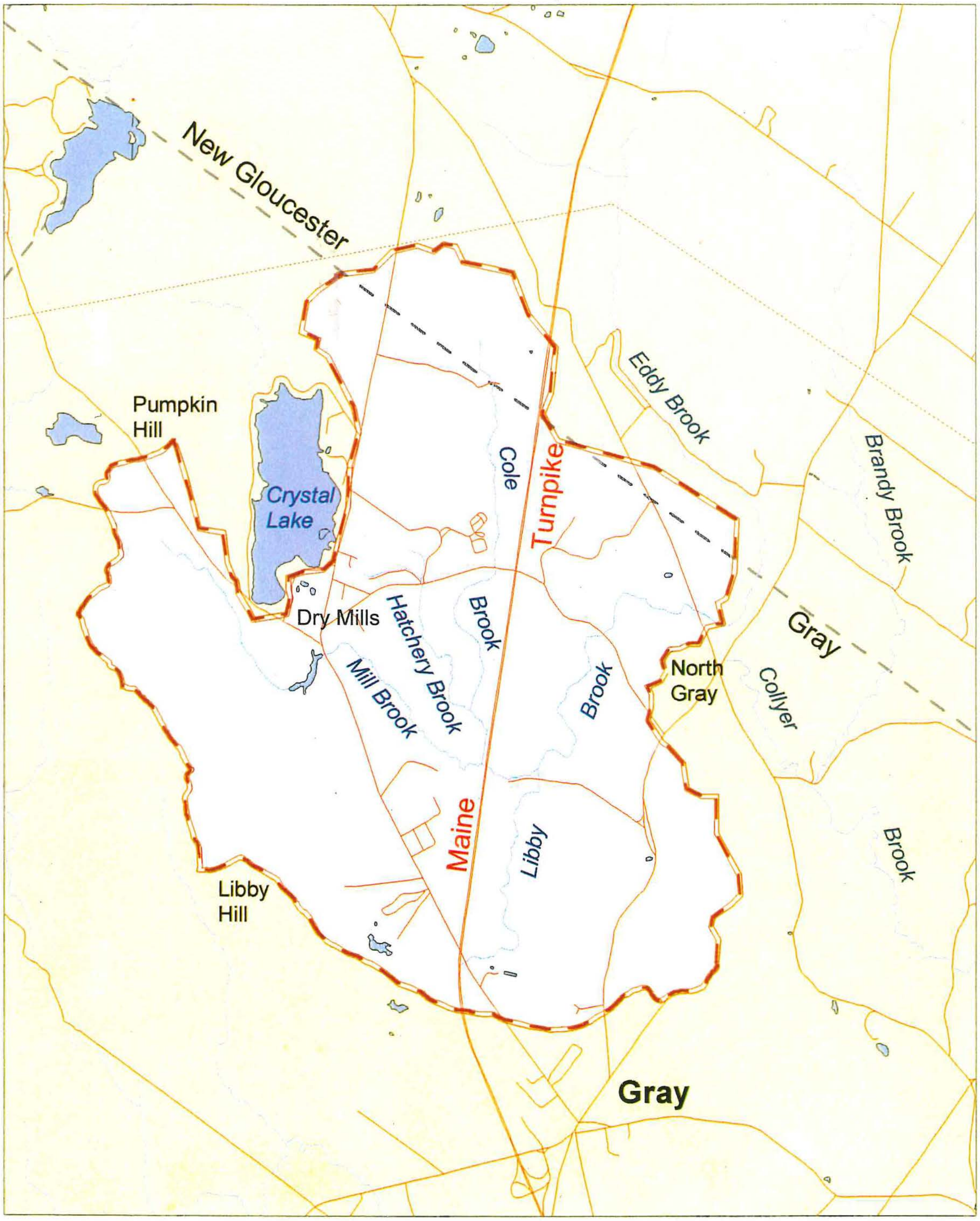
PROPERTY OF THE FRIENDS OF THE ROYAL RIVER

LIBBY BROOK WATERSHED SURVEY
FINAL REPORT



Prepared by:
John MacKinnon, P.E.
Friends of the Royal River

January 2002

ACKNOWLEDGMENTS

We are very grateful to the following Libby Brook Watershed Survey participants, most of whom were involved in this study on a volunteer basis:

Watershed Survey Volunteers

Tim Anderson
Justin Butts
Heidi Hackett
Holli Hackett
Les Hawkes
Joe Hotham
Linda Johnson
Marc Jones
Jessica Kolda
Michelle Leavitt
Zach MacDonald
John MacKinnon
John Milne
Gerome Poulin
Chris Ricardi
Shelby Rousseau
Melissa Witherspoon
David Zarinfar

Plus:
Alicia, Angela, Becka, Brian, Chrissy, Jill, and Sonya, who were among the 17 Gray-New Gloucester High School students from Jerome Poulin's class.

Steering Committee and Technical Staff

Forrest Bell, *Cumberland County Soil and Water Conservation District*
David Ladd, *Maine Department of Environmental Protection*
John MacKinnon, *Friends of the Royal River*
Tamara Lee-Pinard, *AmeriCorps Volunteer*
Jim Pellerin, *Department of Inland Fisheries and Wildlife*
Paul Piszczek, *AmeriCorps Volunteer*
John Rand, *JBR Consulting Hydrogeologist*

We would also like to express our gratitude to Stephanie Bubier, Vice Principal at the Gray-New Gloucester High School, for granting us permission to use school facilities to conduct volunteer training.

In the Summer of 2001, the Maine Department of Environmental Protection (MDEP) awarded $2,982 from their Maine Nonpoint Source Grants Program to the Friends of the Royal River to complete the Libby Brook Watershed Survey Report. The Casco Bay Estuary Project administered the grant for the MDEP.

While this project was funded by a grant from the MDEP, the contents of this document do not necessarily reflect the view and policies of the MDEP, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

It is the policy of the MDEP that no person shall be subjected to discrimination on the grounds of race, color, sex, handicap, age or national origin.

TABLE OF CONTENTS

INTRODUCTION

This Libby Brook Watershed Survey report was prepared by the Friends of the Royal River, a non-profit, all-volunteer organization whose primary mission is to promote grassroots public awareness of the Royal River Watershed and to ensure its protection for generations to come. The report begins by providing background information on Libby Brook and the potential origins and effects of pollutants that may be affecting water quality. The report then discusses the purposes and scope of the watershed survey and its findings. Based on the survey findings, the report presents examples of simple erosion and sediment controls that landowners can use to reduce the amount of pollutants that are unintentionally released into Libby Brook. The report concludes with recommendations for broader measures that individual landowners and the watershed community can take to restore and protect water quality in the Libby Brook Watershed. While the findings and recommendations contained in this report relate to the Libby Brook Watershed, much of the information is transferable to similar land uses throughout the larger Royal River Watershed, which encompasses Libby Brook.

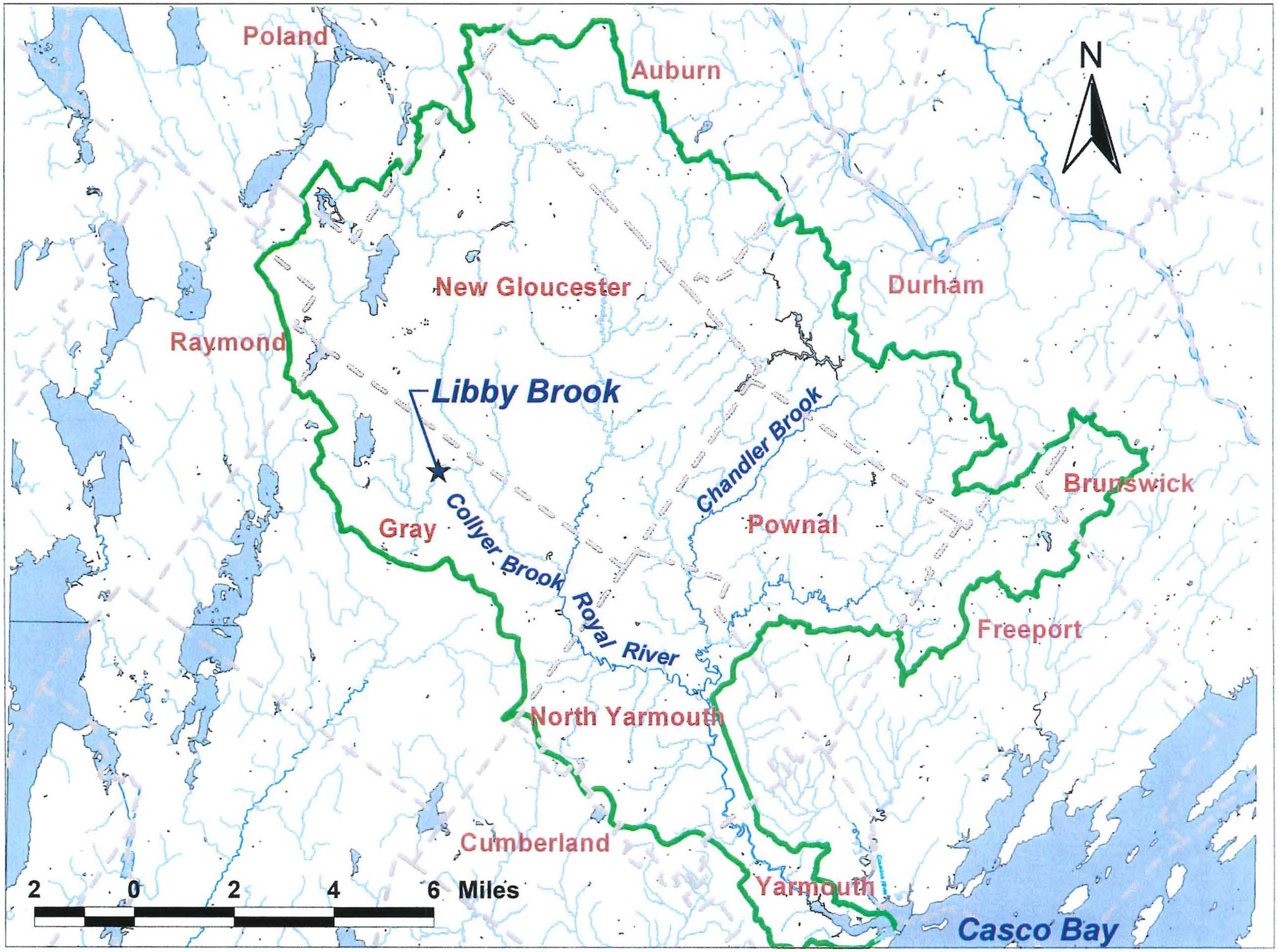
A considerable amount of time has elapsed since the Spring and Summer of 1998, when the watershed survey was conducted, and the date of this report. Conditions at some of the sites found during the survey have undoubtedly changed, for better or worse, since 1998. However, all of the findings from 1998 are included in this report since they illustrate the types of problems that threaten water quality in Libby Brook and its tributaries.

Why is protecting Libby Brook so important?

