Chapter 1
Introduction and Overview

NEW HAMPSHIRE DEPARTMENT OF
Environmental Services

1.1 Purpose

This primer was developed for local and state policy makers and New Hampshire residents. It was written to bring together in one document an overview of the information necessary to understand and make informed policy decisions about New Hampshire's water resources.

1.2 Introduction

New Hampshire is a unique state with a quality of life that consistently rates among the highest in the nation (Public Service of New Hampshire, 2008). The water running through, over, and by New Hampshire has shaped the state's history and will influence its future. The wise management and protection of water resources is critical to New Hampshire's economic prosperity, public health and environment.

New Hampshire is a small state with plentiful, high quality water resources compared to other parts of the country. New Hampshire has almost 17,000 miles of rivers and streams, nearly 1,000 lakes and large ponds, and 238 miles of ocean and estuarine coastline. Groundwater in New Hampshire is found in fractured bedrock and in the sands, gravels and till left by past glaciers. There is great connectivity among New Hampshire's waters and both water quality and quantity are greatly influenced by what occurs on the landscape (see Figure 1-17, the fold-out graphic).

New Hampshire is also the fastest growing of all the New England states and our landscape will continue to change to accommodate the projected 260,000 new people that are expected to move to the state between 2005 and 2030 (New Hampshire Office of Energy and Planning [NHOEP], 2006). Hundreds of thousands of tourists come to New Hampshire each year to enjoy the state's beautiful lakes, rivers, mountains and coast in the summer and its ski areas, snowmobile trails and ice-fishing spots in the winter. Whether it is needed for drinking, manufacturing, recreating, waste assimilation, or ecosystem health, water is a cornerstone of New Hampshire's beauty and prosperity.

In 2003 a statutory Water Resources Committee was established in the Legislature to study water related issues. The New Hampshire Department of Environmental Services (DES), in conjunction with this committee, sought and acquired limited funding to begin development of a comprehensive water resource plan to ensure the sustainability of New Hampshire's water resources. Development of this primer to inform policy makers and citizens is an initial step toward development of a statewide water resource plan. Thanks to legislative actions and the hard work of many stakeholders, for the first time a description of New Hampshire specific issues and topics related to surface water, groundwater, water quantity, water quality, water use and conservation, and water related infrastructure will be contained in one document.

New Hampshire has long been a national leader in the protection of water resources. Foresighted leadership by policy makers at the state and local levels on many water related issues has been occurring for more than a century in New Hampshire, starting with the protection and treatment of drinking water and other early regulatory and non-regulatory approaches to address septic systems, wastewater disposal, wetlands, surface waters, groundwater and dams. The primer was developed to provide policy makers with the information they will need to continue to protect water resources given the current and future challenges of increasing water demand, a changing landscape as economic and population growth occurs, multiple water users with competing needs, climate change,and aging water infrastructure for water supply, stormwater, wastewater and dams.

1.3 Primer Organization

This document has been organized so that it can be read either in its entirety to give the reader an in-depth understanding of the complex and interconnected nature of New Hampshire's water resources and water resource issues, or by a particular chapter to understand specific water resource topics. An attempt has been made to strike a balance between providing a comprehensive overview and describing the state's more pressing water resource topics in greater depth.

The primer has 12 chapters.

Chapter 1 – Introduction and Overview provides a brief description of the four primary challenges to sustainable water resource management that underlie the remaining topic specific chapters. These include:

- Landscape Change and Increased Demand for Water Related to Population and Economic Growth.
- Climate Change: Increasing temperature, more frequent and intense storms, etc.
- Aging and Inadequate Water Infrastructure: Wastewater, drinking water, stormwater and dams.
- Information Needs: Water quantity and quality data collection, analysis and management.

This chapter also provides a section called "New Hampshire Water at a Glance" (Section 1.5) that contains summary information about New Hampshire's water resources, water use, water infrastructure and water law.

The remaining chapters are Rivers, Lakes and Ponds, Groundwater, Wetlands, Coastal and Estuarine Waters, Water Use and Conservation, Drinking Water, Wastewater, Stormwater, Dams, and Floods and Droughts. Each of these chapters provides information about the topic, issues related to it, and current management efforts, together with a few key stakeholder recommendations. Throughout the document, information sources cited within the text are fully referenced at the end of each chapter.

1.4 Underlying Challenges

In writing this document, four underlying challenges emerged that are of importance to most, if not all, of the specific topics covered in chapters 2 through 12. Accordingly, they are being introduced and described briefly in this overview chapter. In the chapters that follow, there is additional information about these challenges that pertains specifically to the chapter's topic.

Challenge 1: Landscape Change and Increased Demand for Water Related to Economic and Population Growth

Between 1990 and 2004 New Hampshire grew by 17.2 percent, twice the rate of the rest of New England. It is projected that between 2005 and 2030 there will be 260,000 new residents in New Hampshire and approximately 73 percent of them will live in the four southeastern counties (Figure 1-1) (NHOEP, 2006). Although New Hampshire's growth has slowed recently, the inevitable increasing population will result in more land development and, therefore, more demand for water. Significantly, recent trends suggest that this new growth comes with a greater need for water than historic development. It is also clear that as the landscape is developed, stormwater runoff must be addressed in a new way to avoid further degradation of surface water quality, replenish groundwater, and limit flooding and infrastructure damage. Water use efficiency practices and low impact development techniques are available to reduce the negative impacts of growth and support water sustainability. These are discussed in detail in Chapter 7 – Water Use and Conservation and Chapter 10 – Stormwater. Concerns regarding increased water use and stormwater, both related to growth and landscape change, are introduced briefly below because of their significance to protecting both water quantity and water quality.

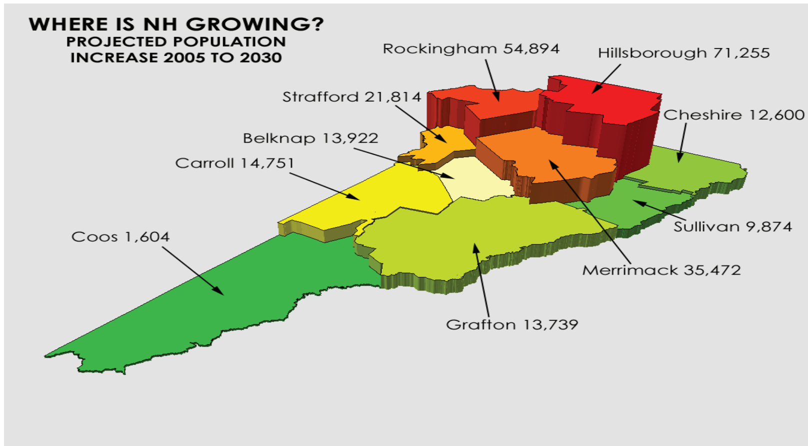

Figure 1-1. Projected population growth in New Hampshire. ***Source: SPNHF, 2008; data source: New Hampshire Office of Energy and Planning, 2006.***

Increasing Water Use

Water use in New Hampshire continues to increase over time with the state's growing population. From 1960 to 2000 New Hampshire's population doubled from 606,400 to nearly 1.2 million (SPNHF, 2005). Similarly, withdrawals from groundwater and surface water by public water systems increased from 54 million gallons to 97 million gallons per day (MacKichan & Kammerer, 1961; Hutson et al., 2004). The U.S. Geological Survey (USGS) estimates that the average overall water use in New Hampshire is 211 million gallons per day (Hutson et al., 2004).

National estimates indicate that the average American uses approximately 100 gallons of water per day (Hutson et al. 2004; USEPA, 2008). A recent study specific to the Seacoast Region of New Hampshire derived an annual average use of 75 gallons per day (Horn et al., 2008). The current trend for residential development is toward large homes with more bathrooms, hot tubs, dishwashers and garbage disposals. Newer homes also tend to have large lawns and in-ground irrigation systems. These trends mean more water demand per residential unit and will likely increase the average daily water use over time.

