SECTION 7

EXISTING WASTEWATER NEEDS ANALYSIS

7.1 WASTEWATER NEEDS ANALYSIS SUMMARY

As established in Section 6, the Town does not have a municipal wastewater collection, treatment and disposal system. This section reviews the needs of the community relative to a municipal wastewater collection, treatment and disposal system. The wastewater needs analysis is to identify areas where existing conditions may cause a risk to public health, environmental resources, or financial burden. Areas determined to have needs were analyzed in more detail to determine feasible wastewater management solutions. Wastewater flows from areas determined to have highest need were also calculated.

In order to evaluate wastewater needs, risk factors were established and a risk score was calculated for each property in town. This risk score serves to compare lots relative to the likelihood of current or future consequences to the environment as well as difficulties in siting an on-site wastewater disposal system due to a variety of factors, such as soil conditions, depth to groundwater, size of the parcel - small lots, proximity to environmental resources, etc. Based upon these factors the lots were assigned a risk score between 0 and 100.

The Town was then broken into 16 Need Study Areas based on similarities in geography, risk profile, and land use. A statistical analysis using GIS information was completed to determine which study areas have the highest risks. The analysis was verified by conducting a windshield survey which included driving throughout the community and comparing the analysis output to the conditions observed in the field. The survey affirmed the results of the GIS analysis. The 16 Needs Areas were ranked according to their risk points per lot. Four study areas with the highest average risk points per lot were then analyzed for potential wastewater alternatives and an estimated volume was calculated for the potential wastewater flows.

7.2 WASTEWATER NEEDS ASSESSMENT METHODOLOGY

In order to determine wastewater needs in North Reading, an analysis was completed using geographic information system data (GIS). The data was obtained from various sources including the MassGIS database and the Town.

The wastewater needs matrix was created by generating a list of important, definable, and measurable factors which may make a particular property a candidate for future municipal wastewater management. Properties, for the purpose of this analysis, are defined as lots based on the MassGIS tax parcel layer. The goal of the matrix was to conduct a town-wide analysis to analyze the Town using the criteria to establish areas within the community that may represent a risk from on-site wastewater treatment and disposal and require further evaluation. Factors considered and evaluation criteria are presented in Table 7-1.

TABLE 7-1
SCORING FACTORS

Parameter	Unit	Source
Known Septic Failure	Yes/No	North Reading Board of Health Records
Has Tight Tank	Yes/No	North Reading Board of Health Records
Water Use Class	Class	North Reading Zoning GIS Layer
Proximity to Impaired Water	Miles	MassGIS Integrated Waters Layer
Lot Size	Acres	North Reading Tax Parcel GIS Layer
Soil Drainage	Categories	USDA National Cooperative Soil Survey
Ponding	Yes/No	USDA National Cooperative Soil Survey
Flooding	Frequency	MassGIS FEMA Flood Mapping
Septic System Age	Years	North Reading Board of Health Records
Pump Out Frequency	Years/pump	North Reading Board of Health Records
Within Zone 2 or IWPA	Yes/No	MassGIS Zone 2 and IWPA GIS Layers
Depth to GW	Feet	USDA National Cooperative Soil Survey
Depth to Restrictive Layer	Feet	USDA National Cooperative Soil Survey
Water Use per Acre	GPD/acre	North Reading Water Billing records
Adjacent to Wetland	Yes/No	MassGIS MassDEP Wetlands Layer
Private Well	Yes/No	North Reading Well Records
Outstanding Water Resource Protection Zone	Yes/No	MassGIS OWR Layer

Each factor has a corresponding range of scores from 0 to 5 which were chosen based on the potential risk of the property. Risk refers to the likelihood of current or future challenges regarding the use of an on-site wastewater treatment and disposal system. For example, for the property lot size factor, properties with the smallest lots were assigned larger scores, while the larger lots received a lower score. A property with a small lot is more likely to be unable to appropriately manage wastewater on-site as compared to a lot with a higher available land area.

In addition to the gradation of scores (0-5) within a factor, each scoring factor was assigned a weight to prioritize the factor relative to the other factors. For example, a factor with a direct correlation to poor wastewater management would receive a greater weighting factor compared to a factor with indirect correlation. The weight factors range from 1 to 5 and are multiplied by the factor score to produce the final factor score. The scoring matrix determines a score for each property in the community and property's final score is the sum of all of its weighted factor scores. These score tallies represent the likelihood of the property to have a current or future challenge associated with the on-site management of wastewater. The weights of each factor are shown in Table 7-2. A description of how each category is weighted follows.

TABLE 7-2
FACTOR WEIGHTING

Parameter	Weight
Known Septic Failure	5
Has Tight Tank	5
Water Use Class (Commercial or Industrial)	5
Proximity to impaired water	5
Lot size	2
Soil Drainage	2
Ponding	2
Flooding	2
Septic System Age	2
Pump Out frequency	2
Within Zone 2 or IWPA	2
Depth to GW	1
Depth to Restrictive Layer	1
Water Use per Acre	1
Adjacent to wetland	1
Private well	1
Outstanding Water Resource Protection Zone	1

7.2.1 Category 5 Factors

As shown in Table 7-2, the factors with the highest weight are properties with known septic system rehabilitation, tight tanks, commercial or industrial water use, permit violations, or proximity to impaired waters. Each of these factors was determined to have a likely direct negative impact on the water quality, or represent circumstances which impose current or future risks.

7.2.1.1 Septic System Rehabilitations

Properties with known septic system rehabilitations pose an immediate risk of pollution to the community's water resources and public health as they are indicators of failed septic systems. Failed septic systems have been linked to the impaired waters in the area as presented in Ipswich River Watershed 2000 Water Quality Assessment Report. Failed systems often result in discharge of wastewater to the environment which pollute local resources such as; rivers, streams, ponds, lakes, wetlands and water supplies. The score was determined using data received from the North Reading Board of Health. Known septic system failures are presented on a map in Section 6 in Figure 6-2.

- Properties with known septic rehabilitation were given a score of 5

- Properties without known rehabilitation were assigned a score of 0

While the fact that rehabilitation represents the improvement of an existing limitation or failure, it also identifies that there was a limitation with the prior system and those limitations are still relevant to the specific property.

7.2.1.2 Tight Tanks

Properties with tight tanks likely cannot accommodate sustainable onsite wastewater treatment systems. The tight tank is installed to capture wastewater or industrial wastewater that cannot be disposed of via conventional systems. These properties require frequent pumping which is costly and inefficient. The transport of wastewater also increases greenhouse gas emissions, and poses a threat for accidental or illicit discharge of wastewater. The score was determined using data received from the North Reading Board of Health. Treatment systems by type are depicted in Section 6 in Figure 6-1.

- Properties known to have a tight tank received a score of 5
- All other properties received a score of 0

7.2.1.3 Water Use Class

Properties were classified by water use class. Water use classifications were identified as a priority since some water use types correlate to higher volumes, increased concentrations of wastewater discharge and pollutants not appropriate for on-site septic wastewater treatment and disposal. For example, discharges from commercial and industrial users may contain chemicals, grease, byproducts or other pollutants that are not commonly seen from domestic users. These wastes are often not treated sufficiently by traditional septic systems and require more advanced treatment. The water use was determined based on the properties' zoning designation as shown in Figure 2-2.

- Properties with industrial water use received a score of 5
- Properties with commercial water use received a score of 4
- Properties with institutional water use received a score of 3
- All other properties received a score of 0

7.2.1.4 Impaired Waters

Properties within close proximity to impaired waters are considered a priority. Water bodies are evaluated as part of the Federal Clean Water Act in regards to their ability to support their designated uses, for example swimming, fishing, and drinking water. Waters may be impaired by pollutants, invasive species, low flow conditions, and habitat alterations. For the purpose of this evaluation, Category 5 waters were evaluated. Category 5 impaired waters are impaired for one or more of its designated uses and requires calculation of a Total Maximum Daily Load (TMDL) for the impairing pollutant. Category 4 waters on the other hand, do not require calculation of a

TMDL, as their impairments are due to factors such as low flow, habitat alterations, and invasive species, which are not likely the result of human pollutant discharge. Impaired waters are known to be impacted by septic systems as stated in Ipswich River Watershed 2000 Water Quality Assessment Report. Reducing pollution in the vicinity of the impaired waters was deemed a significant factor for the analysis. The scores for this category are graduated since the likelihood of pollution reaching impaired water decreases the further the point source is from the water body. Impaired waters in North Reading include Martins Pond, Martins Brook and the Ipswich River and are shown in Section 2 in Figure 2-11

- Properties within ¼ mile of impaired waters were assigned a score of 5
- Properties within ½ mile of impaired waters were assigned a score of 2
- All other properties were assigned 0

7.2.2 Category 2 Factors

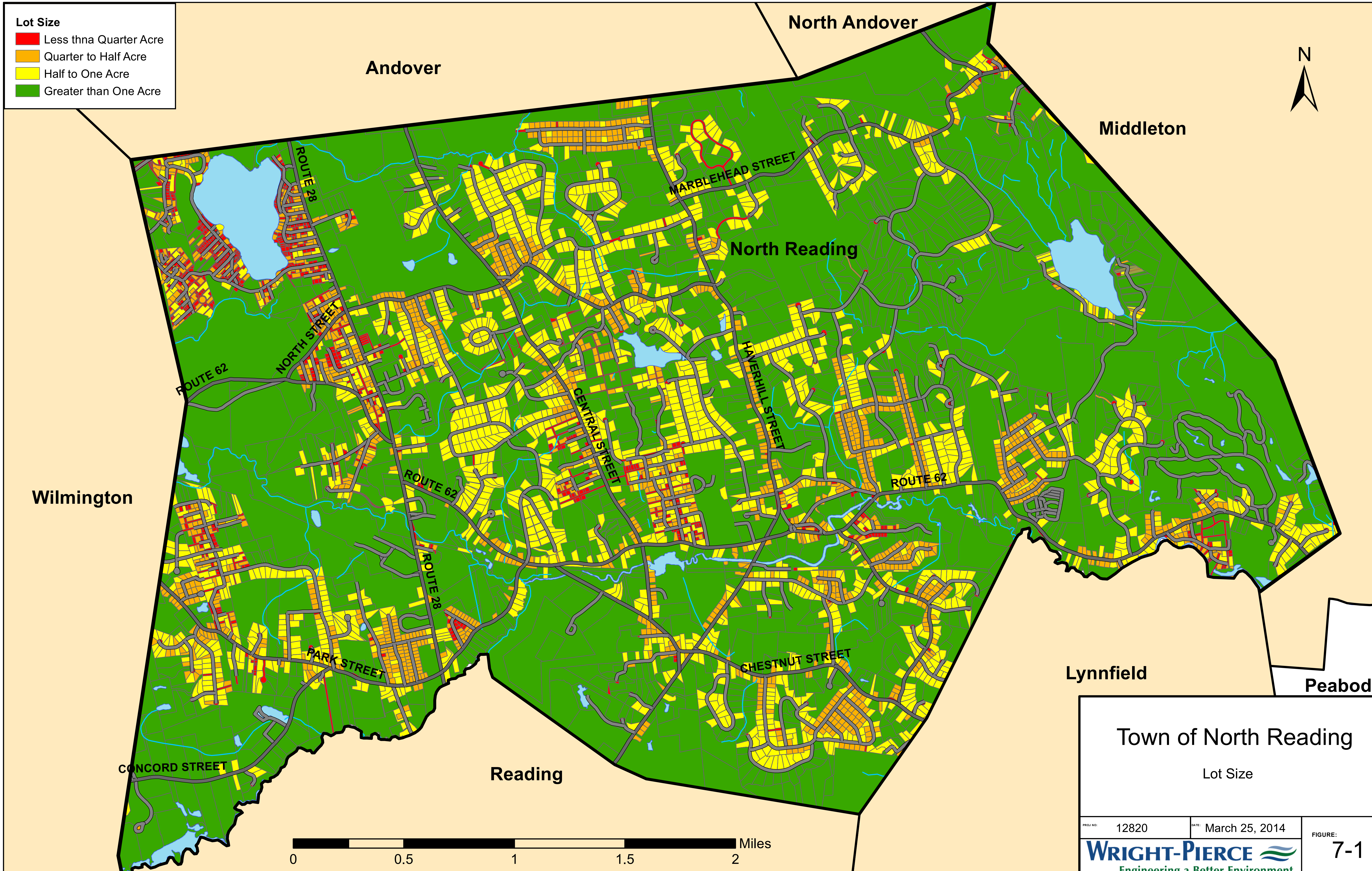
Many of the categories receiving a weight of 2 represent factors that make installing or maintaining an onsite treatment system challenging. In many cases, these factors can be accommodated, but due to the cost or complexity of the system, risk of failure or insufficient maintenance creates a risk for current and future on-site wastewater management. Some of these categories include poor soils, frequent ponding or flooding, or septic systems age. Other factors with a weight of 2 include properties in proximity to groundwater supplies. Each of the categories also include a graduated score range based on the severity of the condition.

