0.01				4
38-2	2.43	Pillings Pond	160	5.3	0.45	1.1	0.02				4
40-2	2.16	Unnamed Pond	308	5.1	0.42	0.9	0.01				4
28-1	1.44	Unnamed Stream	495	3.0	0.49	0.6	0.01				4
32-5	2.03	Unnamed Pond	754	3.3	0.62	1.2	0.02			x	4
46-1	1.74	Pillings Pond	925	3.5	0.49	0.9	0.01				4
23-1	2.46	Unnamed Stream	1047	5.3	0.46	1.1	0.02				4
45-6	0.53	Pillings Pond	13	1.0	0.51	0.3	0.00				5
52-3	0.49	Pillings Pond	28	0.8	0.59	0.3	0.00				5
39-4	0.84	Unnamed Wetland	45	2.2	0.38	0.5	0.01				5
28-7	0.69	Unnamed Stream	11	1.3	0.55	0.4	0.01				5
40-1	0.65	Unnamed Pond	3	1.2	0.55	0.4	0.01				5
33-3a	0.59	Unnamed Stream	38	0.8	0.74	0.4	0.01				5
39-8	0.25	Unnamed Pond	17	1.0	0.25	0.1	0.00				5
39-5	0.98	Unnamed Wetland	107	1.7	0.59	0.5	0.01				5
52-5	0.97	Pillings Pond	112	1.5	0.64	0.5	0.01				5
33-2	0.80	Unnamed Pond	64	2.3	0.36	0.5	0.01			x	5
28-6	0.68	Unnamed Stream	83	1.1	0.64	0.4	0.01				5
45-3	0.48	Pillings Pond	51	0.9	0.56	0.2	0.00				5
39-7	0.79	Unnamed Stream	193	1.8	0.43	0.5	0.01				5
Total	**195**			**394**		**96**	**2**				

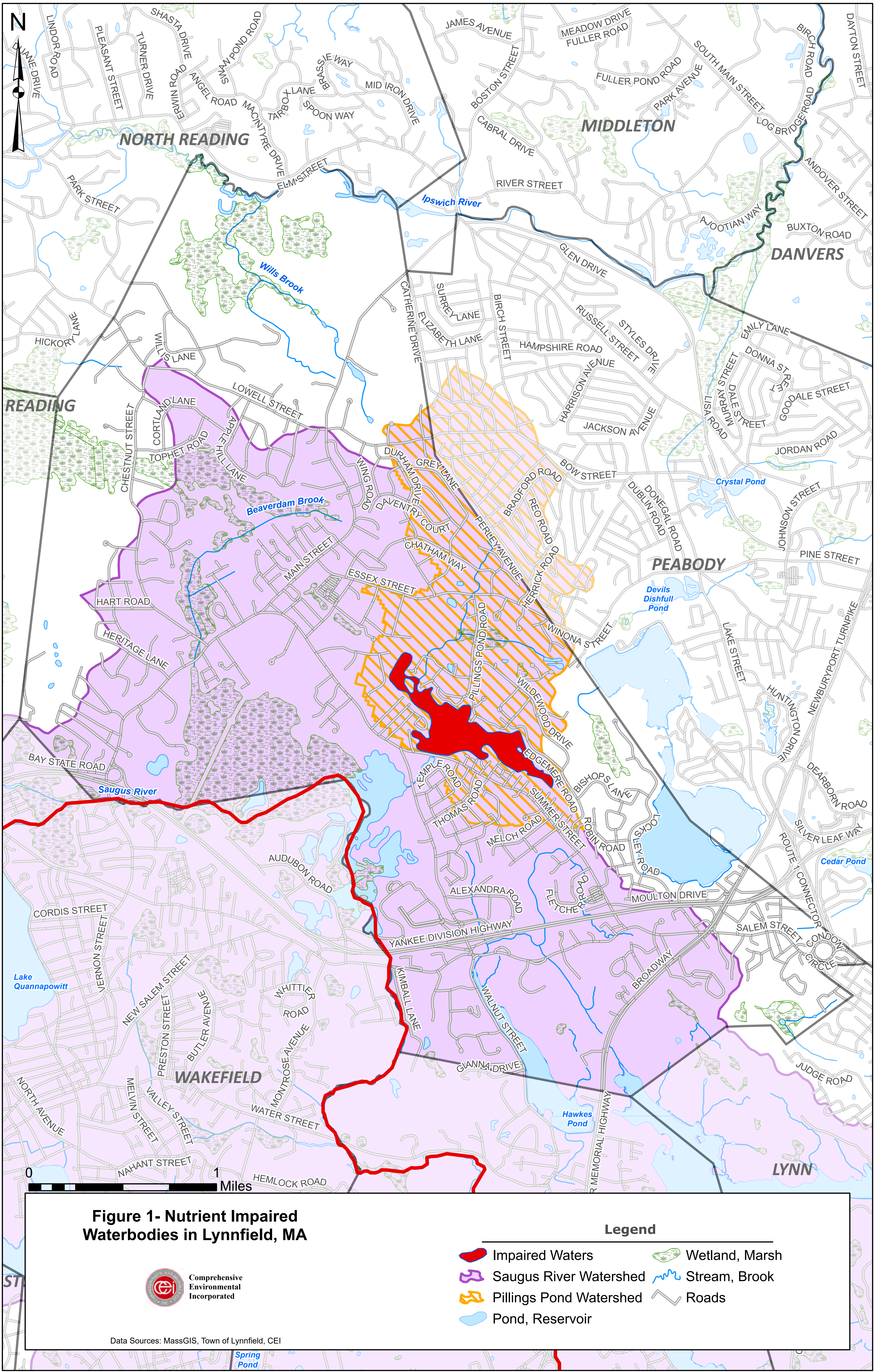

Figure 1- Nutrient Impaired Waterbodies in Lynnfield, MA

Legend

- 🟥 Impaired Waters
- Saugus River Watershed
- Pillings Pond Watershed
- Pond, Reservoir
- Wetland, Marsh
- Stream, Brook
- Roads

Comprehensive
Environmental
Incorporated

Data Sources: MassGIS, Town of Lynnfield, CEI

6/21/2022

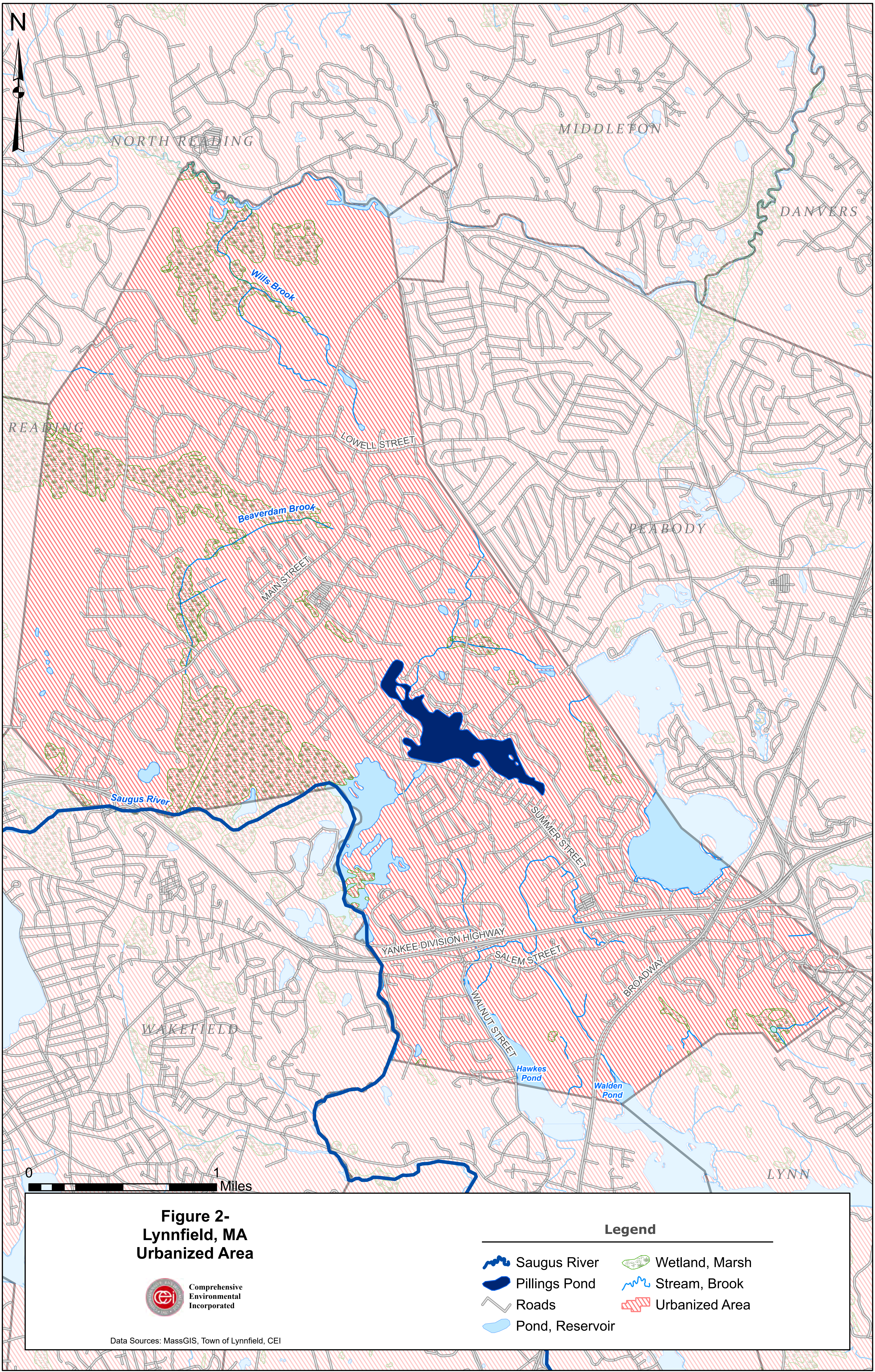

Figure 2-
Lynnfield, MA
Urbanized Area

Comprehensive
Environmental
Incorporated

Data Sources: MassGIS, Town of Lynnfield, CEI

5/31/2022

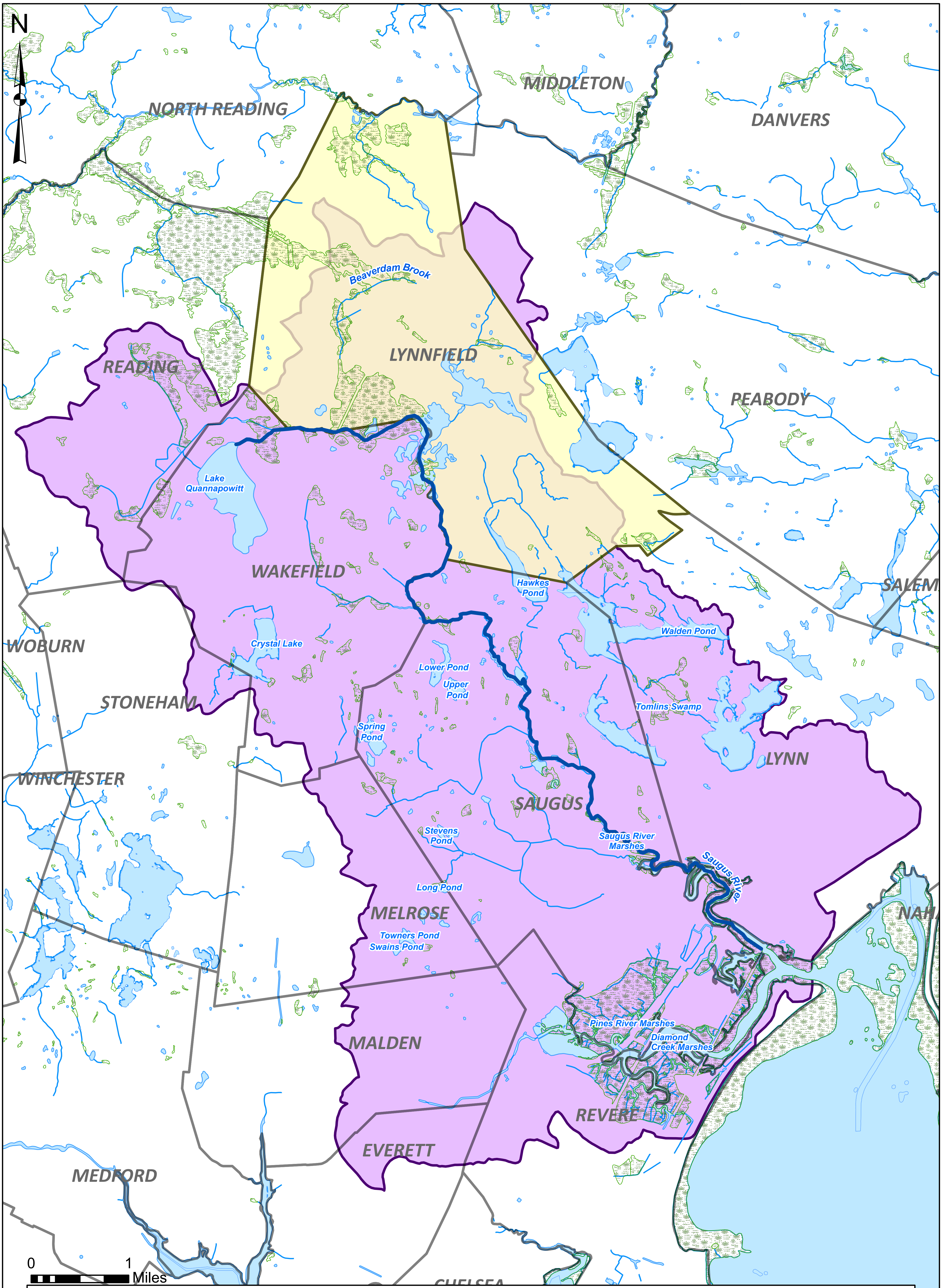

Figure 3-
Saugus River Watershed

Legend

🟨 Town Of Lynnfield	Pond, Reservoir
Saugus River	Wetland, Marsh
Saugus River Watershed	Stream, Brook

Comprehensive
Environmental
Incorporated

Data Sources: MassGIS, Town of Lynnfield, CEI

5/31/2022

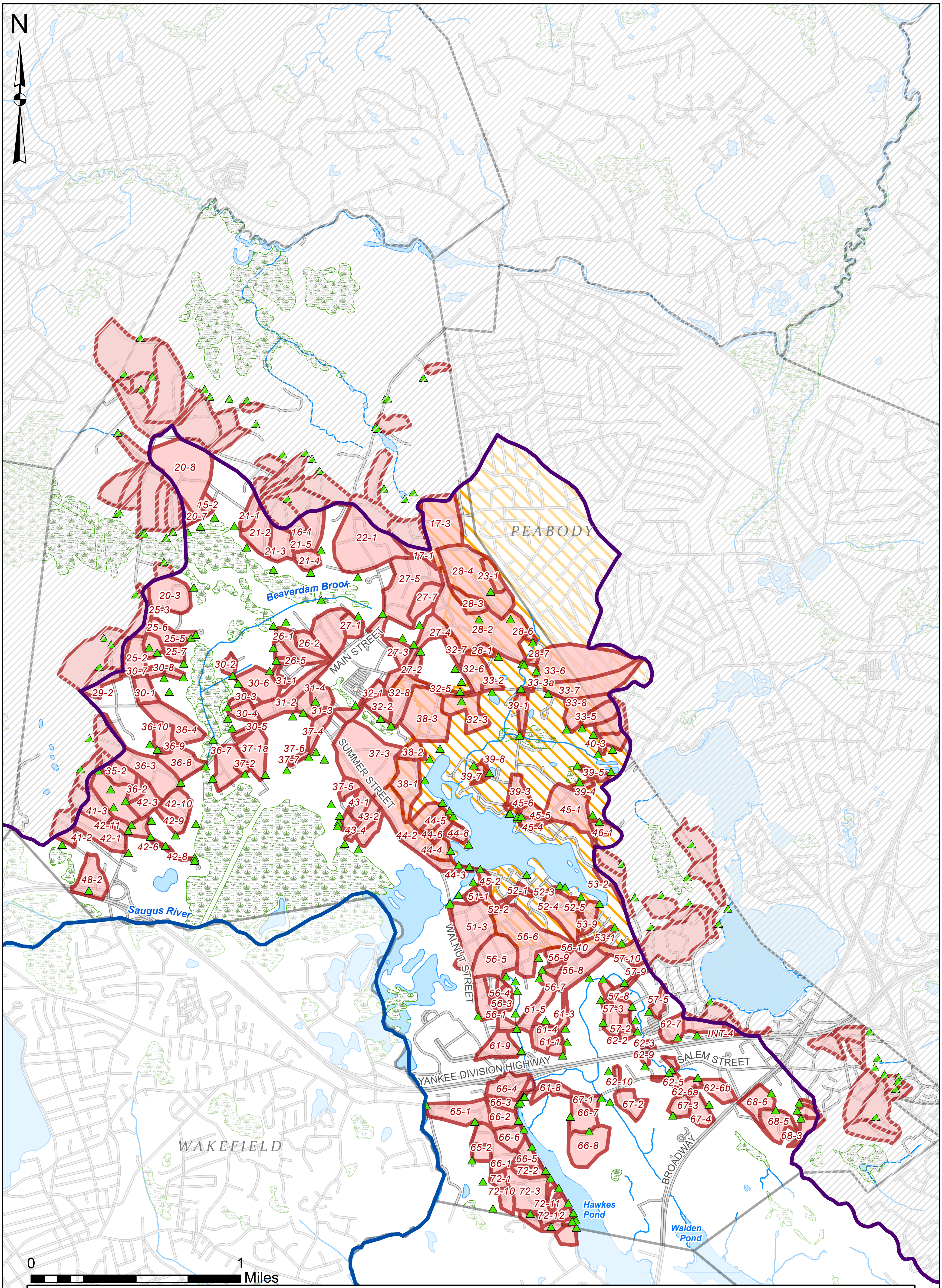

Figure 4- Saugus River Nutrient Source Area in Lynnfield, MA

Comprehensive
Environmental
Incorporated

Legend

- ▲ Outfalls
- 🟥 Source Area
- Saugus River
- Saugus River Watershed
- Pillings Pond Watershed
- Other Watershed
- Roads
- Pond, Reservoir
- Wetland, Marsh
- Stream, Brook

Data Sources: MassGIS, Town of Lynnfield, CEI

7/5/2022

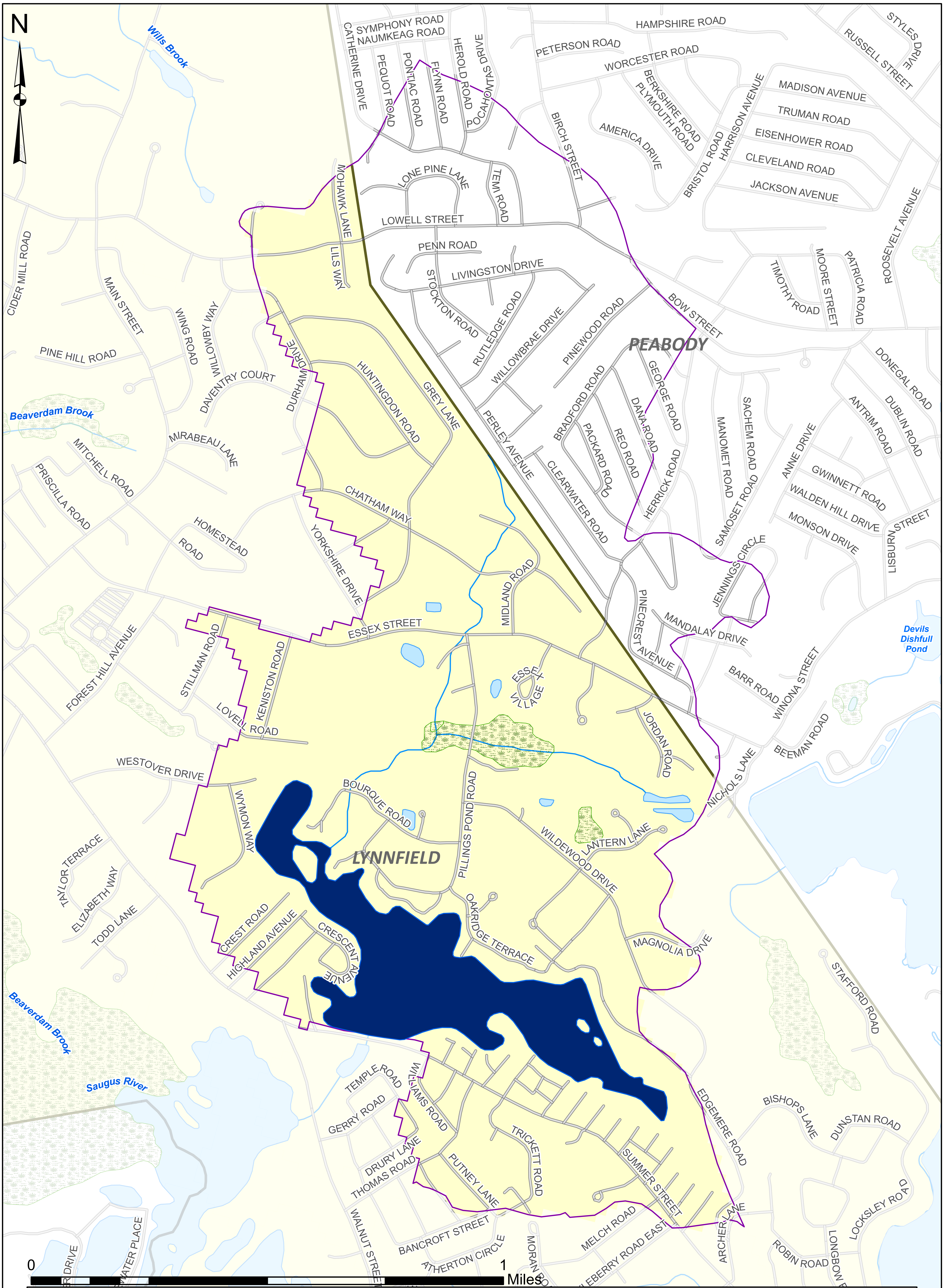

Figure 5-
Pillings Pond Watershed

Comprehensive Environmental Incorporated

Legend

- ▭ Town Of Lynnfield
- ● Pillings Pond
- ▭ Pillings Pond Watershed
- ● Pond, Reservoir
- ▨ Wetland, Marsh
- ∿ Stream, Brook
- ∿ Roads

Data Sources: MassGIS, Town of Lynnfield, CEI

4/12/2022

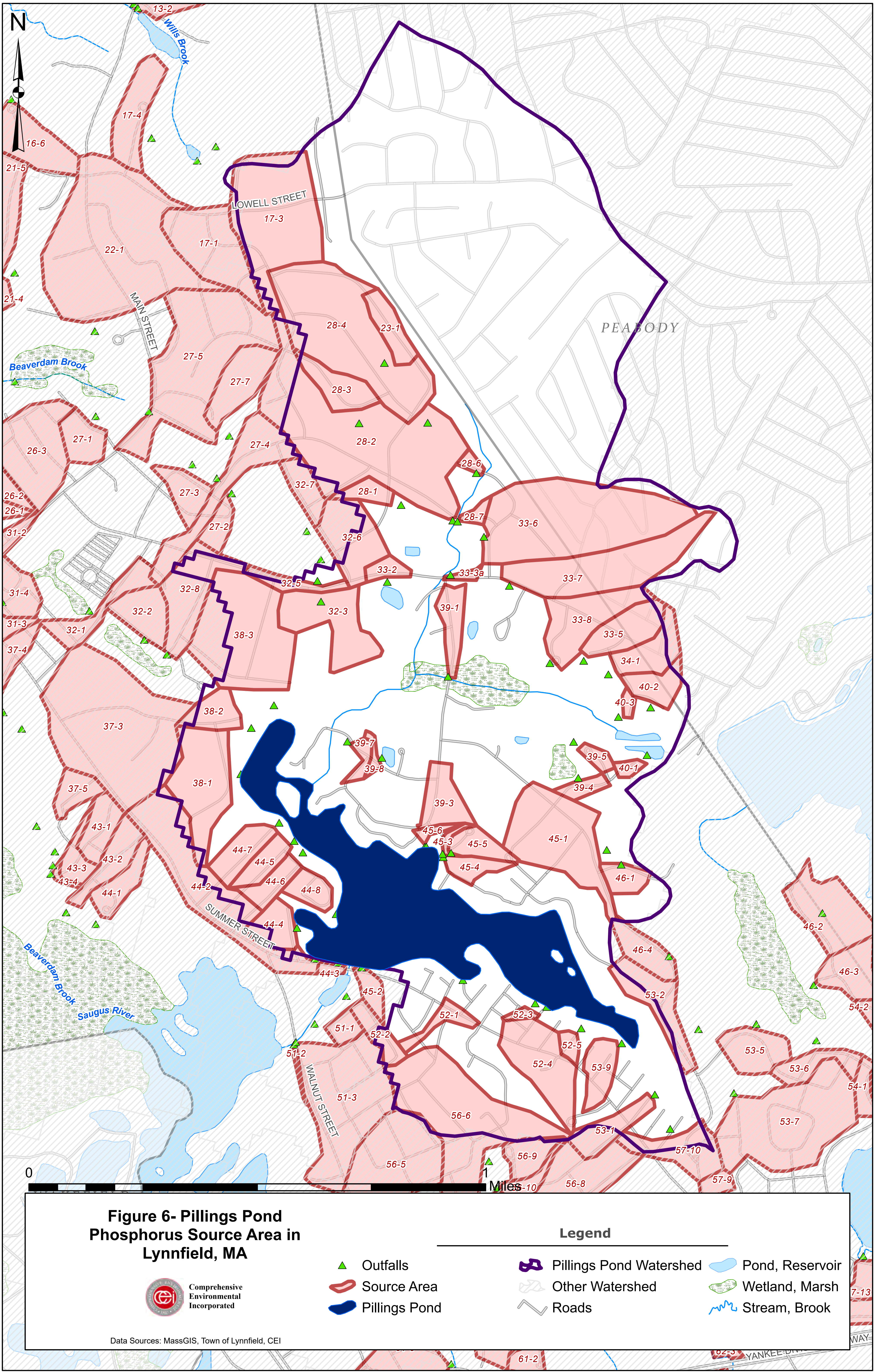

Figure 6- Pillings Pond Phosphorus Source Area in Lynnfield, MA

Data Sources: MassGIS, Town of Lynnfield, CEI

7/5/2022

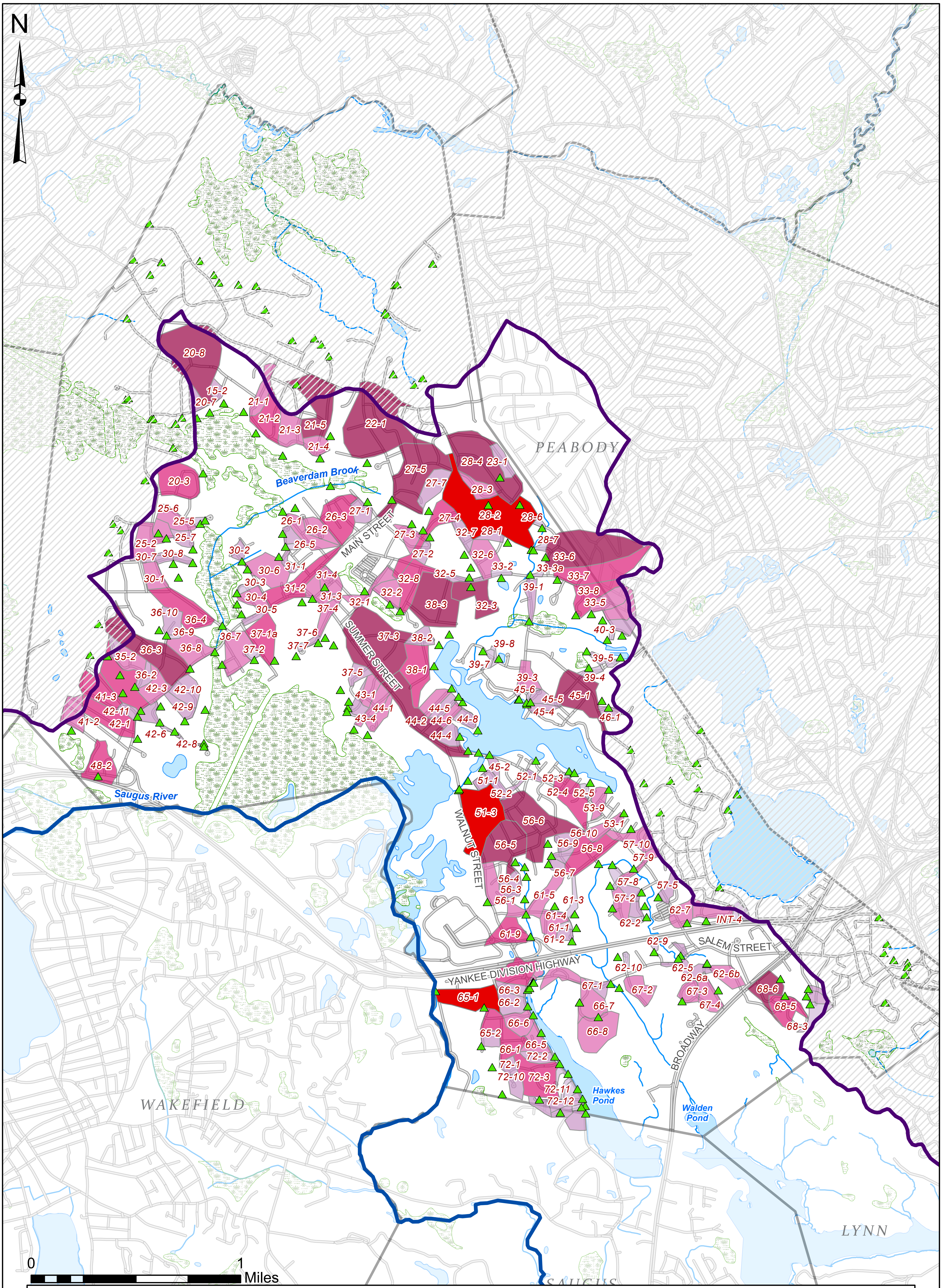

Figure 8- Saugus River Nutrient Source Area Catchment Prioritization Lynnfield, MA

Comprehensive
Environmental
Incorporated

Data Sources: MassGIS, Town of Lynnfield, CEI

Legend

- Top 3 Catchment
- Catchment Priority Group:
- 1
- 2
- 3
- 4
- 5
- ▲ Outfalls
- Saugus River
- Saugus River Watershed
- Other Watershed
- Pond, Reservoir
- Wetland, Marsh
- Stream, Brook