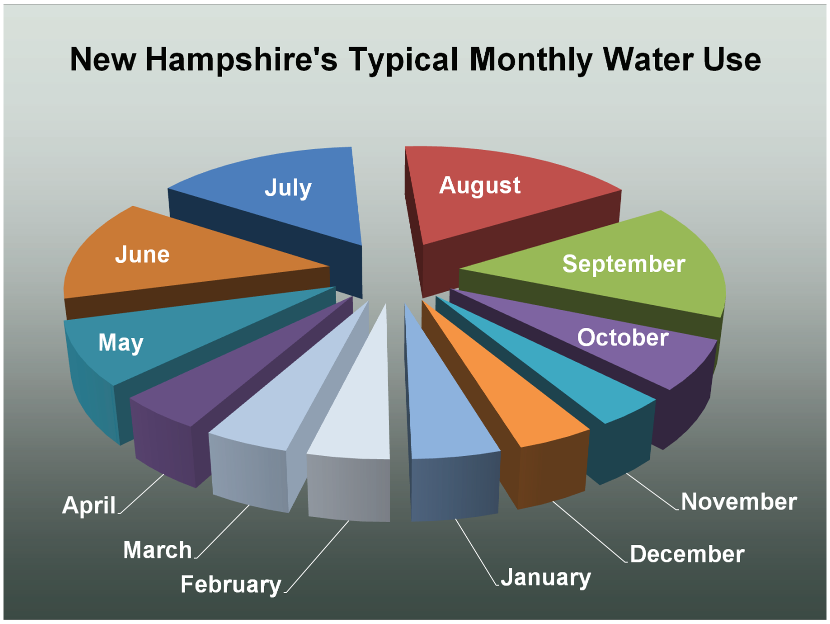

Figure 1-2. New Hampshire's typical monthly water use. ***Source: NHDES Drinking Water and Groundwater Bureau.***

The amount of water use varies significantly from one season to another. Typically, winter water use represents the domestic indoor water needs of a household. Water use increases substantially during the summer months due to discretionary outdoor uses of water. Many public water systems have reported a summer water demand that is twice the winter demand due primarily to lawn irrigation (Figure 1-2). In the summer, water demand increases at a time when there is naturally less water available in the environment due to plant uptake and evaporation. Temperature rise due to climate change will only exacerbate this situation. Chapter 8 – Drinking Water, discusses public water supply issues related to meeting summer water demand. Chapter 7 – Water Use and Conservation, provides information on current and projected water use and ways to use water more efficiently, which is increasingly important given climate change and aging, leaking infrastructure.

Figure 1-3. Example of water not being used efficiently and runoff from impervious surfaces. ***Source: Dukes, 2007.***

Landscape Change and Managing Stormwater

Long-term trends show that each year an average of 13,500 acres of New Hampshire's forest land is converted to other land uses (SPNHF, 2006). This change in the landscape means many more buildings, roads, driveways and parking lot areas. All of these create impervious surfaces – a surface that reduces or prevents the infiltration of water into the ground. Impervious surfaces affect the natural movement and treatment of precipitation that falls on the landscape, i.e., stormwater. Chapter 10 – Stormwater, explains the mechanics of this phenomenon. The most obvious

Figure 1-4. Stormwater draining to our surface water causes water quality impairment. ***Source: NHDES Watershed Management Bureau.***

effect of increased imperviousness is increased flooding because less water can soak into the ground. Historically, the increased volume of stormwater was managed by directing it to the nearest surface water as quickly as possible. Because of downstream flooding and erosion concerns, stormwater management evolved to include measures such as detention ponds, designed to store and slowly release stormwater while also allowing for the settling of some sediment. However, it is now evident that stormwater management must improve to halt the degradation of surface water quality, increase groundwater recharge, and limit flooding and infrastructure damage.

In 2008 23,778 acres of New Hampshire's lakes and rivers were classified as having threatened or impaired water quality. DES believes this to be largely attributed to stormwater, which picks up contaminants and nutrients as it moves through the developed landscape, discharging it into these water bodies. DES has also estimated that one acre of impervious surface where runoff is routed to surface water removes an estimated 250,000 to 500,000 gallons of water each year that would have otherwise replenished groundwater.

Chapter 10 – Stormwater, explains these issues in detail. It also describes a new approach to stormwater management known as Low Impact Development. Low Impact Development includes a number of techniques to limit flooding, erosion, and water quality degradation, while allowing groundwater to be replenished. Of all the techniques, clustering and concentrating development while leaving large open spaces offers the greatest challenge and biggest benefit. Not only will it result in improved water quantity and quality, it will protect the working and undeveloped landscape that is fundamental to New Hampshire's identity and prosperity.

Challenge 2: Climate Change

Evidence of climate change is unequivocal and includes observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (Intergovernmental Panel on Climate Change, 2007). Most of the continental U.S. has already experienced a statistically significant trend toward increasingly frequent storms with extreme precipitation, a trend that is most pronounced in New Hampshire (Figure 1-5).

EPA's National Water Program Strategy Response to Climate Change, released in August 2008, summarizes climate change related impacts on water as follows.

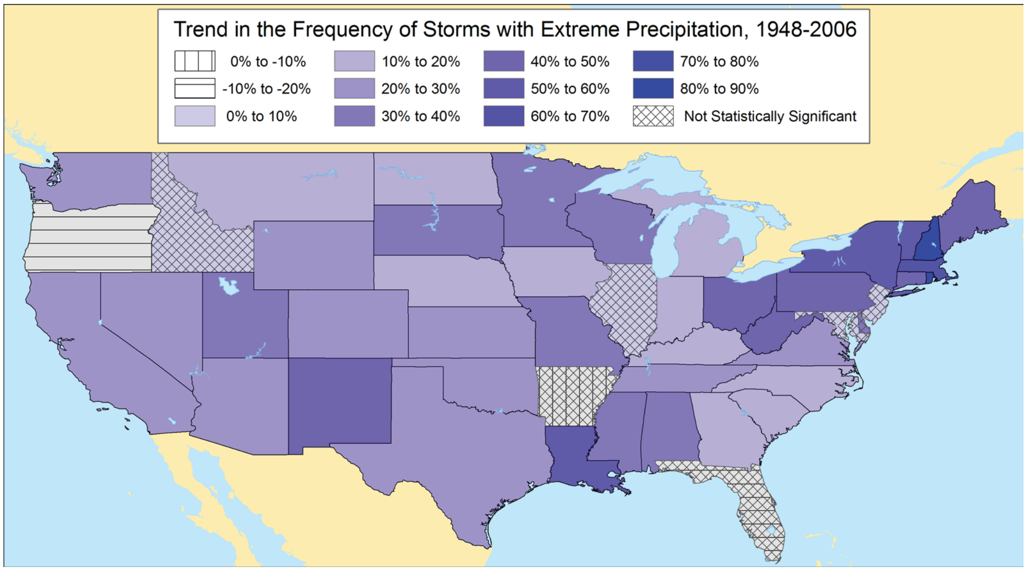

Figure 1-5. Trend in the frequency of extreme precipitation by state. New Hampshire and Rhode Island show the highest increase in the frequency of storms with extreme precipitation. *Source: Madsen & Figdor, 2007.*

1. **Increases in Water Pollution Problems:** Warmer air temperatures will result in warmer water. Warmer waters will:
   - Hold less dissolved oxygen making instances of low oxygen levels and "hypoxia," i.e., when dissolved oxygen declines to the point where aquatic species can no longer survive, more likely.
   - Foster harmful algal blooms and change the toxicity of some pollutants. The number of waters recognized as "impaired" is likely to increase, even if pollution levels are stable.
2. **More Extreme Water-Related Events:** Heavier precipitation will increase the risks of flooding, expand floodplains, increase the variability of streamflows, i.e., higher high flows and lower low flows, increase the velocity of water during high flow periods and increase erosion. These changes will have adverse effects on water quality and aquatic system health. For example, increases in intense rainfall result in more nutrients, pathogens, and toxins being washed into water bodies.
3. **Changes to the Availability of Drinking Water Supplies:** Changing patterns of precipitation and snowmelt, and increased water loss due to evaporation as a result of warmer air temperatures will result in changes to the availability of water for drinking and for use for agriculture and industry. In other areas, sea level rise and salt water intrusion will have the same effect. Warmer air temperatures may also result in increased demands on community water supplies and the water needs for agriculture, industry, and energy production are likely to increase.
4. **Water Body Boundary Movement and Displacement:** Rising sea levels will move ocean and estuarine shorelines by inundating lowlands, displacing wetlands, and altering the tidal range in rivers and bays. Changing water flow to lakes and streams, increased evaporation, and changed precipitation in some areas, will affect the size of wetlands and lakes.

5. **Changing Aquatic Biology:** As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to the warmer water, i.e., cold water fish will be replaced by warm water fish. This process, however, will occur at an uneven pace disrupting aquatic system health and allowing non-indigenous and/or invasive species to become established. In 50 years or so, warmer water and changing flows may result in significant deterioration of aquatic ecosystem health in some areas.

6. **Collective Impacts on Coastal Areas:** Coastal areas are likely to see multiple impacts of climate change. These impacts include sea level rise, increased damage from floods and storms, changes in drinking water supplies, and increasing temperature and acidification of the oceans. These overlapping impacts of climate change make protecting water resources in coastal areas especially challenging.

Climate change will affect regions of the country differently. New Hampshire can expect impacts associated with more frequent extreme precipitation events, rising sea levels, less precipitation falling as snow, warmer temperatures, and peak recharge to groundwater occurring earlier in the year. For more information on predicted impacts for the Northeast under various emission scenarios, see Appendix A: Confronting Climate Change in the U.S. Northeast (Executive Summary).