7.2.2.1 Lot Size

Onsite treatment requires ample space to site a groundwater discharge system, like a leach field. Properties with smaller lot sizes are at risk for not being able to site a appropriately sized onsite system. Property size was determined by calculating the area of the lot using the North Reading Tax Parcel data.

- Properties smaller than 0.25 acres were assigned a score of 5
- Properties between 0.25 and 0.33 acres were assigned a score of 3
- Properties between 0.33 and 0.5 acres were assigned a score of 2
- Properties between 0.5 and 1.0 acres were assigned a score of 1
- All other properties were assigned 0

Figure 7-1 presents the distribution on lot sizes in North Reading



Town of North Reading

Lot Size

PROJ NO: 12820	DATE: March 25, 2014	FIGURE: 7-1

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7.2.2.2 Soil Drainage Class

The ability for the soil to drain well, and transport the wastewater from the SAS is an important factor in the success of an on-site wastewater management system, such as a septic system. Properties with poor soil drainage represent a higher risk of a failing system or of a lot being unsuitable for siting a new system. The soil drainage class was determined using data from the USDA National Cooperative Soil Survey as shown in Section 2 in Figure 2-8.

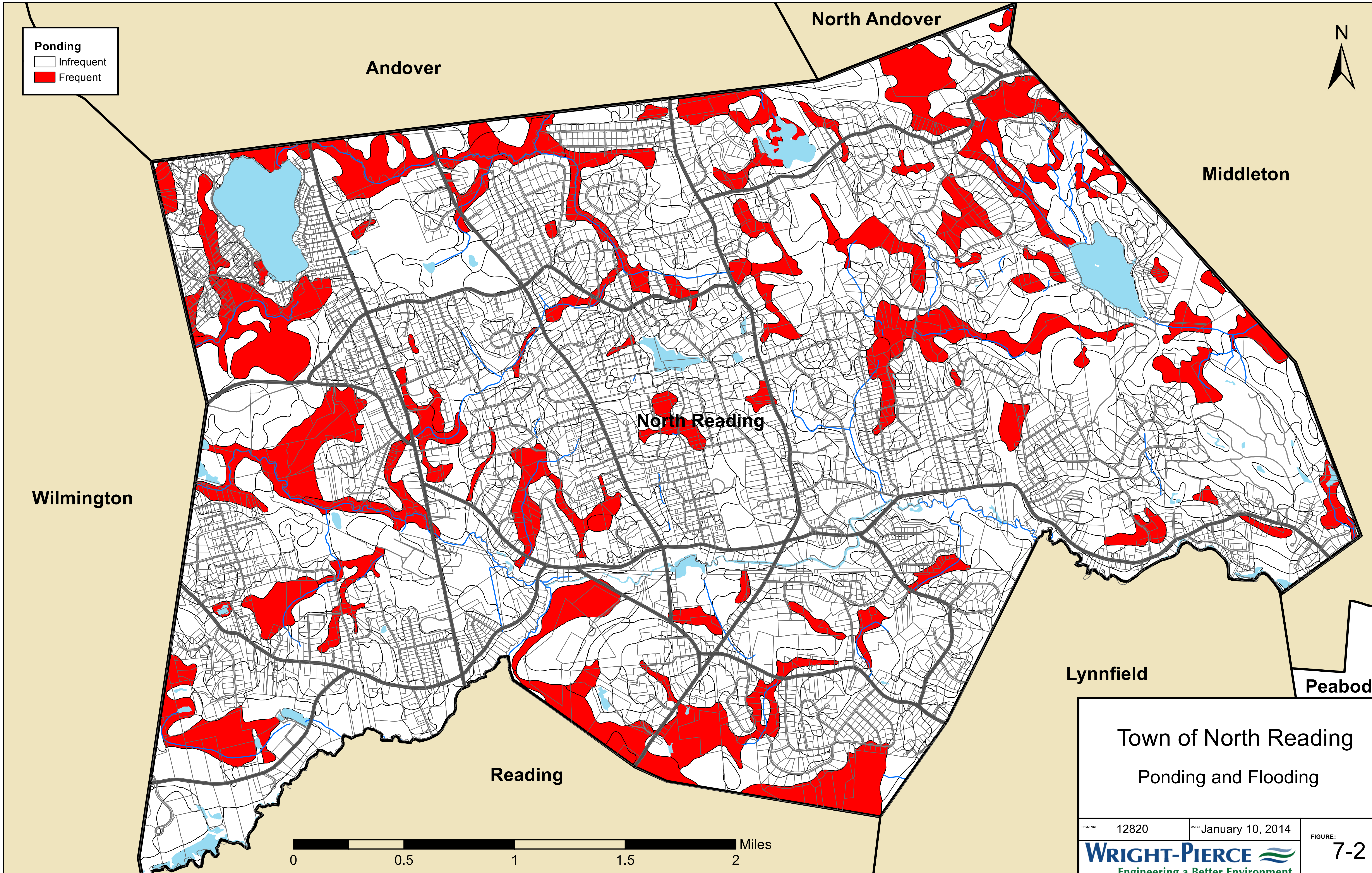
- Properties with very poorly drained soils were assigned a score of 5
- Properties with poorly drained soils were assigned a score of 4
- All other properties were assigned 0

7.2.2.3 Ponding

Areas with frequent ponding pose a risk for sub-standard wastewater management as during periods of ponding. The SAS relies on important characteristics and soil saturation impairs the ability of the SAS to leach the wastewater and provide post septic tank treatment. It also can promote breakout of wastewater, which is a potential public health issue. Ponding is often caused by poor soils drainage; it can also be caused by the presence of a localized perched soil lens, topography, or various other causes.

- Properties with frequent ponding were assigned a score of 5
- Properties with rare ponding were assigned a score of 1
- Properties with no ponding were assigned a score of 0

Figure 7-2 shows locations in North Reading with frequent ponding.



Ponding
Infrequent
Frequent
Andover
North Andover
Middleton
Wilmington
North Reading
Lynnfield
Peabody
Reading
N
0
0.5
1
1.5
2
Miles
Town of North Reading
Ponding and Flooding
12820
January 10, 2014
FIGURE:
7-2
WRIGHT-PIERCE
Engineering a Better Environment

7.2.2.4 Flooding

Similar to ponding, areas with frequent flooding pose a risk for pollution since during periods of flooding, wastewater cannot migrate downward into the soil. Instead the wastewater mixes with the surface water where it is susceptible to runoff and other illicit discharges. Properties were identified as at risk for flooding if they were within a FEMA designated 100-year floodplain as shown in Figure 2-14

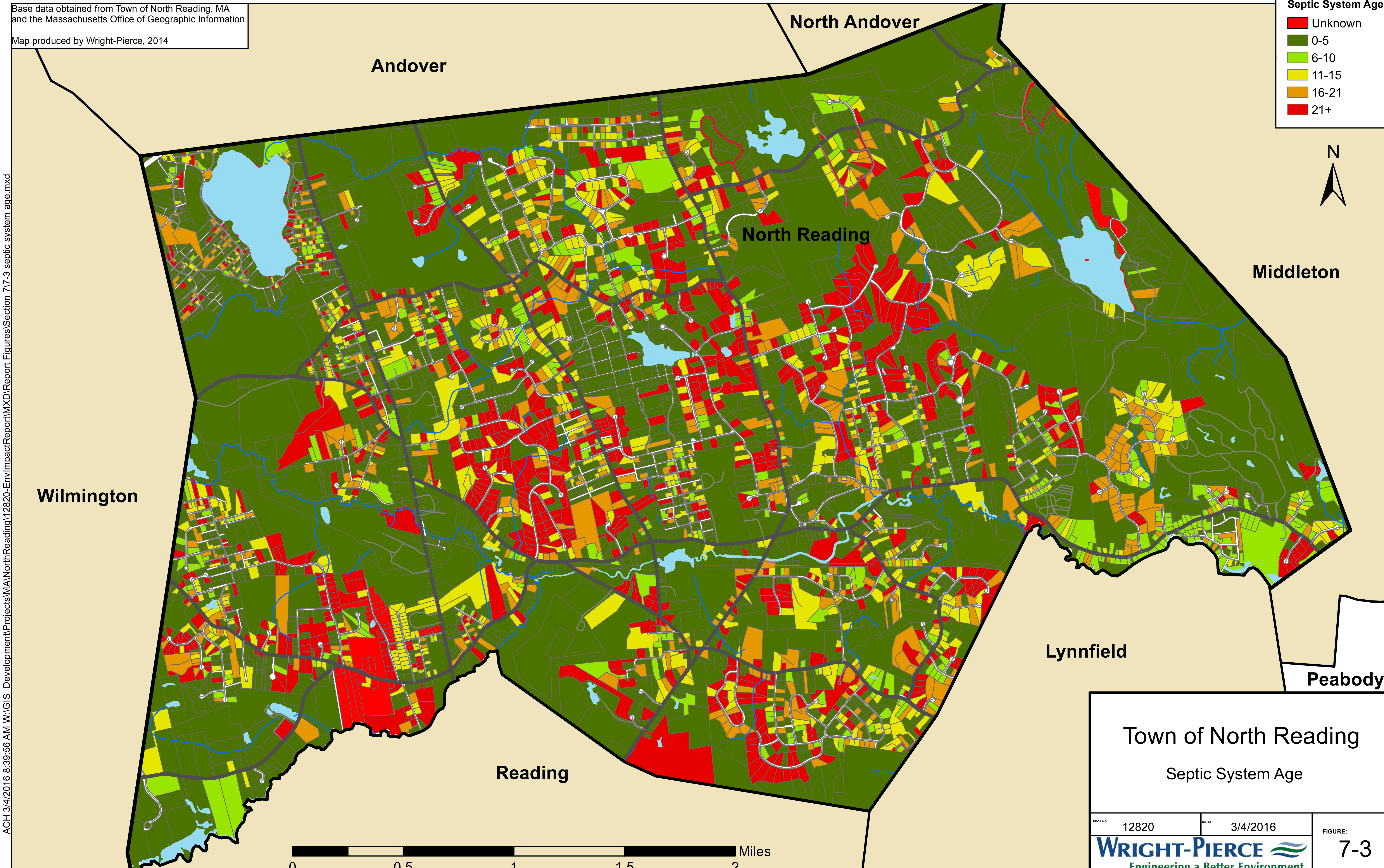
- Properties within FEMA floodplain were assigned a score of 5
- Properties with no flooding were assigned a score of 0

7.2.2.5 Septic System Age

Older septic systems pose a higher risk since they are not constructed to modern standards and likely provide a lower level of treatment to the wastewater. As they are reaching the end of their design like they are more likely of future failure. In addition, improper/reduced system maintenance throughout the life of the system increases the likelihood of failure. The septic system age was determined by reviewing the North Reading Board of Health septic system records.

- Properties with septic systems more than 20 years old were assigned a score of 5
- Properties with septic systems between 15 and 20 years old were assigned a score of 3
- Properties with septic systems between 10 and 15 years old were assigned a score of 1
- All other properties were assigned 0

Figure 7-3 shows the distribution on known septic ages in North Reading.



Town of North Reading

Septic System Age

PROJ NO:	DATE:	FIGURE:
12820	3/4/2016	7-3

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7.2.2.6 Pump Out Frequency

Depending upon the cited source and the individual's use of the septic system, MassDEP recommends that septic tanks are pumped out every three to five years; however, systems that are pumped more frequently may represent a symptom of a failed or failing septic system. The septic system pumping frequency was determined by reviewing the North Reading Board of Health septic system records. A frequently pumped system is defined by pumping every two years or more frequently.

