Lake Gardner Bacteriological Study

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Massachusetts Executive Office of Energy and Environmental Affairs
Richard K. Sullivan Jr., Secretary

Department of Environmental Protection
Kenneth L. Kimmel, Commissioner

Bureau of Resource Protection
Ann Lowery, Acting Assistant Commissioner

Division of Municipal Services
Steven J. McCurdy, Director

Prepared by:
Comprehensive Environmental Inc.
225 Cedar Hill Street
Marlborough, MA

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Executive Summary

The Lake Gardner Bacteriological Study was completed by the Town of Amesbury to identify bacteria sources within the Lake's watershed. A water monitoring program was conducted during the summer and fall of 2010 to identify and evaluate potential threats to water quality and develop Best Management Practices (BMPs) that address pollution sources. Land use evaluations and site specific investigations were completed to help identify pollution sources and direct improvement efforts. Long and short term remediation BMPs were developed to help the Town manage activities in the watershed and improve water quality in Lake Gardner.

Lake Gardner is a 93 acre impoundment located along the Powow River. A dam located on the south end of the lake is used to control the flow of water and to maintain a sufficient volume to providing an area for recreational uses. The lake is used for recreations such as swimming, motorized and non-motorized boating, fishing, wildlife viewing and habitat for aquatic life.

The reach of the Powow River where Lake Gardner is located is listed as Category 5 impaired water bodies on the 2010 303(d) List of Impaired Waters for pathogens, fecal coliform, total suspended solids (TSS) and turbidity. A Category 5 impaired water body is defined as a water body which is impaired or threatened for one or more uses and requiring the development of a TMDL. Lake Gardner drainage area is included in the Draft Pathogen TMDL for the Merrimack River Watershed, which reports the sources of bacteria in the watershed vary and are difficult to provide accurate quantitative estimates because bacteria sources are often intermittent and difficult to monitor. However, the TMDL indicates most sources are believed to be stormwater related.

A review of the in-lake and stormwater samples supports the TMDL's association of water quality impacts with stormwater runoff. Water quality data compiled during this study and previous studies supports indicated stormwater runoff is the primary source for bacteria and other pollutants entering Lake Gardner. A description of the past watershed studies with summaries of the data collection results are included to help demonstrate historic water quality impacts to the lake and support BMP recommendations throughout the watershed.

This study presents recommendations for structural and non-structural stormwater BMPs to help prevent bacteria and nutrient inputs to the lake, in-lake management of aquatic vegetation, watershed monitoring and public education techniques. The water quality improvement recommendations include:

- Structural stormwater BMPs to collect stormwater from existing drainage systems and provide infiltration and treatment prior to discharging to the lake.

- Large drainage systems and outfalls discharging directly to the lake are the highest priority for structural BMPs.
- Stone trench constructed upgradient along the public beach to prevent shoreline erosion.
- Managing waterfowl through landscape management techniques, fencing and hazing.
- Pet waste management through public education materials and providing additional pet waste bag dispensers at Woodsom Farm and other trailhead locations within the watershed.
- Management of aquatic vegetation by developing a hand-pulling program.
- Conduct additional investigation of the aquatic vegetation in Lake Gardner to determine if lake drawdown is appropriate for managing non-native invasive species.
- Conduct additional investigation of the types of herbicide approved for aquatic use to help manage vegetation.
- Monthly water monitoring at the Tuxbury Pond outlet during the months which Tuxbury Pond Camping Area is in use to identify potential septic system failures in the future.
- Distribute public education materials to homeowners in the Town of South Hampton which outline proper use and care of septic systems, including routine pumping and inspections.
- Perform a video inspection of the sewer adjacent to the lake Gardner once every five years.
- Periodic visits to the horse farm on South Hampton Road to inspect the manure and pasture management practices at the farm.
- Town should enforce 50-foot vegetated buffer by contacting property managers for each farm located in the Lake Gardner watershed. Periodic follow up visits should be made to ensure buffers are being maintained and to convey the importance of protecting the Town's water resources.
- Develop a broad based educational program for residents in watershed that includes materials on proper landscape management techniques that focus on water resource protection.
- Develop a Community Based Social Marketing (CBSM) program to help identify problem areas for watershed protection and develop strategies to changing the behavior of residents in the watershed.

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1.0 Introduction

The purpose of the Lake Gardner Bacteriological Study was to obtain water quality data and assess land use activities within the Lake Gardner watershed in order to develop a long-term restoration plan to address sources of bacteria. The Town of Amesbury hired Comprehensive Environmental Inc. (CEI) to conduct a water monitoring program to identify and evaluate potential threats to water quality and develop Best Management Practices (BMPs) that address pollution sources.

The Lake Gardner Bacteriological Study was conducted during the summer and fall of 2010. Water samples were collected from Lake Gardner, Powow River and storm drain outfalls that discharge to the lake. Assistance with water sampling was provided by volunteers of the Lake Gardner Improvement Association (LGIA). The samples were analyzed at a laboratory for bacteria, sediment and nutrients to identify areas with elevated levels of pollution where restoration efforts are required. Limited historical water quality data was available for Lake Gardner other than the bacteria sampling for swimming areas during the summer months. The water sampling program completed under this study supplemented the existing data to help identify and evaluate potential threats to water quality from nonpoint source pollution.

This work is part of the Town of Amesbury's continuing efforts to improve water quality in Lake Gardner and protect the surrounding area as a recreational resource through past beach facility improvements, land conservation and implementation of stormwater BMPs. Results from this study provide additional information needed to develop specific structural and non-structural BMP recommendations for a long-term restoration plan. The restoration plan will help the Town budget for expenses to accomplish specific goals to improve water quality in the lake.

2.0 Study Area Background

The study area for the Lake Gardner Bacteriological Study includes a 1,970 acre watershed which is located in the northern end of Amesbury and a small portion of South Hampton, NH, as illustrated in **Figure 2-1**. Lake Gardner covers approximately 93 acres within Amesbury and is fed by the Powow River from the north. Included in the study area is a reach of the Powow River that begins at the outlet of Tuxbury Pond and ends at the outlet of the Lake Gardner. Below Tuxbury Pond, the Powow River meanders primarily through wooded open space and wetland areas and passes two farms before entering Lake Gardner.

Impounded water in the Lake Gardner is controlled by an earthen dam located along the south shoreline that was built in 1872. The dam has a granite core with a gravity spillway that discharges water through a 16-foot wide sluiceway controlled by three adjustable gates. In addition to the overflow spillway and sluiceway, a low level outlet with a 24 inch valve is located on the left side of the sluiceway. The structure was privately owned and operated until 1964 when the Town of Amesbury obtained ownership of the dam.

The Lake Gardener Dam is used to control the flow of water out of the lake and to maintain sufficient stormwater storage volume while providing an area for recreational uses. Field measurements indicate the spillway maintains an average water depth of 6 to 7 feet in the lake.

Dams at Tuxbury Pond, Lake Attitash and Meadowbrook Pond are used by the Town to control the flow of water into the Powow River. The control structures are used to insure an adequate supply of water to meet the needs of the Amesbury Water Treatment Plant (WTP), which is located on Newton Road.

Water entering Tuxbury Pond from the Powow River is significantly reduced during dry seasons due to impoundments which largely control flow upstream in New Hampshire. As a result, Town relies on water impounded within Lake Attitash and Meadowbrook Pond to maintain flow in the Powow River for water supply needs during dry periods at the WTP. The Newton Road Weir impounds water for the WTP intake which results in a reduction of downstream flow to Lake Gardner. The lake typically remains stagnant during the summer when flow over the dam ceases.

A public beach located at the south end of Lake Gardner is a popular recreational spot with parking for approximately 100 vehicles. Access is from an entrance on High Street or from Battis Farm (part of the Powow Conservation Area) located on South Hampton Road. Trails at the northern end of the beach area follow a narrow strip of land that links the Beach to the trails of the Powow River Conservation Area. The lake is used for recreation such as swimming, motorized and non-motorized boating, fishing, wildlife viewing and habitat for aquatic life. Canoes, kayaks, small sail craft, and other car top boats can be launched from the northern end of the beach area.

The LGIA performs water sampling at several beach areas at Lake Gardner on behalf of the Town of Amesbury throughout the swimming season. Sampling locations include the Lake Gardner Beach (public beach), Glen Devin Beach and Whitehall Lake Beach. Water samples are collected on a weekly basis from May through August and analyzed for E. coli bacteria. The LGIA works closely with the Town's Board of Health and Lakes & Waterways Commission to monitor bacteria levels in the lake which is used to evaluate water quality and safety for in-lake recreation.

3.0 Water Quality Concerns

Despite the lake awareness events, public education, and beach facility improvements, periodic beach closures occur due to elevated bacteria levels. Algal blooms, sedimentation and nuisance aquatic weeds also plague Lake Gardner. A draft Total Maximum Daily Load (TMDL) Study was completed on the Merrimack River Basin by the Massachusetts Department of Environmental Protection (MassDEP) to address pathogen impairment in surface waters within the watershed. Fecal coliform and E. coli bacteria are indicators of contamination from sewage and/or feces of warm blooded animals, which may carry pathogenic (disease causing) organisms that pose a risk to human health. Common sources of bacterial contamination include direct surface stormwater runoff, failing septic systems, wild and domestic animal waste, combined sewer overflows (CSO), surcharging sanitary sewers, illicit sewer connections to storm drains and recreational activities.

Very little water quality data was available for Lake Gardner other than the required bacteria sampling for swimming in the summer months. A more defined sampling program was completed during the Bacteriological Study to develop additional water quality data to assess impacts of land use activities in the study area.

3.1 Previous Watershed Studies

Several past reports were reviewed to identify pertinent water quality data that would help with the Lake Gardner watershed assessment for bacteriological sources and other water quality impacts. A summary of each report that was reviewed is provided below.

Merrimack River Watershed Pathogen TMDL
The MassDEP is responsible for monitoring the water resources in the State and to identify impaired waters and developing a plan to bring them back into compliance with the Massachusetts Water Quality Standards (WQS). Once a water body is identified as impaired, it is included on the 303(d) List of Impaired Waters and the MassDEP is required by the Federal Clean Water Act (CWA) to develop a "pollution budget" designed to restore the health of the impaired water body. The process of developing pollution budget is referred to as a Total Maximum Daily Load (TMDL), which includes identifying the sources of the pollutant from direct discharges (point sources) and indirect discharges (non-point sources), determining the maximum amount of the pollutant that can be discharged to a specific water body to meet water quality standards, and assigning pollutant load allocations to the sources.

The Draft Pathogen TMDL for the Merrimack River Watershed Report provides municipalities with information on potential contamination sources to address bacterial and other fecal-related pollution in the Merrimack River watershed. Sources of bacteria in the Merrimack River watershed vary and are difficult to provide accurate quantitative estimates because bacteria sources are often intermittent and difficult to monitor. However, the TMDL indicated most sources are believed to be stormwater related.

There are 22 water body segments in the Merrimack River watershed that are listed as pathogen impaired requiring a TMDL. The segment of Powow River from the outlet of Tuxbury Pond to Lake Gardner is a Class A water body and Lake Gardner to the tidal portion of the river is a Class B water body. Both segments are listed as Category 5 impaired water bodies on the 2010 303(d) List of Impaired Waters for pathogens, fecal coliform, total suspended solids (TSS) and turbidity. A Category 5 impaired water body is defined as a water body which is impaired or threatened for one or more uses and requiring the development of a TMDL.

Merrimack River Watershed 2004 Water Quality Assessment Report
The Water Quality Assessment Report presents water quality conditions of several water body segments in the Merrimack River watershed. Water samples were collected from each segment and field observations were conducted by MassDEP, Division of Watershed Management (DWM) staff in 2004. The water quality data and field observation were used to assess the status of the designated uses as defined in the WQS.

The 2004 Water Quality Assessment Report includes the segment of the Powow River between the outlet of Lake Gardner, Amesbury to the tidal portion just downstream of Main Street, Amesbury. (Segment MA84A-25). MassDEP DWM habitat assessment indicated quality was degraded by channel alteration, poor bank stability and little to no riparian vegetative zone.

Five E. coli samples were collected which resulted in a geometric mean of 531 CFU/100ml. which violates the WQS geometric mean criterion of 126 CFU/100ml for E. coli, the Primary Contact Recreational Use. Field crews also sampled a pipe discharging to the river just downstream from the water quality sampling location. Elevated bacteria counts were documented during both dry and wet weather sampling. This segment of the Powow River was assessed as impaired for primary contact with the source of impairment indicated as "unspecified urban stormwater with source unknown."

There were no field observations of prolonged objectionable deposits, odors, turbidity or color, or overabundant growths of aquatic plants but there was an observation of sewage odors from a pipe just downstream from the sampling location. Green filamentous algae was observed in the open riffle areas (% of macroalgal cover estimated at 80%) which was a concern. The aesthetics use was assessed as support but was identified with an alert status due to the pipe discharge and occasional sewage odors and the growth of green algae in the open riffle habitat. Monitoring recommendations included additional bacteria monitoring to characterize the impairment and identify unknown sources.

Northeast Region Bacteria Source Tracking 2008 Results

The Bacteria Source Tracking (BST) program was established at MassDEP's Northeast Regional Office (NERO) in 2007. The goal of the program is to improve the water quality of pathogen impaired water bodies by locating sources of bacteria pollution and recommending appropriate remediation actions.

In 2008, the BST program collected over 300 samples which were analyzed for E. coli (in freshwater conditions) or Enterococcus spp. concentrations (generally in brackish/saline conditions). Samples were collected in twenty-five NERO municipalities in 9 different watersheds, ranging from small stream segments to specific storm drain outfall pipes. Based on the sampling data collected, a number of "hot spots" were identified, which warranted further MassDEP actions.

Sampling locations in the Powwow River sub-watershed were chosen based on DWM assessment reports and through field reconnaissance. The closest water sample collected from the Powow River on the downstream side of High Street bridge (site PwwR10), which is approximately 250 feet downstream of Lake Gardner.

Four rounds of sampling occurred during the 2008 bacteria source tracking but only two samples were collected at site PwwR10. Only one of the samples met precision of field or laboratory data quality objectives. This sample revealed Enterococcus spp. concentrations of 75 MPN/100mL.

Watershed and Waterway Management Plan

The Department of Public Works developed the Watershed and Waterways Management Plan for the intent to be use as a formal policy for the operation and management of the watershed, lakes, rivers and water control structures located within the Town of Amesbury. The purpose of the plan is to protect the public safety, to insure an adequate supply of water to meet the needs of the Amesbury Water Treatment Plant (WTP), to protect wetlands resources, to maximize water quality, to minimize the impact of seasonal water level fluctuations on abutting properties, and to preserve historical recreational uses in the watershed.

The management plan focuses on seasonal operation procedures and maintenance of waterways tributary to the Town's drinking water intake and provides general guidance on how to manage flood conditions within the primary waterways of the Town. Preventive maintenance includes the annual activities required to preserve all of the Town's lakes, ponds, rivers and streams. This includes keeping all waterways clear of debris and any other unnatural objects. It also provides standard procedures for protecting the watershed from ecological degradation.

Supplemental Environmental Project

A Supplemental Environmental Project (SEP) was completed for the Town of Amesbury in 1999 as part of an Administrative Consent order issued by MassDEP. The SEP included wet and dry weather stormwater monitoring for the Lake Attitash and Lake Gardner areas to identify discharges to the lakes that were contributing significant pollutant loadings. The outcome of the monitoring program would determine if a stormwater management plan was required to address illicit connections to the drainage system.

The monitoring program included three dry weather and two wet weather sampling locations at outfalls that discharge to Lake Gardner. Locations for dry weather samples include the outfalls at Glen Devin Condominiums (site D1) behind 101 Whitehall Road (site D2) and behind 81 Whitehall Road (site D3). Sampling parameters included three forms of bacteria: fecal coliform, E. coli and enterococcus. Sample results at site D1 showed no bacteria and low levels were found in samples at sites D2 and D3. **Appendix A** includes Table 2-1 from the SEP report, which provides the dry weather sampling results.

Wet weather sampling was conducted at 101 Whitehall Road (site W2) and behind 37 Unicorn Circle (site W3). Samples were collected during storm events that occurred in December 1998. Wet weather sample results were significantly different that the dry weather samples. Bacteria levels were high in samples collected at both outfalls during the first storm including several samples collected at site W3 with bacteria levels that are characteristic of sanitary waste water. No fecal coliform or E. coli bacteria were present in the samples collected at site W2 during the second and third storm events. **Appendix A** includes Figure

3-2 and Tables 3-2, 3-3 and 3-4 from the SEP report, which provide the sampling locations and wet weather sampling results.

The monitoring program found stormwater samples collected during rain events had a significant impact on pollutant loading to Lake Gardner. As a result, the report recommended a stormwater management plan was required to address sources of bacteria and investigate potential illicit connections to the drainage system.

Stormwater Management Plan for Lake Attitash and Lake Gardner
Based on the findings of the 1999 SEP, a stormwater management plan was recommended to review existing land use planning, ordinances and stormwater management efforts (e.g. street sweeping, catch basin cleaning). The stormwater management plan provided recommendations for structural and non-structural BMPs that could be employed in the Lake Attitash and Lake Gardner watersheds and on a town-wide basis. Recommendations included organization of a stormwater management team, improvements to town ordinances to further protect stormwater quality, promotion of increased drainage system management and inspections, public education, continued stormwater monitoring program and periodic revisions to the management plan.

Lake Gardner Watershed Assessment
The Lake Gardner Watershed Assessment was completed by a team of students from the Department of Urban and Environmental Policy and Planning at Tufts University. The report was completed in 2003 and focused on the relationship between land use and water quality in the Lake Gardner watershed. Recommendations provided in the report relied on water quality data that had been generated from past reports. The Stormwater Management Plan for Lake Attitash and Lake Gardner was the primary source of information which included monitoring results from the previous SEP report.

The Tufts team conducted interviews with state and local officials and volunteer organizations (e.g LGIA and Powow River Watershed Association) to identify areas of concern and the efforts to improve water quality at the time of the report. Several references to public education and improved buffer areas around the lake were made during the interviews. Other concerns included lake accessibility, impacts of waterfowl and the need for a routine water monitoring program.

Recommendations provided in the Lake Gardner Watershed Assessment reflect the concerns that were presented in the interviews. A long-term monitoring program was recommended to assess the water quality in Lake Gardner and storm drain outfalls. Vegetated buffers where also recommended to serve many functions including the filtration pollutants from stormwater runoff, a deterrent for geese and to improve aquatic habitat by providing shade along the shoreline. Among the other recommendations were tighter regulatory standards for Lake Gardner under the Town’s Water Resource Protection District (WRPD), coordination of stakeholders for water quality monitoring and public educations, and increasing conservation land and open space to provide protection to water resources and create new recreation opportunities.

4.0 Watershed and Land Use Observations

The majority of land use within the Lake Gardner study area is forest or cropland. Residential areas are scattered with the highest concentration found along the western shore of Lake Gardner (see **Figure 4-1**). Residential properties are primarily medium to low density lots with a small percentage of high density and multi-family complexes near the lake. Land uses such as open space, recreation, commercial and mining make up the remaining portion of the land found in the study area. **Table 4-1** includes the total land area for each category of land use.

Table 4-1
Land Use Characteristics

Landuse Description	Area (Acres)	Percentage of Watershed
Forested	8,814	41.6%
Fields/Crops	5,718	27.0%
Residential Medium Density	1,766	8.3%
Water	1,081	5.1%
Residential Low Density	1,545	7.3%
Open Space	784	3.7%
Wetlands	694	3.3%
Residential Multi-Family	510	2.4%
Residential High Density	98	0.5%
Commercial	64	0.3%
Mining	48	0.2%
Roads	41	0.2%
Recreation	24	0.1%
Total	21,185	

4.1 Significant Land Use Features

During field surveys of the study area, CEI conducted meetings with the Town of Amesbury Department of Public Works, the Town of South Hampton Board of Health agent and members of the LGIA. Interviews with town employees were very helpful in order to obtain local knowledge of the area and a broad view of potential pollution sources for Lake Gardner. Pertinent information collected during the interviews included current and historic land use operations, septic system records and utilities information.

Once CEI was familiar with the general land use characteristics, field surveys of the watershed were completed to identify potential pollution sources such as horse farms, agricultural farms, recreational uses and residential activities. **Figure 4-2** is a map of the study area which includes locations of field observations where potential pollution sources were further evaluated. The following paragraphs highlight land use features that were identified by CEI as potential sources of bacteria and nutrients to Lake Gardner and received follow up evaluation. Interviews that were conducted with town employees and LGIA volunteers provided information for each site to help assess these areas of concern.

Battis Farm

Battis Farm is a Town owned property located along the northeast shore of Lake Gardner. The 70 acre farm is part of the Powow River Conservation District and is used for the production of hay and forage crops. Surrounding land consists of open space, low density residential development, and other agricultural land. The farm is also used for passive recreation with trails that are connected to adjacent conservation areas including the Camp Kent Environmental Center and a portion of Powow Hill.

The Town currently applies water treatment plant residuals (Type II sludge) to the Battis Farm fields on a rotating basis among four contiguous fields with the approval from the Massachusetts Department of Environmental Protection (MassDEP). Pursuant to 310 CMR 32.00, the water treatment sludge may be used for growing any vegetation. The sludge from the treatment plant's lagoons is applied annually to the farmland as a beneficial soil amendment for the production of crops and as a recycling effort and cost savings to the town. Sludge applications occur in the fall and tilled into the soil within 48 hours.

Laboratory analysis of the sludge filter cake is conducted annually and percent solids analyzed prior to removal of sludge for spreading. Microbiological testing of the residual sludge is conducted annually to demonstrate stabilization and compliance with MassDEP regulations. Soils, groundwater, and vegetation at the farm are also analyzed on an annual basis to demonstrate stabilization and compliance with MassDEP regulations. Assessments of potential environmental impacts have been performed routinely with satisfactory results, and the project consistently meets expectations, and provides a suitable means of disposal for the water treatment plant sludge.

The soils in the area of Battis farm are classified as Charlton fine sandy loam with moderate infiltration rates which reduces the potential for excessive runoff. A large drainage swale lies at the end of the fields which conveys surface runoff and sub-surface drainage westerly towards Lake Gardner. The vegetated swale provides pretreatment to runoff, however, improvements to the swale could promote additional infiltration and treatment. Wooded buffers are maintained between fields and the shoreline of Lake Gardner to intercept surface runoff and reduce nutrients and other pollutants, however due to the nature of the farm operation, a wider buffer is recommended to ensure the farming activities are not impacting water quality in Lake Gardner. The Town of Amesbury minimum 50-foot buffer requirement should be maintained along the shore of the lake and any streams or drainage channels.

Camp Kent Environmental Center

The Camp Kent Environmental Center includes 16 acres of conservation land with a nature center offers educational programs that focus on teaching children about nature and environmental science while participating in traditional summer camp activities. The center is a former Girl Scout Camp that is now owned by the Town of Amesbury. Environmental education programs are held during the summer.

The center is a carry in/carry out facility where all materials that are brought to the center must be carried out when visitors leave. Access to the property is available from the public parking area at Battis Farm and no motorized vehicles are allowed on the property or trails.

An initial concern for this property was the possibility that the center could be a source of bacteria because there were no Health Department records of septic system on the property. However, during interviews with the Amesbury DPW, CEI learned a new septic system had been designed and installed in 1999. Bathroom facilities are available at the center and there no current indication that activities on the property create a source of bacteria to Lake Gardner.

South Hampton Road Horse Farm

A local horse farm on South Hampton Road is adjacent to Battis Farm and the Powow Conservation Area. The farm is approximately 12 acres and is a full service boarding facility with approximately 14 horse stalls. Riding lessons are also available at the farm which utilizes several large paddock or pasture areas and a 65' x 125' covered and lit arena for year round riding. The farm is located on the trail system of the Powwow Conservation Area.

The proximity of the horse farm to the shore of Lake Gardner raises concerns for the manure and pasture management practices at the farm and a potential source for bacteria and nutrients. Fortunately the majority of the facility is outside of the Lake Gardner watershed, including the stable and arena buildings, and a wooded buffer of approximately 500 feet is provided between the lake and paddock areas.

The remaining concern for water quality involves the use of the trail system with sections that follow the shore line and cross riparian areas or tributaries to the lake. Common environmental impacts to trails from horse use are vegetation loss, trail widening, erosion and muddiness. Manure left on the trail may also pose a threat to water quality since the trail system is in close proximity to the shore and could easily be washed into the lake.

Although horse traffic primarily occurs in the Battis Farm area of the trail system, steep trails leading to the top of Powow Hill are susceptible to erosion and horse traffic along these slopes could cause significant damage. CEI recommends reinforcement and stabilization of certain trails be evaluated.

Woodsom Farm

The 379-acre Woodsom Farm is located on Lion's Mouth Road and was acquired by town in 1989 to preserve the property as open space. The site was farmed as early as 1790 and was once the largest dairy farm in Essex County. The farmhouse and cow barn are still privately owned.

Land features at the farm consist of rolling hills, fields, woods and wetland areas. A proposed Lion's Mouth Historic District would preserve the property for agricultural uses.

Woodsom farm is currently used for active and passive recreation with some areas of the farm still being hayed. The fields on the south side of Lion’s Mouth Road are fertilized and hayed to prevent the area from becoming forested. The north side of the farm is also hayed, however fertilizer is not applied in this area since the hay is a lower grade that is only used for construction purposes.

The Town works with agricultural property owners and farmers to prevent impacts to wetlands from farming practices. Each farm is provided an aerial map that shows the property and boundaries of adjacent wetlands. The farmers are required to maintain a 50 foot buffer from the edge of wetlands.

Efforts are being made at the Woodsom Farm to maintain vegetated buffers, however, a review of aerial photos shows buffers are not being used to protect drainage channels and tributaries to Powow River. An overlay of the National Wetland Inventory (NWI) indicates a portion of the hay fields are within the boundary of a wetland area. The existing buffers are not meeting the 50 foot requirement to sufficiently treat runoff and protect local wetlands and water resources.

Pet owners frequent the north side of the farm where dogs are exercised. Pet waste bag dispensers are installed at the farm but the Town believes more are needed based on the high number of dogs that visit the farm on a daily basis. There is a concern that runoff from the northern field is a source of bacteria and nutrients to the Powow River due to the potential that all of the pet waste is not being picked up. Pet waste that is washed into the river will impact water quality downstream in Lake Gardner. There is approximately 1,600 feet of the Powow River that flows along the bank of the field and several feet of tributaries and drainage ditches that receive runoff from the fields that will also transport bacteria to the river. Buffer areas need to be expanded at the farm to offer better protection to the adjacent surface waters and wetlands.

Tuxbury Pond Camping Area

Tuxbury Pond is located on the state border between Amesbury and South Hampton. The pond is located approximately one mile upstream on the Powow River where the Amesbury’s water treatment plant draws water for the community water supply. Tuxbury Pond Camping Area is situated on the eastern shore of Tuxbury Pond, just north of the state line. This is a seasonal campground with 274 existing camp sites that are primarily used for trailers. The campground was issued a cease and desist order in 2009 after the South Hampton Board of Health discovered several problems with the campground’s sewage system and water supply while reviewing a petition to add an additional 224 sites.

Among the problems reported were evidence of prior sewage overflow from a septic tank into Tuxbury Pond, wiring for alarms meant to alert management to an overflow that were cut, pumps that were non-operational and a drinking-water pump house littered with the carcasses of dead animals. A septic failure of this magnitude is a significant source of bacteria and nutrients entering the pond that washes downstream to Lake Gardner.

According to the South Hampton Board of Health, the sewage system includes 16 lift stations on the campground which pump sewage to an on-site treatment facility. These lift stations were not working at the time of the Board of Health inspection. The treatment system was designed for 6,000 gallons per day but it was discovered that the system was receiving as much as 60,000 per day during in-season periods.