In addition to the many other issues that New Hampshire faces in managing water resources, the impact of climate change and the need for adaptation strategies must be factored into future water protection efforts. Because of the anticipated growth in population and water demand in the seacoast as well as the anticipated impact from tidal flooding, an adaptation strategy for the coastal zone is essential.

New Hampshire is limited in its ability to significantly reduce greenhouse gas emissions that contribute to global warming. To the extent it can, the state has taken many steps towards being part of the solution, including the governor's formation of a Climate Change Task Force. Also, DES is a member of a Climate Change Workgroup at the New England Interstate Water Pollution Control Commission to work regionally in addressing water related impacts from climate change. Many communities have also taken on this challenge at the local level. Ultimately, the severity of impact from climate change will depend on societal and personal choices regarding the use of fossil fuels.

Challenge 3: Aging and Inadequate Water Infrastructure

New Hampshire residents are dependent on an array of infrastructure throughout the state that moves, stores, and treats water. Categories of water infrastructure include drinking water, wastewater, stormwater and dams. The story for each category is largely the same: the initial investment to construct the infrastructure was made long ago and there is a scarcity of funds to maintain and improve much of this infrastructure. Municipalities, in particular, face significant infrastructure related challenges. An overview of this issue is provided here. For each category, a great deal more information concerning the need to address aging infrastructure is provided in the associated chapter.

Drinking Water and Wastewater (Chapters 8 and 9)

Collecting and treating wastewater to protect water quality and treating and distributing water to provide safe drinking water require a great deal of infrastructure. For most municipalities, this infrastructure needs to be upgraded over the next 10 to 15 years to ensure capacity for economic growth, to meet more stringent environmental standards, and to replace aged system components. Over 30 municipal wastewater systems are at 80 percent or more of their design capacity. Projected wastewater infrastructure needs are $800 million to $1 billion over the next 10 years (Commission to Study the Publicly Owned Treatment Plants, 2007). Projected water supply system needs are about $600 million for the next 15 to 20 years (USEPA, 2005). User affordability, especially for low income households, is a major concern as water and sewer rates increase to pay for improvements. In the past there were significant federal grant programs to assist with wastewater infrastructure needs and limited state grant funds to help water systems comply with new drinking water treatment rules. Both water and wastewater have federally originated state revolving loan funds (SRFs). However the amount of funding available is much less than what is necessary. For instance the demand for drinking water SRF funds in 2008 was $39 million, while the funding available was $10 million.

Stormwater (Chapter 10)

An effort is underway to identify the statewide need for maintaining and upgrading municipal stormwater infrastructure. Given the more frequent, intense storms resulting from climate change, there is particular concern that undersized culverts will exacerbate flooding damage. Currently, there are no grant or loan funds designated specifically for stormwater infrastructure. Small source water protection and non-point source grants have been used for this purpose in some places and the SRF that has historically been used for wastewater infrastructure will be made eligible for this purpose. However, as noted above, this SRF is under-funded to meet current wastewater demands.

Dams (Chapter 11)

The 3,070 dams in New Hampshire must be maintained to keep them safe. Occasional upgrade or rehabilitation is necessary due to deterioration, changing technical standards, improved techniques, better understanding of the area's precipitation conditions, increases in downstream populations, and changing land use (Figure 1-6). There are 2,358 privately owned dams in New Hampshire. The state owns 273 dams, 12 are owned by utilities, 389 are owned by municipalities, and 38 are owned by the federal government. Many were constructed years ago for mills that no longer exist; in many cases the removal of

Figure 1-6. Installation of the automated spillway gates is an example of an upgrade at the Mascoma Lake Dam on the Mascoma River in Lebanon. *Source: NHDES Dam Bureau.*

these dams would result in substantial environmental improvement, often at less cost than dam rehabilitation. Operation, maintenance and rehabilitation of dams can range in cost from the low thousands to millions of dollars, and owners are responsible for these expenses. Maintenance of privately owned dams is of greatest concern. However, the state Dam Maintenance Fund that supports maintenance and upgrades for state owned dams is significantly less than what is needed and what it has been historically. The reasons for this are explained in detail in Chapter 11 – Dams.

Overall, New Hampshire is heavily reliant on water-related infrastructure to clean, move and store water. A significant investment to maintain and improve existing infrastructure must be a priority.

Challenge 4: Information Needs

Historically, New Hampshire has consistently invested in obtaining critical water-related data. The state is in an enviable position with respect to our water resource knowledge. Appendix C provides an overview of recent and ongoing projects, studies and initiatives focusing on water resource characterization, water quality assessment, and water planning, protection and eduction. There is, however, still some key information that must be obtained, analyzed and managed so that informed policy decisions about water resources can occur. Table 1-1 presents a brief description of key, current information needs and directs the reader to topic chapters that provide additional justification for this data. In addition to collecting the data identified in the table, resources are needed to analyze and manage the information so that it can be used by scientists, regulators and policy makers.

Table 1-1. Information needs for New Hampshire's water resources.

Information Needed / Related Chapter(s)	Importance
Stream Gages to Manage Protected Instream Flow Levels Chapter 2 – Rivers	As water use increases, a network of stream gages designed to monitor critical flow periods is needed so withdrawals and impoundments can be operated to preserve aquatic life. USGS now operates a network of gages in cooperation with DES, but more are needed.
Stream Morphology Chapter 2 – Rivers	New Hampshire has very limited data on the geomorphic characteristics of its rivers and streams. River morphology, or their form and shape, is a naturally dynamic process; rivers are not static systems. By knowing how a river system will achieve a stable morphology over time, significant human infrastructure and aquatic resource impacts could be prevented.

Information Needed / Related Chapter(s)	Importance
Groundwater Levels Chapter 4 – Groundwater Chapter 8 – Drinking Water	New Hampshire currently has a very limited network of wells where groundwater levels are routinely monitored. There is a great deal of concern regarding overuse of groundwater. A comprehensive groundwater monitoring network would provide the data to identify groundwater level changes and interpret their cause.
Water Quality Chapter 2 – Rivers Chapter 3 – Lakes and Ponds Chapter 4 – Groundwater Chapter 6 – Coastal and Estuarine Waters Chapter 8 – Drinking Water Chapter 9 – Wastewater Chapter 10 – Stormwater	Surface waters: The majority of the state's surface waters have not been assessed due to lack of data. More data, better utilization of existing data from multiple sources, and more efficient (statistical) analyses are needed. Groundwater: The primary data needed is information on the occurrence of naturally occurring contaminants such as arsenic, radionuclides, fluoride, beryllium, etc. This information would be used to promote increased private well testing in high risk areas.
Lake Carrying Capacity Chapter 3 – Lakes and Ponds	Lake carrying capacity is identified as important for lake management in RSA 483-A. Additional data on types and intensity of recreational lake use are needed to effectively assess carrying capacity.
Invasive Species Chapter 3 – Lakes and Ponds	Invasive aquatic species are a continuing threat. Volunteer "Weed Watchers" provide early detection. More comprehensive mapping of known infestations is needed for targeted exotics control efforts.
Updated Flood Elevations Chapter 12 – Floods and Droughts	Current flood maps are often inaccurate and do not reflect changes in hydrology from recent development or increased flood elevations associated with climate change. Updated maps are needed to keep development out of floodplains and for emergency preparedness.

1.5 New Hampshire Water at a Glance: Occurrence, Impairment, Uses, Infrastructure and Law

This section provides a summary of New Hampshire's water resources, including important facts and statistics to set the stage for the topic-specific chapters to follow.

1.5.1 Water Occurrence

The total area of New Hampshire is 9,304 square miles, comprising 9,027 square miles of land and 277 square miles of inland water, not including wetlands. There are approximately 23 square miles of estuarine tidal water and 238 miles of ocean and estuarine coastline. Although New Hampshire has only 18 miles of Atlantic Ocean coastline, its tidal waters, including Great Bay and Hampton Harbor estuaries and the Piscataqua River, are major ecological and recreational resources in a heavily populated portion of the state.

New Hampshire's approximately 1,000 larger lakes and ponds total nearly 165,000 acres and vary in size from small ponds to Lake Winnipesaukee, the largest lake, which is 22 miles long and eight miles wide. Lake Winnipesaukee is at the heart of the Lakes Region, a prime tourist location.

Figure 1-7. New Hampshire's major watersheds in a New England context. New Hampshire has five major watersheds that extend into other New England states. ***Source: NHDES Watershed Management Bureau.***

There are five major watersheds or drainage basins in New Hampshire. The largest is the Connecticut River watershed, followed by the Merrimack River, Saco River, Androscoggin River and Coastal watersheds (Figure 1-7). In total there are nearly 17,000 miles of rivers and streams in New Hampshire.