7/8/2022

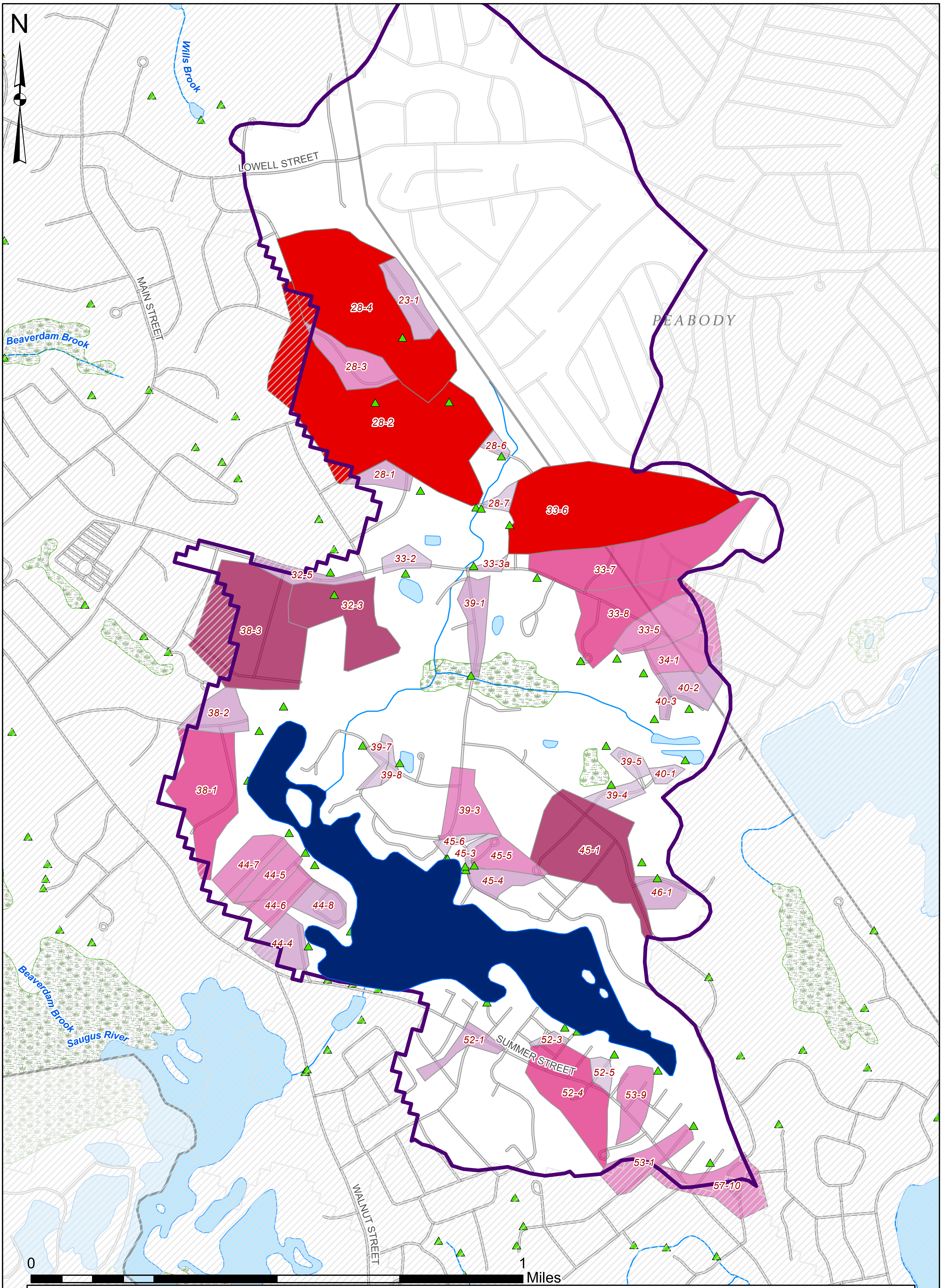

Figure 8- Pillings Pond Phosphorus Source Area Catchment Prioritization Lynnfield, MA

Comprehensive
Environmental
Incorporated

Data Sources: MassGIS, Town of Lynnfield, CEI

Legend

Top 3 Catchment	4	Other Watershed
Catchment Priority Group:	5	Pond, Reservoir
1	▲ Outfalls	Wetland, Marsh
2	Pillings Pond	Stream, Brook
3	Pillings Pond Watershed	

7/5/2022

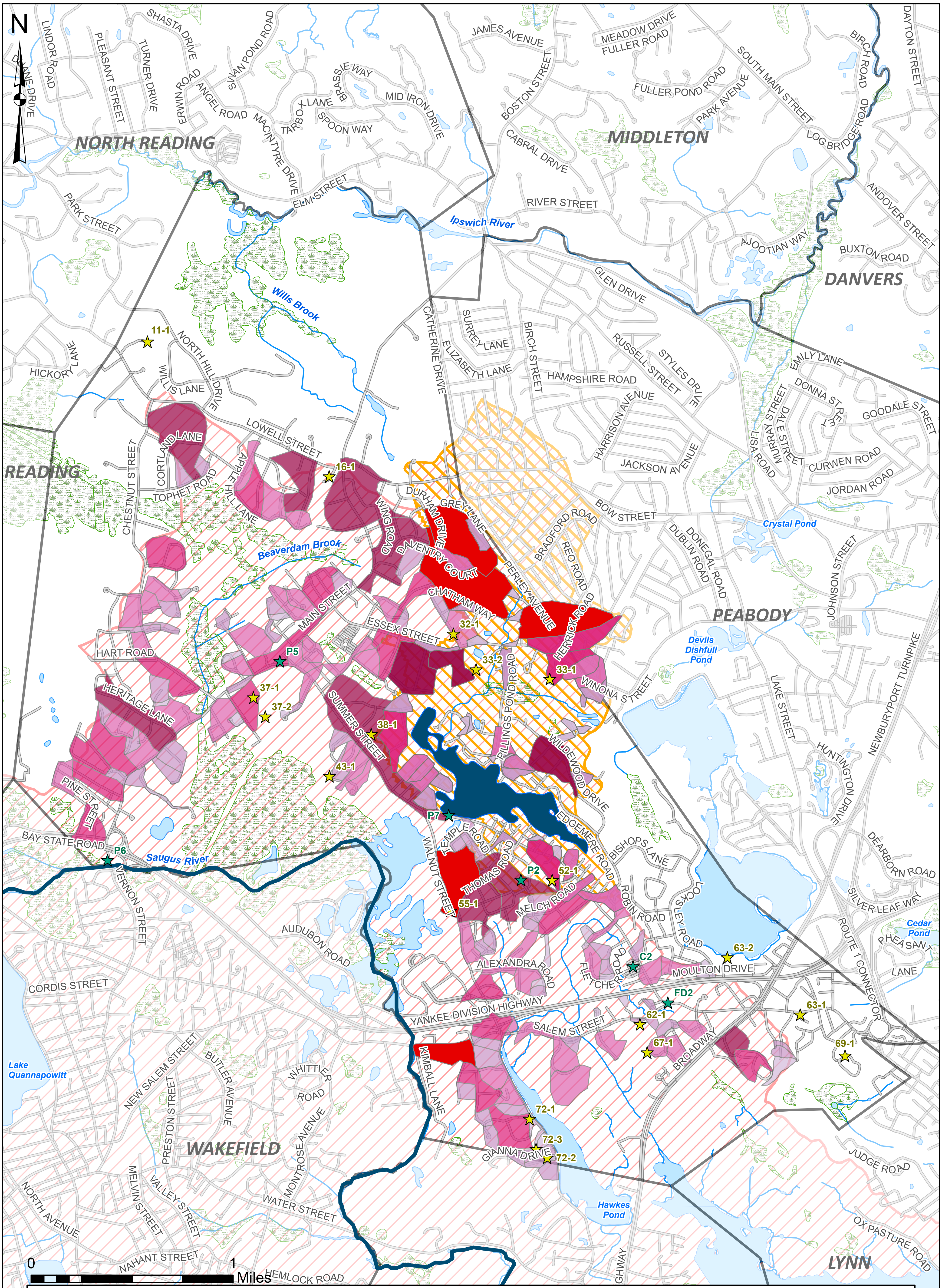

Figure 9- Lynnfield, MA
Nutrient Impaired Watersheds, Existing BMPs and Potential Retrofits

Comprehensive Environmental Incorporated

Data Sources: MassGIS, Town of Lynnfield, CEI

Legend

★ Proposed BMP	3	Roads
★ Existing BMP	4	Pond, Reservoir
Top Catchment	5	Wetland, Marsh
Catchment Priority Group:	Impaired Waters	Stream, Brook
1	Saugus River Watershed	
2	Pillings Pond Watershed	

7/8/2022

Appendix A

DCIA Calculation Methodology

Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachusetts Small MS4 Permit

Small MS4 Permit Technical Support Document, Revised April 2014 (Original Document, April 2011)

Draft NPDES Permit Focuses on DCIA

The 2010 NPDES Small MS4 draft permits for Massachusetts require regulated communities to estimate the number of acres of **impervious area** (**IA**) and **directly connected impervious area** (**DCIA**) that have been added or removed each year due to development, redevelopment, and or retrofitting activities (Draft North Coastal Permit Section 2.4.6.9). Beginning with the second year annual report, IA and DCIA estimates must be provided for each subbasin within your regulated MS4 area. This technical support tool outlines accepted methods for estimating and reporting IA and DCIA in three steps:

Step 1. Establish Baseline IA/DCIA Use EPA estimates or refine with local data

Step 2. Calculate Annual Change Add/remove IA/DCIA for new projects completed in reporting year

Step 3. Report Net Change Summarize in annual NPDES report by Subbasin

What does DCIA really mean?

Impervious surfaces such as roadways, parking lots, rooftops, sidewalks, driveways, and other pavements impede stormwater infiltration and generate surface runoff. Research has shown that total watershed IA is correlated with a number of negative impacts on our water resources such as increased flood peaks and frequency, increased sediment, nutrient, and other pollutant levels, channel erosion, impairments to aquatic biota, and reduced recharge to groundwater (Center for Watershed Protection, 2003). Typically watersheds with 4-6% IA start to show these impacts, though recent work has found lower % IA threshold values for sensitive species (Wenger et al., 2008). Watersheds exceeding 12% IA often fail to meet aquatic life criteria and narrative standards (Stanfield and Kilgore, 2006).

For the purposes of the MS4 permit, DCIA is considered the portion of IA with a direct hydraulic connection to the permittee's MS4 or a waterbody via continuous paved surfaces, gutters, drain pipes, or other conventional conveyance and detention structures that do not reduce runoff volume. DCIA does not include:

- IA draining to stormwater practices designed to meet recharge and other volume reduction criteria.
- Isolated IA with an indirect hydraulic connection to the MS4, or that otherwise drain to a pervious area.
- Swimming pools or man-made impoundments, unless drained to an MS4.
- The surface area of natural waterbodies (e.g., wetlands, ponds, lakes, streams, rivers).

Accepted Methods for Estimating IA & DCIA

Step 1. Establish Baseline IA/DCIA

Use the estimates of existing IA and DCIA provided by EPA to establish the baseline acreage from which future additions or reductions of impervious cover can be tracked and measured.

For each regulated municipality in Massachusetts, EPA will provide graphical and tabular estimates of IA/DCIA ordered by land use type and subbasin. **Permittees may simply use these baseline estimates as is, or develop more accurate estimates when justified.** This may include using local data to refine EPA's estimates or the direct measure of IA (**Figure 1**). If the EPA estimates are not used for the baseline, permittees must provide in the annual report a description of the alternative methodology used.

Figure 1. EPA will use IA extrapolated from 2005, 1-meter orthoimagery provided by MassGIS (upper). A comparison of a MassGIS-derived IA estimate (shown in purple) vs. a refined direct measurement (shown in green) by the Town of Reading, MA illustrates differences in precision (lower).

Once IA has been established, DCIA can be estimated using empirical formulas developed by Sutherland as a function of IA for various watershed types (CWP, 2000). **Table 1** summarizes appropriate equations to apply for *average*, *highly connected*, *totally connected*, *somewhat connected*, and *mostly disconnected* watersheds. EPA will provide each municipality with DCIA estimates based on land use and assumed watershed conditions; however, **permittees may opt to refine these estimates to better reflect actual basin conditions where justified.**

Table 1. Sutherland Equations to Determine DCIA (%)

Watershed Selection Criteria	Assumed Land Use	Equation *(where IA(%) ≥ 1)*
Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	Commercial, Industrial, Institutional, Open land, and Med. density residential	$DCIA=0.1(IA)^{1.5}$
Highly connected: Same as above, but residential rooftops are connected	High density residential	$DCIA=0.4(IA)^{1.2}$
Totally connected: 100% storm sewered with all IA connected	--	DCIA=IA
Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	Low density residential	$DCIA=0.04(IA)^{1.7}$
Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	Agricultural; Forested	$DCIA=0.01(IA)^{2}$

Why Quantify Your IA & DCIA?

New construction, redevelopment, and restoration activities can change existing IA and DCIA – potentially exacerbating or reducing existing watershed impairments. Understanding watershed imperviousness is important for communities because it:

- Informs management of impaired waterbodies and prioritization of watershed restoration efforts;
- Facilitates investigation of existing chronic flooding and stormwater drainage problems, and avoidance of new problems;
- Indicates potential threats to drinking water reservoirs/aquifers; commercial fisheries, and recreational waters;
- Demonstrates progress toward achieving future **Total Maximum Daily Load (TMDL)** allocations based on impervious cover thresholds;
- Serves as an educational tool for encouraging environmentally sensitive land use planning and **Low Impact Development (LID);**
- Facilitates equitable derivation of possible stormwater utility fees based on parcel-specific impervious cover; and
- Provides guidance for directing stormwater retrofit efforts.

Step 2. Calculate Annual Change

Once baseline IA/DCIA is established for each subbasin, permittees must annually track the change in IA and DCIA acreage from development, redevelopment, and retrofit projects completed that year.

To account for the estimated annual change in DCIA, permittees will need to determine how much IA and DCIA have been added or removed as a result of individual development, redevelopment, or retrofit projects completed during the reporting period.

The acres of DCIA for each project will be based on two factors: **(1) the amount of site IA, and (2) the effectiveness of stormwater best management practices (BMPs)** employed to reduce associated runoff. Practices that reduce runoff volume will lower DCIA. Note that practices that remove stormwater pollutants but do not provide runoff reduction benefits are not considered effective at reducing DCIA.

This information must be obtained from site plans and verified by as-built drawings or site inspection upon project completion. For all completed projects:

(1) Determine the former and new IA for each site.

(2) Determine the number and type of existing and/or new BMP(s) used, and calculate the amount of IA removed, managed, and unmanaged draining to each BMP.

(3) For each BMP designed in accordance with specifications provided in MassDEP's Stormwater Handbook (v.2, chp.2), select the appropriate "disconnection" multiplier from **Table 2**.

For infiltration trenches or basins, determine appropriate runoff volume reduction using **Table 3** depending on site-specific soil infiltration rates and runoff depth captured as derived from the EPA 2010 BMP Performance Curves. Use **Equation 1** to generate the BMP "disconnection" multiplier.

Eq. 1 Multiplier = 1 - % Runoff Reduction Volume/100

(4) Calculate DCIA for each BMP using **Equation 2** if adding newly created IA at new construction or redevelopment site, OR by using **Equation 3** if reducing existing IA in a retrofit or redevelopment scenario.

Eq. 2 Added $DCIA_{BMPi} = IA_{BMPi}$ * BMP Multiplier

Eq. 3 Reduced $DCIA_{BMPi} = IA_{BMPi}$ * (1 – BMP Multiplier)

(5) Calculate DCIA for entire project site draining to BMPs by summing DCIA for individual BMPs using **Equation 4**.

Eq. 4 Site $DCIA_{added} = \sum_{i=1}^{n} DCIA_{BMPi}$ + New Unmanaged IA

Table 2. Determining DCIA based on Interim Default BMP Disconnection Multipliers or EPA's Infiltration Curves

BMP Description	% Runoff Volume Reduction[1]	BMP Disconnection Multiplier[2]
Removal of pavement; restoration of infiltration capacity	100%	0
Redirection of rooftop runoff to infiltration areas, rain gardens or dry wells	85%	0.15
Permeable pavement, bioretention practices, dry/vegetated water quality swales	75%	0.25
Disconnection to qualified pervious area[3]	50%	0.50
Infiltration trenches	15-100%	0.85-0
Infiltration basins	13-100%	0.87-0
Non-runoff reduction practices (i.e., detention ponds, wetlands, sand filters, hydrodynamic separators, etc)	0%	1.0

[1] Interim default values for % runoff reduction based on Schueler 2009 and are subject to change as more data becomes available. Values for infiltration trenches and basins are based on soil infiltration rates and depth of runoff treated. See Tables 3 and 4 to determine the site specific values to apply.

[2] BMP multiplier = 1 - %Runoff Volume Reduction/100

[3] Areas given MassDEP LID Site Design Credits per the MA Stormwater Standards (Vol. 3, Chapter 1) are assigned % reduction values based on upper estimates of rooftop disconnection to pervious area as reported by Chesapeake Stormwater Network (2009).

Table 3. Percent Runoff Reduction based on EPA's 2010 Infiltration Curves

Storage Capacity: Runoff Depth from DCIA (inches)	Soil Infiltration Rate (in/hr)					
	0.17	0.27	0.52	1.02	2.41	8.27
Infiltration Trench						
0.1	15%	18%	22%	26%	34%	54%
0.2	28%	32%	38%	45%	55%	76%
0.4	49%	55%	62%	68%	78%	93%
0.6	64%	70%	76%	81%	88%	97%
0.8	75%	79%	84%	88%	93%	99%
1.0	82%	85%	89%	92%	96%	100%
1.5	92%	93%	95%	97% Eq. 4	99%	100%
2.0	95%	96%	97%	98%	100%	100%
Infiltration Basin						
0.1	13%	16%	20%	24%	33%	55%
0.2	25%	30%	36%	42%	54%	77%
0.4	44%	51%	58%	66%	78%	93%
0.6	59%	66%	73%	79%	88%	98%
0.8	71%	76%	81%	87%	93%	99%
1.0	78%	82%	87%	91%	96%	100%
1.5	89%	91%	94%	96%	99%	100%
2.0	94%	95%	97%	98%	100%	100%

Example Subbasin DCIA Calculations

Baseline conditions for subbasin #54203 were estimated to include 100 acres IA and 50 acres DCIA. By the second year of NPDES reporting, two construction projects were completed that resulted in an overall change in the amount of subbasin IA and DCIA as follows:

Project 1: New 5-acre residential townhome complex with 4 acres of new IA, of which, 0.9 acres drain to a bioretention facility, 3 acres drain to an infiltration basin, and 0.1 acres drain untreated to the main road. The infiltration basin is designed based on a soil infiltration rate of 0.52 in/hr and 0.8 inches of runoff captured.

Step 1. Establish new IA to add to baseline = 4.0 ac

Steps 2 -4. Determine DCIA per BMP

Eq. 3 Multiplier$_{\text{inf. basin}}$ = 1 - 81/100 = 0.19

Eq. 4 DCIA$_{\text{bioretention}}$ = 0.9 ac * 0.25 = 0.23 ac
DCIA$_{\text{inf. basin}}$ = 3.0 ac * 0.19 = 0.57 ac

Step 5. Sum DCIA for entire site

Eq. 6 Total Project DCIA= 0.23 ac + 0.57 ac + 0.1 ac$_{\text{unmanaged}}$
= 0.9 ac DCIA to add to baseline

Project 2: Redevelopment of an 8-acre retail outlet with 5.5 acres of existing IA. After redevelopment, there are now 6.0 acres total IA. 3.0 acres of IA continues to drain to an existing detention pond, but 1.0 acre of overflow parking was converted to pervious pavement. A new bioretention retrofit now captures 0.7 acres of IA that used to drain to the pond, as well as 0.5 acres of newly added IA. The remaining 0.8 acre of site IA remains untreated.

Step 1. Establish new IA to add to baseline = 6.0 ac - 5.5 ac
= 0.5 ac

Steps 2-4. Determine DCIA per BMP to be added or subtracted from baseline.

Eq. 4 Added DCIA$_{\text{bioretention-new IA}}$ = 0.5 ac * 0.25 = 0.13 ac

Eq. 5 Reduced DCIA$_{\text{porous pavement}}$ = 1 ac *(1-0.25) = 0.75 ac
Reduced DCIA$_{\text{drypond}}$ = 3.0 ac *(1-1.0) = 0 ac
Reduced DCIA$_{\text{bio-existing IA}}$ = 0.7 ac *(1-0.25) = 0.53 ac

Step 5. Sum DCIA for entire site.

Eq. 6 Total Project Added DCIA = 0.13 ac + 0 ac$_{\text{new unmanaged IA}}$
= 0.13 ac DCIA to add to baseline

Eq. 6 Total Reduced DCIA = 0.75 ac + 0 ac+0.53 ac
= 1.28 ac DCIA to subtract from baseline

End of Year Report: Totals for Subbasin #54203:

IA = 100 ac$_{\text{baseline}}$ + 4.0 ac$_{\text{project 1}}$ + 0.5 ac$_{\text{project 2}}$
= 104.5 ac *(net gain of **4.5 ac**)*

DCIA = 50 ac$_{\text{baseline}}$ +0.9 ac$_{\text{project 1}}$ + 0.13 ac $_{\text{project 2}}$ – 1.28 ac$_{\text{project 2}}$
= 49.75 ac DCIA *(net reduction of **0.25 ac**)*

Step 3.
Report Net Change in IA & DCIA

Starting in year 2, permittees must include a summary of net changes in IA/DCIA by subbasin and document methodology in its annual report.

Permittees will be required to summarize IA and DCIA estimates for all completed construction, redevelopment, and retrofit projects within each subbasin. **EPA will provide a tracking spreadsheet to each community to assist in the calculation and tracking of this information.** For individual BMPs at each site, permitees will need to track the type of practice, the IA captured, and the % runoff reduction and "disconnection" multiplier assigned to that practice. Consider incorporating these DCIA accounting elements into your program's existing BMP tracking database.

Checklist of What to Expect EPA to Provide

EPA will provide all regulated MS4 communities in Massachusetts with the following information:

- Delineation of subbasin boundaries.
- Baseline estimates of IA for each subbasin in your regulated area in tabular and GIS formats (i.e., as an impervious area map layer).
- Baseline estimate of DCIA for each subbasin (tabular format).
- DCIA calculation and tracking spreadsheet.

What are the Costs of Annual DCIA Tracking?

The cost will vary depending on the size of the regulated area, amount of existing IA, sophistication of existing GIS, number of new projects requiring tracking, and the level of effort required to obtain information for each site. Refining the EPA-provided baseline estimates of IA and DCIA may require collecting new data, purchasing new software/GIS, and additional staff time. This effort may not be worth the cost if the annual **net change** in IA and DCIA is the true measure of interest. Factors adding to overall effort may include:

- Refining EPA's baseline estimates, particularly if local IA mapping doesn't already exist.
- Over-complicating the analysis by refining given equations.
- Not easily obtaining required IA and BMP information from proposed site plans. Determine the most efficient method to obtain this information as soon as possible – changing applicant reporting requirements may be a solution.
- Verifying as-built conditions with individual site visits. Consider alternatives (e.g., occupancy certifications).
- Maintaining an updated impervious and stormwater infrastructure layer in GIS, particularly if new projects have to be hand-digitized. Possibly require applicants to submit plans electronically.
- Not integrating effort with other existing programs (i.e., plan review, building inspection, or stormwater utility).

How Does LID Influence IA and DCIA?

Incorporating LID techniques into site design can reduce IA & DCIA, protect natural areas, and minimize alterations to existing hydrology on site. The use of BMPs that maximize runoff reduction benefits (e.g., practices with low BMP multipliers in **Table 2** and those shown in **Figure 2**) can result in a higher "disconnection" factor than when using traditional detention ponds. Your community can help reduce total IA and DCIA by:

- Adopting LID design requirements for new development projects.
- Providing for LID Site Design Credits per MassDEP's Stormwater Management Standards.
- Requiring documentation of design methods used to minimize site IA and to disconnect IA.
- Requiring site designers to calculate and submit %IA and %DCIA for each site.
- Retrofitting existing, unmanaged impervious areas.

Figure 2. BMPs such as the bioretention, porous pavers, and infiltration trenches seen here are designed to provide water quality treatment and maximize runoff reduction through improved infiltration, evapotranspiration, and plant uptake. These are effective practices for reducing DCIA.

Are we Required to Follow This Protocol?

Permittees are encouraged to refine DCIA baseline estimates where local data is more accurate; however the general methodology for calculating annual change in

DCIA should be applied. Deviations from the methodology are subject to review by EPA and must be described in the annual report.

Where Can I go for More Information?

For more information regarding the new permit requirements for Massachusetts and for the North Coastal Small MS4s specifically, go to www.epa.gov/ne/npdes/stormwater/index.html and www.epa.gov/ne/npdes/stormwater/draft_manc_sms4gp.html, respectively. Here you will find links to relevant permit documents; community-specific mapping and statistics for baseline IA and DCIA estimates; detailed descriptions of methods used to calculate IA and DCIA estimates; and the calculation and tracking spreadsheet template.

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EPA's Methodology to Calculate Baseline Estimates of Impervious Area (IA) and Directly Connected Impervious Area (DCIA) for Massachusetts Communities

This document presents EPA's methodology for calculating baseline estimates of impervious area (IA) and directly connected impervious area (DCIA) to support and provide guidance for relevant provisions of the Massachusetts North Coastal Small MS4 General Permit ("General Permit"). Baseline estimates are available for each Massachusetts municipality in a Microsoft Excel format, titled "IC Stats" on the following EPA website: http://www.epa.gov/ne/npdes/stormwater/ma.html.

EPA also provides maps showing the extent of impervious cover within each community, also available on the above-mentioned website. The "IC Maps" display subbasins, impervious area (IA), and the portion of each community subject to the Permit as defined by 2000 Census urbanized areas ("Regulated/Urbanized Area"). The methodology used by EPA to develop the estimates is presented here to provide the user with an understanding of the basis for the estimates, and to facilitate refinements to the estimates by the user where desired.

Step 1: Aggregation of the MassGIS Land Use 2005 Datalayer into 10 Land Use Codes

EPA aggregated the forty (40) land use categories included in the Commonwealth's Office of Geographic and Environmental Information (MassGIS) Land Use 2005 datalayer (available at url: http://www.mass.gov/mgis/lus2005.htm) into ten (10) commonly used land use categories. The EPA Code, Code Definition, and corresponding MassGIS 2005 Land Use Codes for these land uses are shown in below in Table 1.

Table 1: EPA Aggregation of MassGIS 2005 Land Use Codes

EPA Code	Code Definition	MassGIS 2005 Land Use Codes
1	Commercial	15
2	Industrial	16, 18, 19, 29, 39
3	Low Density Residential	13, 38
4	Medium Density Residential	12
5	High Density Residential	10, 11
6	Urban Public/Institutional	7, 8, 31
7	Agriculture	1, 2, 35, 36
8	Forest	3, 40
9	Open Land	5, 6, 9, 17, 24, 26, 34
10	Water	4, 14, 20, 23, 25, 37

For communities required by the General Permit to implement a Phosphorus Control Plan, please note: the *Final TMDL for Nutrients in the Lower Charles River Basin, Massachusetts (CN 301.0)* presents annual phosphorus loadings based on land cover area (shown in Table 6-4 in the TMDL). The TMDL aggregated the twenty-one (21) land use categories included in the Commonwealth's Office of Geographic and Environmental Information (MassGIS) Land Use 1999 datalayer (available at url: http://www.mass.gov/mgis/lus.htm) into eight (8) commonly used land use categories.

Because EPA's aggregation for the IA and DCIA baseline estimates uses the MassGIS Land Use 2005 datalayer, the categories shown in Table 1, above, do not perfectly match the land cover areas identified in Table 6-4 of the TMDL. For further clarification, please refer to the Phosphorus Control Plan (PCP) Information on EPA's website at url: http://www.epa.gov/region1/npdes/stormwater/draft_manc_sms4gp.html

Table 1A, at the end of this document, shows the MassGIS 2005 Land Use Codes, the descriptions, and the EPA aggregations.

Step 2: Identification of Subbasins

EPA selected the "Massachusetts Nested Subbasins" presented in "Local and Cumulative Impervious Cover of Massachusetts Stream Basins," U.S. Geological Survey Data Series 451, developed by Sara L. Brandt and Peter A. Steeves in cooperation with the U.S. Environmental Protection Agency, for use in the IA-DCIA analysis. This document is available at url: http://pubs.usgs.gov/ds/451/. The Massachusetts Nested Subbasins datalayer is available at url:
http://water.usgs.gov/GIS/metadata/usgswrd/XML/ds451_subbasins.xml

The hydrology of the Cape Cod and Plymouth-Carver Regions of Massachusetts is dominated by groundwater flow. Subbasins in these areas cannot be delineated by surface topography, but are instead defined by groundwater elevation and flow direction. For the following municipalities, the area of one or more subbasins is based on "Groundwater Contributing Area":

- Barnstable
- Bourne
- Brewster
- Carver
- Chatham
- Dennis
- Duxbury
- Eastham
- Falmouth
- Halifax
- Harwich
- Kingston
- Marion
- Marshfield
- Mashpee
- Middleborough
- Orleans
- Pembroke
- Plymouth
- Plympton
- Rochester
- Sandwich
- Wareham
- Yarmouth

The Massachusetts Groundwater Contributing Areas are available at url:
http://water.usgs.gov/GIS/metadata/usgswrd/XML/ds451_gwcontrib_areas.xml

Step 3: Calculation of Impervious Area in each Subbasin for each EPA Land Use Code

Using its GIS, EPA estimated the area and relative percentage of IA (both within the entire subbasin and only within the Regulated/Urbanized Area) for each EPA Land Use Code within the Massachusetts Nested Subbasins in each community. The IA estimates were generated using the MassGIS 2005 Impervious Surface 1-meter datalayer (available at url: http://www.mass.gov/mgis/impervious_surface.htm).

The Regulated/Urbanized Area is equivalent to the urbanized area as defined by the 2000 Census. EPA provided urbanized area maps to all regulated communities and web-published the maps at url: http://www.epa.gov/ne/npdes/stormwater/2003-permit-archives.html. The Urbanized Area datalayers are available from MassGIS at url: http://www.mass.gov/mgis/eot_layers.htm.

Step 4: Application of Sutherland Equations to Estimate DCIA %

Using the percent IA estimates calculated in Step 3, EPA applied the "Sutherland Equations" taken from Sutherland, R.C., "Methodology for Estimating the Effective Impervious Area of Urban Watersheds", Watershed Protection Techniques, Vol. 2, No. 1, fall 1995, to calculate DCIA %. Table 2 shows the EPA Land Use Class and Land Use Name, the watershed selection criteria, and the Sutherland Equation applied to each EPA Code. The Sutherland Equations are only valid where IA % is greater than 1; therefore, EPA assumed DCIA % to be zero where the IA % within a given land use is less than one.

Table 2: EPA Land Use Classes and Corresponding Sutherland Equations

EPA Code	Land Use	Watershed Selection Criteria	Sutherland Equation (where IA(%) >1)
1	Commercial	Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	DCIA%=0.1(IA%)^1.5
2	Industrial	Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	DCIA%=0.1(IA%)^1.5
3	Low Density Residential	Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	DCIA%=0.04(IA%)^1.7
4	Medium Density Residential	Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	DCIA%=0.1(IA%)^1.5
5	High Density Residential	Highly connected: Same as above, but residential rooftops are connected	DCIA%=0.4(IA%)^1.2
6	Urban Public/ Institutional	Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	DCIA%=0.1(IA%)^1.5
7	Agriculture	Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	DCIA%=0.01(IA%)^2

EPA Code	**Land Use**	**Watershed Selection Criteria**	**Sutherland Equation (where IA(%) >1)**
8	Forest	Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	DCIA%=0.01(IA%)^2
9	Open Land	Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	DCIA%=0.1(IA%)^1.5
10	Water	n/a	n/a

Step 5: Estimation of DCIA Area

EPA used the DCIA % calculated in Step 4 to estimate the acres of DCIA, for each EPA land use class, within each subbasin, within each community.

For Total Area, (including Un-Regulated Areas), calculation is as follows:

DCIA (acres) = DCIA % of Total Area (%) * Total Area (acres) / 100

For the Urbanized/Regulated Area Only, calculation is as follows:

DCIA (acres) = DCIA % of Urbanized/Regulated Area (%) * All Urbanized/Regulated Area (acres) / 100

Step 6: Summation of Total Area, IA, and DCIA for each Subbasin within Massachusetts Communities

EPA summed the IA and DCIA areas of all land use classes over each subbasin, and recalculated IA % and DCIA % based on these summations.