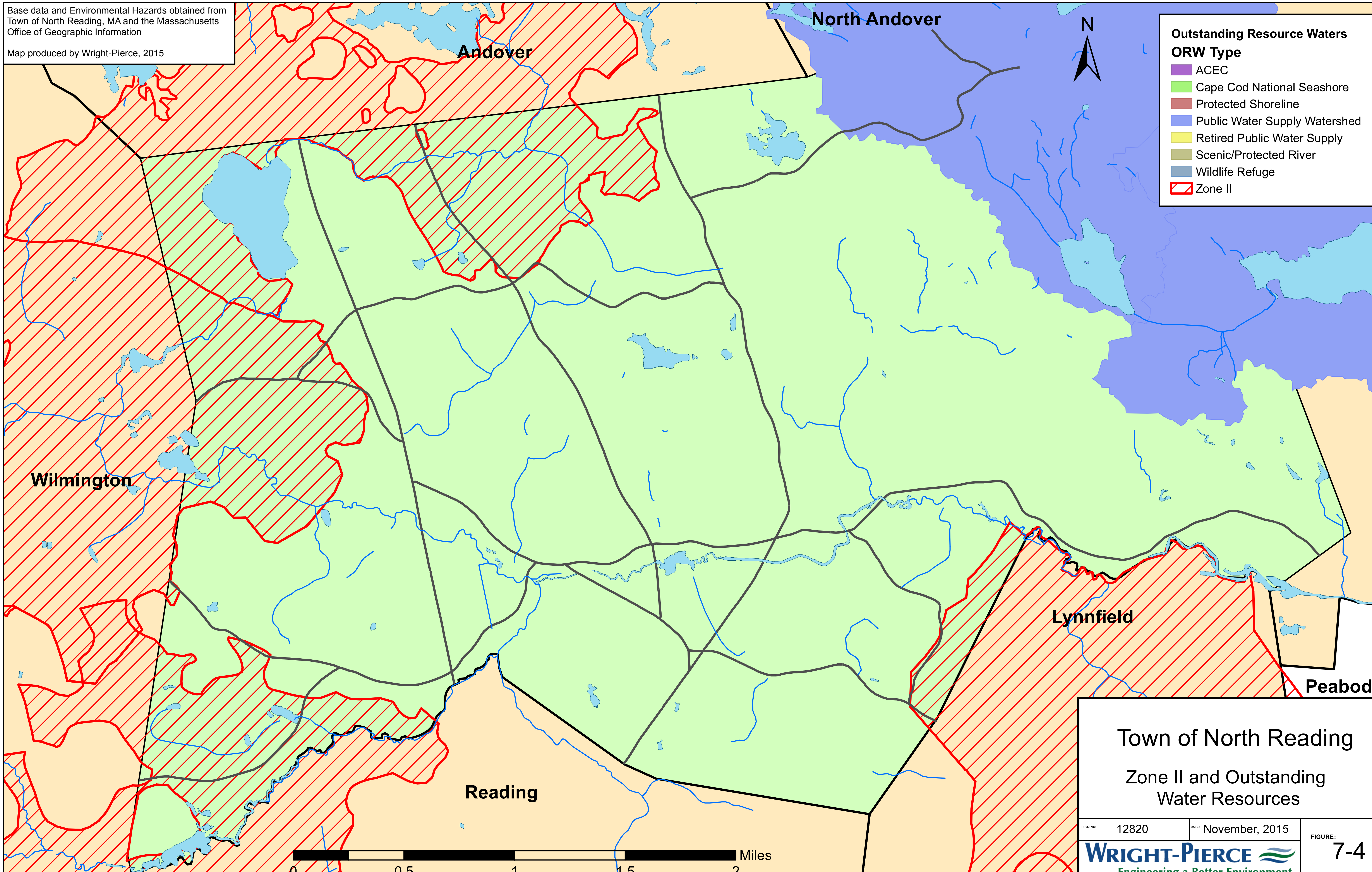
- Properties with septic systems pumped frequently were assigned a score of 3
- Properties with septic systems pumped at normal intervals were assigned a score of 0

7.2.2.7 Zone 2 or IWPA

Properties within close proximity to public groundwater resources are considered a priority. Preventing pollution in the vicinity of the water sources is an important health issue. Areas that have been determined to be a wellhead protection area through hydro-geologic modeling are considered Zone 2. Interim Wellhead Protection Area's (IWPA) are those that have not been modeled, but are still protected recharge areas for public groundwater sources

- Properties within a Zone 2 or IWPA were assigned a score of 5
- All other properties were assigned 0

Figure 7-4 presents location in North Reading with water resource protection areas, such as Zone II protection zones.



Town of North Reading

Zone II and Outstanding Water Resources

PROJ NO:	DATE:	FIGURE:
12820	November, 2015	7-4

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7.2.3 Category 1 Factors

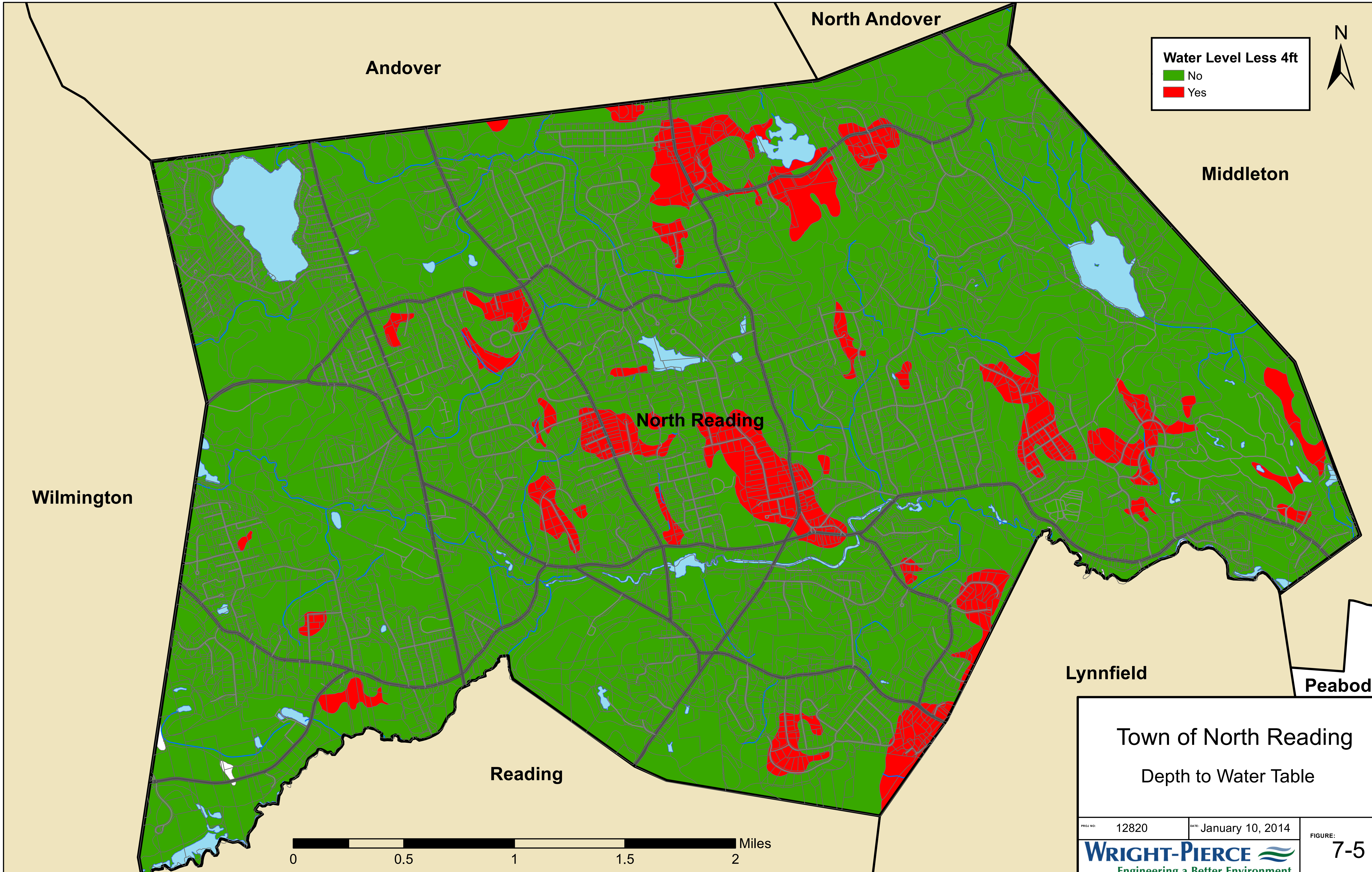
Finally, the factors receiving a weight of 1 include factors with identified indirect influence on ability of a property to support on-site wastewater treatment and disposal. These factors include items that pose economic challenges, or environmental concerns which may be mitigated. These factors are weighted significantly less, but should not be ignored. Unfortunately, while these challenges may be mitigated, often times these challenges lead to neglect and poor system performance. Therefore, just because a factor can be mitigated, does not mean it does not pose a risk to the system. For example, often times with failed septic system, the system remains unrepaired until the home is sold, or homeowners opt not to sell the property (or transfer the property within the family) since the system has failed Title 5 inspection.

7.2.3.1 Depth to Groundwater Table

Depth to groundwater is an important factor in the design of a groundwater discharge system. Modern SAS leach fields are required to have a minimum of four feet of separation from the groundwater. Lots with shallow groundwater require a mounded system which are often more complex and expensive than typical systems. They also represent specific site conditions that limit the ability to provide optimal system performance and future problems are likely to again occur.

- Properties with groundwater one foot or less below the surface were assigned a score of 5
- Properties with groundwater between one and two feet below the surface were assigned a score of 2
- Properties with groundwater between two and four feet below the surface were assigned a score of 1
- All other properties were assigned a score of zero

Figure 7-5 shows the areas in North Reading were the depth to groundwater is less than four feet.



Andover
North Andover
Middleton
Wilmington
North Reading
Reading
Lynnfield
Peabody
Water Level Less 4ft
No
Yes
N
0
0.5
1
1.5
2
Miles
Town of North Reading
Depth to Water Table
12820
January 10, 2014
FIGURE:
7-5
WRIGHT-PIERCE
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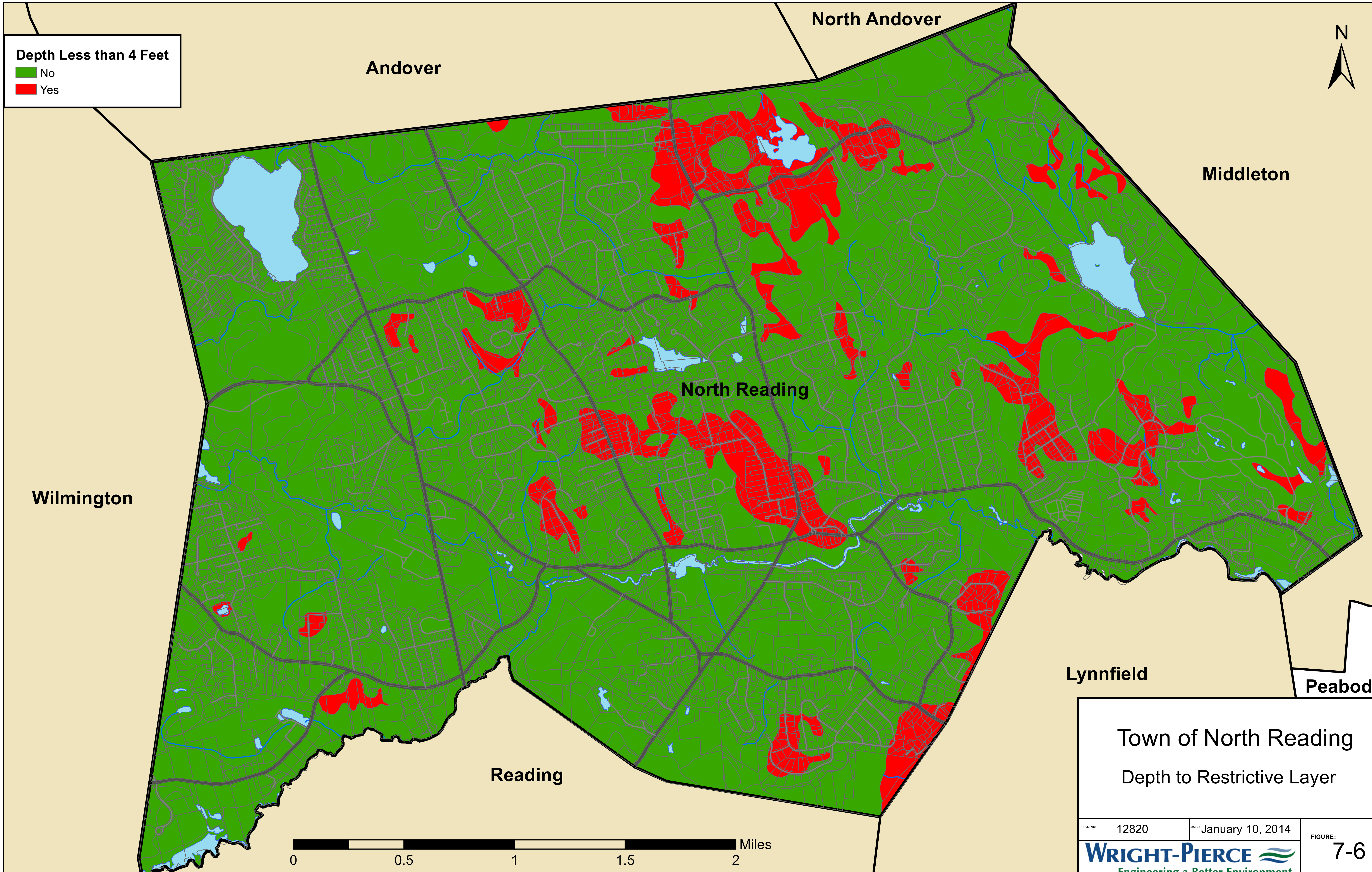
7.2.3.2 Depth to Restrictive Layer