Libby Brook flows into Collyer Brook, which is one of the major tributaries of the Royal River (Figure 1). With a ***watershed*** area of more than 23 square miles, Libby Brook drains a large part of the Town of Gray and a small portion of the Town of New Gloucester (Figure 2). Tributaries of Libby Brook include Mill Brook, Hatchery Brook, and Cole Brook (see Figure 2). The physical characteristics of Libby Brook and its tributaries reflect the varied landscape in the watershed, which ranges from relatively steep areas where tributaries tumble over rocky streambeds, to relatively flat areas where the streams slowly meander through wet, marshy areas.

> ***Watershed***
>
> A watershed encompasses all of the land that slopes down to a water body, such as Libby Brook, so that rainfall and snowmelt flowing over the land eventually reaches the water body. The watershed boundary is an imaginary line along the high ground that separates neighboring watersheds.

Because the physical characteristics of Libby Brook and its tributaries are so varied, they have created rich habitat for a large number of game and non-game fish and wildlife species. Libby Brook has been identified by the Maine Department of Inland Fish and Wildlife as prime habitat for brook trout and brown trout (NEA, 1997). This is largely a result of the spring water that feeds the streams, and the long stretches of forested stream buffers that provide shade, shelter, and food for the trout. Brook Trout population surveys in the watershed have found streams where greater than 200 Brook Trout resided within a 200-foot stretch of the stream (Pellerin, J., 1998). The outstanding quality of the water is of critical importance to the Dry Mills Fish



Royal River Watershed Outline

Streams

Lakes and Ponds

Town Line

Map produced by:
Watershed Solutions, Inc.
2001

GIS Project created by:
Robert Houston
US Fish and Wildlife Service

Figure 1
Location of Libby Brook in the Royal River Watershed

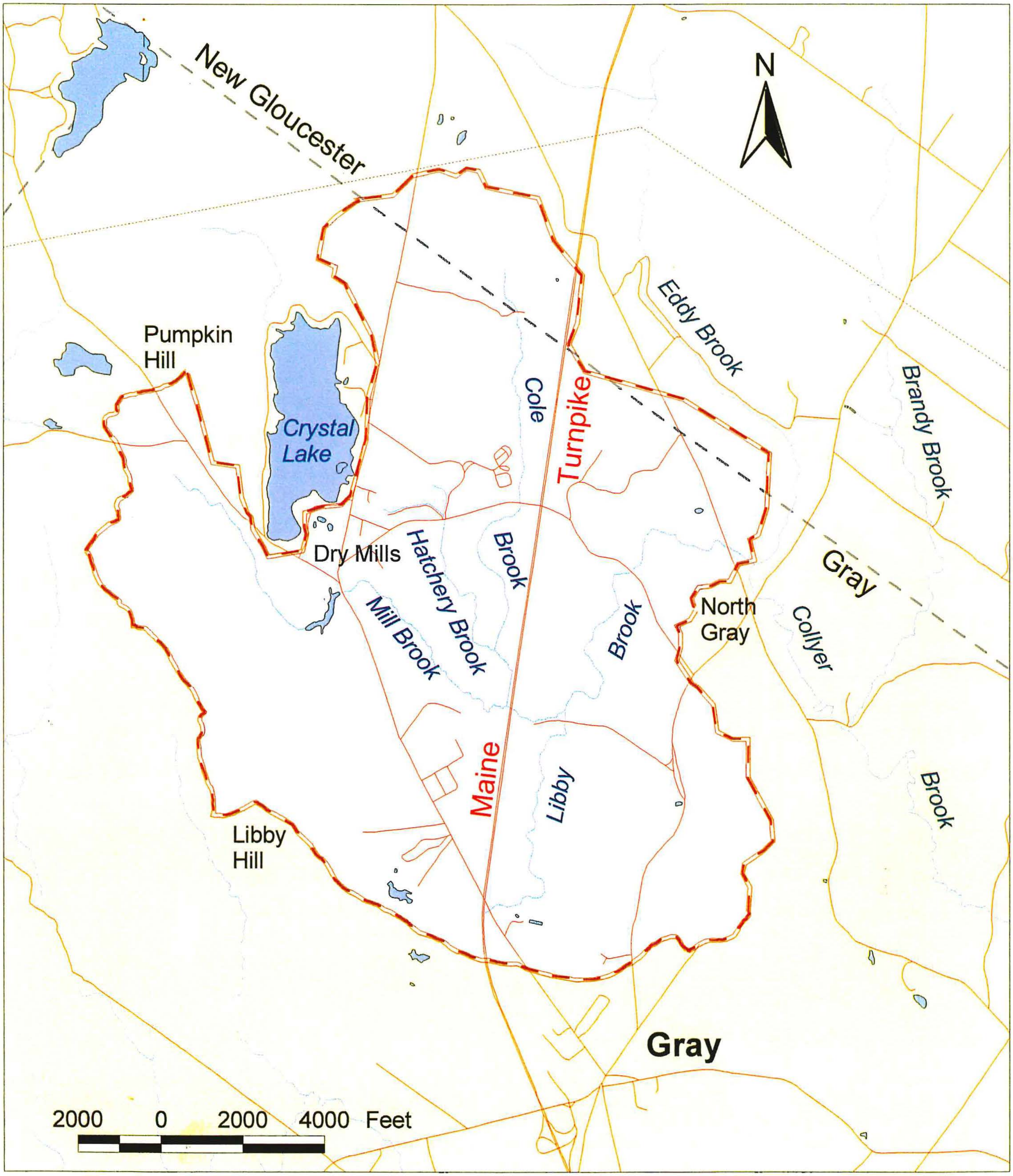


Figure 2
Libby Brook Watershed

Map produced by:
Watershed Solutions, Inc.
2001

Data Source:
Maine Office of GIS

Hatchery located on Hatchery Brook, immediately upstream of Weymouth Road. The fish hatchery raises brook, brown, and lake trout.

The health and the biological productivity of Libby Brook and its tributaries affect the abundance and diversity of wildlife species that directly and indirectly depend on the streams for food and shelter. Animals such as raccoon, otter, and mink are the direct beneficiaries of productive fisheries in the streams while animals such as white-tail deer take advantage of the cover and the forage provided by the diverse vegetation.

Aside from the biological productivity of Libby Brook and its tributaries, they provide other important functions, such as flood storage. The unaltered floodplains and wetlands of these streams provide temporary storage space for floodwaters. This effectively reduces the peak flows associated with floods that may otherwise result in severe streambank erosion and property damage in downstream areas. The disastrous effects of flooding that have been amplified by the clearing of floodplains and the filling of wetlands for development have been well-documented elsewhere in the U.S.

Is there anything harming Libby Brook?

The prime trout habitat provided by Libby Brook and its tributaries is indicative of the superior water quality that naturally occurs in the watershed. The Friends of the Royal River (FORR) monitored water quality in as many as 28 sampling locations throughout the Royal River Watershed during the spring, summer, and fall months from 1993 through 1999 (FORR, 2001). The monitoring results show that the oxygen concentrations in Libby Brook, Eddy Brook, and Collyer Brook were consistently higher than oxygen concentrations measured in other parts of the Royal River Watershed. Relatively high oxygen concentrations are necessary for the survival of coldwater fish species such as brook trout and brown trout. These results are encouraging but there are other measurements of water quality and habitat that show early signs of problems typically associated with agricultural and urban development.

As a watershed becomes developed, the portion of rainfall and snowmelt that seeps into the ground diminishes and the amount that flows into streams from road ditches and storm sewers increases. Much of the water, or runoff, that enters ditches and storm sewers has washed over a landscape that includes cultivated fields, pastures, lawns, driveways, and roads. Detached soil particles and substances that have dripped, dropped, or been deposited onto the ground are flushed from these surfaces by runoff, yielding ***polluted runoff***. Polluted runoff can ultimately harm water quality and habitat in Libby Brook and its tributaries.

How bad is polluted runoff?

Polluted runoff can contain a variety of pollutants, depending on the land use in the watershed. In developing watersheds, runoff typically contains the following pollutants:

- elevated levels of nutrients such as nitrogen and phosphorous
- sediment from soil erosion
- bacteria

- toxic substances such as pesticides, herbicides, petroleum products, and metals

Maine's Biennial Water Quality Assessment Report identifies polluted runoff as the sole cause of the failure of Maine streams to meet their designated uses, such as fishing and swimming (Maine DEP, 1999). The U.S. Environmental Protection Agency estimates that 60 percent of all remaining water pollution in the U.S. comes from polluted runoff.

Nutrients. Although nutrients are necessary for plant growth both on land and in water, water bodies that are overloaded with nutrients sometimes experience ***algal blooms***, which can rob the water of the dissolved oxygen that other aquatic organisms need to survive. Plant growth in freshwater is generally controlled by the availability of phosphorous. The more phosphorous that is available to plants, the more rapid the plant growth.

> ***Algal Blooms***
>
> A surplus of nutrients in a water body can cause an algal bloom, or algae (microscopic plants) population explosion, that can turn clear water to a cloudy green color. In extreme cases, thick, foul smelling scum forms on the water and fish kills may occur when decomposing algae depletes the water's oxygen supply.

Phosphorous found in polluted runoff is often associated with the overuse of fertilizers on lawns, gardens, and crops. Fertilizer overuse is often greatest in residential areas because most homeowners are unaware of the nutrient requirements of their soil and simply follow the instructions accompanying their favorite brand of fertilizer. Phosphorous is also a naturally-occurring nutrient in soil and is washed into water bodies wherever soil erosion is taking place, including tilled fields, construction sites, road ditches, gravel roads, and gravel driveways.

Sediment. Sediment from soil erosion not only carries attached phosphorous and toxic substances into water bodies, it can also settle out and smother habitat located on stream bottoms. It can clog and abrade fish gills, hinder the feeding processes of some shellfish, suffocate aquatic insect larvae living on the bottom, and clog spawning beds where some species of trout and salmon lay eggs.

If the amount of sediment entering a stream exceeds the rate at which sediment is moved downstream, the stream channel fills up. The sediment will occupy space that would otherwise be filled with water. Therefore, sediment from soil erosion will also diminish a stream's capacity to carry water and flooding can occur more frequently. Shallower water also means that sunlight absorbed by the stream bottom heats up the water quicker, and fish species that cannot tolerate warm water (e.g., Brook Trout) may not survive.

Bacteria. Although high bacterial concentrations do not necessarily present a health hazard to humans, they do indicate the possible presence of pathogens, or disease-causing microbes. National studies have found that polluted runoff in storm sewers contains an average ***fecal coliform bacteria*** level of 15,000 to 20,000 counts per 100 milliliters (ml) of water (Center for Watershed

> ***Fecal Coliform Bacteria***
>
> Fecal coliform bacteria in water indicates the presence of fecal wastes originating from the digestive systems of warm-blooded animals. The measurement unit for fecal coliforms is counts (i.e., number of bacteria colonies counted under a microscope) per 100 milliliters of water sample.

Protection, 1999). These numbers far surpass the standard used to set a safe level for water contact recreation. The fecal coliform standard typically used for water contact recreation is 200 counts per 100 ml of water. In a developing watershed such as the Libby Brook Watershed, common sources of bacteria in polluted runoff include pets, wildlife, livestock, and failing septic systems.