The New Hampshire Department of Environmental Services (NHDES) worked with the owners of the campground to resolve the sewage and water supply systems violations at the site. A thorough inspection was completed by the BOH and new as-built septic plans were submitted. The Town of Amesbury does not have jurisdiction at the camp area, however, annual septic system inspection reports should be obtained and reviewed by the Amesbury Board of Health to ensure the system is properly operated and maintained.

South Hampton Farm

A small farm is located on Whitehall Road in South Hampton is located adjacent to the Powow River with a property boundary that crosses the New Hampshire/Massachusetts state line. The majority of the fields are located within Amesbury, adjacent to the Powow River. Aerial photos of the farm show buffers are not being maintained along the perimeters of drainage channels and tributaries to Powow River. An overlay of the National Wetland Inventory (NWI) indicates the fields being farmed are within the boundary of a wetland area.

As previously discussed, the Town of Amesbury works with local farmers to maintain vegetated buffers and prevent water quality impacts to adjacent wetlands and water resources. However, buffers are not being maintained at this farm. The proximity of the fields to wetlands and surface water and the low permeability of the soils in this area create concern that the farming practices at this site may be impacting the water quality of the river and downstream in Lake Gardner. CEI recommends the Town of Amesbury work with the farm to establish and maintain the minimum 50-foot buffer requirement along the wetland areas and shoreline of the Powow River that are adjacent to the fields.

Vineyard

A 12 acre vineyard in South Hampton is located near the inlet of Lake Gardner. The Jewell Towne Vineyard was first planted in the mid 1980’s as a hobby and has expanded over the years. The vineyard’s website indicates 20 varieties of grapes are currently grown which are used to produce wine at the property. Approximately 3,800 cases of wine are produced and distributed in over 80 stores and restaurants throughout New Hampshire and Massachusetts. The winery includes a wine cellar, a bottling room and tasting room.

As with any type of farming practice, nutrient runoff from the vineyard was a concern due to its close proximity to the Powow River at the inlet of Lake Gardner. A review of aerial photographs of the vineyard found a significant wooded buffer surrounded the field where grapes are grown. Approximately 300 feet of wooded buffer separate the edge of the field to the shore of Lake Gardner. Based on this observation, the vineyard does not appear to pose a risk to water quality in the lake.

Residential Development
While the majority of the study area remains undeveloped, residential areas along the western shore of Lake Gardner pose a significant risk to water quality. There are five multi-family residential areas along Whitehall Road that include three condominium and two apartment complexes (see **Figure 4-2**). The remaining residential development is high and medium density (average lot size is 1/4 - 1/2 acres).

Land development reduces the absorption capacity of a watershed by increasing the amount of impervious surfaces. Stormwater runoff in undeveloped areas, such as forests and open spaces, flows in a slow and even manner across the ground surface which promotes infiltration through the soil. In medium and high density residential development areas, approximately 25% to 65% of the ground is covered by impervious surfaces which create a significant amount of runoff. Past and current stormwater quality samples collected from residential developments along the shore of the Lake Gardner indicate these areas are a major source of bacteria and other pollutants.

Public Beach
The Amesbury DPW has been dealing with beach and shore erosion issues at the town beach. Steep slopes adjacent to the beach cause stormwater runoff to flow across the beach and groundwater to upwell at the base of the hill where the beach is located. The result is a large volume of sand is carried into Lake Gardner each spring when snowmelt occurs and the water table is high.

Shoreline and beach erosion is considered a non-point source of pollution for Lake Gardner. Excessive amounts of sediment being deposited in the lake results in the destruction of aquatic habitat and a reduction in the diversity and abundance of aquatic life. Finer-grained sediments tend to remain suspended in the water, reducing water clarity and affecting aquatic habitat. High turbidity also decreases the water's aesthetic appeal for recreational activities. The annual deposition of eroded sediments contributes to the in-filling of the lake. Stormwater runoff at the beach also creates a non-point source of nutrients and fecal matter which are washed into the lake.

The Amesbury DPW has taken measures to redirect surface runoff and groundwater to prevent beach erosion. A vegetated swale was constructed upgradient of the beach to collect runoff from the adjacent hill and convey it to a settling basin before discharging to Lake Gardner. Reducing the amount of stormwater reaching the beach has helped with stabilization and the pretreatment provided by the basin has improved water quality of runoff entering the lake at the beach area. However the upwelling groundwater continues to form channels along the slope of the beach and wash sand into the lake.

5.0 Soil Survey

Soil information for the Lake Gardner watershed was obtained through a soil survey developed by the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). Soil surveys contain detailed descriptions of surficial geology and are used to evaluate soil characteristics for intended uses such as constructing stormwater BMPs, agricultural farming, housing and onsite septic systems. The Soil Survey of Essex County, Massachusetts was used to help determine where to focus improvement efforts and prioritize BMPs that reduce sediment and nutrient inputs to the lake.

The hydrologic group classification indicates the ability of a soil to infiltrate stormwater and is used to estimate runoff from rainfall. Soils are placed into four hydrologic groups A, B, C, and D, which are described in **Table 5-1**. **Figure 5-1**, illustrates the hydrologic group for soils found in the Lake Gardner watershed. GIS soils data was not available for the watershed area within New Hampshire. Copies of the USDA soils maps that cover New Hampshire are provided in **Appendix B**.

Table 5-1
Hydrologic Soil Groups

Hydrologic Group	Soils Characteristics
A	Soils with low runoff potential having high infiltration rates even when thoroughly wetted and consisting of deep, well drained to excessively well-drained sands or gravels.
B	Soils having moderate infiltration rates even when thoroughly wetted and consisting of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures.
C	Soils having slow infiltration rates that could include a layer that impedes downward movement of water, or soils with moderately fine to fine textures.
D	Soils with high runoff potential having very slow infiltration rates and consisting primarily of clay soils.

The Lake Gardner watershed is split into four areas with distinct porosity characteristics. Sandy loam soils found on east side of the lake have moderate infiltration rates while soils on the west side of the lake tend to have slow infiltrating soils. These slow infiltrating soils follow the ridgeline along Whitehall Road. A small pocket of moderate infiltrating soils is located in the area of Unicorn Circle. Very slow infiltration rates are characteristic of soils located along the Powow River corridor where silty loam is predominate. These soils are also found in the large wetland areas near Lions Mouth Road. A large area located on the western boundary of the watershed has the highest infiltration rates with soils made up of a sand and gravel complex.

6.0 Septic Systems

Developed areas within the Town of Amesbury are serviced by public sewer so there is not a concern for septic system failures for the majority of the watershed. Homes in the Town of South Hampton all use on-site septic systems for sewage disposal. The most common system for individual homes includes a sewer line from the house that leads to an underground septic tank in the yard. Flow from the tank disperses into the soil through a system of underground drains or perforated pipes located in a leach field.

Soils characteristics of developed areas in South Hampton were reviewed to determine their capacity to absorb septic effluent. Among the characteristics that affect use of soils for septic systems are the content of sand, silt, and clay, flood hazard, depth to water table and hydrologic properties. Effluent moves faster through sandy and gravelly soils than through soils with high clay content that have limited pore space for holding effluent.

There are three soil types that are predominant in the developed areas, including Paxton fine sandy loam, Woodbridge fine sandy loam and Scituate-Newfields complex. The characteristics of the three soil types are very similar. Descriptions provided in the Soil Survey of Rockingham County, New Hampshire include the following:

- Soils are well suited for urban development, but the wetness in spring and the restricted permeability are limitations.
- Hydrologic soil group C.
- Permeability is moderate in the upper part of the profile and slow in the lower part.
- Depth to seasonal high water table: 1.5 to 2.5 feet.

Movement of effluent through soil is determined mainly by the porosity of the soil and by the type of clay in the soil. If the soil is not porous, the effluent simply builds up and seeps to the surface. Characteristics provided above indicate the high groundwater and restricted permeability of the soils create limitations for use with septic systems but are acceptable if properly designed.

Several of the properties that use septic systems in the watershed did not have records of the design or current condition. Some of these systems include properties in close proximity to the Powow River. The South Hampton Board of Health had records for fifteen properties along Whitehall Road and Jewell Street that indicate septic systems are operating properly and include modern septic system designs. Dry weather samples collected downstream of properties with septic systems had inconclusive results and did not indicate bacteria or nutrient sources are being introduced to the surface water due to septic failures.

7.0 Drainage Observations

Storm drain systems in the study area are primarily located along the western shore of Lake Gardner where the majority of development has occurred. A total of nine outfalls were chosen as monitoring locations to collect wet weather stormwater samples. Eight of the outfalls are located along Whitehall Road and a few additional secondary roads in residential areas. The ninth outfall is located on the east side of the lake near the public beach. Outfall locations are shown in **Figure 7-1**.

During monitoring events, two additional outfalls were sampled. One was located at the Glen Devin Condominiums and a second pipe in a field located at 117 Whitehall Road. The Glen Devin outfall was observed with dry weather flow and was sampled during an in-lake monitoring round. The pipe located in the field was sampled because the property owner and LGIA volunteers were concerned that it presented a water quality concern.

Drainage systems along Whitehall Road collect runoff from residential developments and road ways before discharging directly to Lake Gardner at outfall locations 4-12 and 4-13. The remaining outfalls on the west side of the lake discharge to detention ponds or riprap outlets to provide pretreatment before stormwater enters the lake. Outfall 4-2 collects runoff from a residential area and discharges to a drainage ditch before entering the lake just north of the beach area.

Drainage catch basins in later developed areas such as Nancy drive and Woodsom Drive, have deep sumps with hoods to trap sediment and prevent floatable material from washing out of the structure. Structures in older developments like Unicorn Circle do not have hoods but sumps provide sediment removal. The Amesbury DPW has completed drainage improvements along Whitehall Road to include deep sump structures with hoods to prevent sediment and other pollutants from discharging to Lake Gardner.

Sewer Pipe Crossing Lake Gardner

An active sewer pipe currently runs along the western shore of Lake Gardner. The sewer line was installed in 1976 and was originally a force main that redirected sewage collected along Whitehall Road back to the treatment plant located toward the center of town. Previously, failures at the pump house could cause the system to overflow into a small tributary to the Powow River. Now, the force main has been reconfigured to a gravity fed system and the current configuration is not under pressure and does not use a pump house. Interviews with the Amesbury DPW informed CEI that the sewer pipe is approximately 10 to 12 feet below the lake and there have been no problems with this section of the sewer system. It is not believed to be a current source of bacteria to Lake Gardner.

8.0 Evaluation Methodology

The methodology to evaluate pollutant sources and water quality in the Lake Gardner watershed began by collecting historical information from the Towns of Amesbury and South Hampton. The second phase of the watershed evaluation involved multiple rounds of water sampling to establish a baseline of the water quality in the lake and the associated stormwater discharges at outfalls. Water quality data was then used to perform the third phase of the evaluation as a basis for comparing current and historic data.

8.1 Water Quality Monitoring

Although historical data has been collected at the beaches for bacteria concentrations, very little in-lake sampling has been completed in Lake Gardner. The objective of the water quality monitoring program was to collect water samples at multiple in-lake locations and stormwater outfalls to determine the extent of bacterial contribution and other pollutants entering Lake Gardner from non-point sources throughout the watershed. **Figure 8-1** shows the dry and wet weather sampling locations. Water quality samples were collected by LGIA volunteers from Powow River and Lake Gardner during three dry weather events. Volunteers also collected two rounds of samples at stormwater outfall locations during wet weather events.

Water samples collected during dry and wet weather events were analyzed for both fecal coliform and *E. coli* bacteria. In addition to bacteria, all samples were analyzed for total phosphorus, ammonia nitrogen, nitrate nitrogen, total suspended solids, turbidity and dissolved oxygen in order to develop a comprehensive set of water quality data. Field parameters recorded during sampling events include temperature, pH, total dissolved solids and conductivity. These secondary parameters are significant when evaluating water quality for bacteria and will often help identify non-point pollution sources. Monitoring procedures were in accordance with the Lake Gardner Bacteriological Study Quality Assurance Project Plan (QAPP). A copy of the QAPP is provided in **Appendix C**.

The sampling approach for this study was to collect two rounds of dry weather samples in early summer, followed by two wet weather rounds during the mid summer and then a final round of dry weather samples. This sampling approach was intended to develop in-lake water quality data before and after storm events and to identify upstream pollutant source contributions from the Powow River and surrounding watershed. Wet weather samples collected at drainage outfalls were intended to isolate drainage areas to help identify potential sources of bacteria to Lake Gardner. Laboratory results of the dry and wet weather samples would then be compared to evaluate the bacteria concentrations and determine the correlation between bacteria levels in stormwater runoff and in-lake observations.

An extended period of dry weather occurred during the summer and early fall of the monitoring period which affected the sampling schedule. The initial plan to collect wet weather samples during the summer was delayed since there were no significant storms from July through September meeting the defined storm event criteria. The storms that did occur either did not generate sufficient runoff to discharge from the drainage systems or occurred during a time when samples could not be delivered and processed at the laboratory to meet required hold times (primarily for bacteria analysis). As a result of these conditions, wet weather samples were collected approximately a week apart in late October and early November. The final round of dry weather samples were completed a week after the second round of wet weather samples were collected.

Initially, there was some concern for the extended dry period that occurred prior to the first wet weather sampling rounds. It was anticipated that the unusual long dry period would increase the buildup of pollutant in the drainage areas and result in uncharacteristically high concentrations in the first flush of stormwater. However, a review of the laboratory data indicates the pollutant concentrations in the stormwater collected during the first storm event were not significantly higher than those collected a week later.

A second concern involved the season when the final round of in-lake dry weather samples were collected. Since the samples were collected in November, the effect of seasonal lake turnover could influence in-lake pollutant concentrations. Lake turnover typically occurs twice per year, once in the spring during ice melt and once during the fall season. As air temperature begins to drop during the fall, the surface water (epilimnion) of a lake is cooled and becomes denser. The dense water will drop through the water column of a lake and cause a turnover affect throughout the water body. During turnover, sediment and decayed vegetation become suspended in the water column causing higher levels of turbidity and increase bacteria, nutrient and dissolved oxygen concentrations.

Due to the shallow depth maintained in Lake Gardner (approximately 6 to 7 feet), stratification does not occur. Temperatures recorded during the monitoring period show the surface and bottom of the lake were the same, resulting in no separation of thermal layers. The steady flow of the Powow River entering the lake prevents the water from becoming stagnant and stratified during the spring and fall seasons.

Residence time of the water in Lake Gardner is approximately 8 days. The short residence time is due to the large (50 mi^2) watershed of the Powow River that is upstream of the lake. Residence time increases during seasonal low flow periods, however, even small summer storms generate significant flow in the Powow River which effectively flushes water in and out of the lake. As a result, long-term average in-lake pollutant loadings are reduced by constantly flushing water through the lake.

Due to the natural characteristics of Lake Gardner and the Powow River, it was concluded that the late season water samples were not affected by lake turnover.

8.2 Dry Weather Monitoring

Dry weather events are defined as no precipitation occurring within 72 hours prior to a sampling event. In-lake samples were collected during dry weather events at five locations including the surface and bottom of the deep hole (approximately 7 feet deep) in Lake Gardner. Three rounds of dry weather samples were collected at each location. In-lake samples were collected by two LGIA volunteers using a small boat. As previously mentioned, dry weather flows found at two drainage system outfalls were also sampled to determine if they were potential illicit discharges to the lake.

The Powow River was sampled on the upstream side of the Newton Road culvert, just downstream of the Tuxbury Pond outlet. This location was selected to assess water quality exiting the pond since this is the point where the Powow River enters the study area for Lake Gardner. Samples collected at the Jewell Street station were taken upstream of the bridge that crosses the Powow River. This sampling point was used to isolate sections of the Powow River to identity potential water quality impacts from the nearby farms along this reach of the river. Samples were collected at the Lake Inlet station where the Powow River widens into Lake Gardner. This location was selected to determine pollutant loads contributing to the lake from upstream sources. Finally, samples were collected at the Lake Outlet station downstream of the Lake Gardner dam to determine pollutant loads leaving the lake.

The Deep Hole sampling station was located towards the southern end of the lake. Samples were collected from this location at the surface and bottom of the lake to determine if there were significant differences in water quality and physical characteristics that would influence the improvement strategies.

During in-lake sampling, sediment depth was also measured at the Deep Hole location. Sediment depths were measured at this location to determine the existing conditions of Lake Gardner and have a future point of comparison. This data can be used to evaluate the feasibility of dredging sediment deposits in the lake to improve water quality.

8.3 Wet Weather Monitoring

Wet weather events are defined as a storm event greater than 0.5 inch of precipitation in a 24-hour period, with first flush occurring ten minutes after flow is observed. Two sampling rounds were completed during the monitoring period. Stormwater was sampled under wet weather conditions to determine water quality discharging from the drainage systems contributing to Lake Gardner. Water quality data was used to determine needs for local controls to minimize direct bacteria inputs to the lake.

Nine stormwater outfalls were originally identified that discharge in close proximity to Lake Gardner. Seven of the outfalls were flowing and sampled during the first storm event. Eight outfalls were sampled during the second storm event. A ninth outfall located in a field adjacent to Lake Gardner was sampled during the second storm event.

Due to the extended dry period during the summer, greater storage capacity of the soils and catch basin sumps minimized the runoff that was generated at the outfalls during the storm events. No flow was observed from outfalls 4-8 and 4-9 during the first round of wet weather sampling. Outfall 4-8 remained dry during the second wet weather sampling round.

8.4 Monitoring Results

Three rounds of dry weather water quality data are presented in **Table 8-1**. All locations were sampled during each round and no problems were recorded by the LGIA volunteers. Laboratory analyses were performed in accordance with QA/QC procedures that are outlined in the QAPP. Laboratory reports are included in **Appendix D**.

Table 8-1
Dry Weather Monitoring Results

Dry Weather 6/25/2010						
Pollutant	**Newton Road**	**Jewell Street**	**Lake Inlet**	**Lake Outlet**	**Deep Hole (shallow)**	**Deep Hole (deep)**
E.Coli (MPN/100 ml)	5	12	7	39	6	10
Fecal Coliform (MPN/100 ml)	130	50	140	110	14	13
Nitrate-N (mg/L)	0.07	0.08	0.11	0.10	0.07	0.06
Ammonia-N (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Phosphorous-P (mg/L)	0.017	0.009	0.010	0.010	0.007	0.013
Dissolved Oxygen (mg/L)	7.3	6.2	8.7	8.2	8.1	8.1
Turbidity (NTU)	1	1	2	2	1	2
Suspended Solids (mg/L)	4E	4E	3E	2E	2E	2
Temperature (°F)	80	81.5	81	72	79	79
pH	5.4	5.4	5.4	5.4	5.4	5.4
Total Dissolved Solids (mg/L)	69	74	77	72	82	79
Conductivity (µS/cm)	137	150	155	145	199	156

Dry Weather 7/9/2010						
Pollutant	**Newton Road**	**Jewell Street**	**Lake Inlet**	**Lake Outlet**	**Deep Hole (shallow)**	**Deep Hole (deep)**
E.Coli (MPN/100 ml)	7	150	7	23	2	3
Fecal Coliform (MPN/100 ml)	70	900	170	70	30	17
Nitrate-N (mg/L)	0.07	0.06	0.07	0.10	0.06	0.06
Ammonia-N (mg/L)	<0.05	<0.05	<0.05	0.05	<0.05	<0.05
Total Phosphorous-P (mg/L)	0.02	0.01	0.02	0.02	0.01	0.01
Dissolved Oxygen (mg/L)	5.9	6.9	7.9	6.7	8.0	8.0
Turbidity (NTU)	2	2	1	1	1	1
Suspended Solids (mg/L)	9	2	1E	<1E	<1E	<1E
Temperature (°F)	89	91	86	90.8	86	85
pH	5.8	5.8	5.0	5.0	5.0	5.0
Total Dissolved Solids (mg/L)	92	95	88	93	89	89
Conductivity (µS/cm)	183	191	176	187	179	179

Table 8-1 (continued)
Dry Weather Monitoring Results

Dry Weather 11/12/2010							Outfall Samples	
Pollutant	**Newton Road**	**Jewell Street**	**Lake Inlet**	**Lake Outlet**	**Deep Hole (shallow)**	**Deep Hole (deep)**	**Glen Devin**	**4-15**
E.Coli (MPN/100 ml)	30	30	50	50	50	23	13	27
Fecal Coliform (MPN/100 ml)	30	30	50	80	50	23	21	34
Nitrate-N (mg/L)	0.06	<0.05	0.07	0.08	0.07	<0.05	2.40	2.70
Ammonia-N (mg/L)	<0.05	0.05	0.05	<0.05	<0.05	0.07	<0.05	0.07
Total Phosphorous-P (mg/L)	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02
Dissolved Oxygen (mg/L)	10.6	10.6	10.2	11.6	10.9	10.8	11.0	11.0
Turbidity (NTU)	2	2	1	2	2	6.0	<1	<1
Suspended Solids (mg/L)	1E	4E	2E	1E	2E	29	<1	<1
Temperature (°F)	44	44	49	50	49	49	56	58
pH	7.7	7.3	7.2	7.4	7.0	7.1	7.4	7.4
Total Dissolved Solids (mg/L)	71	69	70	79	72	72	229	178
Conductivity (µS/cm)	143	141	140	150	146	143	457	352

Dry Weather Results

- E. coli samples did not exceed Massachusetts Water Quality Standards (WQS) for the Class A or Class B water bodies at any monitoring location and results of other parameters do not indicate an illicit discharge source.
- A sample collected at Jewell Street on 7/9/10 had elevated E. coli and fecal coliform counts of 150 MPN/100ml and 900 MPN/100ml respectively. A downstream sample collected at the lake inlet had significantly lower bacteria concentrations.
- Total Phosphorous concentrations were consistent throughout the watershed and were within an acceptable range for lakes and rivers.
- Dissolved Oxygen levels for all samples were above the WQS.
- Dissolved Oxygen levels increased in November, likely due to cooler water holding more oxygen and greater flow through the lake after fall rain storms.
- Water temperatures varied with seasonal atmospheric weather. Temperatures measured on 7/9/10 exceed WQS of 83°F which is attributed to the lack of groundwater inflow into the river and lake due to the extended dry and warm summer experienced during the monitoring period.

- Dry weather flow samples collected from outfalls at Glen Devin and 4-15 found elevated levels of Nitrate, TDS and conductivity but low bacteria and ammonia concentrations. These results are likely from landscaping activities and fertilizer runoff from residential lawns.
- Conductivity remained relatively consistent and uniform for all the sampling locations over the three monitoring rounds.
- When comparing the Lake Inlet and Lake Outlet monitoring data, the Lake's impoundment had little effect on water quality.
- Sediment thickness measured in Lake Gardner was approximately 1.5 feet. Deposits are not significant or appear to be affecting water quality. Dredging is not required to remove sediment in the lake.

Two rounds of wet weather water quality data are presented in **Table 8-2**. No problems were recorded by the LGIA volunteers during each sampling round. Laboratory analyses were performed in accordance to the QA/QC procedures that are outlined in the QAPP. Laboratory reports are included in **Appendix D**.

Table 8-2
Wet Weather Monitoring Results

Wet Weather 10/27/2010							
Pollutant	**4-2**	**4-4**	**4-5**	**4-7**	**4-12**	**4-13**	**4-15**
E.Coli (MPN/100 ml)	>1600	170.0	>1600	>1600	>1600	>1600	>1600
Fecal Coliform (MPN/100 ml)	>1600	500	>1600	>1600	>1600	>1600	>1600
Nitrate-N (mg/L)	<0.05	3.2	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia-N (mg/L)	0.13	0.07	0.13	0.41	0.06	0.07	0.07
Total Phosphorous-P (mg/L)	0.15	0.03	0.29	0.15	0.23	0.29	0.58
Dissolved Oxygen (mg/L)	8.8	5.3	8.7	8.3	8.3	7.5	7.3
Suspended Solids (mg/L)	200	< 5	16	12	17	42	52
Turbidity (NTU)	22	3	6	6	53	26	20
Temperature (°F)	65	64	67	64	69	68	68
pH	8.3	6.4	8.6	8.4	8.4	7.7	8.4

Note: The upper limit of the lab analysis for bacteria count was 1,600 MPN/100 ml.

Table 8-2 (continued)
Wet Weather Monitoring Results

Wet Weather 11/4/2010									
Pollutant	**4-2**	**4-4**	**4-5**	**4-7**	**4-9**	**4-12**	**4-13**	**4-15**	**Field 117 Whitehall Road**
E.Coli (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	4
Fecal Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	4
Nitrate-N (mg/L)	0.45	0.51	0.49	0.23	0.26	0.39	0.27	0.72	0.35
Ammonia-N (mg/L)	0.23	0.22	0.32	0.32	0.17	0.11	0.29	0.2	0.16
Total Phosphorous-P (mg/L)	0.37	0.41	0.36	0.12	0.07	0.44	0.35	0.75	0.05
Dissolved Oxygen (mg/L)	10.0	8.3	9.4	8.1	10.1	8.9	10.6	10.5	7.9
Suspended Solids (mg/L)	37	14	12	17	11	21	42	18	7
Turbidity (NTU)	57	8	9	13	6	16	21	14	7
Temperature (°F)	53	57	64	56	58	59	59	62	59
pH	5.6	5.4	6.2	5.4	5.9	5.8	5.5	5.9	5.2
Total Dissolved Solids (mg/L)	136	64	68	39	40	117	46	112	201
Conductivity (µS/cm)	276	129	138	77	80	235	94	222	401

Note: The upper limit of the lab analysis for bacteria count was 1,600 MPN/100 ml.

<u>Wet Weather Results</u>

- E. coli samples consistently exceeded the WQS for Class B water bodies. Only two wet weather samples were within standards.
- Fecal coliform samples showed the same excessive concentrations as E. coli.
- Total Phosphorous concentrations were much higher than the acceptable range for lakes and rivers.
- Nitrate concentrations varied greatly from the first sampling round to the second round.
- Water samples with high concentrations of suspended solids and total dissolved solids were collected from older drainage systems and higher density developments.
- Outfalls 4-2, 4-12, 4-13 and 4-15 had consistently high concentrations of suspended solids, total dissolved solids and/or turbidity.
- Dissolved Oxygen levels for all samples were above the WQS although outfall 4-4 was much lower than the other outfalls. Flowing water is more likely to have higher DO levels.
- Water temperatures were consistent with the ambient temperature in late fall.

Beach Sampling Results

The LGIA collected weekly water quality samples at the Lake Gardner Public Beach and Glen Devin Beach between the months of June and September. Test results from the sampling rounds are provided in **Table 8-3**. A sample collected on 8/4/10 contained E. coli concentrations in excess of 2,400 colonies/100 ml. According to the town, The Massachusetts Department of Public Health requires beach closures when bacteria exceed 1,000 mpn/100 ml of water and beach advisories when bacteria exceeds 235 mpn/100 ml of water. A second sample was collected at the beach on 8/6/10 to validate the water quality with a result of 30 mpn/100 ml. The cause of the spiked test result is unknown.

Table 8-3
Lake Gardner Beach Samples for 2010

	Lake Gardner Beach		**Glen Devin Beach**	
Sample Date	E.Coli (colonies/100 ml)	Water Temperature (°F)	E.Coli (colonies/100 ml)	Water Temperature (°F)
6/23/2010	1	68	16	68
6/30/2010	33	-	8	-
7/7/2010	20	75	11	74
7/14/2010	8	74	14	74
7/21/2010	6	72	11	72
7/28/2010	8	-	48	-
8/4/2010	>2,400	76	31	78
8/11/2010	5	78	44	80
8/25/2010	18	70	43	70
9/1/2010	6	78	20	79

9.0 Findings and Conclusions

The objective of the Lake Gardner Bacteriological Study was to collect water samples in the lake and at outfalls to identify sources of bacteria and other constituents that degrade water quality of the lake. While drainage systems adjacent to the lake have previously been identified as a significant source of bacteria, in-lake water quality information had been lacking. The intent of the bacteriological study was to develop in-lake water quality data and identify potential land use threats in the Lake Gardner watershed.