Groundwater in New Hampshire is found in fractured rock formations and in the surficial material deposited and shaped by receding glaciers. Sand and gravel materials of glacial origin are called stratified drift. Surficial aquifers are relatively shallow, generally less than 100 feet thick. The shallow nature of surficial aquifers and the limited space for water in fractured bedrock limits the storage of water in the ground. In general, surface waters and groundwater are highly interconnected with one another in New Hampshire.

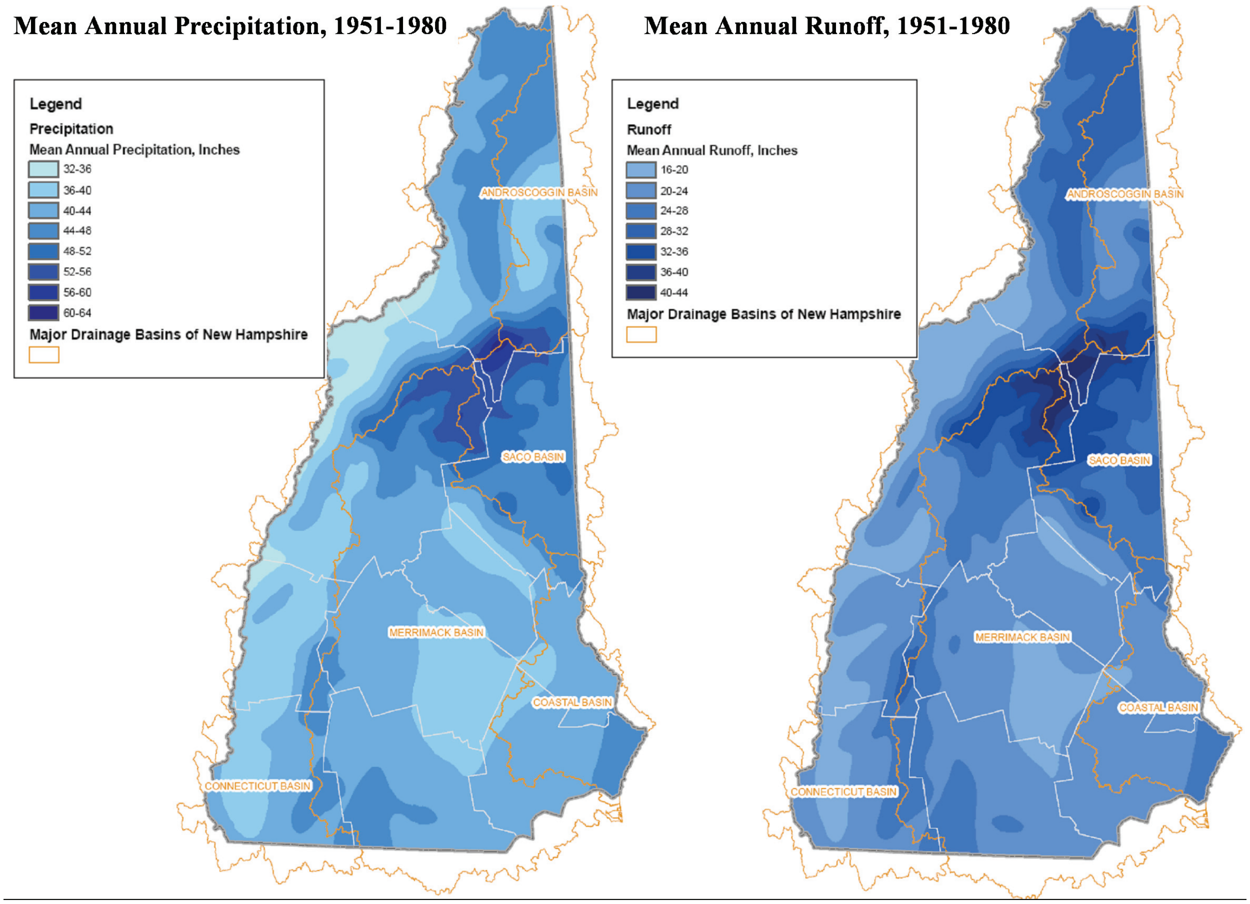

Figure 1-8. New Hampshire's mean annual precipitation and runoff from 1951 to 1980. ***Data Source: Randall, 1996.***

New Hampshire has a changeable temperate climate, with wide variations in daily and seasonal temperatures. The variations are affected by proximity to the ocean, mountains, lakes or rivers. The state experiences four seasons, with short, relatively cool summers and often long, cold winters. The average annual daily temperature for central New Hampshire is 45° F. Mean annual precipitation is typically between 35 and 45 inches, including a mean annual snowfall of between 65 and 75 inches. Mean annual precipitation and runoff across the state can be seen in Figure 1-8. When the ground is not frozen, on average 40 percent of precipitation recharges groundwater, with more recharge occurring prior to and after the growing season.

Hydrologic Cycle

The hydrologic cycle (see Figure 1-17, the fold-out graphic) governs the occurrence and movement of New Hampshire's water resources. Water falls on the land as rain or frozen precipitation and moves through various water bodies on its way to the ocean. It may move fast or slow; be evaporated; be stored for awhile in groundwater, wetlands, lakes or impoundments; and be used for drinking water supply, hydropower, or a variety of other uses. Water picks up chemicals and other substances along the way. Some of these are natural and some are manmade. New Hampshire has seven basic water body types: rivers and streams, lakes and ponds, wetlands, inland tidal waters (estuaries), impoundments (dammed rivers), ocean waters, and groundwater. Water that runs off the land or seeps from groundwater into surface waters moves through ever larger streams and rivers, residing along the way in lakes, wetlands and impoundments until it reaches tidal waters along the coast. Human uses of water may occur at any point along the way, as may the effects of too much water – floods, or too little water – droughts.

1.5.2 Water Quality Assessment

Surface Waters

New Hampshire's surface waters and wetlands are home to a myriad of aquatic life and provide essential habitat for many other wildlife, among other uses. DES maintains a statewide catalog of surface water bodies and a statewide database of water quality data. Every two years all available water quality data are used to assess the extent to which each water body is attaining the water quality to support each of five designated uses (aquatic life, recreation in and on the water, drinking water supply, wildlife, fish and shellfish consumption). These assessments and an interpretive report, sometimes called the "305(b) Surface Water Quality Report" after a section of the federal Clean Water Act, are posted on the DES website. The most recent report was released in 2008 (NHDES, 2008b). A water body that is attaining water quality to support a designated use is called supporting, and one that is not is called impaired.

Table 1-2 is a summary of 2008 assessments. The table really only reflects two of the five designated uses, aquatic life and recreation. As for the other uses, all waters are impaired for fish consumption due to mercury in fish tissue, caused by atmospheric deposition, so this use has been excluded from the table. Similarly, all waters are presumed to support drinking water supply after adequate treatment, although detailed criteria have not been developed. Finally all waters are unassessed for the wildlife use because criteria have not been developed, so the table does not reflect the status of this use.

Table 1-2. Summary of surface water quality standard (WQS) assessments. ***Source: NHDES, 2008b.***

Water Body Type	Overall Use Support (excluding mercury fish advisory) based on Site Specific Assessments (Percent of Assessment Units and Designated Uses)			
	Fully Meets WQS	Insufficient Information or No Data	Impaired	Total Assessed
Rivers / Streams	67.3%	29.5%	3.2%	70.5%
Impoundments	55.1%	39.8%	5.1%	60.2%
Lakes	57.7%	30.6%	11.7%	69.4%
Estuaries	51.2%	18.5%	29.3%	81.5%
Ocean	54.7%	15.4%	29.8%	84.6%
All Waters	57.4%	26.8%	15.8%	73.2%

Figure 1-9 summarizes the causes of impairment for rivers. Summary charts for other water body types are similar. The largest cause is pH, which is attributable to acid rain. Next are Escherichia coli bacteria, which are indicators of contamination with human or animal wastes. Dissolved oxygen, which is essential for aquatic life, is also a significant cause of impairment.