Toxic Substances. Sources of toxic substances in polluted runoff are not just limited to industrial land uses in a watershed but include the following potential sources that can be found in residential or commercial areas:

- Oil, grease, antifreeze, engine emissions, and road salt that are deposited onto paved areas are ultimately flushed into storm sewers or ditches.
- "Do-it-yourselfers" that perform their own car maintenance sometimes unwittingly dispose of used automotive fluids into storm drains or onto the ground.
- Sump pumps and floor drains in homes and businesses discharging to storm sewers or the nearest ditch can produce severe toxic effects on the receiving water body because hazardous waste is sometimes illegally disposed of in this manner.
- Pesticides and herbicides applied to lawns, gardens, and crops can eventually find their way into waterways, even if they are applied according to the manufacturer's instructions. Some herbicides and pesticides, such as diazinon, can be harmful to aquatic life even at very low levels (Center for Watershed Protection, 2000).

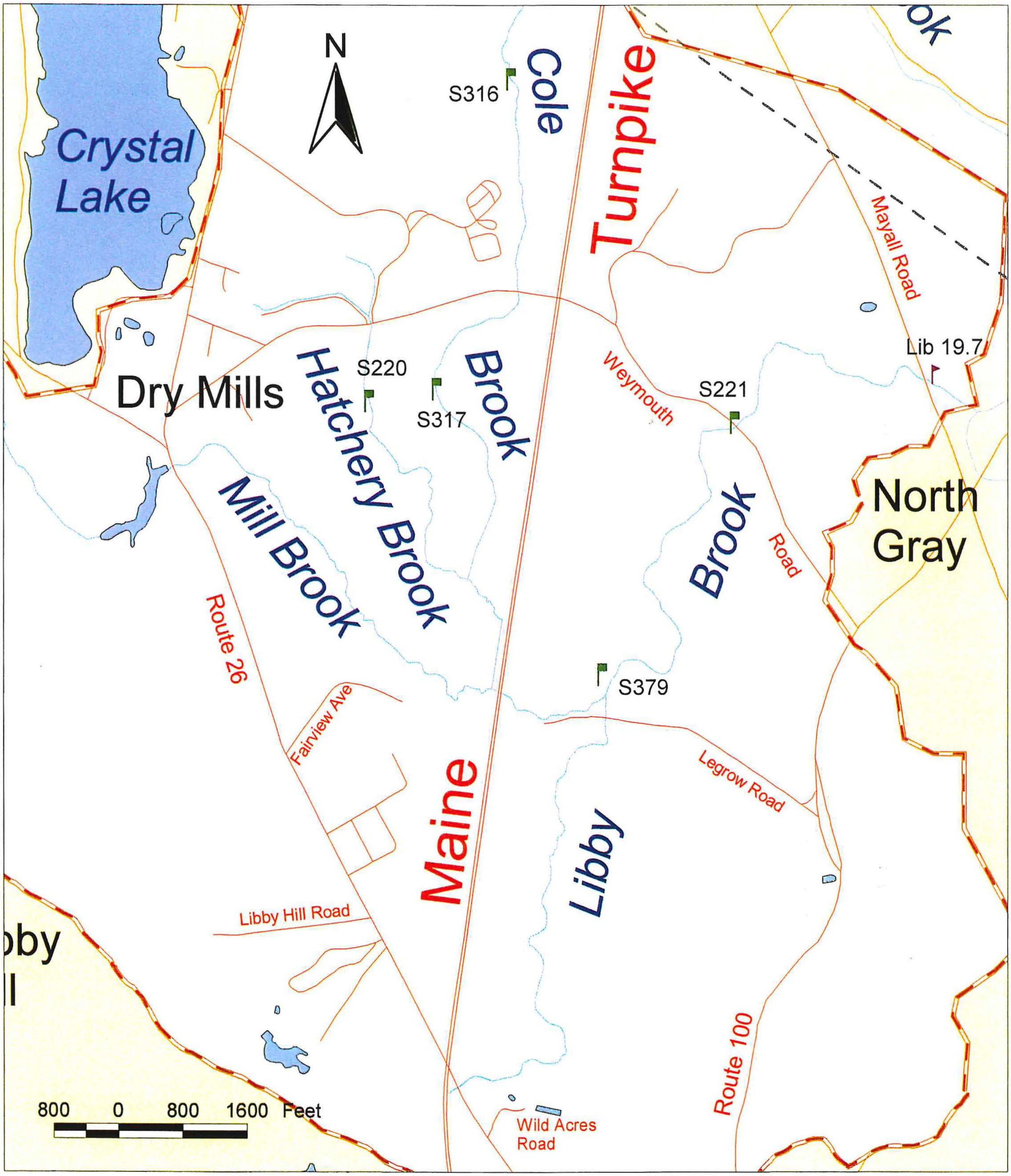
Many of the toxic substances found in polluted runoff are persistent in the environment, meaning that they degrade slowly and can accumulate in the food chain.

Has polluted runoff affected water quality in Libby Brook?

Water quality data for Libby Brook and its tributaries were acquired from two sources: 1) monitoring conducted by FORR in 1998 and 1999 and 2) biological monitoring conducted by the Maine Department of Environmental Protection (DEP) in 1994 and 1999. A summary of the water quality data is presented in the following paragraphs.

FORR Monitoring. FORR monitored water quality at one location in the Libby Brook Watershed for two consecutive years, 1998 and 1999 (FORR, 2001). The monitoring station was located where Mayall Road crosses Libby Brook and had the site identification number LiB19.7 (Figure 3). Each year, eight water samples were collected at this location and tested for the following parameters:

- dissolved oxygen; the amount of dissolved oxygen in the water sample as compared to the maximum amount of oxygen that water can hold at that temperature (reported as percent saturation)
- turbidity: the amount of suspended solid particles (e.g., silt produced by soil erosion) in the water sample that gives it a cloudy appearance (reported as Nephelometric Turbidity Units [NTUs])
- *E. coli:* the amount of a particular group of coliform bacteria (reported as counts per 100 ml of water)



Libby Brook Watershed Boundary

Streams

Lakes and Ponds

Roads

Friends of Royal River Monitoring Location

Maine Department of Environmental Protection Monitoring Location

Map Produced by: Watershed Solutions, Inc. 2001

Data Source: Maine Office of GIS

Figure 3
Water Quality Monitoring Locations

As previously stated in this report, the FORR found that dissolved oxygen in Libby Brook, Eddy Brook, and Collyer Brook were consistently higher than oxygen concentrations measured in other parts of the Royal River Watershed. All of the 16 samples that were collected at LiB19.7 over the 2-year period were above the minimum level allowed for Class B waters, the classification assigned to Libby Brook and its tributaries under Maine's surface water classification system. A description of the uses and standards for Class B waters is provided in Appendix A. The dissolved oxygen standard for Class B waters during the critical summer months is 75 percent of saturation and the lowest dissolved oxygen recorded for LiB19.7 was 82.2 percent (FORR, 2001). This result indicates that the amount of dissolved oxygen in Libby Brook is adequate to support indigenous fish species and other aquatic organisms.

> ***Geometric Mean***
>
> A geometric mean is a type of averaging that tends to reduce the bias that extremely high or extremely low monitoring results normally have on an average.

There is no turbidity standard for Class B waters so the FORR compared the turbidity results from each sampling location to the ***geometric mean*** (3.22 NTUs) for all of the samples collected in the Royal River Watershed over the seven years of monitoring (FORR, 2001). The turbidity results for LiB19.7 were generally below the geometric mean in 1998 but were consistently above the geometric mean in 1999. The difference in the turbidity results between the two years could simply reflect greater rainfall and associated runoff in 1999 relative to 1998, or it could indicate some type of soil disturbance activity occurring at a construction site upstream of LiB19.7 in 1999.

The geometric means for *E. coli* levels at Lib19.7 were compared to a standard of 125 counts per 100 ml for Class B waters (FORR, 2001). The standard is based on what is considered the acceptable geometric mean for a set of eight samples (i.e., one year of sampling). The geometric mean calculated for the *E. coli* results from 1998 (i.e., 119 counts per 100 ml) was below the standard but the geometric mean from 1999 (i.e., 233 counts per 100 ml) was well above the standard. The increase in *E. coli* levels from 1998 to 1999 appears to mirror the increase in turbidity over the same period. This observation supports the theory that there was greater rainfall and associated runoff in 1999 since *E. coli* levels elsewhere in the Royal River Watershed rose and fell depending on the amount of rainfall and runoff preceding each sampling event. Regardless, the results indicate that *E. coli* levels in Libby Brook frequently exceeded the acceptable standard for Class B waters. Interestingly, the Class B standard is the same standard that is commonly used to determine whether freshwater bodies are open or closed to swimming (Center for Watershed Protection, 1999). Therefore, swimming in waters containing *E. coli* levels above the Class B standard may present a higher risk of contracting a disease caused by the ingestion of pathogens.

<u>Maine DEP Biological Monitoring</u>. The Maine DEP has monitored the aquatic biological community at five locations in the Libby River and its tributaries. Two monitoring stations were located in Libby Brook (S221 and S379), two stations were located in Cole Brook (S316 and S317), and one station was located in Hatchery Brook (S220) (see Figure 3). Results for one station (S221) are from monitoring that was conducted in 1994 and results for the other four stations (S220, S316, S317, and S379) are from monitoring that was conducted in 1999.

Maine DEP biologists begin stream monitoring by placing mesh bag or wire basket samplers filled with clean rock onto the stream bottom for a period of 4 weeks (Maine DEP, 2000). The clean rock attracts what the scientific community refers to as "benthic macroinvertebrates". These are small, but visible, animals that have no backbones and live on the bottom of rivers and streams. These animals include clams, snails, crayfish, leeches, and especially immature aquatic insects such as caddisflies, mayflies, and stoneflies. The animals colonize the samplers over the four-week period and are captured when Maine DEP biologists collect the samplers for analysis. The animals retrieved from the bags or baskets are preserved and then sorted. Different groups of animals are identified by genus or species and the number of individuals within each group are counted. These results are entered into a computer program that determines the water quality classification of the stream based on the abundance and diversity of the animals (Tsomides, 2001). To meet biological standards for Class B waters, biological monitoring must show that the habitat for aquatic life is unimpaired (see Appendix A).

The following table presents the water quality classification determined by the computer model for each of the monitoring stations in the Libby Brook Watershed.

Table 1 – Libby Brook Watershed Biological Monitoring Results

Monitoring Station (Stream)	Year Sampled	Computer Model Classification
S221 (Libby Brook)	1994	Class B
S379 (Libby Brook)	1999	Class C
S316 (Cole Brook)	1999	Class A
S317 (Cole Brook)	1999	Class C
S220 (Hatchery Brook)	1999	Class C

Table 1 shows that Libby Brook and its tributaries failed to meet the Class B biological standard at three out of four monitoring stations in 1999. In other words, aquatic habitat was impaired at specific locations in Libby Brook, Cole Brook, and Hatchery Brook in the summer of 1999. Aquatic habitat in Cole Brook at S316 was actually better than the Class B standard in 1999.

Overall, the FORR and the Maine DEP monitoring results point to a bad year for water quality and aquatic habitat in 1999. Whether that year was an isolated case of relatively poor water quality or part of a trend of deteriorating water quality will not be known without more monitoring. The FORR do not have plans for additional water quality monitoring in the near future and the Maine DEP may not perform another round of biological monitoring until 2004. In the meantime, it is appropriate to presume that polluted runoff has had an effect on water quality and aquatic habitat, and that the problem will only get worse unless measures are taken to control the sources that are contributing to polluted runoff. As has been learned on China Lake and elsewhere in Maine, an ounce of prevention is worth a pound of cure when it comes to saving a water body from the effects of polluted runoff.