Table 1A: MassGIS Land Use Codes and Descriptions, and EPA Codes

MassGIS Land Use Code	**MassGIS Land Use Description**	**MassGIS Detailed Definition**	**EPA Code**
1	Cropland	Generally tilled land used to grow row crops. Boundaries follow the shape of the fields and include associated buildings (e.g., barns). This category also includes turf farms that grow sod.	**7**
2	Pasture	Fields and associated facilities (barns and other outbuildings) used for animal grazing and for the growing of grasses for hay.	**7**
3	Forest	Areas where tree canopy covers at least 50% of the land. Both coniferous and deciduous forests belong to this class.	**8**
4	Non-Forested Wetland	DEP Wetlands (1:12,000) WETCODEs 4, 7, 8, 12, 23, 18, 20, and 21.	**10**

MassGIS Land Use Code	**MassGIS Land Use Description**	**MassGIS Detailed Definition**	**EPA Code**
5	Mining	Includes sand and gravel pits, mines and quarries. The boundaries extend to the edges of the site's activities, including on-site machinery, parking lots, roads and buildings.	**9**
6	Open Land	Vacant land, idle agriculture, rock outcrops, and barren areas. Vacant land is not maintained for any evident purpose and it does not support large plant growth.	**9**
7	Participation Recreation	Facilities used by the public for active recreation. Includes ball fields, tennis courts, basketball courts, athletic tracks, ski areas, playgrounds, and bike paths plus associated parking lots. Primary and secondary school recreational facilities are in this category, but university stadiums and arenas are considered Spectator Recreation. Recreation facilities not open to the public such as those belonging to private residences are mostly labeled with the associated residential land use class not participation recreation. However, some private facilities may also be mapped.	**6**
8	Spectator Recreation	University and professional stadiums designed for spectators as well as zoos, amusement parks, drive-in theaters, fairgrounds, race tracks and associated facilities and parking lots.	**6**
9	Water-Based Recreation	Swimming pools, water parks, developed freshwater and saltwater sandy beach areas and associated parking lots. Also included are scenic areas overlooking lakes or other water bodies, which may or may not include access to the water (such as a boat launch). Water-based recreation facilities related to universities are in this class. Private pools owned by individual residences are usually included in the Residential category. Marinas are separated into code 29.	**9**
10	Multi-Family Residential	Duplexes (usually with two front doors, two entrance pathways, and sometimes two driveways), apartment buildings, condominium complexes, including buildings and maintained lawns. Note: This category was difficult to assess via photo interpretation, particularly in highly urban areas.	**5**
11	High Density Residential	Housing on smaller than 1/4 acre lots. See notes below for details on Residential interpretation.	**5**
12	Medium Density Residential	Housing on 1/4 - 1/2 acre lots. See notes below for details on Residential interpretation.	**4**

MassGIS Land Use Code	**MassGIS Land Use Description**	**MassGIS Detailed Definition**	**EPA Code**
13	Low Density Residential	Housing on 1/2 - 1 acre lots. See notes below for details on Residential interpretation.	**3**
14	Saltwater Wetland	DEP Wetlands (1:12,000) WETCODEs 11 and 27.	**10**
15	Commercial	Malls, shopping centers and larger strip commercial areas, plus neighborhood stores and medical offices (not hospitals). Lawn and garden centers that do not produce or grow the product are also considered commercial.	**1**
16	Industrial	Light and heavy industry, including buildings, equipment and parking areas.	**2**
17	Transitional	Open areas in the process of being developed from one land use to another (if the future land use is at all uncertain). Formerly identified as "Urban Open".	**9**
18	Transportation	Airports (including landing strips, hangars, parking areas and related facilities), railroads and rail stations, and divided highways (related facilities would include rest areas, highway maintenance areas, storage areas, and on/off ramps). Also includes docks, warehouses, and related land-based storage facilities, and terminal freight and storage facilities. Roads and bridges less than 200 feet in width that are the center of two differing land use classes will have the land use classes meet at the center line of the road (i.e., these roads/bridges themselves will not be separated into this class).	**2**
19	Waste Disposal	Landfills, dumps, and water and sewage treatment facilities such as pump houses, and associated parking lots. Capped landfills that have been converted to other uses are coded with their present land use.	**2**
20	Water	DEP Wetlands (1:12,000) WETCODEs 9 and 22.	**10**
23	Cranberry bog	Both active and recently inactive cranberry bogs and the sandy areas adjacent to the bogs that are used in the growing process. Impervious features associated with cranberry bogs such as parking lots and machinery are included. Modified from DEP Wetlands (1:12,000) WETCODE 5.	**10**
24	Powerline/Utility	Powerline and other maintained public utility corridors and associated facilities, including power plants and their parking areas.	**9**
25	Saltwater Sandy Beach	DEP Wetlands (1:12,000) WETCODEs 1, 2, 3, 6, 10, 13, 17 and 19	**10**

MassGIS Land Use Code	**MassGIS Land Use Description**	**MassGIS Detailed Definition**	**EPA Code**
26	Golf Course	Includes the greenways, sand traps, water bodies within the course, associated buildings and parking lots. Large forest patches within the course greater than 1 acre are classified as Forest (class 3). Does not include driving ranges or miniature golf courses.	**9**
29	Marina	Include parking lots and associated facilities but not docks (in class 18)	**2**
31	Urban Public/Institutional	Lands comprising schools, churches, colleges, hospitals, museums, prisons, town halls or court houses, police and fire stations, including parking lots, dormitories, and university housing. Also may include public open green spaces like town commons.	**6**
34	Cemetery	Includes the gravestones, monuments, parking lots, road networks and associated buildings.	**9**
35	Orchard	Fruit farms and associated facilities.	**7**
36	Nursery	Greenhouses and associated buildings as well as any surrounding maintained lawn. Christmas tree (small conifer) farms are also classified as Nurseries.	**7**
37	Forested Wetland	DEP Wetlands (1:12,000) WETCODEs 14, 15, 16, 24, 25 and 26.	**10**
38	Very Low Density Residential	Housing on > 1 acre lots and very remote, rural housing. See notes below for details on Residential interpretation.	**3**
39	Junkyard	Includes the storage of car, metal, machinery and other debris as well as associated buildings as a business.	**2**
40	Brushland/Successional	Predominantly (> 25%) shrub cover, and some immature trees not large or dense enough to be classified as forest. It also includes areas that are more permanently shrubby, such as heath areas, wild blueberries or mountain laurel.	**8**

Appendix B

Nutrient Load Calculations – Saugus River

Phosphorus Load Calculations – Pillings Pond

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
23-1	5	1	Forest	C		0.35	0.05	0.18	2.46	23.13
			Highway	C	0.60		0.80	6.29		
			LDR	C	0.53	3.73	1.58	16.37		
			Open	C		0.12	0.03	0.29		
28-1	3	1	Forest	C		0.02	0.00	0.01	1.44	14.09
			Highway	C	0.13		0.18	1.38		
			LDR	A		0.00	0.00	0.00		
			LDR	C	0.51	2.28	1.25	12.64		
			Open	C		0.02	0.00	0.06		
28-2	52	9	Forest	A		0.39	0.05	0.19	19.66	185.42
			Forest	C		1.80	0.23	0.90		
			Forest	C/D		0.14	0.02	0.07		
			HDR	A		5.66	0.17	1.70		
			Highway	A	0.47		0.63	4.91		
			Highway	C	3.00		4.01	31.46		
			Highway	C/D	0.35		0.47	3.71		
			LDR	A	0.86	8.17	1.55	14.56		
			LDR	B/D	0.03	0.24	0.10	1.03		
			LDR	C	3.11	18.98	8.71	89.39		
			LDR	C/D	1.02	7.17	3.64	36.68		
			Open	A		0.11	0.00	0.03		
			Open	C		0.26	0.06	0.63		
			Open	C/D		0.05	0.01	0.15		
28-3	7	1	Forest	C		0.16	0.02	0.08	3.16	30.14
			Forest	C/D		0.00	0.00	0.00		
			Highway	C	0.73		0.98	7.69		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	C/D	0.00		0.00	0.00		
			LDR	C	0.62	4.53	1.89	19.58		
			LDR	C/D	0.07	0.41	0.22	2.26		
			Open	C		0.22	0.05	0.53		
			Open	C/D		0.00	0.00	0.00		
28-4	37	7	Forest	C		1.17	0.15	0.59	16.58	159.37
			Forest	C/D		0.00	0.00	0.00		
			Highway	C	3.40		4.55	35.68		
			Highway	C/D	0.04		0.05	0.41		
			LDR	C	3.78	28.30	11.69	121.25		
			LDR	C/D	0.01	0.01	0.02	0.17		
			Open	C		0.53	0.11	1.28		
28-6	1	0	Forest	A		0.01	0.00	0.00	0.68	5.64
			Forest	B/D		0.04	0.00	0.02		
			HDR	A		0.01	0.00	0.00		
			HDR	B/D	0.02	0.16	0.07	0.61		
			Highway	A	0.22		0.30	2.32		
			Highway	B/D	0.09		0.13	0.99		
			LDR	A	0.10	0.35	0.17	1.57		
			LDR	B/D	0.00	0.02	0.01	0.10		
			Open	A		0.02	0.00	0.01		
			Open	B/D		0.01	0.00	0.01		
28-7	1	0	Forest	A		0.01	0.00	0.00	0.69	6.20
			Forest	B/D		0.17	0.02	0.08		
			HDR	A		0.01	0.00	0.00		
			HDR	B/D		0.16	0.03	0.39		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	A	0.01		0.02	0.13		
			Highway	B/D	0.20		0.27	2.12		
			Highway	C	0.00		0.00	0.00		
			LDR	B/D	0.06	0.33	0.15	1.57		
			LDR	C	0.09	0.20	0.18	1.81		
			Open	B/D	0.01	0.00	0.01	0.09		
			Open	C		0.00	0.00	0.00		
32-3	14	9	Forest	A		0.84	0.11	0.42	12.98	101.60
			Forest	B/D		0.00	0.00	0.00		
			Forest	C/D		0.18	0.02	0.09		
			Forest			2.08	0.27	1.04		
			Highway	A	0.02		0.02	0.16		
			Highway		9.04		12.12	94.94		
			LDR	C/D		0.29	0.08	0.89		
			Open	A		0.00	0.00	0.00		
			Open	C/D		0.00	0.00	0.00		
			Open			1.69	0.35	4.05		
32-5	3	1	Forest	A		0.06	0.01	0.03	2.03	16.74
			Forest	C		0.22	0.03	0.11		
			Forest	C/D		0.12	0.02	0.06		
			Forest			0.33	0.04	0.17		
			Highway	A	0.03		0.04	0.29		
			Highway	C	0.36		0.49	3.82		
			Highway	C/D	0.11		0.15	1.18		
			Highway		0.60		0.80	6.30		
			LDR	A		0.00	0.00	0.00		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	C	0.00	0.30	0.07	0.79		
			LDR	C/D	0.06	0.70	0.30	3.06		
			LDR		0.00	0.24	0.06	0.65		
			Open	C		0.00	0.00	0.01		
			Open	C/D		0.01	0.00	0.03		
			Open			0.11	0.02	0.26		
33-2	2	1	Forest	A		0.18	0.02	0.09	0.80	6.45
			Forest	B/D		0.14	0.02	0.07		
			Highway	A	0.36		0.48	3.75		
			Highway	B/D	0.06		0.08	0.61		
			LDR	A	0.11	1.36	0.20	1.92		
			Open	A		0.05	0.00	0.01		
33-3a	1	0	Forest	A		0.05	0.01	0.02	0.59	4.86
			Forest	B/D		0.13	0.02	0.07		
			Forest	C		0.01	0.00	0.01		
			Highway	A	0.12		0.16	1.25		
			Highway	B/D	0.10		0.13	1.02		
			Highway	C	0.07		0.09	0.70		
			LDR	B/D	0.00	0.07	0.02	0.17		
			LDR	C	0.09	0.12	0.16	1.57		
			Open	A		0.01	0.00	0.00		
			Open	B/D		0.00	0.00	0.01		
			Open	C		0.01	0.00	0.04		
33-5	8	2	Forest	C		0.93	0.12	0.46	4.37	39.81
			Highway	C	1.21		1.62	12.67		
			LDR	C	0.99	5.04	2.57	26.09		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	C	0.02	0.13	0.06	0.59		
33-6	40	11	Forest	B/D		0.01	0.00	0.00	21.17	196.57
			Forest	C		2.25	0.29	1.12		
			Forest	D		0.02	0.00	0.01		
			Highway	B/D	0.01		0.01	0.10		
			Highway	C	5.28		7.08	55.48		
			Highway	D	0.01		0.01	0.07		
			LDR	B/D	0.01	0.12	0.04	0.41		
			LDR	C	5.28	24.34	13.14	132.91		
			LDR	D	0.06	0.21	0.17	1.59		
			Open	B/D		0.00	0.00	0.01		
			Open	C	0.00	2.00	0.43	4.86		
			Open	D		0.00	0.00	0.00		
33-7	22	4	Forest	C		4.83	0.63	2.41	8.53	76.89
			Forest	D		1.53	0.20	0.77		
			Forest			0.07	0.01	0.03		
			Highway	C	1.37		1.83	14.34		
			Highway	D	0.02		0.03	0.22		
			Highway		0.14		0.18	1.42		
			LDR	C	1.74	9.78	4.70	47.99		
			LDR	D	0.01	0.35	0.14	1.35		
			LDR		0.31	0.91	0.66	6.58		
			Open	C		0.67	0.14	1.60		
			Open	D		0.00	0.00	0.00		
			Open			0.07	0.01	0.17		
33-8	13	3	Forest	C		0.75	0.10	0.38	6.28	58.87

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	C	1.45		1.95	15.24		
			LDR	C	1.57	8.51	4.17	42.50		
			Open	C	0.00	0.30	0.07	0.75		
34-1	7	2	Forest	C		1.13	0.15	0.57	3.38	30.99
			Forest	C/D		0.00	0.00	0.00		
			Highway	C	0.77		1.03	8.11		
			Highway	C/D	0.02		0.03	0.26		
			LDR	C	0.76	4.10	2.01	20.51		
			LDR	C/D	0.06	0.09	0.11	1.08		
			Open	C		0.18	0.04	0.42		
			Open	C/D		0.01	0.00	0.04		
38-1	17	4	Forest	C		1.22	0.16	0.61	8.45	77.32
			Forest	C/D		0.57	0.07	0.29		
			HDR	C	0.17	0.53	0.51	3.67		
			HDR	C/D	0.01	0.09	0.04	0.36		
			Highway	C	0.50		0.67	5.23		
			Highway	C/D	0.77		1.04	8.13		
			Highway		0.54		0.72	5.62		
			LDR	C	1.29	6.43	3.32	33.68		
			LDR	C/D	0.46	2.80	1.50	15.09		
			Open	C		0.22	0.05	0.54		
			Open	C/D		1.31	0.38	4.07		
			Open			0.02	0.00	0.04		
38-2	5	1	Forest	C		0.74	0.10	0.37	2.43	22.36
			Highway	C	0.61		0.82	6.45		
			LDR	C	0.51	3.41	1.49	15.40		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	C		0.06	0.01	0.14		
38-3	29	6	Forest	C		0.12	0.02	0.06	14.93	137.98
			Forest	C/D		3.22	0.42	1.61		
			Forest	D		0.02	0.00	0.01		
			Forest			0.06	0.01	0.03		
			Highway	C	0.34		0.45	3.55		
			Highway	C/D	1.52		2.04	15.96		
			Highway	D	0.01		0.01	0.08		
			Highway		0.91		1.22	9.53		
			LDR	C	0.51	1.73	1.15	11.41		
			LDR	C/D	2.26	13.79	7.44	74.69		
			LDR	D	0.49	3.29	1.96	18.74		
			Open	C		0.04	0.01	0.09		
			Open	C/D	0.01	0.64	0.20	2.11		
			Open	D		0.01	0.00	0.04		
			Open			0.04	0.01	0.09		
39-1	5	1	Forest	A		0.39	0.05	0.20	2.29	19.85
			Forest	B/D		0.04	0.00	0.02		
			Highway	A	0.68		0.91	7.12		
			Highway	B/D	0.04		0.06	0.46		
			LDR	A	0.47	2.67	0.79	7.36		
			LDR	B/D	0.25	0.47	0.48	4.68		
			Open	A		0.05	0.00	0.02		
39-3	7	1	Forest	C		0.99	0.13	0.49	3.00	28.12
			Highway	C	0.51		0.69	5.37		
			LDR	A	0.00	0.02	0.01	0.06		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	C	0.82	4.26	2.15	21.84		
			Open	C		0.15	0.03	0.36		
39-4	2	1	Forest	A		0.22	0.03	0.11	0.84	7.01
			Forest			0.02	0.00	0.01		
			Highway	A	0.37		0.50	3.89		
			Highway		0.04		0.06	0.46		
			LDR	A	0.10	1.20	0.19	1.75		
			LDR		0.01	0.25	0.07	0.73		
			Open	A	0.00	0.00	0.00	0.00		
			Open			0.03	0.01	0.06		
39-5	2	1	Forest			0.16	0.02	0.08	0.98	8.84
			Highway		0.31		0.42	3.30		
			LDR		0.22	0.93	0.54	5.39		
			Open			0.03	0.01	0.07		
39-7	2	0	Forest	A		0.13	0.02	0.06	0.79	6.69
			Forest	C		0.09	0.01	0.05		
			Highway	A	0.16		0.22	1.71		
			Highway	C	0.21		0.28	2.17		
			LDR	A	0.00	0.63	0.02	0.23		
			LDR	C	0.08	0.53	0.24	2.46		
			Open	A		0.00	0.00	0.00		
			Open	C		0.00	0.00	0.01		
39-8	1	0	Forest	A		0.10	0.01	0.05	0.25	2.25
			Highway	A	0.06		0.07	0.58		
			LDR	A	0.02	0.59	0.05	0.48		
			LDR	C	0.05	0.17	0.11	1.14		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
40-1	1	0	Forest			0.11	0.01	0.05	0.65	5.62
			Highway		0.32		0.42	3.33		
			LDR		0.04	0.71	0.21	2.23		
			Open			0.00	0.00	0.00		
40-2	5	1	Forest	C		0.43	0.06	0.21	2.16	20.52
			Forest	C/D		0.11	0.01	0.05		
			Highway	C	0.23		0.30	2.39		
			Highway	C/D	0.19		0.25	1.96		
			LDR	C	0.40	2.99	1.23	12.75		
			LDR	C/D	0.08	0.53	0.27	2.72		
			Open	C		0.07	0.01	0.17		
			Open	C/D		0.09	0.02	0.27		
40-3	2	1	Forest	C		0.02	0.00	0.01	1.02	8.78
			Forest	C/D		0.09	0.01	0.05		
			Highway	C	0.05		0.06	0.48		
			Highway	C/D	0.16		0.21	1.65		
			LDR	C	0.01	0.02	0.02	0.17		
			LDR	C/D	0.10	0.40	0.26	2.61		
			Open	C/D		0.04	0.01	0.13		
			Forest	C		0.16	0.02	0.08		
			Highway	C	0.24		0.33	2.55		
			LDR	C	0.01	0.37	0.09	1.01		
			Open	C		0.02	0.00	0.04		
44-4	5	1	Forest	C		2.07	0.27	1.04	1.95	17.19
			Highway	C	0.26		0.34	2.70		
			LDR	C	0.49	2.45	1.27	12.85		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	C	0.03	0.09	0.07	0.60		
44-5	4	1	Forest	C		0.08	0.01	0.04	2.61	24.65
			Highway	C	0.41		0.55	4.30		
			LDR	C	0.95	2.72	2.02	19.99		
			Open	C		0.13	0.03	0.32		
44-6	4	2	Forest	C		0.18	0.02	0.09	2.75	25.28
			Highway	C	0.63		0.85	6.64		
			LDR	C	0.89	2.43	1.86	18.36		
			Open	C		0.08	0.02	0.19		
44-7	6	1	Forest	C		0.28	0.04	0.14	2.71	26.29
			Highway	C	0.38		0.51	3.96		
			LDR	C	0.80	4.40	2.14	21.84		
			Open	C		0.15	0.03	0.35		
44-8	4	1	Forest	C		0.41	0.05	0.21	2.49	22.04
			HDR	C	0.09	0.16	0.24	1.61		
			Highway	C	0.58		0.78	6.08		
			LDR	C	0.64	1.77	1.35	13.35		
			Open	C	0.00	0.32	0.07	0.80		
45-1	22	6	Forest	A		0.76	0.10	0.38	11.44	104.57
			Forest	C		0.14	0.02	0.07		
			Forest	C/D		0.35	0.04	0.17		
			Highway	A	0.93		1.25	9.77		
			Highway	C	0.67		0.89	7.00		
			Highway	C/D	0.85		1.13	8.89		
			LDR	A	1.39	5.27	2.26	21.11		
			LDR	C	1.28	4.41	2.88	28.68		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	C/D	0.97	4.45	2.76	27.40		
			Open	A	0.00	0.21	0.01	0.11		
			Open	C		0.08	0.02	0.18		
			Open	C/D		0.26	0.07	0.80		
45-3	1	0	Forest	C		0.10	0.01	0.05	0.48	4.41
			Highway	C	0.08		0.11	0.87		
			LDR	C	0.16	0.41	0.33	3.24		
			Open	C		0.11	0.02	0.25		
45-4	3	0	Forest	C		0.21	0.03	0.10	1.35	13.38
			HDR	C	0.01	0.18	0.05	0.52		
			Highway	C	0.08		0.10	0.82		
			LDR	C	0.41	2.57	1.16	11.94		
			Open	C		0.00	0.00	0.01		
45-5	4	1	Forest	C		0.09	0.01	0.04	2.69	24.17
			HDR	C	0.14	0.64	0.46	3.51		
			Highway	C	0.53		0.71	5.53		
			LDR	C	0.68	2.13	1.49	14.77		
			Open	C		0.13	0.03	0.31		
45-6	1	0	Forest	C		0.15	0.02	0.08	0.53	4.95
			Highway	C	0.05		0.06	0.50		
			LDR	C	0.20	0.61	0.44	4.36		
			Open	C		0.01	0.00	0.02		
46-1	4	1	Forest	A		0.02	0.00	0.01	1.74	15.48
			Forest	C/D		0.76	0.10	0.38		
			Highway	A	0.15		0.20	1.58		
			Highway	C/D	0.19		0.26	2.01		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	A	0.19	0.54	0.31	2.89		
			LDR	C/D	0.33	1.22	0.85	8.43		
			Open	A	0.00	0.08	0.00	0.03		
			Open	C/D		0.05	0.01	0.14		
52-1	3	1	Forest	C		0.08	0.01	0.04	1.83	16.75
			Forest	C/D		0.08	0.01	0.04		
			Highway	C	0.39		0.52	4.10		
			Highway	C/D	0.13		0.18	1.41		
			LDR	C	0.36	1.65	0.89	9.05		
			LDR	C/D	0.06	0.21	0.16	1.53		
			Open	C		0.13	0.03	0.32		
			Open	C/D	0.01	0.06	0.03	0.27		
52-3	1	0	Forest	C		0.12	0.02	0.06	0.49	4.39
			Highway	C	0.13		0.17	1.32		
			LDR	C	0.13	0.42	0.29	2.88		
			Open	C	0.01	0.03	0.01	0.12		
52-4	14	4	Forest	B		0.00	0.00	0.00	7.55	69.16
			Forest	B/D		0.04	0.01	0.02		
			Forest	C		0.68	0.09	0.34		
			Forest			0.29	0.04	0.15		
			Highway	B	0.00		0.00	0.00		
			Highway	B/D	0.03		0.04	0.28		
			Highway	C	1.15		1.54	12.04		
			Highway		0.98		1.31	10.27		
			LDR	B		0.23	0.03	0.27		
			LDR	B/D	0.01	1.34	0.30	3.34		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	C	1.70	6.40	3.93	39.34		
			LDR			0.22	0.05	0.54		
			Open	B		0.03	0.00	0.04		
			Open	C	0.02	0.19	0.06	0.64		
			Open			0.78	0.16	1.88		
52-5	2	1	Forest	C		0.02	0.00	0.01	0.97	9.03
			Highway	C	0.19		0.26	2.02		
			LDR	C	0.33	0.92	0.69	6.86		
			Open	C		0.06	0.01	0.14		
53-1	6	2	Forest	B		1.00	0.13	0.50	3.06	26.98
			Forest	C		0.10	0.01	0.05		
			Highway	B	0.37		0.50	3.90		
			Highway	C	0.31		0.42	3.28		
			LDR	B	0.64	2.27	1.24	11.73		
			LDR	C	0.34	0.91	0.70	6.94		
			Open	B		0.18	0.02	0.21		
			Open	C		0.15	0.03	0.36		
53-9	5	2	Forest	C		0.32	0.04	0.16	3.04	28.25
			Highway	B	0.01		0.01	0.06		
			Highway	C	0.56		0.75	5.84		
			LDR	B	0.14	0.52	0.27	2.53		
			LDR	C	0.89	2.72	1.92	19.06		
			Open	B		0.00	0.00	0.00		
			Open	C		0.25	0.05	0.60		
			Water	C		0.00				
57-10	9	3	Forest	A		0.11	0.01	0.05	4.79	42.67

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Forest	B/D		0.17	0.02	0.08		
			Forest	C		0.12	0.02	0.06		
			Forest	C/D		0.00	0.00	0.00		
			Forest			0.71	0.09	0.36		
			Highway	A	0.15		0.20	1.54		
			Highway	C	0.38		0.50	3.95		
			Highway	C/D	0.01		0.01	0.09		
			Highway		0.91		1.22	9.53		
			Industrial	C		0.00	0.00	0.00		
			Industrial	C/D		0.00	0.00	0.00		
			LDR	A	0.30	1.37	0.50	4.70		
			LDR	B	0.03	0.14	0.07	0.65		
			LDR	B/D	0.00	0.01	0.00	0.04		
			LDR	C	0.25	1.16	0.63	6.37		
			LDR	C/D		0.00	0.00	0.00		
			LDR		0.59	2.66	1.45	14.66		
			Open	A	0.01	0.01	0.02	0.16		
			Open	C		0.04	0.01	0.10		
			Open			0.14	0.03	0.33		
15-2	3	1	Forest	C		0.06	0.01	0.03	1.42	13.55
			Highway	C	0.34		0.46	3.59		
			LDR	C	0.29	2.34	0.94	9.75		
			Open	C		0.07	0.02	0.18		
20-3	18	3	Forest	A		0.32	0.04	0.16	6.14	56.64
			Forest	B		0.02	0.00	0.01		
			Forest	C		0.17	0.02	0.08		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	A	0.89		1.19	9.36		
			Highway	B	0.02		0.03	0.26		
			Highway	C	0.63		0.84	6.59		
			LDR	A	0.65	5.49	1.16	10.87		
			LDR	B	0.17	3.05	0.62	6.05		
			LDR	C	0.64	5.84	2.20	23.06		
			Open	A		0.12	0.00	0.04		
			Open	C		0.07	0.01	0.16		
20-7	4	1	Forest	C		0.14	0.02	0.07	1.74	17.02
			Highway	C	0.32		0.42	3.33		
			LDR	C	0.35	3.54	1.28	13.47		
			Open	C		0.06	0.01	0.15		
20-8	43	5	Forest	C		0.50	0.06	0.25	15.67	157.92
			Highway	C	1.57		2.11	16.53		
			LDR	C	3.04	33.34	11.62	122.86		
			LDR	D	0.11	4.40	1.80	17.42		
			Open	C		0.36	0.08	0.86		
21-1	8	2	Forest	C		0.40	0.05	0.20	4.43	41.17
			Highway	C	1.08		1.45	11.35		
			LDR	C	1.12	5.43	2.85	28.88		
			Open	C	0.02	0.20	0.08	0.75		
21-2	13	3	Forest	C		0.37	0.05	0.19	6.36	60.68
			Highway	C	1.31		1.75	13.74		
			LDR	C	1.64	9.79	4.55	46.61		
			Open	C		0.06	0.01	0.14		
21-3	11	2	Forest	C		0.46	0.06	0.23	4.23	41.51

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	C	0.66		0.88	6.91		
			LDR	C	1.00	8.37	3.27	34.14		
			Open	C		0.09	0.02	0.23		
21-4	6	1	Forest	C		0.33	0.04	0.16	2.77	25.91
			Forest	D		0.03	0.00	0.01		
			Highway	C	0.67		0.89	7.00		
			Highway	D	0.05		0.07	0.55		
			LDR	A/D		0.00	0.00	0.00		
			LDR	C	0.54	3.83	1.62	16.75		
			LDR	D	0.00	0.32	0.13	1.24		
			Open	C		0.08	0.02	0.19		
21-5	24	4	Forest	A		0.08	0.01	0.04	10.73	103.81
			Forest	B		0.03	0.00	0.01		
			Forest	C		0.54	0.07	0.27		
			Highway	A	0.39		0.52	4.11		
			Highway	B	0.11		0.14	1.11		
			Highway	C	0.95		1.28	10.02		
			LDR	A	0.11	1.21	0.21	1.94		
			LDR	B	0.00	0.15	0.02	0.24		
			LDR	C	2.76	15.47	7.44	76.05		
			LDR	D	0.09	2.31	1.00	9.62		
			Open	A		0.10	0.00	0.03		
			Open	B		0.00	0.00	0.00		
			Open	C		0.15	0.03	0.37		
22-1	54	10	Commercial	A		0.18	0.01	0.06	22.45	212.48
			Commercial	C		0.04	0.01	0.10		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Forest	A		0.22	0.03	0.11		
			Forest	B		0.09	0.01	0.05		
			Forest	C		2.52	0.33	1.26		
			Forest	C/D		0.04	0.01	0.02		
			Forest			0.07	0.01	0.03		
			Highway	A	0.27		0.36	2.86		
			Highway	B	0.46		0.62	4.86		
			Highway	C	2.80		3.76	29.43		
			Highway	C/D	0.10		0.13	1.04		
			Highway		0.20		0.26	2.06		
			LDR	A	0.66	2.74	1.08	10.07		
			LDR	B	1.23	8.64	2.91	27.74		
			LDR	C	4.07	24.52	11.34	116.28		
			LDR	C/D	0.14	0.77	0.43	4.35		
			LDR		0.22	3.06	0.98	10.44		
			Open	A		0.11	0.00	0.03		
			Open	B		0.12	0.01	0.15		
			Open	C	0.03	0.46	0.15	1.48		
			Open			0.02	0.00	0.05		
25-10	5	1	Forest	C/D		0.00	0.00	0.00	2.64	25.47
			Highway	C	0.09		0.12	0.93		
			Highway	C/D	0.31		0.42	3.31		
			LDR	C	0.19	1.20	0.54	5.50		
			LDR	C/D	0.45	2.88	1.52	15.31		
			Open	C/D		0.14	0.04	0.42		
25-2	10	1	Forest	C		0.95	0.12	0.48	3.92	35.68

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Forest	C/D		1.14	0.15	0.57		
			HDR	C/D	0.02	0.17	0.09	0.78		
			Highway	C	0.30		0.41	3.20		
			Highway	C/D	0.52		0.70	5.47		
			LDR	C	0.22	2.84	0.94	9.99		
			LDR	C/D	0.43	2.69	1.43	14.37		
			Open	C		0.03	0.01	0.07		
			Open	C/D	0.00	0.23	0.07	0.75		
25-5	1	0	Forest	A		0.11	0.01	0.05	0.41	3.40
			Forest	A/D		0.02	0.00	0.01		
			Highway	A	0.17		0.23	1.77		
			Highway	A/D	0.03		0.04	0.34		
			LDR	A	0.07	0.78	0.12	1.17		
			LDR	A/D		0.02	0.00	0.05		
			Open	A		0.00	0.00	0.00		
25-6	8	2	Forest	A		0.04	0.01	0.02	3.92	37.49
			Forest	C		0.20	0.03	0.10		
			Highway	A	0.09		0.12	0.96		
			Highway	C	0.55		0.74	5.78		
			LDR	A	0.31	0.65	0.48	4.51		
			LDR	C	0.90	5.41	2.51	25.69		
			Open	A		0.01	0.00	0.00		
			Open	C		0.18	0.04	0.43		
25-7	4	1	Forest	A		0.15	0.02	0.08	1.67	15.95
			Forest	B/D		0.00	0.00	0.00		
			Forest	C		0.03	0.00	0.02		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	A	0.24		0.33	2.55		
			Highway	C	0.10		0.14	1.07		
			LDR	A	0.02	0.70	0.05	0.51		
			LDR	B/D		0.00	0.00	0.00		
			LDR	C	0.27	2.20	0.87	9.03		
			LDR	C/D	0.08	0.50	0.26	2.66		
			Open	A		0.02	0.00	0.01		
			Open	C		0.01	0.00	0.03		
26-1	9	2	Forest	A		0.36	0.05	0.18	4.40	40.30
			Forest	C		0.28	0.04	0.14		
			Highway	A	0.41		0.54	4.27		
			Highway	C	0.47		0.63	4.93		
			LDR	A	0.57	2.44	0.94	8.78		
			LDR	C	0.95	3.50	2.18	21.84		
			Open	A		0.06	0.00	0.02		
			Open	C		0.06	0.01	0.14		
26-2	7	2	Forest	A		0.04	0.01	0.02	3.23	30.24
			Forest	C		0.04	0.00	0.02		
			Highway	A	0.30		0.40	3.17		
			Highway	C	0.33		0.45	3.52		
			LDR	A	0.39	1.64	0.64	5.97		
			LDR	C	0.66	3.29	1.69	17.17		
			Open	A		0.10	0.00	0.03		
			Open	C		0.14	0.03	0.35		
26-3	17	5	Forest	A		0.56	0.07	0.28	8.40	75.92
			Forest	C		0.39	0.05	0.20		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	A	1.08		1.45	11.33		
			Highway	C	0.71		0.95	7.45		
			LDR	A	2.22	6.92	3.59	33.44		
			LDR	C	0.91	4.11	2.25	22.74		
			Open	A		0.35	0.01	0.10		
			Open	C		0.16	0.03	0.38		
26-4	3	1	Forest	A		0.39	0.05	0.19	1.28	11.11
			Forest	C		0.13	0.02	0.07		
			Highway	A	0.27		0.36	2.80		
			LDR	A	0.47	1.83	0.77	7.19		
			LDR	C	0.01	0.20	0.06	0.65		
			Open	A		0.02	0.00	0.01		
			Open	C	0.01	0.02	0.02	0.20		
26-5	2	1	Forest	A		0.04	0.01	0.02	0.86	7.80
			Forest	C		0.07	0.01	0.03		
			Highway	A	0.07		0.10	0.78		
			Highway	C	0.09		0.12	0.95		
			LDR	A	0.15	0.69	0.25	2.35		
			LDR	C	0.19	0.37	0.36	3.51		
			Open	A		0.01	0.00	0.00		
			Open	C	0.00	0.04	0.01	0.15		
27-1	5	1	Forest	A		0.15	0.02	0.07	1.71	15.05
			Highway	A	0.39		0.52	4.10		
			LDR	A	0.68	4.17	1.16	10.85		
			Open	A		0.10	0.00	0.03		
27-2	3	1	Forest	C		0.12	0.02	0.06	1.33	13.11