In-lake water quality was used to evaluate the impacts of land use activities that were identified as potential threats. Three rounds of dry weather water samples revealed bacteria levels were consistently low in the Powow River and Lake Gardner and there were no results to indicate a specific land use activity as a source of bacteria.

Three rounds of in-lake samples did not provide conclusive data to support field observations of land use threats identified in the Lake Gardner watershed. The unusually dry summer produced no runoff which reduced the amount of bacteria and nutrients that would normally be washed into the waterbodies. When storms that did eventually occur in the fall, little runoff occurred because the majority of stormwater was absorbed and infiltrated into the ground. Years with greater annual rainfall may produce greater water quality impacts due to increased runoff.

The limited dry weather data set does not give a full account of how the land use activities impact water quality and the field observations of potential threats should not go unnoticed. Despite the analytical results, recommendations to address potential bacteria sources due to land use activities are provided below.

While in-lake water samples did not necessarily provide conclusive results to support field observations, the analytical results of wet weather samples did identify various pollutant sources in the watershed. Wet weather samples collected at drainage outfalls indicate residential areas adjacent to the lake are a significant source of pollution.

Significant findings of the analytical results are provided below followed with site specific recommendations for stormwater BMPs. In addition to the individual BMPs, recommendations for watershed-wide water quality improvements are provided that are intended for a long-term restoration plan to address bacteria issues.

9.1 Water Quality Findings

Bacteria

Water quality impairment due to bacteria has been historically documented in stormwater samples collected at outfalls that discharge to the Lake Gardner. Excessive concentrations of E. coli bacteria can indicate the presence of sewage or other sources of fecal matter. E. coli originate solely from intestinal sources as opposed to fecal coliforms and thus are a better indicator of fecal pollution. Watershed characteristics will often influence the amount of bacteria that enters a water body. Indicator bacteria levels generally increase with development activities, including increased impervious cover, illicit sewer connections, and failed septic systems (Draft Pathogen TMDL for the Merrimack River Watershed).

Past and present water sampling results suggest stormwater runoff is contributing a significant amount of bacteria to Lake Gardner. Bacteria levels tend to increase with wet weather events as stormwater runoff carries fecal matter into a water body that has accumulated on the adjacent land surface. This is evident from the in-lake bacteria samples collected during this study since an increase in bacteria was observed throughout the watershed following two wet weather events.

Analytical results of the dry weather samples collected in Lake Gardner and upstream along the Powow River indicate E. coli samples did not exceed the Massachusetts Water Quality Standards (WQS) for a Class A (Powow River) or B (Lake Gardner) water body. The criteria for both water bodies states the geometric mean of all E. coli samples taken within the most recent six

months shall not exceed 126 colonies/100 ml, typically based on a minimum of five samples, and no single sample shall exceed 235 colonies per 100 ml. A sample collected at Jewell Street on 7/9/10 had an elevated E. coli count of 150 MPN/100ml however; the downstream sample collected at the lake inlet was significantly lower. Both locations did show elevated fecal bacteria counts of 900 colonies per 100 ml and 170 colonies per 100 ml respectively, however this was an isolated event and no trends in the data were established to suggest a significant source of bacteria was present along this reach of the river.
Stormwater samples collected from drainage outfalls exceeded the WQS for E. coli bacteria at all but one location. Land uses in the drainage areas for these outfalls are primarily high and medium density residential. A high percentage of impervious surfaces are found in these areas which affects the watershed's natural capacity to filter and infiltrate runoff. As a result, wet weather samples collected at eight out of nine outfalls had concentrations >1,600 MPN/100 ml. Dry weather flows sampled at two outfalls were significantly lower which indicates surface runoff or stormwater is the source of bacteria.

Stormwater samples collected during the Supplemental Environmental Project (SEP) were consistent with those collected by the LGIA during this study. Dry weather flows collected during the SEP at three outfalls along Whitehall Road had low to non-detect levels of Fecal Coliform and E. Coli bacteria were present. Wet weather samples collected at the same outfall locations had much higher levels. Data tables for the SEP dry and wet weather samples are provided in **Appendix A**. This historic data supports the results of the recent samples and further indicates surface runoff is the primary source of bacteria for Lake Gardner.

Nutrients

In addition to bacteria, water samples were analyzed for phosphorous and nitrogen to evaluate the degree of eutrophication in the lake. As previously mentioned, Lake Gardner has moderate in-lake nutrient levels with high inputs from the surrounding drainage systems. Water quality samples collected during previous studies have also found high nutrient concentrations in stormwater runoff. Excessive nutrients enhance the growth of aquatic vegetation and algal blooms which disrupt the normal function of an aquatic ecosystem. Therefore, one of the long-term management goals in the protection and preservation of Lake Gardner is to minimize its watershed-based nutrient loads.

The care of landscaped areas can contribute significant amounts of nutrients to nearby surface waters. Grassed areas and lawns grown at the edge of the water can provide a direct source for fertilizers to Lake Gardner. However, over-fertilization within the watershed can also significantly add to the nutrient load through stormwater runoff that is collected by drainage systems.

Total Phosphorous

Total phosphorous concentrations in dry weather samples were uniform throughout the watershed between 0.01 and 0.02 mg/l and remained consistent through seasonal changes. The accumulated water quality data indicates the in-lake phosphorus concentrations are reasonable for a waterbody located in an urban area. To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, total phosphates as phosphorus (P) should not exceed 0.05 mg/l in any stream at the point where it enters any lake or reservoir, nor 0.025 mg/l within the lake or reservoir (US EPA, 1986).

Site Specific Numerical Criteria for total phosphorous are provided for several Massachusetts lakes and rivers in Table 28 of the WQS. The typical range of phosphorous concentrations found in ponds included in the table is 0.01 to 0.03 mg/l. Although the Merrimack River Basin was not included in the table, the total phosphorous concentrations in samples collected from the Lake Gardner watershed are within this range.

Nitrates
Dry weather samples collected from outfalls at Glen Devin and 4-15 had elevated levels of Nitrate-N at 2.4 and 2.7 mg/l, respectively. Low bacteria and ammonia concentrations indicate the flows are probably not the result of an illicit connection (e.g. sewer cross-connection) and may be from landscaping activities and fertilizer runoff from residential lawns.

Wet weather samples collected at outfall 4-15 had the higher nutrient concentrations than the other outfall locations. Analytical results of samples collected on 11/4/2010 found concentrations of 0.75 mg/l of phosphorous and 0.72 mg/l of nitrates were present in the stormwater runoff. The drainage area for this outfall includes medium density residential properties with the majority of the lots composed of grass lawns. Results of wet and dry weather samples indicate the drainage area contributing runoff to this outfall is a significant source of nutrients in the watershed.

Ammonia
Another form of nitrogen includes ammonia (NH_3). Ammonia is excreted by animals and is produced during the decomposition of plants and animals. Sources of ammonia found in stormwater or water bodies are sewage, pet waste, fertilizers, industrial wastewaters, and runoff from animal feedlots.

Ammonia concentrations in Lake Gardner were usually low and often below the laboratory detection limit. In contrast, ammonia is present in all of the stormwater samples collected at outfalls. The source of ammonia in the stormwater runoff is likely due to wash off of pet waste and fertilizer.

Suspended Solids and Turbidity
Suspended solids and turbidity is an indicator of the amount of organic and mineral particulate matter in water that is transported in the water column. While turbid water can hamper recreational use and aesthetic enjoyment of a water body, the effect on the aquatic ecosystem is a larger concern. Suspended solids can impact the diversity of aquatic life in a lake as pollution sensitive species expire. The survival rate of fish is reduced by decreasing the hatching rate of eggs and reducing the available food sources. Damage to the invertebrate population also occurs as the floor suspended materials settle out and blanket the bottom of the water body. Nutrient rich suspended solids will promote algae blooms.

Total suspended solids and turbidity levels of the in-lake samples were consistently low. A higher value recorded at the deep hole location on 11/12/2010 is attributed to sediment being stirred up during this monitoring event. Wet weather samples had higher levels than in-lake samples due to the fact that the stormwater is being collected from drainage systems where sediments are accumulated. Outfall 4-2 and 4-13 had turbidity and suspended solids levels that were consistently higher than the other outfall samples. This is likely due to lack of deep sump drainage structures in these drainage areas. Outfall 4-13 collects runoff from the heavily travelled Whitehall Road which accumulates more sediment and debris compared to the less travelled side roads where the other drainage systems are located.

Dissolved Oxygen

Dissolved oxygen (DO) is a measure of the amount of oxygen in water that is available for chemical reactions and use by aquatic organisms. Oxygen in water is primarily derived from the atmosphere by mechanical mixing of moving water, such as a stream or large river. Stagnant water bodies often have lower DO levels since less internal mixing occurs.

DO levels in water can also be affected by aquatic vegetation. As the vegetation photosynthesizes, dissolved oxygen levels in the water increase, and as the vegetation respire, levels can be decreased as oxygen is uses up to produces CO_2. Decomposition of organic matter will also result in the loss of oxygen due to microorganism uptake and chemical reactions that consume oxygen. Pollution from discharges such as urban runoff, wastewater and sewage treatment plants, often containing organic materials, will cause a decrease in DO levels as the microorganisms use oxygen in the decomposition process. Finally, the temperature of water also controls the amount of DO in water. Cold water can absorb more oxygen, producing higher values, while warm water produces lower values.

In-lake samples indicate the DO in Lake Gardner is within a typical range found in lakes and ponds. Levels ranged from 7.9 mg/L at the inlet of the lake during low flows to 10.9 mg/L at the deep hole of the lake following two storm events occurring in the fall. The higher concentrations are attributed to the turbulence caused by an increase in flow and cooler temperatures of the water. The typical range of DO levels in natural water bodies is 5 to 10 mg/L. The constant flow of the Powow River into Lake Gardner keeps DO levels relatively constant in the lake as surface water mixes throughout the water column. DO levels at the bottom of deep hole were equal to the surface which indicates anoxic conditions did not occur during this study at the bottom of the lake.

pH

The pH of a water body is an important factor in determining the health of an aquatic ecosystem since organisms have a low tolerance for pH values lower or higher than the 5 to 8 range. Values outside of this range can decrease the survival of the organisms and lead to loss of ecosystem diversity. Low pH can be caused by respiration of aquatic vegetation or from bacterial decay of organic matter in the water producing high levels of CO_2. High pH levels can occur when algae and aquatic vegetation use CO_2 for photosynthesis.

Field measurements of pH in Lake Gardner found values were lower during the two sampling rounds completed in the summer than those measured in during the fall round. The increased pH may be partially attributed to the effects of high algal densities that consume carbon dioxide and cause a rise in pH, however greater flow from the Powow River following the storm events could also be the cause for the increase.

9.2 Other Water Quality Concerns

Cyanobacteria
A recently completed Lake Attitash Management Plan indicated cyanobacteria blooms that occurred in August 2009 measured cell concentrations from 62,000 - 350,000 cells/mL that exceeded the Massachusetts Department of Public Health (DPH)'s recommended levels of 70,000 cells/mL. Cyanobacteria (blue-green algae) are single-celled organisms found in fresh and marine water bodies. Increased growth of cyanobacteria occurs when a waterbody becomes stagnant and nutrient-rich.

There are specific species of cyanobacteria that produce toxins, which have been linked to human and animal illnesses. Skin exposure may give people an irritating rash, hives or blisters (especially on the mouth). Ingesting water can cause irritation to eyes and nose, asthma-like symptoms, sore throat and muscle pain. Significant exposure will cause vomiting, diarrhea, liver and kidney toxicity or neurotoxicity where lips, fingers and toes become numb.

Although cyanobacteria bacteria has not become a major water quality concern in Lake Gardner, interviews with the Amesbury DPW indicated there have been beach closures at the Glen-Devine condominiums due to blue-green algae blooms. The key management action for abatement of cyanobacteria is to address the source of the problem by control and reduction of external nutrient loading to the water body, and thus of the concentrations within it (World Health Organization (WHO)). Excess phosphorus from non-point sources in the Lake Gardner watershed suggests cyanobacteria blooms may become a water quality impact that will be difficult to resolve, as proven in Lake Attitash. Several methods for reducing nutrient loading to the lake are provided in the recommendations that follow.

Aquatic Vegetation and Algae Blooms
Aquatic vegetation and algae is an important component of an aquatic ecosystem, providing habitat and food for a wide variety of organisms. Large aquatic plants provide cover for fish and other wildlife, while algae provides food for insects and other invertebrates. The complexity and productivity of an aquatic ecosystem will increase in a water body with moderate plant biomass. However, will become detrimental to the water quality and aquatic

Excessive aquatic vegetation and algae blooms have been observed in Lake Gardner and has been a common complaint among residents and LGIA members. An increase of vegetation is typically the result of invasive and exotic species which out-compete native plants. The extent of invasive species in Lake Gardner has been documented by the LGIA through a weed survey conducted in 2009. Nutrient-rich water in the lake increases the rate of growth and spread of vegetation which degrades water quality and the aquatic habitat. Impacts to the esthetics of lake and recreational activities such as swimming and boating have also occurred due to the spread of vegetation.

Aquatic vegetation can significantly influence the internal nutrient cycling especially in areas of heavy growth. Plants remove nutrients during the growing season from the sediment and incorporate it into plant biomass. Once a plant dies the tissue decays and nutrients are released back into the water column. The amount of nutrients released and timing of this cycling will greatly influence algae growth and promote blooms. Algae blooms often occurs during the end of the summer season since nutrient uptake in aquatic vegetation that occurs during the growing season leaves little for algae to utilize.

Internal and external nutrient loading in Lake Gardner, particularly phosphorous, contribute to the formation of algae blooms. An algae bloom is the accumulation of plant-like organisms with the visible appearance of a green mat on the surface water. Algae or phytoplankton are present all year and will bloom as phytoplankton use up the nutrients in the water. As previously discussed, phosphorus concentrations in excess of 25 µg/l are considered to be sufficient to stimulate algal blooms and concentrations in samples collected from Lake Gardner were between 10 and 20 µg/l.

As the phytoplankton growth slows, cells will begin to die and sink to the bottom of the lake where bacteria will decompose the organic material. This creates a concern for the aquatic ecosystem since the microbial oxygen demand will result in low oxygen levels in the lake, which will negatively impact aquatic life.

10.0 Existing Stormwater Management Programs

The Town of Amesbury conducts a variety of stormwater management programs to reduce stormwater pollution and improve water quality in their resource waters. An annual assessment of these programs is completed by the Town as required by the National Pollution Discharge Elimination System (NPDES) Phase II Stormwater General Permit. Each year six minimum control measures must be met to remain in compliance with their permit conditions. A list of the six goals with examples of programs conducted by the Town is summarized below.

<u>Public Education and Outreach</u>

- Distribution of educational materials to the community with information about the voluntary yard waste and household hazardous waste programs.
- Conduct outreach activities about the impacts of stormwater discharges on local waterbodies.
- Installation of stormdrain markers, stenciling and door hanger brochures.
- Installation of pet waste signs and bag dispensers.

<u>Public Participation/Involvement</u>

- Voluntary yard waste disposal program.
- Conduct public meeting with the Lakes and Waterways Commission to discuss stormwater management topics.

Illicit Discharge Detection and Elimination (IDDE)

- 100% of the Town's drainage system is mapped in GIS.
- Dry weather flow inspections were completed during the mapping process.
- Dry weather flows are sampled and analyzed to determine potential illicit discharge sources.
- Follow up IDDE investigations were performed if sample results indicate a potential illicit discharge source is occurring.
- Periodic inspection of outfalls is conducted annually on 25% of the Town's outfalls.
- Draft Stormwater Management Ordinance has been developed and under review by Town departments.

Construction Site Stormwater Runoff Control

- Draft Stormwater Management Ordinance has been developed and under review by Town departments.
- Re-assessment of stormwater management plan to identify possible improvement areas.
- Requirement of erosion and sediment control plan be submitted to the Town for review prior to construction of all projects.

Post-Construction Stormwater Management in New Development and Redevelopment

- Development of standards for regulating stormwater controls for all new and redevelopment projects and inspection controls.

Pollution Prevention and Good Housekeeping in Municipal Operations

- All streets are swept annually with efforts to sweep heavily travelled streets twice per year.
- Deicing chemicals are no longer used by the Town.
- Spill Prevention Control Plan (SPCC) database was developed for all facilities in the Town that require a SPCC plan to help promote pollution prevention throughout the Town.
- Approximately 2,000 catch basins are cleaned once every two years.
- Curbside trash removal, recycling program, yard waste disposal and household hazardous waste programs are all conducted and advertised in conjunction with the public education program.
- Storm drain flushing is performed as needed.
- Television inspections were conducted on several sections of the drainage system where illicit detection investigations have been conducted. Additional inspections will be completed as needed.
- Required Spill Control Plans from all non-residential establishments.

Annual commitments made by the Town to meet NPDES requirements have made a significant improvement to reduce stormwater pollution. The IDDE program has successfully identified and removed a number of illicit discharges (e.g. broken sewer pipes and cross-connections) that had previously gone undetected. Public education programs have also had success in making the community aware of the efforts being made by the Town and setting an example for others to follow. Environmental groups such as the LGIA have been instrumental in the success of the stormwater management programs by taking interest in protecting the Town's water resources and dedicating time to support the Town's efforts.

Stormwater projects in the Lake Gardner watershed such as the installation deep sump catch basins along Whitehall Road and a vegetated swale with a settling basin at the Town Beach. While both BMPs have improved water quality in the lake, additional BMPs are needed in to treat stormwater in developed areas. Recommendations for structural BMPs were chosen for their ability to primarily remove bacteria and nutrients. Long term remediation programs are intended to improve land management techniques and maintain an awareness of activities that can impact water quality in the Lake Gardner watershed.

11.0 Stormwater BMP Recommendations

The primary bacteria source in the Lake Gardner watershed was found in stormwater runoff collected at drainage outfalls in developed areas near the lake. The bacteria concentration from all the drainage systems, with the exception of the outfall pipe at 117 Whitehall Road, made it difficult to prioritize structural BMPs. The results consistently exceeded the upper limit of the lab analysis to accurately count the bacteria colonies in the stormwater samples. Since the bacteria results were essentially the same for each drainage system, recommendations for structural BMPs required further evaluation of the stormwater quality and characteristics of the individual drainage areas to identify priority areas.

Since the analytical results essentially provided the same bacteria concentration for all wet weather samples, the total potential pollutant loads from each drainage area were compared to help prioritize BMP locations. To achieve this, land use characteristics were used to develop the percentage of impervious surfaces in each drainage sub-basin surrounding Lake Gardner. The percent impervious values were obtained from EPA TR-55 Handbook to calculate the total impervious area. These areas were multiplied by one inch of runoff to estimate the volume of runoff that would be generated from the sub-basins during a typical storm event.

Pollutant loads at each outfall were then estimated by multiplying the runoff volume by the pollutant concentrations found in wet weather stormwater samples. Wet weather samples collected on November 4, 2010 were used for prioritizing outfalls since this date provided the most complete set of stormwater data. The results of this analysis are provided in **Table 11-1**.

Table 11-1
BMP Location Priority

Outfall ID	Drainage Area (acres)	Impervious Area (acres)	Runoff Volume (cf)	Nitrate (lbs)	Ammonia (lbs)	Total Phosphorous (lbs)	Suspended Solids (lbs)	Total Dissolved Solids (lbs)	BMP Priority
4-2*	0.95	0.62	2,252	0.06	0.03	0.05	5.14	17.37	High
4-4	12.73	3.18	11,554	0.36	0.16	0.29	9.98	45.60	Medium
4-5	10.15	2.54	9,209	0.28	0.18	0.20	6.82	38.66	Medium
4-7	1.95	1.17	4,249	0.06	0.08	0.03	4.46	10.23	Low
4-9	9.02	1.35	4,912	0.08	0.05	0.02	3.34	12.13	Low
4-12*	6.53	3.62	13,132	0.32	0.09	0.36	17.02	94.85	High
4-13*	21.93	2.28	8,260	0.14	0.15	0.18	21.42	23.46	High
4-15	13.12	8.53	30,953	1.38	0.38	1.43	34.40	214.08	High

* Indicates drainage system discharges directly to Lake Gardner. The remaining outfalls discharge to detention ponds.

Structural stormwater BMP locations were prioritized for their greatest potential to improve water quality in the Lake Gardner watershed. Drainage systems received a high, medium or low priority designation based on estimated pollutant loads and whether BMPs already exist at the outfalls. Locations where forebays and detention ponds currently provide stormwater treatment did not rank as high as other outfalls that discharge directly to the lake.

The lowest priority outfalls include 4-7 and 4-9 are located in a new development on Nancy Drive. The outfalls and discharge to separate detention ponds with sediment forebays and outlet control structures to control stormwater discharge rates. Water samples collected at these outfalls indicate pollutants loads are lower than the other outfalls to Lake Gardner.

Outfalls 4-4 and 4-5 are medium priority because of the moderate pollutant load estimates for these drainage systems. Both outfalls discharge to large detention ponds with well established vegetation where stormwater is treated and infiltrated. Once the high priority areas have been addressed, stormwater improvements should be made to these systems that focus on sediment and bacteria removal.

The outfalls outlined in the recommendation section below are considered the highest priority areas because they present the greatest threat to the water quality of Lake Gardner and provide various alternatives to improve water quality in Lake Gardner to address high levels of bacteria found in stormwater runoff. Three of the high priority outfalls discharge directly to Lake Gardner with little or no stormwater pretreatment. The remaining, lower priority, outfalls include existing “end of pipe” treatment by detention ponds. However, improvements to provide disbursed infiltration and additional forms of treatment should be incorporated for the lower priority systems in the future to further improve base flow and stormwater quality entering Lake Gardner.

11.1 Structural BMP Recommendations

The following is a list of the three highest priority structural BMP locations based on the previously discussed ranking methodology. The pollution source of each BMP is described along with a brief narrative of pertinent design information for each of the structural BMP recommendations. Each recommendation incorporates a stormwater recharge component in order to maximize bacteria removal. The Massachusetts Stormwater Handbook indicates BMPs that include an infiltration component can have bacteria removal efficiencies up to 90% and nutrient removal up to 70%.

Outfall 4-12 on Whitehall Road

Pollution Source: The drainage area for Outfall 4-12 collects runoff from Whitehall Road and a multi-family residential complex. A drainage swale located on the south side of Whitehall road collects runoff from the drainage system before entering a culvert that discharges to Lake Gardner. Vegetation in the swale is inadequate to provide treatment through bioremediation. A deep sump catch basin was recently installed by the Town between the swale and outfall to collect sediment. The volume of sediment discharged from the swale fills the sump and limiting the basin's ability to provide pretreatment. The outfall discharges directly to Lake Gardner.

Ownership Info: City owned right of way. Surveying may be required to illustrate property boundaries.

Proposed BMP: Drainage improvements for this BMP include modifications to an existing swale to treat runoff and provide infiltration. The swale can be upgraded with check dams to disrupt the channel to increase stormwater residence time and provide a steady flow to the lake. A stone bed below the swale with two infiltration chambers will provide storage and promote groundwater recharge while treating stormwater for bacteria. Native plantings throughout the swale will help filter runoff and provide nutrient uptake. **Figure 11-1** represents a conceptual drawing of the drainage swale improvements.

Approximate Cost: $26,000
(Cost includes design, permitting and construction)

Outfall 4-13 on Whitehall Road

Pollution Source: The drainage area for Outfall 4-13 also collects runoff from Whitehall Road. Several of the drainage structures in this drainage system are old and do not provide pretreatment of stormwater before discharging to Lake Gardner.

Ownership Info: City owned right of way. Surveying may be required to illustrate property boundaries.

Proposed BMP: This system provides an opportunity to install a series of structural BMPs to remove sediment and promote infiltration. Four new deep sump catch basins with offline leaching pipes are recommended to reduce sediment loading to the lake while removing bacteria and nutrients through infiltration. **Figure 11-2** identifies the locations of BMPs in this drainage area and **Figure 11-3** represents a conceptual drawing of a deep sump catch basin with an offline leaching pipe.

Approximate Construction Cost: $48,000
(Cost includes design, permitting and construction)

Outfall 4-15 on Unicorn Circle

Pollution Source: The drainage area for Outfall 4-15 collects runoff from a condominium complex that discharges to a large detention area adjacent to Unicorn Circle. The detention area is adjacent to the shore of Lake Gardner. A significant amount of impervious surface in this drainage area generates large volumes of runoff during storm events and pollutant buildup is also significant due to the high density of the development. Existing drainage structures provide little pretreatment to stormwater runoff. Additional sediment is generated at the detention area due to a collapsed outlet pipe that is causing bank erosion.

Ownership Info: City owned property, drainage easement and right of way. Surveying may be required to illustrate property boundaries.

Proposed BMP: Multiple BMP options are recommended for this system since there are several existing drainage structures that can be upgraded and sufficient room to utilize roadway shoulders. A series of stormwater BMPs will be used to remove sediment, bacteria and other pollutants from stormwater while increasing groundwater recharge through disbursed infiltration.

Stormwater BMPs include replacing two existing catch basins with deep sump basins with off-line leaching trenches to remove sediment and provide infiltration. An extended shoulder along Cynthia Lane provides a large area to divert runoff from Whitehall Road and Cynthia Lane where a terraced vegetated swale will convey stormwater through several pools. The swale will provide nutrient treatment and promote recharge as stormwater is collected. Replacing the broken outfall pipe with a headwall and forebay will provide additional sediment removal and stabilize the bank along the detention pond. **Figure 11-4** identifies the locations of BMPs in this drainage area.

Approximate Construction Cost: $77,000
(Cost includes design, permitting and construction)

Outfall 4-2 on Orchard Court

Pollution Source: The drainage area for Outfall 4-2 collects runoff from residential area located at the south end of Lake Gardner and discharges adjacent to the public beach. Although nutrient loading in this drainage area was low, there was a significant amount of suspended solids and total dissolved solids in the samples that were collected from the outfall. The high concentration of solids in the stormwater samples indicates the drainage structures are not providing sufficient pretreatment of stormwater to remove sediment before discharging to the lake. This outfall was ranked high due to the proximity of the outfall to the beach and its direct discharge to the lake.

Ownership Info: City owned right of way. Surveying may be required to illustrate property boundaries.

Proposed BMP: This system provides an opportunity to install structural BMPs to remove sediment and provide infiltration. Two new deep sump catch basins with offline leaching pipes will reduce sediment loading to the lake while removing bacteria and nutrients through infiltration. **Figure 11-5** identifies the locations of BMPs in this drainage area.

Approximate Construction Cost: $10,500 per structure to converted
(Cost includes design, permitting and construction)

Public Beach Erosion

Pollution Source: Shoreline and beach erosion at the Lake Gardner Public Beach is a nonpoint pollution source due to the sediment that is washed into the lake on an annual basis. A vegetated swale and settling basin were constructed by the Amesbury DPW to redirect the surface runoff away from the beach, however the upwelling of groundwater at the base of a steep hill continues to form small channels along the toe of slope of the beach and wash sand into the lake.

Ownership Info: City owned property.

Proposed BMP: A subsurface stone trench is a simple and effective way to redirect groundwater and protect the beach from erosion. The stone trench would be constructed upgradient along the length of the beach to convey the groundwater to an existing settling basin adjacent to the beach. **Figure 11-6** shows the beach and location of the stone trench. There would be no safety concerns since the stone trenches would be constructed below the ground surface and covered with grass. Using trenches to redirecting groundwater is a cost effective and maintenance free method of managing seasonal groundwater and preventing soil erosion at the beach.

Approximate Construction Cost: $30,000
(Cost includes design, permitting and construction)

11.2 Long Term Remediation

The long term remediation BMPs provided below include non-structural approaches that require commitment and persistence to be effective at improving water quality. The BMPs are intended to be implemented by various individuals or groups including residents, recreational users, commercial businesses and the Town of Amesbury. The benefit of non-structural BMPs for long term water quality improvements is the relatively low cost required to support these practices.