Similar to the depth to groundwater item discussed above, insufficient depth to a restrictive layer poses challenges to the design of a groundwater discharge system. In the case of bedrock, or other restrictions that cannot be removed, a mounded system is required. Where the restrictive layer is a clay lens or other such removable restrictions, the restrictions may be removed and Title 5 material placed. Septic system leach fields are required to have a minimum of 4 feet of separation from restrictive layers. Lots with shallow restrictive layers require more complex and expensive systems. They also represent specific site conditions that limit the ability to provide optimal system performance and future problems are likely to again occur.

- Properties with a restrictive layer one foot or less below the surface were assigned a score of 5
- Properties with a restrictive layer between one and two feet below the surface were assigned a score of 2
- Properties with a restrictive layer between two and four feet below the surface were assigned a score of 1
- All other properties were assigned a score of zero

Figure 7-6 shows areas in Town with shallow soil restrictions, such as bedrock or perched clay layers.



Town of North Reading

Depth to Restrictive Layer

PROJ NO: 12820	DATE: January 10, 2014	FIGURE: 7-6

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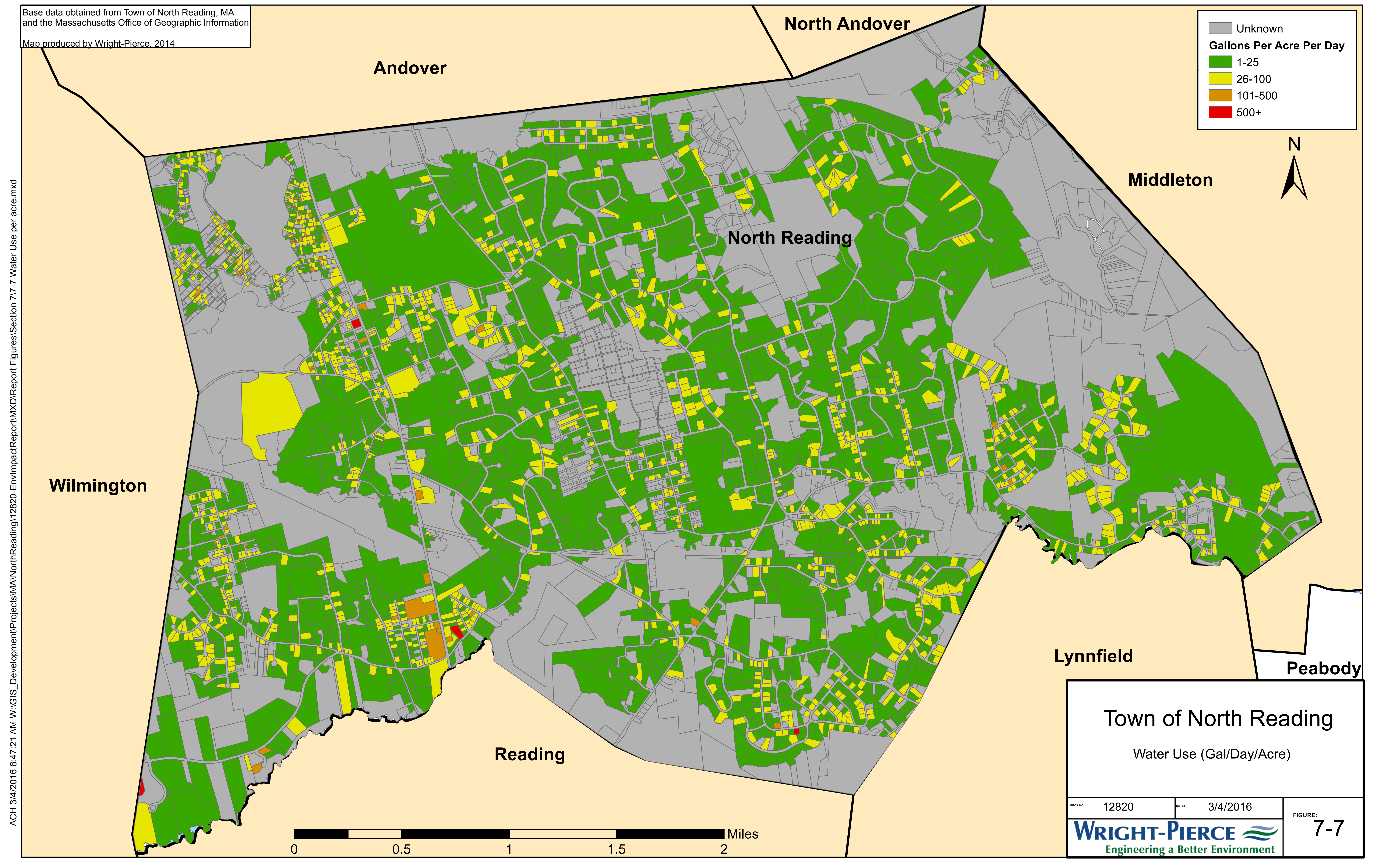
7.2.3.3 Water Use per Acre

The volume of wastewater generated by a property is correlated to its water use; therefore, properties with high water use often generate more wastewater which results in a higher volume of wastewater required for treatment and disposal by the on-site system. The higher volumes of wastewater can be adequately treated onsite as long as a properly sized system is in place and is maintained appropriately. However the higher flows can represent a risk to the system by stressing the ability of the system to manage the flows and potential for failure of the SAS. Existing water usage records were used as compared to the size of the parcel to calculate a value for each lot.

- Properties with gallon per day per acre (gpd/acre) use over 500 were assigned a score of 5
- Properties with gpd/acre use between 250 and 500 were assigned a score of 4
- Properties with gpd/acre use between 100 and 250 were assigned a score of 3
- Properties with gpd/acre use between 25 and 100 were assigned a score of 2
- All other properties were assigned 0

Figure 7-7 shows the distribution of water use per acre in North Reading.


Base data obtained from Town of North Reading, MA
and the Massachusetts Office of Geographic Information
Map produced by Wright-Pierce, 2014
Unknown
Gallons Per Acre Per Day
1-25
26-100
101-500
500+
N
North Andover
Andover
Middleton
North Reading
Wilmington
Lynnfield
Peabody
Reading
Miles
0
0.5
1
1.5
2
Town of North Reading
Water Use (Gal/Day/Acre)
PROJ NO: 12820
DATE: 3/4/2016
FIGURE: 7-7
WRIGHT-PIERCE
Engineering a Better Environment
ACH 3/4/2016 8:47:21 AM W:\GIS_Development\Projects\MA\NorthReading\12820-EnvImpactReport\MXD\Report Figures\Section 7\7-7 Water Use per acre.mxd

7.2.3.4 Wetlands

Wetlands are an important protected resource and also represent the proximity from the on-site wastewater management and disposal system to wetlands resources. Wastewater discharge within a wetland or its 100-ft buffer zone poses a risk of pollutants entering the resource area and makes siting a system challenging. Wetlands are depicted in Figure 2-12.

- Properties that had wetlands resources within the boundaries were assigned a score of 5
- Properties that had a portion of the parcel within the buffer zone of a wetland were assigned a score of 3
- All other properties were assigned 0

7.2.3.5 Private Wells

The local Board of Health requires mandatory offsets for a septic system from a private well. These offsets eliminate much of the risk of a properly working septic system contaminating the drinking water. Siting a SAS on a property with a private well can be challenging and some risk remains that a poorly performing system could pollute the groundwater within the well's zone of influence. Private well users are depicted in Section 3 in Figure 3-10.

- Properties with private drinking water wells were assigned a score of 5
- All other properties were assigned 0

7.2.3.6 Outstanding Water Resource Protection Zone

Similar to groundwater sources, public surface water sources and other Outstanding Water Resources (OWR) must be protected from potential pollution. Surface water sources are prone to pollution via runoff. poorly performing on-site wastewater treatment and disposal systems can lead to pollution which may enter a surface water source. Since surface water requires more advanced treatment than groundwater source, the risk of pollution leading to a health concern is lower for surface water sources when compared to ground water sources. OWR areas are shown on map with Zone II protection areas at the end of this section.

- Properties within a OWR protection zone were assigned a score of 5
- All other properties were assigned 0

7.2.4 Wastewater Matrix Analysis Trends/Summary

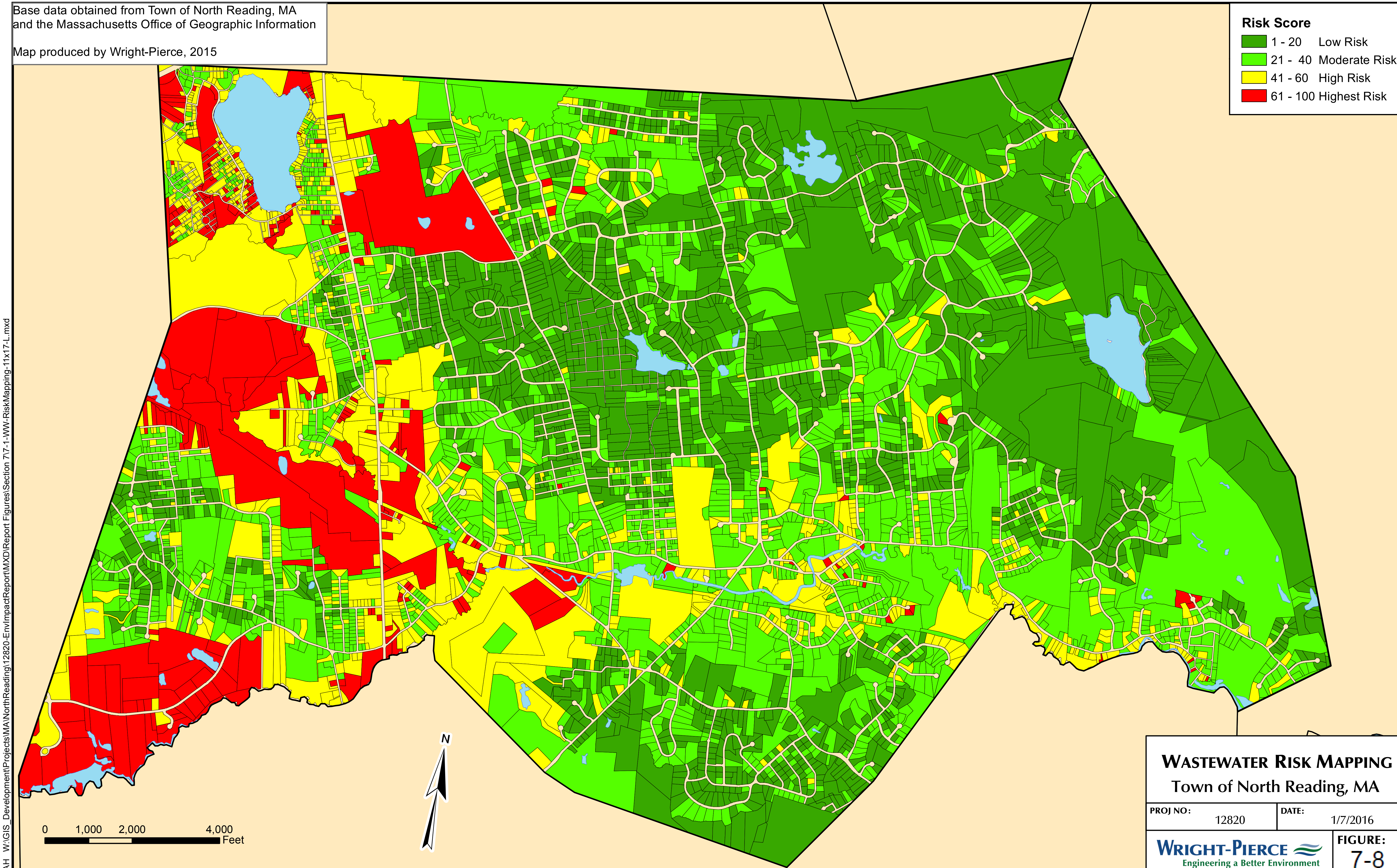
A summary of the scoring system assigned for the analysis is presented in Table 7-3.