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	C	0.21		0.28	2.16		
			LDR	B/D		0.01	0.00	0.01		
			LDR	C	0.31	2.64	1.03	10.75		
			Open	C		0.05	0.01	0.13		
27-3	5	1	Forest	A		0.12	0.02	0.06	2.82	26.41
			Forest	C		0.17	0.02	0.09		
			Highway	A	0.05		0.07	0.53		
			Highway	C	0.48		0.64	5.03		
			LDR	A	0.08	0.46	0.14	1.32		
			LDR	C	0.84	3.04	1.91	19.08		
			Open	A		0.05	0.00	0.01		
			Open	C		0.12	0.02	0.28		
27-4	14	3	Forest	B/D		0.14	0.02	0.07	6.42	58.86
			Forest	C		1.82	0.24	0.91		
			Highway	B/D	0.13		0.18	1.38		
			Highway	C	1.65		2.21	17.35		
			LDR	B/D	0.00	0.40	0.08	0.96		
			LDR	C	1.22	8.43	3.62	37.42		
			Open	C		0.32	0.07	0.76		
27-5	37	9	Forest	A		0.05	0.01	0.02	18.39	169.60
			Forest	B/D		0.34	0.04	0.17		
			Forest	C		2.74	0.36	1.37		
			Forest	C/D		0.45	0.06	0.22		
			Highway	A	0.30		0.41	3.18		
			Highway	B/D	0.38		0.50	3.96		
			Highway	C	2.52		3.38	26.46		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	C/D	1.05		1.41	11.06		
			LDR	A	0.25	1.75	0.43	4.03		
			LDR	B/D	0.01	0.39	0.10	1.07		
			LDR	C	2.49	12.72	6.46	65.66		
			LDR	C/D	1.69	8.65	5.07	50.60		
			Open	A		0.12	0.00	0.04		
			Open	B/D		0.00	0.00	0.00		
			Open	C	0.01	0.42	0.11	1.16		
			Open	C/D		0.20	0.06	0.61		
27-7	9	1	Forest	C		5.55	0.72	2.77	2.56	20.47
			Highway	C	0.24		0.33	2.56		
			LDR	C	0.52	2.61	1.34	13.62		
			LDR	C/D	0.02	0.15	0.08	0.80		
			Open	C	0.06	0.03	0.09	0.71		
30-1	7	1	Forest	C		0.31	0.04	0.15	2.90	28.54
			Highway	C	0.30		0.40	3.17		
			LDR	C	0.88	5.22	2.43	24.87		
			Open	C		0.14	0.03	0.34		
30-2	3	1	Forest	A		0.08	0.01	0.04	1.28	11.15
			Forest	B/D		0.04	0.01	0.02		
			Highway	A	0.39		0.52	4.05		
			Highway	B/D	0.01		0.01	0.09		
			LDR	A	0.43	1.93	0.71	6.61		
			LDR	B/D	0.00	0.10	0.03	0.30		
			Open	A		0.11	0.00	0.03		
			Open	B/D	0.00	0.00	0.00	0.01		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
30-3	2	1	Forest	A		0.11	0.01	0.05	0.80	6.93
			Highway	A	0.21		0.28	2.23		
			LDR	A	0.30	1.31	0.50	4.63		
			Open	A		0.07	0.00	0.02		
30-4	6	2	Forest	A		0.19	0.02	0.10	2.95	26.13
			Highway	A	0.59		0.79	6.21		
			Highway		0.01		0.01	0.07		
			LDR	A	1.31	3.77	2.11	19.63		
			LDR		0.00	0.02	0.01	0.08		
			Open	A		0.13	0.00	0.04		
			Open			0.00	0.00	0.01		
30-5	3	1	Forest	A		0.02	0.00	0.01	1.57	13.21
			Forest			0.10	0.01	0.05		
			Highway	A	0.14		0.19	1.48		
			Highway		0.79		1.05	8.26		
			LDR	A	0.05	0.33	0.09	0.82		
			LDR		0.00	0.01	0.01	0.07		
			Open	A		0.02	0.00	0.01		
			Open			1.04	0.22	2.51		
30-6	14	1	Commercial	A	0.48	0.25	0.85	7.21	3.18	25.06
			Commercial	B/D		0.07	0.01	0.17		
			Forest	A		4.44	0.58	2.22		
			Forest	B/D		1.26	0.16	0.63		
			HDR	A		0.01	0.00	0.00		
			Highway	A	0.30		0.41	3.19		
			LDR	A	0.44	4.52	0.80	7.52		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	B/D		1.57	0.33	3.76		
			Open	A		0.80	0.02	0.24		
			Open	B/D		0.05	0.01	0.11		
30-7	4	1	Forest	C		0.36	0.05	0.18	1.70	15.59
			Forest	C/D		0.15	0.02	0.07		
			Highway	C	0.18		0.25	1.92		
			Highway	C/D	0.23		0.31	2.40		
			LDR	C	0.22	1.30	0.60	6.16		
			LDR	C/D	0.13	0.89	0.45	4.55		
			Open	C		0.08	0.02	0.20		
			Open	C/D		0.03	0.01	0.10		
30-8	3	1	Forest	B/D		0.01	0.00	0.00	2.14	19.46
			Forest	C/D		0.01	0.00	0.00		
			Highway	B/D	0.04		0.06	0.47		
			Highway	C/D	0.51		0.68	5.31		
			LDR	B/D	0.00	0.04	0.01	0.12		
			LDR	C	0.01	0.01	0.01	0.13		
			LDR	C/D	0.60	1.37	1.31	12.73		
			Open	B/D		0.00	0.00	0.01		
			Open	C/D	0.00	0.22	0.06	0.68		
31-1	3	1	Forest	A		0.18	0.02	0.09	1.31	10.98
			Highway	A	0.52		0.70	5.50		
			Industrial	A	0.03	0.06	0.05	0.43		
			LDR	A	0.32	1.56	0.53	4.92		
			Open	A		0.12	0.00	0.04		
31-2	17	7	Commercial	A	1.28	0.18	2.29	19.30	11.47	94.43

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Commercial	B/D		0.01	0.00	0.01		
			Forest	A		1.44	0.19	0.72		
			Forest	C		0.41	0.05	0.21		
			Forest			0.16	0.02	0.08		
			HDR	A	0.32	0.96	0.77	4.79		
			HDR	B/D		0.02	0.00	0.05		
			HDR	C	0.03	0.05	0.08	0.52		
			HDR		0.00	0.01	0.00	0.03		
			Highway	A	2.27		3.04	23.82		
			Highway	C	0.91		1.22	9.59		
			Highway		0.44		0.58	4.58		
			LDR	A	1.22	4.16	1.98	18.43		
			LDR	B/D		0.33	0.07	0.80		
			LDR	C	0.51	1.22	1.03	10.09		
			LDR		0.03	0.00	0.05	0.43		
			Open	A	0.00	0.66	0.02	0.20		
			Open	C	0.01	0.11	0.04	0.40		
			Open			0.16	0.03	0.39		
31-3	7	3	Commercial	A	0.14	0.09	0.26	2.17	5.19	42.29
			Commercial	C	0.01	0.01	0.02	0.20		
			Forest	A		0.65	0.08	0.33		
			Forest	C		0.33	0.04	0.16		
			Forest			0.00	0.00	0.00		
			HDR	A	0.12	0.04	0.29	1.74		
			HDR	C	0.03	0.05	0.08	0.55		
			Highway	A	2.03		2.71	21.27		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	C	0.25		0.34	2.64		
			Highway		0.14		0.19	1.45		
			LDR	A	0.04	0.55	0.07	0.70		
			LDR	C	0.46	1.81	1.08	10.79		
			Open	A		0.22	0.01	0.07		
			Open	C		0.08	0.02	0.20		
			Open			0.01	0.00	0.01		
31-4	7	2	Forest	C		0.75	0.10	0.37	4.13	34.98
			Forest			0.51	0.07	0.26		
			HDR	C	0.10	0.36	0.31	2.28		
			Highway	C	1.02		1.37	10.71		
			Highway		0.61		0.82	6.45		
			LDR	C	0.56	1.83	1.23	12.26		
			Open	C	0.00	0.36	0.08	0.91		
			Open			0.72	0.15	1.74		
32-1	7	2	Forest	B/D		0.15	0.02	0.07	3.84	33.93
			Forest	C		1.06	0.14	0.53		
			Forest	C/D		0.01	0.00	0.00		
			Highway	B/D	0.23		0.30	2.36		
			Highway	C	1.05		1.40	10.98		
			Highway	C/D	0.05		0.07	0.54		
			LDR	B/D	0.05	0.28	0.13	1.37		
			LDR	C	0.66	3.30	1.70	17.26		
			LDR	C/D	0.01	0.03	0.02	0.19		
			Open	B/D		0.01	0.00	0.04		
			Open	C		0.24	0.05	0.57		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
32-2	7	1	Forest	B/D		0.00	0.00	0.00	2.76	27.07
			Forest	C		0.22	0.03	0.11		
			Highway	B/D	0.00		0.00	0.00		
			Highway	C	0.51		0.68	5.35		
			LDR	B/D		0.00	0.00	0.01		
			LDR	C	0.54	5.76	2.03	21.41		
			Open	B/D		0.00	0.00	0.00		
			Open	C		0.08	0.02	0.18		
32-6	12	2	Forest	A		0.57	0.07	0.28	3.81	34.79
			Forest	C		0.00	0.00	0.00		
			Highway	A	0.86		1.15	9.05		
			LDR	A	0.94	5.79	1.60	15.01		
			LDR	C	0.22	3.02	0.97	10.32		
			Open	A		0.40	0.01	0.12		
32-7	5	1	Forest	A		0.00	0.00	0.00	2.35	21.52
			Forest	C		0.36	0.05	0.18		
			Highway	A	0.01		0.02	0.15		
			Highway	C	0.75		1.01	7.90		
			LDR	A	0.01	0.02	0.01	0.09		
			LDR	C	0.39	3.14	1.26	13.09		
			Open	A		0.01	0.00	0.00		
			Open	C		0.05	0.01	0.12		
32-8	13	3	Forest	B/D		0.01	0.00	0.01	6.79	63.72
			Forest	C		0.26	0.03	0.13		
			Forest	C/D		0.55	0.07	0.28		
			Forest	D		0.00	0.00	0.00		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	B/D	0.03		0.04	0.28		
			Highway	C	0.49		0.66	5.14		
			Highway	C/D	0.80		1.07	8.37		
			LDR	B/D	0.02	0.05	0.05	0.46		
			LDR	C	0.67	5.13	2.10	21.81		
			LDR	C/D	1.03	3.22	2.49	24.44		
			LDR	D	0.05	0.30	0.19	1.84		
			Open	B/D		0.00	0.00	0.00		
			Open	C		0.14	0.03	0.34		
			Open	C/D	0.00	0.20	0.06	0.62		
35-1	8	1	Forest	C		0.32	0.04	0.16	3.41	32.32
			Forest	C/D		0.19	0.02	0.09		
			Highway	C	0.61		0.81	6.36		
			Highway	C/D	0.13		0.18	1.41		
			LDR	C	0.55	4.27	1.74	18.07		
			LDR	C/D	0.15	1.24	0.59	5.94		
			Open	C		0.08	0.02	0.20		
			Open	C/D		0.03	0.01	0.09		
35-2	3	1	Forest	C		0.02	0.00	0.01	1.65	15.21
			Forest	C/D		0.06	0.01	0.03		
			Highway	C	0.26		0.35	2.76		
			Highway	C/D	0.14		0.19	1.47		
			LDR	C	0.36	1.12	0.78	7.73		
			LDR	C/D	0.12	0.34	0.28	2.74		
			Open	C		0.11	0.02	0.26		
			Open	C/D		0.07	0.02	0.21		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
36-10	7	1	Forest	D		0.00	0.00	0.00	2.52	24.36
			Forest			0.71	0.09	0.35		
			Highway		0.44		0.59	4.59		
			LDR	D		0.12	0.04	0.42		
			LDR		0.48	2.60	1.28	13.03		
			Open			2.49	0.52	5.97		
36-2	4	1	Forest	A		0.00	0.00	0.00	2.09	19.47
			Forest	C		0.01	0.00	0.01		
			Forest	C/D		0.04	0.01	0.02		
			Highway	A	0.02		0.03	0.22		
			Highway	C	0.08		0.11	0.85		
			Highway	C/D	0.38		0.51	4.02		
			LDR	A	0.04	0.20	0.07	0.65		
			LDR	C	0.24	1.21	0.61	6.23		
			LDR	C/D	0.25	1.18	0.72	7.17		
			Open	C		0.04	0.01	0.09		
			Open	C/D		0.07	0.02	0.21		
36-3	31	6	Forest	A		1.01	0.13	0.50	13.01	123.10
			Forest	C		0.93	0.12	0.46		
			Highway	A	0.40		0.54	4.23		
			Highway	C	2.37		3.17	24.84		
			LDR	A	0.35	2.85	0.62	5.83		
			LDR	C	2.75	19.34	8.25	85.23		
			Open	A	0.01	0.19	0.03	0.21		
			Open	C		0.75	0.16	1.79		
36-4	17	4	Forest	A		0.02	0.00	0.01	8.26	72.01

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Forest	B/D		0.00	0.00	0.00		
			Forest	C		1.93	0.25	0.96		
			Forest			1.61	0.21	0.80		
			HDR	C		0.09	0.02	0.22		
			HDR		0.08	1.05	0.40	3.58		
			Highway	A	0.14		0.18	1.44		
			Highway	B/D	0.02		0.02	0.18		
			Highway	C	1.08		1.45	11.34		
			Highway		1.69		2.26	17.72		
			LDR	A	0.18	0.32	0.28	2.63		
			LDR	B/D	0.00	0.00	0.00	0.03		
			LDR	C	0.53	3.55	1.56	16.04		
			LDR		0.45	3.34	1.39	14.40		
			Open	A		0.01	0.00	0.00		
			Open	B/D		0.00	0.00	0.01		
			Open	C		0.33	0.07	0.80		
			Open			0.77	0.16	1.84		
36-7	13	3	Forest	A		0.28	0.04	0.14	5.26	47.22
			Forest	B/D		0.06	0.01	0.03		
			Highway	A	1.16		1.55	12.15		
			Highway	B/D	0.05		0.06	0.51		
			LDR	A	1.71	7.44	2.82	26.36		
			LDR	B/D	0.24	1.85	0.75	7.80		
			Open	A		0.40	0.01	0.12		
			Open	B/D		0.05	0.01	0.12		
36-8	13	2	Forest	A		0.19	0.03	0.10	4.49	44.65

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Forest	B/D		0.04	0.01	0.02		
			Forest	C		0.00	0.00	0.00		
			Highway	A	0.44		0.59	4.66		
			Highway	B/D	0.09		0.12	0.95		
			LDR	A	0.16	1.65	0.30	2.79		
			LDR	B/D	0.00	0.22	0.05	0.55		
			LDR	C	0.30	2.32	0.94	9.73		
			LDR		0.70	6.64	2.46	25.81		
			Open	A		0.11	0.00	0.03		
36-9	1	0	Forest	C		0.01	0.00	0.00	0.33	3.44
			Forest			0.00	0.00	0.00		
			Highway	C	0.02		0.03	0.22		
			Highway	D	0.00		0.00	0.01		
			Highway		0.00		0.00	0.01		
			LDR	C	0.01	0.18	0.05	0.51		
			LDR		0.07	0.69	0.26	2.69		
			Open	C		0.00	0.00	0.00		
			Open			0.00	0.00	0.00		
37-1a	14	6	Forest	A		0.50	0.06	0.25	8.82	74.34
			Forest			0.69	0.09	0.34		
			Highway	A	0.77		1.04	8.13		
			Highway		3.65		4.89	38.29		
			LDR	A	1.18	2.85	1.87	17.45		
			LDR			0.00	0.00	0.01		
			Open	A		0.12	0.00	0.04		
			Open			4.10	0.86	9.83		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
37-2	2	1	Forest	A		0.06	0.01	0.03	0.95	8.18
			Forest	B/D		0.04	0.01	0.02		
			Highway	A	0.15		0.20	1.55		
			Highway	B/D	0.18		0.24	1.89		
			LDR	A	0.28	1.06	0.45	4.23		
			LDR	B/D	0.02	0.03	0.04	0.34		
			Open	A		0.04	0.00	0.01		
			Open	B/D		0.04	0.01	0.11		
37-3	46	8	Forest	C		2.26	0.29	1.13	20.39	185.21
			Forest	C/D		3.46	0.45	1.73		
			Forest			1.83	0.24	0.92		
			HDR	C	0.48	1.64	1.46	10.70		
			HDR	C/D	0.00	0.33	0.10	1.02		
			Highway	C	1.80		2.42	18.92		
			Highway	C/D	1.65		2.21	17.31		
			Highway		0.82		1.10	8.62		
			LDR	C	1.85	11.80	5.29	54.39		
			LDR	C/D	1.42	12.52	5.79	58.84		
			LDR		0.06	0.41	0.17	1.79		
			Open	C		1.51	0.32	3.62		
			Open	C/D		1.14	0.33	3.54		
			Open			1.12	0.24	2.69		
37-4	6	2	Forest	A		0.19	0.03	0.10	3.40	29.73
			Forest	C		0.09	0.01	0.05		
			Highway	A	0.86		1.15	9.02		
			Highway	C	0.23		0.30	2.39		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway		0.16		0.22	1.70		
			LDR	A	0.45	1.30	0.73	6.79		
			LDR	C	0.40	1.52	0.93	9.27		
			Open	A		0.33	0.01	0.10		
			Open	C		0.13	0.03	0.32		
			Open	C/D		0.00	0.00	0.00		
37-5	4	1	Forest	C		0.75	0.10	0.37	2.00	18.40
			Highway	C	0.42		0.57	4.45		
			LDR	C	0.51	2.24	1.25	12.61		
			Open	C		0.40	0.08	0.97		
37-6	1	1	Forest	A		0.01	0.00	0.00	1.43	12.62
			Forest	C		0.01	0.00	0.00		
			Forest	C/D		0.02	0.00	0.01		
			Highway	A	0.07		0.09	0.74		
			Highway	C	0.18		0.24	1.88		
			Highway	C/D	0.10		0.14	1.06		
			LDR	A	0.18	0.04	0.28	2.57		
			LDR	C	0.39	0.02	0.59	5.49		
			LDR	C/D	0.04	0.04	0.08	0.75		
			Open	A		0.02	0.00	0.01		
			Open	C/D		0.03	0.01	0.10		
37-7	1	0	Forest	A		0.04	0.01	0.02	0.43	3.76
			Forest	C		0.22	0.03	0.11		
			Highway	C	0.14		0.18	1.45		
			LDR	C	0.08	0.38	0.20	2.04		
			Open	C		0.06	0.01	0.14		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
41-2	9	3	Forest	A		0.57	0.07	0.29	4.46	39.37
			Forest	A/D		0.10	0.01	0.05		
			Forest			0.04	0.00	0.02		
			Highway	A	1.04		1.39	10.90		
			Highway	A/D	0.00		0.00	0.00		
			Highway		0.19		0.25	1.95		
			LDR	A	1.18	3.95	1.92	17.85		
			LDR	A/D		0.00	0.00	0.00		
			LDR		0.31	1.58	0.81	8.20		
			Open	A		0.17	0.01	0.05		
			Open			0.02	0.00	0.05		
41-3	13	3	Forest	A		0.09	0.01	0.05	5.96	54.83
			Forest			0.43	0.06	0.22		
			Highway	A	0.54		0.73	5.70		
			Highway		1.05		1.40	10.99		
			LDR	A	0.57	3.27	0.96	8.98		
			LDR		0.94	6.43	2.77	28.63		
			Open	A		0.05	0.00	0.02		
			Open			0.11	0.02	0.25		
42-1	16	4	Forest	A		0.35	0.04	0.17	6.57	60.14
			Forest			0.26	0.03	0.13		
			Highway	A	1.05		1.40	10.99		
			Highway		0.21		0.28	2.21		
			LDR	A	1.59	7.09	2.63	24.57		
			LDR		0.86	4.12	2.17	22.03		
			Open	A		0.13	0.00	0.04		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open			0.00	0.00	0.00		
42-10	9	2	Forest	A		0.21	0.03	0.10	2.67	23.79
			Highway	A	0.51		0.68	5.36		
			LDR	A	1.14	7.29	1.95	18.27		
			Open	A		0.17	0.00	0.05		
42-11	3	1	Forest	A/D		0.04	0.01	0.02	1.81	16.10
			Forest			0.24	0.03	0.12		
			Highway	A	0.01		0.01	0.06		
			Highway	A/D	0.01		0.02	0.13		
			Highway		0.66		0.89	6.95		
			Industrial	A/D		0.10	0.02	0.25		
			Industrial			0.03	0.01	0.06		
			LDR	A	0.00	0.00	0.00	0.01		
			LDR	A/D		0.03	0.01	0.08		
			LDR		0.31	1.64	0.81	8.24		
			Open			0.08	0.02	0.18		
42-2	19	1	Forest	A		0.08	0.01	0.04	5.93	57.73
			Forest	A/D		1.32	0.17	0.66		
			Forest	C/D		2.28	0.30	1.14		
			Highway	A	0.18		0.24	1.91		
			Highway	A/D	0.08		0.11	0.85		
			Highway	C/D	0.00		0.00	0.03		
			Industrial	A		0.08	0.00	0.02		
			Industrial	A/D		0.27	0.06	0.65		
			LDR	A	0.08	0.35	0.13	1.21		
			LDR	A/D	0.01	3.13	0.67	7.59		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	C	0.11	0.91	0.36	3.79		
			LDR	C/D	0.49	6.69	2.68	27.60		
			LDR		0.41	2.26	1.10	11.27		
			Open	A		0.01	0.00	0.00		
			Open	C/D		0.31	0.09	0.95		
42-3	9	2	Forest	A		0.28	0.04	0.14	3.03	27.21
			Forest	C		0.01	0.00	0.01		
			Highway	A	0.77		1.03	8.05		
			Highway	C	0.00		0.00	0.03		
			Highway	C/D	0.00		0.00	0.02		
			LDR	A	0.76	5.33	1.32	12.33		
			LDR	C	0.13	0.62	0.32	3.25		
			LDR	C/D	0.00	1.05	0.31	3.33		
			Open	A		0.13	0.00	0.04		
			Open	C		0.00	0.00	0.00		
			Open	C/D		0.01	0.00	0.02		
42-5	5	1	Forest	A		0.11	0.01	0.05	1.42	12.19
			Forest	A/D		1.29	0.17	0.64		
			Forest			0.01	0.00	0.00		
			HDR	A/D	0.00	0.01	0.00	0.02		
			Highway	A	0.18		0.24	1.85		
			Highway	A/D	0.22		0.30	2.31		
			Highway		0.00		0.00	0.01		
			Industrial	A		0.22	0.01	0.07		
			Industrial	A/D	0.00	0.85	0.18	2.04		
			Industrial			0.26	0.06	0.63		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	A	0.16	0.72	0.26	2.45		
			LDR	A/D	0.00	0.17	0.04	0.43		
			LDR		0.07	0.24	0.16	1.56		
			Open	A		0.02	0.00	0.00		
			Open	A/D		0.03	0.01	0.08		
			Open			0.01	0.00	0.02		
42-6	1	0	Forest	A/D		0.44	0.06	0.22	0.86	6.34
			HDR	A	0.02	0.03	0.05	0.28		
			HDR	A/D	0.08	0.20	0.22	1.58		
			Highway	A/D	0.40		0.53	4.17		
			Open	A/D		0.04	0.01	0.09		
42-8	1	0	Forest	A/D		0.22	0.03	0.11	0.68	4.85
			HDR	A		0.01	0.00	0.00		
			HDR	A/D	0.02	0.06	0.06	0.43		
			HDR		0.08	0.02	0.18	1.12		
			Highway	A/D	0.19		0.26	2.04		
			Highway		0.11		0.14	1.11		
			Open	A/D		0.01	0.00	0.03		
			Open			0.00	0.00	0.00		
42-9	5	1	Forest	A		0.07	0.01	0.03	1.50	13.16
			Highway	A	0.40		0.53	4.15		
			LDR	A	0.55	4.05	0.96	8.96		
			Open	A		0.04	0.00	0.01		
43-1	6	2	Forest	C		0.12	0.02	0.06	3.65	34.36
			Highway	C	0.56		0.74	5.83		
			LDR	C	1.39	3.24	2.79	27.39		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	C/D	0.01	0.13	0.05	0.56		
			Open	C		0.22	0.05	0.52		
43-2	7	2	Forest	C		0.10	0.01	0.05	3.80	35.26
			Forest	C/D		0.08	0.01	0.04		
			Highway	C	0.49		0.65	5.10		
			Highway	C/D	0.47		0.63	4.90		
			LDR	C	0.33	2.50	1.02	10.64		
			LDR	C/D	0.61	1.72	1.42	13.89		
			Open	C		0.18	0.04	0.44		
			Open	C/D		0.06	0.02	0.20		
43-3	4	1	Forest	C		0.04	0.01	0.02	1.95	18.57
			Highway	C	0.30		0.41	3.20		
			Highway	C/D	0.02		0.03	0.25		
			LDR	C	0.52	2.10	1.23	12.39		
			LDR	C/D	0.07	0.46	0.24	2.40		
			Open	C		0.11	0.02	0.26		
			Open	C/D		0.02	0.00	0.05		
43-4	1	0	Forest	C		0.00	0.00	0.00	0.43	3.83
			Highway	C	0.17		0.22	1.74		
			LDR	C	0.08	0.37	0.20	2.05		
			Open	C		0.01	0.00	0.03		
44-1	5	1	Forest	C		0.17	0.02	0.08	2.76	26.50
			Highway	C	0.34		0.46	3.60		
			LDR	C	0.35	1.10	0.77	7.63		
			LDR	C/D	0.43	2.83	1.48	14.89		
			Open	C		0.12	0.03	0.30		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
44-2	25	8	Forest	C		1.20	0.16	0.60	15.13	133.14
			Forest	C/D		0.58	0.08	0.29		
			Forest			0.20	0.03	0.10		
			HDR	C	0.10	1.29	0.50	4.50		
			HDR	C/D	0.32	0.90	1.01	7.32		
			Highway	C	2.64		3.53	27.69		
			Highway	C/D	0.74		0.99	7.74		
			Highway		1.52		2.03	15.93		
			LDR	C	1.99	9.43	5.01	50.70		
			LDR	C/D	0.42	2.92	1.49	15.01		
			Open	C	0.05	0.49	0.18	1.74		
			Open	C/D		0.21	0.06	0.64		
			Open			0.37	0.08	0.88		
45-2	3	1	Forest	C		0.06	0.01	0.03	1.37	13.10
			Highway	C	0.21		0.28	2.17		
			LDR	C	0.44	1.92	1.07	10.78		
			Open	C	0.00	0.03	0.01	0.12		
48-2	14	5	Forest	A		1.89	0.25	0.94	7.75	63.29
			Highway	A	3.28		4.40	34.48		
			LDR	A	1.51	6.21	2.49	23.19		
			Open	A	0.40	0.59	0.62	4.67		
51-1	2	1	Forest	C		0.13	0.02	0.06	1.40	13.00
			Highway	C	0.34		0.46	3.57		
			LDR	C	0.38	1.58	0.91	9.19		
			Open	C		0.07	0.02	0.18		
51-2	1	0	Forest	C		0.02	0.00	0.01	0.22	2.23

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	C	0.00		0.00	0.03		
			LDR	C	0.08	0.38	0.21	2.08		
			Open	C	0.00	0.05	0.01	0.12		
51-3	29	9	Forest	B		0.19	0.03	0.10	16.31	150.75
			Forest	C		1.18	0.15	0.59		
			Highway	B	0.62		0.83	6.50		
			Highway	C	3.24		4.34	33.99		
			LDR	B	0.88	2.33	1.61	15.18		
			LDR	C	3.79	16.20	9.16	92.27		
			Open	B		0.13	0.02	0.15		
			Open	C	0.00	0.82	0.17	1.96		
52-2	4	1	Forest	C		0.30	0.04	0.15	2.24	20.62
			Highway	C	0.61		0.81	6.38		
			LDR	C	0.53	2.54	1.34	13.57		
			Open	C		0.22	0.05	0.52		
56-1	9	2	Commercial			0.00	0.00	0.01	4.61	42.51
			Forest	B		0.02	0.00	0.01		
			Forest	C		0.01	0.00	0.00		
			Forest			0.32	0.04	0.16		
			Highway	B	0.07		0.09	0.73		
			Highway	C	0.00		0.00	0.02		
			Highway		1.28		1.71	13.43		
			LDR	B	0.03	0.13	0.06	0.58		
			LDR	C	0.02	0.10	0.05	0.54		
			LDR		0.94	5.67	2.62	26.91		
			Open	B		0.00	0.00	0.00		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open			0.05	0.01	0.11		
56-10	3	1	Forest	B		0.51	0.07	0.26	1.78	15.66
			Forest	C		0.12	0.02	0.06		
			Highway	C	0.52		0.70	5.47		
			LDR	B	0.06	0.16	0.11	1.02		
			LDR	C	0.41	1.19	0.87	8.62		
			Open	B		0.05	0.01	0.05		
			Open	C		0.08	0.02	0.18		
56-3	3	1	Forest	C		0.12	0.02	0.06	1.81	16.53
			Forest			0.06	0.01	0.03		
			Highway	C	0.41		0.54	4.27		
			Highway		0.11		0.15	1.17		
			LDR	C	0.33	1.14	0.75	7.43		
			LDR		0.14	0.67	0.35	3.51		
			Open	C		0.02	0.00	0.05		
56-4	3	1	Forest	C		0.10	0.01	0.05	1.27	12.14
			Highway	C	0.30		0.41	3.18		
			LDR	C	0.26	2.11	0.83	8.66		
			Open	C		0.10	0.02	0.25		
56-5	22	6	Forest	B		0.06	0.01	0.03	11.49	107.79
			Forest	C		0.61	0.08	0.30		
			Highway	B	0.20		0.27	2.12		
			Highway	C	2.08		2.78	21.81		
			LDR	B	0.35	2.92	0.89	8.48		
			LDR	C	3.11	12.54	7.37	74.00		
			LDR			0.05	0.01	0.13		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	B		0.03	0.00	0.04		
			Open	C		0.37	0.08	0.89		
56-6	34	8	Forest	B		0.34	0.04	0.17	16.47	149.73
			Forest	C		2.69	0.35	1.35		
			Forest	C/D		3.11	0.40	1.56		
			Forest			0.06	0.01	0.03		
			Highway	B	0.02		0.02	0.19		
			Highway	C	2.75		3.69	28.90		
			Highway	C/D	0.24		0.33	2.56		
			Highway		0.81		1.08	8.49		
			LDR	B/D	0.00	0.82	0.17	1.98		
			LDR	C	4.04	15.50	9.40	94.22		
			LDR	C/D	0.07	1.05	0.41	4.20		
			Open	B		0.06	0.01	0.08		
			Open	C		0.48	0.10	1.16		
			Open	C/D		1.45	0.42	4.49		
			Open			0.15	0.03	0.35		
56-7	3	0	Forest	B/D		0.00	0.00	0.00	1.12	11.01
			Forest	C		0.03	0.00	0.01		
			Highway	B/D	0.01		0.02	0.12		
			Highway	C	0.15		0.19	1.53		
			LDR	B/D	0.01	0.06	0.03	0.31		
			LDR	C	0.29	2.06	0.87	9.02		
			Open	C		0.01	0.00	0.01		
56-8	16	5	Forest	B		1.07	0.14	0.54	9.25	84.61
			Forest	C		0.30	0.04	0.15		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	B	0.37		0.49	3.87		
			Highway	C	1.56		2.09	16.34		
			LDR	B	0.75	2.29	1.41	13.27		
			LDR	C	2.31	7.07	5.00	49.57		
			Open	B		0.12	0.01	0.15		
			Open	C	0.00	0.28	0.06	0.72		
56-9	5	1	Forest	B		1.15	0.15	0.57	1.77	15.09
			Forest	C		0.66	0.09	0.33		
			Forest			0.00	0.00	0.00		
			Highway	B	0.12		0.16	1.29		
			Highway	C	0.29		0.39	3.06		
			Highway		0.06		0.08	0.65		
			LDR	B		0.23	0.03	0.28		
			LDR	C	0.30	1.80	0.84	8.62		
			Open	B		0.05	0.01	0.06		
			Open	C		0.07	0.01	0.16		
			Open			0.03	0.01	0.07		
57-2	3	1	Forest	C		0.33	0.04	0.16	1.24	11.39
			Highway	C	0.32		0.43	3.36		
			LDR	C	0.29	1.54	0.76	7.73		
			Open	C		0.06	0.01	0.14		
57-3	4	0	Forest	C		0.21	0.03	0.10	1.26	12.48
			Highway	C	0.18		0.24	1.89		
			LDR	C	0.24	2.93	0.98	10.45		
			Open	C		0.01	0.00	0.03		
57-5	4	1	Forest	A		0.13	0.02	0.06	1.33	12.47