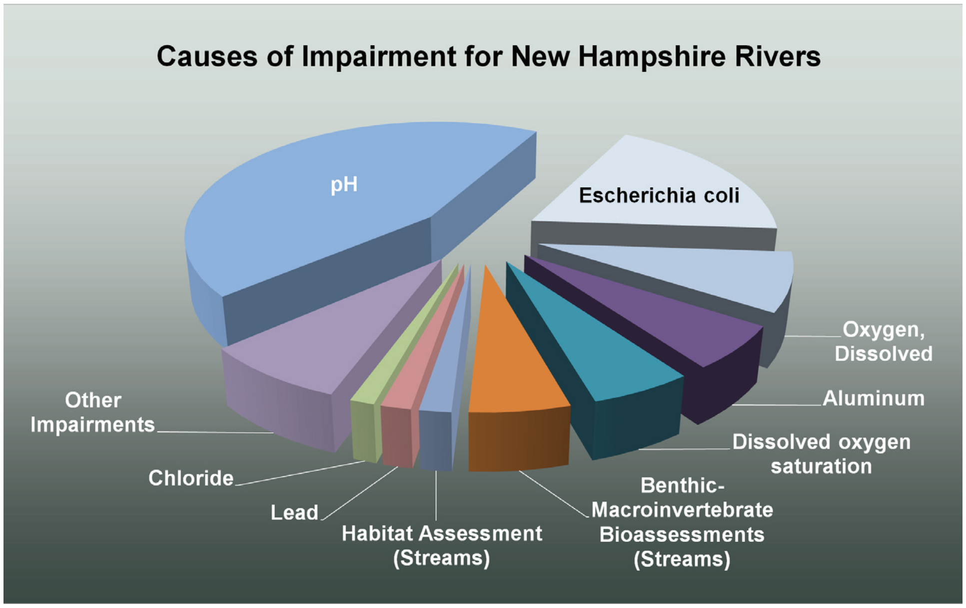

Figure 1-9. Causes of impairment for New Hampshire rivers.
Source: NHDES, 2008b.

Groundwater

Groundwater is present everywhere beneath the land surface. Underneath most of New Hampshire the bedrock is the main groundwater resource, but in river valleys and some associated glacial formations such as eskers and kame terraces, stratified drift deposits of sand and gravel can produce moderate to large sustained yields of groundwater. Natural groundwater quality is generally good. The predominant crystalline rock formations produce groundwater of low mineral content, hardness and alkalinity. Although the majority of groundwater can be used as a drinking water source with little or no treatment, most groundwater is of low pH and highly corrosive to water supply distribution systems. Ambient groundwater quality from both bedrock and stratified drift aquifers can be impacted by such aesthetic concerns as iron, manganese, taste and odor. Bedrock well water quality is sometimes impacted by naturally occurring contaminants including fluoride, arsenic (Figure 1-10), mineral radioactivity and radon gas. Elevated concentrations of radon gas occur frequently in bedrock wells, and elevated arsenic levels are found in some locations, correlated with specific bedrock

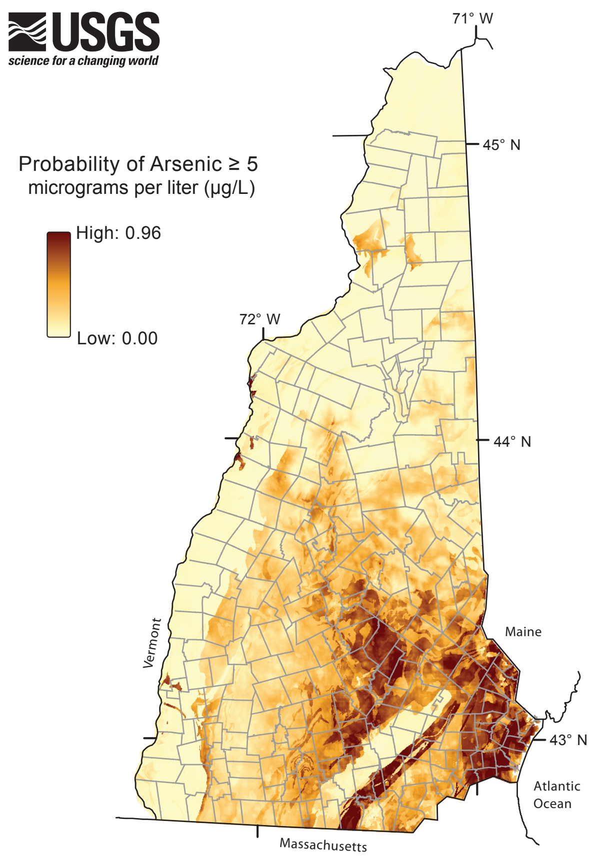

Figure 1-10. Probability that wells in each area of New Hampshire are likely to have water with arsenic concentrations exceeding 5 micrograms per liter (µg/L). ***Source: Ayotte et al. 2006.***

formations. In addition to naturally occurring contaminants, there are many areas of localized contamination due primarily to releases of petroleum and volatile organic compounds from petroleum facilities, commercial and industrial operations and landfills. Due to widespread winter application of road salt, sodium is also a contaminant often found in groundwater. The leading causes of manmade groundwater contamination requiring remediation are spills and leaks at underground storage tank sites (LUST), heating oil storage tank sites (OPUF), hazardous waste facilities, and other motor fuel storage facilities (Figures 1-11 and 1-12).

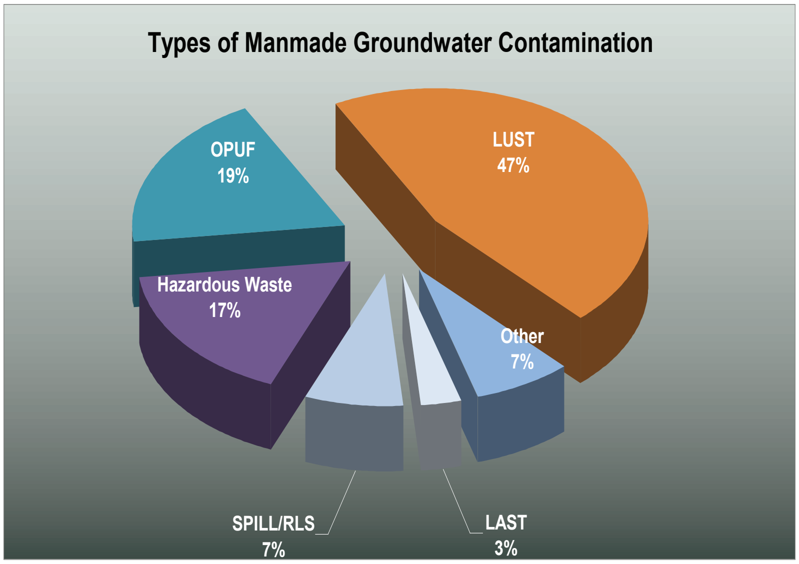

Figure 1-11. Types of manmade groundwater contamination sites that require remediation in New Hampshire. The leading causes of contamination are LUST (leaking underground storage tank) sites, followed by OPUF (on-premise heating oil tank) sites, hazardous waste sites, SPILL/RLS (oil spill or release) sites, other types of contamination, and LAST (aboveground bulk storage containing motor fuel) sites. *Source: NHDES, 2008c.*