Waterfowl

Waterfowl are a concern at Lake Gardner regarding their impact on water quality and risk to public health. Fecal contamination from geese and ducks present a non-point source pollution that is known to carry pathogens such as E. coli and nutrients including nitrogen and phosphorus. These nutrients act as fertilizers, which promote eutrophication in the lake.

Members of the LGIA have indicated that Canada geese populations have continued to increase over the past few years on Lake Gardner. Urban development along the lake provides a source of food and land access that support geese populations beyond their natural levels. Canada geese are attracted to lawns because of easy access, high nutrient content and safety of the open environment.

Managing waterfowl in urban areas is not a quick or easy process. The key to controlling waterfowl populations is to make the area less attractive than other sites they could use. Several nonlethal techniques can be used to manage waterfowl. Examples of nonlethal control techniques include:

Landscape Modification

One of the most effective and environmentally sound methods for reducing goose damage to lawns and yards is to modify the landscape adjacent to a water body to include a vegetated buffer. The vegetated buffer works by deterring waterfowl from sites by restricting their ability to easily move between water and land without flying. Waterfowl will avoid areas with buffers of bushes, hedges or other tall plantings such as ornamental trees because of the difficulty of crossing an uneven surface. The vegetation also makes the site appear unsafe due to the risk of concealed predators.

Waterfowl will primarily feed in areas with the most nutritious grass, such as lawns that are mowed and fertilized regularly. However, waterfowl can be discouraged from feeding on lawns by making the grass less attractive. By simply mowing a lawn less frequent and allowing it to grow taller will make it difficult for waterfowl to access the young, tender shoots. Replacing lawn with other ground cover, such as ivy, ornamental grasses or periwinkle, will make the area less attractive to waterfowl.

Fencing

Canada geese can also be discouraged from accessing land from the water by installing a 30- to 36-inch-high fence at the water’s edge. Fencing will help keep geese from accessing land because they require a long unobstructed path to gain speed to fly. Another reason adults will not cross over a fence is because they will not leave their goslings behind. Although this technique is effective for controlling geese, it is not effective for ducks since they do not require much room to take flight. A 2 to 3 strand fence made of Mylar flashing tape or snow drift fences placed along the shore has proven to be an effective deterrent to geese as well.

CEI recommends installing fencing along the shore of the public beach to deter geese. The gentle slope of the beach area provides ideal conditions for geese to accessing the shore and feed on the lawn. Fencing should be installed during the off-seasons of swimming and boating activities and maintained during the spring to prevent geese from using the area as a nest site. Property managers for the private beaches located on Lake Gardner should be provided with educational materials that outline the benefits of installing fencing along beach areas during off-season periods to deter geese.

Hazing

Hazing involves chasing waterfowl from a site each time they arrive to deter them from nesting on the property since nesting waterfowl cannot be harassed without a federal permit. Efforts must be consistently performed until the waterfowl leave an area, and efforts must be continued as soon as any return. Dogs are often successfully used to chase the waterfowl since the birds react quickly to this threat. Any type of dog will work well for hazing, however breeds that are bread to herd animals, such as border collies, work well because of their relentless desire to pursue waterfowl.

Decoys

Predator decoys such as a wolf or coyote may help deter waterfowl. Decoys of a group of swans will also prevent other waterfowl from entering an area because of the aggressive nature of swans to protect their young and their territory. Decoys should be moved often (every two to three days) so waterfowl will not become accustomed to the decoys and begin to ignore them after a few days.

Frightening Devices

Frightening devices should be in place before the beginning of the nesting season to prevent waterfowl from occupying an area. As with decoys, frightening devices need to be moved in varying combinations to improve their effectiveness and prevent waterfowl from becoming accustomed to them. Common devices include mylar streamers, flagging, balloons, scarecrows, and recorded distress calls. Pyrotechnics (shellcrackers, bangers, noise bombs, etc.) are effective at frightening waterfowl but are loud and can be annoying to neighbors. Local ordinances should be checked for any restrictions that apply to these devices prior to using them.

Pet Waste Management

Pet waste deposited on impervious surfaces as well as some pervious surfaces can be transported by stormwater to nearby surface waters. Fecal matter can potentially contain pathogenic viruses and bacteria and be a source of nutrient loading to the water body. As pet waste decays, it may result in fish kills and promote weed and algal growth. Pet waste can also be a factor in beach closures and human illness due to high bacteria counts. The majority of improperly disposed of pet waste occurs in public areas such as streets and parks. However, pet owners with yards that abut the lake and those near storm drains that discharge to a surface water may also contribute fecal pollution.

The Town of Amesbury provides pet waste bag dispensers at Woodsom Farm due to the high number of dogs that visit the farm on a daily basis but the Town believes more are needed. CEI recommends installing additional bag dispensers at Woodsom Farm and other locations throughout the watershed, concentrating on areas where dog walking is most prevalent. A small sign should accompany the dispensers with a notice that the area is within the Lake Gardner watershed and urge users to dispose of pet waste properly. The cost of a pet waste dispenser is approximately $350 each.

Brochures can help educate dog owners on the importance of cleaning up after pets, how to safely dispose of pet waste and why to keep pet waste out of storm drains. Homeowners with yards that abut the lake should also be encouraged to use pet waste composters for disposal. There are several commercial brands available. Brochures distributed to watershed residents and veterinary clinics can illustrate how a watershed works and how the actions of pet owners can ultimately affect water quality. Costs associated with mailing brochures are approximately $1,000 (assume 1,000 mailings).

Aquatic Vegetation Management

A variety of techniques are available to manage aquatic vegetation including harvesting, biological, mechanical, chemical and manipulation of water level. Combining more than one technique has proven to be beneficial to managing vegetation under appropriate conditions. While each management technique can be effective, the impacts to the Lake's water quality and ecosystem are unpredictable and require a comprehensive evaluation before implementing any method. Two aquatic vegetation management techniques for Lake Gardner were considered for their effectiveness at controlling invasive species and the cost benefits. Other management techniques discussed herein, such as dredging and chemical controls are not as practical for controlling vegetation in Lake Gardner.

Hand Pulling

A practical control method for managing aquatic vegetation is hand-pulling. The benefit of removing vegetation by hand is it allows the removal of undesirable invasive species aquatic plants while leaving desirable native plants. Manual pulling is an economic and effective method for removing unwanted vegetation but is labor intensive and requires a commitment that includes more than one season.

Hand-pulling of submersed plants like milfoil involves dislodging plants from the bottom sediments and removing them from the water body. This method often creates plant fragments that will re-root if care is not given to collect the entire plant. Hand pulling is typically performed in shallow water less than 4 to 6 feet deep. Since no special equipment is needed, trained volunteers can be utilized to complete the work.

The recent weed survey was completed by the LGIA, which inventoried the aquatic vegetation in Lake Gardner, is a good starting point to identify areas with advanced infestation of invasive species that can be removed using hand-pulling techniques. CEI recommends the Town works with LGIA volunteers to begin hand-pulling program that focuses on areas where vegetation can be removed and managed using this method. There would be no cost associated with hand pulling vegetation assuming volunteers would perform the work and the plant material disposed at a Town facility.

Water Level Drawdown

An alternative method for managing aquatic vegetation in Lake Gardner is to perform a lake drawdown to expose areas of the shore where aquatic vegetation is abundant. During drawdown, the littoral benthic community is exposed for an extended period of time. Low water levels will expose the plants to desiccation (drying) that ultimately affects plant vascular structure, thereby rendering the plant incapable of nutrient transport and function. Additional stress is placed on the vegetation when water is lowered during the winter months by creating a prolonged freezing period which results in frost heaving of the lake bottom which in turn uproots the plants to cause further mortality.

The Amesbury Watershed and Waterways Management Plan supports water level drawdown and states it can be an effective means of controlling nuisance and invasive vegetation in ponds and lakes. The sluiceway and gates at Lake Gardner Dam can be fully opened to allow the lake level to drop to elevation 77.4 feet from its average level of 86.4 feet. A drawdown can be accomplished without affecting any other water bodies.

Lake Gardner is within an area of Priority Habitat of Rare Species and Estimated Habitat of Rare Wildlife. A drawdown of the lake would require state regulatory requirements are met and approval from the Natural Heritage and Endangered Species Program. State regulations also require the Massachusetts Department of Fish & Game be contacted to determine if a permit is required and to provide notice prior to ten days from such drawdown.

While lake drawdown is an economical method to control aquatic vegetation, this technique may or may not affect target species with a predictable outcome. Various varieties of aquatic plants respond differently to drawdown. An aquatic plant inventory conducted by the LGIA identified several species (e.g. Pondweed, Watermilfoil and Pickerelweed) that would be susceptible to a lake drawdown, while few “drawdown-resistant” plants (e.g. Bulrush, Arrowhead) were identified. Further identification of the invasive plant species before drawdown will help determine the long term effects a drawdown will have on Lake Gardner’s aquatic vegetation. Other considerations when planning a lake drawdown include impacts to aquatic wildlife and their habitat, fish populations, adjacent wetlands, recreational use during the winter months and release/refill rates.

CEI recommends conducting additional investigation of the aquatic vegetation in Lake Gardner to determine if this technique is appropriate for managing non-native invasive species in the lake. Results from the investigation are needed for the Town to determine if drawdown is a viable option for improving the water quality in Lake Gardner. The cost to conduct additional investigation and determine the feasibility of lake drawdown is approximately $10,000. Permitting cost associated with a lake drawdown is approximately $5,000.

Dredging
Dredging is an effective technique for removing aquatic vegetation and nutrients from a water body, however there are disadvantages in using such a broad brushed approach for improving water quality. The primary disadvantage is the high cost to stage and operate dredging equipment and dispose of the sediment material that is removed. Non-selective dredging could also significantly impact the aquatic habitat in the lake which can outweigh the benefit of removing the vegetation.

Dredging is usually not performed solely for aquatic plant management but to restore lakes that have been filled in with sediments, have excess nutrients, have inadequate pelagic and hypolimnetic zones, need deepening, or require removal of toxic substances (Peterson 1982). Sediment thickness measurements in Lake Gardner indicate there is not an excessive amount of sediment built up. However, the measurement was made at one location and does not necessarily represent sediment deposits throughout the lake. Additional investigation and depth probing should be performed to confirm the sediment thickness.

Due to the high cost, impacts to aquatic habitat, and the difficulty of disposing sediment, dredging should not be performed for aquatic plant management in Lake Gardner.

Aquatic Herbicide Control
Aquatic herbicides are specifically formulated chemicals intended for use in water to kill or control aquatic plants. Herbicides are typically sprayed directly onto floating or emergent aquatic plants or added directly to the waterbody. The two general types of herbicide are selective and non-selective. Selective herbicides only affect certain groups of plants while non-selective herbicides will kill most vegetation they come in contact with.

Aquatic herbicides are often effective at controlling vegetation but several treatments may be required while plants are actively growing. Some herbicides have swimming, drinking, fishing, and water use restrictions that may cause a conflict with recreational activities in Lake Gardner. Many people in the community may have strong feelings against using chemicals in the lake.

CEI recommends conducting an investigation of the types of herbicide approved for aquatic use by the United States Environmental Protection Agency (EPA) to determine if their use would be appropriate and cost effective for managing non-native invasive vegetation in Lake Gardner. The short residence time of Lake Gardner would need to be considered to determine if sufficient contact time would be allow herbicide treatment to be an effective alternative. The cost to evaluate the feasibility of herbicide use is approximately $10,000. Permitting cost associated with a herbicide application is approximately $5,000.

Alum Treatment
Aluminum sulfate (alum) is often used in lakes to bind phosphorus in sediments control excessive algae growth by reducing the internal loading of phosphorous. When applied to water, alum forms an aluminum hydroxide precipitate called a floc, which removes phosphorus from the water column. As the floc settles to the bottom of the lake it continues to bind to the

phosphorous in the sediment and prevents it from releasing into the water column making it unavailable for algae growth.

The shallow depth to surface area ratio of Lake Gardner initially makes alum treatment appear to be a viable method for controlling algae blooms, however, the short residence time of Lake Gardner also limits the effectiveness of alum treatment. The continuous flow through the lake provides insufficient time for alum to bind phosphorous in the sediments. Although total phosphorous concentrations in the lake fall within an acceptable range for lakes and rivers, concentrations in stormwater runoff were significantly greater. Alum treatment to control algae blooms doesn’t address the primary source of phosphorous and funding for water quality improvements for Lake Gardner would be better spent on other long term management programs.

Chlorination Treatment

Chlorine is known as one of the most effective methods of eliminating bacterial pathogens and viruses from water. Chlorination treatment is often used to disinfect drinking water that is supplied by surface water reservoirs. There are many naturally occurring organic (i.e. decaying vegetation) and inorganic compounds that react with the chlorine to produce disinfection by-products. These by-products are potentially toxic chemical compounds that are formed in extremely low concentrations during the disinfection of water supplies.

The short residence time of Lake Gardner would limit the effectiveness of chlorination treatment. The continuous flow through the lake would make it difficult to control chlorine concentrations (i.e. over-chlorination) in the lake and would provide insufficient time for treatment. Due to the high risk for impacting the aquatic habitat and short residence time, chlorination treatment should not be performed for microbial management in Lake Gardner.

Campsite Monitoring

Monthly water monitoring should be conducted at Tuxbury Pond during the months which Tuxbury Pond Camping Area is in use. Due to the results of recent Board of Health inspections, reliance on the campground staff to properly conduct on-site inspections and report system failures is not a reliable option. Monitoring the water quality in Tuxbury Pond will identify future failures at the campground and avoid impacts to the downstream water quality in the Powow River and Lake Gardner. Advanced warning from samples collected at Tuxbury Pond will also help Amesbury Treatment Plant prepare for poor water quality in the Powow River.

CEI recommends the Town of Amesbury include a monitoring location at the outlet of Tuxbury Pond as part of the seasonal water sampling program that is performed by LGIA members at the Lake Gardner beaches. Early detection of bacteria will help the Town identify water quality concerns and prevent exposure to the recreational users. The additional cost to analyze samples collected at the outlet of Tuxbury Pond would be approximately $400 per year. This assumes 10 samples would be collected by the LGIA volunteers between the months of June and September.

Septic Systems
Due to the location of several septic systems in the Town of South Hampton, failing systems could be a threat to the water quality in the Powow River and Lake Gardner. Improperly maintained on-site sewage disposal systems could contribute nutrients and bacteria to the adjacent surface waters. The South Hampton Board of Health does not require inspections of septic systems but does keep records of new and replacement systems. The Board of Health should consider keeping maintenance records for septic systems in order to monitor for potential failures and systems in need of repair.

CEI recommends public education materials be distributed to homeowners which outline proper use and care of septic systems. Distribution of materials is something a volunteer group such as the LGIA can take the lead on. Providing homeowners with this information will help prevent septic failures in the Lake Gardner watershed and reduce the risk of bacteria and nutrient contamination.

Gravity Sewer Main
The sewer pipe that runs along the western shore of Lake Gardner has not presented a problem in the past but should be periodically inspected to identify pipe damage and obstructions that inhibit proper flow that could introduce contaminants into the lake. As a precaution, video inspections should be performed on this section of the sewer system to identify any maintenance that needs to be performed. CEI recommends the Town perform a video inspection of the sewer adjacent to the lake once every five years. The daily rate for performing a video inspection is approximately $1,500.

Horse Farm
As previously discussed, a local horse farm on South Hampton Road is located adjacent to Battis Farm and the Powow Conservation Area. The proximity of the horse farm to the shore of Lake Gardner is a concern as a potential source of bacteria and nutrients. If horse manure is not properly stockpiled or if feeding and watering areas are located close to the lake, bacteria and nutrients can travel into the water body through stormwater runoff. CEI recommends the Town visit the horse farm to inspect the manure and pasture management practices at the farm. BMPs for farms are readily available through various sources such as USDA, US EPA and MassDEP

Vegetated Buffers
Vegetated buffers provide several benefits to improve the water quality of adjacent water bodies. One of the primary benefits for establishing a vegetated buffer is to intercept runoff from fields and lawns in order to trap sediment, fertilizer, organics (such as manure), pesticides, and other pollutants before reaching a water body. The vegetation in a buffer zone also prevents erosion along stream banks and shorelines of lakes and ponds by stabilizing the soil with an established root mass and reducing runoff velocities.

As previously discussed, the Town of Amesbury requires farmers to maintain a 50 foot buffer from the edge of wetlands to prevent impacts from farming practices. Based on field observations and a review of reviews of aerial photos, the required buffer is not being maintained by the farms in the Lake Gardner watershed.

Establishing and maintaining a vegetated buffer is an inexpensive and effective way to improve the water quality. The Town should contact property managers for each farm located in the Lake Gardner watershed to make sure they are aware of the required buffer. Periodic follow up visits should be made to ensure buffers are being maintained and convey the importance of protecting the Town's water resources.

Landscape Management
The extent of nonpoint source pollution caused by landscape practices is site-specific and depends on such factors as: soil type, application rate, type of fertilizer, precipitation, watering amount, and topography.

To address this issue, CEI recommends a broad based educational program for residents adjacent to the lake as well as those within the entire watershed system. The education effort should include the sustained distribution of educational material highlighting the relationship between lawn and garden management, the concept of a watershed, and water quality. Material should focus on one or two main landscaping topics and how each practice can help protect water quality by reducing the amount of nutrients that enter nearby surface waters.

Homeowners along the shore of Lake Gardner should be encouraged to establish vegetated buffers. Landscaped buffers should include plants species that are native to the area. An added benefit for a homeowner to establishing a vegetated buffer is to deter waterfowl from accessing land from the water.

The series of educational material should include information on the following issues:

- Soil testing with test resource information
- Fertilizer minimization and "phosphorus free" fertilizers
- Recycling of yard trimmings
- Composting and its benefit as a fertilizer
- Fertilizer application rates and proper timing
- Use of native vegetation in landscaping
- Runoff potential reduction through proper irrigation and re-use/infiltration of roof run-off
- Use of vegetation buffers between lawns and surface water or between lawns and catch basins

In addition to the above issues and brochures, the educational effort may also include the participation of local nurseries and garden stores as well as garden clubs. These business owners and organizations should be encouraged to hold short workshops for the general public on the above issues. This will help educate their customers as well as allow them an opportunity to showcase some of the products that would cater to the above needs such as phosphorus free fertilizers.

Community Based Social Marketing (CBSM)
CBSM is a new, more scientific approach to public education where specific behaviors are promoted, and where barriers to these specific behaviors are eliminated. This approach involves the community and direct contact with people as opposed to conventional public education – the advertising approach. Media and advertising can be successful at raising public awareness and providing education on a particular issue (such as educating residents on why protecting the watershed is important) but these approaches have not worked well for environmental issues. This is not likely because most environmental issues, for example, composting yard waste instead of dumping it in water bodies, requires a greater level of commitment and time than changing from one product to another. CEI's approach uses the latest methods found effective at actually changing behavior. Key steps in our approach include:

- **ID Problem Areas**
  This includes determining the initial problem area. One example is dumping of yard waste in and around water bodies that results in clogged pipes, flooding and excessive nutrient input. How much of a problem is it and are there other targeted problem areas that should be identified?
- **Determine Target Behaviors**
  Based on the yard waste example above, ideal behaviors will be encouraging residents to home compost or utilize the Town collection service which accepts yard waste. This step involves identifying the target behaviors to address the problem area: what behavior do you want to change and how?
- **Develop Survey**
  A survey can be an ideal tool to determine why residents DO NOT recycle or compost yard waste but will also tell us why people DO recycle and compost yard waste. Are there model citizens in the watershed that do it right? What barriers are stopping people from doing the right thing? Lack of awareness? Time constraints? Other barriers?
- **Pilot and Distribute Survey**
  No matter how large or small the survey, it should be piloted to a small group of the target audience to ensure all questions are understandable and desired results are obtained. This group of say 12 people will be individually contacted to make sure the questions made sense to them and to gauge the usefulness of the results that will be tabulated when it is done on a larger scale.
- **Identify Barriers & Competing Behaviors**
  Through the above survey and statistical analysis, we can identify barriers and benefits people perceive in the desired behavior. Some residents of the watershed likely already compost: why? The survey will also tell us what barriers prevent others from doing this (don't know how: don't have a vehicle to transport yard waste to the facility, don't care, can't make it during open hours, too time consuming, concerns about odors, etc.).
- **Develop An Action List on How To Tip the Scale**
  Once barriers and competing behaviors have been recognized within a target group, we can then determine how to change the ratio of benefits and barriers so that the target behavior(s) becomes more attractive.

Determining a method for evaluating the program is essential to the success of the program. This data can often be used for future projects and in obtaining future funding such as state and federal grants. The cost to develop the survey, compile results and perform a statistical analysis is approximately $15,000.

12.0 Stormwater BMP Funding Alternatives

Cities and towns are facing more stormwater regulations and programs than ever before. TMDLs (total maximum daily loads) for pollutants are being established with calls for major reductions in pollutant loads. Round 1 of the Phase II program is over, yet many towns are behind on compliance. Now Round 2 is out (in draft for some areas) and the whole program repeats with additional work to be done.

Faced with these increased regulatory requirements, communities are now realizing that the biggest impediment is how to pay for the work that is required to remain in compliance and avoid costly fines. Funding sources identified below provide different options to pay for the required planning, monitoring, engineering and construction projects associated with stormwater management.

Stormwater Utility
Many cities and towns are establishing stormwater utilities as a mechanism that can be used by to fund the cost of municipal services related to stormwater management operations. A stormwater utility creates a sustainable funding mechanism dedicated to recover the costs for maintaining the stormwater infrastructure, capital improvements and repairs. Similar to other utilities, administration and funding of a stormwater utility is separately from the revenues in the municipal general fund. This ensures a dedicated revenue source to fund stormwater management expenses.

Stormwater fees charged to individual properties and are often based on impervious area. The average quarterly fee for a single family home is $10 to $15 which pays for stormwater management operations. Three methods are most often used to calculate stormwater utilities service fees. Since impervious area is the most important factor influencing stormwater runoff it is the basis in which each method uses for calculating fees.

Equivalent Residential Unit (ERU)
A majority of stormwater utilities use the ERU method for setting fees. The ERU is based on the impervious area of a single family residential (SFR) home. A representative SFR parcel is used to determine the typical impervious area which is equal to one ERU.

The impervious areas of non-SFR parcels (e.g. commercial, industrial) are usually individually measured are billed on the basis of how much impervious area is on the parcel, regardless of the total area of the parcel. Each non-SFR impervious area is divided by the impervious area of the typical SFR parcel to determine the number of ERUs to be billed to the parcel.

Intensity of Development (ID)
The ID method is based on the percentage of impervious area relative to an entire parcel's size. All parcels (including vacant/undeveloped land) are assigned a fee category on this basis which represents the intensity of development occurring on the property. Stormwater utility fees are calculated by multiplying the assigned category rate with the total area (impervious plus pervious).

Since the ID method accounts for stormwater from the pervious portion a property, it can be more equitable than the ERU method. It accounts for completely pervious parcels and therefore can allow vacant/undeveloped parcels to be billed. However properties are grouped into broad ID categories and are not billed in direct proportion to their relative stormwater discharges. This method can be more difficult to implement and explain to rate payers than the ERU method.

Equivalent Hydraulic Area (EHA)
Parcels are billed on the basis of the combined impact of their impervious and pervious areas in generating stormwater runoff. The impervious area is charged at a much higher rate than the pervious area.

Similar to the ID method, EHA accounts for flow from the impervious and pervious portion of a property and can be more equitable than the ERU method. The EHA method is perceived to be more practical and fair compared to the ID method because properties are billed on the basis of direct measurements of pervious and impervious areas to determine a unique EHA which a fee is applied instead of being grouped into a category.
Because pervious area analysis is required in addition to impervious area, this approach requires more time to determine the billing units and rate. It is also more complicated to explain to than the ERU method.

Clean Water State Revolving Loan Fund (SRF) Program
The Massachusetts State Revolving Fund for water pollution abatement projects was established to provide a low-cost funding mechanism to assist municipalities seeking to comply with federal and state water quality requirements. Administered by MassDEP and the MA Water Pollution Abatement Trust, this 2% subsidized loan operates on a yearly $300-$350 million budget and typically finances approximately 50-70 projects annually. The SRF Program applies an increased emphasis on watershed management priorities. A major goal of the SRF Program is to provide incentives to communities to undertake projects with meaningful water quality and public health benefits and which address the needs of the communities and the watershed.

Coastal Zone Management (CZM)
The Coastal Nonpoint Source Pollution (Coastal NPS) grant program assists public and non-profit entities in implementing nonpoint source (NPS) pollution control efforts. Coastal NPS grant funding can be used for watershed- or subwatershed-scale NPS assessments, development of local planning tools, public education and outreach, design and/or implementation of Smart Growth and Low-Impact Development strategies for NPS control, and efforts to eliminate or manage pollution from septic systems and publicly owned marinas.

The Coastal Pollutant Remediation (CPR) Grant Program was established in 1996 by the Massachusetts Legislature to help communities identify and improve water quality impaired by non-point source (NPS) pollution. The CPR program provides funding to Massachusetts municipalities to assess and remediate stormwater pollution from paved surfaces. Since 1996, more than $6 million in CPR grants have been awarded.

Section 319 Nonpoint Source Competitive Grants Program

This grant program is authorized under Section 319 of the federal Clean Water Act for implementation projects that address the prevention, control, and abatement of nonpoint source (NPS) pollution. In Massachusetts, s. 319 funds have traditionally been the main source of funds for stormwater mitigation work. However, 319 funds cannot be used to do work required under Phase I or Phase II. In general, eligible projects must: implement measures that address the prevention, control, and abatement of NPS pollution; target the major source(s) of nonpoint source pollution within a watershed/subwatershed; contain an appropriate method for evaluating the project results; and must address activities that are identified in the Massachusetts NPS Management Plan. Proposals may be submitted by any interested Massachusetts public or private organization. To be eligible to receive funding, a 40% non-federal match is required from the grantee.

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Legend

Watershed Study Area

0 2,000 4,000 6,000 Feet

0 0.25 0.5 0.75 1 Miles

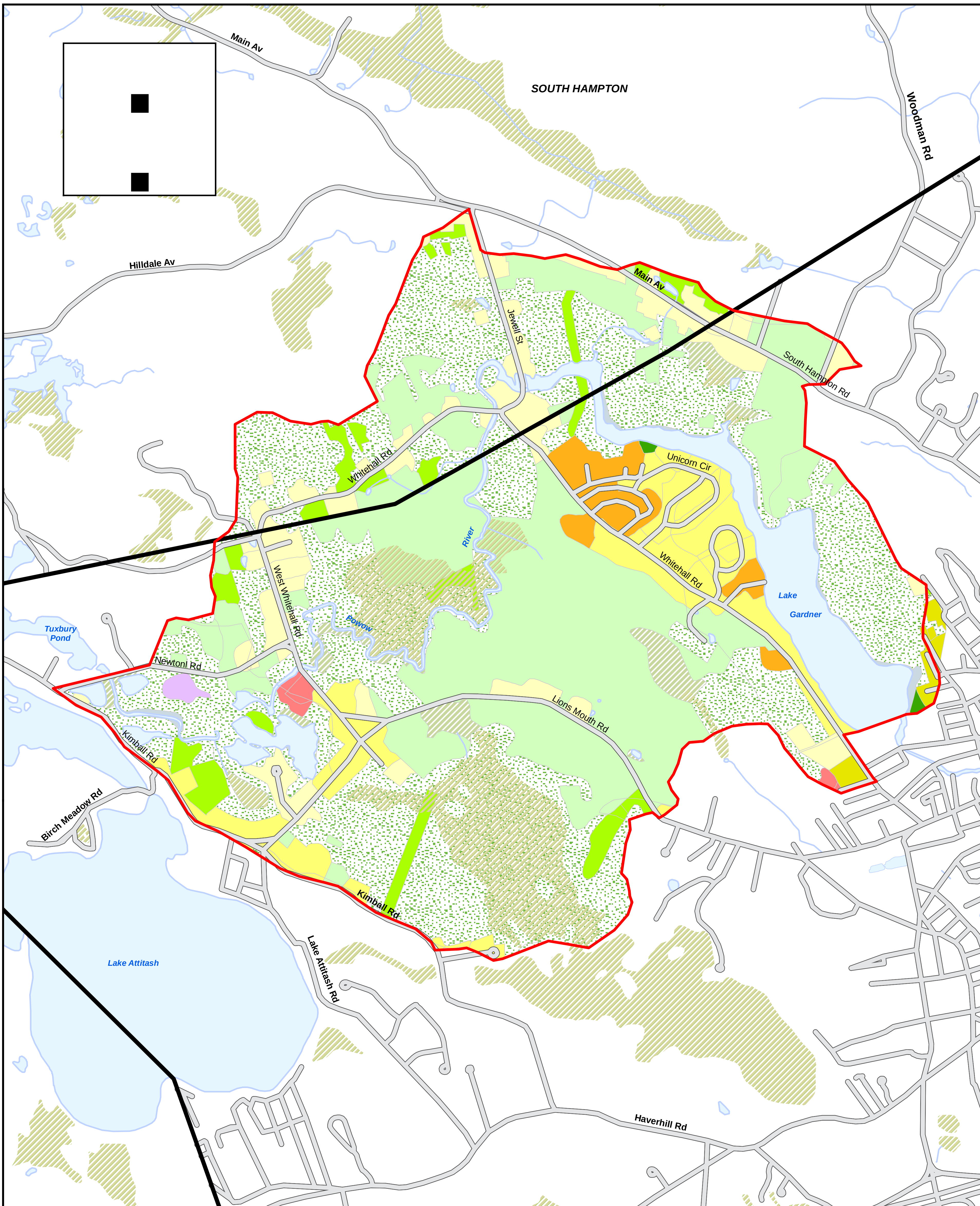
Figure 2-1

Project Study Area

Lake Gardner Bacteriological Study

Amesbury, MA

Comprehensive Environmental Inc.