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	A	0.24		0.32	2.48		
			LDR	A	0.31	1.49	0.52	4.84		
			LDR		0.11	1.47	0.47	5.04		
			Open	A		0.13	0.00	0.04		
57-7	2	0	Forest	C		0.22	0.03	0.11	0.92	8.60
			Highway	C	0.18		0.24	1.90		
			LDR	C	0.27	1.16	0.65	6.57		
			Open	C		0.01	0.00	0.03		
57-8	1	0	Forest	C		0.08	0.01	0.04	0.47	3.89
			Highway	C	0.26		0.35	2.78		
			LDR	C	0.05	0.15	0.11	1.07		
			Open	C		0.00	0.00	0.00		
57-9	5	2	Forest	A		0.04	0.01	0.02	2.85	25.48
			Forest	C		0.14	0.02	0.07		
			Forest	C/D		0.08	0.01	0.04		
			Forest			0.04	0.01	0.02		
			Highway	A	0.20		0.27	2.13		
			Highway	C	0.56		0.76	5.93		
			Highway	C/D	0.09		0.12	0.97		
			Highway		0.20		0.27	2.12		
			LDR	A	0.02	0.12	0.03	0.29		
			LDR	C	0.18	1.00	0.48	4.91		
			LDR	C/D	0.06	0.23	0.16	1.59		
			LDR		0.22	1.64	0.69	7.11		
			Open	A		0.03	0.00	0.01		
			Open	C		0.05	0.01	0.13		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	C/D		0.05	0.01	0.14		
61-1	1	0	Forest	C/D		0.03	0.00	0.02	0.62	5.86
			Highway	C/D	0.16		0.22	1.69		
			LDR	C/D	0.00	0.36	0.11	1.16		
			LDR		0.09	0.72	0.29	3.00		
61-2	2	0	Forest	C/D		0.12	0.02	0.06	1.10	10.43
			Highway	C/D	0.24		0.33	2.57		
			LDR	C/D	0.04	0.80	0.30	3.11		
			LDR		0.15	1.09	0.45	4.69		
			Open	C/D		0.00	0.00	0.00		
61-3	3	0	Forest	B		1.25	0.16	0.62	0.88	7.39
			Forest	C		0.00	0.00	0.00		
			Forest	C/D		0.31	0.04	0.15		
			Highway	C	0.00		0.00	0.00		
			Highway	C/D	0.03		0.04	0.30		
			LDR	B	0.15	0.66	0.30	2.84		
			LDR	C	0.08	0.19	0.16	1.59		
			LDR	C/D	0.01	0.55	0.18	1.87		
			Open	C/D		0.00	0.00	0.01		
61-4	8	2	Forest	C/D		0.02	0.00	0.01	3.76	35.37
			Forest			0.18	0.02	0.09		
			Highway	C/D	0.14		0.18	1.43		
			Highway		0.87		1.17	9.15		
			LDR	C/D	0.00	0.08	0.03	0.28		
			LDR		0.79	5.46	2.34	24.18		
			Open	C/D		0.01	0.00	0.02		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open			0.09	0.02	0.21		
61-5	12	2	Forest	B		0.00	0.00	0.00	5.37	48.56
			Forest	B/D		1.70	0.22	0.85		
			Forest	C/D		0.80	0.10	0.40		
			Forest			0.13	0.02	0.06		
			Highway	C/D	0.81		1.08	8.46		
			Highway		0.53		0.72	5.62		
			LDR	B		0.13	0.02	0.16		
			LDR	B/D	0.09	1.34	0.42	4.49		
			LDR	C	0.09	0.33	0.20	2.04		
			LDR	C/D	0.31	1.96	1.03	10.41		
			LDR		0.53	3.34	1.51	15.50		
			Open	C/D		0.12	0.03	0.36		
			Open			0.09	0.02	0.22		
61-8	8	3	Commercial	C	0.04	0.06	0.09	0.81	5.09	45.37
			Forest	C		0.74	0.10	0.37		
			Forest	C/D		0.09	0.01	0.04		
			Highway	C	1.33		1.78	13.98		
			Highway	C/D	0.22		0.29	2.27		
			Industrial	C	0.10	0.16	0.20	1.81		
			LDR	C	0.98	3.32	2.18	21.77		
			LDR	C/D	0.06	0.35	0.19	1.91		
			LDR	D	0.06	0.02	0.10	0.89		
			Open	C	0.01	0.45	0.11	1.19		
			Open	C/D		0.11	0.03	0.33		
61-9	11	3	Commercial	C	0.52	0.22	0.96	8.27	6.77	60.22

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Commercial	C/D	0.57	1.63	1.49	13.63		
			Commercial			0.10	0.02	0.24		
			Forest	C/D		0.51	0.07	0.25		
			Forest			0.51	0.07	0.26		
			Highway	C/D	0.84		1.13	8.86		
			Highway		0.71		0.94	7.40		
			LDR	C/D		0.31	0.09	0.96		
			LDR		0.73	3.95	1.94	19.83		
			Open	C/D		0.07	0.02	0.21		
			Open			0.13	0.03	0.30		
62-1	7	1	Forest	C		0.39	0.05	0.19	3.22	30.62
			Highway	C	0.65		0.87	6.84		
			Industrial	C		0.02	0.00	0.04		
			LDR	C	0.82	4.96	2.29	23.47		
			Open	C		0.03	0.01	0.08		
62-10	1	1	Highway	B	0.45		0.60	4.73	0.97	8.04
			LDR	B	0.12	0.50	0.24	2.29		
			Open	B	0.06	0.32	0.12	1.02		
62-2	2	1	Forest	B		0.02	0.00	0.01	0.99	8.70
			Forest	C		0.12	0.02	0.06		
			Highway	B	0.01		0.01	0.08		
			Highway	C	0.37		0.50	3.92		
			LDR	B	0.04	0.16	0.08	0.73		
			LDR	C	0.17	0.65	0.39	3.90		
62-4	1	1	Commercial	B	0.11	0.00	0.20	1.69	2.31	19.34
			Commercial		0.98	0.09	1.76	14.87		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Forest			0.01	0.00	0.00		
			Highway	B	0.02		0.03	0.24		
			Highway		0.24		0.32	2.53		
62-5	3	1	Forest	B		0.30	0.04	0.15	1.50	12.69
			HDR	B	0.01	0.12	0.04	0.32		
			Highway	B	0.55		0.74	5.77		
			LDR	B	0.34	1.35	0.67	6.36		
			Open	B		0.07	0.01	0.09		
62-6a	3	1	Forest			0.09	0.01	0.04	1.31	12.45
			Highway		0.23		0.31	2.41		
			LDR	B	0.15	1.31	0.38	3.62		
			LDR		0.20	1.49	0.61	6.35		
			Open			0.01	0.00	0.03		
62-6b	7	2	Forest	A		0.10	0.01	0.05	3.84	35.47
			Forest			0.15	0.02	0.07		
			Highway	A	0.43		0.57	4.48		
			Highway		0.34		0.45	3.55		
			LDR	A	0.65	1.55	1.04	9.64		
			LDR		0.69	3.18	1.72	17.37		
			Open	A	0.00	0.12	0.01	0.08		
			Open			0.09	0.02	0.21		
62-7	7	2	Forest	A		0.75	0.10	0.37	2.90	25.36
			Forest			0.02	0.00	0.01		
			HDR	A	0.06	0.15	0.14	0.89		
			HDR			0.01	0.00	0.02		
			Highway	A	0.89		1.19	9.32		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway		0.05		0.07	0.52		
			LDR	A	0.45	2.18	0.75	7.04		
			LDR		0.06	2.61	0.64	7.16		
			Open	A		0.10	0.00	0.03		
			Open			0.00	0.00	0.00		
62-8	8	2	Forest			0.37	0.05	0.19	4.12	38.97
			Highway		0.78		1.04	8.16		
			LDR		1.23	5.45	3.02	30.45		
			Open			0.08	0.02	0.18		
62-9	1	0	Forest	A		0.55	0.07	0.27	0.24	1.42
			Forest	A/D		0.35	0.05	0.18		
			Highway	A	0.04		0.05	0.42		
			Highway	A/D	0.04		0.06	0.46		
			LDR	A		0.23	0.01	0.07		
			LDR	A/D		0.01	0.00	0.01		
65-1	17	6	Commercial	A	0.57	0.18	1.03	8.68	12.65	101.86
			Commercial	C	0.05	0.05	0.09	0.80		
			Commercial		1.74	1.59	3.43	29.93		
			Forest	A		0.36	0.05	0.18		
			Forest	B		1.34	0.17	0.67		
			Forest	B/D		0.05	0.01	0.02		
			Forest	C		1.52	0.20	0.76		
			Forest			0.01	0.00	0.01		
			HDR	C	0.00	0.22	0.05	0.53		
			HDR		1.26	1.47	3.23	21.26		
			Highway	A	0.26		0.35	2.70		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway	B	0.15		0.21	1.62		
			Highway	B/D	0.02		0.03	0.23		
			Highway	C	0.71		0.95	7.47		
			Highway		0.62		0.83	6.50		
			LDR	B	0.11	1.01	0.28	2.72		
			LDR	C	0.68	3.08	1.68	16.95		
			Open	A	0.00	0.03	0.00	0.03		
			Open	B/D	0.00		0.00	0.01		
			Open	C		0.08	0.02	0.19		
			Open			0.25	0.05	0.60		
65-2	4	1	Commercial	B		0.06	0.01	0.07	2.25	20.86
			Forest	B		0.19	0.03	0.10		
			Forest	D		0.04	0.01	0.02		
			Highway	B	0.21		0.29	2.25		
			Highway	D	0.02		0.03	0.23		
			LDR	B		0.06	0.01	0.07		
			LDR	D	0.40	3.46	1.89	18.09		
			Open	B		0.01	0.00	0.01		
			Open	D		0.01	0.00	0.03		
66-1	15	4	Commercial	B		0.04	0.01	0.05	7.17	62.87
			Forest	B		0.72	0.09	0.36		
			Forest	D		0.09	0.01	0.05		
			Highway	B	1.58		2.12	16.59		
			Highway	D	0.56		0.75	5.86		
			Industrial	B	0.04	1.95	0.30	2.91		
			LDR	B	1.05	5.63	2.27	21.54		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	D	0.46	2.47	1.61	15.35		
			Open	B		0.08	0.01	0.09		
			Open	D		0.02	0.01	0.08		
66-2	8	1	Forest	B		2.00	0.26	1.00	2.44	20.60
			Forest	C		0.90	0.12	0.45		
			Highway	B	0.13		0.18	1.40		
			Highway	C	0.14		0.19	1.51		
			LDR	B	0.68	3.11	1.40	13.28		
			LDR	C	0.10	0.64	0.28	2.90		
			Open	C		0.02	0.01	0.06		
66-3	4	1	Forest	C		0.86	0.11	0.43	1.79	14.95
			Forest	C/D		1.11	0.14	0.56		
			Highway	C	0.10		0.13	1.04		
			Highway	C/D	0.38		0.50	3.94		
			LDR	C	0.11	0.72	0.33	3.36		
			LDR	C/D	0.22	0.68	0.53	5.22		
			Open	C		0.01	0.00	0.03		
			Open	C/D		0.12	0.04	0.38		
66-4	12	5	Commercial	C/D		0.00	0.00	0.00	8.28	69.62
			Forest	C		0.10	0.01	0.05		
			Forest	C/D		1.60	0.21	0.80		
			Highway	C	0.09		0.12	0.96		
			Highway	C/D	4.14		5.55	43.47		
			LDR	C	0.05	0.63	0.20	2.16		
			LDR	C/D	0.57	2.98	1.73	17.28		
			Open	C		0.05	0.01	0.12		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	C/D		1.54	0.45	4.77		
66-5	7	1	Forest	B		0.01	0.00	0.00	3.30	30.28
			Forest	D		0.30	0.04	0.15		
			Highway	B	0.01		0.01	0.11		
			Highway	D	0.46		0.61	4.80		
			Industrial	B		0.45	0.05	0.54		
			Industrial	D	0.00	1.19	0.44	4.30		
			LDR	B	0.05	0.35	0.11	1.07		
			LDR	D	0.51	3.33	2.00	19.14		
			Open	D		0.05	0.02	0.17		
66-6	8	2	Forest	B		0.24	0.03	0.12	3.60	32.22
			Forest	D		0.19	0.02	0.09		
			Highway	B	0.71		0.95	7.46		
			Highway	D	0.15		0.20	1.55		
			LDR	B	0.37	3.39	0.97	9.33		
			LDR	D	0.28	2.69	1.42	13.65		
			Open	D		0.01	0.00	0.02		
66-7	11	2	Forest	B		0.01	0.00	0.00	4.62	42.92
			Forest	C		0.12	0.02	0.06		
			HDR	B		1.23	0.15	1.47		
			HDR	C	0.13	1.96	0.72	6.59		
			Highway	B	0.31		0.42	3.29		
			Highway	C	0.56		0.75	5.88		
			LDR	B	0.81	2.03	1.47	13.79		
			LDR	C	0.20	3.66	1.08	11.66		
			Open	B		0.04	0.00	0.05		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	C		0.05	0.01	0.13		
66-8	18	2	Forest	B		0.01	0.00	0.01	6.01	48.89
			Forest	C		0.01	0.00	0.01		
			HDR	B	0.98	5.94	2.98	20.91		
			HDR	C	0.14	2.39	0.83	7.76		
			HDR	D		0.12	0.05	0.44		
			Highway	B	0.36		0.48	3.78		
			Highway	C	0.13		0.18	1.40		
			Industrial	B		3.66	0.44	4.39		
			Industrial	D		1.24	0.46	4.48		
			LDR	B	0.17	2.49	0.55	5.34		
			LDR	C		0.09	0.02	0.22		
			Open	B		0.03	0.00	0.04		
			Open	C		0.05	0.01	0.12		
67-1	3	1	Forest	A/D		0.03	0.00	0.01	1.63	13.62
			Forest	B		0.01	0.00	0.00		
			Forest	C		0.48	0.06	0.24		
			Forest	D		0.09	0.01	0.05		
			HDR	B		0.29	0.03	0.35		
			HDR	C	0.01	0.35	0.10	0.97		
			Highway	A/D	0.07		0.09	0.72		
			Highway	B	0.00		0.00	0.01		
			Highway	C	0.75		1.00	7.84		
			LDR	B	0.03	0.54	0.11	1.03		
			LDR	C	0.03	0.38	0.13	1.37		
			LDR	D	0.01	0.05	0.03	0.31		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Open	A/D		0.01	0.00	0.01		
			Open	C		0.29	0.06	0.70		
67-2	8	1	Forest	B		0.10	0.01	0.05	3.15	27.22
			Forest	D		0.00	0.00	0.00		
			HDR	B	0.18	1.50	0.59	4.32		
			Highway	B	0.57		0.76	5.96		
			Highway	D	0.04		0.05	0.41		
			LDR	B	0.67	4.84	1.61	15.31		
			LDR	D	0.03	0.13	0.09	0.85		
			Open	B		0.21	0.03	0.25		
			Open	D		0.02	0.01	0.07		
67-3	5	2	Forest	B		0.01	0.00	0.00	3.18	27.66
			Highway	B	1.10		1.48	11.56		
			LDR	B	0.85	3.15	1.67	15.75		
			Open	B		0.28	0.03	0.34		
67-4	8	2	Forest			0.14	0.02	0.07	4.44	41.06
			Highway	B	0.40		0.54	4.21		
			Highway		0.48		0.64	5.02		
			LDR	B	0.75	1.83	1.36	12.82		
			LDR		0.77	3.05	1.82	18.23		
			Open	B		0.05	0.01	0.06		
			Open			0.27	0.06	0.66		
68-1	4	1	Forest	B		0.17	0.02	0.09	1.63	15.78
			Forest	C		0.22	0.03	0.11		
			Highway	B	0.01		0.01	0.07		
			Highway	C	0.18		0.24	1.90		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			Highway		0.00		0.01	0.04		
			LDR	B	0.07	0.23	0.13	1.22		
			LDR	C	0.23	1.22	0.61	6.19		
			LDR		0.11	1.66	0.52	5.58		
			Open	B	0.03	0.05	0.04	0.35		
			Open	C	0.00	0.09	0.02	0.22		
			Open			0.01	0.00	0.02		
68-3	5	0	Forest	B		1.22	0.16	0.61	1.03	8.37
			Forest	D		0.88	0.11	0.44		
			Forest			0.04	0.01	0.02		
			HDR	B		0.04	0.00	0.05		
			HDR	D		0.03	0.01	0.12		
			Highway	B	0.00		0.00	0.02		
			Highway		0.01		0.01	0.06		
			LDR	B	0.22	2.39	0.62	6.00		
			LDR		0.01	0.27	0.08	0.83		
			Open	B	0.01	0.10	0.02	0.19		
			Open			0.01	0.00	0.03		
68-5	11	4	Forest	B		0.07	0.01	0.03	11.40	73.22
			Forest	D		2.59	0.34	1.29		
			HDR	B	2.59	1.10	6.13	37.79		
			HDR	D	1.52	2.17	4.34	29.28		
			Highway	D	0.35		0.46	3.63		
			LDR	B	0.00	0.00	0.00	0.01		
			Open	B	0.00	0.15	0.02	0.22		
			Open	D		0.27	0.10	0.96		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
68-6	11	8	Commercial	A	3.57	0.32	6.37	53.69	13.38	108.31
			Commercial	A/D	0.00	0.05	0.02	0.19		
			Commercial	B	0.88	0.08	1.58	13.33		
			Commercial	D	0.33	0.05	0.60	5.12		
			Forest	A		0.00	0.00	0.00		
			Forest	D		0.50	0.06	0.25		
			HDR	B	0.05	1.20	0.26	2.15		
			HDR	D	0.26	0.71	0.86	6.21		
			Highway	A	0.80		1.08	8.45		
			Highway	D	0.10		0.13	1.00		
			Open	A	1.17	0.09	1.79	13.28		
			Open	B	0.23		0.35	2.61		
			Open	D	0.17	0.02	0.27	2.04		
72-1	3	1	Forest	B		0.12	0.02	0.06	1.65	14.72
			Highway	B	0.39		0.52	4.05		
			Industrial	B	0.00	0.34	0.04	0.42		
			LDR	B	0.55	1.91	1.07	10.07		
			Open	B		0.10	0.01	0.12		
72-10	4	1	Forest	B		0.09	0.01	0.04	1.38	12.42
			Highway	B	0.34		0.46	3.58		
			LDR	B	0.31	3.60	0.90	8.71		
			Open	B		0.08	0.01	0.09		
72-11	2	0	Forest	B		0.09	0.01	0.05	0.75	6.68
			Highway	B	0.19		0.25	1.97		
			LDR	B	0.18	1.79	0.49	4.66		
			Open	B		0.00	0.00	0.00		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
72-12	3	1	Forest	B		0.53	0.07	0.26	2.33	19.13
			Forest	C		0.09	0.01	0.04		
			Highway	B	0.69		0.92	7.20		
			Highway	C	0.17		0.23	1.79		
			LDR	B	0.40	0.78	0.70	6.59		
			Open	B	0.21	0.43	0.37	2.87		
			Open	C	0.00	0.13	0.03	0.37		
72-13	5	1	Forest	B		1.23	0.16	0.61	1.79	14.98
			Forest	C		0.01	0.00	0.00		
			Highway	B	0.50		0.66	5.20		
			Highway	C	0.00		0.00	0.02		
			LDR	B	0.41	2.64	0.94	8.99		
			Open	B		0.12	0.01	0.14		
			Open	C	0.00	0.00	0.00	0.00		
72-14	3	1	Forest	B		0.91	0.12	0.46	1.31	10.62
			Highway	B	0.49		0.66	5.16		
			LDR	B	0.27	0.88	0.52	4.91		
			Open	B		0.07	0.01	0.09		
72-15	1	0	Forest	B		0.39	0.05	0.20	0.44	3.35
			Highway	B	0.25		0.34	2.64		
			LDR	B	0.02	0.22	0.05	0.52		
72-2	5	0	Forest	D		0.08	0.01	0.04	1.29	12.41
			Highway	D	0.03		0.03	0.27		
			Industrial	B		1.62	0.19	1.94		
			Industrial	D		1.47	0.54	5.30		
			LDR	B	0.13	0.66	0.27	2.60		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
			LDR	D	0.03	0.50	0.23	2.22		
			Open	D		0.01	0.00	0.04		
72-3	19	4	Forest	B		0.40	0.05	0.20	7.59	69.62
			Forest	C		0.34	0.04	0.17		
			Forest	D		0.00	0.00	0.00		
			Highway	B	1.19		1.60	12.50		
			Highway	C	0.26		0.35	2.77		
			Industrial	B		0.89	0.11	1.07		
			LDR	B	1.75	10.66	3.94	37.47		
			LDR	C	0.48	3.32	1.42	14.69		
			LDR	D	0.03	0.05	0.06	0.57		
			Open	B		0.06	0.01	0.08		
			Open	C		0.04	0.01	0.10		
72-4	3	1	Forest	B		0.15	0.02	0.08	0.97	8.36
			Forest	C		0.04	0.00	0.02		
			Highway	B	0.27		0.36	2.81		
			Highway	C	0.10		0.14	1.08		
			LDR	B	0.10	1.67	0.36	3.46		
			LDR	C	0.04	0.17	0.09	0.92		
72-6	0	0	Forest	B		0.01	0.00	0.01	0.15	1.21
			Highway	B	0.11		0.15	1.14		
			LDR	B	0.00	0.02	0.01	0.06		
72-7	5	1	Forest	B		0.40	0.05	0.20	1.78	15.88
			Highway	B	0.34		0.46	3.57		
			LDR	B	0.55	3.54	1.27	12.06		
			Open	B		0.05	0.01	0.05		

Nutrient Load Calculations – Saugus River

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP BMP Load (lbs P/year)	TN BMP Load (lbs N/year)	Total Outfall TP Load (lbs P/year)	Total Outfall TN Load (lbs N/year)
INT-3	2	0	Forest	B		0.05	0.01	0.02	1.04	9.79
			Forest			0.06	0.01	0.03		
			Highway	B	0.08		0.11	0.88		
			Highway		0.19		0.26	2.01		
			LDR	B		0.12	0.01	0.14		
			LDR		0.20	1.57	0.63	6.56		
			Open	B		0.06	0.01	0.07		
			Open			0.03	0.01	0.07		
INT-4	1	0	Forest	B		0.14	0.02	0.07	0.57	5.20
			Highway	B	0.11		0.14	1.10		
			LDR	B	0.08	0.42	0.17	1.57		
			LDR		0.09	0.45	0.23	2.34		
			Open	B		0.09	0.01	0.11		
Total	**1618**	**382**							**781**	**7054**