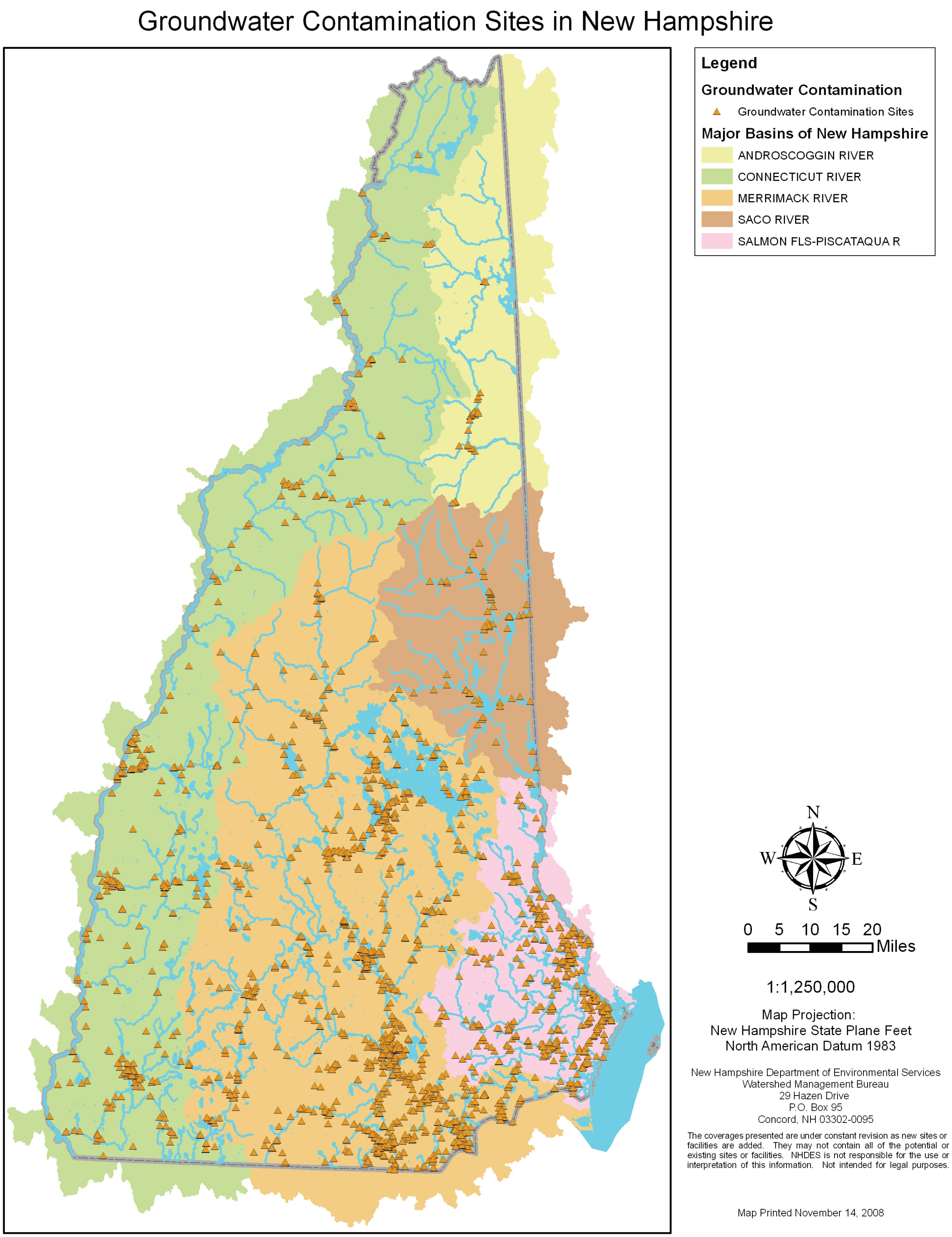

Figure 1-12. Sites in New Hampshire where groundwater contamination management by NHDES has occurred.

1.5.3 Water Use

Based on an estimate made by the USGS for water use in New Hampshire for the year 2000, New Hampshire uses approximately 211 million gallons per day (Hutson et al., 2004). This figure excludes approximately 236 million gallons per day of freshwater that is used at thermoelectric plants where the water is generally not consumed and is returned to the location from which it was extracted. Of the 211 million gallons of water that is used, 127 million gallons per day (60 percent) is extracted from surface water and 84 million gallons per day (40 percent) is extracted from groundwater. Public water suppliers that supply water to homes, businesses and institutions are the largest users of all water and of surface water in the state. Cumulatively, self-supplied domestic water use, typically individual private wells, represents the largest use of groundwater in New Hampshire (Figure 1-13).

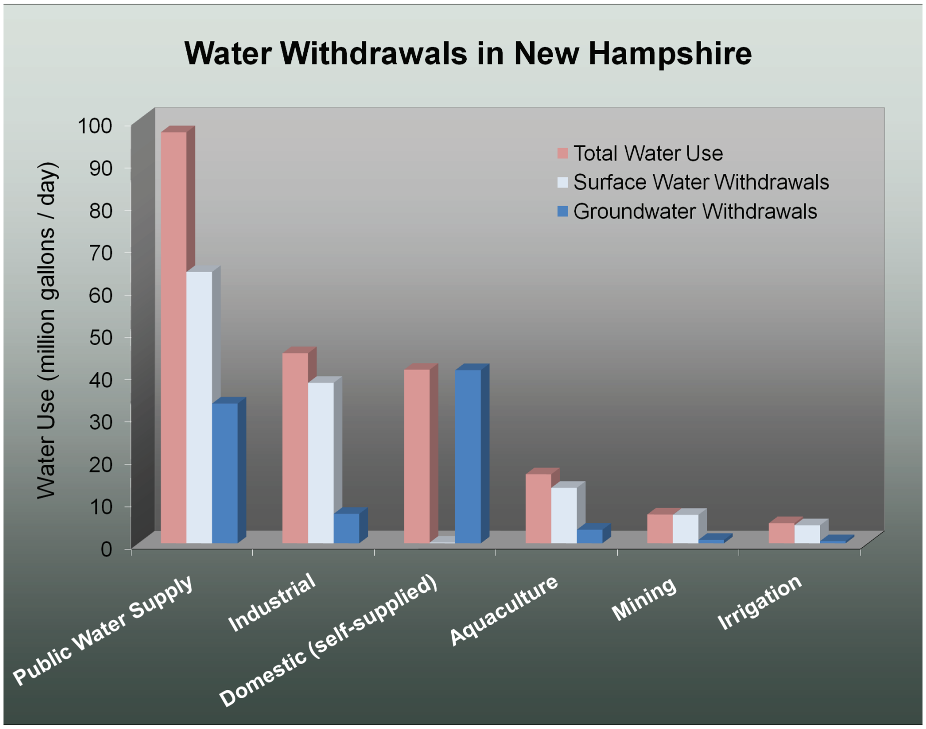

Figure 1-13. Water withdrawals in New Hampshire. *Source: NHDES, 2008a.*

1.5.4 Water Infrastructure

Figures 1-14 through 1-16 show the geographic distribution of the state's water infrastructure: its public water systems, water and sewer service areas, and dams. Statistics and additional information describing these infrastructure categories can be found in Chapter 8 – Drinking Water, Chapter 9 – Wastewater, and Chapter 11 – Dams.

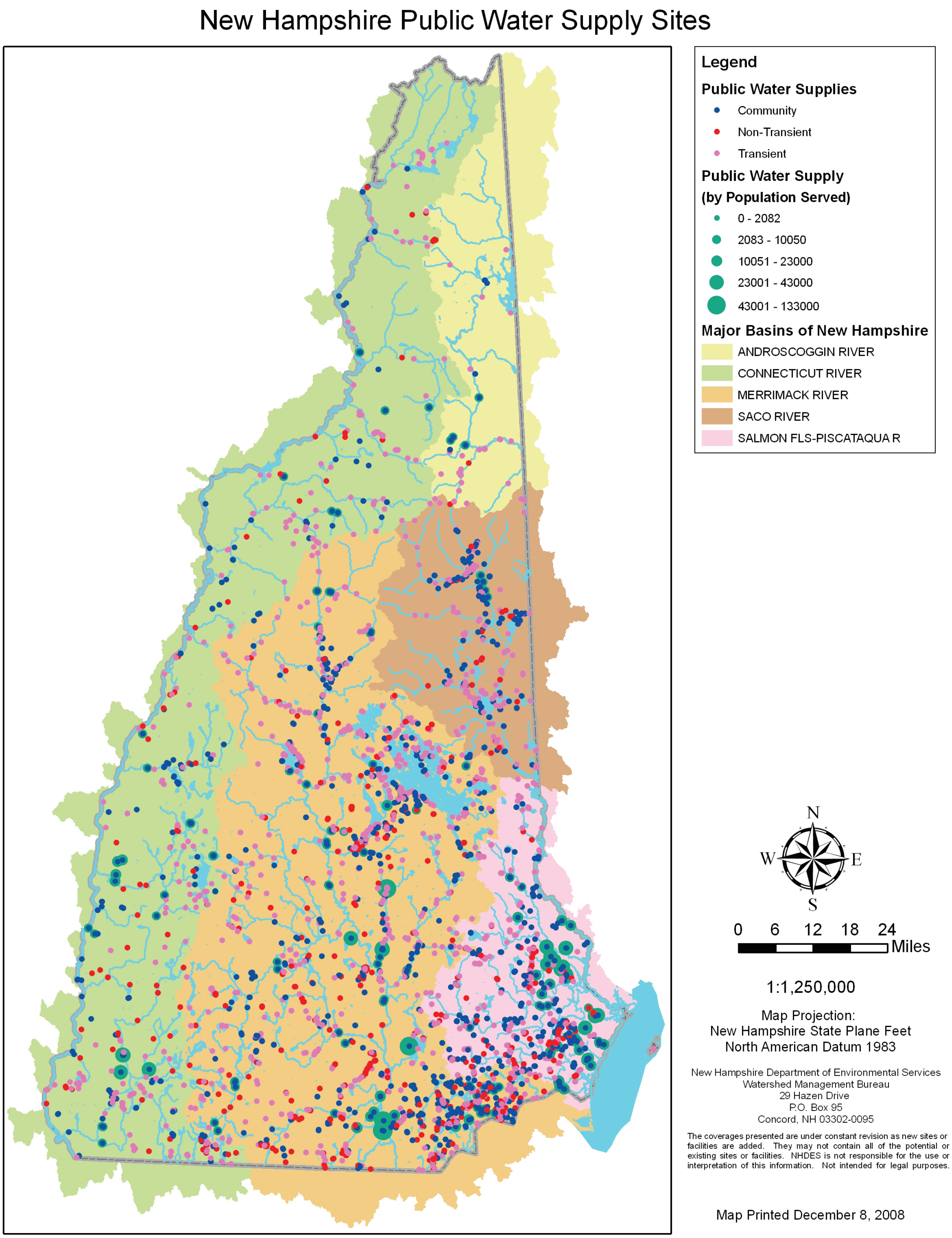

Figure 1-14. New Hampshire public water systems.