TABLE 7-3
WASTEWATER FACTOR SCORING

Parameter	Weight	Range 1	Score 1	Range 2	Score 2	Range 3	Score 3	Range 4	Score 4	Range 5	Score 5
Known Septic Rehab	5	Yes	5	no	0						
Has Tight Tank	5	Yes	5	no	0						
Water Use Class	5	Industrial	5	Commercial	4	Institutional	3	All others	0		
Proximity to Impaired water	5	Within 1/4 mile	5	Within 1/2 mile	2	> thin 1	0				
Lot size	2	<0.25 acre	5	0.26-0.33	3	0.34-0.5	2	0.51-1	1	>1	0
Soil Drainage	2	Very Poorly Drained	5	Poorly Drained	4	Moderately well drained or better					
Ponding	2	Frequent	5	Rare/Never	0						
Flooding	2	Within 100yr	5	Not in Floodplain	0						
Septic System Age	2	>20	5	15-20	3	10-15	1	<10	0		
Pump Out frequency	2	frequent	3	normal	0						
Within Zone 2 or IWPA	2	Yes	5	no	0						

Parameter	Weight	Range 1	Score 1	Range 2	Score 2	Range 3	Score 3	Range 4	Score 4	Range 5	Score 5
Depth to GW	1	<1	5	2-1	2	4-2	1	>4	0		
Depth to Restrictive Layer	1	<1	5	2-1	2	4-2	1	>4	0		
Water Use (gpd per acre)	1	>500	5	250-499	4	100-249	3	25-99	2	<259	02
Adjacent to wetland	1	In Wetland	5	In buffer	3	not in buffer or wetland	0				
Private well	1	Yes	5	no	0						
Outstanding Water Resource Protection Zone	1	Yes	5	no	0						

Every lot in town received an aggregate score based on the sum of its score in each risk category. For simplicity, the aggregate scores were normalized to a risk score out of 100. A chart was created plotting each lot's score. The curve that resulted was used to determine what risk level related to the scoring system. The curve had natural break points at scores of 60, 40 and 20 once rounded to even numbers. Lots with a risk score greater than 60 were categorized as Highest Risk (represented in red), risk scores between 40 and 60 were categorized as High Risk (represented in yellow), risk scores between 20 and 40 were categorized as Moderate Risk (represented in light green), and risk scores less than 20 were categorized as Low Risk (represented in dark green). In GIS, each parcel was tagged with its score and color coded as described above. The resulting map is shown as Figure 7-8.



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7.3 DELINEATION OF STUDY AREAS

After completion of the wastewater needs matrix and the subsequent mapping, the Town was segmented into areas that gathered similar scored parcels together within a geographic area. The delineation also accounted for natural and manmade geographic areas, such as roads, water resources and zoning constraints. This resulted in the formation of 16 study areas to allow for analysis of the need for a potential municipal wastewater management solution. The study areas are used as general guidelines to aid in analysis but do not define specific limits of wastewater needs.

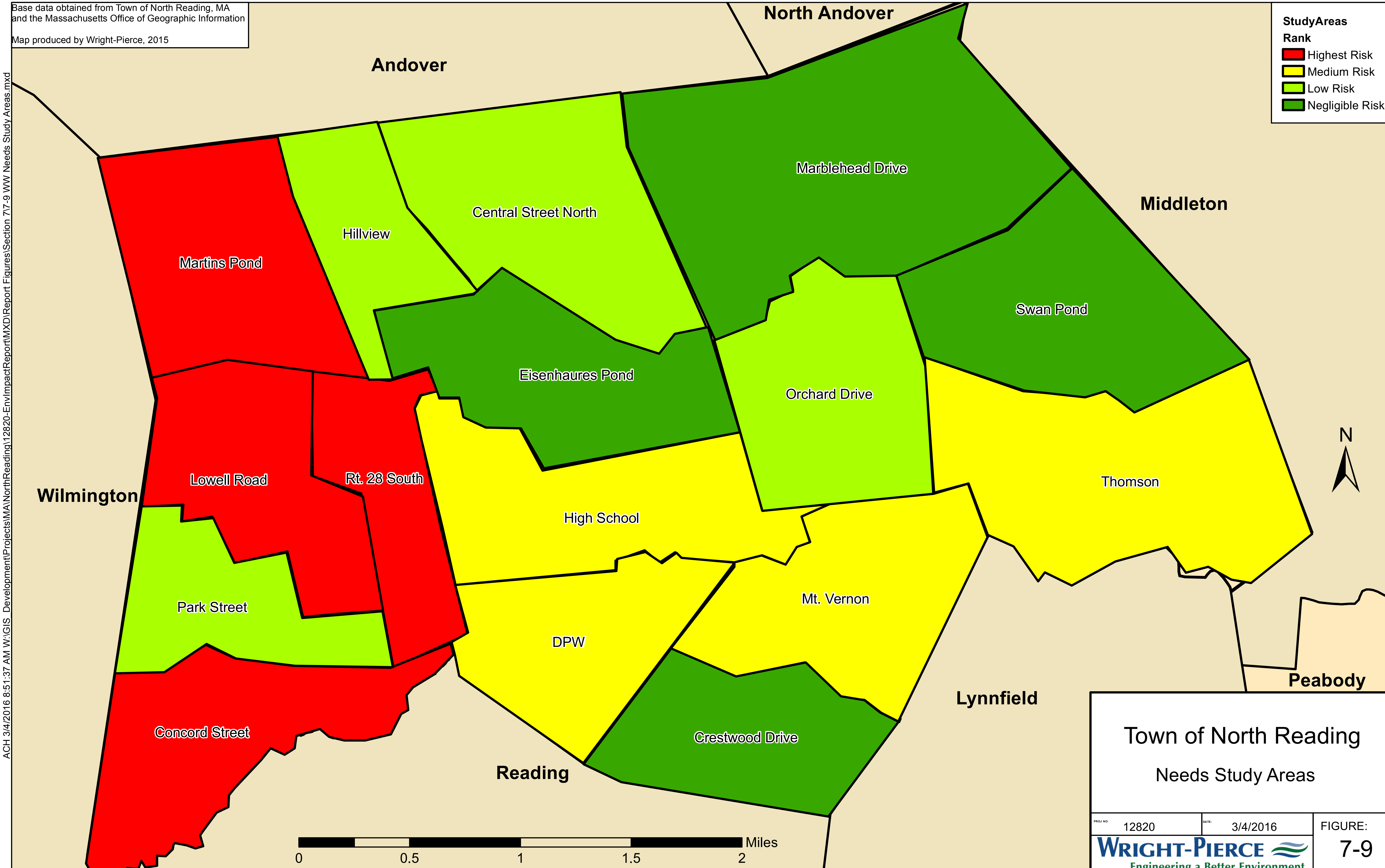
The study areas are named as follows:

- Martins Pond
- Lowell Road
- Park Street
- Concord Street
- Route 28 South
- Hillview
- Central Street North
- Eisenhaures Pond
- High School
- Department of Public Works
- Crestwood Drive
- Mount Vernon
- Marblehead Street
- Orchard Drive
- Thomson
- Swan Pond

Following creation of the study areas, the wastewater needs matrix was applied to the study areas in GIS to determine overall characteristics of each study areas. Total risk points were calculated for each study area as the sum of the risk points of each lot in the study area. The average points per lot in each study area was calculated and the top three factors that influenced risk scores in each study area was also calculated. Table 7-4 shows a summary of these trends. Figure 7-8 shows the location of the study areas. Each study area was assigned an overall need level, as symbolized in the map. The needs level was designated as high, medium, low and negligible. Rankings are based on average risk points per lot for each study area.

TABLE 7-4
WASTEWATER NEEDS STUDY AREAS TRENDS SUMMARY

Study Area	Total Risk Points	% of Town Risk Points	Points per Lot	Rank	Top 3 Factors		
					1	2	3
Lowell Road	7,057	3.8%	56.5	1	Impaired Water	Zone2/IWPA	Flood Zone
Martins Pond	39,288	21.0%	55.1	2	Impaired Water	Lot Size	Zone2/IWPA
Rt 28 South	11,876	6.3%	53.5	3	Impaired Water	Water Use Class	Lot Size
Concord Street	9,387	5.0%	49.7	4	Impaired Water	Water Use Class	Zone2/IWPA
DPW	5,838	3.1%	39.7	5	Impaired Water	System Age	System Age
Mt. Vernon	14,198	7.6%	38.4	6	Impaired Water	Septic Fails	System Age
High School	19,287	10.3%	37.7	7	Impaired Water	System Age	Lot Size
Thomson	15,272	8.1%	35.3	8	Impaired Water	Water Use	Lot Size
Orchard Drive	13,453	7.2%	33.3	9	Impaired Water	System Age	Flood Zone
Park Street	13,024	6.9%	32.8	10	Impaired Water	Lot Size	System Age
Hillview	3,353	1.8%	29.9	11	Water Use Class	Impaired Water	System Age
Central Street North	12,815	6.8%	26.2	12	Zone2/IWPA	Septic Fails	Flood Zone
Marblehead Drive	8,216	4.4%	20.5	13	Wetlands	Flood Zone	ORW
Crestwood Drive	5,331	2.8%	20.0	14	System Age	Septic Fails	Water Use
Swan Pond	1,921	1.0%	19.6	15	Wetlands	ORW	Flood Zone
Eisenhuaer Pond	7,085	3.8%	15.3	16	System Age	Lot Size	Water Use
Town Total	**187,401**	**100.0%**	**35.1**				



Town of North Reading

Needs Study Areas

PROJ NO:	DATE:	FIGURE:
12820	3/4/2016	7-9

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7.4 STUDY AREA DESCRIPTIONS AND ASSESSMENTS

A windshield survey was conducted to confirm the results of the Needs Study area analysis and trends shown in Table 7-4. The overall condition, age, and density of residential neighborhoods were noted. Particular attention was paid to high risk or “red” designated lots to determine if they were typical to the specific area or atypical. The presence of a single “red” designated lot within an area of low risk lots represents an outlier data point and is likely associated with very site specific constraints rather than a larger area problem. As developed in the needs analysis, “red” designated lots were determined to have the highest likelihood of current or future on-site wastewater treatment and disposal system insufficiency as well as difficulties in siting on-site wastewater disposal systems. Particular attention was paid to the Top 3 Factors that influenced the risk scores in each area.

7.4.1 Martins Pond

The Martin Pond study area is located in the northwestern part of Town. The study area is bordered by Andover to the north and Wilmington to the west. It is also bordered by the Lowell Road study area to the south and Hillview study area to the east.

The Martins Ponds study area consists of 713 lots, 17 percent of which are highest risk, 50 percent are high risk, and 33 percent are moderate or low risk. The Martins Pond Study Area ranks 1st among all study areas for total needs risk scoring, and 2nd for risk score per lot. The top three factors influencing scores in the Martins Pond study area are impaired waters, lot size, and Zone 2/IPWA.

Based on the windshield survey, the area matches the summary. The majority of lots in this area are small, residential lots located to the east and west of impaired water, Martins Pond. The area has some retaining walls and mounded systems were observed.