Legend

Land Use

- Fields/Crops
- Forested
- Open Space
- Recreation
- Res - Low Density
- Res - Medium Density
- Res - High Density
- Res - Multi-Family
- Water
- Wetlands
- Roads
- Mining
- Commercial
- Watershed Study Area
- Town Boundary

Data Sources: MassGIS, NH GRANIT

0 2,000 4,000 6,000 Feet

0 0.25 0.5 0.75 1 Miles

Figure 4-1

Land Use Characteristics

Lake Gardner Bacteriological Study

Amesbury, MA

Comprehensive Environmental Inc.

Legend

- Watershed Study Area
- Town Boundary

Hydrography

- Surface Water
- Wetland
- Stream, Brook

Data Sources: MassGIS, NH GRANIT

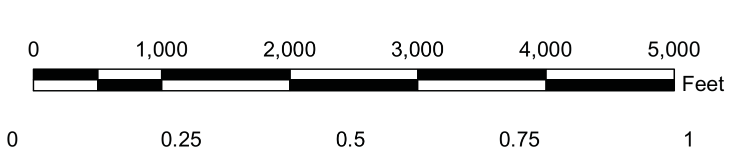


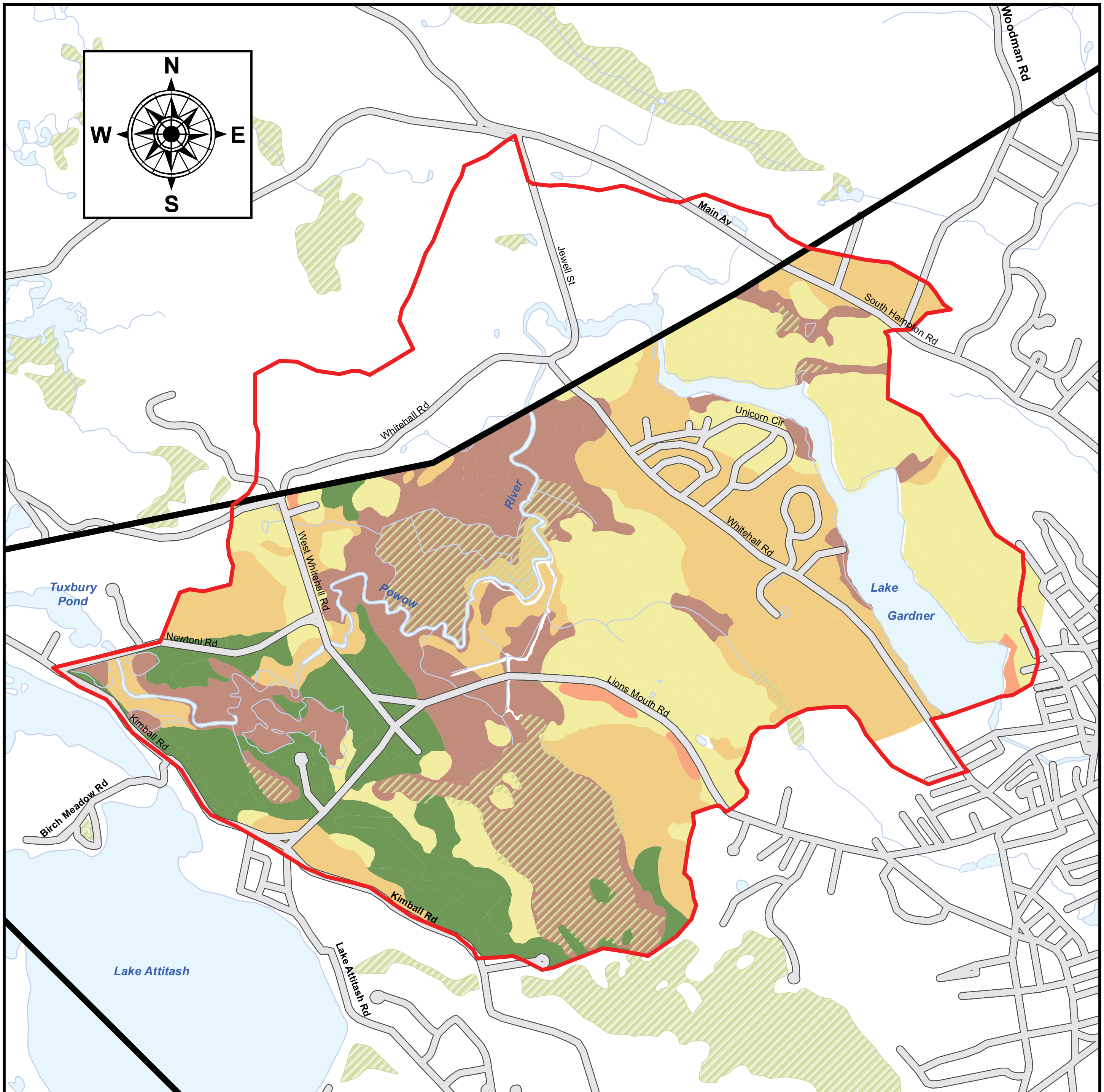
Figure 4-2

Significant Land Use Features

Lake Gardner Bacteriological Study

Amesbury, MA

Comprehensive Environmental Inc.



Legend

Soils - Hydrologic Group
- A - High Infiltration
- B - Moderate Infiltration
- C - Slow Infiltration
- D - Very Slow Infiltration
- Unclassified

Hydrography
- Surface Water
- Wetland
- Stream, Brook
- Watershed Study Area
- Town Boundary

Data Sources: MassGIS, NH GRANIT

0 2,000 4,000 6,000 Feet

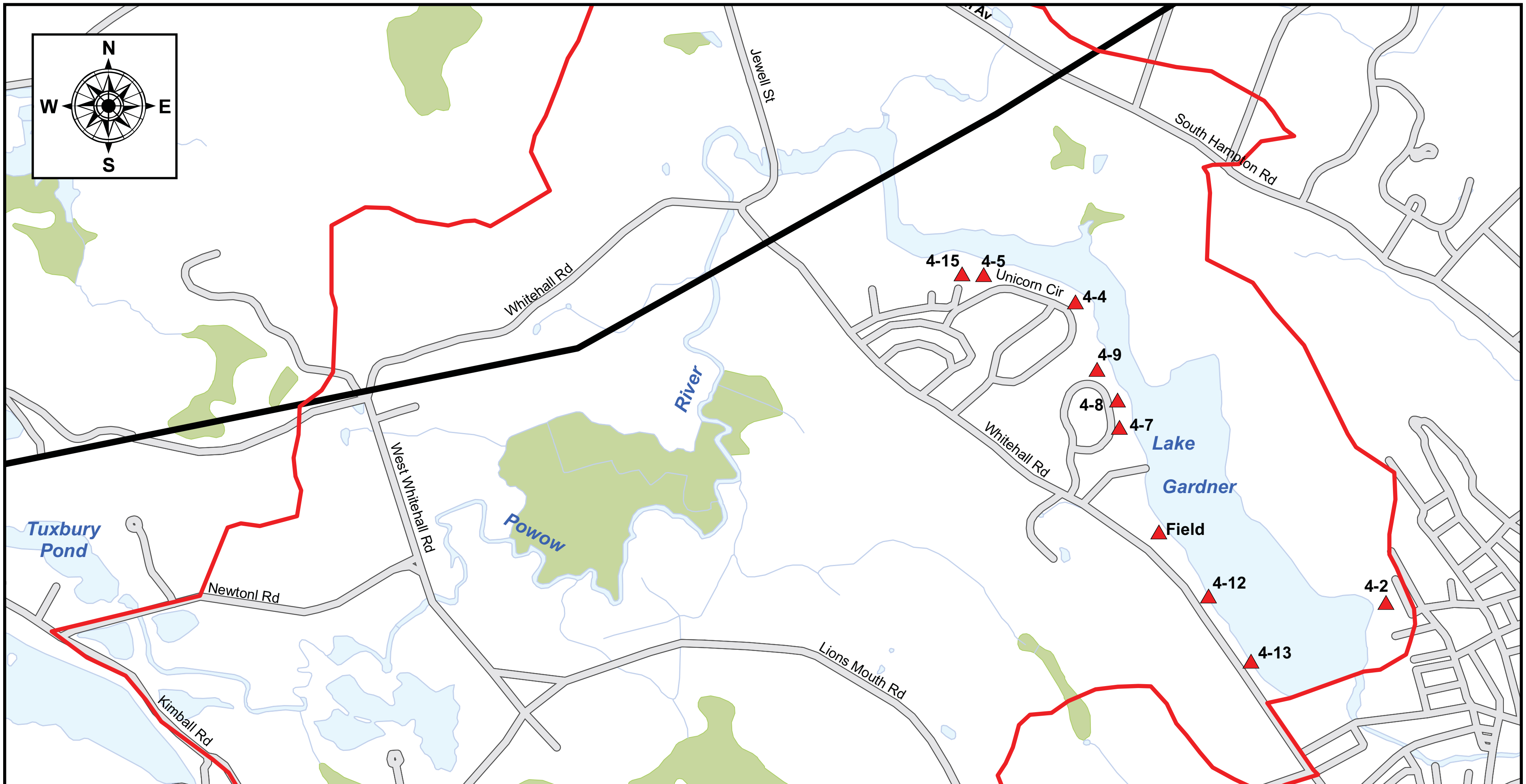
Figure 5-1

Surficial Geology

Lake Gardner Bacteriological Study

Amesbury, MA

Comprehensive Environmental Inc.



Legend

- Outfall Locations
- Watershed Study Area
- Town Boundary

Hydrography

- Surface Water
- Wetland
- Stream, Brook

Data Sources: MassGIS, NH GRANIT

0 1,500 3,000 4,500 Feet

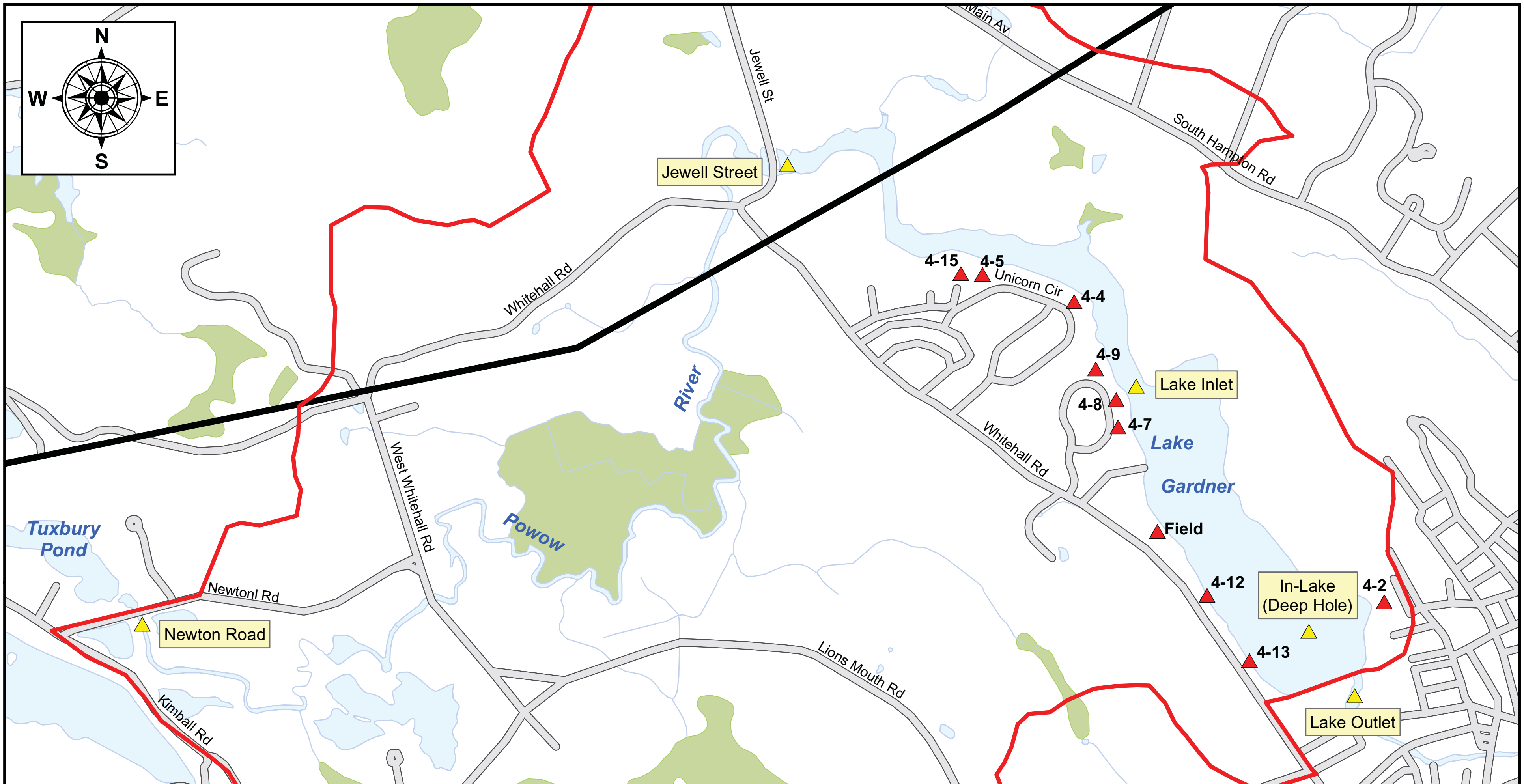
Figure 7-1

Outfall Locations

Lake Gardner Bacteriological Study
Amesbury, MA

Comprehensive Environmental Inc.

0 0.25 0.5 0.75 1



Legend

Monitoring Locations

- Dry Weather
- Wet Weather

Hydrography

- Surface Water
- Wetland
- Watershed Study Area
- Town Boundary

Data Sources: MassGIS, NH GRANIT

0 | 1,500 | 3,000 | 4,500 Feet

Figure 8-1

Monitoring Locations

Lake Gardner Bacteriological Study

Amesbury, MA

Comprehensive Environmental Inc.

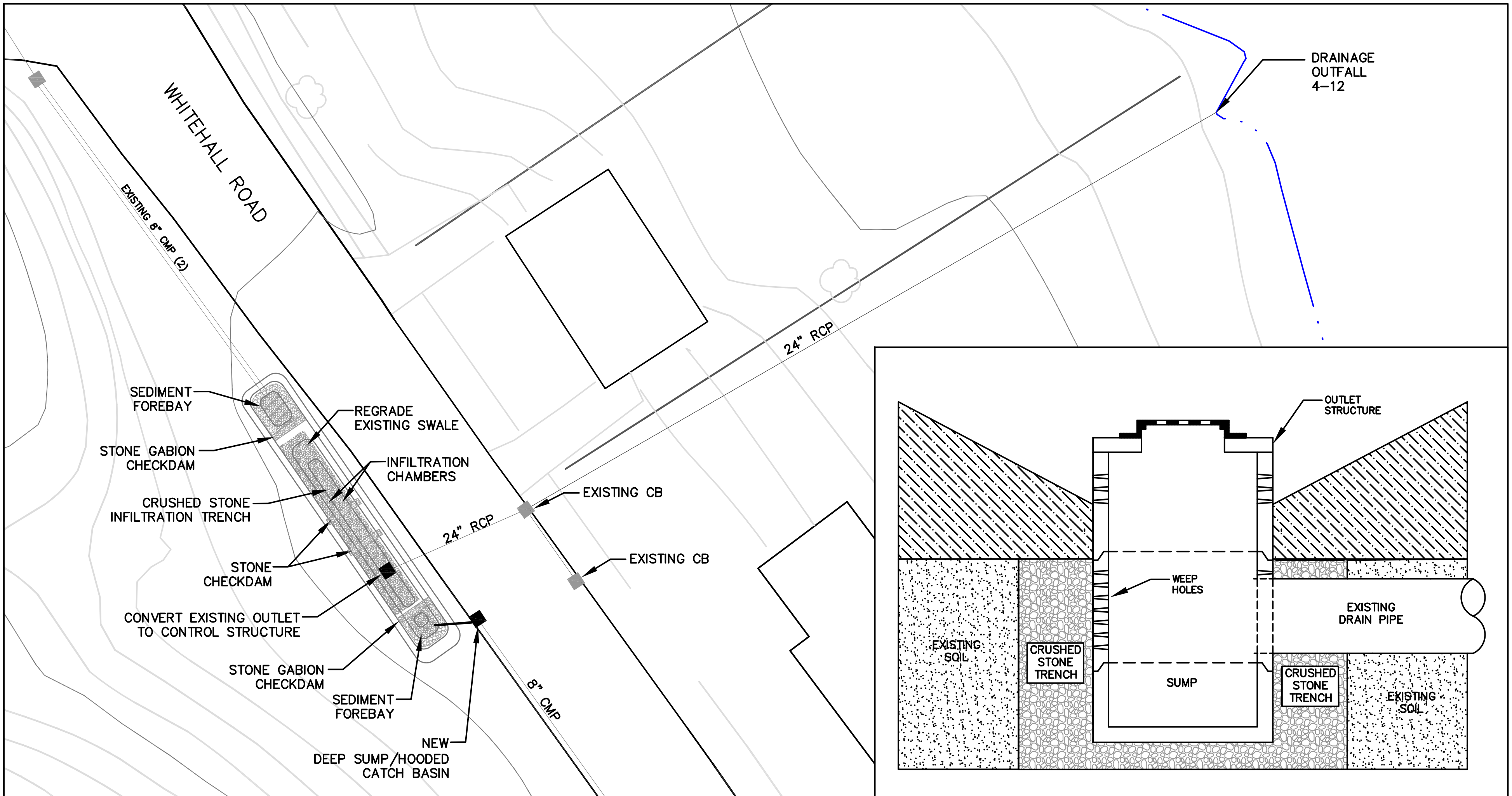


Figure 11-1

INFILTRATION TREATMENT SWALE
WITH
OUTLET CONTROL STRUCTURE

Lake Gardner Bacteriological Study

Amesbury, Massachusetts

COMPREHENSIVE ENVIRONMENTAL INC.

LEGEND

Existing Drainage Structures

- Catch Basin
- Drainage Manhole
- Outfall
- Drain Pipe

0 50 100 150 200 250 Feet

Figure 11-2

Whitehall Road Stormwater BMPs

Amesbury, MA

Comprehensive Environmental Inc.

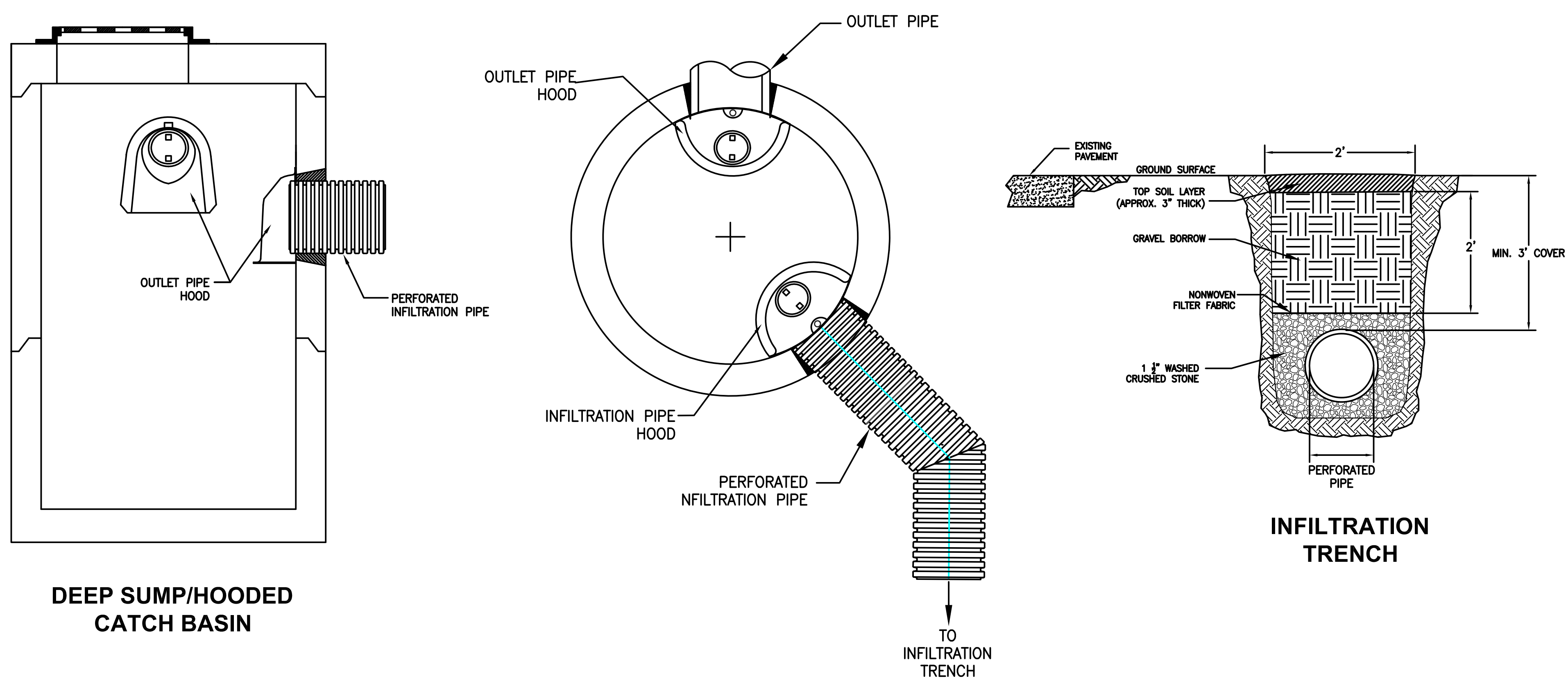


Figure 11-3

TYPICAL
DEEP SUMP/HOODED CATCH BASIN
WITH SUB-SURFACE
INFILTRATION TRENCH

Lake Gardner Bacteriological Study

Amesbury, Massachusetts

COMPREHENSIVE ENVIRONMENTAL INC.

LEGEND

Existing Drainage Structures

- Catch Basin
- Drainage Manhole
- Outfall
- Drain Pipe

0 100 200 300 400 500 Feet

Figure 11-4

Unicorn Circle Stormwater BMPs

Amesbury, MA

Comprehensive Environmental Inc.

LEGEND

Existing Drainage Structures

- Catch Basin
- Drainage Manhole
- Outfall
- Drain Pipe

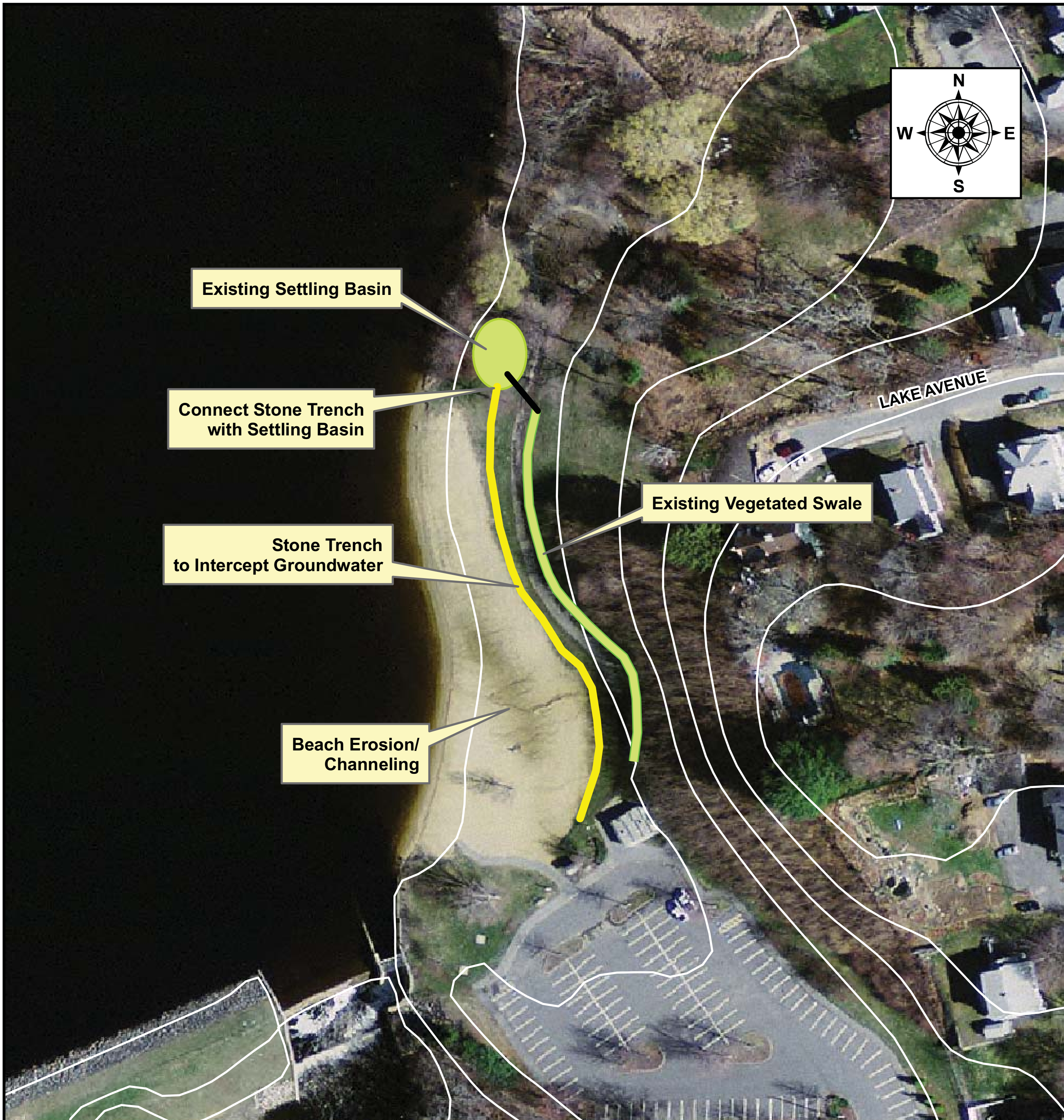
0 50 100 150 200 250 Feet

Figure 11-5

Orchard Court Stormwater BMPs

Amesbury, MA

Comprehensive Environmental Inc.