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
23-1	5	1	Forest	C		0.4	0.0	2.5
			Highway	C	0.6		0.8	
			LDR	C	0.5	3.7	1.6	
			Open	C		0.1	0.0	
28-1	3	1	Forest	C		0.0	0.0	1.4
			Highway	C	0.1		0.2	
			LDR	A		0.0	0.0	
			LDR	C	0.5	2.3	1.3	
			Open	C		0.0	0.0	
28-2	52	9	Forest	A		0.4	0.1	19.7
			Forest	C		1.8	0.2	
			Forest	C/D		0.1	0.0	
			HDR	A		5.7	0.2	
			Highway	A	0.5		0.6	
			Highway	C	3.0		4.0	
			Highway	C/D	0.4		0.5	
			LDR	A	0.9	8.2	1.6	
			LDR	B/D	0.0	0.2	0.1	
			LDR	C	3.1	19.0	8.7	
			LDR	C/D	1.0	7.2	3.6	
			Open	A		0.1	0.0	
			Open	C		0.3	0.1	
			Open	C/D		0.0	0.0	
28-3	7	1	Forest	C		0.2	0.0	3.2
			Forest	C/D		0.0	0.0	
			Highway	C	0.7		1.0	
			Highway	C/D	0.0		0.0	
			LDR	C	0.6	4.5	1.9	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			LDR	C/D	0.1	0.4	0.2	
			Open	C		0.2	0.0	
			Open	C/D		0.0	0.0	
28-4	37	7	Forest	C		1.2	0.2	16.6
			Forest	C/D		0.0	0.0	
			Highway	C	3.4		4.6	
			Highway	C/D	0.0		0.1	
			LDR	C	3.8	28.3	11.7	
			LDR	C/D	0.0	0.0	0.0	
			Open	C		0.5	0.1	
28-6	1	0	Forest	A		0.0	0.0	0.7
			Forest	B/D		0.0	0.0	
			HDR	A		0.0	0.0	
			HDR	B/D	0.0	0.2	0.1	
			Highway	A	0.2		0.3	
			Highway	B/D	0.1		0.1	
			LDR	A	0.1	0.4	0.2	
			LDR	B/D	0.0	0.0	0.0	
			Open	A		0.0	0.0	
			Open	B/D		0.0	0.0	
28-7	1	0	Forest	A		0.0	0.0	0.7
			Forest	B/D		0.2	0.0	
			HDR	A		0.0	0.0	
			HDR	B/D		0.2	0.0	
			Highway	A	0.0		0.0	
			Highway	B/D	0.2		0.3	
			Highway	C	0.0		0.0	
			LDR	B/D	0.1	0.3	0.2	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			LDR	C	0.1	0.2	0.2	
			Open	B/D	0.0	0.0	0.0	
			Open	C		0.0	0.0	
32-3	14	9	Forest	A		0.8	0.1	13.0
			Forest	B/D		0.0	0.0	
			Forest	C/D		0.2	0.0	
			Forest			2.1	0.3	
			Highway	A	0.0		0.0	
			Highway		9.0		12.1	
			LDR	C/D		0.3	0.1	
			Open	A		0.0	0.0	
			Open	C/D		0.0	0.0	
			Open			1.7	0.4	
32-5	3	1	Forest	A		0.1	0.0	2.0
			Forest	C		0.2	0.0	
			Forest	C/D		0.1	0.0	
			Forest			0.3	0.0	
			Highway	A	0.0		0.0	
			Highway	C	0.4		0.5	
			Highway	C/D	0.1		0.2	
			Highway		0.6		0.8	
			LDR	A		0.0	0.0	
			LDR	C	0.0	0.3	0.1	
			LDR	C/D	0.1	0.7	0.3	
			LDR		0.0	0.2	0.1	
			Open	C		0.0	0.0	
			Open	C/D		0.0	0.0	
			Open			0.1	0.0	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
33-2	2	1	Forest	A		0.2	0.0	0.8
			Forest	B/D		0.1	0.0	
			Highway	A	0.4		0.5	
			Highway	B/D	0.1		0.1	
			LDR	A	0.1	1.4	0.2	
			Open	A		0.0	0.0	
33-3a	1	0	Forest	A		0.0	0.0	0.6
			Forest	B/D		0.1	0.0	
			Forest	C		0.0	0.0	
			Highway	A	0.1		0.2	
			Highway	B/D	0.1		0.1	
			Highway	C	0.1		0.1	
			LDR	B/D	0.0	0.1	0.0	
			LDR	C	0.1	0.1	0.2	
			Open	A		0.0	0.0	
			Open	B/D		0.0	0.0	
			Open	C		0.0	0.0	
33-5	8	2	Forest	C		0.9	0.1	4.4
			Highway	C	1.2		1.6	
			LDR	C	1.0	5.0	2.6	
			Open	C	0.0	0.1	0.1	
33-6	40	11	Forest	B/D		0.0	0.0	21.2
			Forest	C		2.2	0.3	
			Forest	D		0.0	0.0	
			Highway	B/D	0.0		0.0	
			Highway	C	5.3		7.1	
			Highway	D	0.0		0.0	
			LDR	B/D	0.0	0.1	0.0	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			LDR	C	5.3	24.3	13.1	
			LDR	D	0.1	0.2	0.2	
			Open	B/D		0.0	0.0	
			Open	C	0.0	2.0	0.4	
			Open	D		0.0	0.0	
33-7	22	4	Forest	C		4.8	0.6	8.5
			Forest	D		1.5	0.2	
			Forest			0.1	0.0	
			Highway	C	1.4		1.8	
			Highway	D	0.0		0.0	
			Highway		0.1		0.2	
			LDR	C	1.7	9.8	4.7	
			LDR	D	0.0	0.4	0.1	
			LDR		0.3	0.9	0.7	
			Open	C		0.7	0.1	
			Open	D		0.0	0.0	
			Open			0.1	0.0	
33-8	13	3	Forest	C		0.8	0.1	6.3
			Highway	C	1.5		1.9	
			LDR	C	1.6	8.5	4.2	
			Open	C	0.0	0.3	0.1	
34-1	7	2	Forest	C		1.1	0.1	3.4
			Forest	C/D		0.0	0.0	
			Highway	C	0.8		1.0	
			Highway	C/D	0.0		0.0	
			LDR	C	0.8	4.1	2.0	
			LDR	C/D	0.1	0.1	0.1	
			Open	C		0.2	0.0	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			Open	C/D		0.0	0.0	
38-1	17	4	Forest	C		1.2	0.2	8.5
			Forest	C/D		0.6	0.1	
			HDR	C	0.2	0.5	0.5	
			HDR	C/D	0.0	0.1	0.0	
			Highway	C	0.5		0.7	
			Highway	C/D	0.8		1.0	
			Highway		0.5		0.7	
			LDR	C	1.3	6.4	3.3	
			LDR	C/D	0.5	2.8	1.5	
			Open	C		0.2	0.0	
			Open	C/D		1.3	0.4	
			Open			0.0	0.0	
38-2	5	1	Forest	C		0.7	0.1	2.4
			Highway	C	0.6		0.8	
			LDR	C	0.5	3.4	1.5	
			Open	C		0.1	0.0	
38-3	29	6	Forest	C		0.1	0.0	14.9
			Forest	C/D		3.2	0.4	
			Forest	D		0.0	0.0	
			Forest			0.1	0.0	
			Highway	C	0.3		0.5	
			Highway	C/D	1.5		2.0	
			Highway	D	0.0		0.0	
			Highway		0.9		1.2	
			LDR	C	0.5	1.7	1.1	
			LDR	C/D	2.3	13.8	7.4	
			LDR	D	0.5	3.3	2.0	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			Open	C		0.0	0.0	
			Open	C/D	0.0	0.6	0.2	
			Open	D		0.0	0.0	
			Open			0.0	0.0	
39-1	5	1	Forest	A		0.4	0.1	2.3
			Forest	B/D		0.0	0.0	
			Highway	A	0.7		0.9	
			Highway	B/D	0.0		0.1	
			LDR	A	0.5	2.7	0.8	
			LDR	B/D	0.3	0.5	0.5	
			Open	A		0.1	0.0	
39-3	7	1	Forest	C		1.0	0.1	3.0
			Highway	C	0.5		0.7	
			LDR	A	0.0	0.0	0.0	
			LDR	C	0.8	4.3	2.1	
			Open	C		0.2	0.0	
39-4	2	1	Forest	A		0.2	0.0	0.8
			Forest			0.0	0.0	
			Highway	A	0.4		0.5	
			Highway		0.0		0.1	
			LDR	A	0.1	1.2	0.2	
			LDR		0.0	0.2	0.1	
			Open	A	0.0	0.0	0.0	
			Open			0.0	0.0	
39-5	2	1	Forest			0.2	0.0	1.0
			Highway		0.3		0.4	
			LDR		0.2	0.9	0.5	
			Open			0.0	0.0	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
39-7	2	0	Forest	A		0.1	0.0	0.8
			Forest	C		0.1	0.0	
			Highway	A	0.2		0.2	
			Highway	C	0.2		0.3	
			LDR	A	0.0	0.6	0.0	
			LDR	C	0.1	0.5	0.2	
			Open	A		0.0	0.0	
			Open	C		0.0	0.0	
39-8	1	0	Forest	A		0.1	0.0	0.3
			Highway	A	0.1		0.1	
			LDR	A	0.0	0.6	0.0	
			LDR	C	0.1	0.2	0.1	
40-1	1	0	Forest			0.1	0.0	0.6
			Highway		0.3		0.4	
			LDR		0.0	0.7	0.2	
			Open			0.0	0.0	
40-2	5	1	Forest	C		0.4	0.1	2.2
			Forest	C/D		0.1	0.0	
			Highway	C	0.2		0.3	
			Highway	C/D	0.2		0.3	
			LDR	C	0.4	3.0	1.2	
			LDR	C/D	0.1	0.5	0.3	
			Open	C		0.1	0.0	
			Open	C/D		0.1	0.0	
40-3	2	1	Forest	C		0.0	0.0	1.0
			Forest	C/D		0.1	0.0	
			Highway	C	0.0		0.1	
			Highway	C/D	0.2		0.2	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			LDR	C	0.0	0.0	0.0	
			LDR	C/D	0.1	0.4	0.3	
			Open	C/D		0.0	0.0	
			Forest	C		0.2	0.0	
			Highway	C	0.2		0.3	
			LDR	C	0.0	0.4	0.1	
			Open	C		0.0	0.0	
44-4	5	1	Forest	C		2.1	0.3	2.0
			Highway	C	0.3		0.3	
			LDR	C	0.5	2.5	1.3	
			Open	C	0.0	0.1	0.1	
44-5	4	1	Forest	C		0.1	0.0	2.6
			Highway	C	0.4		0.5	
			LDR	C	1.0	2.7	2.0	
			Open	C		0.1	0.0	
44-6	4	2	Forest	C		0.2	0.0	2.7
			Highway	C	0.6		0.8	
			LDR	C	0.9	2.4	1.9	
			Open	C		0.1	0.0	
44-7	6	1	Forest	C		0.3	0.0	2.7
			Highway	C	0.4		0.5	
			LDR	C	0.8	4.4	2.1	
			Open	C		0.1	0.0	
44-8	4	1	Forest	C		0.4	0.1	2.5
			HDR	C	0.1	0.2	0.2	
			Highway	C	0.6		0.8	
			LDR	C	0.6	1.8	1.4	
			Open	C	0.0	0.3	0.1	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
45-1	22	6	Forest	A		0.8	0.1	11.4
			Forest	C		0.1	0.0	
			Forest	C/D		0.3	0.0	
			Highway	A	0.9		1.2	
			Highway	C	0.7		0.9	
			Highway	C/D	0.8		1.1	
			LDR	A	1.4	5.3	2.3	
			LDR	C	1.3	4.4	2.9	
			LDR	C/D	1.0	4.4	2.8	
			Open	A	0.0	0.2	0.0	
			Open	C		0.1	0.0	
			Open	C/D		0.3	0.1	
45-3	1	0	Forest	C		0.1	0.0	0.5
			Highway	C	0.1		0.1	
			LDR	C	0.2	0.4	0.3	
			Open	C		0.1	0.0	
45-4	3	0	Forest	C		0.2	0.0	1.3
			HDR	C	0.0	0.2	0.1	
			Highway	C	0.1		0.1	
			LDR	C	0.4	2.6	1.2	
			Open	C		0.0	0.0	
45-5	4	1	Forest	C		0.1	0.0	2.7
			HDR	C	0.1	0.6	0.5	
			Highway	C	0.5		0.7	
			LDR	C	0.7	2.1	1.5	
			Open	C		0.1	0.0	
45-6	1	0	Forest	C		0.2	0.0	0.5
			Highway	C	0.0		0.1	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			LDR	C	0.2	0.6	0.4	
			Open	C		0.0	0.0	
46-1	4	1	Forest	A		0.0	0.0	1.7
			Forest	C/D		0.8	0.1	
			Highway	A	0.2		0.2	
			Highway	C/D	0.2		0.3	
			LDR	A	0.2	0.5	0.3	
			LDR	C/D	0.3	1.2	0.9	
			Open	A	0.0	0.1	0.0	
			Open	C/D		0.0	0.0	
52-1	3	1	Forest	C		0.1	0.0	1.8
			Forest	C/D		0.1	0.0	
			Highway	C	0.4		0.5	
			Highway	C/D	0.1		0.2	
			LDR	C	0.4	1.7	0.9	
			LDR	C/D	0.1	0.2	0.2	
			Open	C		0.1	0.0	
			Open	C/D	0.0	0.1	0.0	
52-3	1	0	Forest	C		0.1	0.0	0.5
			Highway	C	0.1		0.2	
			LDR	C	0.1	0.4	0.3	
			Open	C	0.0	0.0	0.0	
52-4	14	4	Forest	B		0.0	0.0	7.5
			Forest	B/D		0.0	0.0	
			Forest	C		0.7	0.1	
			Forest			0.3	0.0	
			Highway	B	0.0		0.0	
			Highway	B/D	0.0		0.0	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			Highway	C	1.1		1.5	
			Highway		1.0		1.3	
			LDR	B		0.2	0.0	
			LDR	B/D	0.0	1.3	0.3	
			LDR	C	1.7	6.4	3.9	
			LDR			0.2	0.0	
			Open	B		0.0	0.0	
			Open	C	0.0	0.2	0.1	
			Open			0.8	0.2	
52-5	2	1	Forest	C		0.0	0.0	1.0
			Highway	C	0.2		0.3	
			LDR	C	0.3	0.9	0.7	
			Open	C		0.1	0.0	
53-1	6	2	Forest	B		1.0	0.1	3.1
			Forest	C		0.1	0.0	
			Highway	B	0.4		0.5	
			Highway	C	0.3		0.4	
			LDR	B	0.6	2.3	1.2	
			LDR	C	0.3	0.9	0.7	
			Open	B		0.2	0.0	
			Open	C		0.2	0.0	
53-9	5	2	Forest	C		0.3	0.0	3.0
			Highway	B	0.0		0.0	
			Highway	C	0.6		0.7	
			LDR	B	0.1	0.5	0.3	
			LDR	C	0.9	2.7	1.9	
			Open	B		0.0	0.0	
			Open	C		0.2	0.1	

Nutrient Load Calculations – Pillings Pond

Outfall ID	Catchment Area (acres)	Total Impervious Area (acres)	Land Use	Hydric Soil Group	Impervious Area (acres)	Pervious Area (acres)	TP Load (lbs P/year)	Total Outfall TP Load (lbs P/year)
			Water	C		0.0		
57-10	9	3	Forest	A		0.1	0.0	4.8
			Forest	B/D		0.2	0.0	
			Forest	C		0.1	0.0	
			Forest	C/D		0.0	0.0	
			Forest			0.7	0.1	
			Highway	A	0.1		0.2	
			Highway	C	0.4		0.5	
			Highway	C/D	0.0		0.0	
			Highway		0.9		1.2	
			Industrial	C		0.0	0.0	
			Industrial	C/D		0.0	0.0	
			LDR	A	0.3	1.4	0.5	
			LDR	B	0.0	0.1	0.1	
			LDR	B/D	0.0	0.0	0.0	
			LDR	C	0.3	1.2	0.6	
			LDR	C/D		0.0	0.0	
			LDR		0.6	2.7	1.5	
			Open	A	0.0	0.0	0.0	
			Open	C		0.0	0.0	
			Open			0.1	0.0	
Total	**394**	**96**						**195**

Appendix C

BMP Pollutant Reduction Estimate Summary Memo

BMP POLLUTANT REDUCTION CREDITS

To: Charles Richter, P.E., Town of Lynnfield DPW

From: Nick Shaw and Rebecca Balke, P.E., Comprehensive Environmental Inc.

Date: May 1, 2020

Subject: BMP Pollutant Reduction Estimate Summary

Under the Environmental Protection Agency's (EPA's) 2016 National Pollutant Discharge and Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit, regulated communities such as Lynnfield are required to annually inspect stormwater Best Management Practices (BMPs) within the regulated Urbanized Area (UA), estimate pollutant load reductions, and track total annual removals. The Town of Lynnfield DPW originally identified 18 different locations or sites with BMPs and provided detailed design plans for each site.

In response, Comprehensive Environmental Inc. (CEI) performed inspections of stormwater BMPs at the identified locations on June 19, 2019 and June 24, 2019. This was done to evaluate the general condition, to determine parameters for load estimations and to confirm BMP locations, types and sizes.

Inspections included 18 BMP sites/locations and 31 individual BMPs that varied in size, type and condition. The BMP sites are identified by a town-wide GIS grid numbering system and some sites had several different BMPs that were identified, inspected and evaluated.

Upon confirming size, type and the condition of the BMPs; CEI calculated phosphorus, nitrogen and total suspended solids removal efficiencies for each BMP using EPA's BMP Accounting and Tracking Tool (BATT). The BATT calculator requires two different categories of information in order to determine removal efficiencies: 1) subcatchment information, 2) BMP specific information.

Sub-catchment ID, project type, permit type, subcatchment size and land use areas are entered in model calculators under the subcatchment information category. CEI used GIS data including topography and drainage features to delineate subcatchments for each of the 31 BMPs. Land use areas and hydrologic soil groups were determined using GIS information within each of the subcatchments for each BMP. This information is used to develop pollutant loading to each BMP.

Under the BMP information category, the project ID, subsurface infiltration estimates (based on soils), BMP storage volumes, BMP type, BMP location, and BMP operation and maintenance data is entered into the calculator. Infiltration rates were calculated using the Rawl's (1982) rate correlation for Hydrologic Soil Groups. BMP dimensions were scaled from construction plans provided by the Town of Lynnfield in order to calculate storage volumes.

Once this information was entered into the BATT tool, removal efficiencies and load reductions on a pound per year basis for each BMP were calculated. **Table 1** below summarizes the total reduction credit among all BMPs for phosphorus, nitrogen and sediment for all the existing town-owned BMPs located within the Town of Lynnfield Urbanized Areas.

Table 1: Summary of Total Pollutant Load Reductions for All Town-owned Structural BMPs, Lynnfield, MA			
	Removed Phosphorus Load (lb/yr)	**Removed Nitrogen Load (lb/yr)**	**Removed Sediment Load (lb/yr)**
Structural	24	310	12,003
Non-Structural	0	0	0
Land Use Conversion	0	0	0
Total	24	310	12,003

Table 2 provides a summary of inputs for each of the analyzed BMPs with an estimated BMP efficiency and total annual pollutant load for each BMP. The electronic BATT file also stores this data and this file should be maintained by the Town of Lynnfield for any required future updates based on any changes in Town owned BMPs.

Table 2: Pollutant Load Reductions per Structural BMP, Lynnfield, Massachusetts												
BMP No.	Project ID	BMP Type	Subcatment Area (acres)	Impervious Area (acres)	% Impervious Area	BMP Storage Capacity (ft^3)/ Filter Depth (in.)	Phosphorus BMP Efficiency (%)	Nitrogen BMP Efficiency (%)	Sediment BMP Efficiency (%)	Removed Phosphorus Load (lb/yr)	Removed Nitrogen Load (lb/yr)	Removed Sediment Load (lb/yr)
1	DPW_DS_BMP_11-1 (MURPHY WAY NORTHERN BASIN)	EXTENDED DRY DETENTION POND	4.04	2.31	57%	24,000.00	14.0	23.1	49.0	0.54	8.5	547.5
2	DPW_DS_BMP_11-1 (MURPHY WAY SOUTHERN BASIN)	EXTENDED DRY DETENTION POND	7.49	2.31	31%	57,000.00	14.0	23.1	49.0	0.64	10.4	648.6
3	DPW_DS_BMP_16-1 (ROURKE LANE)	INFILTRATION TRENCH	15.7	4.2	27%	460.00	9.8	19.3	14.8	0.66	12.0	285.5
4	DPW_DS_BMP_32-1 (YORKSHIRE DRIVE)	EXTENDED DRY DETENTION POND	12.57	2.79	22%	90.00	0.3	0.1	1.6	0.01	0.1	20.7
5	DPW_DS_BMP_33-1 (MELODY LANE)	EXTENDED DRY DETENTION POND	10.99	3.29	30%	1,200.00	8.9	8.2	39.8	0.59	5.4	757.6
6	DPW_DS_BMP_33-2 (HIGH SCHOOL INFILTRATION SYSTEM)	INFILTRATION TRENCH	4.39	1.15	26%	1,400.00	47.4	81.0	72.8	1.02	14.8	333.0
7	DPW_DS_BMP_33-2 (HIGH SCHOOL POROUS PAVEMENT NEAR ENTRANCE)	POROUS PAVEMENT	3.42	1.89	55%	4,000.00	75.0	77.0	96.0	2.56	22.3	695.2
8	DPW_DS_BMP_33-2 (HIGH SCHOOL POROUS PAVEMENT NEAR SWALE)	POROUS PAVEMENT	2.1	0.92	44%	20,500.00	75.0	77.0	96.0	1.25	10.9	341.4
9	DPW_DS_BMP_33-2 (HIGH SCHOOL SWALE/DRY INFILTRATION BASIN)	INFILTRATION BASIN	1.05	0.1	10%	4,500.00	98.8	100.0	100.0	0.20	1.8	44.5
10	DPW_DS_BMP_37-1 (MIDDLE SCHOOL INFILTRATION TRENCH NEAR BASEBALL FIELD)	INFILTRATION TRENCH	2.617	1.741	67%	1,800.00	23.5	46.3	35.6	0.73	12.3	236.1
11	DPW_DS_BMP_37-1 (MIDDLE SCHOOL INFILTRATION TRENCH NEAR TENNIS COURT)	INFILTRATION TRENCH	3.781	2.412	64%	450.00	17.0	33.4	25.7	0.74	12.3	236.4
12	DPW_DS_BMP_37-1 (MIDDLE SCHOOL LEACHING CATCH BASINS)	INFILTRATION BASIN	1.976	1.318	67%	910.00	64.7	80.0	86.0	1.53	16.1	432.0
13	DPW_DS_BMP_37-2 (MIDDLE SCHOOL TRACK NORTHERN BASIN)	BIORETENTION	1.792	0.379	21%	5,600.00	63.0	40.0	100.0	0.39	1.9	256.3
14	DPW_DS_BMP_37-2 (MIDDLE SCHOOL TRACK SOUTHERN BASIN)	BIORETENTION	1.8	0.503	28%	2,700.00	63.0	40.0	100.0	0.51	2.4	336.0
15	DPW_DS_BMP_38-1 (SUMMER STREET SCHOOL)	INFILTRATION TRENCH	2.65	0.68	26%	70.00	1.9	6.0	3.4	0.03	1.0	14.0
16	DPW_DS_BMP_43-1 (ELIZABETH WAY)	EXTENDED DRY DETENTION POND	8.97	3.06	34%	51,000.00	14.0	23.1	49.0	0.82	13.3	831.3
17	DPW_DS_BMP_52-1 (HUCKLEBERRY SCHOOL DETENTION TANK)	EXTENDED DRY DETENTION POND	3.12	2.23	71%	10,000.00	12.5	15.6	46.5	0.51	5.4	403.3
18	DPW_DS_BMP_52-1 (HUCKLEBERRY SCHOOL GALLEYS)	INFILTRATION TRENCH	2.45	2.23	91%	2,900.00	62.3	86.9	85.5	2.49	29.4	724.9
19	DPW_DS_BMP_55-1 (THISTLE LANE)	INFILTRATION BASIN	2.72	1.2	44%	230.00	19.7	29.1	33.7	0.40	5.4	192.7
20	DPW_DS_BMP_62-1 (SENIOR CENTER EASTERN BASIN)	INFILTRATION BASIN	1.39	0.76	55%	75.00	11.1	16.0	18.2	0.16	2.0	55.6
21	DPW_DS_BMP_62-1 (SENIOR CENTER SOUTHERN BASIN)	INFILTRATION BASIN	1.57	0.62	39%	75.00	13.7	19.7	22.3	0.17	2.1	58.5
22	DPW_DS_BMP_62-1 (SENIOR CENTER WESTERN BASIN)	INFILTRATION BASIN	0.48	0.23	48%	75.00	36.8	53.0	60.2	0.16	2.0	56.7
23	DPW_DS_BMP_63-1 (FALL WAY)	INFILTRATION TRENCH	17.54	4.68	27%	1,500.00	15.6	48.5	27.7	1.85	54.9	894.1
24	DPW_DS_BMP_63-2 (NEWHALL PARK INFILTRATION SYSTEM)	INFILTRATION TRENCH	7.47	2.42	32%	1,600.00	30.2	69.0	51.5	1.55	29.5	1007.7
25	DPW_DS_BMP_63-2 (NEWHALL PARK VORSENTRY UNIT)	EXTENDED DRY DETENTION POND	0.68	0.17	25%	90.00	4.4	2.1	24.0	0.02	0.1	35.7
26	DPW_DS_BMP_67-1 (HORSESHOE DRIVE)	WET POND/CREATED WETLAND	5.67	2.59	46%	160,000.00	63.0	40.0	86.0	2.71	16.0	1055.7
27	DPW_DS_BMP_69-1 (LYNNBROOK ROAD)	EXTENDED DRY DETENTION POND	10.19	3.02	30%	91,000.00	14.0	23.1	49.0	0.76	11.8	753.0
28	DPW_DS_BMP_72-1 (BLUE JAY ROAD)	EXTENDED DRY DETENTION POND	34.69	20.3	59%	530.00	0.2	0.1	1.3	0.07	0.3	120.8
29	DPW_DS_BMP_72-2 (GIANNA DRIVE EASTERN SWALE)	GRASS SWALE (CONVEYANCE)	1.82	0.36	20%	11,600.00	36.0	23.1	90.0	0.26	1.3	249.1
30	DPW_DS_BMP_72-2 (GIANNA DRIVE WESTERN SWALE)	GRASS SWALE (CONVEYANCE)	0.72	0.28	39%	19,300.00	36.0	23.1	90.0	0.17	1.0	122.3
31	DPW_DS_BMP_72-3 (MANSFIELD ROAD)	WET POND/CREATED WETLAND	1.40	0.63	45%	36,000.00	63.0	40.0	86.0	0.66	3.9	257.3
									TOTAL:	24.18	310.27	12003.43

Appendix D

Municipal Property Retrofit Memo

MUNICIPAL PROPERTY BMP RETROFITS

To:	Patrick McAlpine, Town Engineer
From:	Nicole Haggerty, EIT & Rebecca Balke, P.E., Comprehensive Environmental Inc.
Date:	June 30, 2022
Subject:	Municipal Property BMP Retrofits

Permit Requirements and Project Background

Under the Environmental Protection Agency's (EPA's) 2016 National Pollutant Discharge and Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit, as amended (Permit), the Town of Lynnfield is required to identify a minimum of five town-owned properties and infrastructure that could potentially be modified or retrofitted with stormwater Best Management Practices (BMPs) designed to reduce the frequency, volume and pollutant loads of stormwater discharges to its MS4 through the mitigation of impervious area. At a minimum, Lynnfield must consider municipal property with significant impervious area that could be mitigated, existing street right-of-ways, outfalls and conventional stormwater conveyances and controls that could be readily modified or retrofitted.

The potential for retrofitting particular properties must consider factors such as maintenance access; subsurface geology; depth to water table; proximity to aquifers and subsurface infrastructure including sanitary sewers and septic systems; and opportunities for public use and education. Sites must be priority ranked based on factors such as schedules for planned capital improvements to storm and sanitary sewer infrastructure and paving projects as available; current storm sewer level of service (if known); and control of discharges to impaired or critical receiving waters, first or second order streams, public swimming beaches, drinking water supply sources and shellfish growing areas.

Lynnfield must maintain a minimum of five sites for retrofits within its inventory, until such time as when it has less than five sites remaining for improvements. Beginning with the fifth year MS4 annual report and in each subsequent annual report, Lynnfield must report on those permittee-owned properties and infrastructure inventoried that have been retrofitted with BMPs to mitigate impervious area and associated water quality impacts.

This memorandum outlines activities completed by Comprehensive Environmental Inc. (CEI) to assist the Town of Lynnfield with meeting the above Permit requirements, with a focus on potential retrofit opportunities on developed municipal parcels. Analysis of infrastructure, open space, and undeveloped land available to mitigate stormwater runoff from nearby areas will be evaluated under a future effort.

Municipal Parcel Retrofits

Desktop and Field Analysis

Twenty-four Town-owned facilities were identified within the MS4 regulated area. These parcels were advanced for additional desktop and field analysis as outlined further in the next section. CEI first developed a series of parcel maps for each facility to be used for recording existing conditions and field notes. Parcel maps typically showed an aerial view of each facility, along with property lines, topography data, available drainage information, and other relevant information. Nicole Haggerty, EIT of CEI conducted field assessments of all 24 facilities in spring 2022. The goal was to evaluate opportunities to reduce pollutant loads discharging to the MS4 or surface water bodies from the site through reduction or treatment of stormwater runoff from impervious surfaces.

A map of all 24 facilities is provided as **Figure 1** at the end of this memorandum. A summary of the existing conditions for each site is included as **Table 1**, with proposed retrofit conditions provided as **Table 2** at the end of this memorandum.

Proposed BMP Selection

Proposed conceptual BMPs have been selected based largely on available space, soil types within the area, and proximity to wetland areas. For planning, pollutant removal, and cost estimating purposes, locations with larger areas available for implementation were assigned BMPs with larger footprints such as infiltration basins, extended detention basins, or constructed wetlands, whereas smaller areas were assigned smaller BMPs such as rain gardens, trenches, or swales. Implementation areas with soils classified primarily as HSG C or D were assigned non-infiltrating BMP types such as extended detention basins. Areas located in close proximity to wetlands are assumed to have relatively high groundwater, and thus were assigned BMP types such as constructed wetlands.

For the purposes of this initial screening effort, BMP selection focused on surface BMPs that could be installed in existing available spaces with little disturbance to existing paved surfaces, as a typical surface BMP is less expensive on a pounds of pollutant removed than a subsurface system installed below a parking lot or ball field. More expensive underground infiltration BMPs (e.g., subsurface infiltration) will be considered for proposed redevelopment projects where demolition, reconstruction and/or repaving are proposed to minimize the costs of installation. The use of subsurface infiltration BMPs would significantly increase treatment costs, as they can cost up to 4-10 times more than surface BMPs. Other BMPs that disturb pavement, including leaching catch basins and porous pavement will also be evaluated during redevelopment projects. Actual BMP types and sizes are expected to be refined as part of future designs and in consideration of the cost benefit (e.g., cost per pound of removal).

BMP Unit Costs

Costs for BMP design and construction were estimated based on a memorandum from EPA titled "Methodology for developing cost estimates for Opti-Tool" (**Attachment A**). This memorandum built on multiple previous studies dating as far back as 2010 to estimate total implementation costs for multiple types of stormwater BMPs on a dollars per cubic foot of constructed volume in 2016 dollars, and assumed that 35% of the construction cost would go towards engineering design and other contingencies. For the purposes of this memorandum, 2016 dollars were then converted to 2022 dollars by adding 18% to the total cost in order to account for inflation over the preceding six years.

Additionally, the Opti-Tool memorandum notes that cost adjustment factors may be incorporated to more accurately account for BMP site constraints associated with installation in urban environments as follows:

- Undeveloped areas: 1.0;
- Partially developed areas: 1.5;
- Developed areas: 2.0; and
- Highly urban setting: 3.0.

Based on current development conditions, a cost adjustment factor of 1.5 was applied to all potential BMPs. A summary of costing data is provided in **Table 3** at the end of this memorandum.

Actual engineering costs depend on many factors, and engineering for larger projects generally consist of a lower total percent of the construction cost, with the inverse being true for smaller projects (e.g., a $250,000 construction project may have a $50,000 engineering cost or 20% of construction, whereas a $50,000 construction project may have a $25,000 engineering cost or 50% of construction). Costs outlined in this memorandum are for guidance and comparison purposes only. Future design phases will further refine costs associated with all BMPs.

Prioritization

Facilities were prioritized into groups, or tiers, of sites based on the ability to locate a BMP, the location with respect to an impaired watershed, and public education value, as follows:

- **Tier 1** – sites with good BMP implementation opportunities;
- **Tier 2** – sites with good to fair BMP implementation opportunities that do not meet Tier 1 standards;
- **Tier 3** – sites with existing BMP(s) that require further investigation to determine drainage connections and potential to retrofit additional existing structures;
- **Tier 4** – sites where opportunities are limited to replacing pavement with porous pavement and/or replacing catch basins with leaching catch basins (LCBs) and/or installing subsurface systems – best coordinated with repaving; and,
- **N/A** – sites with no opportunities for improvements and/or no WQ benefits.

Tier 1 sites represent the top locations for recommended BMP implementation. Pre-conceptual designs for the top five sites have been prepared and are included as **Attachment B**.

Conclusions

Most of Lynnfield's municipal sites have small impervious areas, with many discharging stormwater onto adjacent pervious surfaces, where some existing treatment is provided. Those with the largest impervious areas already have existing stormwater treatment BMPs. This provided limited opportunities for municipal retrofits with large phosphorus reduction impacts.

Based on calculations from the BATT calculator, implementation of all five stormwater BMPs at the five Tier 1 facilities will remove a total of 3.62 pounds of phosphorus for a total engineering and construction cost of approximately $260,600 at an average cost of $72,000 per pound of phosphorus removed.

Recommendations and Next Steps

It is recommended that the Town first move forward with further evaluation and design of BMPs at the Tier 1 facilities outlined in **Table 4** below. As noted above, these locations were identified as higher priority as they have good opportunities for retrofit, discharge to waterbodies, or their tributaries, with a phosphorus impairment, and have good public education opportunities.

Table 4 – Tier 1 Priority BMPs

Location		Proposed BMP(s)		Estimated Costs	TP Reduction	
Facility Name	**Address**	**Type**	**Estimated Size**	**Construction & Engineering**	**Lbs / Year**	**Dollars / Pound**
Lynnfield Common	Main Street	Forebay	15’ x 30’ x 2’ deep	$69,500	1.74	$39,900
		Infiltration basin	60’ x 30’ x 3’ deep			
Rotary Park	Summer Street- Lot 176	2 Forebays	10’ x 15’ x 1’ deep	$82,100	0.34	$241,500
		2 Rain gardens	45’ x 15’ x 2’ deep			
Willow Cemetery	Summer Street	2 Rain gardens	30’ x 20’ x 2’ deep	$65,600	0.32	$205,000
Fire Department and Post Office	Salem and Summer Streets	Forebay	10’ x 20’ x 1’ deep	$18,800	1.11	$16,900
		Infiltration basin	30’ x 25’ x 2’ deep			
Glen Meadow Park	Trickett Road	Rain garden	30’ x 15’ x 2’ deep	$24,600	0.11	$223,600

The Town should also consider investigating, and implementing where feasible, water quality treatment BMPs as part of drainage improvements during roadway improvement projects. These projects also provide an opportunity to incorporate water quality BMPs, however, such opportunities are often restricted to areas located within, or immediately adjacent to, the roadway. Example roadway intersection improvements for Lynnfield’s consideration are provided in **Attachment C**, however, other alternative designs may also be considered depending on site-specific conditions. Implementation of such BMPs requires evaluation on a case-by-case basis in consideration of the size of the right-of-way (ROW), soil type, surrounding drainage infrastructure and location of other utilities. The cost and amount of phosphorus removed from these systems will vary based on the size of the BMP and contributing drainage area.

If you have any further questions or would like additional information, please feel free to contact me at 800.725.2550 x308 or rbalke@ceiengineers.com. Thank you.