The east side of the pond, between Hillside Road and Route 28 (Main Street), is densely populated with older homes on small lots. The area’s close proximity to Martins Pond and frequent sloping creates a high potential for breakout/runoff into the pond.

The West side of the pond is less densely populated than the east, but still has smaller lots. The potential for pollutant runoff into the pond is lesser in this area. The area along Andover Road and Burroughs Road is wooded and rural.

The eastern border of this study area contains Route 28, with a mix of commercial lots, including part of the Hillview Country Club.

7.4.2 Lowell Road

The Lowell Road study area is located in the west part of Town. The study area is bordered by Wilmington to the west. It is also bordered by the Martins Pond study area to the north, Park Street study area to south, and Route 28 South study area to the east.

The Lowell Road study area consists of 125 lots, 31 percent of which are highest risk, 27 percent are high risk, and 42 percent are moderate or low risk. The Lowell Road Study Area ranks 12th among all study areas for total needs risk scoring, but is ranked 1st for risk score per lot due to the low overall count of lots in this area

The top three factors influencing scores in the Lowell Road area are impaired waters, zone 2/IPWA and flood zones. From our survey it appears these factors are accurate as Peppers Brook, a tributary to Martins Brook - an impaired water, runs through this area.

Also contained in this area are the Edgewood Luxury apartments, a sports playing field, and in the South east corner is the United States Post Office distribution center, which has its own wastewater treatment facility. There is one neighborhood off Abbot Road and along Peppers Brook. This neighborhood is comprised of older homes on half acre lots, and is medium density. The remaining 50% of the area is comprised of woodlands and wetlands.

7.4.3 Park Street

The Park Street study area is located in the south west part of Town. The study area is bordered by Wilmington to the west. It is also bordered by the Lowell Road study area to the north, Concord Street study area to south, and Route 28 South study area to the east.

The Park Street study area consists of 397 lots, less than 1 percent of which are highest risk, 15 percent are high risk, and 85 percent are moderate or low risk. The Park Street Study Area ranks 6th among all study areas for total needs risk scoring, and is ranked 10th for risk score per lot.

The top three factors influencing scores in the Park Street area are impaired waters, lot size and system age.

The area is mainly classified by residential neighborhoods, with the exception of a school. Along Lowell road is a dense neighborhood with older homes on 1/3 acre lots, which aligns with the lot size and system age being risk factors. The area is characterized by septic systems. Mounded SAS were not prevalent in the area. Vegetated wetlands are present in the northern part of the study area. Much of the area is also within ½ mile of impaired waters. Martins and Pepper Brook are to the north while the Ipswich River is to the south.

7.4.4 Concord Street

The Concord Street study area is located in the southwest part of Town. The study area is bordered by Wilmington to the west and Reading to the south and east. It is also bordered by the Park Street study area to the north.

The Concord Street study area consists of 189 lots, 24 percent of which are highest risk, 22 percent are high risk, and 54 percent are moderate or low risk. The Concord Street Study Area ranks 9th among all study areas for total needs risk scoring, and is ranked 4th for risk score per lot.

The top three factors influencing scores in the Concord Street area are impaired waters, water use class and Zone 2/IPWA.

This study area is unique to North Reading as there are many larger, commercial and industrial lots along Concord Street. A highly populated office park complex is at the North Reading, Reading and Wilmington border, as well as Interstate 93. This busy office park and commercial area supports the water use class risk factor. The area is bounded on the south by the Ipswich River, which is an impaired water body.

Residential neighborhoods continue from the southern part of the Park Street study area into the Northern third of the Concord Street study area. Redmond Ave specifically is a newer development with half acre lots, with vegetated wetlands at the end of the neighborhood. These wetlands and residential neighborhoods border the commercial and industrial section of the area.

More residential lots are in the eastern section of the area, which are categorized by larger, rural homes on about ½ acre lots bordering the Ipswich River.

7.4.5 Route 28 South

The Route 28 South study area is located in the southwest part of Town. The study area is bordered by the Lowell Road and Park Street study areas to the west. It is also bordered by the Martins Pond and Hillview study areas to the north, Concord Street study area to south, and the High School and DPW study areas to the east.

The Route 28 South study area consists of 222 lots, 17 percent of which are highest risk, 46 percent are high risk, and 37 percent are moderate or low risk. The Route 28 South Study Area ranks 8th among all study areas for total needs risk scoring, and is ranked 3rd for risk score per lot.

The top three factors influencing scores in the Route 28 South area are impaired waters, water use class and lot size.

Our windshield survey shows that the area is categorized by commercial lots surrounded by wetlands. The area is somewhat non-residential with some smaller scattered residential neighborhoods and apartments. There are a few scattered abandoned commercial lots directly along Route 28. The residential neighborhoods at the North (Nichols Street) and South (Damon Street) of the area contribute to the lot size risk.

7.4.6 Hillview

The Hillview study area is located in the northwest part of Town. The study area is bordered by Andover to the north. It is also bordered by the Martins Pond study area to the west, Route 28 South and Eisenhaures study areas to the south and Central Street study area to the east.

The Hillview study area consists of 112 lots, one percent of which are highest risk, 15 percent are high risk, and percent are moderate or low risk. The Hillview Study Area ranks 15th among all study areas for total needs risk scoring, and 11th for risk score per lot.

The top three factors influencing scores in the Hillview Study area are water use class, impaired waters, and system age.

There is only one high risk lot in this area, which is the Hillview Country Club. This lot takes up about half of the study area, which may contribute to the area's high water use class score which is specifically attributable to lawn maintenance. This area also contains the Meadow View Care center, a nursing home that contains its own wastewater treatment plant, which contributes to the water use classification. It should be noted that although the country club received a high risk score, the size of the property mitigates much of this risk.

The area is located in close proximity to Martins Pond. There appeared to be a low likelihood of influence on Martins Pond due to topography. The Northeast section of the area has two cul-de-sacs containing larger homes on large to medium sized lots. North Street is an average density residential neighborhood. Overall, the Hillview Study area appeared to have a slightly lower risk than anticipated.

7.4.7 Central Street North

The Central Street North study area is located in the north part of Town. The study area is bordered by Andover to the north. It is also bordered by the Hillview study area to the west, Eisenhaures study area to the south and Marblehead Drive study area to the east.

The Central Street North study area consists of 489 lots, one percent of which are highest risk, eight percent are high risk, and 91 percent are moderate or low risk. The Central Street North Study Area ranks 7th among all study areas for total needs risk scoring, and 12th for risk score per lot.

The top three factors influencing the Central Street North study area are Zone 2/IPWA, septic fails, and flood zone.

The summary shows the area is largely low and very low risk lots, with a few scattered high risk lots. Our survey showed that these "red" lots generally were consistent with the residential neighborhood where they were located. Mounded systems were observed in these neighborhoods.

Our windshield survey showed that this area is a mix of older and newer residential neighborhoods of varying lot size. Along Pineridge Road, sump pumps in basements were evident. Some ledge outcroppings were also noted. These conditions support the flooding scores observed in this area. Our windshield survey also showed that this area was a mix of new and older development. For example, Agatha road was a newer development, with mounded septic systems. On the other hand, Hillview Road had older homes on larger ½-1 acre lots.

7.4.8 Eisenhaures Pond

The Eisenhaures Pond study area is located in the central part of Town. The study area is bordered by the Central Street North study area to the north, the Hillview and Route 28 South study areas to the west, the High School study area to the south, and Orchard Drive study area to the east.

The Eisenhaures Pond study area consists of 464 lots, one percent are high risk, and 99 percent are moderate or low risk. There are no high risk lots. The Eisenhaures Pond Study Area ranks 11th among all study areas for total needs risk scoring, and 16^{th} for risk score per lot.

The top three factors influencing the Eisenhaures Pond study area include system age, lot size, and water use. Like the Central Street North study area, our windshield survey showed that this area is a mix of older and newer residential neighborhoods of varying lot size. Active landscaping and lawn maintenance was observed, which is consistent with the water use class risk score.

7.4.9 High School

The High School study area is located in the center of Town. The study area is bordered by the Eisenhaures study area to the north, the Route 28 South study area to the west, the DPW study area to the south and Orchard Drive study area to the east.

The High School study area consists of 511 lots, two percent of which are highest risk, 20 percent are high risk, and 78 percent are moderate or low risk. The High School Study Area ranks 2nd among all study areas for total needs risk scoring, and 7th for risk score per lot.

The top three factors influencing the High School study area included impaired waters, system age, and lot size. The southern border of the study area is defined by the impaired Ipswich River. Scores resulting from proximity to impaired waters makes up nearly half of the study area scores. The summary shows that the majority of the lots are green, followed by yellow lots and a few red lots.

The three high risk lots along Winter Street appeared to be older homes in a mixed residential and commercial neighborhood. The septic systems were in front of the homes slightly mounded, and located along the Ipswich River. The high risk lots on Park Street and Old Farm Lane were consistent with the neighborhood.

The windshield survey showed that this area is commercial with intermittent residential areas as well as conservation land. While Winter Street, Freedom Drive and Central Street were medium density residential neighborhoods with larger lots, Oakdale Street showed smaller, half acre lots. This may have contributed to the system age and lot size risk factors. Also notable to this area is the new on-site wastewater treatment and disposal facility serving the recently constructed middle and high school complex.

7.4.10 Department of Public Works (DPW)

The DPW study area is located in the south area of Town. The study area is bordered by Reading to the south. It is also bordered by the High School study area to the north, Route 28 South study area to west, and the Mt. Vernon and Crestwood Drive study areas to the east.

The DPW study area consists of 147 lots, five percent of which are highest risk, 27 percent are high risk, and 68 percent are moderate or low risk. The DPW Study Area ranks 13th among all study areas for total needs risk scoring, and 5th for risk score per lot.

The top three factors influencing the DPW study area are impaired waters, system age and flood zone. Nearly 70 percent of the lots of low or lowest risk, but larger medium and high risk lots take up over half the land in the area. The DPW complex, Moynihan Lumber and Maguire Field take up much of the land in the area. This study area is bordered on the north by the Ipswich River, thus influencing its impaired water scores.

North of Chestnut street is some commercial and industrial. There is a mix of open land and residential lots with ½-1 acre lots.

7.4.11 Crestwood Drive

The Crestwood Drive study area is located in the south of Town. The study area is bordered by Reading to the south and Lynnfield to the east. It is also bordered by the Mt. Vernon study area to the north, and DPW study area to the west.

The Crestwood Drive study area consists of 267 lots, one percent of which are high risk, and 99 percent are moderate or low risk. There are no high risk lots. The Crestwood Drive Study Area ranks 14th among all study areas for total needs risk scoring, and 14th for risk score per lot.

The top three factors influencing the Crestwood Drive study area scores are system age, septic fails, and water use. There were no high risk lots in this area. Our windshield survey showed that the area is mainly residential. Older homes, with a mix of new, on half acre lots are typical of this area. Some ledge outcropping was observed.

7.4.12 Mount Vernon

The Mt Vernon study area is located in the south area of Town. The study area is bordered by Lynnfield to the east. It is also bordered by the Orchard Drive study area to the north, Crestwood Drive study are to the south, and the DPW study area to the west.

The Mt Vernon study area consists of 370 lots, two percent of which are highest risk, 21 percent are high risk, and 77 percent are moderate or low risk. The Mt Vernon Study Area ranks 4th among all study areas for total needs risk scoring, and 6th for risk score per lot.

The top three factors influencing the Mount Vernon study area are impaired waters, septic fails and system age. The Ipswich River borders this study area on the North side. The summary indicates that there were clusters of "red" lots on Wright Street, Williams Road and Washington Streets. On Washington Street, these lots were observed to be small, set-back lots. On Williams Road these lots were observed to be consistent with the neighborhood, with septic systems visible and slightly mounded. The red lots on Wright Street were also observed to be consistent with the neighborhood, with one lot showing signs of a possible rehabilitated septic system.

Overall this area was a mix of newer and older homes on big lots. Many of the cul-de-sacs were surrounded by woodlands and wetlands.

7.4.13 Marblehead Street

The Marblehead Street study area is located in the northeast part of Town. The study area is bordered by North Andover to the north and Middleton to the east. It is also bordered by the Orchard Drive and Swan Pond study areas to the south, and Central Street North study area to the west.