LEGEND

Existing Drainage Structures

- Catch Basin
- Drainage Manhole
- Outfall
- Drain Pipe

0 50 100 150 200 250 Feet

Figure 11-6

Town Beach Erosion Stormwater BMPs

Amesbury, MA

Comprehensive Environmental Inc.

Appendix A
Supplemental Environmental Project (SEP)
Tables & Figures

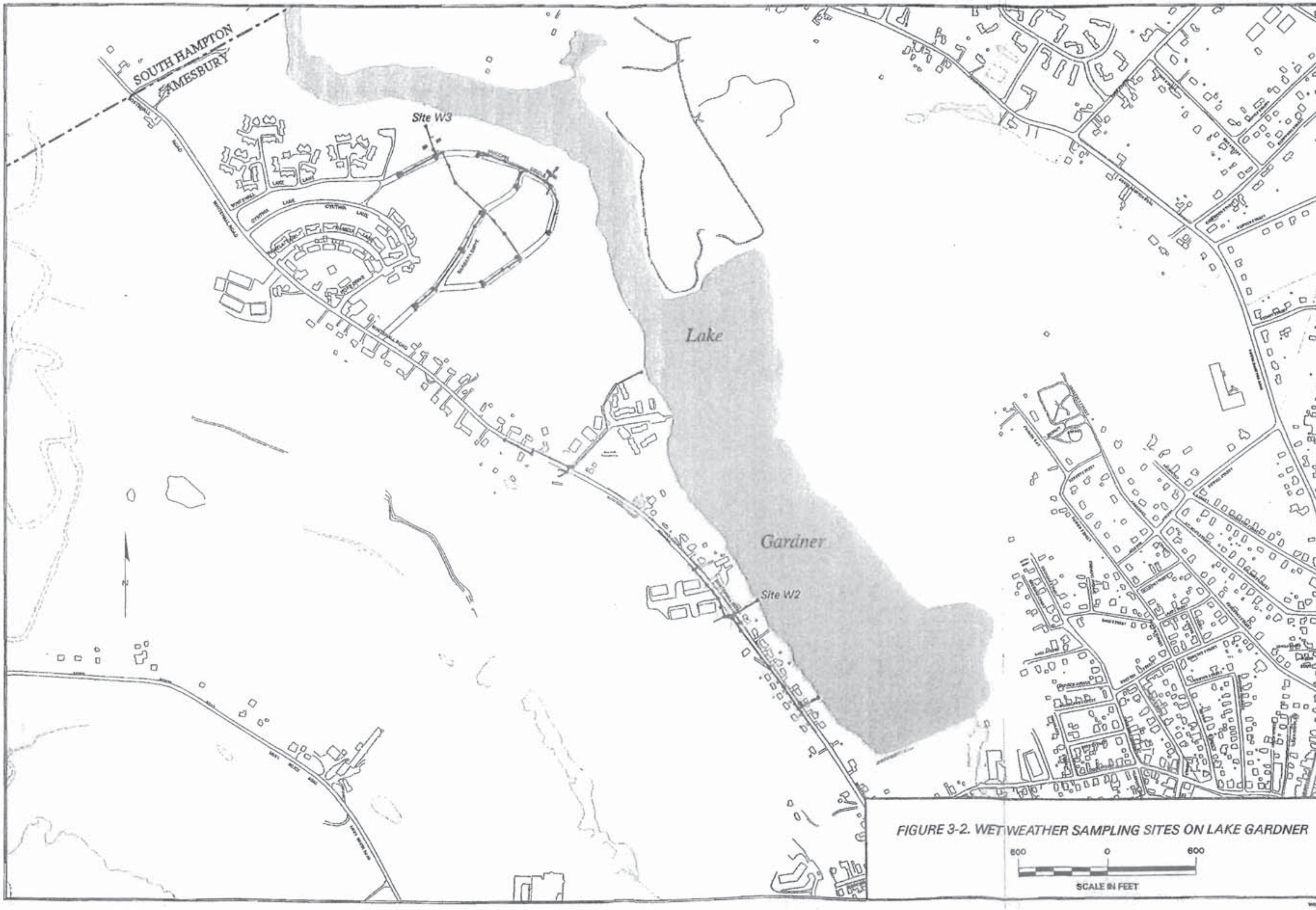


FIGURE 3-2. WET WEATHER SAMPLING SITES ON LAKE GARDNER

TABLE 2-1. DRY WEATHER SAMPLING RESULTS

11/4/98

Parameter	Lake Gardner			Lake Attitash		Detection
	Site D1	Site D2	Site D3	Site D4	Site D5	Limit
Conductance (umhos/cm)	330	190	170	190	390	N/A
Ammonia (mg/L as N)	0.05	ND	0.05	0.19	0.1	.05
Surfactants (mg/L)	ND	ND	ND	ND	ND	.005
Fluoride (mg/L)	ND	0.05	ND	ND	ND	.05
Enterococcus Bacteria (CFU/100 mL)	ND	ND	37	ND	33	1
Fecal Coliform (CFU/100 mL)	ND	40	116	1	57	1
E. Coli Bacteria (CFU/100 mL)	ND	ND	2	ND	37	1
Estimated Flow (gpm)	5-8	2-3	1-2	0.5-1	1-2	N/A

TABLE 3-2. SUMMARY OF STORMWATER RUNOFF QUALITY DATA FOR THE DECEMBER 8, 1998 STORM EVENT

Sample Site/Parameter	Sample Number										
	1	2	3	4	5	6	7	8	9	10	11
Site No. W1 - Lake Attitash Behind #11 Lake Shore Drive											
- Time	2:45	3:00	3:15	3:30	4:00	4:30	5:00	5:30	6:30	7:30	8:30
- Ammonia, mg/L as N (1)	0.11	0.20	0.20	0.20	0.20	0.19	0.17	0.17	0.15	0.13	0.12
- Fecal coliform bacteria, CFU/100 mL (2)	2,660	2,830	9,590	ND	23,000	4,416	32	13,000	186	7,584	10,944
- E. coli bacteria, CFU/100 mL (3)	10	ND	5,960	ND	21,000	2,304	ND	19,000	1,728	4,032	5,568
- Enterococcus bacteria, CFU/100 mL (4)	7,120	6,480	1,090	11,160	15,000	4,144	Confluent(*)	16,000	Confluent(*)	Confluent(*)	Confluent(*)
- Orthophosphate phosphorus, mg/L (5)		ND		ND				ND		ND	
- Total phosphorus, mg/L (6)				0.17				0.14		0.14	
Site No. W2 - Lake Gardner Behind #101 Whitehall Road											
- Time	2:45	3:00	3:15	3:30	4:00	4:30	5:00	5:30	6:30	7:30	8:30
- Ammonia, mg/L as N (1)	0.21	0.16	0.17	0.13	0.12	0.15	0.12	0.12	0.10	0.06	ND
- Fecal coliform bacteria, CFU/100 mL (2)	ND	ND	24,480	ND	1,000	2,000	2,736	2,944	ND	1,632	576
- E. coli bacteria, CFU/100 mL (3)	50	10	17,280	12,800	ND	2,000	28	2,112	1,408	10,944	530
- Enterococcus bacteria, CFU/100 mL (4)	440	480	2,360	1,550	1,000	ND	928	736	640	1,344	584
Site No. W3 - Lake Gardner Behind #37 Unicorn Circle											
- Time	2:45	3:00	3:15	3:30	4:00	4:30	5:00	5:30	6:30	7:30	8:30
- Ammonia, mg/L as N (1)	0.58	0.58	0.44	0.39	0.37	0.37	0.26	0.22	0.17	0.12	0.12
- Fecal coliform bacteria, CFU/100 mL (2)	280	30,000	1.30E+06	1.10E+06	1.13E+06	1.34E+06	5.20E+05	2.69E+05	680	20,000	5.04E+05
- E. coli bacteria, CFU/100 mL (3)	210	Confluent(*)	5.00E+05	8.44E+05	1.10E+06	8.16E+05	1.68E+05	1.72E+05	1,664	2,918	2.56E+05
- Enterococcus bacteria, CFU/100 mL (4)	920	Confluent(*)	7.44E+05	7.20E+05	6.24E+05	6.00E+05	4.56E+05	3.60E+05	10,000	5,000	2.88E+05

Notes:

(*) Confluent means that the sample was bacteriologically rich, causing colonies to touch, thereby limiting room for growth.
(1) The minimum detection limit for ammonia is 0.05 mg/L.
(2) The minimum detection limits for fecal coliform bacteria range from 2-10 CFU/100 mL depending on the dilution factor.
(3) The minimum detection limits for E. coli bacteria range from 2-1000 CFU/100 mL depending on the dilution factor.
(4) The minimum detection limit for enterococcus bacteria is 1000 CFU/100 mL.
(5) The minimum detection limit for orthophosphate phosphorus is 0.02 mg/L.
(6) The minimum detection limit for total phosphorus is 0.04 mg/L.

TABLE 3-3. SUMMARY OF STORMWATER RUNOFF QUALITY DATA FOR THE DECEMBER 17, 1998 STORM EVENT

Sample Site/Parameter	Sample Number									
	1	2	3	4	5	6	7	8	9	10
Site No. W1 - Lake Attitash Behind #11 Lake Shore Drive										
- Time	2:15	2:30	2:45	3:00	3:30	4:00	4:30	5:00	6:00	7:00
- Ammonia, mg/L as N	2.2	2.1	2.2	2.5	1.6	0.8	0.7	0.51	0.42	0.52
- Fecal coliform bacteria, CFU/100 mL (1)	ND	4,000	ND	ND	ND	7,000	ND	3,000	2,000	ND
- E. coli bacteria, CFU/100 mL (2)	ND	ND	ND	ND	ND	4,000	ND	ND	2,000	4,000
- Enterococcus bacteria, CFU/100 mL (3)	1,000	ND	3,000	1,000	ND	5,000	ND	9,000	6,000	9,000
Site No. W2 - Lake Gardner Behind #101 Whitehall Road										
- Time	3:30	3:45	4:00	4:15	4:45	5:15	5:45	6:15	7:15	
- Ammonia, mg/L as N	0.71	0.65	0.51	0.42	0.3	0.24	0.23	0.23	0.12	
- Fecal coliform bacteria, CFU/100 mL (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	
- E. coli bacteria, CFU/100 mL (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	
- Enterococcus bacteria, CFU/100 mL (3)	1,000	ND	ND	1,000	4,000	ND	15,000	46,000	10,000	
Site No. W3 - Lake Gardner Behind #37 Unicorn Circle										
- Time	3:30	3:45	4:00	4:15	4:45	5:15	5:45	6:15		
- Ammonia, mg/L as N	0.86	0.86	1.00	0.65	0.49	0.37	0.31	0.33		
- Fecal coliform bacteria, CFU/100 mL (1)	15,000	8,000	2.38E+05	93,000	72,000	1.12E+05	61,000	54,000		
- E. coli bacteria, CFU/100 mL (2)	17,000	1,000	2.32E+05	85,000	70,000	1.58E+05	40,000	43,000		
- Enterococcus bacteria, CFU/100 mL (3)	20,000	11,000	2.71E+05	85,000	46,000	37,000	30,000	22,000		

Notes:

(1) The minimum detection limit for fecal coliform bacteria is 1000 CFU/100 mL.
(2) The minimum detection limit for E. coli bacteria is 1000 CFU/100 mL.
(3) The minimum detection limit for enterococcus bacteria is 1000 CFU/100 mL.

TABLE 3-4. SUMMARY OF STORMWATER RUNOFF QUALITY DATA FOR THE DECEMBER 22, 1998 STORM EVENT

Sample Site/Parameter	Sample Number										
	1	2	3	4	5	6	7	8	9	10	11
Site No. W1 - Lake Attitash Behind #11 Lake Shore Drive											
- Time	7:00	7:15	7:30	7:45	8:15	8:45	9:15	9:45	10:15	10:45	11:15
- Ammonia, mg/L as N	0.55	0.51	0.53	0.6	0.65	0.71	0.55	0.55	0.55	0.6	0.55
- Fecal coliform bacteria, CFU/100 mL (1)	1,000	ND	ND	ND	ND	ND	7,000	ND	ND	11,000	ND
- E. coli bacteria, CFU/100 mL (2)	2,000	1,000	ND	ND	ND	ND	3,000	6,000	8,000	8,000	16,000
- Enterococcus bacteria, CFU/100 mL	3,000	6,000	4,000	6,000	4,000	5,000	10,000	13,000	7,000	9,000	12,000
Site No. W2 - Lake Gardner Behind #101 Whitehall Road											
- Time	7:00	7:15	7:30	7:45	8:15	8:45	9:15	9:45	10:15	10:45	11:15
- Ammonia, mg/L as N	0.47	0.4	0.3	0.2	0.13	0.22	0.22	0.1	0.15	0.18	0.1
- Fecal coliform bacteria, CFU/100 mL (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
- E. coli bacteria, CFU/100 mL (2)	ND	ND	ND	ND	ND	ND	200	200	ND	ND	ND
- Enterococcus bacteria, CFU/100 mL	800	1,200	600	400	400	200	200	200	400	800	200
Site No. W3 - Lake Gardner Behind #37 Unicorn Circle											
- Time	7:00	7:15	7:30	7:45	8:15	8:45	9:45	10:15	10:45	11:15	
- Ammonia, mg/L as N	0.26	---	0.35	0.34	0.29	0.22	0.21	0.22	0.28	0.3	
- Fecal coliform bacteria, CFU/100 mL (1)	ND	ND	ND	ND	40,000	82,000	1.41E+05	49,000	36,000	1.13E+05	
- E. coli bacteria, CFU/100 mL (2)	ND	7,000	ND	ND	74,000	8,000	1.13E+05	3,000	ND	85,000	
- Enterococcus bacteria, CFU/100 mL	8,000	56,000	60,000	64,000	60,000	40,000	98,000	44,000	30,000	55,000	

Notes:

(1) The minimum detection limits for fecal coliform bacteria range from 200-1000 CFU/100 mL depending on the dilution factor.

(2) The minimum detection limits for E. coli bacteria range from 200-1000 CFU/100 mL depending on the dilution factor.

Appendix B
USDA Soil Survey Maps


680 000 FEET
150 000 FEET
EAST KINGSTON
HOG HILL
KENSINGTON
SOUTH HAMPTON
HAMPTON FALLS
SEABROOK
Muddy Pond
HOG HILL
SWAMP
HORSE HILL
INDIAN GROUND HILL
Back River
Powwow River
BUGSMOUTH HILL
South Hampton
ESSEX COUNTY, MASSACHUSETTS
(Joins sheet 36)
(Joins inset, sheet 45)


(Joins sheet 42)
SWEET HILL
P L A I S T O W
ESSEX COUNTY, MASSACHUSETTS
INSET
(Joins sheet 37)
(Joins sheet 42)
680 000 FEET
137 000 FEET
135 000 FEET
690 000 FEET
SAWYERS HILL
S O U T H H A M P T O N
Tuxbury Pond
Powwow R
2000 AND 5000-FOOT GRID TICKS
110 000 FEET
675 000 FEET
N
Scale 1:20000
1 Mile
5 000 Feet

Appendix C
Quality Assurance Project Plan (QAPP)
(Provided on CD)

Appendix D
Water Quality Laboratory Reports

eastern analytical, inc.
professional laboratory services

ACCREDITED IN ACCORDANCE WITH nelac

Curt Busto
Comprehensive Environmental, Inc.
21 Depot Street
Merrimack, NH 03054

Subject: Laboratory Report

Eastern Analytical, Inc. ID:	90357
Client Identification:	Lake Gardner | 175-7
Date Received:	6/25/2010

Dear Mr. Busto:

Enclosed please find the laboratory report for the above identified project. All analyses were performed in accordance with our QA/QC Program. Unless otherwise stated, holding times, preservation techniques, container types, and sample conditions adhered to EPA Protocol. Samples which were collected by Eastern Analytical, Inc. (EAI) were collected in accordance with approved EPA procedures. Eastern Analytical, Inc. certifies that the enclosed test results meet all requirements of NELAP and other applicable state certifications. Please refer to our website at www.eailabs.com for a copy of our NELAP certificate and accredited parameters.

The following standard abbreviations and conventions apply to all EAI reports:

- Solid samples are reported on a dry weight basis, unless otherwise noted
- < : "less than" followed by the reporting limit
- > : "greater than" followed by the reporting limit
- %R : % Recovery

Eastern Analytical Inc. maintains certification in the following states: Connecticut (PH-0492), Maine (NH005), Massachusetts (M-NH005), New Hampshire/NELAP (1012), Rhode Island (269) and Vermont (VT1012).

The following information is contained within this report: Sample Conditions summary, Analytical Results/Data, Quality Control data (if requested) and copies of the Chain of Custody. This report may not be reproduced except in full, without the the written approval of the laboratory.

If you have any questions regarding the results contained within, please feel free to directly contact me or the chemist(s) who performed the testing in question. Unless otherwise requested, we will dispose of the sample(s) 30 days from the sample receipt date.

We appreciate this opportunity to be of service and look forward to your continued patronage.

Sincerely,

Lorraine Olashaw (signature)	7-13-10	3
Lorraine Olashaw, Lab Director	Date	# of pages (excluding cover letter)

SAMPLE CONDITIONS PAGE

Eastern Analytical, Inc. ID#: 90357

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | 175-7**

Temperature upon receipt (°C): 6 **Received on ice or cold packs (Yes/No): Y**

Lab ID	Sample ID	Date Received	Date Sampled	Sample Matrix	% Dry Weight	Exceptions/Comments (other than thermal preservation)
90357.01	Newton Road	6/25/10	6/25/10	aqueous		Adheres to Sample Acceptance Policy
90357.02	Jewell Street	6/25/10	6/25/10	aqueous		Adheres to Sample Acceptance Policy
90357.03	Lake Inlet	6/25/10	6/25/10	aqueous		Adheres to Sample Acceptance Policy
90357.04	Lake Outlet	6/25/10	6/25/10	aqueous		Adheres to Sample Acceptance Policy
90357.05	Deep Hole (Shallow)	6/25/10	6/25/10	aqueous		Adheres to Sample Acceptance Policy
90357.06	Deep Hole (Deep)	6/25/10	6/25/10	aqueous		Adheres to Sample Acceptance Policy

Samples were properly preserved and the pH measured when applicable unless otherwise noted. Analysis of solids for pH, Flashpoint, Ignitibility, Paint Filter, Corrosivity, Conductivity and Specific Gravity are reported on an "as received" basis.

All results contained in this report relate only to the above listed samples.

References include:
1) EPA 600/4-79-020, 1983
2) Standard Methods for Examination of Water and Wastewater : Inorganics, 19th Edition, 1995; Microbiology, 20th Edition, 1998
3) Test Methods for Evaluating Solid Waste SW 846 3rd Edition including updates IVA and IVB
4) Hach Water Analysis Handbook, 2nd edition, 1992

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 90357

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | 175-7**

Sample ID:	Newton Road	Jewell Street	Lake Inlet	Lake Outlet					
Lab Sample ID:	90357.01	90357.02	90357.03	90357.04					
Matrix:	aqueous	aqueous	aqueous	aqueous					
Date Sampled:	6/25/10	6/25/10	6/25/10	6/25/10		Analysis			
Date Received:	6/25/10	6/25/10	6/25/10	6/25/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Nitrate-N	**0.07**	**0.08**	**0.11**	**0.10**	mg/L	06/25/10	19:02	353.2	KL
Ammonia-N	< 0.05	< 0.05	< 0.05	< 0.05	mg/L	07/01/10	14:00	4500NH3D	SEL
Total Phosphorus-P	**0.017**	**0.009**	**0.010**	**0.010**	mg/L	07/08/10	13:00	365.3	SKC
Dissolved Oxygen	**7.3**	**6.2**	**8.7**	**8.2**	mg/L	06/25/10	16:20	4500O-G	SKC
Turbidity	**1.1**	**1.2**	**1.7**	**1.6**	NTU	06/25/10	17:05	180.1	JL
E.coli	**5.2**	**12.1**	**7.4**	**38.8**	MPN/100ml	06/25/10	16:15	9223B	KL
Fecal Coliform	**130**	**50**	**140**	**110**	MPN/100ml	06/25/10	16:30	9221E	SFW
Solids Suspended	**4E**	**4E**	**3E**	**2E**	mg/L	06/29/10	9:30	2540D	KJR

Sample ID:	Deep Hole (Shallow)	Deep Hole (Deep)					
Lab Sample ID:	90357.05	90357.06					
Matrix:	aqueous	aqueous					
Date Sampled:	6/25/10	6/25/10		Analysis			
Date Received:	6/25/10	6/25/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Nitrate-N	**0.07**	**0.06**	mg/L	06/25/10	19:06	353.2	KL
Ammonia-N	< 0.05	< 0.05	mg/L	07/01/10	14:00	4500NH3D	SEL
Total Phosphorus-P	**0.007**	**0.013**	mg/L	07/08/10	13:00	365.3	SKC
Dissolved Oxygen	**8.1**	**8.1**	mg/L	06/25/10	16:30	4500O-G	SKC
Turbidity	**1.2**	**2.2**	NTU	06/25/10	17:05	180.1	JL
E.coli	**6.3**	**9.7**	MPN/100ml	06/25/10	16:15	9223B	KL
Fecal Coliform	**14**	**13**	MPN/100ml	06/25/10	16:30	9221E	SFW
Solids Suspended	**2E**	**2**	mg/L	06/29/10	9:30	2540D	KJR

Dissolved Oxygen (DO): Sample bottles were not completely full of sample which may have allowed the air to mix with the sample potentially biasing the results.
Solids Suspended Estimated: The sample results designated with "E" after the concentration indicate that these are estimated results. The silty matter in the samples did not permit the needed volume of sample to pass through the filter and achieve the desired reporting limit sensitivity.

Page 1 of 2

Chain-of-Custody Record

90357

Bold Fields Required. Please Circle Requested Analysis.

Sample I.D.	Sampling Date/Time *If Composite, Indicate Start Date/Time 6/25/10	Matrix (see below)	Grab/*Composite	VOC: NH524.2 Full List 524.2 / 524.2 BTEX 524.2 MTBE only	VOC: NH8260B Full List 8260B / 8021B VTICs 624	VOC: 8021B BTEX HALOS	VOC: 8015B GRO MEGRO MAVPH	SVOC: 8270C 625 SVTICs / ABN A BN PAH	SVOC: TPH8100 L1 L2	SVOC: 8015B DRO MEDRO MAEPH	SVOC: 608 Pest/PCB / Pest 8081A PCB 8082	SVOC: Oil & Grease 1664 TPH 1664	TCLP: TCLP 1311 ABN Metals / VOC Pest Herb	Metals: Dissolved Metals (list below)	Metals: Total Metals (list below)	Inorganics: TS (TSS) TDS Spec. Con.	Inorganics: Br Cl F SO_4 / NO_2 (NO_3) NO_2/NO_3	Inorganics: BOD CBOD T. Alk.	Inorganics: TKN (NH_3) (T. Phos.)	Inorganics: pH T. Res. Chlorine	Inorganics: COD Phenols TOC	Inorganics: Total Cyanide Total Sulfide	Inorganics: Reactive Cyanide Reactive Sulfide / Flashpoint Ignitability	Micro: T. Coliform (E. Coli) / (F. Coliform)	Micro: Enterococci / Heterotrophic Plate Count	Other: (Turbidity) *	Other: Dissolved Oxygen		# of Containers	Notes MeOH Vial #
Newton Road	1:01pm	SW	G													x	x		x x					x x		x	✓			
Jewell Street	1:25	SW	G													x	x		x x					x x		x	✓			
Lake Inlet	1247	SW	G													x	x		x x					x x		x	✓			
Lake Outlet	150	SW	G													x	x		x x					x x		x	✓			
Deep Hole (Shallow)	1:10	SW	G													x	x		x x					x x		x	✓			
Deep Hole (Deep)	1:27	SW	G													x	x		x x					x x		x	✓			
Stormwater 4-15		SW	G													x	x		x x					x x		x				
Stormwater 4-5		SW	G													x	x		x x					x x		x				
Stormwater 4-4		SW	G													x	x		x x					x x		x				
Stormwater 4-9		SW	G													x	x		x x					x x		x				
Matrix: A-Air; S-Soil; GW-Ground Water; SW-Surface Water; DW-Drinking Water; WW-Waste Water. Preservative: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH																N/A	N/A		N/A H2SO4					Na2S2O3 Na2S2O3		N/A				

Project Manager: Curt Busto

Company: Comprehensive Environmental Inc.

Address: 21 Depot Street

City: Merrimack State: NH Zip: 03054

Phone: 800-725-2550 Ext.: 304

Fax: 800-331-0892

E-Mail: cbusto@ceiengineers.com

Site Name: Lake Gardner

Project #: 175-7

State: NH (MA) ME VT Other:

Is your project **RGP**? Y / N

Quote #: 1007664 PO #:

Date Needed:

QA/QC Reporting Level: A (B) C or MA MCP Presumptive Certainty

Reporting Options: Prelims: (Yes) or No. If Yes: Fax or (PDF)

Electronic Options: No Fax (E-Mail) PDF Equis

Temp. 6 4 °C Ice? (Yes) No

Sampler(s): Bruce Gargin Bernadette Lucas

Relinquished By	Date	Time	Received By
[signature]	6/25/10	4:23	Norman Cain
Norman Cain	6/25/10	1550	[signature]

Metals: 8 RCRA 13 PP Fe, Mn Pb, Cu

Other Metals:

Dissolved Metals Field Filtered? Yes No

Notes: (ie: special detection limits, billing info, if different)

*DO per C. Busto. 6/25/10 [initials]

eastern analytical, inc. 25 Chenell Drive | Concord, NH 03301 | Tel: 603.228.0525 | 1.800.287.0525 | Fax: 603.228.4591 | E-Mail: customer_service@eailabs.com | www.eailabs.com

professional laboratory services

(White: Original Green: Project Manager)

Lake Gardner Field Data Sheet

Date (m/d/y): 6/25/10 Weather Today: Sunny 84° Weather over past 72 hours: dry

	Sample Name	Time of Sample	Observer Initials	Field Samples (Record the appropriate value off of the multi-meter once values have stabilized) Temperature (°C)	pH	Total Dissolved Solids (TDS) (ppm)	Conductivity (uS/cm)	Laboratory Samples (Place a check mark in each box once the sample has been collected) T.P.	Amm.	Nitr.	Fecal	E.coli	TSS	Trbdty	Comments (record duplicate samples, GPS coordinates, unusual site conditions, issues, or other observations)
Stormwater Outfall Pipes (use multi-meter)	Stormwater 4-3														
	Stormwater 4-4														
	Stormwater 4-5														
	Stormwater 4-7														
	Stormwater 4-8														
	Stormwater 4-9														
	Stormwater 4-12														
	Stormwater 4-13														
	Stormwater 4-15														
In-lake (use multi-meter)	Deep Hole (Shallow)	1:10	BL	99	5.40	~~79~~ 82	~~156~~ 194								
	Deep Hole (Deep)	1:29	BL	79	5.40	79	156								
	Newton Road	1500	BG	80.0	5.38	69	137								
	Jewell Street	125	BG	81.5	5.36	74	150								
	Lake Inlet	12:47	BL	81	5.39	77	155								
	Lake Outlet	150	BG	72	5.37	72	145								

Lake Outlet Flow at Dam	Flow Over Spillway?	Flow from Outlet Pipe>	Secchi Disk Reading at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Flow Present at Lake Gardner Dam (observation, yes or no) yes			Secchi Disk Reading (use Secchi Disk)	5.8		5.8

Depth to Bottom at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)	Sediment Depth at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Depth to Bottom of Lake (use Secchi Disk)	7.44			Sediment Depth at Deep Hole (use pole and zip ties)	.93		.93

Water Column at Deep Hole	Depth 1 (ft)	Temp. (°C)	DO (mg/L)	Depth 2 (ft)	Temp. (°C)	DO (mg/L)	Depth 3 (ft)	Temp. (°C)	DO (mg/L)	Depth 4 (ft)	Temp. (°C)	DO (mg/L)	Depth 5 (ft)	Temp. (°C)	DO (mg/L)	Comments
Depth, Temperature, and Dissolved Oxygen (use multi-meter)																

eastern analytical, inc.