What is being done to protect Libby Brook from polluted runoff?

The Maine DEP has determined that Collyer Brook, including all its tributaries (e.g., Libby Brook), warrants special consideration in terms of protecting it from polluted runoff. Collyer Brook has been listed as a "Non-point Source Priority Watershed" in the State of Maine because its water quality is either impaired or threatened to some degree due to polluted runoff. ***Non-point source pollution*** is a widely used term for polluted runoff. Collyer Brook's listing as a Priority Watershed means that eligible projects designed to cleanup polluted runoff in the watershed are more likely to receive Federal funding than similar projects in other watersheds that are not on the list.

State regulations and town ordinances control some of the landowner activities that are known to produce polluted runoff. Maine DEP staff and Town Code Enforcement Officers can advise landowners who are interested in taking measures to reduce polluted runoff from their property, especially if the projects are located near streams and other protected natural resources. Their knowledge of the activities that are allowed in or adjacent to protected natural resources will provide landowners with the information they need to design and construct projects in accordance with applicable rules and regulations.

PURPOSES AND SCOPE OF THE WATERSHED SURVEY

This watershed survey was designed to serve two purposes:

1. Restore water quality and aquatic habitat in the Libby Brook Watershed by identifying existing problems associated with polluted runoff and recommending solutions to those problems.
2. Protect water quality and aquatic habitat in the Libby Brook Watershed by providing guidance to the watershed community on preventing future problems associated with polluted runoff.

In order to serve the purposes of this watershed survey, the following three goals were established:

1. Identify and characterize sources (i.e., sites) that are producing polluted runoff and make general recommendations for controlling the sources.
2. Raise public awareness about the impact of certain land uses on water quality and habitat.
3. Provide information to landowners and the community on the measures they can take to protect water quality and habitat.

The first goal was accomplished by conducting a two-part survey of the watershed. The first part was conducted using trained volunteers to identify and characterize sources (sites) of polluted runoff. The watershed was divided into sectors and teams of two to four volunteers were assigned a sector that they surveyed by car or on foot. When the teams found a source of polluted runoff, they recorded the location, land use, type of polluted runoff, and approximate dimensions of the site. The second part of the survey was conducted using a team of people experienced in the use of polluted runoff controls. They visited each of the sites identified in the first part of the survey, checked the recorded information for accuracy, and recommended solutions to control polluted runoff from each site. They also ranked each site according to the relative difficulty of designing polluted runoff controls and the relative cost of the controls. Finally, they assigned a ranking of low, medium, or high priority to the site based on impact to water quality, difficulty of designing controls, and cost of controls. For example, a site with a high impact but low difficulty and cost rankings was given high priority. A site with a low impact but high difficulty and cost rankings was given low priority. A table of the survey findings is presented in Appendix B.

The second goal was accomplished by reaching out to the public in a watershed-wide mailing to landowners, during a public meeting, and in the course of the watershed survey. This report will also serve to raise public awareness by identifying and evaluating the causes and effects of polluted runoff.

The third goal will be accomplished by the publication and distribution of this report to interested landowners in the Libby Brook Watershed and to members of the greater Gray community. This report contains information on specific polluted runoff controls and provides recommendations for preventing polluted runoff from harming Libby Brook and its tributaries.

SUMMARY OF WATERSHED SURVEY FINDINGS

The first part of the survey using teams of trained volunteers identified 48 sites that appeared to be sources of polluted runoff. The second part of the survey using the technical team eliminated a few of the sites from the original list but added more, lengthening the list to a **total of 50 sites**. A table containing the survey findings is presented in Appendix B. The site locations are shown in Figure 4.

Problems at all of the sites involved soil erosion and either the potential for, or the actual movement of sediment into a nearby water body. As discussed in the report introduction, sediment from soil erosion not only carries attached phosphorous and toxic substances into water bodies, it can also settle out and smother habitat located on stream bottoms. Sediment is not the only concern associated with soil erosion. Erosion creates areas of bare soil that can "short-circuit" runoff around vegetated areas, or buffers, that naturally filter sediment and other pollutants from runoff. Consequently, soil erosion is a two-edged sword in the stream environment; it is a source of harmful sediment and attached pollutants and it creates an unimpeded pathway for the flow of polluted runoff into streams.

For purposes of this survey report, the sites have been categorized by land use. The land use categories include driveways, private roads, state roads, town roads, agriculture, commercial, residential, streambank, all-terrain vehicle (ATV) paths, log roads, and foot paths. There were four construction sites identified in the commercial and residential categories during the 1998 survey where earth moving activities had temporarily exposed bare soil to rainfall and runoff. Technical team members returned to the four former construction sites in the Summer of 2001 to confirm that they had revegetated since the 1998 survey. These sites now appear to be stable and are no longer subject to soil erosion. Consequently, they have been highlighted in Appendix B as "former sites".

Examples of sites in the road, agriculture, residential/commercial, and streambank land use categories are shown in Figures 5, 6, 7, and 8, respectively. Common problems associated with each of those categories and typical solutions are also presented in the figures. More details on the problems and solutions associated with all of the categories are presented in the following paragraphs.

Driveways, Private Roads, State Roads, and Town Road Sites

The combined categories of driveways, private roads, state roads, and town roads accounted for more than half (i.e., 52 percent) of the sites. This is not unusual because watershed surveys elsewhere in Maine have found that roads are usually the primary source of polluted runoff. Gravel roads, in particular, are prone to erosion on steep slopes and at stream crossings. Paved roads fare better but they often have eroding gravel shoulders and inadequate ditches.

Most of the problems associated with the road sites identified during the survey can be corrected through more regular maintenance and greater use of erosion control materials. Erosion control materials that hold soil in place can be permanent or temporary. Some permanent erosion control materials and their uses include:

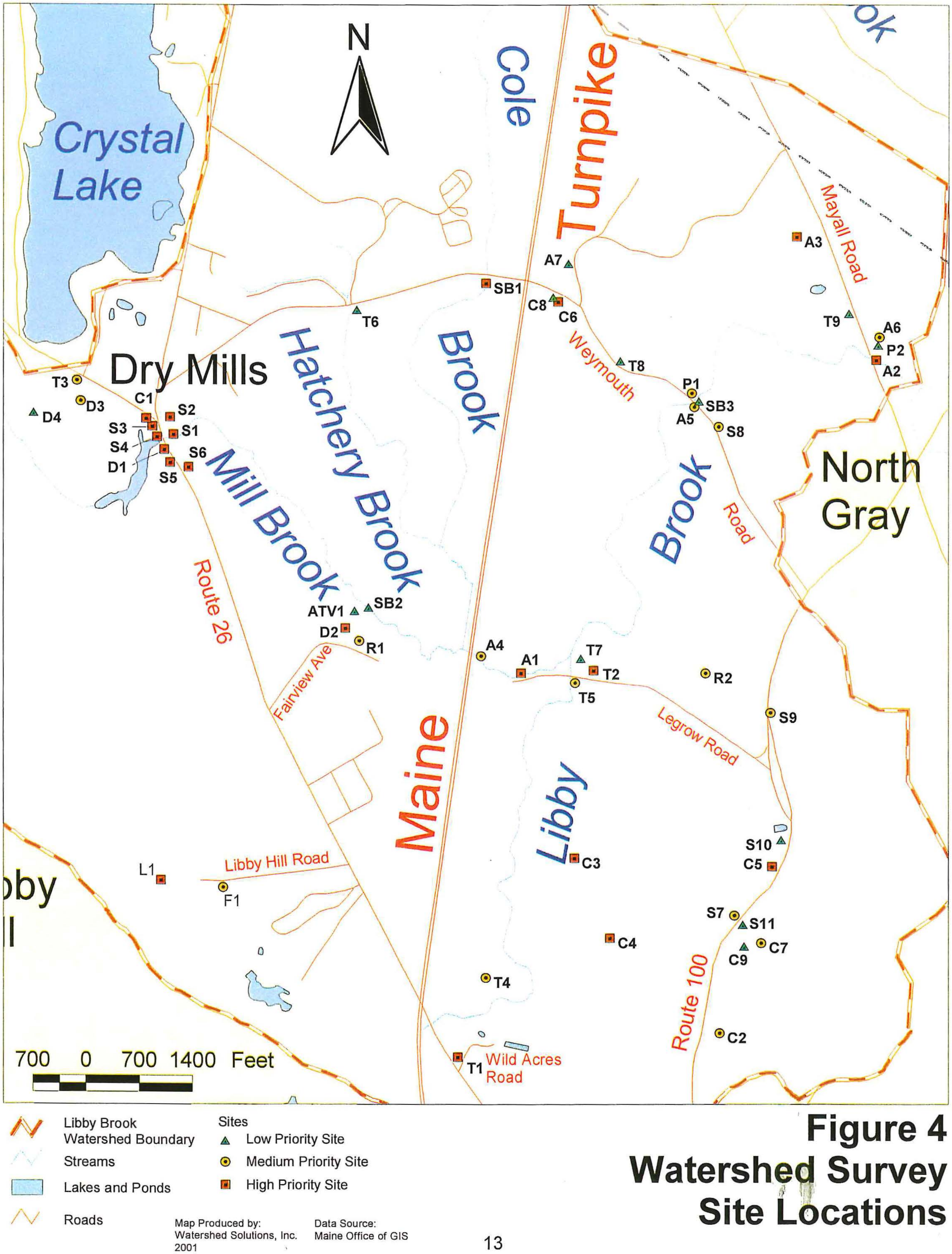


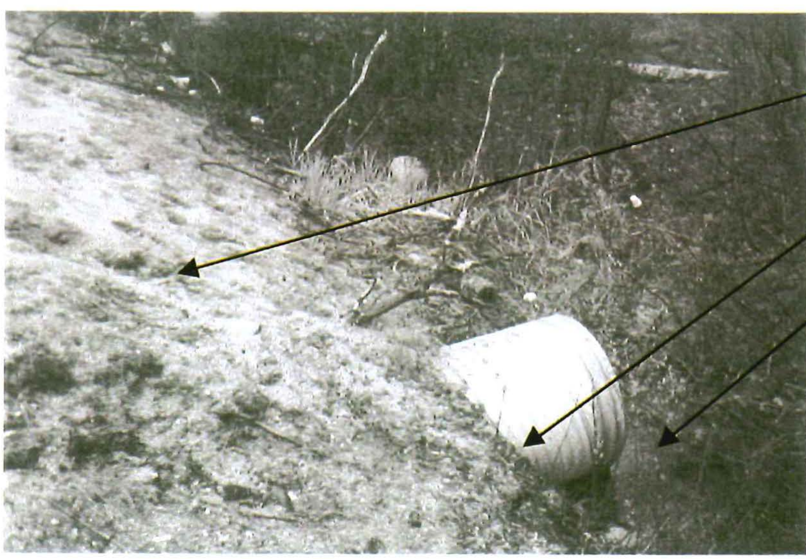
Figure 4
Watershed Survey Site Locations