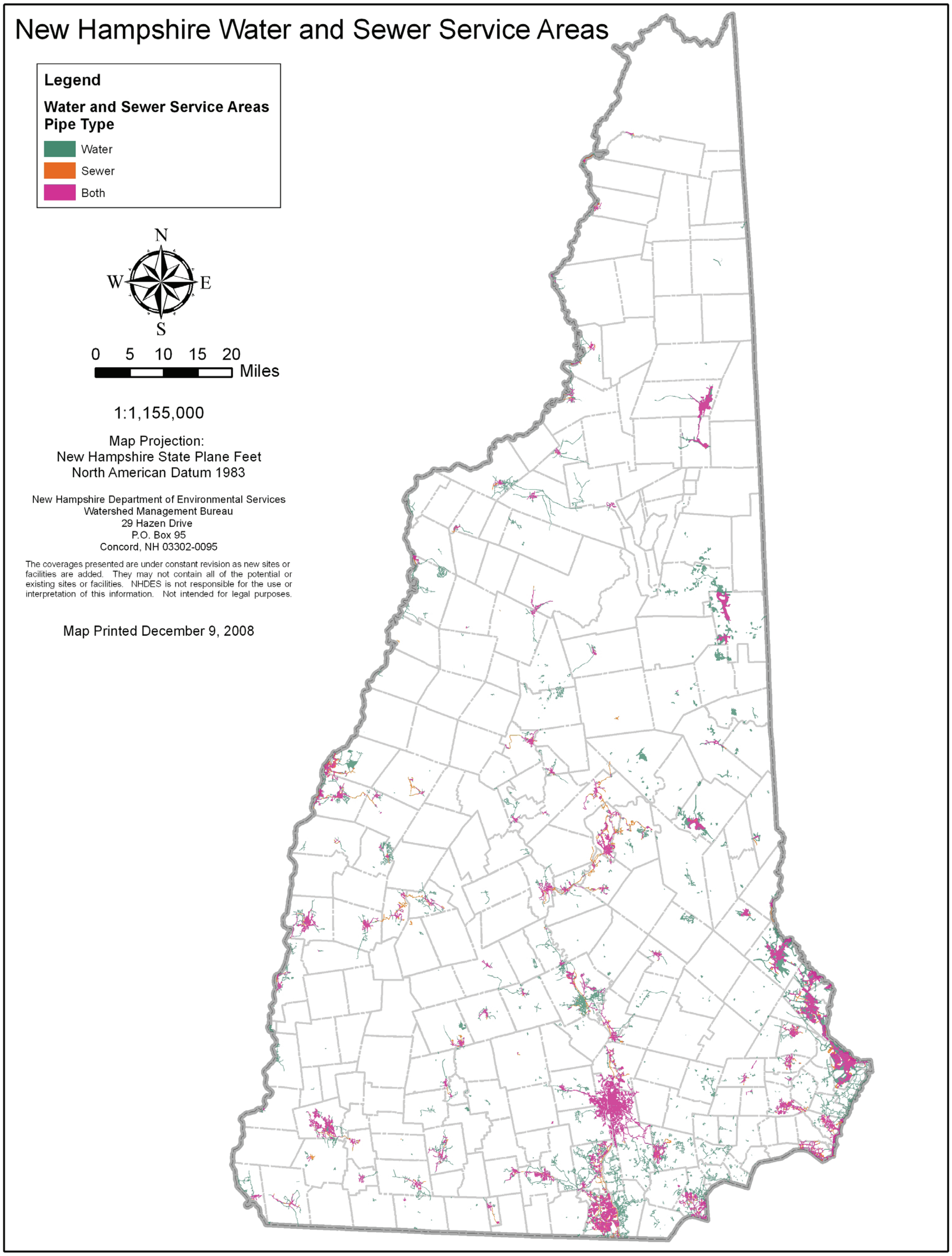

Figure 1-15. New Hampshire's water and sewer infrastructure.

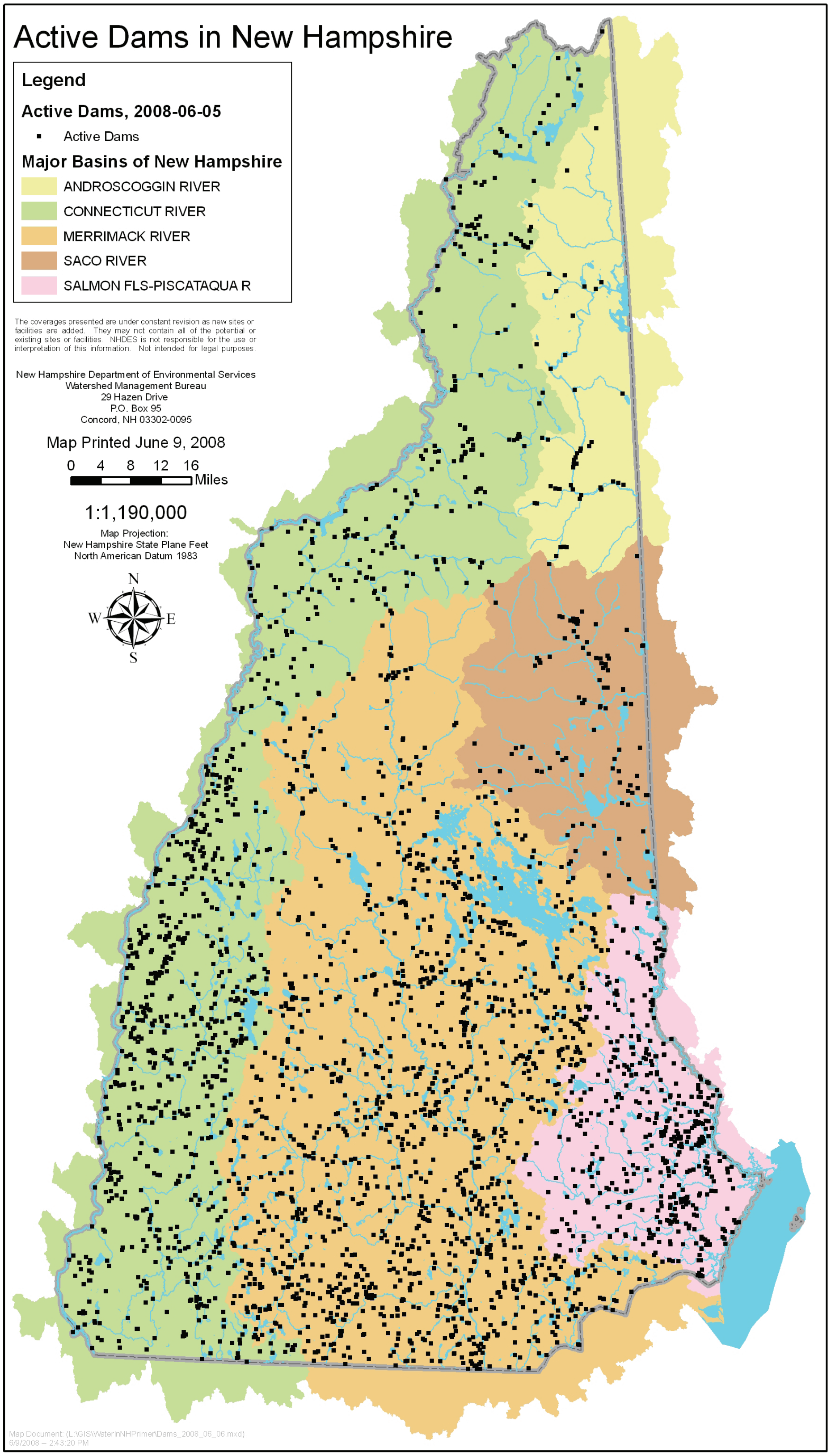

Figure 1-16. New Hampshire's active dams.

1.5.5 Water Law

There are a myriad of state and federal laws related to water resource assessment, protection and remediation. Appendix D contains a table that lists the federal and state authorities that pertain to the state's water-related programs. Federal laws, state laws, and water rights are described briefly below.

Federal Laws

In terms of federal programs, the most significant water related laws include the Clean Water Act, the Safe Drinking Water Act, the Coastal Zone Management Act, and the Resource Conservation and Recovery Act. Superfund and other federal waste site cleanup programs, as well as the federal law governing pesticide use, also serve to protect water. A very brief description of the primary federal statutes is contained in the table below.