Curt Busto
Comprehensive Environmental, Inc.
21 Depot Street
Merrimack , NH 03054

ACCREDITED IN ACCORDANCE WITH nelac

Subject: Laboratory Report

Eastern Analytical, Inc. ID:	90734
Client Identification:	Lake Gardner | 175-7
Date Received:	7/9/2010

Dear Mr. Busto :

Enclosed please find the laboratory report for the above identified project. All analyses were performed in accordance with our QA/QC Program. Unless otherwise stated, holding times, preservation techniques, container types, and sample conditions adhered to EPA Protocol. Samples which were collected by Eastern Analytical, Inc. (EAI) were collected in accordance with approved EPA procedures. Eastern Analytical, Inc. certifies that the enclosed test results meet all requirements of NELAP and other applicable state certifications. Please refer to our website at www.eailabs.com for a copy of our NELAP certificate and accredited parameters.

The following standard abbreviations and conventions apply to all EAI reports:

- Solid samples are reported on a dry weight basis, unless otherwise noted
- < : "less than" followed by the reporting limit
- > : "greater than" followed by the reporting limit
- %R : % Recovery

Eastern Analytical Inc. maintains certification in the following states: Connecticut (PH-0492), Maine (NH005), Massachusetts (M-NH005), New Hampshire/NELAP (1012), Rhode Island (269) and Vermont (VT1012).

The following information is contained within this report: Sample Conditions summary, Analytical Results/Data, Quality Control data (if requested) and copies of the Chain of Custody. This report may not be reproduced except in full, without the the written approval of the laboratory.

If you have any questions regarding the results contained within, please feel free to directly contact me or the chemist(s) who performed the testing in question. Unless otherwise requested, we will dispose of the sample(s) 30 days from the sample receipt date.

We appreciate this opportunity to be of service and look forward to your continued patronage.

Sincerely,

Michael Swett for	7/21/10	4
Lorraine Olashaw, Lab Director	Date	# of pages (excluding cover letter)

SAMPLE CONDITIONS PAGE

Eastern Analytical, Inc. ID#: 90734

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | 175-7**

Temperature upon receipt (°C): 6

Received on ice or cold packs (Yes/No): Y

Lab ID	Sample ID	Date Received	Date Sampled	Sample Matrix	% Dry Weight	Exceptions/Comments (other than thermal preservation)
90734.01	Newton Road	7/9/10	7/9/10	aqueous		Adheres to Sample Acceptance Policy
90734.02	Jewell Street	7/9/10	7/9/10	aqueous		Adheres to Sample Acceptance Policy
90734.03	Lake Inlet	7/9/10	7/9/10	aqueous		Adheres to Sample Acceptance Policy
90734.04	Lake Outlet	7/9/10	7/9/10	aqueous		Adheres to Sample Acceptance Policy
90734.05	Deep Hole (Shallow)	7/9/10	7/9/10	aqueous		Adheres to Sample Acceptance Policy
90734.06	Deep Hole (Deep)	7/9/10	7/9/10	aqueous		Adheres to Sample Acceptance Policy

Samples were properly preserved and the pH measured when applicable unless otherwise noted. Analysis of solids for pH, Flashpoint, Ignitibility, Paint Filter, Corrosivity, Conductivity and Specific Gravity are reported on an "as received" basis.

All results contained in this report relate only to the above listed samples.

References include:
1) EPA 600/4-79-020, 1983
2) Standard Methods for Examination of Water and Wastewater : Inorganics, 19th Edition, 1995; Microbiology, 20th Edition, 1998
3) Test Methods for Evaluating Solid Waste SW 846 3rd Edition including updates IVA and IVB
4) Hach Water Analysis Handbook, 2nd edition, 1992

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 90734

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | 175-7**

Sample ID:	Newton Road	Jewell Street	Lake Inlet	Lake Outlet					
Lab Sample ID:	90734.01	90734.02	90734.03	90734.04					
Matrix:	aqueous	aqueous	aqueous	aqueous					
Date Sampled:	7/9/10	7/9/10	7/9/10	7/9/10		**Analysis**			
Date Received:	7/9/10	7/9/10	7/9/10	7/9/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Solids Suspended	**9**	**2**	**1 E**	< 1 E	mg/L	07/13/10	11:00	2540D	KJR
Nitrate-N	**0.07**	**0.06**	**0.07**	**0.10**	mg/L	07/09/10	19:38	353.2	KL
Ammonia-N	< 0.05	< 0.05	< 0.05	**0.05**	mg/L	07/19/10	10:20	4500NH3D	SEL
Total Phosphorus-P	**0.02**	**0.01**	**0.02**	**0.02**	mg/L	07/19/10	18:16	365.3	SKC
Dissolved Oxygen	**5.9**	**6.9**	**7.9**	**6.7**	mg/L	07/09/10	15:55	4500O-G	SKC
Turbidity	**2**	**2**	**1**	**1**	NTU	07/09/10	16:20	180.1	NZ
E.coli	**7.3**	**150.0**	**7.4**	**23.3**	MPN/100ml	07/09/10	16:00	9223B	KL
Fecal Coliform	**70**	**900**	**170**	**70**	MPN/100ml	07/09/10	16:30	9221E	SFW

Sample ID:	Deep Hole (Shallow)	Deep Hole (Deep)					
Lab Sample ID:	90734.05	90734.06					
Matrix:	aqueous	aqueous					
Date Sampled:	7/9/10	7/9/10		**Analysis**			
Date Received:	7/9/10	7/9/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Solids Suspended	< 1 E	< 1 E	mg/L	07/13/10	11:00	2540D	KJR
Nitrate-N	**0.06**	**0.06**	mg/L	07/09/10	19:47	353.2	KL
Ammonia-N	< 0.05	< 0.05	mg/L	07/19/10	10:20	4500NH3D	SEL
Total Phosphorus-P	**0.01**	**0.01**	mg/L	07/19/10	18:26	365.3	SKC
Dissolved Oxygen	**8.0**	**8.0**	mg/L	07/09/10	15:55	4500O-G	SKC
Turbidity	**1**	**1**	NTU	07/09/10	16:20	180.1	NZ
E.coli	**2.0**	**3.1**	MPN/100ml	07/09/10	16:00	9223B	KL
Fecal Coliform	**30**	**17**	MPN/100ml	07/09/10	16:30	9221E	SFW

Solids Suspended: Due to the sample matrix, the sample volume required to meet the 1mg/L requested reporting limit would not pass through the filter. These are estimated values.

QC REPORT

Eastern Analytical, Inc. ID#: 90734

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | 175-7**

Parameter Name	Blank	LCS	LCSD	Units	Date of Analysis	Limits	RPD	Method
Solids Suspended	< 1	96 (96 %R)		mg/L	7/13/10	90 - 110	20	2540D
Nitrate-N	< 0.05	4.9 (99 %R)	5.0 (101 %R) (2 RPD)	mg/L	7/9/10	90 - 110	20	353.2
Ammonia-N	< 0.05	2.1 (107 %R)	2.1 (104 %R) (3 RPD)	mg/L	7/19/10	90 - 110	20	4500NH3D
Total Phosphorus-P	< 0.01	0.30 (100 %R)	0.29 (98 %R) (2 RPD)	mg/L	7/19/10	90 - 110	20	365.3
Turbidity	< 1	< 1 (96 %R)	< 1 (99 %R) (3 RPD)	NTU	7/9/10	85 - 110	20	180.1

Parameter Name	MS/MSD Parent ID	MS/MSD Parent	Matrix Spike	MSD	Units	Date of Analysis	Limits	RPD	Method
Solids Suspended					mg/L	7/13/10		20	2540D
Nitrate-N	90734.03	0.07	9.9 (98 %R)	9.9 (98 %R) (0 RPD)	mg/L	7/9/10	80-120	20	353.2
Ammonia-N	90880.06	< 0.05	2.2 (111 %R)	2.2 (109 %R) (2 RPD)	mg/L	7/19/10	80-120	20	4500NH3
Total Phosphorus-P	90740.03	0.20	0.50 (98 %R)	0.51 (102 %R) (4 RPD)	mg/L	7/19/10	80-120	20	365.3
Turbidity					NTU	7/9/10		20	180.1

Parameter Name	Duplicate Parent ID	Duplicate Parent	Duplicate	Units	Date of Analysis	RPD	Method
Solids Suspended	90772.02	9	9 (0 RPD)	mg/L	7/13/10	20	2540D
Nitrate-N				mg/L	7/9/10	20	353.2
Ammonia-N				mg/L	7/19/10	20	4500NH3D
Total Phosphorus-P				mg/L	7/19/10	20	365.3
Turbidity	90734.01	2	2 (1 RPD)	NTU	7/9/10	20	180.1

Samples were analyzed within holding times unless noted on the sample results page.
Instrumentation was calibrated in accordance with the method requirements.
The method blanks were free of contamination at the reporting limits.
The associated matrix spikes and/or Laboratory Control Samples met the above stated criteria.
Exceptions to the above statements are flagged or noted above or on the QC Narrative page.
* Flagged analyte recoveries deviated from the QA/QC limits.

Page 1 of 2

Chain-of-Custody Record

For 90734

4

Bold Fields Required. Please Circle Requested Analysis.

Sample I.D.	Sampling Date/Time *If Composite, Indicate Start Date/Time 7/9/10	Matrix (see below)	Grab/*Composite	VOC: NH524.2 Full List 524.2 / 524.2 BTEX 524.2 MTBE only	VOC: NH8260B Full List 8260B / 8021B VTICs 624	VOC: 8021B BTEX HALOS	VOC: 8015B GRO MEGRO MAVPH	SVOC: 8270C 625 SVTICs / ABN A BN PAH	SVOC: TPH8100 L1 L2	SVOC: 8015B DRO MEDRO MAEPH	SVOC: 608 PEST/PCB PCB 8082 / PEST 8081A	SVOC: Oil & Grease 1664 TPH 1664	TCLP: TCLP 1311 ABN Metals / VOC Pest Herb	Metals: Dissolved Metals (List Below)	Metals: Total Metals (List Below)	Inorganics: TS (TSS) TDS Spec. Con.	Inorganics: Br Cl F SO_4 / NO_2 (NO_3) NO_2/NO_3	Inorganics: BOD CBOD T. Alk.	Inorganics: TKN (NH_3) (T. Phos.)	Inorganics: pH T. Res. Chlorine	Inorganics: COD Phenols TOC	Inorganics: Total Cyanide Total Sulfide	Inorganics: Reactive Cyanide Reactive Sulfide / Flashpoint Ignitability	Micro: T. Coliform (F. Coliform) (E. Coli)	Micro: Enterococci / Heterotrophic Plate Count	Other: (Turbidity)	Other: Dissolved Oxygen per L.B.	# of Containers	Notes MeOH Vial #
Newton Road NR	1:00	SW	G													x	x		x x					x x		x	✓		
Jewell Street JS	1:20	SW	G													x	x		x x					x x		x	✓		
Lake Inlet (LI)	12:59	SW	G													x	x		x x					x x		x	✓		
Lake Outlet LO	1:35	SW	G													x	x		x x					x x		x	✓		
DHS Deep Hole (Shallow)	1:28	SW	G													x	x		x x					x x		x	✓		
DHD Deep Hole (Deep)	1:32	SW	G													x	x		x x					x x		x	✓		
Stormwater 4-15		SW	G													x	x		x x					x x		x			
Stormwater 4-5		SW	G													x	x		x x					x x		x			
Stormwater 4-4		SW	G													x	x		x x					x x		x			
Stormwater 4-9		SW	G													x	x		x x					x x		x			
Matrix: A-Air; S-Soil; GW-Ground Water; SW-Surface Water; DW-Drinking Water; WW-Waste Water Preservative: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH																N/A	N/A		N/A H2SO4					Na2S2O3 Na2S2O3		N/A			

Project Manager: Curt Busto

Company: Comprehensive Environmental Inc.

Address: 21 Depot Street

City: Merrimack State: NH Zip: 03054

Phone: 800-725-2550 Ext.: 304

Fax: 800-331-0892

E-Mail: cbusto@ceiengineers.com

Site Name: Lake Gardner

Project #: 175-7

State: NH (MA) ME VT Other:

Is Your Project RGP? Y / N

Quote #: 1007664 PO #:

Date Needed:

Temp. 6 °C

Ice? (Yes) No

QA/QC Reporting Level: A (B) C OR MA MCP Presumptive Certainty

Reporting Options: Prelims: (Yes) or No. If Yes: Fax or (PDF)

Electronic Options: No Fax (E-Mail) PDF Equis

Sampler(s): Bruce Georgian

Relinquished By:	Date:	Time:	Received By:
Bruce Georgian	7/9/10	2:30	Norman Carr
Norman Carr	7/9/10	1545	[signature]

Metals: 8 RCRA 13 PP Fe, Mn Pb, Cu

Other Metals:

Dissolved Metals Field Filtered? Yes No

Notes: (IE: Special Detection Limits, Billing Info, If Different)

Lake Gardner Field Data Sheet

Date (m/d/y): 7/9/16　　Weather Today: Sunny, Dry, 92°　　Weather over past 72 hours: Dry, Hot

	Sample Name	Time of Sample	Observer Initials	Field Samples (Record the appropriate value off of the multi-meter once values have stabilized) Temperature (°C)	pH	Total Dissolved Solids (TDS) (ppm)	Conductivity (µS/cm)	Laboratory Samples (Place a check mark in each box once the sample has been collected) T.P.	Amm.	Nitr.	Fecal	E.coli	TSS	Trbdty	Comments (record duplicate samples, GPS coordinates, unusual site conditions, issues, or other observations)
Stormwater Outfall Pipes (use multi-meter)	Stormwater 4-2														
	Stormwater 4-4														
	Stormwater 4-5														
	Stormwater 4-7														
	Stormwater 4-8														
	Stormwater 4-9														
	Stormwater 4-12														
	Stormwater 4-13														
	Stormwater 4-15														
In-lake (use multi-meter)	Deep Hole (Shallow)	1:28	MB	86	4.98	89	179								
	Deep Hole (Deep)	1:32	MB	85	4.99	89	179								
	Newton Road	1:00	BG	88.6	5.81	92	183								
	Jewell Street	1:50	BG	90.8	5.79	95	191								
	Lake Inlet	12:59	MB	86	4.98	88	176								
	Lake Outlet	1:35	BG	90.8	4.96	93	187								

Lake Outlet Flow at Dam	Flow Over Spillway?	Flow from Outlet Pipe>	Secchi Disk Reading at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Flow Present at Lake Gardner Dam (observation, yes or no)	NO		Secchi Disk Reading (use Secchi Disk)	6.3 ft		

Depth to Bottom at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)	Sediment Depth at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Depth to Bottom of Lake (use Secchi Disk)	6.3 ft			Sediment Depth at Deep Hole (use pole and zip ties)	2 inches		

Water Column at Deep Hole	Depth 1 (ft)	Temp. (°C)	DO (mg/L)	Depth 2 (ft)	Temp. (°C)	DO (mg/L)	Depth 3 (ft)	Temp. (°C)	DO (mg/L)	Depth 4 (ft)	Temp. (°C)	DO (mg/L)	Depth 5 (ft)	Temp. (°C)	DO (mg/L)	Comments
Depth, Temperature, and Dissolved Oxygen (use multi-meter)																

Include DO

eastern analytical, inc.

professional laboratory services

Curt Busto
Comprehensive Environmental, Inc.
21 Depot Street
Merrimack , NH 03054

Subject: Laboratory Report

Eastern Analytical, Inc. ID:	94058
Client Identification:	Lake Gardner | 175-7
Date Received:	10/27/2010

Dear Mr. Busto :

Enclosed please find the laboratory report for the above identified project. All analyses were performed in accordance with our QA/QC Program. Unless otherwise stated, holding times, preservation techniques, container types, and sample conditions adhered to EPA Protocol. Samples which were collected by Eastern Analytical, Inc. (EAI) were collected in accordance with approved EPA procedures. Eastern Analytical, Inc. certifies that the enclosed test results meet all requirements of NELAP and other applicable state certifications. Please refer to our website at www.eailabs.com for a copy of our NELAP certificate and accredited parameters.

The following standard abbreviations and conventions apply to all EAI reports:

- Solid samples are reported on a dry weight basis, unless otherwise noted
- < : "less than" followed by the reporting limit
- > : "greater than" followed by the reporting limit
- %R : % Recovery

Eastern Analytical Inc. maintains certification in the following states: Connecticut (PH-0492), Maine (NH005), Massachusetts (M-NH005), New Hampshire/NELAP (1012), Rhode Island (269) and Vermont (VT1012).

The following information is contained within this report: Sample Conditions summary, Analytical Results/Data, Quality Control data (if requested) and copies of the Chain of Custody. This report may not be reproduced except in full, without the the written approval of the laboratory.

If you have any questions regarding the results contained within, please feel free to directly contact me or the chemist(s) who performed the testing in question. Unless otherwise requested, we will dispose of the sample(s) 30 days from the sample receipt date.

We appreciate this opportunity to be of service and look forward to your continued patronage.

Sincerely,

Lorraine Olashaw (signature)

Lorraine Olashaw, Lab Director	11-8-10	3
	Date	# of pages (excluding cover letter)

SAMPLE CONDITIONS PAGE

Eastern Analytical, Inc. ID#: 94058

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | 175-7**

Temperature upon receipt (°C): 3

Received on ice or cold packs (Yes/No): Y

Lab ID	Sample ID	Date Received	Date Sampled	Sample Matrix	% Dry Weight	Exceptions/Comments (other than thermal preservation)
94058.01	4-2	10/27/10	10/27/10	aqueous		Adheres to Sample Acceptance Policy
94058.02	4-13	10/27/10	10/27/10	aqueous		Adheres to Sample Acceptance Policy
94058.03	4-12	10/27/10	10/27/10	aqueous		Adheres to Sample Acceptance Policy
94058.04	4-7	10/27/10	10/27/10	aqueous		Adheres to Sample Acceptance Policy
94058.05	4-4	10/27/10	10/27/10	aqueous		Adheres to Sample Acceptance Policy
94058.06	4-15	10/27/10	10/27/10	aqueous		Adheres to Sample Acceptance Policy
94058.07	4-5	10/27/10	10/27/10	aqueous		Adheres to Sample Acceptance Policy

Samples were properly preserved and the pH measured when applicable unless otherwise noted. Analysis of solids for pH, Flashpoint, Ignitibility, Paint Filter, Corrosivity, Conductivity and Specific Gravity are reported on an "as received" basis.

All results contained in this report relate only to the above listed samples.

References include:
1) EPA 600/4-79-020, 1983
2) Standard Methods for Examination of Water and Wastewater : Inorganics, 19th Edition, 1995; Microbiology, 20th Edition, 1998
3) Test Methods for Evaluating Solid Waste SW 846 3rd Edition including updates IVA and IVB
4) Hach Water Analysis Handbook, 2nd edition, 1992

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 94058

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | 175-7**

Sample ID:	4-2	4-13	4-12	4-7					
Lab Sample ID:	94058.01	94058.02	94058.03	94058.04					
Matrix:	aqueous	aqueous	aqueous	aqueous					
Date Sampled:	10/27/10	10/27/10	10/27/10	10/27/10		Analysis			
Date Received:	10/27/10	10/27/10	10/27/10	10/27/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Solids Suspended	**200**	**42**	**17**	**12**	mg/L	10/29/10	11:30	2540D	JCC
Nitrate-N	< 0.5	< 0.5	< 0.5	< 0.5	mg/L	10/27/10	18:30	353.2	KL
Ammonia-N	**0.13**	**0.07**	**0.06**	**0.41**	mg/L	11/05/10	11:00	4500NH3D	SEL
Total Phosphorus-P	**0.15**	**0.29**	**0.23**	**0.15**	mg/L	10/28/10	15:49	365.1	SKC
Dissolved Oxygen	**8.8**	**7.5**	**8.3**	**8.3**	mg/L	10/27/10	13:55	4500O-G	SKC
Turbidity	**22**	**26**	**53**	**6**	NTU	10/28/10	14:35	180.1	NZ
E.coli	**> 1600**	**> 1600**	**> 1600**	**> 1600**	MPN/100ml	10/27/10	14:20	9221F	SFW
Fecal Coliform	**> 1600**	**> 1600**	**> 1600**	**> 1600**	MPN/100ml	10/27/10	14:20	9221E	SFW

Sample ID:	4-4	4-15	4-5					
Lab Sample ID:	94058.05	94058.06	94058.07					
Matrix:	aqueous	aqueous	aqueous					
Date Sampled:	10/27/10	10/27/10	10/27/10		Analysis			
Date Received:	10/27/10	10/27/10	10/27/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Solids Suspended	< 5	**52**	**16**	mg/L	10/29/10	11:30	2540D	JCC
Nitrate-N	**3.2**	< 0.5	< 0.5	mg/L	10/27/10	18:35	353.2	KL
Ammonia-N	**0.07**	**0.07**	**0.13**	mg/L	11/05/10	11:00	4500NH3D	SEL
Total Phosphorus-P	**0.03**	**0.58**	**0.29**	mg/L	10/28/10	17:01	365.1	SKC
Dissolved Oxygen	**5.3**	**7.3**	**8.7**	mg/L	10/27/10	14:08	4500O-G	SKC
Turbidity	**3**	**20**	**6**	NTU	10/28/10	14:35	180.1	NZ
E.coli	**170**	**> 1600**	**> 1600**	MPN/100ml	10/27/10	14:20	9221F	SFW
Fecal Coliform	**500**	**> 1600**	**> 1600**	MPN/100ml	10/27/10	14:20	9221E	SFW

Ammonia: Method 4500NH3D has been modified to incorporate automated technology.

Page 1 of 1

Chain-of-Custody Record

Fo 94058

Bold Fields Required. Please Circle Requested Analysis.

Stormwater Sample I.D.	Sampling Date/Time (*If Composite, Indicate Both Start & Finish Date/Time)	Matrix (see below)	Grab/*Composite	VOC: 524.2 / 524.2 BTEX / 524.2 MTBE only	VOC: 8260B 624 VTICs / 1,4 Dioxane EDB DBCP	VOC: 8021B BTEX HALOS	VOC: 8015B GRO MEGRO MAVPH	SVOC: 8270C 625 SVTICs / ABN A BN PAH	SVOC: TPH8100 L1 L2	SVOC: 8015B DRO MEDRO MAEPH	SVOC: PEST 608 PCB 608 / PEST 8081A PCB 8082	SVOC: Oil & Grease 1664 TPH 1664	TCLP: TCLP 1311 ABN Metals / VOC Pest Herb	Metals: Dissolved Metals (list below)	Metals: Total Metals (list below)	Inorganics: TS (TSS) TDS Spec. Con.	Inorganics: Br Cl F SO4 / NO2 (NO3) NO2/NO3	Inorganics: BOD CBOD T. Alk.	Inorganics: TKN (NH3) (T. Phos.)	Inorganics: pH T. Res. Chlorine	Inorganics: COD Phenols TOC	Inorganics: Total Cyanide Total Sulfide	Inorganics: Reactive Cyanide Reactive Sulfide / Flashpoint Ignitability	Micro: T. Coliform (F. Coliform) (E. Coli)	Micro: Enterococci / Heterotrophic Plate Count	Other: Turbidity	Other	Other	# of Containers	Notes MeOH Vial #
4-2	10/27/10 10:24 a	SW	X													X	X		XX					XX		X			7	
4-13	10/27/10 10:20 am	↓	X													X	X		XX					XX		X			7	
4-12	10/27/10 10:1[illegible] am	↓	X													X	X		XX					XX		X			7	
4-7	10/27/10 10:30 am	↓	X													X	X		XX					XX		X			7	
~~4-8~~																														
~~4-9~~																														
4-4	10/27/10 10:15 am	↓	X													X	X		XX					XX		X			7	
4-15	10/27/10 10:12 am	↓	X													X	X		XX					XX		X			7	
4-5	10/27/10 10:25 a	↓	X													X	X		XX					XX		X			7	

Matrix: A-Air; S-Soil; GW-Ground Water; SW-Surface Water; DW-Drinking Water; WW-Waste Water

Preservative: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH

Project Manager: Curt Busto

Company: CEI

Address: 21 Depot St.

City: Merrimack **State:** NH **Zip:** 03054

Phone: 603-424-8444 **Ext.:** 304

Fax:

E-Mail: cbusto@ceiengineers.com

Site Name: Lake Gardner

Project #: 175-7

State: NH MA ME VT Other:

Regulatory Program: **NPDES:** RGP POTW Stormwater or GWP, Oil Fund, Brownfield or Other:

Quote #: **PO #:**

Date Needed:

QA/QC Reporting Level
A B C
or
MA MCP Presumptive Certainty

Reporting Options
Prelims: Yes or No
If Yes: Fax or PDF

Electronic Options
No Fax E-Mail PDF Equis

Temp. 3 °C
Ice? (Yes) No

Sampler(s): Scott Salvucci

Relinquished By:	Date:	Time:	Received By:
Bruce Gagnon	10/27	11:57	[signature]
[signature]	10/27/10	1337	[signature]

Metals: 8 RCRA 13 PP Fe, Mn Pb, Cu

Other Metals:

Dissolved Metals Field Filtered? Yes No

Notes: (ie: Special Detection Limits, Billing Info, If Different)

Site History:

Suspected Contamination:

Field Readings:

eastern analytical, inc. *professional laboratory services* 25 Chenell Drive | Concord, NH 03301 | Tel: 603.228.0525 | 1.800.287.0525 | Fax: 603.228.4591 | E-Mail: customer_service@eailabs.com | www.eailabs.com

(White: Original Green: Project Manager)

Lake Gardner Field Data Sheet

Date (m/d/y): 10/27/10 Weather Today: Rain / Overcast Weather over past 72 hours: Dry

	Sample Name	Time of Sample AM	Observer Initials	Temperature (~~°C~~ °F)	pH	Total Dissolved Solids (TDS) (ppm)	Conductivity (µS/cm)	T.P.	Amm.	Nitr.	Fecal	E.coli	TSS	Trbdty	Comments (record duplicate samples, GPS coordinates, unusual site conditions, issues, or other observations)
				Field Samples (Record the appropriate value off of the multi-meter once values have stabilized)				Laboratory Samples (Place a check mark in each box once the sample has been collected)							
Stormwater Outfall Pipes (use multi-meter)	Stormwater 42	10:24	RC	64.6	8.31	0.19	0.39	✓	✓	✓	✓	✓	✓	✓	
	Stormwater 44	10:27	BG	64.2	6.41	0.03	0.07	✓	✓	✓	✓	✓	✓	✓	
	Stormwater 45	10:25	MB	67.2	8.57			✓	✓	✓	✓	✓	✓	✓	
	Stormwater 47	10:30	SS	63.5	8.42	0.06	0.12	✓	✓	✓	✓	✓	✓	✓	
	Stormwater 48	/	/												No Flow
	Stormwater 49	/	/												
	Stormwater 412	10:14	~~MB~~ AM	68.9	8.44	0.24	0.48	✓	✓	✓	✓	✓	✓	✓	
	Stormwater 413	10:20	~~MB~~ AM	67.9	7.68	0.13	0.29	✓	✓	✓	✓	✓	✓	✓	
	Stormwater 415	10:12	MB	67.7	8.43	0.06	0.12	✓	✓	✓	✓	✓	✓	✓	
In-lake (use multi-meter)	Deep Hole (Shallow)														
	Deep Hole (Deep)														
	Newton Road														
	Jewell Street														
	Lake Inlet														
	Lake Outlet														

Lake Outlet Flow at Dam	Flow Over Spillway?	Flow from Outlet Pipe>	Secchi Disk Reading at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Flow Present at Lake Gardner Dam (observation, yes or no)			Secchi Disk Reading (use Secchi Disk)			

Depth to Bottom at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)	Sediment Depth at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Depth to Bottom of Lake (use Secchi Disk)				Sediment Depth at Deep Hole (use pole and zip ties)			

Water Column at Deep Hole	Depth 1 (ft)	Temp. (°C)	DO (mg/L)	Depth 2 (ft)	Temp. (°C)	DO (mg/L)	Depth 3 (ft)	Temp. (°C)	DO (mg/L)	Depth 4 (ft)	Temp. (°C)	DO (mg/L)	Depth 5 (ft)	Temp. (°C)	DO (mg/L)	Comments
Depth, Temperature, and Dissolved Oxygen (use multi-meter)																

eastern analytical, inc.

professional laboratory services

Curt Busto
Comprehensive Environmental, Inc.
21 Depot Street
Merrimack, NH 03054

Subject: Laboratory Report

Eastern Analytical, Inc. ID:	94386
Client Identification:	Lake Gardner | Amesbury
Date Received:	11/4/2010

Dear Mr. Busto :

Enclosed please find the laboratory report for the above identified project. All analyses were performed in accordance with our QA/QC Program. Unless otherwise stated, holding times, preservation techniques, container types, and sample conditions adhered to EPA Protocol. Samples which were collected by Eastern Analytical, Inc. (EAI) were collected in accordance with approved EPA procedures. Eastern Analytical, Inc. certifies that the enclosed test results meet all requirements of NELAP and other applicable state certifications. Please refer to our website at www.eailabs.com for a copy of our NELAP certificate and accredited parameters.