FIGURE 5
ROAD SITES

Common Problems	Road shoulder erosion	Unstable culvert inlet/outlet	Ditch erosion
Possible Solutions	• Use a coarser gravel on road shoulders that will not wash out so easily • Spray a commercial non-toxic solution onto road shoulders that binds the gravel particles together	• Place rip rap around culvert inlets and outlets to stabilize slopes and channels • Excavate and place rip rap in "plunge pools" to dissipate high velocity flows in ditches	• Broaden ditches, if possible, to spread out flows • Use stone check dams in steep ditches • Place rip rap or erosion control blankets in ditches where erosive forces are severe

Problem:
- Winter sand and eroded road shoulder material is washed into storm drain inlet located directly over a stream
- Polluted runoff from an upstream parking lot also flows into the storm drain inlet

Possible Solutions:
- Excavate a ditch at toe of embankment and construct a sediment trap upstream of the storm drain inlet
- Stack rock-filled mesh bags around the storm drain inlet



Problem:
- Bare soil on road embankment eroding into stream
- Unstable soil around culvert outlet
- Stream channel filling with sediment reduces channel capacity and harms aquatic habitat

Possible Solutions:
- Place rip rap around culvert outlet
- Seed and mulch other bare soil areas on road embankment

FIGURE 6
AGRICULTURAL SITES

Common Problems	Streambank vegetation trampled by livestock	Bare soil eroding into stream	Manure washed into stream
Possible Solutions	• Fence-off the streambank in order to eliminate or restrict livestock access to stream • Construct a "ramp" out of timbers, stone, or concrete for livestock access to stream*	• Revegetate streambank using dormant cuttings of water-loving plants such as willow or red osier dogwood* • Stabilize streambank during revegetation using erosion control blankets or brush mattresses*	• Limit the amount of time that livestock spends in water or on streambank • Remove manure from the streambank

Problem:

- Livestock have trampled and stripped the streambank of vegetation
- Bare soil is eroding into the stream
- Manure washed into the stream could lead to elevated bacteria levels in the water

Possible Solutions:

- Construct a fence along the top of the streambank in order to eliminate or restrict livestock access to the stream
- Pump water up from the stream into the small pond for drinking water

*Most soil disturbance and construction activities near water bodies and wetlands are subject to Federal, State, and Local regulations or ordinances. Be sure to contact the Town's Code Enforcement Officer before you start work to determine whether a permit is required.

FIGURE 7
RESIDENTIAL AND COMMERCIAL SITES

Common Problems	Bare soil on construction sites	Inadequate erosion and sediment controls on construction sites	No vegetated buffer between developed areas and streams
Possible Solutions	• Revegetate disturbed sites as quickly as possible after construction • Large sites should be constructed in phases to limit the area of soil bared at any one time during construction	• Bare soil should be covered with hay, straw, or compost mulch to limit erosion • Erosion and sediment controls should be frequently inspected and maintained to remove accumulated sediment	• Maintain vegetated buffers at least 75 feet wide between developed areas and streams • Ideally, vegetation in buffers should be composed of a diverse plant community, from groundcover to trees

Problem:
- Soil is bare and prone to erosion
- No established erosion and sediment controls other than debris berms
- Roof runoff discharges onto bare soil

Possible Solutions:
- Spread temporary mulch over bare soil during construction
- Loam, seed, and mulch bare soil immediately after construction
- Install sediment barriers on downhill edge of site
- Direct roof runoff away from bare soil

FIGURE 8
STREAMBANK SITES

Common Problems	Road culvert discharge impinging on streambank	Streambank vegetation trampled by foot traffic	Runoff from developed land causing accelerated erosion
Possible Solutions	• Stabilize streambank by placing rip rap along the toe of the slope* • Use large boulders and stumps to deflect flow away from streambank*	• Build alternate paths set back away from streambank* • Limit foot traffic to streambanks reinforced by rock*	• Distribute runoff into vegetated buffers to reduce runoff velocity • Construct artificial wetlands or ponds that temporarily store runoff

Problem:
- Foot traffic has trampled vegetation on the streambank, leaving the soil bare
- Bare soil is eroding into the stream
- Streambank erosion will accelerate during high flows because there is no vegetation holding the soil in place

Possible Solutions:
- Relocate path parallel to stream away from the streambank
- Stabilize streambank using rip rap and/or vegetation
- Limit foot traffic to an area where the streambank has been reinforced

*Most soil disturbance and construction activities near water bodies and wetlands are subject to Federal, State, and Local regulations or ordinances. Be sure to contact the Town's Code Enforcement Officer before you start work to determine whether a permit is required.

- Vegetation – considered the preferred solution in most cases, can be initiated by broadcasting (e.g., hydroseeding) or drilling (seeds are dropped into holes formed by the driller)
- Rip Rap - large angular rock that can be used on steep slopes, ditch bottoms, and around culvert inlets and outlets
- Asphalt or "Reclaimed" Asphalt – paving material that can be used on gravel roads and parking lots (reclaimed asphalt is applied much the same way as gravel)
- Turf Reinforcement Mat – mulch materials sandwiched between non-degradable plastic netting that is unrolled and pinned to the ground to cover bare soil like a blanket (seed is generally broadcast onto the area before the mats are unrolled and pinned)

Some temporary erosion control materials and their uses include:

- Mulch – materials such as hay, straw, or compost that are spread over bare soil to protect the soil from erosion until vegetation is established
- Road Surface Stabilizers – dry or wet application of substances such as calcium chloride that bind fine gravel particles together so that they don't erode
- Erosion Control Blanket – mulch materials sandwiched between degradable netting that is unrolled and pinned to the ground to cover bare soil (seed is generally broadcast onto the area before the blankets are unrolled and pinned)

Limiting the amount of water that flows over erosion-prone surfaces is also a key element to preventing erosion. On road sites, that often means diverting excess runoff from roads and ditches into stable, vegetated areas located next to the road. An example of combining this technique with erosion control materials is presented in Figure 9.

Agricultural Sites

Only seven agricultural sites were identified during the survey; however, they included sites with some serious problems. They were typically located near streams, and the combination of bare soil, trampled streambanks, and livestock in or near streams contribute to a high potential for polluted runoff to discharge directly into streams.

Most of the problems associated with agricultural sites identified during the survey can be corrected by re-establishing vegetated buffers along streams and eliminating or restricting livestock access to streams, where applicable. A number of innovative methods for delivering water to livestock already exist. Where soil erosion problems are already severe, various methods for slowing erosion sufficiently to allow the reestablishment of vegetation will have to be implemented. The following methods can be used for controlling severe erosion:

- Diversion Ditches - ditches excavated along the top of a steep slope or across a steep slope in order to intercept and carry runoff away from an eroding slope and into stable, vegetated areas

FIGURE 9
ROAD DITCH TURNOUT AND LEVEL LIP SPREADER

Level lip spreader constructed with crushed stone slowly releases concentrated flow from ditch across a broad area of vegetated buffer.

Concentrated flow in ditch is "turned" towards level lip spreader.

Rip rap placed on this side of turnout protects against scouring.

- Check Dams – structures constructed of stone and/or timbers that are built across eroding gullies or steep ditches to slow runoff and trap sediment
- Wattles – long, cylindrical bundles of material such as straw or dormant branches that are staked across an eroding slope in order to slow runoff and trap sediment

Slowing and/or diverting runoff from eroding areas at agricultural sites is particularly important because of the large amounts of runoff that are often generated from fields, pastures, or barnyards where soil is sometimes packed into a hard layer by livestock or farm equipment. The hard-packed soil resists the infiltration of precipitation, thereby producing greater amounts of runoff that can accelerate erosion problems downstream of an agricultural activity. Typically, a combination of runoff controls have to be used in order correct a severe erosion problem. An example of restricting livestock access to a stream while stabilizing a nearby ditch is presented in Figure 10.

Residential and Commercial Sites

Eleven residential and commercial sites were identified during the survey. These sites included parking lots at commercial establishments, a gravel pit, new home construction, and golf course construction. The most serious problems were associated with the gravel pit and the construction sites, where the combination of large areas of bare soil and their proximity to streams presented a serious threat to water quality. Evidence of negative water quality impacts were actually observed at a construction site where sediment had entered Libby Brook and turned the water from clear to cloudy over a short distance. These problems point to the importance of limiting the area of soil bared at any one time during construction and effectively using and maintaining sediment barriers. Bare soil is obviously unavoidable at gravel pits, but pits are usually developed so that runoff from bare slopes drains into the pit and the sediment from soil erosion is contained within the pit. Where runoff drains outside of gravel pits, sediment barriers should be used.

New homes and golf courses are built on developed sites where runoff generally drains away from structures; therefore, sediment barriers are a necessary component of controlling polluted runoff from construction sites. However, reducing soil erosion is still far simpler and more effective than trying to prevent sediment from leaving the construction site. Reducing soil erosion on large sites can be accomplished by clearing and grading the site in increments, rather than all at once. When finish grading is complete in one area of the site and the soil seeded, mulched, or otherwise stabilized, then clearing and grading can proceed into the next area.

Environmentally-sensitive site design is another method of controlling polluted runoff from residential and commercial development, both during and after construction. Developments that incorporate wide vegetated buffers and large areas of natural, undisturbed land can provide natural sediment barriers. The clustered housing and efficient road design typically associated with this type of development has less impervious surface than conventional developments. Less impervious surface means more infiltration of precipitation into the ground and less polluted runoff into neighboring water bodies.

FIGURE 10
FENCING OUT LIVESTOCK AND STABILIZING ERODED DITCH

Buffer along stream is allowed to naturally revegetate.

Rip rap placed in eroded ditch.

Fence prevents livestock from entering and trampling vegetation and streambank in buffer area.

Because sediment is generated on most construction sites, the proper selection, design, installation, and maintenance of sediment barriers are crucial. The following types of sediment barriers are commonly used on construction sites:

- Silt Fences – a porous, fabric barrier, attached to stakes driven into the ground, that is used to filter sediment from runoff as it leaves a site
- Compost Berms – partially composted wood waste, laid in a windrow on the ground, that is used to filter sediment from runoff as it leaves a site
- Hay Bales – bales of hay, butted together and staked into the ground, that are used to trap sediment in runoff
- Sediment Basins – basins constructed aboveground or in the ground that are large enough to hold runoff until most of the sediment has settled to the bottom of the basin

There is no one sediment barrier that can be used in all situations. An example of the proper use of silt fence and a sediment basin is presented in Figure 11.

Streambank Sites

Three streambank sites were identified during the survey. Erosion at one of these sites was caused by a road culvert that aimed stream flow directly against the streambank, resulting in periodic undermining of the bottom of the bank and the sloughing of bank soil into the stream. Erosion at the other two sites was caused by foot traffic that had trampled streambank vegetation, leaving the banks vulnerable to erosion when the stream is flowing full.

The solution to streambank erosion caused by the road culvert would include protecting the bottom of the streambank from the force of the water by using large rip rap. The rip rap would be large enough to absorb the force of the water without moving. With the bottom of the streambank stabilized by the rip rap, the remainder of the streambank could be stabilized using vegetation. An example of this type of streambank stabilization is shown in Figure 12.