The Marblehead Street study area consists of 400 lots, three percent of which are high risk, and 97 percent are moderate or low risk. There are no highest risk lots. The Marblehead Street Area ranks 10th among all study areas for total needs risk scoring, and 13th for risk score per lot.

The top three factors influencing the Marblehead Street study area are wetlands, flood zones, and ORW. There were no red lots in the summary of the area. The largest residential neighborhood in the area was a mix of large, newer homes. Lots were generally greater than one acre. One mounded system was observed. The remaining neighborhoods were a mix of new and old development. Much landscaping and lawn maintenance was observed which may contribute to a higher water use percentage of scores. Much of this area appeared to be wooded open space and wetlands.

7.4.14 Orchard Drive

The Orchard Drive study area is located in the central part of Town. The study area is bordered by the Marblehead study area to the north, the Mt. Vernon study area to the south, the Swan Pond and Thomson study areas to the east, and Eisenhaures Pond study area to the west.

The Orchard Drive study area consists of 404 lots, one percent of which are highest risk, 16 percent are hihg risk, and 83 percent are moderate or low risk. The Orchard Drive study area ranks 5th among all study areas for total needs risk scoring, and 9th for risk score per lot.

The top three factors influencing the Orchard Drive study area are impaired waters, system age and flood zones. There were three red lots that proved to be consistent with the area during the windshield survey. The red lot on Orchard Drive was located right on the wetlands and the Ipswich River. The septic system on this lot was visible from the road on the front lawn.

The Ipswich River borders this study area on the South. Like most of the study areas, the residential neighborhoods ranged from larger homes in new developments to older 70s era home on 1/3 acre lots. Some mounded systems were observed throughout the area, as well as some ledge outcropping. Wetlands were observed south of Elm Street.

7.4.15 Thomson

The Thomson study area is located in the east part of Town. The study area is bordered by Lynnfield to the south and Middleton to the east. It is also bordered by the Orchard Drive study area to the west, and Swan Pond study area to the north. The Ipswich River borders this area on the South.

The Thomson study area consists of 433 lots, two percent of which are highest risk, 19 percent are hihg risk, and 79 percent are moderate or low risk. The Thomson Area ranks 3rd among all study areas for total needs risk scoring, and 8th for risk score per lot.

The top three factors influencing the Thomson study area are impaired water, water use, and lot size. The area is mainly residential but includes the Thomson Country Club. There were two high risk lots on Riverside Drive, one of which is an abandoned residential property. Both of the abandoned lots were on the bank of the Ipswich River. One of the lots is on a very steep grade. Septic systems were not visible on either of these lots. There were also high risk lots on Lisa Lane. Our survey proved that these lots were consistent with the neighborhood. Approximately one acre lots with mounded septic systems were typical of the area.

While bigger, newer homes were observed along Macintyre Drive and intermittently throughout the area, the areas West and South of these streets were mainly older, smaller homes in dense neighborhoods. The small lots had septic systems at grade.

7.4.16 Swan Pond

The Swan Pond study area is located in the east part of Town. The study area is bordered by Middleton to the east. It is also bordered by the Orchard Drive study area to the west, Marblehead Drive study area to the north and Thomson study area to the south.

The Swan Pond study area consists of 98 lots, one percent of which are high risk, and 99 percent are moderate or low risk. There are no highest risk lots. The Swan Pond Area ranks last among all study areas for total needs risk scoring, and 15th for risk score per lot.

The top three factors influencing the Swan Pond study area are wetlands, ORW, and flood zones. The windshield survey confirmed the results of the needs matrix and also showed that this area is mainly undeveloped conservation land. Dogwood Lane, located to the East of Swan Pond is developing new homes. Bridle Way has newer, larger homes on large lots.

7.4.17 Windshield Survey Summary

Overall the windshield survey was successful in confirming the results of the wastewater needs matrix and consistent with data obtained about the area. Neighborhood characteristics observed matched the area summary characteristics developed through GIS analysis. Windshield survey validated the criteria identified, and relative needs.

7.5 WASTEWATER NEEDS AREA

After confirming the Wastewater Matrix Analysis through the windshield survey, four study areas were chosen for further needs analysis. These areas were chosen based on the results presented previously in Table 7-4, which ranks each of the sixteen study areas by risk points per lot. As provided in the table, there is a quantifiable gap in the risk points per lot between the Concord Street and DPW study areas. This provides an appropriate point of differentiation, when determining the needs of the Town relative to a municipal wastewater management solution. The four areas above the line have risk and criteria that are significantly impacting the environment through the poorly performing on-site systems, an inherent challenge regarding the siting and replacement of existing systems, water quality impacts from existing systems and a percentage of the Town's commercial and industrial users. Within the four needs analysis areas, there are more than 900 parcels.

It is important to note that the top four study areas were used as guidelines for further studying wastewater alternatives. It is not necessary to provide a municipal wastewater solution to all parcels within these areas as many individual lots within the areas are low risk. In addition, lots with high risk scores adjacent to the needs areas with highest/high risk may also warrant a municipal solution. Table 7-5 shows the study areas with the largest average risk points per lot. As shown, these study area's risks are largely influenced by their proximity to impaired waters, drinking water resources, and water use classes.

TABLE 7-5
TOP THREE FACTORS INFLUENCING TOP FOUR STUDY AREAS

Study Area	Top 3 Factors		
	1	2	3
Lowell Road	Impaired Water	Zone2/IWPA	Flood Zone
Martins Pond	Impaired Water	Lot Size	Zone2/IWPA
Rt 28 South	Impaired Water	Water Use Class	Lot Size
Concord Street	Impaired Water	Water Use Class	Zone2/IWPA

7.5.1 Potential Municipal Wastewater Management Scenarios

A simplified, common-sense approach to determining a municipal wastewater plan is needed to continue the analysis. A series of scenarios were developed to determine the benefits and extents of providing a municipal wastewater solution to the four risk areas. These scenarios were evaluated and a wastewater flow (need) for each was calculated.

The first scenario considered capturing all parcels in the top four needs areas. In this scenario every lot within the needs area would be provided with a municipal-owned and operated solution regardless of risk. In this scenario, due to increased infrastructure needs, it was found that the increase in infrastructure required to provide a municipal solution to every lot within the high priority areas provided minimal benefit. While every lot can benefit from municipal wastewater management - capturing even the lowest risk lot can improve water quality - the cost and negative project impacts can become prohibitive and outweigh the benefit of municipal wastewater management.

The second scenario considered captured all of the highest and high risk (red/yellow) residential lots and included all non-residential lots. This scenario specifically excludes moderate and low risk residential lots. In this case, many moderate and low risk lots had sewer installed adjacent to their property, but they were not provided a service. While this may be feasible, it is not considered the best overall approach. As noted previously, moderate and low risk lots still represent some risk of pollution, and may exhibit similar limitations associated with nearby lots (due to the statistical nature of the analysis) and the risk may increase in the future.

Additionally, local Board of Health and MassDEP requirements could require the municipal wastewater management system be available to all customers within a specified distance to an existing system. In this scenario, such a requirement would not be accounted for in the design flows. Therefore; such a requirement could not be practically used with this scenario.

This scenario also becomes inefficient when the number of connections per mile of sewer is considered. A low number of users per mile of sewer will result in high upfront capital cost as well as high operation and maintenance cost per user resulting in unaffordable sewer rates. Inefficient sewer systems would also results in higher energy costs and increased carbon footprint per connection.

A third scenario was selected for further consideration aimed to find a balance between these two scenarios. This scenario prioritized the highest and high risk lots, as well as all non-residential lots, which inherently have an increased risk for releases of pollution to the environment for private wastewater disposal systems not configured to treat these pollutants. It also provided wastewater service to lots adjacent to a proposed sewer. Highest and high risk lots that were secluded or captured too many lower risk lots in order to connect were excluded. This scenario provides a good balance between maximizing sewer to highest/high risk lots, while minimizing the diminishing returns for the provision of municipal wastewater management to the lower risk lots. This scenario is discussed in more detail in the following section.

7.5.2 Proposed Sewer Network

A sewer needs network was used to define the limits of the municipal wastewater management system. While all alternatives do not require the construction of a large-scale sewer, many will require some form of infrastructure to provide a municipal wastewater solution. The sewer network aimed to include all of the highest risk lots, high risk lots and non-residential lots, and limited lower priority lots to only those near our target lots. The decision was made to use engineering judgment along with the scenario's methodology. For example, all lots within 100 feet of the sewer network were connected. In order to capture a high priority lot required extending sewer through low priority areas; it may be excluded due to the additional infrastructure needed to provide a municipal wastewater solution to that lot.

Two large primary zones for municipal wastewater management were identified through this process. A primary zone was identified along the west side of town in the vicinity of Route 28. This zone had the greatest concentration of risk, mainly attributed to the close proximity to Martins Brook and Martins Pond, flood zones, and drinking water resources.

A secondary zone was identified in the southern part of town along Route 62. This zone also exhibits areas of risk. The risk in this zone is slightly more spread out and therefore would be a lower priority than the primary needs area. In addition, an existing treatment plant is located in this area and already serves some of the locations identified as having risk.

Once the network was completed, it was compared to the original goal. The end result of this process is shown in Figure 7-10. The actual proportion of lots served by the sewer network within the four highest risk study areas according to their risk score was:

- 93% of the highest risk lots,
- 91% of the high risk lots,
- 83% of the moderate risk lots, and
- 74% of the low risk lots.

Based on this distribution, the sewer network was considered to be consistent with the goals and represents a good balance of risk abatement and infrastructure needs. In addition to addressing the high risk lots in our study area, the network established benefits to the community as a whole. Town-wide the percentages of highest, high, moderate, and low risk lots captured are 40%, 31%, 12% and 2%, respectively.

As shown in Figure 7-9 the majority of lots within the top four study areas were included in the sewer needs network. As the top four study areas provided the primary focus of the needs area in the Town, the sewer needs network was adjusted to capture some lots in the Park Street, DPW, and High School study areas that had high risk components.


Base data obtained from The Town of North Reading and the Massachusetts Office of Geographic Information
Map produced by Wright-Pierce, 2016
Proposed Gravity Sewer
8
12
Proposed Force Main
4" FM
6" FM
Pump Stations
Martin's Pond Area: 8" Gravity Sewer with Isolated Residential Grinder Pump Stations
12" Gravity Interceptor Approx 20' Deep
Lowell Road Area: 8" Gravity Sewer
Abbott Road Area: 8" Gravity Sewer with Small Residential Pump Station
Southwick Road Area: 8" Gravity Sewer with Two Small Residential Pump Stations
6" Forcemain
503,000 gpd Pump Station and Central Distribution Center
Park Street Area: 8" Gravity Sewer with Residential & Commercial Pump Station
Concord Street Area: 8" Gravity Sewer with Residential & Commercial Pump Station
N
0
950
1,900
3,800
Feet
Proposed Collection System
PROJ NO: 12820
DATE: 1/29/2016
FIGURE: 7-10
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7.6 PROJECTED SEWER WASTEWATER FLOW NEEDS

Anticipated wastewater flows were estimated based on the wastewater needs area developed. To calculate the flow associated with this network, the residential lots were separated from the non-residential lots and sorted based on the risk score.

7.6.1 Residential Wastewater Flows

For the residential lots, calculations used the water demand as determined in the prior water needs analysis. Based upon the Town's average per capita per household of 2.71 persons and 65 gallons per day per capita water used, the average wastewater need per lot was calculated to be 176 gallons per day per lot. This assumes no losses due to evaporation and other outside water use, etc. This calculated water use was then compared to the historic water use for the parcels within the sewer network.

Lots with historic water use greater than 176 gpd were assigned the higher use. All other lots were assigned 176 gpd. This allowed for multifamily lots and top users to be accounted for based on actual usage. Lots using less than this were increased to represent the potential use from any lot that could occur with a transfer of the ownership or a change in the population within the residence.

Using this methodology, the water use for all lots captured in the sewer network was summed resulting in a total residential flow of 192,650 gpd.

7.6.2 Commercial Wastewater Flows

Based on the previous water demand analysis, the projected non-residential water use is 186,823 gpd for the entire town. There are currently 370 lots in town zoned for non-residential use; therefore, the average water use per non-residential lot is 505 gpd per lot. To allow for growth, 505 gpd per lot was assigned to all 316 lots within the top 4 needs study areas that are currently zoned for non-residential use. Therefore, a total non-residential water demand of 159,580 gpd was calculated.