Attachments:

- Table 1: Summary of Existing Conditions
- Table 2: Proposed Improvements
- Table 3: BMP Costing Information
- Figure 1: Municipal Properties Visited
- Attachment A: Memorandum report on Methodology for developing cost estimates for Opti-Tool; February 20, 2016
- Attachment B: Pre-Conceptual Designs for Top Five Locations
- Attachment C: Example Roadway and Intersection BMP Improvements

Table 1- Summary of Existing Conditions

Location Description	Address	Facility ID	Tier	Parcel Area		Existing Conditions Description	Existing BMPs	TMDL or Impaired Waterbody Watershed	Direct or Near-Direct Discharge	Soils[1]		
				Total (acres)	Impervious (acres)					Soil Type	Hydric Soil Group	Soil Area (acres)
Lynnfield Common	Main St	P5	1	1.1	0.1	Almost entirely pervious parcel with a walkway, trees, and memorials. Existing drainage networks on surrounding streets (Main Street, South Commons Street, Summer Street) outfall south of parcel into wooded area.	N/A	Saugus River	No	Merrimac-Urban land complex, 0 to 8 percent slopes	A	1.10
Rotary Park	Summer St-Lot 176	P7	1	0.2	0.0	Small park with benches, walkway, and memorials. Two existing outfalls on northern side of parcel from existing drainage structures on Summer Street. Outfall and connected catch basin on eastern side of parcel completely submerged/ full of water. Outfall on western side of parcel has pipe end in poor condition (RCP, cracking, falling apart into lake). Stormwater pools between parking spaces and street.	N/A	Saugus River	Yes	Paxton-Urban land complex, 3 to 15 percent slopes	C	0.24
										Water		0.00
Willow Cemetery	Summer St	C2	1	5.6	1.4	Runoff from cemetery roads flows east down sloped parcel toward Summer Street. Little is captured by the 1 existing catch basin, it was buried with a couple inches of mud at the time of inspection, runoff mostly sheet flows into grass patches which are eroding. Limited structures in front of parcel on Summer St.	N/A	Saugus River	No	Merrimac fine sandy loam, 3 to 8 percent slopes	A	5.08
										Merrimac-Urban land complex, 0 to 8 percent slopes	A	0.00
										Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	0.49
										Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	0.01
Fire Department and Post Office	Salem & Summer Sts	FD2	1	1.1	0.8	Mostly pervious parcel with small grassed yard. One existing catch basin in grassed area between walkways. Existing drainage network on Salem Street, connections unknown.	N/A	Saugus River	No	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	B	0.35
										Urban land		0.73
Glen Meadow Park	Trickett Rd	P2	1	5.6	0.2	Park with playground, baseball field, basketball courts, and small parking area. Pavement in somewhat poor condition, cracking. Runoff from parking area/ driveway is partially captured by 2 existing catch basins and partially pools in other low spots of lot. Runoff from field and playground captured by 2 existing catch basins.	N/A	Saugus River	No	Paxton-Urban land complex, 3 to 15 percent slopes	C	0.05
										Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	5.59
Freeman Park	Main St	P6	2	0.5	0.0	Small park with rocks and trees, next to wooded wetlands area. Runoff from Main Street captured in existing catch basin across the street from parcel.	N/A	Saugus River	No	Freetown muck, 0 to 1 percent slopes	B/D	0.51
Reedy Meadow Golf Course	165 Summer St	G1	2	116	0.5	Gravel parking area, no existing drainage structures. Runoff conveyed through existing network of grassed ditches and driveway culverts.	N/A	Saugus River	No	Freetown muck, 0 to 1 percent slopes	B/D	77.26
										Merrimac fine sandy loam, 3 to 8 percent slopes	A	5.37
										Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	3.19
										Paxton fine sandy loam, 3 to 8 percent slopes	C	9.67
										Pits, gravel		0.59
										Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	19.92
Summer Street Elementary School & Lynnfield Preschool	262 Summer St	S2, S4	3	9.5	3.3	Active construction at time of inspection, silt sacks in catch basins. Existing catch basins likely capture runoff from parcel and direct flows to existing BMP.	Underground infiltration system	Saugus River	No	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	1.38
										Udorthents, smoothed		4.87
										Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	3.21
Lynnfield Middle School	505 Main St	S5	3	26.9	6.2	Runoff from parcel captured by existing drainage structures and treated by existing BMPs. 3 catch basins in front of parcel on Main Street.	Underground infiltration system, 2 detention basins	Saugus River	No	Freetown muck, 0 to 1 percent slopes	B/D	3.11
										Merrimac-Urban land complex, 0 to 8 percent slopes	A	5.37
										Paxton fine sandy loam, 3 to 8 percent slopes	C	0.86
										Udorthents, smoothed		17.56
Huckleberry Hill Elementary School	5 Knoll Rd	S3	3	11.1	3.4	Runoff is captured by existing drainage structures and treated by existing underground BMP. Existing drainage connections need further investigation when construction is complete, silt sacks were in catch basins at time of field investigation. Pavement in poor condition.	Underground detention system	Saugus River	No	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	B	3.77
										Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	2.15
										Paxton-Urban land complex, 3 to 15 percent slopes	C	0.50
										Swansea muck, 0 to 1 percent slopes	B/D	0.09
										Udorthents, smoothed		4.55
Public Parking	Broadway	PL1	4	0.1	0.1	Entirely impervious parcel, no open space.	N/A	Saugus River	No	Merrimac-Urban land complex, 0 to 8 percent slopes	A	0.09
Forest Hill Cemetery	Forest Hill Ave	C1	4	9.7	2.1	Mostly pervious area. Limited existing drainage structures discharge to nearby wetlands area. Remainder of runoff appears to sheet flow to wetlands area as well. No open space for BMP construction.	N/A	Saugus River	No	Freetown muck, 0 to 1 percent slopes	B/D	0.21
										Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	9.52
Lynnfield Library	18 Summer St	L1	4	0.5	0.4	Almost entirely impervious parcel. Runoff is captured by existing catch basins in recently paved parking lot.	N/A	Saugus River	No	Merrimac-Urban land complex, 0 to 8 percent slopes	A	0.49
Lynnfield Fire Department, Police Department, Town Hall, & DPW	55 Summer St	D1, FD1, PD1, T1	4	3.5	2.5	Almost entirely impervious parcel, no open space. Runoff captured by existing catch basins in parking areas.	N/A	Saugus River	No	Merrimac-Urban land complex, 0 to 8 percent slopes	A	1.46
										Paxton fine sandy loam, 3 to 8 percent slopes	C	0.01
										Udorthents, smoothed		2.02
West Burying Ground	Main St	C4	N/A	0.4	0.0	Small cemetery, no open space. No existing drainage structures.	N/A	Saugus River	No	Freetown muck, 0 to 1 percent slopes	B/D	0.07
										Merrimac-Urban land complex, 0 to 8 percent slopes	A	0.34
Old Burying Ground	Main St	C3	N/A	1.0	0.0	Small cemetery, no open space. No existing drainage structures.	N/A	Saugus River	No	Merrimac-Urban land complex, 0 to 8 percent slopes	A	1.03
Lynnfield High School	235 Essex St	S6	N/A	36.4	19.2	Existing drainage network captures and treats runoff with multiple BMPs.	Underground infiltration systems (2), detention basin, porous pavement	Saugus River	No	Freetown muck, 0 to 1 percent slopes	B/D	2.01
										Hinckley gravelly fine sandy loam, 3 to 8 percent slopes	A	3.76
										Hinckley loamy sand, 8 to 15 percent slopes	A	2.74
										Swansea muck, 0 to 1 percent slopes	B/D	1.22
										Udorthents, smoothed		23.93
										Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	2.72
Jordan Park/ Wildewood Park	Pillings Pond Rd	P1	N/A	7.0	0.1	Newly redone park with children's playground, gravel parking spots (only pavement is driveways and handicap spots), and grassed fields. Existing catch basins and many drainage manholes, potentially an existing infiltration system? Catch basins potentially leaching structures, full of water at time of inspection and no pipes seen. Limited space for additional development.	N/A	Saugus River	No	Merrimac fine sandy loam, 3 to 8 percent slopes	A	4.04
										Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	2.92

Location Description	Address	Facility ID	Tier	Parcel Area		Existing Conditions Description	Existing BMPs	TMDL or Impaired Waterbody Watershed	Direct or Near-Direct Discharge	Soils[1]		
				Total (acres)	Impervious (acres)					Soil Type	Hydric Soil Group	Soil Area (acres)
King Rail Golf Course	397 Walnut St	G2	N/A	86.4	0.0	Almost entirely pervious area. Golf course with gravel driveway and parking spots. No existing drainage nearby.	N/A	Saugus River	Yes	Canton fine sandy loam, 0 to 8 percent slopes, very stony	B	0.10
										Canton fine sandy loam, 8 to 15 percent slopes, very stony	B	4.07
										Freetown muck, 0 to 1 percent slopes	B/D	14.79
										Freetown muck, ponded, 0 to 1 percent slopes	B/D	13.41
										Paxton-Urban land complex, 3 to 15 percent slopes	C	0.44
Newhall Memorial Park	7 Oak St	P3	N/A	3.9	0.7	Park with small parking lot, baseball fields, and tennis courts. Runoff from parking lot captured and treated by existing drainage structures and underground infiltration system.	Underground infiltration system	Ipswich River	Yes	Merrimac-Urban land complex, 0 to 8 percent slopes	A	0.67
										Urban land		3.27
										Water		0.00
Market Street Mall	427 Walnut St	T2	N/A	62.2	40.6	Large parcel, location of big new shopping mall. Drainage discharges to existing ponds next to Walnut Street.	Detention pond(s)	Saugus River	No	Deerfield loamy fine sand, 0 to 3 percent slopes	A	2.12
										Hollis-Urban land-Rock outcrop complex, sloping		1.00
										Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	16.13
										Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	22.60
										Water		0.05
										Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	20.25
Lynnfield Public Schools and Senior Center	525 Salem St	S1	N/A	4.6	2.0	Runoff is captured by existing leaching basins and treated by existing underground infiltration system. No drainage structures in front of parcel on Salem Street.	Underground infiltration system	Saugus River	No	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	B	4.61
South Burying Ground	Salem St	C5	N/A	0.6	0.0	Small cemetery, no open space. No nearby drainage structures on Salem St.	N/A	Boston Harbor	No	Merrimac-Urban land complex, 0 to 8 percent slopes	A	0.42
										Paxton-Urban land complex, 3 to 15 percent slopes	C	0.22
Bow Ridge/ Skull Cliff Park	385 Rear Broadway	P4	N/A	10.9	0.1	Large wooded area with water tower, steeply sloped uphill. Nearby Lynnfield Commons is private community.	N/A	Saugus River	No	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	D	10.93

1. All soils data obtained from GIS sources.

Table 2- Proposed Improvements

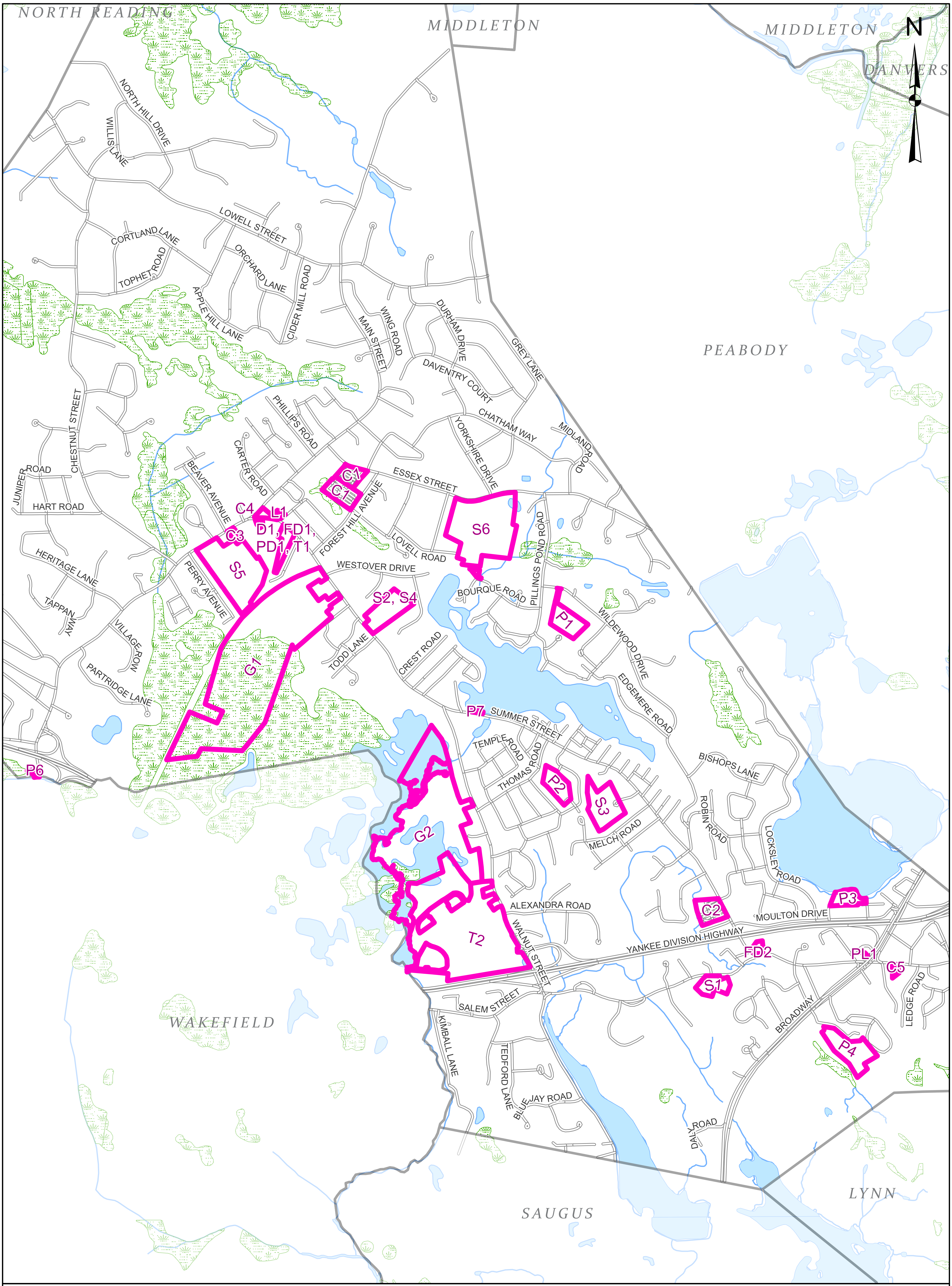
					Treatment Area[1]		Pollutant Loading[2]			Proposed BMP(s)		Pollutant Reduction Estimates[3]			BMP Implementation Costs[4,5]				Dollars per Pound of Removal		
Location Description	**Address**	**Facility ID**	**Tier**	**Conclusions and BMP Opportunities**	**Total (acres)**	**Impervious (Acres)**	**Impervious Area TP Load (lbs/yr)**	**Impervious Area TN Load (lbs/yr)**	**Impervious Area TSS Load (lbs/yr)**	**Proposed BMP(s)**	**Estimated Size**	**TP Reduction (lbs/yr)**	**TN Reduction (lbs/yr)**	**TSS Reduction (lbs/yr)**	**Unit Construction Cost per CF or LF**	**Estimated Construction Costs**	**Estimated Engineering Costs**	**Total BMP Cost (Design & Construction)**	**TP Reduction ($$/lb)**	**TN Reduction ($$/lb)**	**TSS Reduction ($$/lb)**
Lynnfield Common	Main St	P5	1	Construct BMP in open space next to South Common Street. Redirect existing drainage structures on South Common Street.	2.10	1.31	1.76	13.32	1938.97	Forebay Infiltration basin	15' x 30' x 2'deep 60' x 30' x 3'deep	1.74	13.32	1938.97	$8.18	$51,500	$18,000	$69,500	$39,900	$5,200	$40
Rotary Park	Summer St-Lot 176	P7	1	Construct small BMPs in open grassed spaces on each side of parcel (may need to remove some small trees). Redirect existing drainage structures on Summer Street.	0.60	0.41	0.55	4.17	606.85	2 Forebays 2 Rain gardens	10' x 15' x 1'deep 45' x 15' x 2'deep	0.34	1.62	606.85	$20.27	$60,800	$21,300	$82,100	$241,500	$50,700	$140
Willow Cemetery	Summer St	C2	1	Construct small BMPs in grassed areas near the cemetery entrance and provide rip rap inlet pads to direct flows into BMPs and minimize erosion to the grassed areas.	2.81	0.40	0.54	4.07	592.05	2 Rain gardens	30' x 20' x 2'deep	0.32	1.54	592.05	$20.27	$48,600	$17,000	$65,600	$205,000	$42,600	$110
Fire Department and Post Office	Salem & Summer Sts	FD2	1	Construct BMP in grassed area in front of Post Office and extend existing roof drains from fire department and post office to direct flows to proposed BMP. Investigate existing drainage connections on Salem Street to determine the potential to bring flows into BMP and to connect proposed overflow structure to existing manhole.	1.05	0.86	1.15	8.75	1272.91	Forebay Infiltration basin	10' x 20' x 1'deep 30' x 25' x 2'deep	1.11	8.71	1272.91	$8.18	$13,900	$4,900	$18,800	$16,900	$2,200	$10
Glen Meadow Park	Trickett Rd	P2	1	Construct BMP in grassed/wooded area on east side of parcel, will have to remove some trees. Regrade parking lot and/or install additional catch basins to capture runoff that pools in other low spots and direct flows to proposed BMP.	0.62	0.13	0.17	1.32	192.42	Rain garden	30' x 15' x 2'deep	0.11	0.52	192.42	$20.27	$18,200	$6,400	$24,600	$223,600	$47,300	$130
Freeman Park	Main St	P6	2	Potential to construct small BMP, likely minimal benefit as drainage already discharges to wooded wetland area.	0.21	0.13	0.17	1.32	192.42	Rain garden	30' x 15' x 2'deep	0.11	0.52	192.42	$20.27	$18,200	$6,400	$24,600	$223,600	$47,300	$130
Reedy Meadow Golf Course	165 Summer St	G1	2	Potential to improve existing grassed ditches as water quality swales, especially at outfall location of drainage from Summer Street. However, ditches discharge into wetlands area behind golf course anyways, so likely minimal benefit.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summer Street Elementary School & Lynnfield Preschool	262 Summer St	S2, S4	3	When construction is complete, investigate drainage connections to existing BMP to confirm all parcel runoff is being treated.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lynnfield Middle School	505 Main St	S5	3	Investigate drainage connections to existing BMPs to confirm all parcel runoff is being treated. Investigate potential to retrofit drainage from Main Street.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Huckleberry Hill Elementary School	5 Knoll Rd	S3	3	When construction is complete, investigate drainage connections to existing BMP to confirm all parcel runoff is being treated. Investigate potential to retrofit drainage from Knoll Road.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Public Parking	Broadway	PL1	4	Limited opportunities other than LCBs or subsurface treatment systems.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Forest Hill Cemetery	Forest Hill Ave	C1	4	Limited opportunities other than LCBs or subsurface treatment systems.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lynnfield Library	18 Summer St	L1	4	Limited opportunities other than LCBs or subsurface treatment systems.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lynnfield Fire Department, Police Department, Town Hall, & DPW	55 Summer St	D1, FD1, PD1, T1	4	Limited opportunities other than LCBs or subsurface treatment systems.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
West Burying Ground	Main St	C4	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Old Burying Ground	Main St	C3	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lynnfield High School	235 Essex St	S6	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jordan Park/ Wildewood Park	Pillings Pond Rd	P1	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
King Rail Golf Course	397 Walnut St	G2	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Newhall Memorial Park	7 Oak St	P3	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Market Street Mall	427 Walnut St	T2	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lynnfield Public Schools and Senior Center	525 Salem St	S1	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
South Burying Ground	Salem St	C5	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bow Ridge/ Skull Cliff Park	385 Rear Broadway	P4	N/A	No opportunities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
											Totals	**3.73**	**26.23**	**4796**	**---**	**$211,200**	**$74,000**	**$285,200**	**$76,500**	**$10,900**	**$60**

1. Treatment areas may often consist of areas outside of the parcel area.
2. Pollutant loading calculated for impervious areas only using the land use loading rates provided in the BATT calculator for "Highway". Rates are as follows, in pounds per acre per year: 1.34 pounds of Total Phosphorus; 10.17 pounds of Total Nitrogen; 1,480.13 pounds of Total Suspended Solids.
3. Pollutant reduction estimates calculated through EPA's BATT calculator.
4. Information on BMP costing is attached as Attachment A.
5. BMP implementation cost estimates include cost of proposed forebays and proposed BMPs.

Table 3 - BMP Costing Information

Stormwater BMP Type	Unit	OptiTool BMP Estimates, 2016[1,2]	OptiTool BMP Estimates, 2022[3]	Adjusted BMP Estimate, 2022[4]	Adjusted Construction Estimate[4]	Engineering/ Contingency Estimate[5]
Biorentention / Rain Garden	per CF	$15.46	$18.24	$27.36	$20.27	$7.09
Constructed Wetlands	per CF	$6.80	$8.02	$12.04	$8.92	$3.12
Dry Detention Basin	per CF	$6.80	$8.02	$12.04	$8.92	$3.12
Gravel Wetland	per CF	$8.78	$10.36	$15.54	$11.51	$4.03
Infiltration Basin	per CF	$6.24	$7.36	$11.04	$8.18	$2.86
Infiltration Trench	per CF	$12.49	$14.74	$22.11	$16.38	$5.73
Porous Pavement	per CF	$5.32	$6.28	$9.42	$6.98	$2.44
Sand Filter	per CF	$17.94	$21.17	$31.75	$23.52	$8.23
Wet Detention Basin	per CF	$6.80	$8.02	$12.04	$8.92	$3.12
Subsurface Infiltration/Detention System (aka Infiltration Chamber)	per CF	$67.85	$80.06	$120.09	$88.96	$31.14

1. Memorandum on Methodology for developing cost estimates for Opti-Tool is provided as Attachment A.
2. Total includes cost of construction, engineering, and contingencies.
3. 2022 Estimate assumes a 18% markup from 2016 Estimate due to inflation.
4. Adjustment factor of 1.5 is applied to account for construction in developed areas.
5. Engineering/Contingency Estimate is 35% of the Construction Estimate.



▭ Municipal Properties

🟦 Lake, Pond, Reservoir

▨ Wetland, Marsh, Swamp

〰 Stream, Brook

BMP Retrofit Site Inspection Map Lynnfield, MA

Parcel ID:

Comprehensive
Environmental
Incorporated

4/25/2022

Attachment A:

BMP costing table and memorandum report on
Methodology for developing cost estimates for Opti-Tool;
February 20, 2016

MEMORANDUM

DATE: February 20, 2016

TO: Opti-Tool TAC

FROM: Karen Mateleska, EPA Region- I

SUBJECT: **Methodology for developing cost estimates for Opti-Tool**

Introduction

EPA – Region I offered to provide TetraTech with BMP cost information for the New England Stormwater Management Optimization Tool (Opti-Tool). The goal was to include the latest available information that would accurately reflect capital costs for select BMPs installed in the New England region. This document describes the approach used to determine these values.

The unit cost estimates originally developed as part of a 2010 study were used as the basis/starting-point for the cost estimates for the Opti-Tool. This study, entitled *Stormwater Management Plan for Spruce Pond Brook Subwatershed,* was produced by the Charles River Watershed Association (CRWA). The full report can be viewed at: http://www.crwa.org/hs-fs/hub/311892/file-636820515-pdf/Our_Work_/Blue_Cities_Initiative/Scientific_and_Technical/CRWA_Franklin_Plan.pdf. This subwatershed in the Town of Franklin (in eastern Massachusetts) was selected, in part, because it represented one of the many communities in the watershed that would be required to reduce nutrient (phosphorus) loads in stormwater runoff as part of EPA's Phase II MS4 General Stormwater Permit and a TMDL for Nutrients in the Upper/Middle Charles River. The cost estimates developed in the study can predominantly be attributed to CRWA and both Rich Claytor and Nigel Pickering of Horsley Witten Group (CRWA *et al.* 2010). The development of these costs was based on a literature review of BMP cost information and Claytor's extensive experience working in this field with Massachusetts communities. These values were originally reported in Appendix B of the aforementioned CRWA document. Those cost estimates have also been used in additional stormwater studies supported by EPA – Region I, including the *Sustainable Stormwater Funding Evaluation for the Upper Charles River Communities of Bellingham, Franklin, and Milford, MA (*2011). (That report can be viewed at: http://www.epa.gov/region1/npdes/charlesriver/pdfs/20110930-SWUtilityReport.pdf)

Before simply relying on the CRWA cost estimates, additional research was conducted of publicly available (online) resources to determine if more recent BMP cost information for the New England region was available. These resources included:

- EPA's LID webpage: http://water.epa.gov/polwaste/green/
- EPA's 2013 Article: *Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs: http://water.epa.gov/polwaste/green/upload/lid-gi-programs_report_8-6-13_combined.pdf*

- New England Environmental Finance Center: http://efc.muskie.usm.maine.edu/
- UNC Environmental Finance Center's *Catalog of Finance Publications on Green Infrastructure Approaches to Stormwater Management* (This spreadsheet provides a catalog of 46 publications related on green infrastructure for stormwater management that have finance relevance; Several of the sources from the catalog were reviewed for this document) : http://www.efc.sog.unc.edu/reslib/item/catalog-green-infrastructure-and-stormwater-finance-publications
- Houle, *et al. Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management*: http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/Houle_JEE_July-2013.pdf
- University of New Hampshire Stormwater Center's *Forging the Link: Linking the Economic Benefits of LID and Community Decisions: http://www.unh.edu/unhsc/forging-link-topics*
- Center for Neighborhood Technology's *Green Values Stormwater Tool Box: http://greenvalues.cnt.org/* which included the Green Values Calculator: http://greenvalues.cnt.org/national/calculator.php
- Water Environment Research Foundation (WERF): User's Guide to the BMP and LID Whole Life Cost Models, Version 2.0: www.werf.org/bmpcost
- Low Impact Development Center: http://www.lowimpactdevelopment.org/
- ECONorthwest's *The Economics of Low-Impact Development: A Literature Review:* http://www.econw.com/our-work/publications/the-economics-of-low-impact-development-a-literature-review/
- Drexel University's Low Impact Development Rapid Assessment (LIDRA Model) http://www.lidratool.org/home/publications.aspx

A review of these resources did highlight the multitude of variables that can impact the cost of installing LID BMPs and the variety of cost analysis methods that can be used when assessing the cost effectiveness of various LID storm water controls. For example, many of the resources emphasized that costs tend to be site specific. Costs often differ significantly among different geographical locations, depending upon labor and material expenses and the constraints of a particular site. Unfortunately, most of the aforementioned resources highlighted projects outside of the New England region (with the exception of the articles by Houle of the UNHSC and New England Environmental Finance Center.)

EPA's recent (2013) report entitled *Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs* listed the 7 different types of economic analyses that were represented by the 13 case studies highlighted in the report. These ranged from the simplest form of economic analysis (i.e., the capital cost assessment) to more robust forms, including the life cycle cost assessment. Whole life-cycle costs would provide a more accurate estimate of the cost of installing, operating, maintaining, and replacing a project (i.e., BMP) throughout its expected lifetime. However this type of analysis requires solid estimates for capital, land purchase, O&M, and other related costs.

Ideally, the goal was to include a more advanced economic analysis (i.e. – life cycle costs) in the Opti-Tool while still maintaining some level of simplicity for the end user. However, such a robust economic analysis does not currently appear possible because the literary search for more recent BMP cost estimates, reflective of New England states, was largely unsuccessful. However, the search was not entirely fruitless. Jamie Houle of the UNHSC did provide extremely valuable information on capital and maintenance costs for various BMPs that have been tested at the UNHSC. Cost estimates for a particular BMP available from *both* the CRWA study and UNHSC were discussed among Mark Voorhees of EPA, Jamie Houle of UNHSC, and Karen Mateleska of EPA, and a best professional judgment decision was made.

The recommendation at this time is to use a combination of the CRWA cost estimates **and** UNHSC costs estimates as the basis for the Opti-Tool BMP cost estimates, and to use a modified capital cost assessment (which includes a fixed percentage for Design and Contingency Costs) as well as a separate field for maintenance hours (from the UNHSC). The details supporting this approach are described below.

Overview of Scope and Approach

According to a draft memo, dated 6/20/14 from Tetra Tech to EPA Region I, the current SUSTAIN BMP Cost function has seven major individual components, using a formula that would likely be useful in a more detailed design mode. For purposes of simplicity, EPA Region I is proposing the following cost function formula for the tool's "planning" mode:

General Cost Function Formula = Storage Volume of BMP* (ft^3) X Cost Estimate for BMP ($\$/ft^3$) X Adjustment Factor

* Storage Volume of BMP is more accurately defined as (Design) Physical Storage Capacity of BMP; See Section A below for more details

Initially, the intention was to include the preliminary Operations and Maintenance (O&M) costs in the general formula (page 3) by simply multiplying the formula results by our Preliminary O & M costs. However, such an approach would only include **one year's worth** of operations and maintenance, which could have been misleading because it would not have reflected the true life cycle cost of the BMP (i.e., assume life cycle of 20 years). However, simply including the 20 year life cycle cost (O&M cost *20) in the above formula would have greatly increased the cost value and perhaps have created misconceptions about BMP use and affordability.

Therefore, the subcommittee decided to include the anticipated operation and maintenance **hours** required for each BMP per year instead. This parameter was included as a completely separate field in the Opti-Tool. The rationale was that Opti-Tool users need to understand that operation and maintenance impact the overall cost-effectiveness of BMPs and should be considered when selecting a BMP. Including O&M hours (instead of costs) as a separate field, would still highlight this important consideration for stormwater managers.

A. Storage Volume and Proposed Cost Estimate Values

As highlighted above, the general cost function formula used in the Opti-Tool consists of 3 factors: the BMP storage volume, the proposed BMP storage volume cost estimate, and the adjustment factor. The first two factors will be covered together in this memo because they are so closely linked. Table 1 below summarizes the proposed BMP cost estimates for the Opti-Tool.

Table 1: Proposed BMP Cost Estimates for Opti-Tool

BMP (From Opti-Tool)	Cost ($/ft^3) [1]	Cost ($/ft^3) – 2016 dollars[6]
Bioretention (Includes rain garden)	13.37 [2,4]	15.46
Dry Pond or detention basin	5.88 [2,4]	6.80
Enhanced Bioretention (aka-Bio-filtration Practice)	13.5 [2,3]	15.61
Infiltration Basin (or other Surface Infiltration Practice)	5.4 [2,3]	6.24
Infiltration Trench	10.8 [2,3]	12.49
Porous Pavement - Porous Asphalt Pavement	4.60 [2,4]	5.32
Porous Pavement - Pervious Concrete	15.63 [2,4]	18.07
Sand Filter	15.51 [2,4]	17.94
Gravel Wetland System (aka-subsurface gravel wetland)	7.59 [2,4]	8.78
Wet Pond or wet detention basin	5.88 [2,4]	6.80
Subsurface Infiltration/Detention System (aka-Infiltration Chamber)	54.54[5]	67.85

[1] Footnote: Includes 35% add on for design engineering and contingencies

[2] Costs in 2010 dollars

[3] From CRWA Cost Estimates

[4] From UNHSC Cost Estimates; Most of original costs were from 2004 and converted to 2010 dollars using U.S. Department of Labor (USDOL). (2012). Bureau of Labor Statistics consumer price index inflation calculator. http://www.bls.gov/data/inflation_calculator.htm

[5] From Cost Estimate of MA TT Rizzo Project (2008 Dollars)

[6] 2010 costs were converted to 2016 values to adjust for inflation. The ENR Cost Index Method was used for this conversion.

Table 1 includes all of the BMPs that are included in the Opti-Tool. The unit costs represent the dollar amount ($) per cubic foot of storage volume (ft^3), where the storage volume reflects the (design) physical static storage capacity that the relevant BMP can hold. This volume includes the volume of ponding water *and* the volume of water retained in the porous media or subbase materials if applicable. (This storage volume does *not* represent the *treated* volume of stormwater, which may be significantly higher than the physical storage volume of a BMP particularly for systems that are sized dynamically or by a water quality flow rate as opposed to a water quality volume.) This unit cost per storage volume captured by a BMP differs from other (perhaps more traditional) methods that can be used. By choosing to use the unit cost per storage volume instead of volume of water treated, we are trying to eliminate confusion over what the actual dimensions of the BMP will be for the costs being estimated. Additionally, this use of the unit cost per storage volume is consistent with the approach used in developing the BMP performance curves (used in the Opti-Tool) where the x-axis is the actual **physical storage capacity** to hold water. Lastly, expressing the unit costs in this manner will benefit users who are simply interested in using the unit costs (outside of the Opti-Tool) by eliminating the step of modeling hydrology and routing the water through the BMP, which can yield widely varying results depending on modeling approach and supporting assumptions. Attachment A describes the method used in calculating the design storage volume for each of the selected BMPs.

Also, each unit cost per storage value represents the capital cost of construction/installation of the BMP and includes a 35% design/engineering/contingency (D & E) cost. This 35% fixed percentage of the total construction cost follows a general “rule of thumb,” often used by consulting firms. Based upon a conversation between Mark Voorhees and Jamie Houle (two members of the Opti-Tool cost subcommittee), a decision was made to include this D&E cost. The values in Table 1 do *not* include the cost of purchasing any land, nor does it include any O&M costs (which is discussed in more detail in a subsequent section). Therefore, each unit cost in Table 1 that was based on the CRWA’s 2010 values was calculated by multiplying the relevant BMP cost by 1.35.

Since the CRWA study did not include cost estimates for porous pavement or sand filters, which are BMPs included in the Opti-Tool, relevant data was obtained from Jamie Houle of the University of New Hampshire Stormwater Center (UNHSC). He also provided additional cost estimates (as denoted by Footnote 4 in Table 1) for some of the other BMPs included in the tool. UNHSC can provide valuable data because they have been directly involved with the engineering, design and construction of numerous LID controls, as well as evaluating multiple stormwater treatment systems over multiple years at their primary field research facility in Durham, N.H. Since they could provide cost information for both porous asphalt pavement and pervious concrete, separately, the general category of porous pavement was divided into the aforementioned two sub-categories.

It should be noted that the costs used for the Opti-tool *assume linearity*, which will both allow for *and* incentivize the scaling to smaller-sized systems. For example, EPA has estimated that *smaller* capacity designs for BMPs, rather than large-sized BMPs, can increase both the technical and economic feasibility of installing controls, particularly for retrofits. The assumption of linearity was made for the following reasons: 1) Limited data currently exists on the cost of small capacity systems. Until a larger pool of cost data becomes available which will allow for the development of a non-linear cost curve, the current method is the best available alternative; 2) As the installation of smaller systems becomes more wide-spread, it is likely that economies of scale will develop and cost savings will occur. For example, if one entity is contracted to install multiple small systems at once, materials can be bought in bulk and the installation process can become more efficient and less expensive; 3) An undersized system built to treat a large area can be a very cost effective approach. As an example, there should not be a significant cost difference between a 1-inch system treating 1 acre and a 1/10-inch-system that treats 10 acres, since the absolute capacity of the system is the same in both cases. This topic of linearity will be revisited in the future when more data is available.