The following standard abbreviations and conventions apply to all EAI reports:

- Solid samples are reported on a dry weight basis, unless otherwise noted
- < : "less than" followed by the reporting limit
- > : "greater than" followed by the reporting limit
- %R : % Recovery

Eastern Analytical Inc. maintains certification in the following states: Connecticut (PH-0492), Maine (NH005), Massachusetts (M-NH005), New Hampshire/NELAP (1012), Rhode Island (269) and Vermont (VT1012).

The following information is contained within this report: Sample Conditions summary, Analytical Results/Data, Quality Control data (if requested) and copies of the Chain of Custody. This report may not be reproduced except in full, without the the written approval of the laboratory.

If you have any questions regarding the results contained within, please feel free to directly contact me or the chemist(s) who performed the testing in question. Unless otherwise requested, we will dispose of the sample(s) 30 days from the sample receipt date.

We appreciate this opportunity to be of service and look forward to your continued patronage.

Sincerely,

Lorraine Olashaw (signature)	12.7.10	4
Lorraine Olashaw, Lab Director	Date	# of pages (excluding cover letter)

SAMPLE CONDITIONS PAGE

Eastern Analytical, Inc. ID#: 94386

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | Amesbury**

Temperature upon receipt (°C): 5.6 **Received on ice or cold packs (Yes/No): Y**

Lab ID	Sample ID	Date Received	Date Sampled	Sample Matrix	% Dry Weight	Exceptions/Comments (other than thermal preservation)
94386.01	Stormwater 4-2	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.02	Stormwater 4-4	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.03	Stormwater 4-5	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.04	Stormwater 4-7	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.05	Stormwater 4-9	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.06	Stormwater 4-12	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.07	Stormwater 4-13	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.08	Stormwater 4-15	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy
94386.09	Stormwater Field	11/4/10	11/4/10	aqueous		Adheres to Sample Acceptance Policy

Samples were properly preserved and the pH measured when applicable unless otherwise noted. Analysis of solids for pH, Flashpoint, Ignitibility, Paint Filter, Corrosivity, Conductivity and Specific Gravity are reported on an "as received" basis.

All results contained in this report relate only to the above listed samples.

References include:
1) EPA 600/4-79-020, 1983
2) Standard Methods for Examination of Water and Wastewater : Inorganics, 19th Edition, 1995; Microbiology, 20th Edition, 1998
3) Test Methods for Evaluating Solid Waste SW 846 3rd Edition including updates IVA and IVB
4) Hach Water Analysis Handbook, 2nd edition, 1992

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 94386

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | Amesbury**

Sample ID:	Stormwater 4-2	Stormwater 4-4	Stormwater 4-5	Stormwater 4-7					
Lab Sample ID:	94386.01	94386.02	94386.03	94386.04					
Matrix:	aqueous	aqueous	aqueous	aqueous					
Date Sampled:	11/4/10	11/4/10	11/4/10	11/4/10		**Analysis**			
Date Received:	11/4/10	11/4/10	11/4/10	11/4/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Solids Suspended	**37**	**14**	**12**	**17**	mg/L	11/05/10	9:15	2540D	KJR
Ammonia-N	**0.23**	**0.22**	**0.32**	**0.32**	mg/L	11/05/10	11:00	4500NH3D	SEL
Total Phosphorus-P	**0.37**	**0.41**	**0.36**	**0.12**	mg/L	11/12/10	14:46	365.1	SKC
Dissolved Oxygen	**10.0**	**8.3**	**9.4**	**8.1**	mg/L	11/04/10	15:40	4500O-G	SKC
Turbidity	**57**	**8**	**9**	**13**	NTU	11/04/10	16:35	180.1	NZ
E.coli	**> 1600**	**> 1600**	**> 1600**	**> 1600**	MPN/100ml	11/04/10	15:55	9221F	KL
Fecal Coliform	**> 1600**	**> 1600**	**> 1600**	**> 1600**	MPN/100ml	11/04/10	15:55	9221E	KL
Nitrate-N	**0.45**	**0.51**	**0.49**	**0.23**	mg/L	11/05/10	15:13	353.2	KL

Sample ID:	Stormwater 4-9	Stormwater 4-12	Stormwater 4-13	Stormwater 4-15					
Lab Sample ID:	94386.05	94386.06	94386.07	94386.08					
Matrix:	aqueous	aqueous	aqueous	aqueous					
Date Sampled:	11/4/10	11/4/10	11/4/10	11/4/10		**Analysis**			
Date Received:	11/4/10	11/4/10	11/4/10	11/4/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Solids Suspended	**11**	**21**	**17**	**18**	mg/L	11/05/10	9:15	2540D	KJR
Ammonia-N	**0.17**	**0.11**	**0.29**	**0.20**	mg/L	11/05/10	11:00	4500NH3D	SEL
Total Phosphorus-P	**0.07**	**0.44**	**0.35**	**0.75**	mg/L	11/12/10	14:51	365.1	SKC
Dissolved Oxygen	**10.1**	**8.9**	**10.6**	**10.5**	mg/L	11/04/10	16:10	4500O-G	SKC
Turbidity	**6**	**16**	**21**	**14**	NTU	11/04/10	16:35	180.1	NZ
E.coli	**> 1600**	**> 1600**	**> 1600**	**> 1600**	MPN/100ml	11/04/10	15:55	9221F	KL
Fecal Coliform	**> 1600**	**> 1600**	**> 1600**	**> 1600**	MPN/100ml	11/04/10	15:55	9221E	KL
Nitrate-N	**0.26**	**0.39**	**0.27**	**0.72**	mg/L	11/05/10	15:22	353.2	KL

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 94386

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner | Amesbury**

Sample ID: Stormwater Field

Lab Sample ID: 94386.09

Matrix: aqueous

Date Sampled: 11/4/10

Date Received: 11/4/10

		Units	Analysis Date	Analysis Time	Method	Analyst
Solids Suspended	**7**	mg/L	11/05/10	9:15	2540D	KJR
Ammonia-N	**0.16**	mg/L	11/05/10	11:00	4500NH3D	SEL
Total Phosphorus-P	**0.05**	mg/L	11/12/10	14:57	365.1	SKC
Dissolved Oxygen	**7.9**	mg/L	11/04/10	16:20	4500O-G	SKC
Turbidity	**7**	NTU	11/04/10	16:35	180.1	NZ
E.coli	**4**	MPN/100ml	11/04/10	15:55	9221F	KL
Fecal Coliform	**4**	MPN/100ml	11/04/10	15:55	9221E	KL
Nitrate-N	**0.35**	mg/L	11/05/10	15:30	353.2	KL

Page ______ of ______

Chain-of-Custody Record

94386

Bold Fields Required. Please Circle Requested Analysis.

Sample I.D. (Lake Gardner)	Sampling Date/Time (*If Composite, Indicate Both Start & Finish Date/Time) 11-4-10	Matrix (see below)	Grab/*Composite	VOC: 524.2 / 524.2 BTEX / 524.2 MTBE only	VOC: 8260B 624 VTICS / 1,4 Dioxane EDB DBCP	VOC: 8021B BTEX Halos	VOC: 8015B GRO MEGRO MAVPH	SVOC: 8270C 625 SVTICS / ABN A BN PAH	SVOC: TPH8100 LI L2	SVOC: 8015B DRO MEDRO MAEPH	SVOC: PEST 608 PCB 608 / PEST 8081A PCB 8082	SVOC: Oil & Grease 1664 TPH 1664	TCLP: TCLP 1311 ABN Metals / VOC Pest Herb	Metals: Dissolved Metals (list below)	Metals: Total Metals (list below)	Inorganics: TS (TSS) TDS Spec. Con.	Inorganics: Br Cl F SO_4 / NO_2 (NO_3) NO_2/NO_3	Inorganics: BOD CBOD T. Alk.	Inorganics: TKN (NH_3) (T. Phos.)	Inorganics: pH T. Res. Chlorine	Inorganics: COD Phenols TOC	Inorganics: Total Cyanide Total Sulfide	Inorganics: Reactive Cyanide Reactive Sulfide / Flashpoint Ignitability	Micro: T. Coliform (E. Coli)	Micro: Enterococci / Heterotrophic Plate Count	Other: Turb	Other: D.O.	Other	# of Containers	Notes MeOH Vial #
Stormwater 4-2	1135	W	G													X	X		X					X		X	X			
4-4	1145																													
4-5	1145																													
4-7	1145																													
~~4-8~~	DRY																													
4-9	1300																													
4-12	1135																													
4-13	1225																													
4-15	11:12 AM																													
FIELD	1230																													

Matrix: A-Air; S-Soil; GW-Ground Water; SW-Surface Water; DW-Drinking Water; WW-Waste Water

Preservative: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH

Project Manager: Curt Busto

Company: CEI

Address:

City: State: Zip:

Phone: Ext.:

Fax:

E-Mail:

Site Name: LAKE GARDNER

Project #: AMESBURY

State: NH (MA) ME VT Other:

Regulatory Program: **NPDES:** RGP POTW Stormwater or GWP, Oil Fund, Brownfield or Other:

Quote #: PO #:

Date Needed:

QA/QC Reporting Level A B C or MA MCP Presumptive Certainty

Reporting Options Prelims: Yes or No — If Yes: Fax or PDF

Electronic Options No Fax E-Mail PDF Equis

Temp. 5.6 °C — Ice? (Yes) No

Sampler(s): BG, BS, PM, DPW, WD

Relinquished By:	Date:	Time:	Received By:
[signature]	11/4/10	1:45	[signature]
[signature]	11/4/10	15:13	[signature]

Metals: 8 RCRA 13 PP Fe, Mn Pb, Cu

Other Metals:

Dissolved Metals Field Filtered? Yes No

Notes: (ie: Special Detection Limits, Billing Info, If Different)

Site History:

Suspected Contamination:

Field Readings:

Lake Gardner Field Data Sheet

Date (m/d/y): Nov 4, 2010 | Weather Today: 44° rain | Weather over past 72 hours: dry low 40s

	Sample Name	Time of Sample	Observer Initials	Field Samples (Record the appropriate value off of the multi-meter once values have stabilized) Temperature (°F)	pH	Total Dissolved Solids (TDS) (ppm)	Conductivity (µS/cm)	Laboratory Samples (Place a check mark in each box once the sample has been collected) T.P.	Amm.	Nitr.	Fecal	E.coli	TSS	Trbdty	Comments (record duplicate samples, GPS coordinates, unusual site conditions, issues, or other observations)
Stormwater Outfall Pipes (use multi-meter)	Stormwater 4-2	11:35	DPW	53.4	5.56	136	276								
	Stormwater ~~4-4~~ [illegible]	1:00p	PM	58.1	5.89	40	80								
✓	Stormwater 4-5	11:45	BG	63.8	6.23	68	138								
✓	Stormwater 4-7	11:45	PM	56.4	5.37	39	77								
	Stormwater 4-8														
	Stormwater ~~4-10~~ [illegible]	11:45	BG	57.4	5.40	64	129								
	Stormwater 4-12	11:35	DPW	58.8	5.78	117	235								
✓	Stormwater 4-13	12:25p	[illegible]	58.6	5.48	46	94								
✓	Stormwater 4-15	11:12	BG	62.2°F	5.87	112	222								
In-lake (use multi-meter)	Deep Hole (Shallow)														
	Deep Hole (Deep)														
	Newton Road														
	Jewell Street														
	Lake Inlet														
	Lake Outlet														
✓	FIELD	12:30	BG	59.2	5.24	201	401								

Lake Outlet Flow at Dam	Flow Over Spillway?	Flow from Outlet Pipe?	Secchi Disk Reading at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Flow Present at Lake Gardner Dam (observation, yes or no)			Secchi Disk Reading (use Secchi Disk)			

Depth to Bottom at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)	Sediment Depth at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Depth to Bottom of Lake (use Secchi Disk)				Sediment Depth at Deep Hole (use pole and zip ties)			

Water Column at Deep Hole	Depth 1 (ft)	Temp. (°C)	DO (mg/L)	Depth 2 (ft)	Temp. (°C)	DO (mg/L)	Depth 3 (ft)	Temp. (°C)	DO (mg/L)	Depth 4 (ft)	Temp. (°C)	DO (mg/L)	Depth 5 (ft)	Temp. (°C)	DO (mg/L)	Comments
Depth, Temperature, and Dissolved Oxygen (use multi-meter)																

Curt Busto
Comprehensive Environmental, Inc.
21 Depot Street
Merrimack , NH 03054

Subject: Laboratory Report

Eastern Analytical, Inc. ID: 94721
Client Identification: Lake Gardner - Dry Sampling Event
Date Received: 11/12/2010

Dear Mr. Busto :

Enclosed please find the laboratory report for the above identified project. All analyses were performed in accordance with our QA/QC Program. Unless otherwise stated, holding times, preservation techniques, container types, and sample conditions adhered to EPA Protocol. Samples which were collected by Eastern Analytical, Inc. (EAI) were collected in accordance with approved EPA procedures. Eastern Analytical, Inc. certifies that the enclosed test results meet all requirements of NELAP and other applicable state certifications. Please refer to our website at www.eailabs.com for a copy of our NELAP certificate and accredited parameters.

The following standard abbreviations and conventions apply to all EAI reports:

- Solid samples are reported on a dry weight basis, unless otherwise noted
- < : "less than" followed by the reporting limit
- > : "greater than" followed by the reporting limit
- %R : % Recovery

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If you have any questions regarding the results contained within, please feel free to directly contact me or the chemist(s) who performed the testing in question. Unless otherwise requested, we will dispose of the sample(s) 30 days from the sample receipt date.

We appreciate this opportunity to be of service and look forward to your continued patronage.

Sincerely,

Lorraine Olashaw (signature)	12.3.10	5
Lorraine Olashaw, Lab Director	Date	# of pages (excluding cover letter)

SAMPLE CONDITIONS PAGE

Eastern Analytical, Inc. ID#: 94721

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner - Dry Sampling Event**

Temperature upon receipt (°C): 5.6 **Received on ice or cold packs (Yes/No): Y**

Lab ID	Sample ID	Date Received	Date Sampled	Sample Matrix	% Dry Weight	Exceptions/Comments (other than thermal preservation)
94721.01	Newton Rd	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.02	Jewell St	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.03	Lake Outlet	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.04	Lake Inlet 1	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.05	Lake Inlet 2	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.06	Deephole Shallow	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.07	Deephole Deep	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.08	Glenn Dean	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy
94721.09	4-15	11/12/10	11/12/10	aqueous		Adheres to Sample Acceptance Policy

Samples were properly preserved and the pH measured when applicable unless otherwise noted. Analysis of solids for pH, Flashpoint, Ignitibility, Paint Filter, Corrosivity, Conductivity and Specific Gravity are reported on an "as received" basis.

All results contained in this report relate only to the above listed samples.

References include:
1) EPA 600/4-79-020, 1983
2) Standard Methods for Examination of Water and Wastewater : Inorganics, 19th Edition, 1995; Microbiology, 20th Edition, 1998
3) Test Methods for Evaluating Solid Waste SW 846 3rd Edition including updates IVA and IVB
4) Hach Water Analysis Handbook, 2nd edition, 1992

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 94721

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner - Dry Sampling Event**

Sample ID:	Newton Rd	Jewell St	Lake Outlet	Lake Inlet 1					
Lab Sample ID:	94721.01	94721.02	94721.03	94721.04					
Matrix:	aqueous	aqueous	aqueous	aqueous					
Date Sampled:	11/12/10	11/12/10	11/12/10	11/12/10		**Analysis**			
Date Received:	11/12/10	11/12/10	11/12/10	11/12/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Nitrate-N	**0.06**	< 0.05	**0.08**	**0.07**	mg/L	11/12/10	18:06	353.2	KL
Ammonia-N	< 0.05	**0.05**	< 0.05	**0.05**	mg/L	11/17/10	9:50	4500NH3D	SEL
Total Phosphorus-P	**0.02**	**0.02**	**0.02**	**0.01**	mg/L	11/16/10	15:57	365.1	SKC
Dissolved Oxygen	**10.6**	**10.6**	**11.6**	**10.2**	mg/L	11/12/10	16:15	4500O-G	SKC
Turbidity	**2**	**2**	**2**	**1**	NTU	11/12/10	17:20	180.1	NZ
E.coli	**30**	**30**	**50**	**50**	MPN/100ml	11/12/10	16:30	9221F	KL
Fecal Coliform	**30**	**30**	**80**	**50**	MPN/100ml	11/12/10	16:30	9221E	KL
Solids Suspended	**1 E**	**4 E**	**1 E**	**2 E**	mg/L	11/15/10	8:45	2540D	KJR

Sample ID:	Lake Inlet 2	Deephole Shallow	Deephole Deep	Glenn Dean					
Lab Sample ID:	94721.05	94721.06	94721.07	94721.08					
Matrix:	aqueous	aqueous	aqueous	aqueous					
Date Sampled:	11/12/10	11/12/10	11/12/10	11/12/10		**Analysis**			
Date Received:	11/12/10	11/12/10	11/12/10	11/12/10	**Units**	**Date**	**Time**	**Method**	**Analyst**
Nitrate-N	**0.06**	**0.07**	< 0.05	**2.4**	mg/L	11/12/10	18:14	353.2	KL
Ammonia-N	**0.07**	< 0.05	**0.07**	< 0.05	mg/L	11/17/10	9:50	4500NH3D	SEL
Total Phosphorus-P	**0.01**	**0.02**	**0.02**	**0.01**	mg/L	11/16/10	16:09	365.1	SKC
Dissolved Oxygen	**10.2**	**10.9**	**10.8**	**11.0**	mg/L	11/12/10	16:22	4500O-G	SKC
Turbidity	**1**	**2**	**6**	< 1	NTU	11/12/10	17:20	180.1	NZ
E.coli	**23**	**50**	**23**	**13**	MPN/100ml	11/12/10	16:30	9221F	KL
Fecal Coliform	**23**	**50**	**23**	**21**	MPN/100ml	11/12/10	16:30	9221E	KL
Solids Suspended	**1 E**	**2 E**	**29**	< 1	mg/L	11/15/10	8:45	2540D	KJR

Ammonia: Method 4500NH3D has been modified to incorporate automated technology.
Solids Suspended E: Due to the sample matrix, the sample volume required to meet the 1 mg/L requested reporting limit would not pass through the filter. These are estimated values.

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 94721

Client: **Comprehensive Environmental, Inc.** Client Designation: **Lake Gardner - Dry Sampling Event**

Sample ID: 4-15

Lab Sample ID: 94721.09

Matrix: aqueous

Date Sampled: 11/12/10

Date Received: 11/12/10

		Units	Analysis Date	Time	Method	Analyst
Nitrate-N	**2.7**	mg/L	11/12/10	18:19	353.2	KL
Ammonia-N	**0.07**	mg/L	11/17/10	9:50	4500NH3D	SEL
Total Phosphorus-P	**0.02**	mg/L	11/16/10	16:14	365.1	SKC
Dissolved Oxygen	**11.0**	mg/L	11/12/10	16:30	4500O-G	SKC
Turbidity	< 1	NTU	11/12/10	17:20	180.1	NZ
E.coli	**27**	MPN/100ml	11/12/10	16:30	9221F	KL
Fecal Coliform	**34**	MPN/100ml	11/12/10	16:30	9221E	KL
Solids Suspended	< 1	mg/L	11/15/10	8:45	2540D	KJF

Ammonia: Method 4500NH3D has been modified to incorporate automated technology.

QC REPORT

Eastern Analytical, Inc. ID#: 94721

Client: **Comprehensive Environmental,** Client Designation: **Lake Gardner - Dry Sampling Event**

Parameter Name	Blank	LCS	LCSD	Units	Date of Analysis	Limits	RPD	Method
Solids Suspended	< 1	97 (97 %R)	100 (102 %R) (5 RPD)	mg/L	11/15/10	90 - 110	20	2540D
Nitrate-N	< 0.05	5.1 (102 %R)	5.1 (103 %R) (1 RPD)	mg/L	11/12/10	90 - 110	20	353.2
Ammonia-N	< 0.05	2.0 (100 %R)	1.9 (96 %R) (4 RPD)	mg/L	11/17/10	90 - 110	20	4500NH3D
Total Phosphorus-P	< 0.002	0.31 (102 %R)	0.31 (103 %R) (1 RPD)	mg/L	11/16/10	90 - 110	20	365.1
Turbidity	< 1	< 1 (99 %R)	< 1 (99 %R) (0 RPD)	NTU	11/12/10	85 - 110	20	180.1

Samples were analyzed within holding times unless noted on the sample results page.
Instrumentation was calibrated in accordance with the method requirements.
The method blanks were free of contamination at the reporting limits.
The associated matrix spikes and/or Laboratory Control Samples met the above stated criteria.
Exceptions to the above statements are flagged or noted above or on the QC Narrative page.
* Flagged analyte recoveries deviated from the QA/QC limits.

Chain-of-Custody Record

Page ______ of ______

For ___

94721

Bold Fields Required. Please Circle Requested Analysis.

Sample I.D.	11/12/10 Sampling Date/Time *If Composite, Indicate Both Start & Finish Date/Time	Matrix (see below)	Grab/*Composite	VOC: 524.2 / 524.2 BTEX / 524.2 MTBE only	VOC: 8260B 624 VTICs	VOC: 1,4 Dioxane EDB DBCP	VOC: 8021B BTEX HALOS	VOC: 8015B GRO MEGRO MAVPH	SVOC: 8270C 625 SVTICs ABN A BN PAH	SVOC: TPH8100 L1 L2	SVOC: 8015B DRO MEDRO MAEPH	SVOC: PEST 608 PCB 608 PEST 8081A PCB 8082	SVOC: Oil & Grease 1664 TPH 1664	TCLP: TCLP 1311 ABN Metals VOC Pest Herb	Metals: Dissolved Metals (list below)	Metals: Total Metals (list below)	Inorganics: TS (TSS) TDS Spec. Con.	Inorganics: Br F SO_4 NO_2 (NO_3) NO_3/NO_2	Inorganics: BOD CBOD T. Alk.	Inorganics: TKN NH_3 (T. Phos.)	Inorganics: pH T. Res. Chlorine	Inorganics: COD Phenols TOC	Inorganics: Total Cyanide Total Sulfide	Inorganics: Reactive Cyanide Reactive Sulfide Flashpoint Ignitability	Micro: T. Coliform (E. Coli)	Micro: Enterococci Heterotrophic Plate Count	Other: Turb	Other: DO	Other	# of Containers	Notes MeOH Vial #
Newton Rd	1:23																X	X		X					X		X	X			
Jewell St	1:33																														
Lake Outlet	2:03																														
Lake Inlet 1	1:17																														
Lake Inlet 2	1:21																														
Deep hole shallow	1:36																														
Deep hole Deep	1:44																														
Glenn Dean	1:53																														
4-15	1:43																														

Matrix: A-Air; S-Soil; GW-Ground Water; SW-Surface Water; DW-Drinking Water; WW-Waste water

Preservative: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH

Project Manager: Curt Busto

Company:

Address:

City: State: Zip:

Phone: Ext.:

Fax:

E-Mail:

Site Name: Lake Gardner - Dry Sampling Event

Project #:

State: NH MA ME VT Other:

Regulatory Program: **NPDES:** RGP POTW Stormwater or GWP, Oil Fund, Brownfield or Other:

Quote #: PO #:

Date Needed:

QA/QC Reporting Level
A B C
or
MA MCP Presumptive Certainty

Reporting Options
Prelims: Yes or No
If Yes: Fax or PDF

Electronic Options
No Fax E-Mail PDF Equis

Temp. 5.6 °C
Ice? (Yes) No

Sampler(s): Bruce Georgian

Relinquished By:	Date:	Time:	Received By:
[signature]	11/12/10	2:37	[signature]
[signature]	11/12/10	1545	[signature]

Metals: 8 RCRA 13 PP Fe, Mn Pb, Cu

Other Metals:

Dissolved Metals Field Filtered? Yes No

Notes: (ie: Special Detection Limits, Billing Info, If Different)

Site History:

Suspected Contamination:

Field Readings:

Lake Gardner Field Data Sheet

Date (m/d/y): 11/12/10

Weather Today: Sunny 50s foggy

Weather over past 72 hours: Dry 50° Daytime 30s evening

	Sample Name	Time of Sample	Observer Initials	Temperature (°C)	pH	Total Dissolved Solids (TDS) (ppm)	Conductivity (µS/cm)	T.P.	Amm.	Nitr.	Fecal	E.coli	TSS	Trbdty	Comments (record duplicate samples, GPS coordinates, unusual site conditions, issues, or other observations)
Stormwater Outfall Pipes (use multi-meter)	Stormwater 4-2														
	Stormwater 4-4														
	Stormwater 4-5														
	Stormwater 4-7														
	Stormwater 4-8														
	Stormwater 4-15	1:43	BG	58.0	7.35	178	352								
	Stormwater 4-12														
	Clews Beach	1:53	BG	56.0	7.36	229	457								
	Lake Inlet 2	1:21	MB	49.0	6.82	72	145								
In-lake (use multi-meter)	Deep Hole (Shallow)	1:36	MB	49.0	6.97	72	146								
	Deep Hole (Deep)	1:44	MB	49.0	7.12	72	143								
	Newton Road	1:23	BG	43.5	7.68	71	143								
	Jewell Street	1:33	BG	44.0	7.33	69	141								
	Lake Inlet #1	1:17	MB	49.0	7.15	70	140								
	Lake Outlet	2:03	BG	50.0	7.43	79	150								

Lake Outlet Flow at Dam	Flow Over Spillway?	Flow from Outlet Pipe>
Flow Present at Lake Gardner Dam (observation, yes or no)		

Secchi Disk Reading at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Secchi Disk Reading (use Secchi Disk)			

Depth to Bottom at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Depth to Bottom of Lake (use Secchi Disk)	8.4 Ft		

Sediment Depth at Deep Hole	Reading 1 (ft)	Reading 2 (ft)	Average (ft)
Sediment Depth at Deep Hole (use pole and zip ties)	6.8 Ft		

Water Column at Deep Hole	Depth 1 (ft)	Temp. (°C)	DO (mg/L)	Depth 2 (ft)	Temp. (°C)	DO (mg/L)	Depth 3 (ft)	Temp. (°C)	DO (mg/L)	Depth 4 (ft)	Temp. (°C)	DO (mg/L)	Depth 5 (ft)	Temp. (°C)	DO (mg/L)	Comments
Depth, Temperature, and Dissolved Oxygen (use multi-meter)																