Resolving streambank erosion problems caused by foot traffic would obviously require cooperation from the people that use the stream. They would have to agree to using a foot path set back from the streambank and only approach the stream where the banks are reinforced by existing rock or imported rock. Once it is determined that the eroding streambank is no longer subjected to foot traffic, the revegetation process can be accelerated using cuttings of dormant water-loving plants. The cuttings would take root and the resultant trees would rapidly spread along the streambank. Care should be taken to ensure that the cuttings are from trees that are able to thrive in that particular environment.

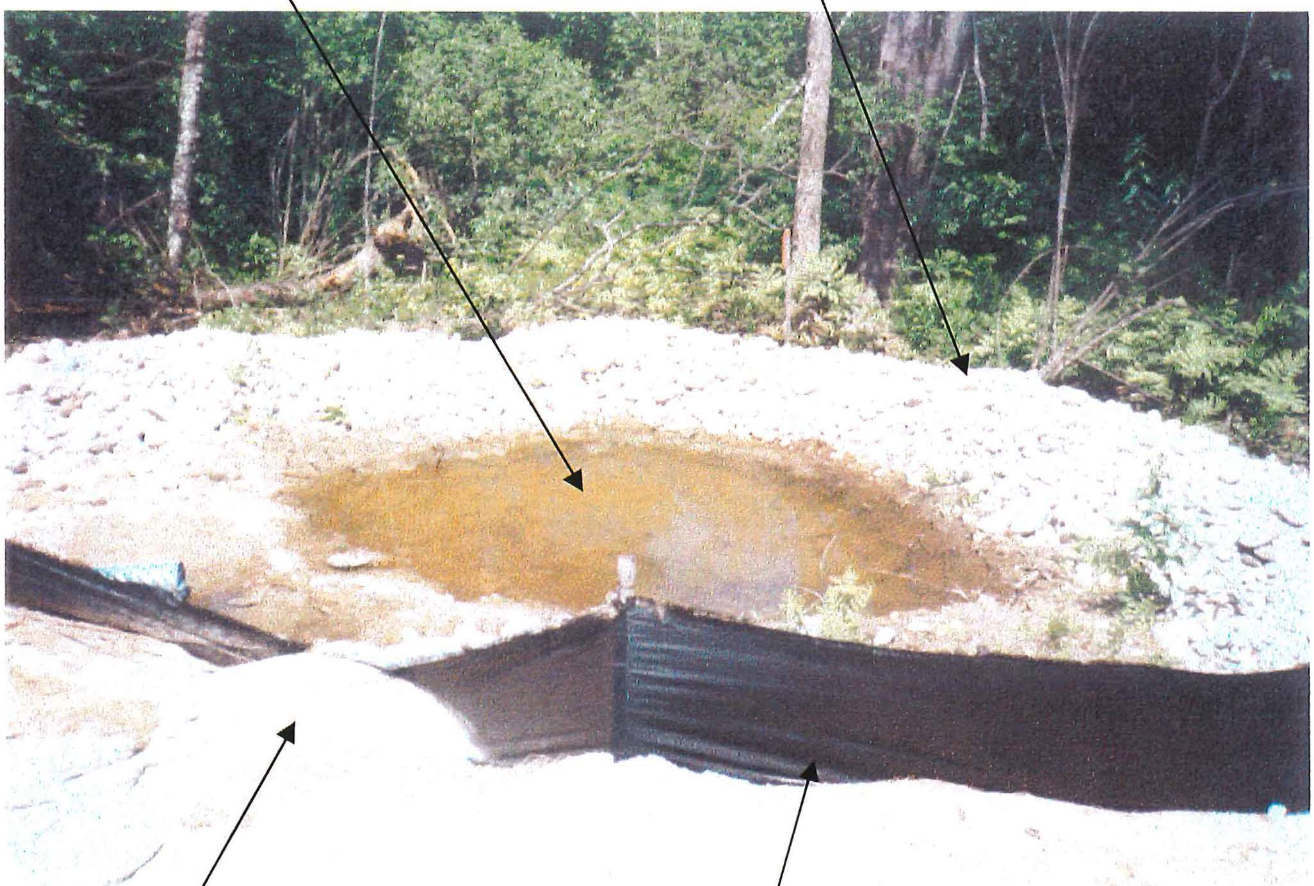
ATV Path, Log Road, and Foot Path Sites

One site from each of these categories was identified during the survey. The common characteristic of these sites was that vegetation had been worn away by foot or vehicle traffic, leaving ruts in the soil that channeled runoff through the sites. Channeled runoff tends to aggravate an existing soil erosion problem by wearing away at the bare soil, carrying even greater quantities of sediment away from a site. In these situations, diverting runoff from the

FIGURE 11
SILT FENCE AND SEDIMENT BASIN AT CONSTRUCTION SITE

Sediment that collects in basin must be periodically removed.

Basin sides constructed with rip rap and shaped into a level lip spreader.

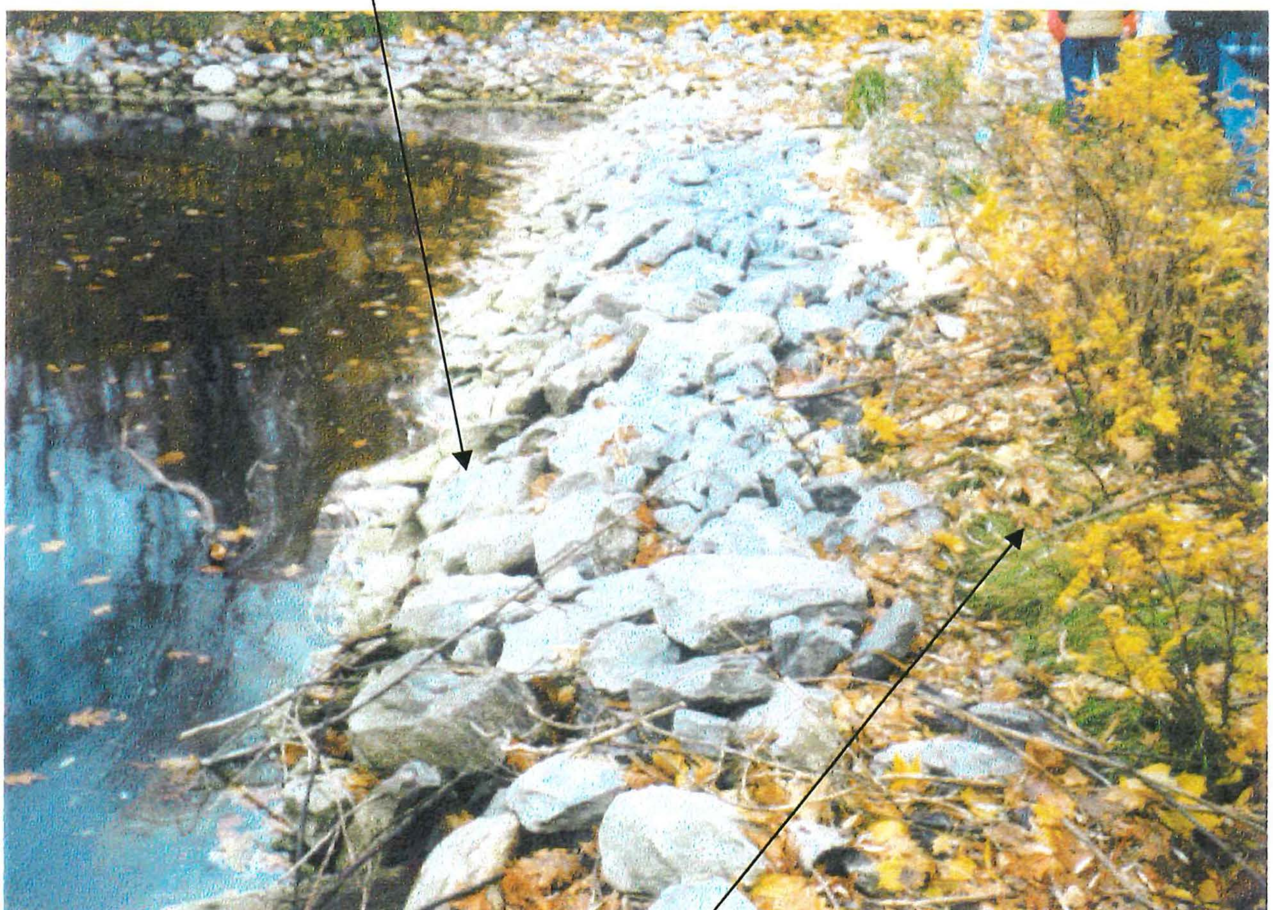


Sediment that accumulates behind silt fence must be periodically removed.

Silt fence is staked and the bottom flap buried in a trench so that runoff cannot pass beneath the fence.

FIGURE 12
STREAMBANK STABILIZATION

Rip rap absorbs the force of waves and currents that might otherwise undermine the base of the streambank.



Vegetation stabilizes the top of the streambank against erosion during floods.

paths or roads into adjacent wooded areas by placing logs, rubber strips, or mounds of stable earth across them would help to eliminate channeled runoff and reduce soil erosion. If the path or road is no longer in use, it can be revegetated by broadcasting seed onto the bare soil and covering the area with a protective layer of mulch. If the path or road will continue to be used, the bare soil should be covered with a material that can stand up to the intended use. A wood chip or bark mulch material can be used where traffic will be light. Granular materials, such as pea stone or crushed stone can be used where traffic will be relatively heavy.

RECOMMENDATIONS

The Friends of the Royal River intend to use the results of the Libby Brook Watershed Survey as the basis for the *restoration* and *protection* of water quality in Libby Brook and its tributaries. According to the survey findings, the following measures should be taken to correct existing problems associated with polluted runoff and to guard against future problems.

1. Integrate erosion and sediment controls into the design, construction, and maintenance of driveways, private roads, state roads, and town roads. In conjunction with reduced sedimentation in Libby Brook and its tributaries, the costs for road maintenance and repair will ultimately be reduced.
2. Control livestock access to streams and reestablish vegetated buffers where streambanks have been trampled and the soil is bare.
3. Limit the area of soil bared at construction sites by phasing site construction, covering bare soil with mulch, and reestablishing vegetation as soon as possible after final grading. Correctly installed and maintained sediment barriers should be used to capture sediment that does leave construction sites.
4. Stabilize eroding streambanks using rock and vegetation and direct foot traffic away from areas that are prone to erosion.
5. Stabilize ATV paths, log roads, and foot paths using a combination of methods that divert runoff away from eroding areas, and either revegetate or cover bare soil with erosion resistant materials.
6. Prepare a comprehensive watershed management plan that outlines a strategy for fixing specific sources of polluted runoff that are identified in this report and for implementing the first five recommendations. The plan could also be used to influence future land development activities in the watershed that could have a negative impact on Libby Brook and its tributaries. Any future development should consider the beneficial effects that natural erosion and sediment controls, such as stream buffers and wetlands, have on water quality and stream habitat. Where feasible, these features should be incorporated into site design.