Since UNHSC typically calculates the capital costs per cubic foot (ft^3) *treated*, using WQv, Jamie Houle converted the costs to represent the capital costs per BMP storage volume (ft^3). This was necessary so the capital cost data would be consistent with the method used in the Opti-Tool. Also, all of the costs were converted to 2010, and ultimately 2015, dollars. As with the CRWA costs, the UNHSC capital costs were already adjusted to include the 35% design/engineering/contingency (D & E) cost. Details of all of these calculations, and any other assumptions made, are presented in Attachment B.

When developing cost estimates, another topic for consideration was whether or not to address the issue of inflation. CRWA's BMP cost estimates were based on capital costs from 2010. As previously stated, UNHSW's cost estimates have also already been converted to constant 2010 dollars using consumer price index inflation rates [U.S. Department of Labor (USDOL) 2014].[1] Therefore, there was the option of converting all of these 2010 costs to 2016 costs, using the U.S. Department of Labor's consumer price index inflation calculator. However, another suggestion was made to use the ENR Cost Index method to adjust for inflation instead because it more closely tracks construction work. At least one New England state (i.e., Vermont) also uses the ENR Cost Index method, so this could provide some consistency, as well. Therefore, the decision was made to ultimately convert all of the costs to 2016 values using the ENR Cost Index method. These values are reflected in Table 1.

To use the index, one calculates the quotient of the current index number (based on the month and year of *current* date) divided by the index number from a given date (e.g., June of 2010). Since the month was not known for the 2010 costs, the month of June was used as an estimate. This assumption was used because it falls mid-way between the construction season and would likely provide a reasonable estimate. Once the quotient was calculated, it was multiplied by the construction cost (found in the middle column in Table 1, above) to provide the 2016 construction cost value

B. Cost Adjustment Factor

Since the cost of installing a BMP will vary depending on the specific site location, the TAC subcommittee believed it was important for the Opti-Tool to include a scalable cost adjustment factor. The proposed cost estimates for the Opti-Tool (in Table 1) are all based on a Cost Adjustment Factor of 1. However, each Opti-Tool user has the option to choose and enter into the tool a cost adjustment factor that is appropriate for their site. This will adjust the storage volume cost function in the Opti-Tool.

For example, the CRWA report included the cost factors summarized in Table 2.

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[1] Reference: U.S. Department of Labor (USDOL). (2014). Bureau of Labor Statistics consumer price index inflation calculator." ⟨http://www.bls.gov/data/inflation_calculator.htm⟩(Sep. 12, 2014)

Table 2: Example of Cost Adjustment Factors

BMP Type	**EXAMPLE** Cost Adjustment Factor
New BMP in undeveloped area	1
New BMP in partially developed area	1.5
New BMP in developed area	2
Difficult installation in highly urban settings	3

(Source: Table 4 of Appendix B of CRWA's Spruce Pond Brook Subwatershed Project for Town of Franklin)

The assumption made was that it would cost more to install a new BMP in a developed area (with more site constraints) than it would cost to install the same BMP in a previously undeveloped area. So in the above example, the cost adjustment factor would be 2 for installing a BMP in a previously developed area versus a cost adjustment factor of 1 for installing a BMP in an undeveloped area.

It should be noted that Table 2 (above) provides just *one example* of adjustment factors. The factor should be flexible enough so that another location (or Opti-Tool user) can adjust it, as needed. For example, the Charles River Watershed (in eastern Massachusetts) used an adjustment factor of 2 for installing a BMP in a developed area, while the State of Vermont uses an adjustment factor of 1.4 to estimate the cost of installing a BMP for existing development.

C. Maintenance (O&M) Costs

Originally, one goal was to include Operation and Maintenance (O&M) costs as part of the cost estimates for the Opti-Tool. These O&M costs would help to provide a more realistic reflection of the long-term expenses of structural storm water controls, which is obviously critical in the practical, real-world implementation of BMPs. However, it is difficult to obtain accurate maintenance costs and they will be highly variable depending on the size, location and equipment needed to perform long-term O&M.

This point was highlighted by a key finding in EPA's recent (2013) publication, *Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs.* The report indicated that only a small percentage of the entities that implement LID and GI approach for stormwater management conduct economic analyses due to the "uncertainties surrounding costs, operation and maintenance (O&M) requirements, budgetary constraints, and difficulties associated with quantifying the benefits provided by LID/GI" and the need "to obtain better estimates of the O&M costs associated with different types of LID/GI projects" was a key finding of the report.

As previously mentioned, one article entitled, *Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management* (Houle *et al. 2013)*, did contain relevant information for BMP costs in the New England region. During initial discussions between EPA Region I (Mark Voorhees) and UNHSC (Jamie Houle), there was concern that not enough data existed on O&M costs to propose accurate values for each of the BMPs included in the Opti-Tool. There was also the concern that the O&M costs were not scaleable. For example, initial O&M costs for each BMP were based on the cost of operation and maintenance per year per acre of IC treated. Scaled differences such as the annual O&M costs for treating 0.5 acres of IC or 2 acres of IC have **not** been evaluated and may or may **not** result in a simple linear relationship. Yet the Opti-Tool costs subcommittee also realized the importance of including some maintenance parameter in order to *initiate* the conversation on the importance of accounting for O&M to maintain the functionality of the BMPs. Therefore Table 3, below, presents these annual maintenance costs (in $) for select BMPs, as well as the annual maintenance hours. Although the O&M costs have been presented in this memo, only the O&M **hours** will be included (as a separate field) in the Opti-Tool.

Table 3: Maintenance Costs ($) and Hours per year for select BMPs – From UNHSC

BMP	Maintenance Cost ($) per year	Annual Maintenance Hours
Bioretention	$1,890.00	20.7
Chamber System	Not Assessed	Not Assessed
Detention Pond	$2,380.00	24.0
Gravel Wetland	$2,138.33	21.7
Porous Asphalt	$1,080.00	6.0
Pervious Concrete	$1,080.00	6.0
Retention Pond	$3,060.00	28.0
Sand Filter	$2,807.50	28.5

*Note: initial costs based on cost of maintenance per year per acre of IC treated

Annual maintenance strategies were evaluated by directly quantifying hours spent categorizing maintenance activities, and assessing difficulty of those activities. To better illustrate costs and anticipate maintenance burdens, activities were characterized into distinct categories and a standard cost structure was applied. This unit conversion can easily be adapted according to local conditions, current economic climate, and regional cost variations which is why we decided to go with maintenance **hours** as those were directly measured and should remain constant. These maintenance activity categories allow more accurate cost predictions and provide insight into the appropriate assignment of maintenance responsibilities.

Annual maintenance costs were normalized to 2012 dollars and calculated for all SCMs by both dollars and personnel hours per acre of IC treated per system per year. It is important to note that inflation was not considered in life cycle maintenance cost projections.

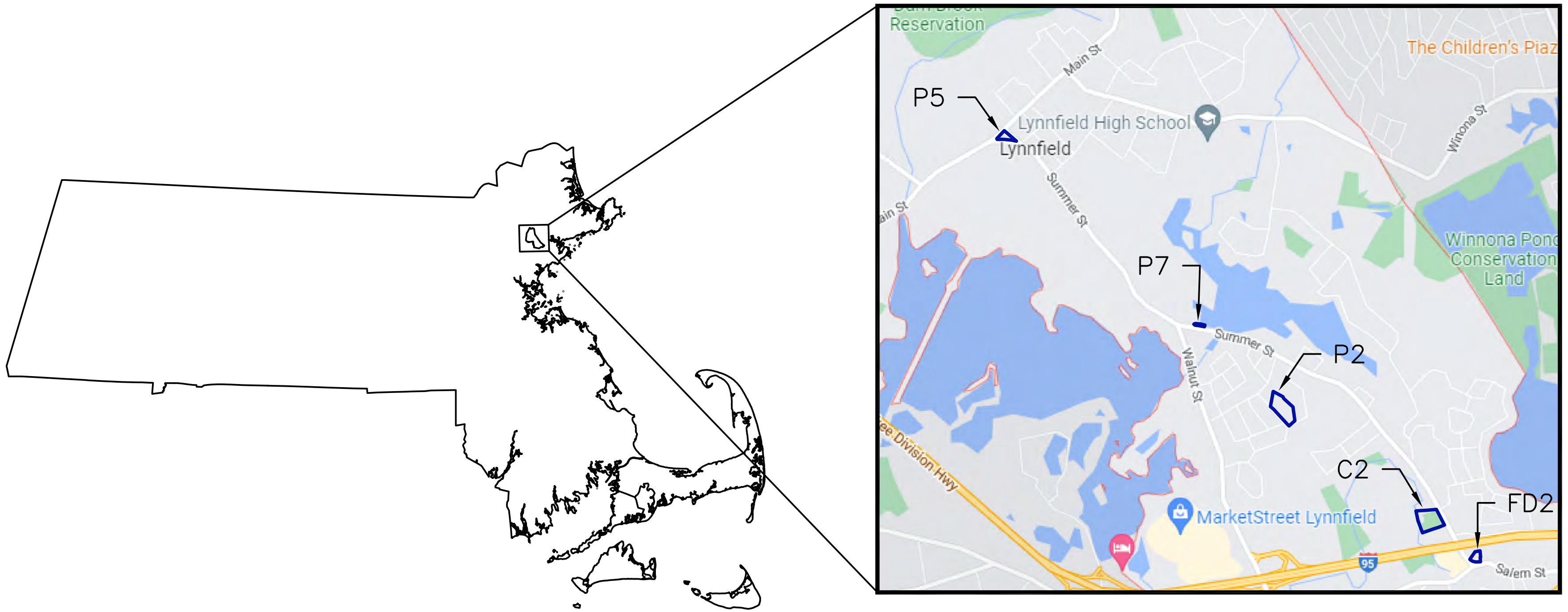
Attachment B:

Pre-Conceptual Designs for Top Five Locations

TOWN OF LYNNFIELD

MUNICIPAL PROPERTY BMP RETROFIT OPPORTUNITIES
LYNNFIELD, MA

JUNE 2022



LOCUS SCALE 1" = 4000'

SHEET	TITLE
C-1	P5- LYNNFIELD COMMON
C-2	P7- ROTARY PARK
C-3	C2- WILLOW CEMETERY
C-4	FD2- FIRE DEPARTMENT AND POST OFFICE
C-5	P2- GLEN MEADOW PARK

COMPREHENSIVE ENVIRONMENTAL INCORPORATED • BOLTON, MASSACHUSETTS

GENERAL NOTES

LEGEND

───	PROJECT PARCEL
───	PROPERTY LINE
─ ─ ─ ─	EXISTING DRAIN PIPE
⊞	CATCH BASIN
○	DRAIN MANHOLE
⁄⁄⁄⁄⁄	BUILDING
───	EDGE OF PAVEMENT
➡	FLOW DIRECTION ARROW
△	OUTFALL
═ ═ ═ ═	PROPOSED DRAIN PIPE

COMPREHENSIVE ENVIRONMENTAL INCORPORATED

41 MAIN ST.
BOLTON, MA 01740

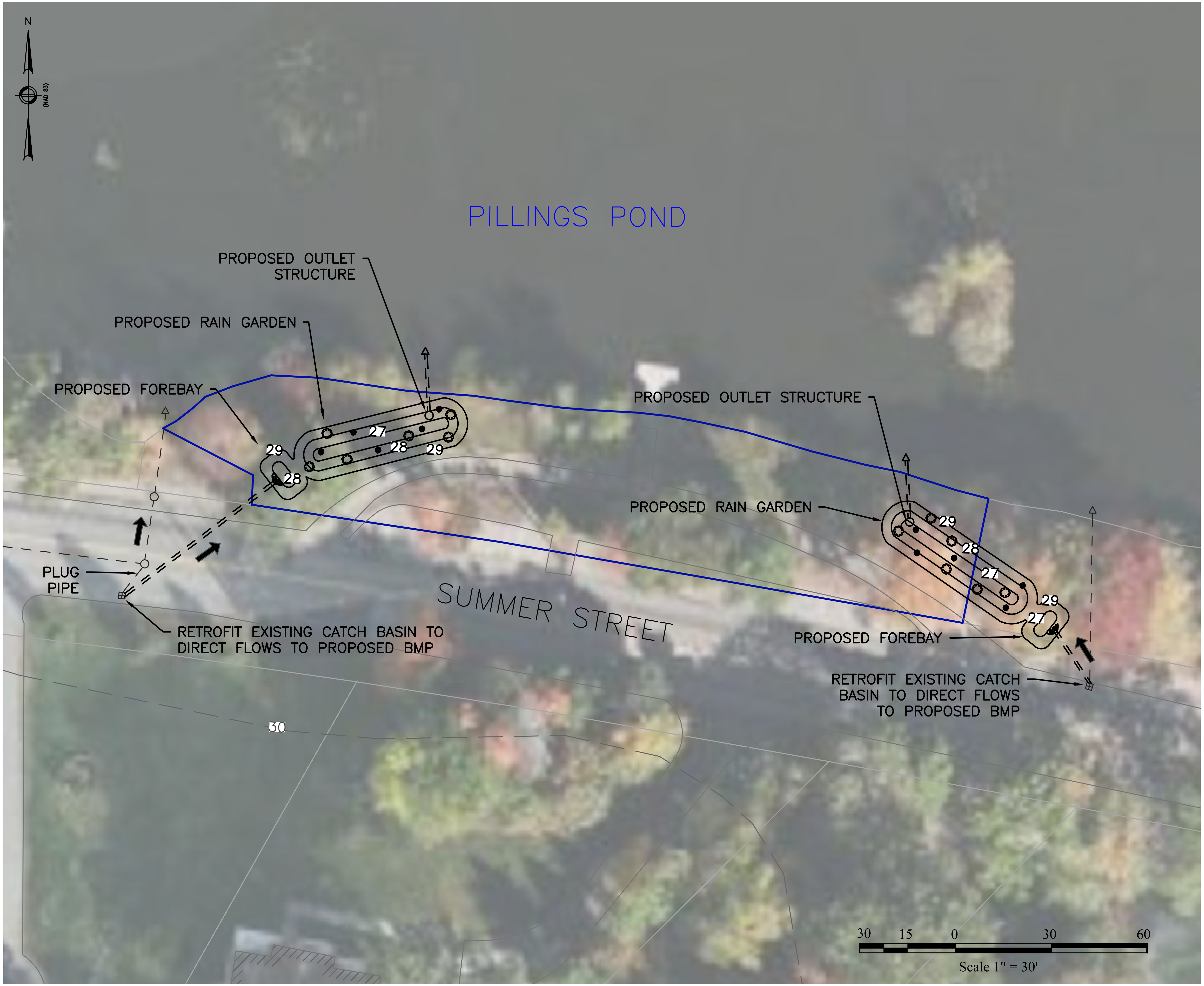
PROPOSED CONDITIONS - P5
LYNNFIELD COMMON
PLAN VIEW

TOWN OF LYNNFIELD, MA

Project No.: 288-16
Date: June 2022
Drawn By: NH
Checked By: RB
Scale: AS SHOWN

Sheet

C-1



GENERAL NOTES

LEGEND

━━	PROJECT PARCEL
──	PROPERTY LINE
— — — —	EXISTING DRAIN PIPE
⊞	CATCH BASIN
○	DRAIN MANHOLE
⁄⁄⁄⁄⁄	BUILDING
──	EDGE OF PAVEMENT
➡	FLOW DIRECTION ARROW
△	OUTFALL
＝ ＝ ＝ ＝	PROPOSED DRAIN PIPE

COMPREHENSIVE ENVIRONMENTAL
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BOLTON, MA 01740

PROPOSED CONDITIONS - P7
ROTARY PARK
PLAN VIEW

TOWN OF LYNNFIELD, MA

Project No.: 288–16
Date: June 2022
Drawn By: NH
Checked By: RB
Scale: AS SHOWN

Sheet

C-2

GENERAL NOTES

LEGEND

───	PROJECT PARCEL
───	PROPERTY LINE
– – – –	EXISTING DRAIN PIPE
⊞	CATCH BASIN
○	DRAIN MANHOLE
▨	BUILDING
───	EDGE OF PAVEMENT
➡	FLOW DIRECTION ARROW
△	OUTFALL
═ ═ ═ ═	PROPOSED DRAIN PIPE

COMPREHENSIVE ENVIRONMENTAL
INCORPORATED

41 MAIN ST.
BOLTON, MA 01740

PROPOSED CONDITIONS - C2
WILLOW CEMETERY
PLAN VIEW

TOWN OF LYNNFIELD, MA

Project No.: 288–16
Date: June 2022
Drawn By: NH
Checked By: RB
Scale: AS SHOWN

Sheet
C-3

GENERAL NOTES

LEGEND

━	PROJECT PARCEL
─	PROPERTY LINE
– – – –	EXISTING DRAIN PIPE
⊞	CATCH BASIN
○	DRAIN MANHOLE
▨	BUILDING
─	EDGE OF PAVEMENT
➡	FLOW DIRECTION ARROW
△	OUTFALL
═ ═ ═ ═	PROPOSED DRAIN PIPE

NOTE: POTENTIAL LOCATION OF INFILTRATION BASIN SHOWN. FURTHER INVESTIGATION OF EXISTING DRAINAGE CONNECTIONS REQUIRED FOR EVALUATION OF POSSIBLE CONNECTIONS TO PROPOSED BMP.

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INCORPORATED

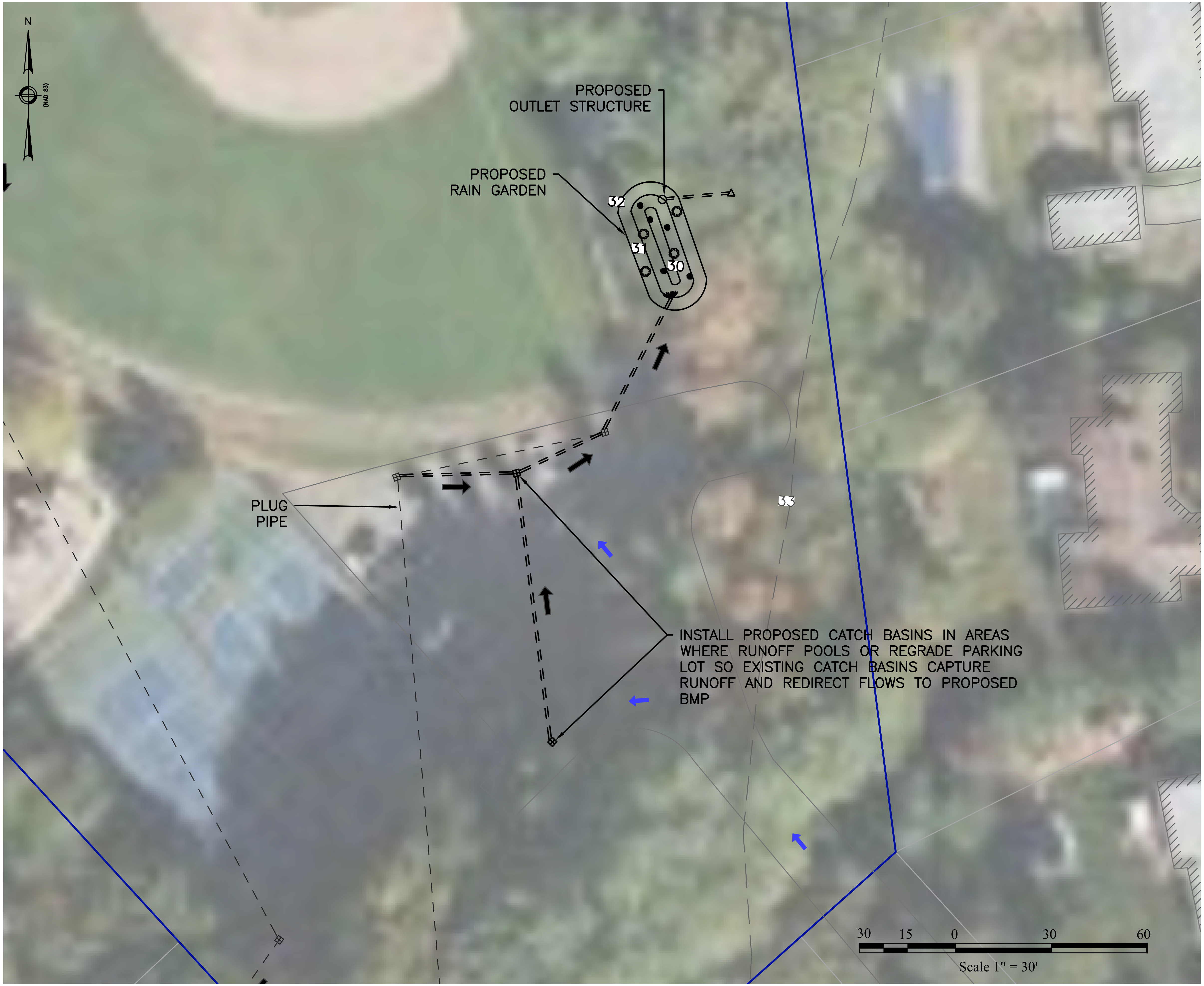
41 MAIN ST.
BOLTON, MA 01740

PROPOSED CONDITIONS - FD2
FIRE DEPARTMENT AND POST OFFICE
PLAN VIEW

TOWN OF LYNNFIELD, MA

Project No.: 288–16
Date: June 2022
Drawn By: NH
Checked By: RB
Scale: AS SHOWN

Sheet
C-4



GENERAL NOTES

LEGEND

━	PROJECT PARCEL
─	PROPERTY LINE
– – – –	EXISTING DRAIN PIPE
⊞	CATCH BASIN
○	DRAIN MANHOLE
▨	BUILDING
─	EDGE OF PAVEMENT
➡	FLOW DIRECTION ARROW
△	OUTFALL
= = = =	PROPOSED DRAIN PIPE

COMPREHENSIVE ENVIRONMENTAL
INCORPORATED

41 MAIN ST.
BOLTON, MA 01740

PROPOSED CONDITIONS - P2
GLEN MEADOW PARK
PLAN VIEW

TOWN OF LYNNFIELD, MA

Project No.: 288–16
Date: June 2022
Drawn By: NH
Checked By: RB
Scale: AS SHOWN

Sheet
C-5

Attachment C:

Example Roadway and Intersection BMP Improvements

TRENCH ID:

LOCATION:

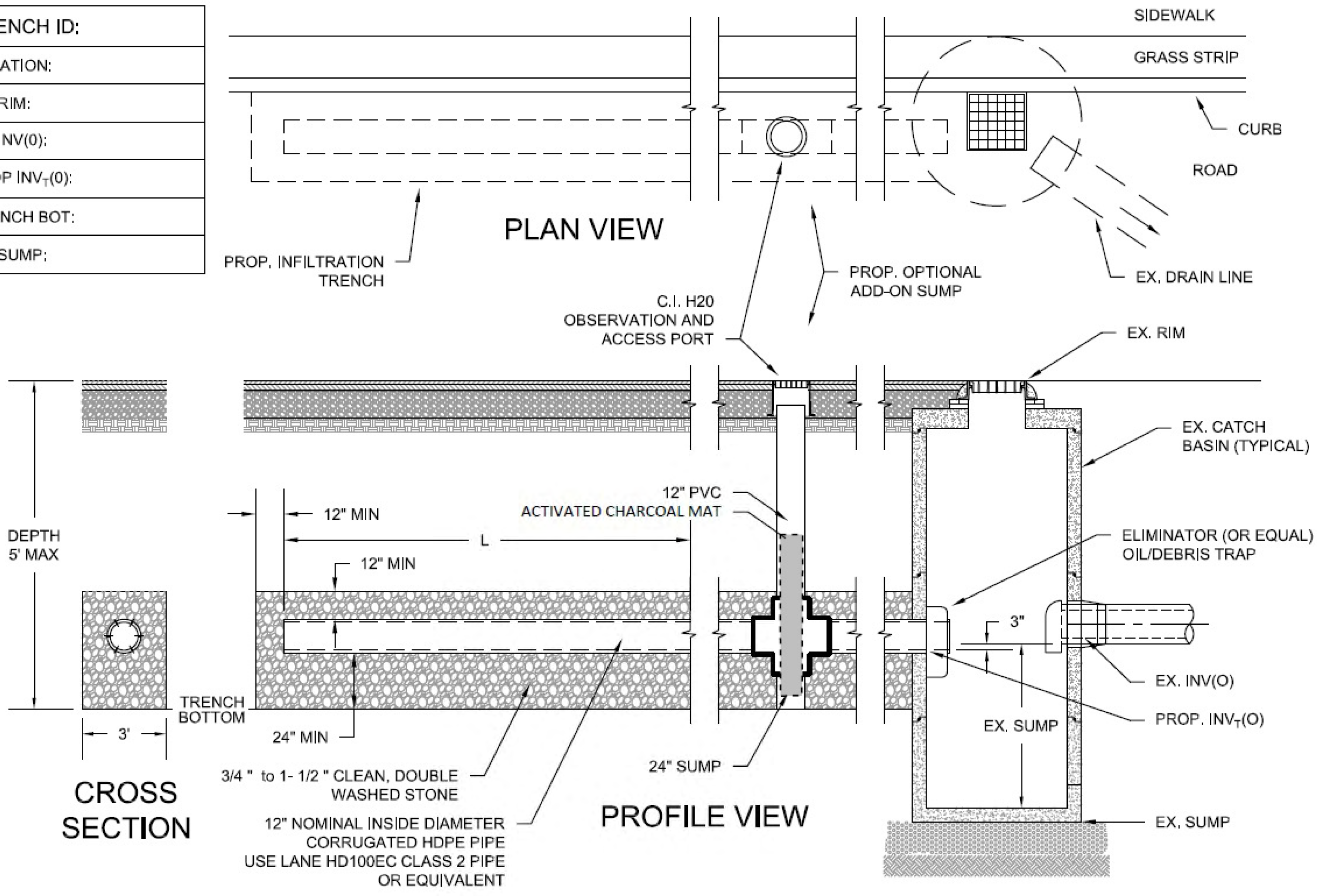
EX. RIM:

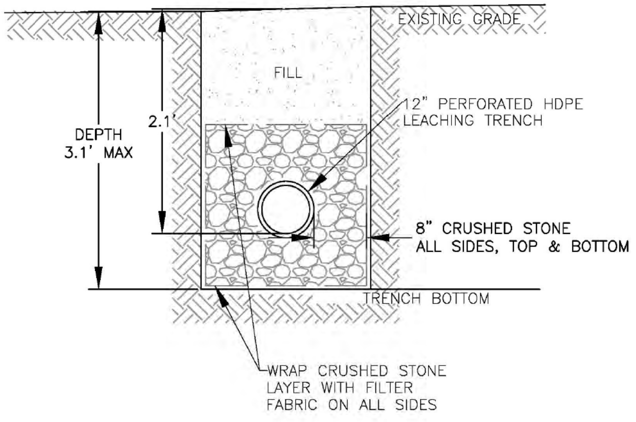
EX. INV(0):

PROP INV_T(0):

TRENCH BOT:

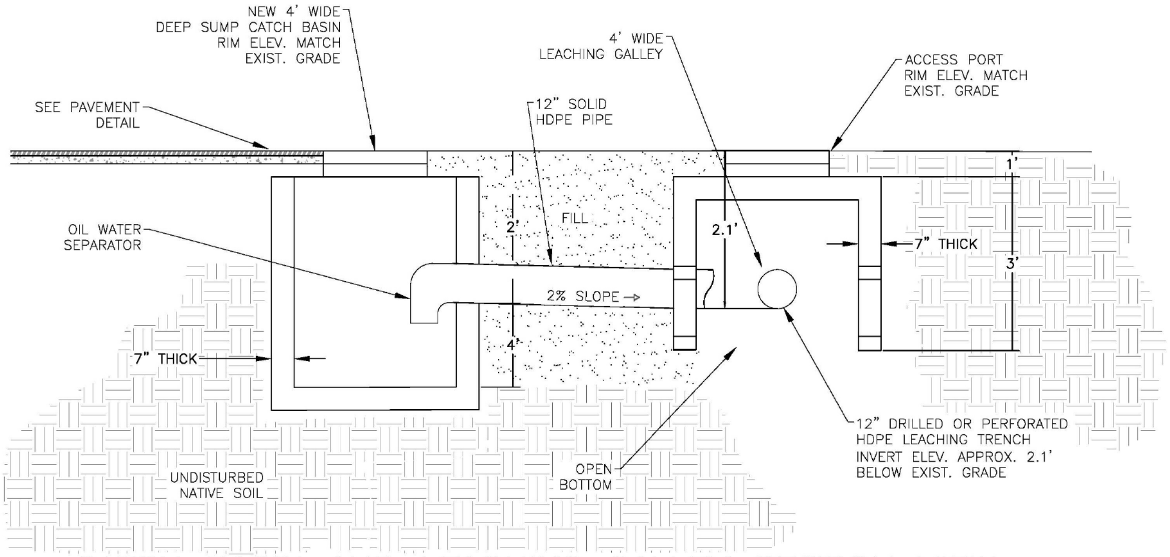
EX. SUMP:





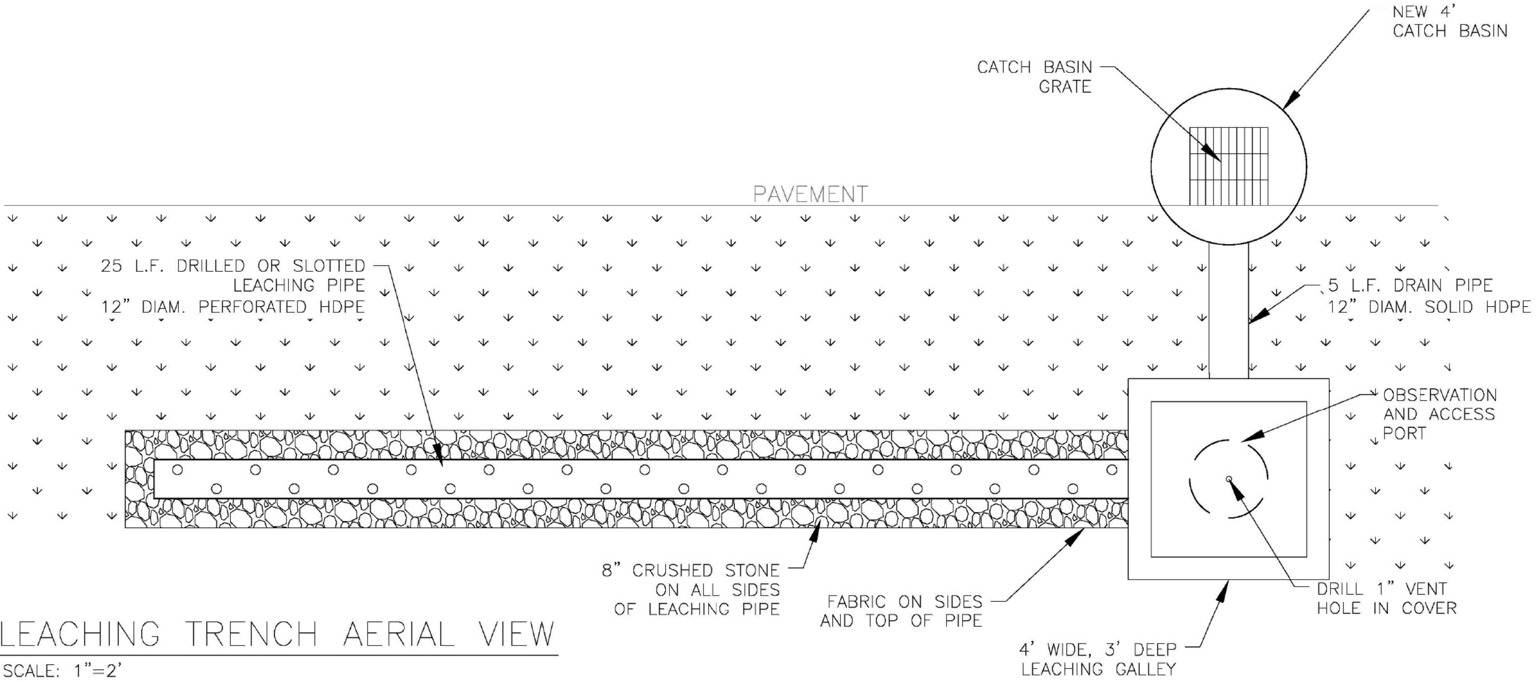
LEACHING TRENCH SECTION VIEW

SCALE N.T.S.



CATCH BASIN AND LEACHING GALLEY SECTION VIEW

SCALE: 1"=3'



LEACHING TRENCH AERIAL VIEW

SCALE: 1"=2'