Important Federal Water Related Laws

Clean Water Act

Adopted in 1972 this Act protects the quality of waters of the United States. Establishing water quality standards, identifying and designating uses of surface waters, and permitting of discharges to surface waters are cornerstones of this Act. In New Hampshire this permitting is done by EPA with input from the state.

Safe Drinking Water Act

Adopted in 1977 this Act is in place to ensure that water supplied by public water systems is safe to drink. Key provisions include oversight of water system design, operation and water treatment. It also establishes drinking water quality standards and monitoring requirements. In New Hampshire DES administers the Safe Drinking Water Act under a primacy agreement with the EPA.

Coastal Zone Management Act

Adopted in 1972 this Act establishes a voluntary partnership between the coastal states and the National Oceanic and Atmospheric Administration (NOAA) to promote a balance of human use and resource protection through funding for permitting and enforcement, pass-through grants, outreach on non-point source pollution and incentives for program change. Federal Consistency provisions assure that federal permits and activities in the coastal zone are consistent with state policy. DES administers this program.

Resource Conservation and Recovery Act

Adopted in 1976 this Act tracks hazardous waste and regulates underground storage tanks. Land uses with underground storage tanks or that generate hazardous waste are of particular concern for water resources. Solid waste is also regulated under this Act. DES administers this program.

State Laws

New Hampshire's water quality law is largely based in statute and administrative rules that DES administers. The law pertaining to water quantity is a mixture of common law, statutes that DES administers, and statutes that provide water rights to particular entities. Each of these is described below. Water-related state laws and administrative rules are also detailed in Appendix D.

Statutes and Administrative Rules

Important water related state statutes are found under Title L, Water Management and Protection. These statutes and the rules they authorize address both water quantity and water quality related issues. Appendix D lists the specific statutes and programs and regulations related to them. In addition to Water Management and Protection Statutes, there are important state water remediation laws that are also identified in Appendix D.

Public Trust and Reasonable Use Doctrines

New Hampshire's water rights system is based on common law, which is predicated on historic court decisions rather than on statutes passed by the state Legislature. There are two important aspects of common law for water: the Public Trust Doctrine and the Riparian Doctrine of Reasonable Use. (A riparian owner is an owner of property adjacent to water). The Public Trust Doctrine is the concept that water flowing by or through a property is not owned by the property owner, but is held in trust by the state for the benefit of all citizens. The use of such water by property owners is governed by the doctrine of reasonable use. "Reasonable use" is generally taken to mean that one riparian property owner's water use may not unreasonably interfere with the water use of another property owner, regardless of which use was established first. "Reasonable use" is a mixed question of fact and law, and the standard may change over time, so what was once reasonable may over time become unreasonable. These doctrines of common law coexist with federal and state laws. For water, the statutes in some ways regulate what is "reasonable." For instance, RSA 485-C establishes when a large groundwater withdrawal causes an impact that is unacceptable.

Legislative Water Grants

Beginning in 1797 until as recently as the 1990s, there have been legislative acts that grant water rights to particular entities. In most cases the grantee is a municipality, although a number of water companies, both existing and defunct, have been granted water rights. Some of the acts appropriate specific bodies of water while some are more general and refer to water in a certain area or municipality. Research done in conjunction with the report of the Public Water Rights Study Committee (1992) provided a partial list of 166 legislative acts granting water rights. Waters described in these laws are still subject to regulations that proactively determine the reasonableness of a particular use.

Both common law and statutory law have evolved over time to reflect society's uses of water, its goals for sustainable management of the resource, and its scientific understanding of the interactions between human activities and the resources. As the state's economy and population grow and various uses of water resources come into conflict with one another, and as the understanding of water resources improves, the challenge is to incorporate the new reality and knowledge into improved laws, policies and programs to ensure that use of water resources can be sustained for future generations.

1.6 Summary

This primer was written to inform New Hampshire policy makers and citizens about the state's water resources and water resource issues. It is an initial step toward development of a comprehensive water plan that will guide sustainable management of water resources to ensure that there is enough good quality water to support New Hampshire's special quality of life. Although the primer is largely organized by topic areas, water is a complex subject in which most topics are interrelated and there are underlying challenges that are relevant to most, if not all, water body types and management approaches. The four underlying challenges highlighted throughout the primer are:

- Landscape Change and Increased Demand for Water Related to Economic and Population Growth.
- Climate Change: Increasing temperature, more frequent and intense storms, etc.
- Aging and Inadequate Water Infrastructure: Wastewater, drinking water, stormwater and dams.
- Information Needs: Water quantity and quality data collection, analysis and management.

In addition to describing these challenges, this chapter provided a section called "New Hampshire Water at a Glance" that provides an overview of the state's water resources, water use, water related infrastructure, and water law.

While Chapters 2 through 12 focus on particular water topics, the reader is encouraged to keep the underlying challenges in mind. The reader is also encouraged to refer often to this chapter's fold-out graphic (Figure 1-17), which illustrates the connectivity between and use of water body types and how land use can influence both water quantity and water quality.

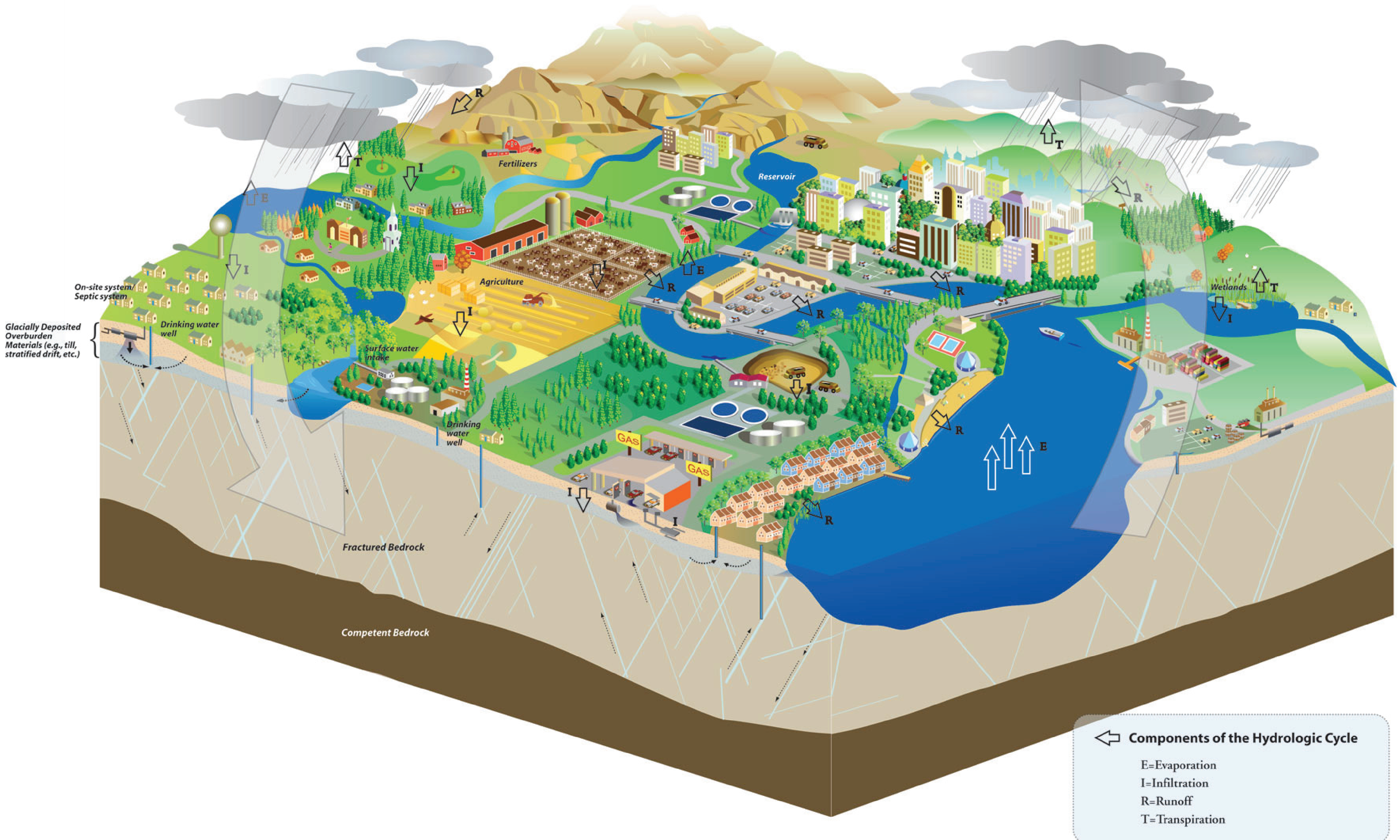

Figure 1-17. Water Occurrence and Use in New Hampshire. (Developed for NHDES and Ground Water Protection Council by Enosis, The Environmental Outreach Group.)

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