The success of any watershed management plan depends on the support and involvement of the watershed community. Accordingly, individual landowners, neighborhood associations, road associations, developers, municipal officials, and local businesses should all be participants in the creation and implementation of such a plan. The following potential action items should be considered when preparing a watershed management plan that addresses the recommendations identified above:

- train municipal road crews on current erosion and sediment control methods;
- develop an education and outreach program that informs private landowners of the importance of protecting and maintaining vegetated buffers along streams as well as promoting proper management of lawn, garden, farm, and car maintenance activities;
- foster a stream stewardship program in the school system, such as the Maine Stream Team Program operated by the Maine DEP;
- research and identify funding sources (e.g., grants) for implementing components of the watershed management plan, and;

- develop a program designed to monitor trends in water quality so that decision-makers can use science to make judgements on where restoration funds are best spent or on how to influence commercial and residential development.

There are several Federal and State funding sources that provide grants to municipalities, non-profit organizations, and private landowners for cleaning up polluted runoff. Grants are available for qualifying "Nonpoint Source Pollution Control Projects" from the Maine DEP. The Natural Resource Conservation Service offers grants under their Wildlife Habitat Improvement Program and their Environmental Quality Improvement Program, primarily to farmers. Most grants require a matching contribution from the grant applicant, which can be funds, construction material, equipment, or labor. A list of agencies and organizations that are able to provide technical advice, funding information, and/or administrative assistance is provided on the back cover of this report.

The outstanding water quality and habitat that are characteristic of Libby Brook and its tributaries are threatened by polluted runoff, especially as the Town of Gray continues to grow. The problem may only get worse if water quality awareness, management, and protection are not promoted. The good news is that each of us can participate in the process to *restore* and *protect* water quality.

GLOSSARY

This glossary provides non-technical definitions of technical terms that are used in this report.

algal bloom	An algae population explosion that can turn clear water to a cloudy green color. In extreme cases, thick, foul smelling scum forms on the water and fish kills may occur when decomposing algae depletes the water's oxygen supply.
benthic macroinvertebrates	Small, but visible, animals that have no backbones and live on the bottom of lakes, rivers, and streams. These animals include clams, snails, crayfish, leeches, and especially immature aquatic insects such as caddisflies, mayflies, and stoneflies.
DEP	Department of Environmental Protection
dissolved oxygen	Oxygen dissolved in water is essential for all plants and animals that live in water. As an indicator of water quality, scientists check the temperature and the amount of dissolved oxygen in a water sample and compare that to the maximum amount that the water could possibly hold at that temperature. The more dissolved oxygen there is, the healthier the aquatic community.
erosion	The detachment and movement of soil particles from an area that is subjected to moving water, wind, ice, and other mechanical and chemical forces. Land development activities which remove vegetation from an area can greatly accelerate erosion.
E. coli	A specific type of fecal coliform bacteria which is often measured in water to determine whether the concentrations are safe for human contact.
fecal coliform bacteria	Bacteria found in fecal wastes originating from the digestive systems of warm-blooded animals. High concentrations do not necessarily present a health hazard to humans but they do indicate the possible presence of pathogens, or disease-causing microbes. The measurement unit for fecal coliforms is counts (i.e., number of colonies counted under a microscope) per 100 milliliters of water sample.
FORR	Friends of the Royal River
geometric mean	Type of averaging that tends to damp out the bias that extremely high or extremely low test results normally have on an average.
mulch	Materials such as hay, straw, bark, and wood waste compost that are spread over bare soil in order to absorb the force of rain drops that would otherwise cause soil erosion. Mulch can also moderate soil temperature

	and moisture fluctuations, producing an environment that is favorable for the germination of seeds.
NTUs	Nephelometric Turbidity Units. The units used to measure the turbidity of a water sample. The units are based on measuring the amount of light that is scattered when a beam of light is passed through a certain volume of water.
polluted runoff	Rainfall and snowmelt that washes over a developed landscape and picks up soil particles or pollutants that have dripped, dropped, or been deposited onto the ground. *Nonpoint source pollution is another term for polluted runoff.*
rip rap	Large angular rocks that are commonly placed in a layer on steep slopes and in ditches where water moving over the ground would otherwise cause soil erosion. The layer of large rocks helps to insulate the soil from the forces of soil erosion.
sediment	Soil particles generated by soil erosion that are transported by flowing water.
stream buffer	A strip of undeveloped land along a stream that is composed of trees, shrubs, groundcovers, and a "duff" layer. A mature stream buffer both slows and filters runoff before it discharges into a stream.
turbidity	The amount of suspended solid particles (e.g., silt from soil erosion) in the water that gives it a cloudy or opaque appearance. Often measured and reported as NTUs.
watershed	All of the land that slopes down to a water body, such as Libby Brook, so that rainfall and snowmelt flowing over the land eventually reaches the water body.
watershed survey	A search, or survey, of a watershed for sources of polluted runoff.

REFERENCES

Center for Watershed Protection, 1999. *Watershed Protection Techniques "Bacteria Issue", Volume 3, Number 1 – April 1999.* Ellicott City, MD.

Center for Watershed Protection, 2000. *Watershed Protection Techniques "Watershed Education Issue", Volume 3, Number 3 – March 2000.* Ellicott City, MD.

FORR, 2001. *Royal River Watershed, Maine, Water Quality Monitoring Report, 1993-1999.* Friends of the Royal River, Yarmouth, Maine.

Maine DEP, 1999. Results of Maine's Biennial Water Quality Assessment Report as presented at the 1999 Maine Water Conference, Augusta, Maine.

Maine DEP, 2000. *Biological Monitoring of Rivers and Streams.* www.state.me.us/dep/blwq/biohompg.htm Update date: May 26, 2000.

NEA, 1997. Northern Ecological Associates, Inc. (NEA) report on the proposed Cole Farm golf course site in Gray, Maine.

Pellerin, J., 1998. E-mail from James Pellerin, Maine Department of Inland Fisheries and Wildlife, sent to John MacKinnon, Friends of the Royal River, on September 23, 1998.

Tsomides, 2001. Phone conversation between John MacKinnon, Friends of the Royal River, and Leon Tsomides, Maine Department of Environmental Protection.

APPENDIX A

MAINE STANDARDS FOR CLASS B WATERS

A. Class B waters shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life. The habitat shall be characterized as unimpaired.

B. The dissolved oxygen content of Class B waters shall not be less than 7 parts per million or 75% of saturation, whichever is higher, except that for the period from October 1st to May 14th, in order to ensure spawning and egg incubation of indigenous fish species, the 7-day mean dissolved oxygen concentration shall not be less tha 9.5 parts per million and the 1-day minimum dissolved oxygen concentration shall not be less than 8.0 parts per million in identified fish spawning areas. Between May 15th and September 30th, the number of Escherichia coli bacteria of human origin in these waters may not exceed a geometric mean of 64 per 100 milliliters or an instantaneous level of 427 per 100 milliliters.

C. Discharges to Class B waters shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.

APPENDIX B

LIBBY BROOK WATERSHED SURVEY SITE INFORMATION AND RANKINGS

Libby Brook Watershed Survey
Site Information and Rankings

Site ID	Land Use	Location	Type of Problem	Length or Area	Recommendations	Technical/ Funding Level to Install	Priority
D1	Driveway	Rt 26, south of Mill Brook crossing (Gray Fire Dept)	Moderate surface erosion , poor shaping, and bare soil on parking area, and direct flow to Mill Brook	30' X 50'	Reshape bare soil area and vegetate, add berm and slope runoff to west (to stand of bamboo). Modify snow management (don't plow toward brook).	*	High
D2	Driveway	27 Fairview Ave	Moderate surface erosion, manmade waterbar that is directing runoff into headwaters of unnamed stream, direct flow to unnamed stream with a natural spring and direct connection to Mill Brook	100' X 10'	Broad based dip placed before stream to disperse runoff to buffer, or level lip spreader placed close to head of spring for same purpose	*	High
D3	Driveway	First driveway on left, heading W on North Raymond Rd from Rt 26	Moderate surface erosion, unstable culvert inlet/outlet, poor shaping, direct flow to Mill Brook	150' X 9'	New surface material, reshape, and add waterbar. Culvert is smaller than culverts placed upstream (larger culvert size should be considered).	**	Medium
D4	Driveway	Further W from site D3	Unstable culvert inlet/outlet (will have problems if left as is), direct flow to Mill Brook	20' X 12'	Rip rap culvert inlet/outlet, seed and mulch	*	Low
P1	Private Road	Near NW corner of Weymouth Rd and Libby Brook crossing	Unstable culvert inlet/outlet and direct flow into wetland tributary of Libby Brook	(10' X 5') X 2	Reshape culvert inlet and outlet and rip rap	*	Medium
P2	Private Road	Mayall Rd	Moderate ditch erosion, unstable culvert inlet/outlet, clogged culvert inlet and direct flow to Libby Brook	(5' X 15')x2	Clear culvert inlet, and rip rap culvert inlet/outlet.	*	Low
S1	State Road	SE corner of Rt 26, Mill Brook crossing	Moderate surface erosion, poor shaping, direct flow to Mill Brook	Not Available	Build up road, reshape shoulder, reditch, and construct sediment trap with level lip spreader that directs flow to a vegetated buffer	***	High
S2	State Road	NE corner of Rt 26, Mill Brook crossing	Moderate surface erosion, poor shaping, direct flow to Mill Brook	Not Available	Construct a plunge pool or sediment trap to dissipate flow before it enters Mill Brook	***	High

Libby Brook Watershed Survey
Site Information and Rankings

Site ID	Land Use	Location	Type of Problem	Length or Area	Recommendations	Technical/ Funding Level to Install	Priority
S3	State Road	NW corner of Rt 26, Mill Brook Crossing	Moderate surface erosion, direct flow to Mill Brook	20' X 20'	Maintenance - remove winter sand, vegetate, plunge pool.	**	High
S4	State Road	SW corner of Rt 26, Mill Brook crossing	Moderate surface erosion, direct flow to Mill Brook	50' X 5'	Ditch turnout	*	High
S5	State Road	Rt 26, south of Mill Brook crossing (Gray Fire Dept)	Moderate shoulder erosion and direct flow to Mill Brook	50' of ditch	Reshape road shoulder, seed, and mulch.	*	High
S6	State Road	East side of Rt 26	Moderate shoulder erosion, winter sand build up, direct flow to Mill Brook	600' of ditch	Reditch, turnout by St. Gregory Church information sign	*	High
S7	State Road	Route 100, 300' N of Cole Farms	Moderate shoulder erosion, stream bank erosion, direct flow to tributary	60' X 10'	Turnout on shoulders before stream, stabilize stream bank - vegetate and rip rap, and remove silt fence from stream channel	**	Medium
S8	State Road	NE side of Weymouth Rd	Severe shoulder erosion, severe ditch erosion and direct flow to manmade ditch	1,100' X 10'	Reditch where filled with sediment, reshape ditch, rip rap ditch bottom along steeper slopes, seed and mulch, and possible sediment trap near junction with existing diversion ditch	**	Medium
S9	State Road	Culvert under Route 100, at junction of Route 100 and Legrow Rd	Severe shoulder erosion, unstable culvert inlet/outlet, direct flow to tributary of Libby Brook	(40' X 15')x2	Vegetate road shoulder and rip rap culvert inlet/outlet.	*	Medium
S10	State Road	Route 100 at Foster Hill Rd Pond	Unstable culvert inlet/outlet and direct flow to duck pond	10' X 10'	Rip rap around culvert	*	Low
S11	State Road	Route 100, ditch between N parking lot and Route 100	Moderate shoulder erosion, severe ditch erosion, direct flow to storm drain along Lewiston Road	300' X 15'	Reditch, vegetate, and erosion controls around storm drain	*	Low