TABLE 7-6
FINAL SEWER FLOWS

Residential Flow Scenario	Non-Residential Flow Scenario	Residential Flow (gpd)	Non-Residential Flow (gpd)	Total Flow (gpd)
93% Red, 91 Yellow, 83% Lt Green, 74% Dark Green	All Non-Residential Zoned Lots	192,650	159,580	352,230

7.6.3 Adjustment Baseline Sewer Flows

Theoretically, water use would be equal to the wastewater discharged; however, in practice oftentimes the sewer discharge is less than the water use for a variety of reasons including: irrigation, car washing, pool makeup water, or other processes that use water without going to the sewer. It is estimated that between 80% and 95% of the water used becomes wastewater depending upon the characteristics of the community. Therefore, using 100% of water use should provide for a conservative estimate of wastewater flow and account for variations that may occur over time within any particular residence.

A 10% safety factor was applied to account for unexpected increases to wastewater flows such as development or redevelopment of parcels.

Another factor in the determination of potential wastewater flows is Infiltration and Inflow (I/I) in the collection system. I/I is expected to be very low in a new sewer system. However, to account for the future, an I/I allowance was added to the wastewater flows. To estimate future I/I, a value of 500 gpd/diameter mile was used. This value is at the top of the range established by the MassDEP's published I/I estimation of 250-500 gpd/diameter mile. The proposed needs network was used to determine the length and size of sewer used for this calculation.

TABLE 7-7
ADJUSTED SEWER FLOWS

Total Flow (gpd)	352,230
Safety Factor	1.1
I/I Allowance (gpd)	114,800
Total Flow (gpd)	502,253

As presented in Table 7-7, a wastewater flow rounded up to 503,000 gpd is proposed for future analyses.

7.6.4 Projected Title 5 Flow Evaluation

Although it is believed that Table 7-7 represents a realistic projection of actual sewer usage, some institutions such as MWRA will require the analysis of flows based on Title 5 guidelines to establish connection requirements. Estimating Title 5 flows is difficult since a lot by lot analysis of potential sewer connections would require an additional level of detail not available for this study.

Using a methodology similar to above, the wastewater flow was broken down into three components: Typical residential, large residential (apartments, Condominiums, etc.), and non-residential.

7.6.4.1 Typical Residential Flows

For the purposes of this analysis, typical residential lots include single family homes as well as small multifamily homes, such as town houses and two-family homes. For these properties it was assumed that the typical house was composed of three bedrooms at a Title 5 flow of 110 gpd per bedroom. Since data shows each home has an average of 2.71 people, assuming all homes are 3 bedroom results in an average of 0.9 people per bedroom. Considering many bedrooms, including master bedrooms and children's rooms, house two or more people, this assumption is conservative and, therefore, accounts for the few instances where a parcel has more than one family.

For large residential flows, large multifamily lots in the study area were identified, and used the Title 5 design flow from their groundwater discharge permits. Estimated residential Title 5 flows are shown in Table 7-8.

TABLE 7-8
ESTIMATED RESIDENTIAL TITLE 5 FLOWS

Source	Assumed Flow	Number of Lots	Number of Bedrooms	Projected Flow (gpd)
Small Residential	110 gpd/bedroom	741	2,223	244,530
Large Residential	Used GWDP Design Flows (Title 5)	3	n/a	129,240
			Total	**373,770**

7.6.4.2 Non-Residential Flows

Determining the Title 5 flows from the non-residential properties using a broad based analysis was completed as follows. Title 5 provides "gpd per 1000 sqft" flow rates for many different classes of non-residential lots. These rates range from 50 gpd/1000 sqft for retail to 96 gpd/1000sqft for super markets. An average flow of 75 gpd/1000 sq ft was used for our analysis. This value is conservative, since the number of retail establishments outnumbers the larger retail establishment (such as supermarkets) in North Reading. It should be noted that many types of non-residential lots such as restaurants use alternative flow calculations based on the number of seats, or employees, etc. It is understood that by selecting a Tile 5 flow per sqft in the middle of the range, some lots will be under estimated while other are over estimated.

LIDAR data showing structure outlines as provided by MassGIS was used to find the total area of existing non-residential buildings. Only buildings within the final needs study areas which are zoned for non-residential use were considered. Based on this data we determined the average area per structure. To account for buildout of currently under-developed lots, the average structure area was applied to all lots currently zoned as non-residential lots. This total buildout structure area was multiplied by the Title 5 flow factor of 75 gpd/1000 sq ft. Please note that this procedure assumes that each non-residential structure is single-storied. The windshield study demonstrated that the majority of the existing non-residential lots in the four needs study areas were single-storied; therefore, the conservatism built into the calculation should cover the few instances where this is not the case. The flows resulting from this analysis are summarized below in Table 7-9.

TABLE 7-9
ESTIMATED NON-RESIDENTIAL TITLE 5 FLOWS

Number of Current Non-Res Lots with Buildings	231
Current SQFT of Buildings	1,734,284
Avg SQFT/per Building	7,508
Total Number of Non Residential Lots in Needs Area	316
Projected SQFT	2,372,528
Non-Residential Flow (gpd/1000 sqft)	**75**
Total Non-Residential Flow (gpd)	**177,940**

TABLE 7-10
ESTIMATED TOTAL TITLE 5 FLOWS

Source	Flow (GPD)
Residential	373,770
Non-Residential	177,940
Total	551,710
I/I Allowance*	114,800
Total Adjusted Flow	**666,510**

*As presented in Table 7-7

While this is the approach taken by MWRA in determining wastewater flows for a connection to their system, we do not agree with the approach and feel the flows are overly conservative. Therefore it is our recommendation to use the calculated flows of 503,000 gpd for the alternative analysis.

7.7 OTHER NEEDS AND CONSIDERATIONS

7.7.1 Ipswich River Needs

Since North Reading is located almost entirely within the Ipswich River watershed and the Ipswich River borders the Town on the South, it is important to consider the river's needs in the alternatives considered. Ipswich River needs are related to flow balancing, water quality, and specific effects on Martins Pond.

7.7.1.1 Flow Balancing

As stated in the Water Supply Needs section of this report, the Ipswich River has been named one of the 20 most stressed rivers in the country, as well as one of America's 10 most endangered rivers in 2003. Extreme low flow conditions threaten wildlife and water supply. High flow conditions are also an issue. Flooding along Martins Brook and other tributaries has been occurred, causing damage to nearby houses and roadways. Increases in impervious surfaces and rerouting of storm water are the primary cause of flooding. Therefore, the Ipswich River has demonstrated a need for flow balancing.

As stated in the ENF Certificate, concerns have been raised by the Ipswich River Watershed Association regarding exporting wastewater out of the Ipswich River basin. As discussed in the Water Supply Needs section, low flows in the Ipswich due to increased withdrawals are a concern. Therefore, wastewater alternatives should consider long term effects and benefits on the Ipswich River. The *Ipswich River Watershed 2000 Water Quality Assessment Report* states that the entire freshwater portion of the river is impaired for aquatic life use, including Martins Brook, this is attributed to low flow conditions. An acknowledgement of the need to provide a solution that balances out the modifications to the Town's water supply and municipal wastewater needs is an important part of the process.

7.7.1.2 Water Quality

Water quality is another important factor to consider. As previously discussed in this section, proximity to impaired waters, including the Ipswich River and its tributaries, was a risk factor used in the Wastewater Management Needs analysis. Impaired waters in North Reading include Martins Pond, Martins Brook and the Ipswich River. In the *Draft Pathogen Total Maximum Daily Loads (TMDL) for the Ipswich River Watershed (*prepared by MassDEP, USEPA, ENSR) TMDLs for pathogen indicators are presented. "TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating water quality standards". According to the report, pathogen impairment has been found in many locations throughout the Ipswich River Watershed. The report stated that likely bacteria sources in the Ipswich River watershed include, but are not limited to, "failing septic systems, sanitary sewer overflows (SSO), [and] sewer pipes connected to storm drains". Furthermore, the report states that "indicator bacteria levels generally increase with increasing development activities, including increased impervious cover, illicit sewer connections, and failed septic systems." Since, North Reading does not currently have a public sewer, septic systems are the primary source of pollution to these impaired water within town. Therefore, a need exists to reduce the pollution and water quality degradation caused by septic systems in North Reading. An excerpt of the TMDL report is included in Appendix F.

7.7.1.3 Martins Pond

Martins Pond is located within the Ipswich River Watershed and has been categorized as animpaired water. *The Martins Pond Assessment and Remediation Project* (Merrimack College, 2007), stated that "there has been evidence that septic systems are a likely contributor to both fecal coliform levels and nutrient loading (particularly N and to a lesser extent P) into Martins Pond". Due to this contamination, Martins Pond has become one of the most eutrophic surface waters in the area, with nitrogen being of particular concern. Sources of nitrogen are "unknown, but it is likely a combination of septic tank inflows, atmospheric deposition, shoreline property run-off (including fertilizers), stormwater conveyance, wetland inputs, nitrogen fixation in the water and sediments, decomposition occurring at lake and pond bottom sediments and inputs from groundwater". Eutrophic waters generally have lower dissolved oxygen levels and poorer overall water quality. The root cause of the eutrophication in Martins Pond was studied as part of the Merrimack College report. An evaluation of septic system age was conducted. The report recommends converting from septic systems to a sewer system as a long-term method of reversing eutrophication. The Draft TMDL for the Ipswich River also cites on-site septic systems as a potential source of bacteria in pathogen impaired segments of Martins Brook.

7.7.2 Downtown Needs

Independent of the Wastewater Needs Analysis conducted by Wright-Pierce, the Town identified a wastewater need downtown. Currently, the Wastewater Treatment Facility located at the High and Middle School is underutilized and underperforming. The facility is designed for an average daily flow of 17,500 gpd. However, as seen in Table 7-11, the average max daily flow for October 2014 through September 2015 is less than 9,000 gpd. The facility's discharge permit requires planning for an upgrade when the facility's annual average flow exceeds 80 percent the of the facility's design flow (14,000 gpd). Therefore, the facility could accommodate up to an additional 5,000 gpd without requiring additional permitting actions.

TABLE 7-11
HIGH SCHOOL WWTF MAX DAILY FLOW

Year	Month	Maximum Daily Flow (gpd)
2014	October	11,300
	November	11,900
	December	7,400
2015	January	8,833
	February	3,500
	March	11,900
	April	12,300
	May	4,800

	June	4,800
	July	8,833
	August	5,300
	September	7,200
	Average	**8,200**

The High School treatment plant represents an opportunity to improve water quality in the downtown area which is adjacent to the Ipswich River by using existing capacity at the plant to capture flow generated nearby. This area contains several commercial and municipal customers including Town-owned facilities. Increasing the flow at the plant would provide all the benefits of a municipal sewer system to the customers in the area while keeping the wastewater discharge in the same general area increasing the cost-effectiveness of the existing facility. This need should be evaluated during the alternatives analysis later in the report.

7.8 WASTEWATER MANAGEMENT NEEDS ANALYSIS SUMMARY

The Wastewater Needs Analysis identified areas where existing conditions may cause a risk to public health, environmental resources, or financial burden. Risk factors such as soil conditions and lot size were established and risk scores were calculated for each property in town. Risk scores served to compare lots relative to the likelihood of current or future pollution to the environment as well as difficulties in siting an on-site wastewater disposal system.

The Town was then broken into 16 Need Study Areas based on similarities in geography, risk profile, and land use. With the help of GIS, it was determined which study areas had the highest average risk points per lot. These study areas, including Lowell Road, Martins Pond, Route 28 South, and Concord Street areas were then analyzed for potential wastewater alternatives and potential wastewater flows

A sewer network was used to define the limits of the municipal wastewater management system based on the four high needs study areas. Many sewer network scenarios were considered. The sewer network scenario aimed to include all of the highest risk lots, high risk lots and non-residential lots, and limits lower priority lots to only those near our target lots. The sewer network was considered to be consistent with the goals and represents a good balance of risk abatement and infrastructure needs.

Projected wastewater flows from the proposed sewer network were calculated using historic water usage data. A wastewater flow of 503,000 gpd is proposed for future analyses and will be used in the alternatives analysis. Furthermore, alternatives must consider impacts to the Ipswich River and the wastewater needs of the downtown area.