Libby Brook Watershed Survey
Site Information and Rankings

Site ID	Land Use	Location	Type of Problem	Length or Area	Recommendations	Technical/ Funding Level to Install	Priority
T1	Town Road	Entrance to Wild Acres Rd - first 600'	Winter sand build up, ditch capability exceeded, direct flow to the headwaters of Libby Brook	600' X 3'	Reditch both sides of road, remove winter sand, and insert new cross culvert to feed ditch runoff to natural detention pond on NW side of road	***	High
T2	Town Road	North side of Legrow Rd	Severe ditch erosion, bank erosion, ditch capacity exceeded, winter sand buildup, unstable culvert inlet/outlet and clogged culvert	289' X 7'	Rip rap culvert, reshape ditch, remove winter sand, clean culvert and seed and mulch ditch.	**	High
T3	Town Road	North Raymond Rd, 150' W of Rt 26	Moderate shoulder erosion, ditch capability exceeded (no ditch), direct flow to stream leading into Mill Brook	300' of ditch: 200' from W, 100' from E	Plunge pool, reditch, maintenance	**	Medium
T4	Town Road	Dead end of Wild Acres Rd	Moderate surface erosion, moderate shoulder erosion, unstable culvert inlet/outlet and direct flow to Libby Brook	150' X 15'	Reshape ditch and road, rip rap & vegetate shoulders, establish buffer to stream, and add turnout before stream crossing	**	Medium
T5	Town Road	Turnaround at Legrow Rd, Libby Brook Crossing	Moderate surface erosion, bare soil, unstable culvert inlet/outlet, direct flow to Libby Brook	40' X 30'	Rip rap around culvert, seed and mulch bare soil and remove winter sand	*	Medium
T6	Town Road	Weymouth Road, Hatchery Brook crossing	Moderate surface erosion, unstable culvert inlet/outlet, and direct flow to Hatchery Brook via ditch	5'	Rip rap	*	Low
T7	Town Road	Dirt Rd off Legrow, along E side of Libby Brook	Moderate shoulder erosion, poor shaping, unstable culvert inlet/outlet and clogged culvert	20' X 5'	Rip rap culvert, reshape shoulder, seed and mulch and clear culvert.	*	Low
T8	Town Road	Along N side of Weymouth Rd, just E of 94 Weymouth Rd	No ditching, moderate shoulder erosion	5' X 100'	Either excavate a ditch and vegetate, or use coarser shoulder material	*	Low
T9	Town Road	Mayall Rd, between mailboxes 377 & 373	Severe ditch erosion and clogged culvert.	750' X 10' - primarily W side of rd	Clear culvert, reditch, rip rap and seed and mulch.	*	Low

Libby Brook Watershed Survey
Site Information and Rankings

Site ID	Land Use	Location	Type of Problem	Length or Area	Recommendations	Technical/ Funding Level to Install	Priority
A1	Agriculture	End of Legrow Rd ext, just inside pasture	Stream bank erosion, bare soil and direct flow to Mill Brook	10' X 7' N side; 15' X 7' S side	Establish riparian buffer and vegetate.	*	High
A2	Agriculture	Mayall Rd	Bare soil with moderate surface erosion, deposited stream sediment, unstable stream access (cows), and direct flow to Libby Brook.	180' of stream bank	Establish buffer, vegetate, and limit livestock access to Libby Brook	**	High
A3	Agriculture	Large area west of Mayall Rd	Bare fields and severe surface erosion (gullies along southern perimeter of cropland), direct flow to Libby Brook	1,000' X 1,500'	Reestablish riparian buffer, possible interceptor trench, rip rap downspout, and level lip spreader at toe to deal with steep slope.	***	High
A4	Agriculture	Mill Brook off Legrow Rd	Lack of riparian buffer, stream bank erosion and severe surface erosion adjacent to stream.	16' X 14'	Establish buffer, vegetate and limit livestock access	*	Medium
A5	Agriculture	Southeast corner of Weymouth Rd, Libby Brook crossing	Bare soil with moderate surface erosion, unstable stream access (cows) and direct flow to Libby Brook.	40' X 30'	Establish buffer, vegetate, and limit livestock access to Libby Brook	*	Medium
A6	Agriculture	Just east of Mayall Rd	Severe surface erosion, bare fields, clogged culvert, and direct flow to tributary of Libby Brook	45' X 90'	Widen ditch, vegetate, and clear culvert	*	Medium
A7	Agriculture	North of Weymouth Rd, just East of Turnpike	Moderate ditch erosion, bare soil, poor ditch shaping, and direct flow to a pond	500' X 5' to 25'	Reshape ditch, vegetate, and rip rap and/or install stone check dams as necessary	***	Low
C1	Commercial	Parking Lot at the corner of Rt 26 and North Raymond Rd	Moderate surface erosion, stockpiled soil (some winter road sand), direct flow to Mill Brook	100' X 20'	New surface material, vegetate, stormwater controls to deal with hydrocarbon runoff from parking lot, adapt new snow management for least impact	***	High
C2	Commercial	Rt 100 LP Gas Station	Moderate surface erosion, bare soil parking lot, and suspected hydrocarbons flowing into a storm drain with unknown destination	0.75 acre	New surface material and storm drain protection	***	Medium

Libby Brook Watershed Survey
Site Information and Rankings

Site ID	Land Use	Location	Type of Problem	Length or Area	Recommendations	Technical/ Funding Level to Install	Priority
C3	Commercial	Cole Farms golf course, NW corner	Moderate surface erosion, bare soil, direct flow to stream, stockpiled soil, unstable construction site, and severe siltation in stream recognized as a direct result of construction	+/- 5 acres	Erosion controls, better planning of construction process to reduce impacts to stream	*	High
C4	Commercial	Cole Farms Golf Course, 1/2 mile from Route 100	Severe surface erosion, stream bank erosion, and direct flow to Libby Brook. (Note: The water through the golf course is clear for 1st 100', then water is severely impacted by excavated areas.) Detention/Sed Pond filled to capacity.	1000' X 10'	Maintenance, vegetate, and erosion controls. Remediation is necessary during construction of golf course! Note: This site will be fixed as golf course is developed	*	High
C5	Commercial	Route 100	Moderate surface erosion, bare soil, unstable construction site, rill erosion and silty water flowing into tributary	300' X 80'	Erosion controls, vegetate, seed and mulch and grade out rills	*	High
C6	Commercial	Weymouth Rd	Severe surface erosion at edge of gravel pit, bare soil, direct flow to tributary of Libby Brook	110' X 15' W side; 80' X 15' E side	Establish erosion controls and vegetated buffer	**	High
C7	Commercial	Cole Farms Restaurant, near maintenance shed uphill from N parking lot	Stockpiled soil (winter road sand) on steep bank , direct flow to stream	28' X 20'	Erosion controls or, more preferably, remove sand and adapt new snow management for least impact	*	Medium
C8	Commercial	Weymouth Rd	Moderate ditch erosion along access road to gravel pit, with winter sand buildup	112' X 5'	Reditch and vegetate	*	Low
C9	Commercial	Cole Farms Restaurant, excavated area around trash compacter	Severe surface erosion, bare soil, direct flow to storm drain along Lewiston Road	45' X 25'	Reduce angle of back slope, seed and mulch	*	Low

Libby Brook Watershed Survey
Site Information and Rankings

Site ID	Land Use	Location	Type of Problem	Length or Area	Recommendations	Technical/ Funding Level to Install	Priority
R1	Residential	27 Fairview Ave	Severe surface erosion, bare soil, unstable construction site - house in place, landscaping not established	30,000 sq. ft.	Reshape, seed and mulch, clean up burn pile and stabilize foundation drain	**	Medium
R2	Residential	Legrow Rd	Lack of buffer, shoreline erosion on man made pond, direct flow to tributary	100' of shoreline	Establish buffer and vegetate	*	Medium
SB1	Stream Bank	Cole Brook, just downstream of Weymouth Rd	Severe stream bank erosion apparently caused by culvert discharge into stream bank.	35' X 23'	Reshape bank and rip rap	**	High
SB2	Stream bank	Mill Brook crossing behind 27 Fairview Ave	Unstable stream access, bare soil	(5' X10') x 4	Seed and mulch both sides of brook on each side of crossing (4 areas) and limit access	*	Low
SB3	Stream bank	NE corner of Weymouth Rd and Libby Brook crossing	Unstable stream access, bare soil, and direct flow to Libby Brook	20 ' of shoreline	Rip rap	**	Low
ATV1	ATV path	Mill Brook crossing behind 27 Fairview Ave	Moderate surface erosion, direct flow to Mill Brook	120' X 8'	Install waterbar on path leading down toward brook - need to divert runoff to buffered area	*	Low
L1	Log Road	Libby Hill, uphill from school	Severe surface erosion, poor shaping, bare soil, no ditching	500' X 12'	Reshape, turnout, waterbar/diversion, broad based ditch, and seed and mulch	***	High
F1	Foot Path	Libby Hill Rd, path to baseball field	Brook crossing needs to be established, currently logs on ground for walking	5' X 5'	Build up path leading to brook, install waterbar, create bridge	**	Medium

Table Notes:

1. "Site ID" corresponds to Site ID on Figure 4.

2. Key for "Technical/Funding Level to Install":
   - * Quick fix, low cost, landowner can usually do work, minimal training needed.
   - ** Moderately complex design, moderate cost, technical assistance necessary, need some equipment.
   - *** Complex design, considerable cost, technical assistance and engineering necessary.

3. Site information and rankings that are shaded in the table correspond to sites that were under construction at the time of the 1998 survey. Earth moving activities had temporarily exposed bare soil to rainfall and runoff. Technical team members returned to these sites in the Summer of 2001 to confirm that they had revegetated since the 1998 survey. These sites now appear stable and are no longer subject to soil erosion. Sites C3 and C4 are now occupied by the Spring Meadows Golf Course that was designed and constructed to direct most of the golf course runoff into manmade ponds and wetlands. The ponds and wetlands serve to settle and filter pollutants from the runoff before it discharges into Libby Brook.

Where Do I Get More Information?

Friends of the Royal River
P.O. Box 90
Yarmouth, ME 04096

Casco Bay Estuary Project
University of Southern Maine
P.O. Box 9300
Portland, ME 04104-9300
(207) 780-4820

Maine Department of Environmental Protection
Will Cook (Enforcement)
Don Kale (Nonpoint Source Pollution Control Projects)
Jeff Varricchione (Stream Team Program)
312 Canco Road
Portland, ME 04103
(207) 822-6300

Town of Gray Code Enforcement Officer
Dry Mills Road
Gray, ME 04039
(207) 657-3112

Cumberland County Soil and Water Conservation District
381 Main Street
Gorham, ME 04038
(207) 839-7839

Natural Resources Conservation Service
381 Main Street
Gorham, ME 04038
(207) 839-7839

Maine Local Roads Center
Technical Services Division
16 State House Station
Augusta, ME 04333-0016
(207) 287-5152

Maine Department of Inland Fisheries and Wildlife
358 Shaker Road
Gray, ME 04039
(207) 657-2345